Policy, Actions and Results:

Can Meaningful Nutrient Reductions be Achieved within the Minnesota and North Dakota Portions of the Red River Drainage Basin?

By

Mark Dettman

A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resource Management

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ABSTRACT

Numerous treaties and management strategies have been created in an attempt to either prevent or repair water-related problems and/or disputes involving the worlds 263 trans-boundary freshwater regimes. Canada and the U.S. are no different. However, modern times have not only revealed potentially new causes for trans-boundary water-related disputes, but weaknesses within the tools commonly used to address such disputes.

Research was conducted using key groups and government departments within both Minnesota and North Dakota in an attempt to identify whether or not the economic, legal and social landscapes of the two states were favourable to reduce the nutrient loading to their portion of the Red River Drainage Basin which inevitably flows in Manitoba and enters Lake Winnipeg. The research revealed that; i) the difficulty of addressing NPS pollution, ii) a lack of cooperation from private landowners, iii) anti-government intervention, iv) a lack of funding for NPS related programs, v) uncertainties with the science, vi) negative economic impacts of implementing solutions, vii) interference by special interest groups and viii) legislative weaknesses of the *Clean Water Act* all create barriers that make achieving meaningful nutrient reductions unlikely.

Due to these barriers, Minnesota's and North Dakota's hydro-hegemonic influence on nutrient levels within the Red River may aid in dictating potentially disastrous ecological conditions to Lake Winnipeg and place its long-term health in question.

ACKNOWLEDGEMENTS

I would like to express thanks to my advisors, Professor Thomas Henley and Dr. John Sinclair for their patience regarding my stubbornness to find a water resources topic of interest and then helping me mould the idea into a feasible project. I would also like to extend my appreciation to committee members Dr. Gordon Goldsborough and Mr. Norm Brandson for the expertise and insight they brought to the project. A special thanks to the administrative staff at the Natural Resources Institute for their help during my years of part-time study.

I would like to thank the numerous individuals from local academic, federal and provincial organizations involved in water research and management for being so accommodating with my initial cold calls as I searched for topics of study and again later on in my search to acquire data and other information. In particular, Karen Scott, Iris Griffon, Kristina Farmer and Nicole Armstrong deserve special thanks. I would also like to thank those individuals south of the border in Minnesota and North Dakota who were gracious and patient enough to take time out of their own schedules to help with this study. In particular, along with those from the federal and state departments who participated in the study, Lance Yohe, Dan Wilkens, Leanne Buck, Ray Bohn, Danny Omdahl, Dick Faught, Gary Thompson and Josh Ihry deserve special thanks.

I would like to thank my partner Jennifer, and especially my daughter Jordan and son Matthew for their patience during the completion of my course work and thesis. Lastly and most importantly, I would like to thank my mom and dad who, from the beginning of my most informative years at school through to completion of my undergraduate degree, always managed to meet the delicate balance between promoting the “education is important” ideology while supporting my decision to follow whatever path I was interested in following and at whatever speed.

Mom and Dad- Thank you very much.

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ACRONYMS

AFO	Animal Feeding Operation
BMP	Best Management Practice
BWT	Boundary Waters Treaty Act or Boundary Waters Act
CD	Conservation District
CWA	Clean Water Act
IJC	International Joint Commission
IRRB	International Red River Board
IWI	International Watersheds Initiative
IWI	International Water Institute

IWRM	Integrated Water Resources Management
LW	Lake Winnipeg
LWSB	Lake Winnipeg Stewardship Board
MBWSR	Minnesota Board of Water and Soil Resources
MDA	Minnesota Department of Agriculture
MDNR	Minnesota Department of Natural Resources
MEQB	Minnesota Environmental Quality Board
MPCA	Minnesota Pollution Control Agency
MSWCD	Minnesota Soil and Water Conservation Districts
MWD	Minnesota Watershed Districts
NDDA	North Dakota State Department of Agriculture
NDDH	North Dakota State Department of Health
NDWC	North Dakota State Water Commission
NDSCD	North Dakota Soil Conservation Districts
NDWRD	North Dakota Water Resource Districts
NPS	Non Point Source
PS	Point Source
RR	Red River
RRBC	Red River Basin Committee
RRDB	Red River Drainage Basin
RRJWRD	Red River Joint Water Resource District
RRWRC	Red River Water Resources Council
RRWMB	Red River Watershed Management Board
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

GLOSSARY OF TERMINOLOGY

Algae- aquatic organisms that survive through photosynthesis; they can range in size from microscopic organisms to large seaweed and giant kelp (IJC, 2014).

Algal Blooms- an excessive and relatively rapid growth of algae on or near the surface of water. It can occur naturally as the result of a change in water temperature and current or as a result of an excess of nutrients in the water (IJC, 2014).

Animal Feeding Operations- are agricultural enterprises where animals are kept and raised in confined situations (United States Environmental Protection Agency).

Basin- all land and water within the confines of a drainage basin (IJC, 2014).

Best Management Practices (BMP)- a term used to describe a range of practical methods, techniques and other actions that allow individuals or organizations to prevent or reduce the risks of water pollution resulting from their activities. Best practices typically evolve over time, as new approaches are introduced, proven to be effective and adopted. Also known as beneficial management practices (IJC, 2014).

Boundary Waters Treaty of 1909 – The agreement between the United States and Canada that established principles and mechanisms for the resolution of disputes related to boundary waters shared by the two countries. The International Joint Commission was created as a result of this treaty (IJC, 2014).

Command and Control- regulations that focus on preventing environmental problems by specifying how a company will manage a pollution-generating process (Stuart, 2013).

Conservation District- is a general term used to describe organizations in both Canada and the U.S. that work with landowners and businesses to carry out natural resource management programs at the local level. Funding for programs mostly comes from various levels and sources of government (Dettman, 2014).

Drainage Basin- See watershed.

Environmental Governance- is the term used to describe how we as humans exercise our authority over natural resources and natural systems. It is about questions concerning how we make environmental decisions and who makes them (Ortolano, 2010).

Eutrophic- describing a body of water with an abundant supply of nutrients and a high rate of formation of organic matter by photosynthesis (A Dictionary of Biology, 2004).

Eutrophic Lakes: contain [great] concentrations of phosphorus, resulting in greater concentrations of chlorophyll-a. These lakes tend to experience high densities of large aquatic plants (macrophytes) and algae, and support productive fisheries. Surface accumulations or 'blooms' of algae may occur during the warmest months, which can significantly reduce water transparency to the point of discouraging recreational activities such as swimming or waterskiing. Oxygen depletion in deep waters may occur throughout the year as a result of excessive microbial decomposition of macrophytes and algae (Government of Alberta).

Eutrophication- The process by which a body of water becomes rich in dissolved nutrients, such as phosphorus, thereby encouraging the growth and decomposition of oxygen-depleting plant life and resulting in harm to other organisms; also known as nutrient enrichment (IJC, 2014).

Harmful Algal Bloom (HAB)- harmful algal blooms (HABs) result from the proliferation of blue-green algae (including cyanobacteria) in environmentally stressed systems, where conditions favor opportunistic growth of one or more noxious species, which displace more benign ones. The blooms are considered harmful because excessive growth can harm ecosystems and produce poisons (or toxins) that can cause illness in humans, domestic pets and wildlife (IJC, 2014).

Hegemony- The predominant influence, as of a state, region, or group, over another or others (The Free Dictionary.com).

Hot Spot- locations within a lake's watershed that contribute a disproportionate share of the total amount of DRP entering the lake (IJC, 2014).

Hydro-hegemony- is hegemony at the river basin level, achieved through water resource control strategies such as resource capture, integration and containment. The strategies are executed through an array of tactics that are enabled by the exploitation of existing power asymmetries within a weak international institutional context (Zeitoun and Warner, 2006).

Hypoxia- a condition where excessive nutrients contribute to algal growth and subsequently high oxygen consumption during decomposition of the algae. This process creates "dead zones", typically near the lake bottom, where dissolved oxygen levels are so low that fish and other aquatic life cannot survive (IJC, 2014).

Integrated Water Resources Management (IWRM)- is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment (Global Water Partnership).

International Joint Commission- International independent agency formed in 1909 by the United States and Canada under the Boundary Waters Treaty to prevent and resolve boundary waters disputes between the two countries. The IJC makes decisions on applications for projects such as dams in boundary waters, issues Orders of Approval and regulates the operations of many of those projects. It also has a permanent reference under the Great Lakes Water Quality Agreement to help the two national governments restore and maintain the chemical, physical, and biological integrity of those waters (IJC, 2014).

Loading- entry of a pollutant, such as phosphorus, into a water body (IJC, 2014).

Mesotrophic Lakes: contain moderate levels of phosphorus, which acts to support greater biological production. Water clarity in mesotrophic lakes is moderate; there is an increased probability of oxygen depletion in the deepest areas (Government of Alberta).

Pollution- sources of pollutants associated with many diffuse locations and origins, typically transported by rainfall and snowmelt runoff over land; for example, excess fertilizers, herbicides and insecticides from agricultural lands and residential areas (IJC, 2014).

Nutrient- a food, or any nourishing substance assimilated by an organism, and required for growth, repair, and normal metabolism. For example, phosphorus and nitrogen are nutrients for algae (IJC, 2014).

Oligotrophic Lakes: contain low levels of phosphorus, which acts to limit biological production, meaning a lower algal biomass. These lakes tend to have clear water and sufficient oxygen throughout the year to support fish and other aquatic organisms (Government of Alberta).

Phosphorus- an element used in a wide range of agricultural, industrial and domestic products; the key nutrient limiting the amount of phytoplankton and attached algae [in most lakes] (IJC, 2014).

Point Sources (PS) *Pollution*- sources of pollutants, such as phosphorus, associated with a specific location; for example, an industrial or sewage treatment plant (IJC, 2014).

Polycentric [Management Systems]- connotes many centers of decision making that are formally independent of each other (Ostrom, 2010).

Producer- a farmer of crops and/or livestock (Dettman, 2014).

Red River Drainage Basin (RRDB)- encompassing parts of two provinces and three states, is one of five major drainage basins making up the Lake Winnipeg watershed (Dettman, 2014).

Red River Joint Water Resource District (RRJWRD)- a joint watershed management board comprised of the fourteen individual Water Resource Districts located on the North Dakota side of the RRDB (Red River Joint Water Resource District).

Red River Watershed Management Board (RRWMB)- a joint watershed management board comprised of the eight Watershed Districts on the Minnesota side of the RRDB (Dettman, 2014).

Riparian- pertaining to, or situated or dwelling on the bank of a river or other body of water (Dictionary.com).

Riparian Position- references the location of an individual property owner, state, province or nation and its position on a river relative to another (i.e. upstream vs. downstream) (Dettman, 2014).

Soil Conservation Districts- a type of conservation district located in North Dakota whose mandate is to work with landowners to help them manage and protect land and water resources (Dettman, 2014).

Soil and Water Conservation Districts- a type of conservation district located in Minnesota whose mandate is to work with landowners to help them manage and protect land and water resources (Dettman, 2014).

Watershed Districts- a state sponsored entity in Minnesota whose mandate is to help land owners manage water (Dettman, 2014).

Water Resource Districts- a state sponsored entity in North Dakota whose mandate is to help land owners manage water (Dettman, 2014).

Water Quality- a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose (United States Geological Survey).

Watershed- the land area that drains water to a particular stream, river, or lake (United States Geological Survey).

One of the most significant aspects of this year's hearings on the pending legislation was the information presented on the degree to which non-point sources contribute to water pollution. Agricultural runoff, animal wastes, soil erosion, fertilizers, pesticides and other farm chemicals that are part of runoff …..…are major contributors to the Nation's water pollution problem. Little has been done to control this major source of pollution …..… It has become clearly established that the waters of the Nation cannot be restored and their quality maintained unless the very complex and difficult problem of non-point sources is addressed.

1972 U.S. Senate Report on the Clean Water Act

Although agriculture is one of the most significant and pernicious causes of water pollution in the U.S., federal environmental laws designed to protect water resources exclude or exempt most agricultural activities. State efforts to address water quality impacts from agriculture have met with little success. The challenge of finding a way to reduce agricultural water pollution without causing severe economic harm to farmers is one of the greatest environmental challenges of our time.

Mary Jane Angelo, Professor of Law
Director, Environmental and Land Use Law Program
University of Florida Levin College of Law, 2013

CHAPTER 1: INTRODUCTION

1.1 Preamble

Approximately 145 countries have rights to the world's 263 trans-boundary freshwater regimes (Giordano and Wolf, 2003). For these, numerous treaties and management strategies have been created in an attempt to either prevent or repair water-related problems and/or disputes of all scales. While records indicate there has been more cooperation than conflict over the past 50 years regarding trans-boundary water resources (Giordano and Wolf, 2003), increased water requirements for increasing populations, uncertainty related to global climate change, and the acknowledged importance of preserving freshwater ecosystems, could all be potential causes of future water-related disputes between trans-boundary nations. However, although many such risks are mutual, according to Bernauer (2002, page 6) "uni-directional externalities are at the heart of many international river management problems".

While Canada and the United States share the longest un-defended border on Earth, the many trans-boundary waters shared have at times been the source of dispute between the two countries. To help mediate disputes related to trans-boundary waters, the two countries cooperated to create the *Boundary Water Treaty* (BWT) and the International Joint Commission (IJC). However, modern times have not only revealed potentially new causes for trans-boundary water related disputes, but potential weaknesses in Canadian and American water law. Further, the polycentric management systems currently used to facilitate the management of water resources, while commonly idealized, also have inherent weaknesses.

Caught between these legal and process related weaknesses is Lake Winnipeg (LW), the

tenth largest body of freshwater in the world. For greater than twenty years, LW has been showing signs of increasing anthropogenic eutrophication (Wassenaar and Rao, 2012). Complicating the issue is the fact that LW is in the situation of being wholly located within one politically sovereign jurisdiction while being impacted by nutrients originating in several different political jurisdictions, a significant portion of which originate within the portion of the Red River Drainage Basin (RRDB) located in Minnesota and North Dakota.

In response to their influence, both a watershed and integrated management approach has been initiated by groups in Minnesota and North Dakota to try and address water issues within the RRDB. However, given the difficulties to achieving nutrient reductions as well as the asymmetrical pay-off of success from a U.S. perspective, it is uncertain whether reductions can be realistically achieved. To date, evidence suggests that little success in reducing nutrients within the Red River has been achieved. As such, after consideration of the state of Lake Winnipeg today, the environmental governance meant to address the problem has to date been unsuccessful.

1.2 Background

1.2.1 A Case for Lake Winnipeg

While a requirement of all life, water is arguably also the most important of natural resources as it is a non-substitutable component for agriculture, industry, commerce, transportation and energy (Feldman, 2007). Canada's surface water resources are considerable. While estimates vary, Canada contains 20 percent of the world's freshwater and between 5-9 percent of the world's renewable freshwater supply (Water Survey of Canada). However,

significant portions of Canada's water resources are either found in remote areas or originate and/or flow through the much more densely populated United States, which exposes them to a larger variety of pressures.

Located in central North America, 100 km north of the City of Winnipeg, Lake Winnipeg covers an area of 24,500 km^2 and is the tenth largest body of freshwater in the world (LWSB, 2006). Lake Winnipeg has a watershed that covers approximately 953,000 km^2 (LWSB, 2006) and includes parts of four provinces (Manitoba, Saskatchewan, Alberta, Ontario) and three states (Minnesota, North Dakota and South Dakota) (Figure 1).

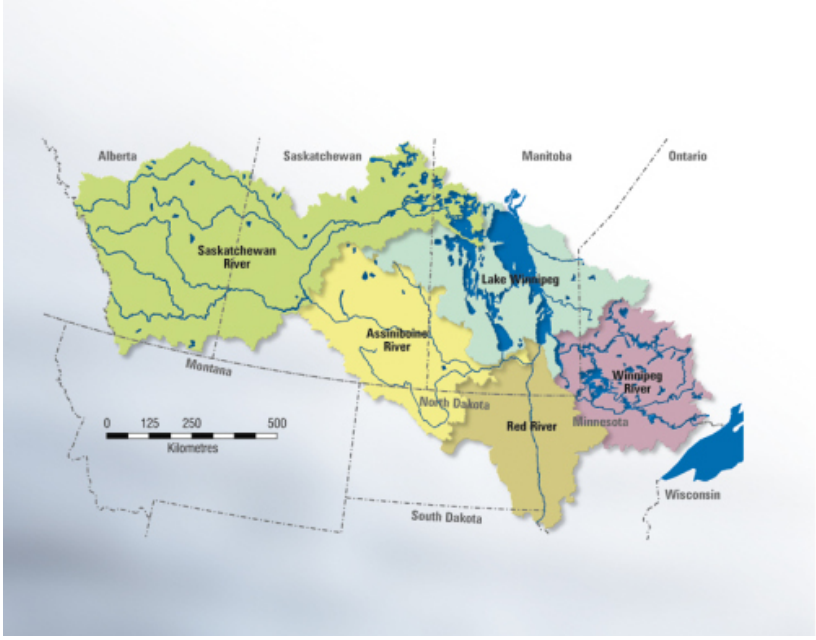

Figure 1: Map Showing the Geographic Extent of the Lake Winnipeg Watershed Divided into Major Basins (courtesy of Partners for the Saskatchewan River Basin)

While large in surface area, LW is generally a shallow lake with an average depth of 12 m and a deepest depth of approximately 60 m (LWSB, 2006). Along with playing its role within the region's ecosystem, the lake not only generates an estimated $110 million per year via recreational activities (LWSB, 2006), it also provides for an intensive commercial fishing industry. As of 2011, LW contributed 62% (6,379,666 kg) of Manitoba's total commercial fishing harvest and 75% ($16,259,317) of total harvest value (Manitoba Conservation and Water

Stewardship, 2012). The total direct and indirect annual value of the Lake Winnipeg and Red River commercial and sport fishery is estimated to be $50 million (Flanders, 2006).

Perhaps most important, Lake Winnipeg is the third largest reservoir in the world and provides Manitoba Hydro with 50% of its water storage capacity and 75% of its generating capacity (LWSB, 2006). Because of this, to provide more reliable flows for the more northern hydro-electric generating stations, LW's water levels are legally regulated under the Manitoba *Water Power Act* (Manitoba Hydro). While LW's only outlet was responsible for generating 79.98% of the total revenue from electricity sales in 2011-2012 totaling approximately $1.2 billion (Manitoba Hydro-Electric Board, 2012), some argue that LW's artificially regulated water level is partially to blame for its ongoing deterioration due to the prevention of nutrients and other contaminants being flushed from the lake (The Nature of Things, 2011).

The ratio of LW's watershed area to the lake surface area is the largest of any lake in the world which, according to Cicke et al. (2006), has the consequence of making the impacts it experiences comparable to a more densely populated area. Having such an extensive watershed and diversity of use, it is not unexpected that LW will be subject to the effects of pollution from both natural and anthropogenic point and non-point sources (Crowe, 1973). A summary of a 2002 report from Manitoba Conservation by the Lake Winnipeg Stewardship Board identified that an estimated 7,900 tonnes of phosphorus (P) and 96,000 tonnes of nitrogen (N) are deposited into LW every year (LWSB, 2006). Of those totals, data also indicates that anthropogenic sources of P and N far outweigh natural sources (Figure 2). Current data indicates little change as it is estimated that 7,655 tonnes of P and 90,700 tonnes N are deposited into LW every year (Manitoba Conservation and Water Stewardship unpublished data, 2012).

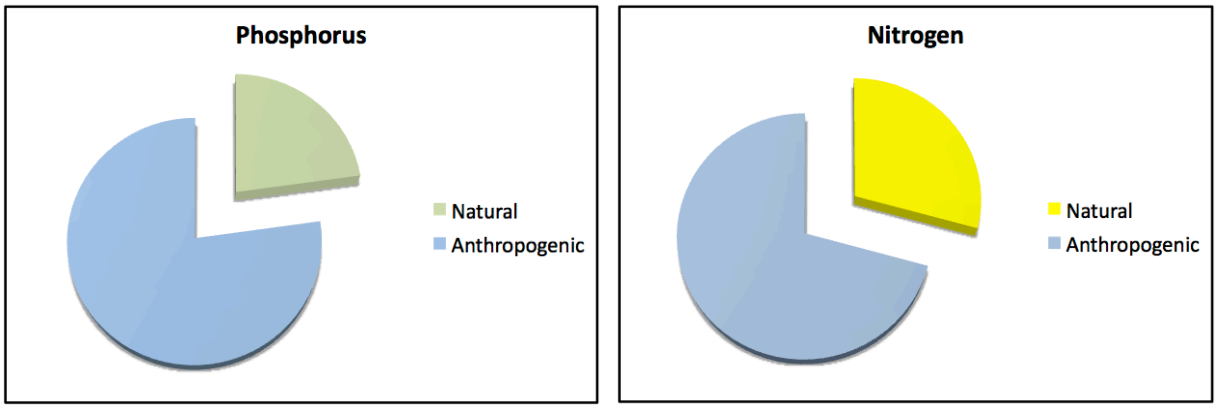

Figure 2: Comparison of Natural vs. Anthropogenic Nutrient Sources to Lake Winnipeg in Tonnes/Yr. (Source- Manitoba Conservation and Water Stewardship unpublished data, 2012)

At present, it is accepted by scientists, government and varying organizations alike that water quality in LW has deteriorated over time, especially over the last 30 years. Evidence points to excessive P and N enrichment from agricultural and urban land uses being the main causes of the deterioration (LWSB, 2006). As such, LW is considered the most eutrophic among the largest lakes in the world (LWSB, 2006). To date, the largest algal bloom ever recorded on LW was 25,000 km^2 (The Nature of Things, 2011) and in early 2013, the Global Nature Fund named LW as "Threatened Lake of the Year" (Figure 3).

1.2.2 The Role of the Red River Drainage Basin to Lake Winnipeg

The Red River (RR) and its entire drainage basin, including the Assiniboine River drainage basin which empties into the RR near the centre of the City of Winnipeg, covers an estimated 287,000 km^2 (Government of Manitoba) and, depending upon the spatial scope used, is one of the five major drainage basins that combine to form the LW watershed. The RRDB

proper, which excludes the Assiniboine River drainage basin, covers an estimated 116,500 km^2 (IRRB) with approximately 80% being located within the United States.

The RR itself, from its inception at Lake Traverse in North Dakota until its endpoint at LW, is 877 km in length and has no large lakes or reservoirs by which to slow flow and aid in the deposition of sediment, contaminants, etc.

Figure 3: Satellite Image of Lake Winnipeg Showing a Full-Lake Algal Bloom (NASA, with modifications by the Lake Winnipeg Research Consortium)

It is well known that flowing water bodies like the RR are heavily influenced by their surrounding landscapes (Allan, 2004). In the case of RRDB proper (excluding the Assiniboine River drainage basin), 74% is farmed with 65% being cropland and 9% pasture (McCullough et al, 2012 via multiple sources). Evidence accumulated over the last three decades indicates nutrient loading to LW from the RR has increased (Wassenaar and Rao, 2012). Therefore, it should be no surprise that despite its modest contributions of water to LW when compared to the lakes other four major drainage basins, the RR is the most significant contributor of total P and total N. Unpublished data from Manitoba Conservation supports this in that the RR, in terms of the percentage of nutrients, is by far the largest single source of both P and N (Figure 4).

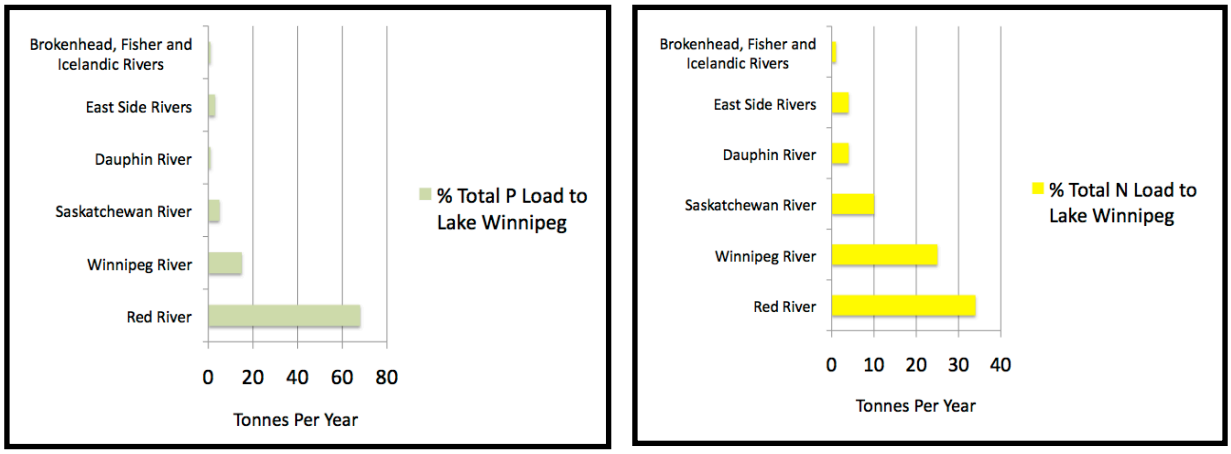

Figure 4: Comparison of Total Nutrient Loading to Lake Winnipeg from Different Watersheds in Tonnes/Yr. (Source- Manitoba Conservation and Water Stewardship unpublished data, 2012)

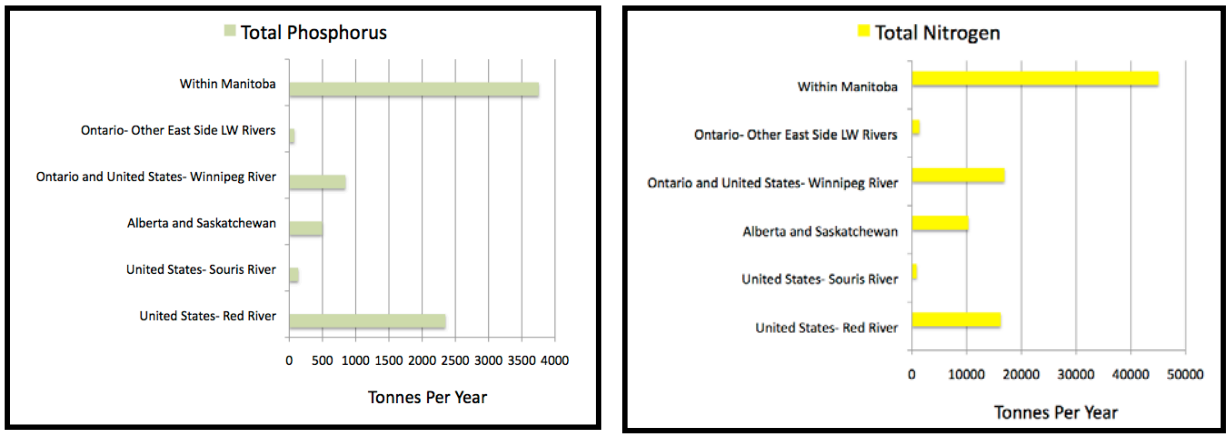

Figure 5: Comparison of Total Nutrient Loading to Lake Winnipeg from Different Jurisdictions in Tonnes/Yr. (Source- Manitoba Conservation and Water Stewardship unpublished data, 2012)

Regarding the jurisdictional source of nutrients to LW, in their summary of data from a 2002 Manitoba Conservation report, the Lake Winnipeg Stewardship Board (2006) identified that of the 35% of the total P loading to LW originating from the United States, 32% comes from the United States portion of the Red River drainage basin. Of the 21% of the total N loading to LW originating from the United States, 20% comes from the United States portion of the RRDB. Current data indicates little change as it is estimated that 31% of the total P loading

and 18% of the total N loading to LW originates from the United States portion of the RR (Figure 5). Most importantly, monitoring data for the RR at the Canada/U.S. Emerson border between 1999 and 2013 taken by Environment Canada indicates static levels of P and rising levels of N (Figure 6).

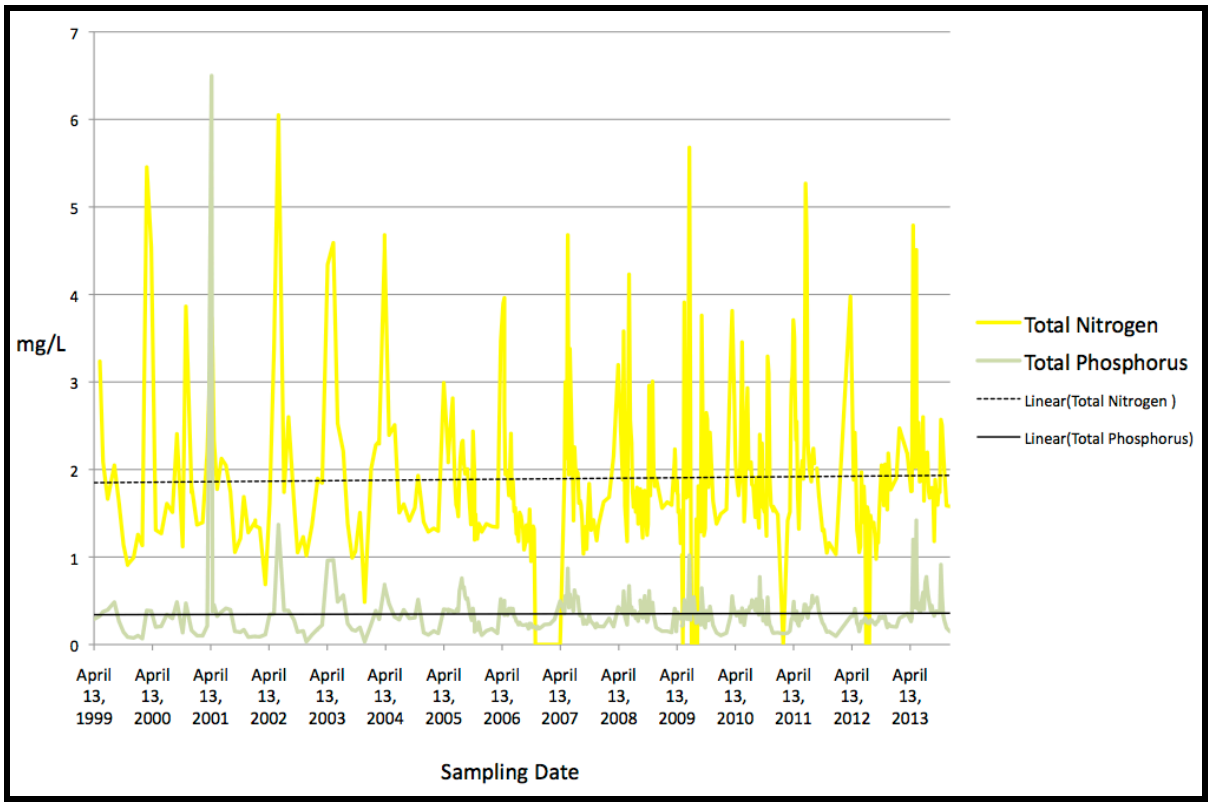

Figure 6: Nutrient Data for the Red River at the Canada/U.S. Emerson Border Between 1999 and 2013 (Source- Environment Canada unpublished data, 2014)

While the extent of agricultural land-use surrounding the southern portions of the LW watershed are known to be an important factor in its ongoing degradation, so to have been other, ongoing human caused physical changes to the land. The RRDB, like similar areas on the prairies, has experienced a dramatic reduction in water storage capacity as land owners,

supported by various levels of government, have drained and backfilled marshes, sloughs and prairie potholes to bring more land into production. In fact, it is estimated that millions of these water holding bodies have been lost over the last decades (The Nature of Things, 2011). Thanks to the estimated 27,000 km of drainage ditches which have been created in southern Manitoba alone (The Nature of Things, 2011) as well as the 50% of wetlands destroyed on the U.S. side of the RRDB (Schindler et al., 2012), natural flooding that occurs within the basin has been exacerbated. Complementing the creation of man-made drainage and the destruction of naturally occurring water storage areas has been the common and increasing use of sub-surface drainage, commonly known as tile drainage, (Kalita et al, 2006; Oquist et al, 2007; Ahiablame, 2010 and Johnson, 2010) which not only reduces water holding levels within the soil, but typically acts "as major transport pathways for soluble agricultural chemicals such as nitrate-N and atrazine" (Kalita et al, 2006, page 184).

Therefore, while flooding has long been a common historic occurrence within the RRDB, McCullough et al.'s (2012) research on the Manitoba portion of the LW watershed has shown that the increase in LW's P levels were associated with a near doubling of the RR's discharge over a ten year period from 1996 to 2005. As such, the combination of agriculture, the purposeful land management policy to dry out the landscape as quick as possible, and the increase in frequency and intensity of flooding events has seen the unintended consequence of causing the RR to become LW's largest single contributor of total P (McCullough et al., 2012).

1.2.3 Understanding the U.S Perspective

Historically, disputes involving water have been related to water quantity whereby an upstream user leaves too little for downstream users or land management from upstream

settlements flood downstream settlements through drainage projects. It was not until the 1960s and 1970s whereby the scientific community had better understanding of freshwater ecology and ecological sensitivity that water quality issues for either human or ecosystem interests were identified (Caldwell, 1984). Nevertheless, water-quality related disputes have shown to be no easier to solve, and maybe even more complex, than water quantity disputes. This is due to two reasons. The first is the same primary issue that plagues water quantity disputes, which is that the self-interest of those in upstream positions has a tendency to trump the interests of those downstream. Second, skepticism by stakeholders related to the science of water quality issues and the way the science is implemented has been documented as being an impediment to the resolution of water quality issues (Maddock, 2004).

Within the United States, individual states, like individual provinces or countries, manage themselves economically to their strengths. Considering 53% of Minnesota's and 89% of North Dakota's total landmass is in "farms" (USDA and USGS) and receipts for agricultural commodities in 2012 totaled $20.5 billion for Minnesota and $8.7 billion for North Dakota (USDA), it is clear that agriculture (whether crops or livestock) is not an insignificant component to the economies of each state. In fact, the net return on cropland alone within the Minnesota and North Dakota portions of the RRDB proper totalled approximately $2.6 billion in 2010 (RRBC, 2011).

Profitable crop production depends on efficient use of fertilizers (Sharpley et al., 1994). To achieve, maintain or expand that agricultural output, it is understandable that producers within both Minnesota and North Dakota act no different than producers the world over in the use of natural and/or synthetic fertilizers. However, although it has been identified that the anthropogenic input of nutrients to agricultural land in the form of fertilizer exceeds outputs in

produce within the U.S. by ~70% for P and ~82% for N (Carpenter et al., 1998), the requirement and motivation to maximize agricultural output for economic gain and well-being creates a dilemma in that the consequences of those actions is a significant component to LW's degradation and that addressing those issues have the potential to impact the profitability of agricultural operations in Minnesota and North Dakota (Maddock, 2004). Stated another way, the fundamental problem is that those who cause NPS pollution do not benefit from reducing it while those that benefit from reduced NPS pollution are not those that cause it (Carpenter and Lathrop, 1999).

The potential decrease in economic output caused by the implementation of measures to lower nutrient loading to the RR within Minnesota and North Dakota is compounded by LW's geographic location, which sees it located entirely within a different country from where nutrient reductions need to be achieved. This lack of prominence to the general population of Minnesota and North Dakota hurts LW because not only is the water body being degraded "out of sight-out of mind," but instituting measures and/or using resources to decrease the nutrient loading to LW would not achieve any return for their own interests and would most likely be politically unpopular. Such a position is supported by a significant number of peer-reviewed studies related to water quality issues in the U.S. which identify a main reason for addressing NPS nutrient issues as being due to the impacts caused internally to the U.S., not externally to Canada or Mexico (Nangia et al, 2008; Nangia et al, 2010 and David et al, 2010). Further still, given the fact that Manitoba itself contributes slightly under 50% of the total nutrients to LW (Manitoba Conservation and Water Stewardship unpublished data, 2012) and has made little progress in achieving nutrient reductions, a negative perception could be created for those

outside Manitoba who may be approached about taking responsibility for their own contributions on the same issue.

While non-point source nutrients originating from agriculture are the biggest concern for LW, point source pollutants from urban areas are also sources. Currently, only one of the three City of Winnipeg wastewater treatment plants has *Biological Nutrient Removal* capability which enables the removal of phosphates and nitrates. Due to this, the City of Winnipeg currently contributes 6.6 percent of the total P load to LW and 4.2 percent of the total N load (City of Winnipeg). Although no data could be found on the amount of nutrients released, the main U.S cities within the RRDB (Bismarck, Fargo, Grand Forks, and Moorhead) all have waste water treatment plants which also release P and N to surface waters. While still 5-10 years away from planned completion (R. Vendramelli, personnel communication, July 21, 2014), the City of Winnipeg is planning on upgrading its remaining two wastewater treatment plants with *Biological Nutrient Removal* capability which will lower the city's contributions of P and N to 2.4 and 2.2 percent of LWs totals (City of Winnipeg). However, on the U.S. side of the RRDB, not only are the wastewater treatment plants not equipped with nutrient removal capability, but opposition exists for making such upgrades. State requests in 2013 for the City of Moorhead to upgrade its plant to reduce P releases was met with objections by city officials who pointed to North Dakota's lack of P limits as a reason why they should not have to incur the costs of upgrades themselves (Gunderson, 2014). As such, if the Moorhead example is any indication, the major point sources of nutrients remaining within the U.S. portion of the RRDB are a long way from being addressed.

Overall, while basic economics can be blamed as being the primary reason for any reluctance of Minnesota and North Dakota to aid Manitoba in combating LW's ongoing

degradation, there is one significant reason why they may help. Although Minnesota's and North Dakota's drying out of the landscape within the RRDB has been purposeful, they have paid a heavy price for those actions. Both the major and non-major flood events that have occurred in the basin over the last twenty years have cost Minnesota and North Dakota billions of dollars. In 2011, the RRBC looked at long-term flood solutions. Estimates of total damages in the U.S. portion of the RRDB alone, for a single 100-year event with existing (2011) protection, were estimated at $5 billion ($3-4 billion for urban damage and $1 billion for agricultural damage). Therefore, since McCullough et al. (2012) clearly identified the relationship between nutrient loading to the RR and flooding, a potential opportunity for improving LW's long-term health is that both Minnesota and North Dakota will increase flood-reducing measures within the RRDB for the purpose of reducing flood-related damages which would, in turn, have the added benefit of lowering the amount of nutrients loaded to the RR.

1.2.4 Specialized Institutions Involved in the Management of the Red River Drainage Basin

The governments of Canada and the United States as well as Minnesota, North Dakota and Manitoba have created several institutions to manage water related issues within the RRDB. Although the main purpose of these institutions has been related to water quantity management, several of them have either added "water quality" as an issue of concern or they are in a position to potentially influence water quality. These groups are;

1.2.4.1 International Joint Commission

The result of the 1909 *Boundary Waters Treaty*, the *International Joint Commission* (IJC) aids in preventing and/or resolving disputes between Canada and the United States related

to trans-boundary waters. It is made up of six members, three appointed by the President of the United States, with the advice and approval of the Senate, and three appointed by the Governor in Council of Canada, on the advice of the Prime Minister (IJC, 2012).

To aid in achieving its mandate, the IJC has established various boards. The *International Red River Board* (IRRB) consists of a Board of eighteen members (nine each from Canada and the U.S.) and has a mandate related to aiding the Commission in resolving disputes within the RRDB (IRRB, 2013). The IRRB participates in the IJC's *International Watersheds Initiative* (IWI), which promotes an integrated ecosystem approach to managing trans-boundary waters.

1.2.4.2 Red River Basin Commission

The Red River Basin Commission (RRBC) is a charitable, non-profit bi-national organization created to help facilitate cooperation in water management within the RRDB. The commission consists of forty-two members representing Manitoba, Minnesota, North Dakota and South Dakota who work towards a unified voice for the RRDB via the development and implementation of an integrated natural resources framework plan (RRBC, 2013).

1.2.4.3 Red River Water Resources Council

The Red River Water Resources Council (RRWRC) is a non-profit organization formed in 1982 by Manitoba, Minnesota and North Dakota. The purpose of the RRWRC is to improve communication between all parties of the RRDB for the betterment of land and water management. Voting members of the council come from Manitoba, Minnesota and North Dakota while advisory non-voting members come from the Red River Basin Commission, the

Red River Watershed Management Board, the North Dakota Red River Joint Board, the US Army Corps of Engineers, the US Natural Resources Conservation Service, the US Geological Service and the US Fish and Wildlife Service (RRBC, 2013).

1.2.4.4 Red River Watershed Management Board

The Red River Watershed Management Board (RRWMB) is a joint board under Minnesota law incorporating the eight Watershed Districts on the Minnesota side of the RRDB. While the RRWMB promotes a basin-wide perspective for water management, its focus is on flood mitigation (RRWMB, 2013).

1.2.4.5 Red River Joint Water Resource District

The Red River Joint Water Resource District (RRJWRD) is a joint board under North Dakota law incorporating the fourteen individual Water Resource Districts located on the North Dakota side of the RRDB. The purpose of the RRJWRD is to provide a coordinated approach to water management and provide funding to member districts for water retention (flood mitigation) projects (RRJWRD, 2013).

1.3 Project Purpose

There are documented success stories related to the control and reversal of anthropogenic eutrophication. While the case of Lake Washington located near Seattle, Washington is perhaps the most well-known (Moore et al., 2003), the clean-up of Lake Erie in the 1970s and 1980s, due both to its size, the extent of degradation, as well as the trans-boundary nature of its reversal, should also be considered as significant. However, when

multiple jurisdictions are involved in solving any type of problem, it has to be acknowledged that existing economic and legal regimes combined with the social world-views and constructs of each jurisdiction conspire to play a large role in the success or failure of any efforts. This makes trans-boundary successes more of an exception rather than the rule.

As such, given the multi-jurisdictional nature of the LW issue, in what potentially could be a first water-resources related study of its kind, an attempt to more closely examine the trans-boundary relationship between the health of LW and the nutrients originating from the U.S. portion of the RRDB proper (excluding the Assiniboine River drainage basin) was developed. Specifically, due to the dynamic nature by which economic, legal and social influences affect the protection of environmental attributes (i.e. water quality), the purpose of the research was to identify whether or not the economic, legal and social landscapes of Minnesota and North Dakota were favourable to achieving nutrient reductions within their portion of the basin.

The research was guided by the following objectives:

1. To identify whether or not actions (regulatory, policy or other) have been taken to date by responsible authorities within the United States portion of the RRDB that may already be contributing to reduced nutrient loading;
2. To identify all existing barriers that have prevented action from being taken in the face of the known problem of nutrient loading;
3. To identify realistic actions that could be taken by responsible authorities and/or stakeholders within the United States portion of the RRDB to reduce nutrient loading; and
4. To make recommendations aimed at identifying solutions to break any barriers identified.

As mentioned, data indicates that approximately one-third of the P and one-quarter of the N loading to LW (Manitoba Conservation and Water Stewardship unpublished data, 2012) comes from sources within the United States portion of the RRDB. However, the overall research question is actually based on one key assumption, which is that nutrient reductions from the U.S. portion of the RRDB are essential to the reversal of LW's on-going eutrophication. I acknowledge the possibility that legislative, policy and land management changes within Manitoba only may have the ability to achieve the desired water quality improvements within LW and that nutrient reductions from within the U.S. portion of the RRDB may not be necessary, but would be none the less highly desirable.

1.4 Methods

The research design consisted of a qualitative research methodology via the use of; i) structured questionnaires, ii) semi-structured interviews and iii) a literature/document review. The structured and semi-structured surveys were carried out with key responsible authorities and organizations within Minnesota and North Dakota that have influence over land and water-related policy and projects. The literature/document review assessed other trans-boundary water disputes/issues, solutions to eutrophication as well as the concept of Integrated Water Resources Management (IWRM) with special focus on its use in trans-boundary disputes. The methods are detailed in Chapter 3.

1.4.1 Study Area

The area of interest for the study was the eastern half of the state of North Dakota and the north/north western half of the state of Minnesota, both of which are located along the Canadian

border in the mid-western United States (Appendix F, Figure 10). Within these areas are contained the largest portion of the RRDB proper.

Table 1: Comparison of Key Minnesota and North Dakota Statistics with Influence Over Water Quality

Parameter	Minnesota	North Dakota
Total Area of State in km^2 (USGS)	225,163	183,108
Total Land Area in km^2 (USGS)	206,232	178,711
Total Water Area in km^2 (USGS)	18,930	4,397
Total Area Owned by Federal & State Government (SP)	23.5%	9.1%
Population (USCB)	5,303,295	672,591
Per Capita Income (CoSG)	$46,227.00	$51,893
State GDP (CoSG)	$294 billion	$46 billion
Total Receipts for Agricultural Commodities 2012 (USDA)	$20.5 billion	$8.7 billion
Total Number of Farms (crop and livestock) 2012 (USDA)	74,542	30,961
Total Land "In Farms" 2012 in km^2 (USDA)	81,082	158,890
Percent of Land Area "In Farms" 2012 (USDA)	51.1%	88.9%
Total Cattle and Calves 2012 (USDA)	2,412,684	1,809,613
Total Hogs and Pigs 2012 (USDA)	7,606,785	133,653
Total Sheep and Lambs 2012 (USDA)	126,506	64,607
Total Poultry 2012 (USDA)	9,693,648	92,754
Total Livestock 2012	19,839,623	2,100,627
Cattle and Calves/km^2	10.7	9.9
Hogs and Pigs/km^2	33.8	0.73
Sheep and Lambs/km^2	0.56	0.35
Poultry/km^2	43	0.51
Total Livestock/km^2	88	11.5
Ratio of Livestock to Population	3.74	3.12

References-
Council of State Governments http://www.statesperform.org/AboutUs.aspx (CoSG)
United States Census Bureau http://www.census.gov/popfinder/?fl=38 (USCB)
United States Department of Agriculture http://www.agcensus.usda.gov/Publications/2012/Full_Report/Census_by_State/ (USDA)
United States Department of Agriculture http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/cash-receipts-by-state.aspx#P7f49aa0cad1046069c18fa1b6c3bded8_2_250iT0R0x0 (USDA)
United States Geological Survey http://water.usgs.gov/edu/wetstates.html (USGS)
http://www.summitpost.org/public-and-private-land-percentages-by-us-states/186111 (SP)

1.5 Relevance

The assessment of the relevance of the proposed topic began via a bibliometric analysis of scientific publications via the University of Manitoba Libraries website. Using the *Web of Science*, *Scopus* and *ScienceDirect* databases, 335 results were returned for studies with "Lake Winnipeg" in the title. Of those, only 13 different returns relating to nutrients/eutrophication were identified. An electronic search was also performed of the Masters and Ph.D Theses completed within the Natural Resource Institute between October 2001 and October 2011. Within these years, one study focused explicitly on LW as a topic while three other studies were arguably somewhat related. I also searched the provincial government environmental library. That search identified 315 titles related to LW. However, the majority of those related to baseline limnological investigations of LW's two basins as well as planning for proposed and completed electrical power generation projects. Lastly, in a 2005 report by the Lake Winnipeg Implementation Committee, a comparison was made between the numbers of scientific publications generated on the five Great Lakes as well as LW from 1981 to 2003. Lake Michigan led with over 3000, followed by Lake Ontario and Lake Erie with both just under 2500. Lake Superior had just fewer than 1500 scientific publications generated about it over this time period while Lake Huron had approximately 1000. Lake Winnipeg was last out of the six lakes with approximately 175. In 2012, LW finally received increased scientific interest when the *Journal of Great Lakes Research* released a 196 page special issue entitled *Lake Winnipeg - The Forgotten Great Lake* which consisted of 18 articles.

Lastly, after performing a general internet search, examples of other trans-boundary water issues with circumstances similar to that of the LW issue (i.e. one side (Canada) is

absorbing all the costs while another side (the United States) is a significant contributor to the source of the problem), could not be found. Looking globally, the European Union (EU) with its abundance of sovereign countries and trans-boundary water bodies seemed like the obvious location for a comparison. However, while the cleanup of the Rhine River involved multiple riparians as well as a single nation state absorbing all the costs for cleanup, the primary source of pollutants were industrial point sources, not agricultural non-point sources (Verweij, 2000). Looking closer at other cases between Canada and the United States moderated by the International Joint Commission, no other cases involving water quality whereby negative impacts are completely asymmetrical could be identified, thus making the circumstances of the LW issue seemingly unique.

With the above in mind, from a purely academic perspective, which is defined in this instance as studies originating from an academic institution, LW as a subject seems to be only a moderately studied subject overall and a marginally studied subject from the perspective of eutrophication and its negative impacts on the lake system. From a government management perspective, LW as a subject appears quite extensively within the provincial government literature. However, other than the studies created in the last decade under the Lake Winnipeg Stewardship Board (LWSB), few relate to the modern issue facing the lake today or the role being played by Minnesota and North Dakota. From a more social perspective, trans-boundary water issues are seemingly an ever growing issue of occurrence. However, trans-boundary water studies typically involve water quantity issues, not water quality issues. Further, cases whereby the water body of concern is located completely in one country but is affected by the actions of a bordering country(ies) are seemingly rare occurrences. As such, the factors involved in the LW, Manitoba/Minnesota/North Dakota issue provide a potentially original opportunity for study.

1.6 Thesis Organization

The thesis is organized into six chapters. Following this introductory chapter, Chapter two provides a review of the literature on eutrophication and its management. Chapter three explains the research methods used in the study and Chapter four presents the results of the study. The thesis closes with Chapters five and six, which will present a discussion of the findings followed by conclusions and recommendations.

CHAPTER 2: EUTROPHICATION AND ITS MANAGEMENT

2.1 What is Eutrophication?

Eutrophication refers to the increase of a water body's primary productivity due to natural or artificial nutrient enrichment (Schwoerbel, 1987). Natural eutrophication can take thousands of years to cause successional changes in a water body's primary productivity, while artificial eutrophication (also called cultural or anthropogenic eutrophication) causes the same changes in a comparatively rapid timeframe (Khan and Ansari, 2005). Cultural eutrophication, according to Schindler (Page 1, 2012), "is the earth's most widespread water quality problem" and although there have been successes in combating and reversing eutrophication, it is in some cases potentially irreversible (Bunting et al, 2010).

Pollutants, or more specifically nutrients when in the context of eutrophication, are categorized as entering water bodies via two main ways, point sources and non-point sources. Point source pollutants (PS) reference pollutants that originate from a single source while non-point source (NPS) pollutants reference pollutants originating from several different or diffuse sources. In modifying data from other studies, Carpenter et al. (1998) identified that of the total N and P discharges from both PSs and NPSs to surface waters in the United States, NPSs totalled 82% of N discharges and 84% of P discharges.

In contemporary times, NPS nutrient loading due to land change and development (primarily agriculture) is the primary cause of eutrophication. While land change is not new, the rate, scale and type of changes have been unprecedented (Diplas, 2002). Further, the main

causes of the NPS nutrient loading now are from excessive fertilizer use and high density livestock operations (Sharpley et al., 1994; Carpenter et al., 1998).

2.2 Impacts of Eutrophication- The Long Term Impact to Lake Winnipeg

The eutrophication of a water body can have a variety of impacts. While some may be positive if viewed within a constrained temporal scope, the vast majority are negative. When viewed from an ecosystem perspective, eutrophication causes an overall increase in primary production. Increased growth of aquatic macrophytes and algae will occur, including changes in the relative composition of algae from non-bloom-forming species to bloom-forming, potentially toxic species (Carpenter et al., 1998). While an overall negative impact on fish and fisheries will occur due to shifts in fish species composition from desirable to less desirable species (Tammi, et al., 1999; Tammi, et al., 1999; Carpenter, 2005; Lee and Jones, 2005; Mehner et al., 2005; Schindler, 2006; and Zheng and Paul, date unknown), in the short-term, fish productivity will typically increase due to the related effects of increased primary production, which increases productivity of invertebrates and so on up the trophic ladder.

Currently, other factors like the accidental introduction to the LW ecosystem of the rainbow smelt (Wassenaar and Rao, 2012) are undoubtedly involved in the proliferation of LW's commercial fishery, but the observed increase is more likely related to the short-term increase in productivity caused by increasingly eutrophic conditions. To support this assertion, the forty year (1950-1990) catch average for walleye, the most commercially prized fish in LW, was 1,308,934 kg/yr (Franzin et al., 2003). Compiling data available from *A Profile of Manitoba's Commercial Fisheries* (Manitoba Conservation and Water Stewardship, 2012), the

ten-year catch average for walleye in LW from 2001-2011 was estimated at 4,111,073 kg/yr (Appendix H). However, when the inevitable shift from desirable to less desirable fish species caused by eutrophication does occur, it can in many cases lead to increased internal nutrient recycling from the water body as those less desirable species re-suspend nutrients formerly bound into lake sediments (Schindler, 2006). This further exacerbates the eutrophication problem. Lastly, the alteration of physical habitat and increased stresses on fish communities occur due to depleted dissolved oxygen content and the creation of desertification zones completely void of oxygen which can lead to fish kills (Joosse et al., 2011).

Once nutrient levels begin to cause the biological and ecosystem based impacts previously discussed, impacts to more socially oriented attributes become apparent. Decreased water quality, increased aquatic vegetation and algal blooms along with the smell from decaying organic matter from washed-up algae and fish-kills all contribute to decreased shoreline property value. This in turn results in decreased tourism, decreased recreational use of the water body and increased costs for municipalities and commercial fisherman to clean and maintain infrastructure and fishing nets (Carpenter et al., 1998; Joosse et al., 2011; and Zheng and Paul, year unknown). While the short-term catch of commercial fisheries may increase, it is known to only last until the fish species composition changes from desirable to less desirable species. The end result could be the collapse of a commercial fishery. Lastly, in areas where significant portions of nutrient loading is due to manure applications to land, water bodies may not only experience increases in hazardous coliform bacteria, but also increases in the abundance, composition and virulence of existing pathogens (Smith and Schindler, 2008).

Estimates of the economic costs of freshwater harmful algal blooms (HABs) in the United States are estimated at between $2.2-$4.6 billion dollars annually (Hudnell, 2010). In

purely economic terms, the total costs related to the eutrophication of a water body are difficult to value (Govindasamy et al, 1994). However, it is clear that unimpeded, sustained exploitation of the natural ecosystem services offered by lakes and their surrounding landscape can have significant impacts on both the ecosystem and the economy. For LW, this means not only a reduction in the $20 million annual commercial fishing industry, but a reduction in tourism and related property values.

2.3 Controlling Eutrophication

Initial attempts at controlling eutrophication treated the symptoms instead of the causes. However, of the two main ways by which nutrients enter a water body, PSs (such as effluent discharge pipes) were the first and easiest to be addressed due to the rather simple means by which their locations could be identified and their releases could be quantified and controlled via command and control mechanisms such as regulations (Daniel et al., 1998; Carpenter and Lathrop, 1999; and Schindler, 2006). As a result, while municipal wastewater systems and agricultural livestock operations still release PS nutrients, they are no longer considered to be as significant a contributor to the eutrophication of water bodies in developed countries that they once were.

It was not until the 1970s that the influence of NPS nutrient loading from land use was realized (Schindler, 2006). Unlike PSs, NPSs are difficult to manage and quantify due to the fact that nutrient additions are intermittent, can reach a water body from practically anywhere on land, are costly to control/regulate and because control of the most important NPSs (i.e. agricultural land) is counter to food production (Bunting et al., 2010). Since nutrient concentrations in lakes are tied to anthropogenic activities (McCullough et al., 2012), two broad

types of management (source management of nutrients and transport management of nutrients) have been identified that are specifically related to controlling the deposition of nutrients in to water bodies from the landscape (Sharpley et al., 1994; Carpenter et al., 1998; Daniel et al., 1998; and McDowell et al., 2002). A third and fourth type of management (the ecosystem approach and integrated water resources management), both less specific for the problem of eutrophication, but potentially essential to the resolution of water disputes outside of a localized temporal setting also exist. All four (source management of nutrients, transport management of nutrients, the ecosystem approach, and integrated water resources management) are discussed below.

2.3.1 Source Management of Nutrients

Source management of nutrients, which refers to the control of purposeful anthropogenic additions of nutrients such as synthetic fertilizer and manure to the land, is generally considered the most important type of management activity for trying to control eutrophication (Haycock and Muscutt, 1995). It includes;

- fertilizer applied at rates that match uptake of crops (Sharpley et al., 1994)
- time of year restrictions for fertilizer application so that the fertilizer is not added during a time in which the crops/soil cannot utilize or absorb it (i.e. spreading manure in winter leads to its loss during spring melt and runoff);
- fertilizer application method restrictions such as the prevention of using the broadcasting method to apply fertilizer which causes increased levels of dissolved P in runoff vs. methods such as direct injection (Sharpley et al., 1994);

- dietary inputs of P linked to needs of livestock would result in livestock excreting less P to the environment (Carpenter et al., 1998);
- temporal management of nutrients that would see the management of fertilizer and manure sourced P, whose availability to be washed into surface waters is short, be different than that of the management for soil P, whose availability is chronically long-term (Kleinman et al., 2011); and
- consideration of both dissolved and particulate P and the specific soil conditions due to P-limited soils being less likely to be a source of P than P-enriched soils (Kleinman et al., 2011).

Within the US portion of the RRDB, initiatives meant to address the source management of nutrients have been implemented. For example, the Minnesota Department of Agriculture provides support to producers with Nutrient Management Strategies (MDA, 2013). Similarly, North Dakota, through a NPS Pollution Management Program as well as programs offered by the United States Department of Agriculture and the Soil Conservation Districts, offer assistance to landowners to protect water resources (RRBC, 2012). However, a shortfall within both states is that implementing Nutrient Management Strategies is not a legal requirement for producers, only voluntary. Further, the Minnesota programs are largely based around the management of only N, not P (MDA, 2013).

Even though Minnesota and North Dakota have made an effort to better manage nutrient additions within their jurisdictions, both Haycock and Muscutt (1995) and Vought et al (1995) agree that changes to agricultural practices as a singular effort to reduce nutrient loading will not achieve significant nutrient reductions due to being too narrow of an approach and not considering the whole agricultural ecosystem. Further, delays may occur in any improvement of a water body impacted by eutrophication even if source management of nutrients is greatly

reduced. This is due not only to the internal recycling of nutrients already in a water body, but because the soil within a catchment may have an accumulation of P which continues to get released to a water body slowly over time (Sharpley et al., 1994; Darracq et al., 2008; and Sprague and Lorenz, 2009). Therefore, control of transport processes is also a necessity.

2.3.2 Transport Management of Nutrients

Transport management of nutrients refers primarily to the control of soil erosion and water runoff from the land. Such management slows surface water flow velocity, decreases soil loss from erosion and increases deposition of material (i.e. nutrients) prior to reaching receiving waters. Transport management of nutrients includes;

- time of year restrictions for fertilizer application (see source management)
- incorporation of other land management techniques such as terracing, conservation tillage, contour tillage etc. to allow maximum uptake of nutrients by both the soil and crop (Sharpley et al., 1994);
- re-establishment of the appropriate type of vegetative buffer zones between agricultural areas and receiving waters to ensure maximum filtration and uptake of nutrients by the vegetation within the buffer (Vought et al., 1995); and
- regulatory protection of existing riparian areas allows for a natural buffer strip and aids in the prevention of erosion which decreases loss of soil bound P.

Similar to source management of nutrients, some initiatives that relate to limiting the transport of nutrients are being developed in Minnesota and North Dakota. For example, the Red River Basin Commission is developing a basin-wide flow reduction strategy which would be

accomplished by constructing numerous impoundments throughout the basin to detain water (RRBC, 2011). Such holding and/or slowing of water aids in reducing nutrient loads to the Red River due to providing increased opportunity for the nutrients to settle out of the water column or be absorbed by vegetation. In North Dakota, of eighty-two potential projects identified by the RRJWD for 2007-2011, eight could be directly related to helping decrease nutrient loading. A further seventeen were related to dam repairs which, due to the linkage with retaining water, can also be deemed to be helpful by creating an opportunity for specific forms of nutrients attached to sediment to settle from the water column and not be transported downstream. However, it must also be pointed out that twenty-one RRJWD projects were related to the creation and/or repair/improvement of water drainage (RRJWRD, 2006), which will increase the potential for erosion and nutrient transport.

2.3.3 The Ecosystem Approach

While it has become more accepted that humans and their actions are inherently linked with the natural environment, it was not always so (United Nations Environment Program, 2010). As a result of the aforementioned realization, the *Convention on Biological Diversity* first suggested that an " 'Ecosystem Approach' be employed as a strategy for integrated land, water and natural resources management, and that human beings be included as an integral component of all the world's ecosystems" (United Nations Environment Program, 2010, page 4).

While newer than Integrated Water Resources Management (discussed in the next section), the twelve principles that were created for the application of the Ecosystem Approach identify both the similarities and differences between it and Integrated Water

Resources Management. Overall, the Ecosystem Approach as developed is much more expansive and inclusive than Integrated Water Resources Management (i.e. the Ecosystem Approach includes consideration of market functions such as market distortions and incentives). However, two key similarities between the Ecosystem Approach and Integrated Water Resources Management that link them together are that they both advocate for the decentralization of management and they both place importance to using the appropriate spatial scales for management.

2.3.4 Integrated Water Resources Management

As natural resource and environmental problems have increased, some believe that they have grown too complex to be solved via conventional scientific and technological solutions (Berkes, 2003). In support of this belief, new multi-disciplinary problem-solving techniques and/or processes began to be developed as options to older approaches (Woolley and McGinnis, 1999). Although identified by many different names, one such technique, generally considered as one of many participatory or "collaborative type processes", is Integrated Water Resources Management (IWRM), which is defined by the Global Water Partnership (GWP) as;

> *a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment* (GWS, 2013).

The basis of IWRM, which thought by many to be the best tool to solve water quality problems (Daniel et al, 1998), is its use of watersheds as the central unit by which planning and

management for/of development is based. A key reason for using watersheds as the central unit for planning and management is due to the simple fact that political boundaries (i.e. federal, state, provincial, county, municipal etc.) almost never coincide with watershed boundaries. As such, development in one area of a watershed is likely to impact elsewhere in a watershed. Watershed-based thinking also not only emphasizes the decentralization of environmental policy-making from the government to local level, but as McGinnis (1999) identifies, it acknowledges that the contemporary systems in place that influence the management of our resources have ignored the spatial hierarchy of ecosystems that include "a range of ecological communities that transcends political, economic, and administrative boundaries and jurisdictions" (page 497). Used properly, IWRM is a continuous and adaptive cycle that involves five main components which, in their simplest form, involve *Planning*, *Data Collection*, *Assessment and Targeting*, *Strategy Development* and *Implementation*.

The idea of a watershed as an appropriate unit for planning dates back to the 1800s (Blomquist and Schlager, 2005) and is viewed as providing one of the best units for intergovernmental management because;

i) they are ecologically meaningful
ii) they easily define an area (spatially) to be managed
iii) they are nested hierarchically (small watersheds are part of larger watersheds) and;
iv) the health of an entire watershed can generally be measured by the health of the aquatic ecosystem (McGinnis, 1999)

It is for the reasons above why the watershed is an appropriate unit for planning and that IWRM and similar processes are being used by the IJC and other institutions in the RRDB in an

attempt to manage all issues of concern. In fact, IWRM has become so popular as a global water resources management tool that, according to Jeffrey and Gearey (2006), it is difficult to overstate the extent to which IWRM has become the standard strategy by which water resources are managed.

Although IWRM can sound as if it is the quintessential water-related problem-solving technique, it (and similar collaborative processes) have both their criticisms and detractors. For example, while the effectiveness of basin-wide management is often not immediately apparent (Kang et al., 2010), authors Jeffrey and Gearey (2006) identify an extensive gap between the theory and practice in IWRM and state that it is immature as a management tool due to a lack of real world success. They concluded by asking whether or not the potential of IWRM is even achievable. Further, Woolley and McGinnis (1999) identify that the "use" values of land are typically not compatible with those of maintaining ecosystem health and function. McGinnis (1999) identifies that the diversity of government and non-government plans and programs have diluted the concept of a watershed approach due primarily to a lack of consistency in its application while Burgess et al., (2000), Blomquist et al., (2005) and Qi and Altinakar (2011) among others all identify that conflicting motivations of the parties involved as well as the requirement for the different actors involved to understand each other's views are inherent weaknesses of such processes. Further, Singleton (2002) identifies that collaborative processes like IWRM shift the definition of success from decreased environmental degradation to one of simply reduced social conflict. Lastly, and perhaps most importantly, considering the international trans-boundary nature of the LW case, as a unit of organization, the watershed does not prevent the emergence, persistence or influence of politics in the decision-making process (Blomquist et al., 2005), which may be a significant factor in trying to address the ongoing

nutrient loading from the U.S.. Due to these inherent problems, the ongoing acceptance by government for the use of IWRM as a management tool could actually be a purposeful and calculated decision by which government is abdicating responsibility on a difficult and controversial issue (Coggins, 1999).

Overall, while some think the "modern resource management paradigm" is dysfunctional (Woolley and McGinnis, 1999), it is clear that due to the biases and inherent limitations of the IWRM process identified above, any dependence on it as a panacea to the water quality issues present within the RRDB may be misguided.

2.3.4.1 Integrated Water Resources Management in the Red River Drainage Basin

Many of the organizations within the RRDB who are involved with water management practice IWRM or some form of it. Due to this, it is important to identify the governing abilities of these organizations. True governing ability is carried by official federal, state and county/municipal departments as well as to some extent by Special Purpose Units of Government like the Minnesota Watershed Districts and the North Dakota Water Resource Districts. Other entities within the study area such as the International Joint Commission or the Red River Basin Commission do not have any governing ability but instead try to influence governing bodies to have any desired changes implemented. Even with the identified use of IWRM by institutions within the US portion of the RRDB, this may not be enough to ensure effective action. Haycock and Muscutt (1995) identify that the issue of NPS pollution is routinely not given the level of acknowledgement that triggers political action to manage the problem and that to achieve change, political reforms are required. The best example of this is

the United States *Clean Water Act, 1972* that was supposed to establish "the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters" (EPA, 2013). Although the influence of the *Act* on NPS pollutants will be discussed further in Section 5.1.8.1, in general, the *Act* not only fails to regulate NPSs of pollutants, but gives agricultural storm water discharges an exemption from its definition of point-source (Parry, 1998).

While use of IWRM as a problem-solving technique for the LW issue can be credited with the proposed development of a RRDB nutrient management strategy and nutrient standards for surface water, it remains to be seen whether the strategy and nutrient standards will not only be meaningful, but implementable.

2.4 Summary

It is clear that the anthropogenic loading of nutrients into fresh water bodies causes eutrophication and that if not addressed, causes severe environmental and economic impacts. While academics have identified both the major sources and types of nutrients causing eutrophication in contemporary times as well as general strategies to control them, that does not mean that a trans-boundary eutrophication issue such as what is seen with LW is easily addressed once the complexities of differing land ownership regimes, legal frameworks, stakeholders and world-views are considered.

CHAPTER 3: STUDY METHODS

3.1 Research Design

The study focused on stakeholders within Minnesota and North Dakota due to the fact that the largest part of the RRDB is found within those two states. The organizations targeted in the research included the United States Department of Agriculture, the United States Environmental Protection Agency, departments from both Minnesota and North Dakota state governments as well as the conservation districts (CDs) and water districts (WDs) that exist within the two states.

According to Lin (1976), choosing a data collection methodology is largely dependent on the type of information being sought. As such, of the four main methods of data collection used in social science research (Lin, 1976), the one used for this study was the qualitative survey method. Two basic types of the qualitative survey exist, the questionnaire survey and the interview survey (Lin, 1976), both of which were used in this study in order to;

1. determine participants level of knowledge and concern about the nutrient loadings into LW and their associated impacts;
2. determine participants level of willingness to address the nutrient loadings to the RRDB within their own state, including what actions have been taken;
3. identify and/or clarify efforts planned or currently initiated by the organizations of interest that may help reduce nutrient loading to the RRDB, and;
4. identify barriers to achieving cooperation in addressing the nutrient loading of the RRDB.

Due to the nature of the research question, the research project was completely dependent on cooperation from organizations and individuals within Minnesota and North Dakota. Although input from the official federal and state departments/agencies of interest was very important to the research question, I deemed the involvement of individual CDs and WDs (particularly the district managers and board/committee members) from within Minnesota and North Dakota as being key to the research. The reason for this was two-fold. First, it is assumed that the managers of each district are knowledgeable in water and land management issues and that board/committee members have at least a basic knowledge related to water issues, land management issues, and related regulations. Second, the results of pre-study interviews with various groups in the RRDB indicated that while the board/committee members generally tend to be landowners and active or retired producers, the board/committee members can be made up of a more diverse representation of the public and also include private business owners/workers, average citizens etc. As such, targeting the board/committee members of CDs and WDs may help offer at least a glimpse into the views of Minnesota and North Dakota's general population.

3.2 Study Participants

Each of the stakeholder groups targeted by the study, their responsibilities and therefore the reasoning for targeting them for this study is outlined below.

3.2.1 United States Federal Government

3.2.1.1 United States Environmental Protection Agency (USEPA)

All freshwaters within the United States are under the purview of the Environmental Protection Agency (EPA). As such, it oversees the U.S. *Clean Water Act* (*CWA*) and *Safe Drinking Water Act* and even has authority over Freshwater Harmful Algal Blooms (FHABs) through the *Harmful Algal Bloom and Hypoxia Research and Control Act* (HABHRCA) (Hudnell, 2010).

3.2.1.2 United States Department of Agriculture (USDA)

One of its eight mission areas, the United States Department of Agriculture (USDA) works to prevent damage to natural resources and the environment, restore the resource base, and promote good land management (USDA, 2013).

3.2.2 Minnesota State Government

2.2.2.1 Minnesota Board of Water and Soil Resources (MBWSR)

The Minnesota Board of Water and Soil Resources assists to improve and protect Minnesota's water and soil resources by working in partnership with local organizations and private landowners (MBWSR, 2013).

3.2.2.2 Minnesota Department of Agriculture (MDA)

The mission of the Minnesota Department of Agriculture is to "*enhance Minnesotans' quality of life by ensuring the integrity of our food supply, the health of our environment, and the strength of our agricultural economy*". The department "*is committed to helping farmers, homeowners, and industry protect … water resources*" through various means (MDA, 2013).

3.2.2.3 Minnesota Department of Natural Resources (MDNR)

With an overarching mandate that includes the conservation and management of the state's natural resources, the DNR is also tasked with the protection of the state's surface water and groundwater resources. (MDNR, 2013)

3.2.2.4 Minnesota Environmental Quality Board (MEQB)

The purpose of the Environmental Quality Board is to "*lead Minnesota environmental policy by responding to key issues, providing appropriate review and coordination, serving as a public forum and developing long-range strategies to enhance Minnesota's environmental quality*". The board works to develop policy, create long-range plans and review proposed projects that would significantly influence Minnesota's environment (MEQB, 2013).

3.2.2.5 Minnesota Pollution Control Agency (MPCA)

The Minnesota Pollution Control Agency "*monitors environmental quality, offers technical and financial assistance and enforces environmental regulations*". The agency also

"*helps protect* (Minnesota's) *water by monitoring its quality, setting standards and controlling what may go into it* (MPCA, 2013).

3.2.3 North Dakota State Government

3.2.3.1 North Dakota State Department of Agriculture (NDDA)

The North Dakota Department of Agriculture is "*fosters the long-term well-being of North Dakota by promoting a healthy economic, environmental and social climate for agriculture and the rural community through leadership, advocacy, education, regulation and other services*" (NDDA, 2013).

3.2.3.2 North Dakota State Department of Health (NDDH)

The North Dakota Department of Health's mission is to "*protect and enhance the health and safety of all North Dakotans and the environment in which* (they) *live*". Under the Environmental Health Section, their goal is to safeguard the quality of North Dakota's air, land and water resources and more specifically (from a water perspective) "*for monitoring the quality of the state's lakes, streams and rivers* (and) *help to ensure that water stays clean for people today, as well as for future generations*" (NDSDH, 2013).

3.2.3.3 North Dakota State Water Commission (NDSWC)

North Dakota's State Water Commission has the primary responsibility to "*provide effective management of North Dakota's water resources*" (NDSWC, 2013). While the

Commission's definition of water resources seemingly includes ecological factors, its mission is focussed both economically and internally towards the needs of the state (NDSWC, 2013).

3.2.4 Special Purpose Units of Government

A key focus of the study was the involvement of personnel from existing conservation districts (CDs). Conservation Districts were created in the United States in the 1930s after the severe drought and soil loss which occurred during the Great Depression. The result of the experience was that the United States Congress unanimously passed legislation in 1937 declaring soil and water conservation a national policy and priority (National Association of Conservation Districts, 2012). Currently, there are almost 3,000 conservation districts in the U.S. (National Association of Conservation Districts, 2012).

While not a part of the U.S. *National Association of Conservation Districts*, a natural by-product of the success of CDs has been the creation of a similar type of entity whose focus is specifically related to the management (quantity and quality) of water. Identified as water districts (WDs) for this thesis, they use a similar structure to CDs but generally tend to follow watershed boundaries instead of county boundaries.

3.2.4.1 Minnesota Soil and Water Conservation Districts

Minnesota Soil and Water Conservation Districts (SWCD) are county level units of government (more commonly known as local units of government) that manage and direct natural resource management programs at the local level and to private landowners by working with both landowners and government (MASWCD, 2013). In total, Minnesota has ninety-one

SWCDs, twenty-three of which are either totally or partially located in the RRDB. Each district is run by an elected governing board whose size is dependent upon the size of the district.

3.2.4.2 Minnesota Watershed Districts

The Minnesota Watershed Districts are local, special-purpose units of government whose boundaries follow those of natural watersheds. A district works to solve and prevent water-related problems (MAWD, 2013). In total, Minnesota has forty-five Watershed Districts. Each district is run by a volunteer Board of Managers appointed by the county. All meetings held by a watershed district board are open to the public.

As previously identified, a special subsidiary of the Minnesota Watershed Districts is the Red River Watershed Management Board (RRWMB), which is comprised of the eight watershed districts located on the Minnesota side of the RRDB.

3.2.4.3 North Dakota Soil Conservation Districts

The North Dakota Soil Conservation Districts are local units of government existing within every county in the state. Of the fifty-three counties and conservation districts, twenty-five are either totally or partially located in the RRDB. The districts attempt to further the widespread application of sound and practical soil and water conservation practices in North Dakota. The day-to-day operations of each district are run by either a district manager or a team of technicians. Management of a district is performed by a board of managers, some of which are appointed and some of which are elected (L. Buck and L. Yohe, personal communication, Friday January 11, 2013).

3.2.4.4 North Dakota Water Resource Districts

Information about the North Dakota Water Resource Districts is difficult to find. While, they are linked to the State Water Commission, as with the other types of CDs, day-to-day operations of a district are run by staff while a board (appointed by county commissioners) makes all management decisions. The main funding source for each district is via a local property tax levy with supplemental funding coming from both state and federal sources.

As identified in Section 1.3.4.5, the Red River Joint Water Resource District (RRJWRD) is a special subsidiary of the North Dakota Water Districts and is comprised of the fourteen water resource districts located on the North Dakota side of the RRDB.

3.3 Data Collection

Structured questionnaire surveys and semi-structured interviews (see Appendix C and D) were used to collect data. Questions were developed using rules created and accepted within the social sciences (i.e., Foddy, 1993). The questions used for both the questionnaire surveys and semi-structured interviews were categorized into three broad themes (economic, legal and social) related to the objectives of the research. In order to ensure the accuracy of responses, certain strategies were used. For example, for both survey and interview questions, some questions were re-worded and asked more than once while some of the questions used for the semi-structured interviews were designed to illicit more conversation on the subject matter than a specific singular response. The structured questionnaire surveys were only used on participants from the CDs and WDs while the semi-structured interviews were only to be used on participants from the fourteen key groups identified within Section 3.2.

Prior to data collection being initiated, pre-testing of the survey and interview questions was performed using two participants recommended by my advisory committee. The pre-test participants not only offered invaluable input due to their significant experience as current/past producers and as participants in Canada-U.S. trans-boundary water issues, but by being American citizens from the study area, they also offered the provision of the specific perspective of interest.

3.3.1 Questionnaire Surveys

One questionnaire survey, consisting of two parts, was used for CD and WD participants. While there are distinct differences between the "water" specific districts and the more general land-based conservation districts within Minnesota and North Dakota, both were of equal importance to the study since both have important influence (either directly or indirectly) over the loss and/or transport of nutrients within the RRDB. All participants were to complete Part I of the survey, while Part II was to only be completed by participants who were active producers of either crops and/or livestock.

The number of potential respondents desired for the questionnaire survey were determined prior to the initiation of recruitment by using the following considerations. The Minnesota portion of the RRDB contains twenty-three Soil and Water Conservation Districts and eight Watershed Districts (Appendix E, Table 4). The North Dakota portion of the RRDB contains twenty-five Soil Conservation Districts and fourteen Water Resource Districts (Appendix E, Table 4). After determining that the average number of people responsible for management of an individual district is between four to six people (one manager and three to six board and/or committee members), it was estimated that the four district types (i.e. Soil and

Water Conservation Districts, Watershed Districts, Soil Conservation Districts and Water Resource Districts) offer the potential for between 280 and 420 individual participants for the surveys (23 + 8 + 25 + 14 = 70, 70 x 4 = 280 and 70 x 6 = 420).

However, due to the fact I did not consider it reasonable to expect participation from all of the CDs and WDs within the RRDB (seventy in total) for the proposed study and in order to avoid problems from managing potentially too large a sample size, to make the numbers more reasonable to work with, I chose arbitrarily to limit the number of CDs and WDs targeted. The targeted recruitment from the various CDs and WDs within the RRDB was as follows: eleven of twenty-three from the Minnesota Soil and Water Conservation Districts, eight of eight from the Minnesota Watershed Districts, twelve of twenty-five from the North Dakota Soil Conservation Districts and seven of fourteen from the North Dakota Water Resource Districts (Appendix E, Table 5). In the cases whereby choices existed as to which districts would be recruited (i.e. eleven of twenty-three from the Minnesota Soil and Water Conservation Districts), the districts chosen were based on recommendations made by either the districts executive level or through individuals who work cooperatively with the districts and were knowledgeable of which districts were best suited to participate.

Therefore, the total number of districts targeted for recruited for the questionnaire survey was thirty-eight, each having between four and six members for participation in the survey, which offered the potential for between 152 and 228 total participants (Appendix E, Table 5).

3.3.2 Semi-Structured Interviews

One schedule was used for all participants of the semi-structured-interviews. All interviews were conducted using twenty-three standardized questions (Appendix D) and pre-

determined “prompts” used to gain clarification if required. The targeted number of study participants was based on the previously mentioned organizations in Section 3.2. Using one participant from each organization, including the executive level of each of the four CDs and WDs, was thought to be both practical and achievable and would provide fourteen total participants for the interviews. Consideration was given to try and recruit multiple people from the same organization for the semi-structured-interviews. The benefit to that strategy would have been more interviews, which would have given more data and made the results more accurate. The negative to using such a strategy is that the organizations of interest may not have supported the involvement of their personnel in this manner for various reasons, the most important of which would be that the potential for contradictions between responses by individuals from the same organization could have raised unwanted problems/embarrassment for the organization. While the identification of contradictions and/or differing ways in which a policy, program etc. is implemented at different levels can be revealing, due to being an outsider (non-American) requesting interviews with U.S. organizations, I did not want to risk alienating any of those organizations. As such, since I did not want to potentially cause any problems for the targeted organizations out of concern that it may impact organizational participation, it was deemed that one interview per organization would be sufficient.

3.3.3 Data Collection Logistics

Contact names for the organizations of interest were identified by one of two means, either by internet search or by recommendations made by one of the individuals used for the pre-test of the survey and interview questions. Initially, each of the contacts from the organizations identified in Section 3.2 was contacted by phone to identify whether they (or

someone else in their organization) would cooperate with me and participate in the study. During these phone calls, I used pre-determined talking points to explain the origin and purpose of the research and to also try and alleviate any potential concerns.

In the case of the CDs and WDs and the questionnaire survey, since the executive levels of each of the four district types (i.e. Soil and Water Conservation Districts, Watershed Districts, Soil Conservation Districts and Water Resource Districts) were targeted as participants for the semi-structured interview component of the study, rather than contact individual districts separately for recruitment to the questionnaire survey component of the study, the executive level were also asked whether or not they would aid in facilitating the recruitment of individual districts. This top-down approach for recruitment was done for three reasons. The first was that since the recruitment of thirty-eight individual districts was the goal for the study, at least thirty-eight separate phone calls would need to be made. Given varying schedules for each of the district managers as well as project timelines, it was determined that this method may not prove feasible or successful. Further, I had the concern that if contact was made with one district, prior notifications could be made between the districts about the project and influence their decision as to whether or not to participate. The second was that I deemed that higher recruitment from the individual CDs of interest would be achieved if "top-down" support was gained from the executive of each of the four district types. In other words, if the executive level agreed to participate in the project, then it was thought that the individual districts would also agree. The third and last reason for requesting the executive level of the individual district types to help facilitate recruitment of individual districts was due to the potential to also use this "top-down" support (if achieved) to distribute information and/or requests down to the individual districts of interest for the questionnaire surveys.

Once recruitment from the organizations of interest for the questionnaire survey was complete (i.e. notification from executive levels to individual districts), data collection was initiated. For the questionnaire survey, the executive level of each of the district types chosen for the study forwarded a package of material electronically to the individual districts of interest that included a copy of the projects Ethics Approval from the University of Manitoba, a copy of the Consent Form which provided an introduction to the researcher, a description of the purpose of the study (Appendix A) and a copy of the questionnaire survey itself along with instructions related to completing the survey. Return of the completed material to me occurred either electronically via e-mail or using a FedEx courier account.

For the semi-structured interviews, consent forms were sent to each participant by e-mail and returned the same way after being signed or they were signed in person. Most of the participants for the semi-structured interviews asked to view the questions in advance of the interview. Although I tried to avoid allowing advance reading of the questions by not offering it as an option, in order to potentially avoid losing participants, the questions were provided to all those who asked. In order to complete the interviews, separate timings were set up with each participant. While it is thought that in-person interviews would be more productive than phone interviews due to their more personal nature, logistical issues (i.e. timelines and the travel required) prevented this from occurring for all participants. As such, the interviews were planned to be conducted either in person or over the phone, which ever was more logistically feasible.

3.3.4 Data Collection Process

The process for recruiting participants from the Minnesota Soil and Water Conservation Districts, Minnesota Watershed Districts, North Dakota Soil Conservation Districts and North Dakota Water Resource Districts for the questionnaire survey component of the study began in December, 2013. A self-imposed deadline for returns was set at March 31, 2014. This was to not only allow me to meet academic deadlines, but to allow for discussion about the project at the district level as well as time for coordination of completions and returns. It was also strategically done so as to try and catch the district managers and any board/committee members who might be producers at a slow time in their year.

By January 2014, after back and forth discussions, the top-down approach for recruitment was agreed to by the executive level individuals on the Minnesota side of the RRDB (i.e. Soil and Water Conservation Districts and Watershed Districts) and saw the executive level send out a group e-mail to the individual district managers of interest containing the package of material previously described and the return date. Although I received three quick responses by district managers saying they would take part, no other responses were received. With only a handful of completed surveys returned by mid-March 2014, I began calling the district managers from the Minnesota Soil and Water Conservation Districts and the Minnesota Watershed Districts that had not provided responses. This effort resulted in several more completed surveys being returned.

Initial recruitment from the North Dakota districts was not easy since contact with executive level from the North Dakota Soil Conservation Districts and the North Dakota Water Resource Districts proved to be difficult. Even after this was rectified, problems still existed.

For instance, the contact person for the North Dakota Soil Conservation Districts was new to the position and had clear concerns about talking to me. Presumably due to these concerns, he eventually directed me to a more knowledgeable person within the North Dakota Soil Conservation Districts community. This was not a timely process and with the end of March deadline approaching and with no sense that the top-down approach was going to work with the North Dakota Soil Conservation Districts, I began calling individual Soil Conservation Districts to try and recruit them. The process was no simpler with the North Dakota Water Resource Districts (focused on via the Red River Joint Water Resource District). Similar personnel changes had been made within the executive level at the Red River Joint Water Resource District's board. Even once the contact person was clarified, the individual and the board as a whole had significant concerns about the nature of the project. I tried to alleviate those concerns by travelling down to a district meeting held at Hillsboro, North Dakota in March and giving a short presentation about the project. The final result was the completion of a group response from the Red River Joint Water Resources Board but no support to have responses from the individual districts within the Red River Joint Water Resources District.

The process for recruiting participants from the fourteen organizations of interest for the semi-structured interview component of the study began in December, 2013. A self-imposed deadline for completions was set at early March, 2014. Of the organizations that did participate, interviews were conducted in person with representatives (active or retired) of the United States Department of Agriculture, the Minnesota Pollution Control Agency, the Minnesota Watershed Districts and the North Dakota Department of Health at the 2014 Red River Basin Commission meeting held in Fargo, North Dakota from January 13-16, 2014. Interviews were conducted by phone with representatives from the United States Environmental Protection Agency, the

Minnesota Board of Soil and Water Resources, the Minnesota Soil and Water Conservation Districts, the North Dakota Department of Agriculture and the North Dakota Soil Conservation Districts on various dates between January 24th and March 29th, 2014. The shortest interview was completed in approximately 45 minutes while the longest lasted approximately $1^{1/2}$ hours.

During the first set of interviews conducted during the Red River Basin Commission conference, it became apparent that the wording of questions 2, 4, 9 and 10 (Appendix D) was not clear which resulted in the interviewer having to clarify their meaning. As such, between the interviews conducted at the Red River Basin Commission conference and the beginning of those conducted over the phone, wording of those questioned was changed to help facilitate clearer responses. Although most participants answered all the questions, in some cases, participants declined to answer some questions due to lack of familiarity on the subject matter.

3.4 Data Analysis

Analysis of collected data was performed via the organization of data from questionnaire surveys and semi-structured interviews on separate MS Excel spreadsheets after which responses were classified and grouped.

3.5 Research Limitations

I have identified two potential limitations related to this research. The first limitation lies within my own inexperience not only with the creation of questions for both the questionnaire and interview surveys but with my inexperience performing interviews and extracting the most information possible from the participants. Inefficiency in design and/or error in application can

influence the results via the potential to decrease the acquisition of accurate and useful data or increase the acquisition of inaccurate data.

The second limitation relates to my actual research question. Although contrary to the 14 years of nutrient data for the Red River at the Canada/U.S. border (Figure 6), it may be possible that actions already taken within Minnesota and North Dakota have resulted in meaningful nutrient reductions within the RRDB from the perspective that nutrient levels are not significantly higher than they would have otherwise been. However, due to the nature of the NPS nutrient problem, quantifying any purported nutrient reductions and attributing them to specific policy or effort would be extremely difficult and open to contentious debate.

CHAPTER 4: RESULTS

In this Chapter, I will discuss the overall participation by the targeted groups, will identify the views of participants from both the structured questionnaire surveys and semi-structured interviews on the issue of nutrient management within the RRDB and will identify the actions taken to date by stakeholders to address the NPS nutrient losses to surface waters.

4.1 Sources of Data Collection- Did the Targeted Participants Participate?

4.1.1 Questionnaire Surveys

The original goal related to recruitment from within the Minnesota and North Dakota CDs and WDs was not achieved. I successfully recruited only 19 of a projected 152 to 228 total participants (8.3-12.5% of the expected responses). However, by using the high and low projections of total respondents, an estimated sample size was calculated (152 + 228 ÷ 2 = 190) after which the calculated estimated response rate for the surveys (number of completed interviews ÷ estimated sample) was determined to be 10% (19 ÷ 190). Discussions with a subject matter expert in analytics identified that a 10% response rate is within the normal range of survey responses (Dr. C. Adams, personal communication, July 2, 2014).

What was achieved was eight participants from the Minnesota Soil and Water Conservation Districts, seven from the Minnesota Watershed Districts, one from the North Dakota Soil Conservation Districts and three from the North Dakota Water Resource Districts which included a group response from the Red River Joint water Resources Board. Broken

down further, 15 of the 19 respondents resided in Minnesota, 12 worked with CDs, 4 were producers and 3 worked in private business. No quantitative explanation can be given for why my response rate was so much lower than expected. However, the short comings between my own expected responses (152 to 228) and actual responses is thought to be due to combination of factors that may include, but not be limited to; too high of expectations on my part, busy schedules of the district managers (i.e. away on holidays), a laissez-faire response by district managers to the original e-mail from their executive level, personnel changes in key positions, a simple lack of desire to participate in the project, concern over the identified requirement to sign a consent form, distrust about the nature of the project as well as distrust of the person doing it (i.e. resentment about a non-American assessing American legislation, policies and actions).

Although the recruitment goals were not met regarding the survey questionnaire component of the study, those who chose to participate and complete the survey provided valuable insight into the research question and its related objectives.

4.1.2 Semi-Structured Interviews

The original goal related to recruitment of one representative from each of the fourteen organizations originally identified as being of interest was not achieved. Of the fourteen organizations targeted, five did not participate in the project. Specifically, the Minnesota Department of Natural Resources did not respond to either phone or e-mail requests. Although contact was made, the Minnesota Department of Agriculture were unwilling to participate (no reason provided). The Minnesota Environmental Quality Board refused to reply to either voice messages or e-mails even after successful contact was initially achieved and consideration for involvement initially given. The North Dakota State Water Commission pulled their

participation after a pre-assessment of the questions on the account that the department and their personnel did not deal with the subject matter. Lastly, the North Dakota Water Resource Districts (via the Red River Joint Water Resources District board) did not feel that they had someone qualified to talk on the subject matter after reviewing the questions. Regarding the interview questions themselves, out of the nine participants involved, a total of 16 out of 207 questions (9 x 23) were not answered. No pattern was evident regarding which questions were and were not answered.

As with the questionnaire survey component of the study, although the recruitment goals were not met regarding the semi-structured interviews, those who chose to participate in the interviews provided valuable insight into the research question and its related objectives.

4.2 Participant Views on Nutrient Management in the Red River Drainage Basin

As previously identified, economic and legal regimes combined with the social world-views within a jurisdiction influence not only the management of a resource (i.e. surface water quality) but the success or failure of any management goals. It was for this reason that the questions used for both the surveys and interviews were categorized into three broad themes (economic, legal and social) related to the objectives of the research.

However, while analyzing the data created from this study, I realized that while the majority of factors that influence the success or failure of a “managed issue” can be categorized within one of the three previously identified themes, not all do. A new factor that I identified as being particularly important for the issue being studied is that of “general government influence”, which I narrowly define (for this study) as involvement in an issue by government

that is related partly to all or some of the economic, legal or social influences yet was separate enough to warrant its own consideration.

Therefore, with the above in mind, the results of the surveys and interviews are organized according to the economic, legal, social or general government influences to which they are related.

4.2.1 Economic Influences

No matter what the issue, economic considerations inevitably have great influence. Although the goal of the research was not economically oriented, the issue of economics was still deemed to be important enough to try and identify to what level economics played a role in both the water and land management policies of Minnesota and North Dakota as well what role they played in the average citizen of each state supporting measures to reduce the degradation of surface waters via NPS nutrient pollution.

Participants of the semi-structured interviews were asked how much influence they thought economic considerations had in the establishment and management of federal and state environmental policies. Given a choice between economic considerations being very

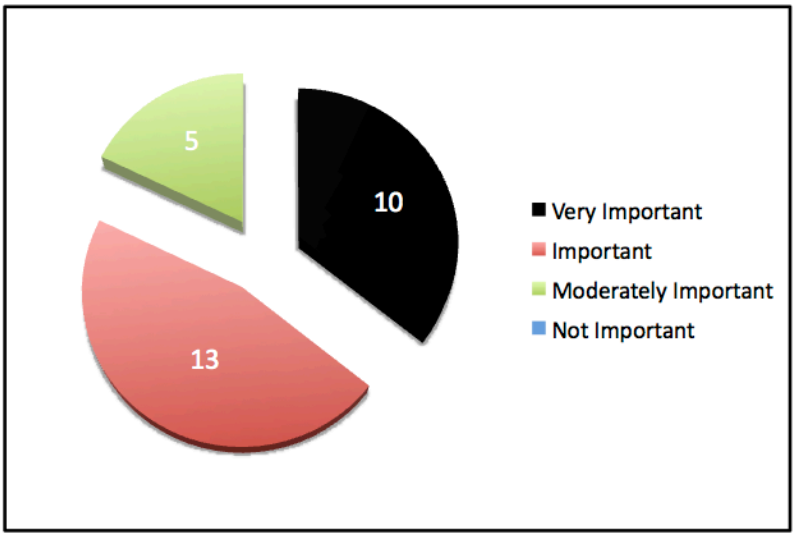

Figure 7: Summary of Views on the Importance of the Economy in the Protection of Land and Water (n = 28)

important, important, moderately important or not important, 66% (6 of 9) chose “very important” while 23% (2) chose “important” and 11% (1) “moderately important”. The questionnaire survey posed a similar question. When asked how important should consideration of the impact to the economy be when creating policy to protect land and water, 58% (11) chose important, 21% (4) “very important” and 21% (4) moderately important”. In combining the results, 13 of 28 chose “important”, 10 of 28 chose “very important” and five chose “moderately important”.

A follow-up question in the semi-structured interviews asked whether or not the participants felt that the influence of economics was purely a government developed position or whether they felt it was based on the assumed position/desires of the greater populace. Overall, with one “no answer”, five of nine participants stated they felt it was based on the position of the greater populace while three felt decisions were based equally on government and assumed positions on the subject by the greater populace.

One last economic oriented question was asked for this study. In Part II of the questionnaire survey, producers asked what loss in annual profit they would be willing to forego in order to decrease NPS nutrient losses from their lands to surface waters. All four producers stated that they would accept no loss in profit.

4.2.2 Legal Influences

As previously identified, the U.S. *CWA* is the main legislation when it comes to protecting the nations surface waters and has enormous influence on state water law and policies. Because of this, a number of the interview questions related to the effectiveness of the *CWA* regarding NPS nutrient pollution. Greater than 50% of the participants not only thought

that the *CWA* can protect surface waters from NPS pollution in its current form, but they also thought that the *Act's* exemptions for agricultural storm water runoff still allows it to meet its objective to "restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and non-point pollution sources …" (U.S. EPA). However, four out of seven respondents (with 2 "no answers") thought that the manner in which the *Act* addresses Animal Feeding Operations (AFOs) reduces the effectiveness of NPS nutrient control. When asked whether the *CWA* adequately protects waters flowing out of the U.S., four out of seven participants (with 2 "no answers") responded that that it does with 1 stating "it doesn't have a mandate to". Only one question within the survey portion of the study specifically mentioned the *CWA* while one other question mentioned "federal/state water quality related legislation". Of those, one out of 16 (19 participants x 1 question with 3 "no opinions") identified weaknesses in the *CWA* as a barrier to more aggressive reduction of NPS nutrient losses to surface waters.

The literature contains extensive information on the successes and failures in the use of command and control management in environmental issues. Research related to the *CWA* as well as federal and state water quality and nutrient management programs in both Minnesota and North Dakota indicated what can only be a purposeful decision by policy makers to avoid command and control measures in favour of optional measures for the protection of water quality in the two states. When asked about this via two separate interview questions, nine of 17 possible responses (9 participants x 2 questions with 1 "no answer") identified that the use of command and control measures are socially less acceptable than are other, non-regulatory options.

Due to the difference in both the nature of the methodology used as well as the participants involved, the issue of "regulation" in water quality management was addressed

differently in the survey than it was in the interviews. When asked about barriers that impeded more aggressive reduction of NPS nutrient losses to surface waters, from a list of greater than ten options, 10 of 16 (with 3 “no answers”) responded that one of the barriers was inherent social views against increased government (i.e. command and control measures). When provided a list of greater than five options on what measures they would support being implemented to ensure protection of downstream waters, only four of 18 (with 1 “no answers”) supported the use of increased regulation. Part II of the survey that was meant only for producers asked whether or not they would support the creation of any new regulations for controlling the application of fertilizer, one responded “yes”, one “no” and two provided “no opinion”.

Lastly, while not related to the efficacy of the *CWA*, an important issue that needed to be touched upon was that of the *Boundary Waters Treaty*, and more specifically its role and potential weaknesses within the RRDB. Because of this, a single question was asked in the interviews on whether the lack of legal enforcement under the *Boundary Waters Treaty* or in its use of the IJC as its mediating body put trans-boundary waters at risk from a water quality perspective. Of the nine participants, five responded “No”, three “Yes” and one “maybe”.

4.2.3 Social Influences

A number of relatively small but important issues related to social influences over land and water management policies and strategies were identified in this research. While some appeared in the literature (i.e. Verweij, 2000; Maddock, 2004), others simply were deemed to be a logical component of whether or not management of NPS nutrients could ever be successful. I chose to touch upon four social influences in the research.

The first relates to the overall view of Minnesotans and North Dakotans as to whether or not they believed that they had any responsibility to ensure water leaving their political jurisdiction is not degraded for downstream users. Of 19 participants in the questionnaire survey, 14 responded that they do have a responsibility to downstream users, while four had "*no opinion*" and one provided no answer. The second, asked to survey participants only, related to the confidence citizens had in "scientists" and the positions developed identifying agricultural as being the largest source of NPS nutrients and that nutrients can dramatically reduce both water quality and ecosystem health. Nine participants responded that they did have confidence in scientists and those conclusions while seven stated that they did not and three with "*no opinion*". The third related to the influence of special interest groups in the development of legislation and/or policy related to environmental issues (i.e. water quality). Of the nine participants in the interviews, 4 replied that special interests have both a negative and positive influence, 3 replied that they had a negative influence only while 1 replied they had a positive influence only. While not addressed on its own, one question within the survey allowed participants to choose "interference by special interest groups" as a barrier to decreasing NPS nutrients to surface waters. Of 16 responses (3 "*no opinion*"), only five chose to identify special interests as a barrier.

The last of the four smaller issues I touched upon was that of the general knowledge of Minnesotans and North Dakotas related to the LW issue as a whole as well as where a significant portion of the nutrients degrading the lake originate. Participants in the interviews were asked to rate their department's/organization's awareness of the issues facing LW on a scale of 1-5 with 1 being lowest. Of the nine participants, four rated their awareness as "4", two at "3.5", two at "3" and one at "2". Similarly, participants in the survey were asked the same

question with one rating their knowledge as a “5”, two as a “4”, nine as a “3”, five as a “2”, two as a “1”. The averaged knowledge between Questionnaire Survey participants and the Semi-Structured Interview participants was close with the former averaging a 2.8 level of knowledge and the later a 3.3 (Table 2).

A follow-up question to participants in the survey asked how they would rate their awareness that 1/3 of the nutrients entering LW originate from the Minnesota and North Dakota portions of the RRDB. Of the responses, one rated their knowledge as a “5”, four as a “4”, seven as a “3”, three as a “2”, two as a “1”. The averaged knowledge of survey participants was 2.9 (Table 3). Interestingly, two participants gave special responses. One stated they would not give an answer until they could see studies that stated such a statistic while the other stated that it was a “*loaded question, who says it*”.

It should be noted that of twenty-eight total participants in this study, twenty-one worked in the land and water conservation/management field. Therefore, since the knowledge of such individuals is expected to be higher than normal for related questions, I assume that the knowledge of the average citizen in Minnesota and North Dakota on these two questions would be significantly lower than the results from this survey imply.

Table 2: Comparison of Knowledge Between Interview and Survey Participants on the Decreasing Health of Lake Winnipeg

Semi-Structured Interview		**Questionnaire Survey**	
# of Participants	Level of Knowledge About the Issue	# of Participants	Level of Knowledge About the Issue
0	5	1	5
4	4	2	4
2	3.5	0	3.5
2	3	9	3
1	2	5	2
0	1	1	1

Table 3: Knowledge of Survey Participants on the Role Played by Minnesota and North Dakota in the Decreasing Health of Lake Winnipeg

# of Participants	Level of Knowledge About Role of MN & ND
1	5
4	4
7	3
3	2
2	1
0	0

Lastly, it was established that Manitoba's own inability to reduce NPS nutrient additions to surface waters within the LW drainage basin may be setting a negative example for Minnesota and North Dakota to reduce nutrients themselves. Upon further consideration, I wondered whether or not any remaining animosity by North Dakotans related to the Devils Lake issue, the Garrison Diversion or other issues could be impacting the effort to decrease NPS nutrients. As such, the overall issue of whether Manitoba's actions were influencing U.S. efforts or support was touched upon within both the surveys and interviews in different ways. For the interviews, participants were first asked whether the inability for Minnesota and North Dakota to achieve nutrient reductions in the RRDB over the last 20 years could be attributed in any way to Manitoba via poor diplomacy, poor leadership or other. Of the nine participants, five responded that Manitoba could be responsible for contributing to a lack of overall results with two responses identifying poor leadership for not taking control of the issue in their "own backyard", one identifying a lack of leadership on a comprehensive "*basin wide*" management strategy, one identifying "contradictory policies" and one identifying Manitoba's actions related to both Devils Lake and the Pembina River as "hurting their reputation". However, when asked whether or not Manitoba's inaction in addressing the NPS nutrient issue in their own jurisdiction would prevent Minnesota and North Dakota from addressing it themselves, seven responded

that it would not because Minnesota and North Dakota would address their own water quality issues regardless of what Manitoba does.

For the questionnaire survey, the topic was addressed much more simply via a single question. When asked if they had experienced or heard of any actions taken by Manitoba that would negatively impact their support for trying to improve water quality within the RRDB, 13 of 15 participants (with two "no opinions") responded that they had not.

4.2.4 General Government Influences

In western democracies whereby government plays a significant role in almost all day-to-day activities, many programs exist that are created and management by government. With regards to the protection of water quality and the attempted control/management of NPS nutrients, it is no different as both federal and state programs exist in an attempt to manage these issues. When asked whether government programs aimed at helping landowners reduce NPS nutrient loading to surface waters could be improved, 100% of the participants in the interviews said that programs could be improved. When given the chance to list the ways programs could be improved, six identified more funding was required, three that programs needed to be more flexible, two that programs needed to be less bureaucratic and single improvements were; better coordination between programs and the U.S. Farm bill, more education to land owners, for programs to be run at the local level, for programs to be more incentive based, increased will to implement programs, increased qualified staff to perform technical work, change to an "outcomes" oriented process and more proactive program staff.

Comparatively, when survey participants were asked the same question, 14 answered "yes", while four had no opinion and one provided no answer. Of those that answered that the

programs did need improvement, choosing from a list of options, 13 stated that programs should be less complicated/bureaucratic, ten stated programs needed increased funding, ten stated that programs needed more flexibility, eight said programs needed to be less restrictive to applicants while single improvements were for more education programs and more monitoring. This same question was somewhat repeated later in the survey when participants were asked whether current financial incentives from government programs for the incorporation of nutrient management related Best Management Practices (BMPs) was enough to attract and/or keep landowners using them, 16 answered "no", two "yes" and one with "no opinion".

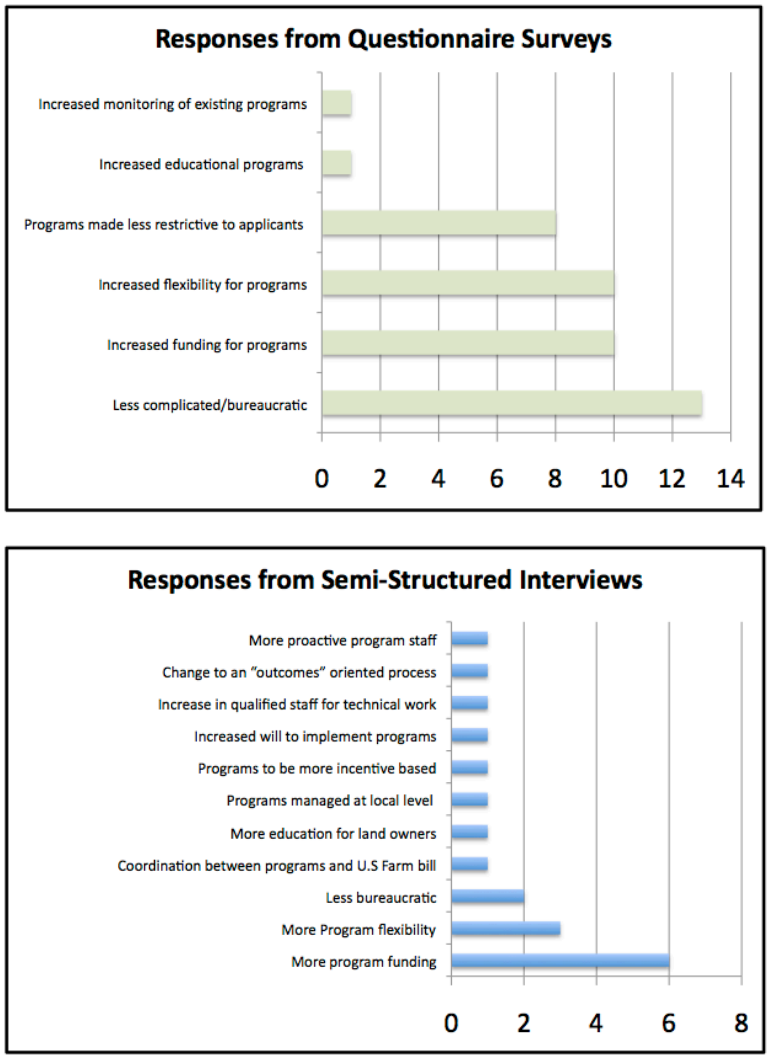

Figure 8: Comparison of Views Between Interviews and Survey Participants on the Ways Government Programs Related to Addressing NPS Nutrient Reductions Could be Improved (n = 19 and 44)

Another type of government influence over the management of NPS nutrient pollution is the use of the polycentric management systems such as the "watershed approach" and "IWRM". While the literature (as noted in Section 2.3.4) identifies both positives and negatives about government

use of such systems, six of nine participants in the interviews identified only positive aspects respecting the use of such systems with one identifying only negatives, one identifying both positives and negatives and one providing no response. When this same subject was expanded on in another question, five participants did not think that the use of such systems was an abdication of government responsibility, while three agreed this was the case and one providing no response.

Participants in the interviews were also asked whether new, soon-to-be established water quality criteria (including nutrients) that is lower than the current criteria and will be used on the Red River at the border could be realistically achieved, four answered “no”, two answered “yes” while three gave special responses that were linked to the timelines given to meet any reductions as well as how low the new criteria would be. For those that answered “no”, the difficulty/complexity of addressing the NPS nutrient issue, along with a lack of political will and increasing populations were identified as the biggest barrier to achieving reductions. When the participants of the questionnaire survey were asked the same question, seven had “no opinion”, seven stated that “yes” reductions could be met, four stated that “no” reductions could not be met and one had “maybe”.

4.2.5 Barriers to Achieving Nutrient Reductions

Given the data that indicates there has been little change in the amount of nutrient loading to the RR originating from the U.S. side of the RRDB (LWSB, 2006; Manitoba Conservation and Water Stewardship unpublished data, 2012), one of, if not the most important objectives of this project, was to try and identify all existing barriers preventing responsible authorities and/or stakeholders from achieving meaningful reductions.

One question within the interviews explicitly asked participants whether or not barriers existed that would inhibit reductions of NPS nutrients to the RRDB and if so, to identify them. All participants identified that barriers did exist and provided at least one example. Specifically, nine identified a lack of funding for programs, five a lack of private landowners support with single listings for a lack of political will, a lack of public support on the issue, a lack of public education on the issue, a lack of flexibility in programs and the voluntary nature of solutions. When combined with other answers given during the interviews, a full list of "barriers" identified included; weakness of the *CWA*, the influence of special interest groups, weaknesses or inefficiencies in federal/state programs aimed at reducing NPS pollution, weaknesses within the polycentric management tools being used, the importance of economic considerations, action taken (or not taken) by Manitoba regarding this issue and others and weaknesses with the *BWT*.

Similar to the interview questions, the survey also only asked one explicit question about the presence of any barriers that may impede nutrient reductions in the RRDB. However, given the nature of surveys, I supplied a list of thirteen potential "barriers", including an "other", a "none" and a "no opinion". With an allowance to choose as many as they thought applied, of the 16 respondents (3 of 19 answered "no opinion") the total number and types of "barriers" identified can be seen in Figure 9.

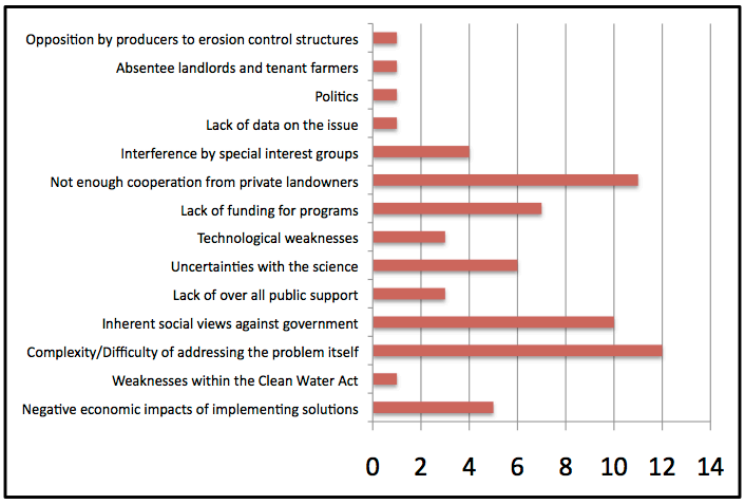

Figure 9: Barriers to Decreasing Nutrient Reductions in the RRDB Identified by Survey Participants (n = 66)

4.3 Actions Taken to Date for the Reduction of NPS Nutrient Losses to Surface Waters

Another of the objectives to this study was to identify actions either taken to date or in the initiation phase that may already be contributing to reduced nutrient loading within the RRDB. Neither the surveys nor interviews were very successful in eliciting from respondents a specific list of programs or initiatives known to result in either the purposeful or accidental lowering of NPS nutrients to surface waters within Minnesota or North Dakota. However, those that were identified included the continual funding of conservation programs within the USDA Farm Bill (federal), the creation and funding of comprehensive local water plans and other programs by Clean Water Legacy Funds (Minnesota) which attempt to address water quality issues, the development and implementation of *Watershed Restoration and Protection Strategies* (WRAPS) which use the watershed approach to protect waters (Minnesota), the incorporation of *Hydrologic Unit Codes* (HUCs) in to their water management which helps to prioritize water quality management activities by identifying all sub-drainage basins within a system (Minnesota), the development and implementation of stricter state regulations related to animal feeding operations which will reduce nutrient losses (North Dakota) and the inclusion of water quality considerations in the development of basin water management plans (Minnesota and North Dakota).

With the above said, document research of federal initiatives as well as initiatives from both Minnesota and North Dakota did reveal other efforts taken to date (note- this is not necessarily an exhaustive list). Amongst them, perhaps the most important for the future has been the support by both Minnesota and North Dakota for the International Water Institute's (IWI) Red River Basin Mapping Initiative which used Light Detection and Ranging (LIDAR) to

"*develop a high resolution digital elevation model (DEM)*" of the RRDB up to the Canada/U.S. border (IWI, 2013). While originally developed for use in planning flood mitigation projects and strategies, Minnesota has further funded the IWI to develop the *Water Quality Decision Support Application* (WQDSA) which uses the LIDAR elevation data for the Minnesota portion of the RRDB to identify likely source areas of pollutants down to a scale of 5 m grids (IWI, 2013 and personnel communication with IWI staff). Seeing as the largest portions of nutrients deposited to water bodies from the land come from few locations (Daniel et al., 1998), the availability of such data may allow land/water managers in Minnesota and North Dakota to focus efforts on areas with the greatest capacity for transporting nutrients from the land to water. Similar work is being done elsewhere in Minnesota via a *Clean Water Fund* joint project involving the University of Minnesota, the Minnesota Department of Agriculture and a Minnesota SWCD that is assessing an array of tool aid in identifying Priority Management Zones (PMZs) and Critical Source Areas (CSAs) to more efficiently implement BMPs in impaired watersheds. Minnesota also approved the *Clean Water, Land and Legacy Amendment, 2008* which increases state sale tax for funding of water related programs.

Other initiatives are reporting and record keeping requirements related to manure management in both Minnesota and North Dakota, the 2005 move by Minnesota to ban the application of phosphate-containing fertilizers in urban landscapes, the creation and use of nutrient management programs administered by the Minnesota Department of Agriculture, the development of the North Dakota Non-Point Source Pollution Management Program Plan by the North Dakota Department of Health and the financial support under the plan to landowners incorporating nutrient related BMPs in to their operations. The U.S. EPA continues to try and address NPS nutrient pollutants through either enforcement under the *CWA* (i.e. EPA vs. Cactus

Hill Ranch Company, EPA vs. Sterling Suffolk Racecourse LLC, EPA vs. Land and Cattle Company etc.) or the provision of grants under Section 319 of the Act for the implementation of NPS related initiatives. Lastly, not only have both Minnesota and North Dakota continued to support the Red River Basin Commission and its efforts related to managing water issues (including water quality) to the mutual benefit of all players in the basin, but after decades of mutual cooperation on other boards and task forces (i.e. International Souris-Red Rivers Engineering Board, International Red River Pollution Board, International Red River Basin Task Force) the U.S. federal government along with Minnesota and North Dakota agreed (along with Canada and Manitoba) in 2001 to "combine the ongoing activities and membership of the International Souris-Red Rivers Engineering Board and the International Red River Pollution Board into the International Red River Board" (IJC, 2013).

4.4 Chapter Summary

A summary of the results from both the surveys and semi-structured interviews revealed several key factors related to nutrient management in the RRDB. First, an extensive list of barriers to successfully reducing NPS nutrient loss to surface waters are deemed to exist. Second, existing federal and state programs related to nutrient management are seen as inefficient and in need of improvement. Third, economic considerations are typically viewed as being "important" to "very important" in the development of land and water protection strategies. Fourth, if the responses to the survey by the low number of producers who participated are accurate, all producers perform at least some type of conservation land management practices, although most could do more than they do. Similarly, no producers are willing to accept a reduction in profit in order to decrease NPS nutrient losses from their lands.

Fifth, if Manitoba hopes to gain successful cooperation to decrease nutrient loadings from the other jurisdictions within the LW watershed, they may need to start considering the implications of what actions they are/are not taking within their own borders with regards to NPS nutrients. Lastly, both Minnesota and North Dakota have shown effort to reduce NPS nutrient additions to the waters within the RRDB.

CHAPTER 5: PUTTING THE DATA IN CONTEXT

For an understanding of how to achieve the successful, long-term prevention of NPS nutrient losses to surface waters, more understanding is needed than the simple identification of perceived barriers or the assessment of actions already taken on the issue. To accomplish this, insight must be gained from both a practical perspective as well as a theoretical perspective. This chapter serves to provide the linkage between the results of the study and other related sources as well as other factors not identified by this study's field work.

5.1 An Assessment of the Barriers Preventing NPS Nutrient Reductions within the Minnesota and North Dakota Portions of the Red River Drainage Basin

As shown from the results of the questionnaire surveys, the semi-structured interviews as well as from the research into available and developing programs, both Minnesota and North Dakota have exhibited different levels of effort in trying to reduce NPS additions from land to surface waters within their political jurisdictions. However, given consideration of not only the water quality data from the Red River at the Canada/U.S. border which indicates little improvements in nutrient levels but the fact that a significant list of barriers to achieving reductions have been identified, it remains to be seen how effective those initiatives taken to date by Minnesota and North Dakota actually are. As such, to fully understand why reductions have not been achieved, the barriers themselves that have been deemed to prevent meaningful reductions need to be more closely examined and understood. Here, discussion focuses on eight of the 14 individual barriers identified from the questionnaire surveys and the semi-structured interviews (Figure 9) that have enough support from the literature to be deemed as valid

barriers. Further, some additional barriers deemed to be potentially significant but neglected by the project participants are also discussed.

5.1.1 The Difficulty of Addressing the NPS Pollution Problem

Prior to the collection of data, I proposed that the general complexity and difficulty of addressing NPS pollutants (especially agriculturally sourced NPS nutrients) was potentially a significant reason why NPS nutrient additions to surface water were not with any regularity, being reduced anywhere in the world. This thought was supported by the results of the research with participants identifying it as the largest single barrier. But what does it really mean? As identified in Section 2.3 of this paper, NPS nutrients are difficult to manage for a variety of reasons. Losses of agriculturally sourced NPS nutrients are dependent upon factors such as crop type, soil type, topography, land management practices and climate. Serious challenges exist regarding the intermittent nature of losses (Bunting et al., 2010), the implementation of monitoring and enforcement programs (Boyd, 2000) as well as from the economic, political and other complexities that are also a part of the issue (Adler, 2013). It was also identified by one of the interview participants that “NPS pollution has not always been taken seriously by government”. It is for these reasons why, in the face of a serious known problem, strong legal frameworks meant to address the problem still have not been developed in the U.S. and Canada. The result of this inaction has been a reliance on landowner use of BMPs to control NPS pollutants. While having the ability to help reductions, BMPs have proven largely unsuccessful due to the voluntary and intermittent nature of their usage.

Given the difficulties related to the nature of the problem, project participants seem to be correct in identifying the difficulty of addressing NPS nutrients as being the largest single

barrier to achieving nutrient reductions within the RRDB. Authors Laitos and Ruckriegle (2013) support this conclusion when they point out "even the EPA has acknowledged that '[w]ithout a clear understanding of how to minimize pollution from non-point sources, state and local organizations will be unable to develop strategies to protect their water resources" (page 1045).

With no appetite to address the difficulties of the issue via changes to the *CWA*, the creation of science-based NPS legislation at the state level, increased incentives for landowners or wide-scale implementation of technologically based solutions such as that related to the IWI's *Red River Basin Mapping Initiative*, successful reduction in NPS nutrient pollution anywhere within the U.S. will continue to be difficult.

5.1.2 Lack of Cooperation from Private Landowners

As identified by Chouinard et al. (2000), claims exist that "farmers are inherent stewards of the land and, provided the information, will adopt conservation technologies" (page 66). Other claims identify that producers will only implement conservation practices if they are profitable (i.e. they will not forgo profit to implement conservation practices). Not only does economic *rational choice theory* support the latter claim being the correct explanation as to what guides a producer's decision making, but the results of this study, whereby 100% of the producers stated that they would not forgo profit in order to reduce NPS nutrients from their lands, indicated the same. Yet if this was true, then under similar conditions, they should all make the same choices (Chouinard et al., 2000), which has been identified as not true (Chouinard et al., 2000). In a 2000 study, Chouinard et al. identified that the motivations of a producers willingness to implement conservation practices as well as what the triggers are for determining the degree of implementation, are extensive within the conservation literature, yet

contradictory. However, although the conclusions of their study indicated a clearer linkage to "profit maximization as the primary motivational factor" (page 79), weaknesses in the methodologies used in the studies assessed by Chouinard et al. leave that answer in doubt.

More contemporary studies investigating what causes producers to adopt conservation practices in their operations revealed much the same as Wossink and Osmond, 2002 and Lemke et al., 2010 both identified the importance of economics and lost economic opportunity as being of prime importance while Prokopy et al. (2008) identified that "the results are clearly inconclusive about what factors consistently determine BMP adoption" (page 308).

As such, until more conclusive research is performed, the only person who knows why a producer makes the choice he/she makes, is the producer themselves. It may be guided solely by profit, personal satisfaction of being a good steward, the seeking of personal recognition of being a good steward (Chouinard et al, 2000) or even religious beliefs. Or it may be guided by all those factors (and more). However, since it has been identified that a common practice by landowners is to apply two years' worth of fertilizer in one year for certain crop types to save money, time, and labor (IJC, 2014), since it has been identified that the application of fertilizer to agricultural lands exceeds outputs in produce (Carpenter et al., 1998) and given data from the USDA (2011) that indicates "nearly twice as much manure was added to about the same number of crop and pasture acres in 2008 as in 1996" (page 18), cooperation from private landowners regarding NPS nutrient pollution clearly has considerable room for improvement.

5.1.3 Anti- Government Intervention

The results of the questionnaire survey identified that 53% of respondents identified "inherent social views against government" as a potential barrier to reducing NPS nutrient loading within the U.S. portion of the RRDB. This result should not have been a surprise for as Verweij (2000) states, "more than any other nation, Americans value liberty, egalitarianism, individualism, populism and laissez-faire" (page 1029) which translates into a single commonality, "a dislike and distrust of central government" (page 1029). Author Ari Shapiro, in an article titled *Distrusting Government: As American As Apple Pie*, states that "a study of history shows that the roots of government distrust stretch far back into America's past". To add one more explanation for such anti-authoritarian views (specifically related to environmental issues), Adler (2013) points to "collective societal amnesia" over "the rivers catching fire, the massive fish kills, or the beaches filled with raw sewage" (p 779) that helped to first draw attention to the issues of water pollution and ecological destruction (today, citizens from neither Minnesota or North Dakota are experiencing firsthand the on-going degradation of LW). To quantify such views, the results of a 2011 survey of U.S. citizens by Gallup Analytics not only indicated "historic negativity towards the government", but it identified that almost half (49%) believe "that the federal government poses an immediate threat to individuals' rights and freedoms" (Gallup Analytics). In 2013, that number climbed to 53% (Pew Research Center for the People & the Press). While most of the participants in the semi-structured interviews identified "social palatability" as one of the reasons why increased regulatory measures to limit NPS nutrient losses were not seriously considered, one participant identified more specifically

that it was due to “the culture within the U.S.” which I have linked as being related to anti-government world-views.

How does anti-government world-views relate to the issue of reducing NPS nutrients? In Minnesota, 23.5% of the total state is owned by the federal or state government. In North Dakota, it’s dramatically lower with only 9.1% of the state owned by the federal or state government. Westra et al. (2002) point out that any regulation over producers may be considered by some as a taking of private property rights and production rights even though the action of producers are negatively impacting the property rights of others whose property, livelihood, aesthetic well-being etc. are connected to the water in which the producers are degrading. Regardless of how it is viewed, the U.S. has some of the strongest protections in the world for private property holders and any type of forced requirement for private landowners related to lowering NPS nutrients from their land would most likely be viewed as negative.

As such, for an issue that is almost fully dependent upon the voluntary implementation of conservation land management practices by private landowners and for an issue where those same landowners own 76-91% of the land in question, it becomes clear how inherent anti-government world-views can be a significant barrier to achieving a goal that requires their cooperation. An example of the interconnectivity between the two issues was the failure of the *CWA’s* Section 208. According to Laitos and Ruckriegle (2013), “the most significant explanation for Section 208s failure lies in the basic resistance of local governments to federal efforts to dictate planning structures and results, however flexibly those programs are designed” (page 1042). In other words, knowing that government designed and dictated measures to prevent water pollution would not be readily accepted and the repercussions would probably occur during elections, local (mostly rural) governments did not cooperate.

5.1.4 Lack of Funding for Programs

Though one of the largest barriers to achieving NPS nutrient reductions identified by study participants, the concern over the lack of funding available for water quality projects, especially those related to NPS nutrient reductions is hard to quantify. The most significant funding source for land conservation related programs (and one identified by participants in this study) is what is commonly known as the U.S. *Farm Bill*. Re-legislated approximately every five years, the Bill (the current version of which was approved in 2014 and is in effect for 10 years), is funded for $956 billion and establishes agricultural, nutrition, conservation, and forestry policy in the U.S. (U.S. Senate Committee). The funding allocated for conservation-related programs in the current version of the bill is for approximately $56 billion, up from approximately $38 billion in the 2002 version of the bill (Chouinard et al, 2000).

Funding specifically for NPS reduction efforts also comes from Section 319 of the *CWA* and which is administered through the EPA. However, in terms of available dollars, Laitos and Ruckriegle (2013) identified that when the section was enacted in 1987, $400 million/year was authorized to fund state programs but that the U.S. Congress has "never fully appropriated the total amount of funds" (page 1043). The authors close their description of Section 319 funding by stating that it "provides little economic support to states" (page 1045).

While states access and use both Farm Bill and Section 319 funding for management within their boundaries, they do also use some of their own funds. For Minnesota, the current biennial budget indicates a total of $312.5 million being budgeted for all costs related to environmental and agriculture services through 2014-2015 (Minnesota State Budget Office, 2013). It does not give a further breakdown between salaries for employees, specific program

expenditures etc. For North Dakota, the current biennial report does not identify a complete line-item list of expenditures for various operating units (i.e. Department of Health which oversees water quality issues) nor does it identify the source of the funding (i.e. internally sourced or federally sourced). Further, the WDs in Minnesota and North Dakota both have the ability to generate funding for their programs through tax levies.

Without more detailed information on how much money is actually available for programs meant to address NPS pollutants, it is hard to make a conclusion one way or the other as to whether or not the "lack of funding" issue raised by participants in this study is a real or perceived barrier. As one interview participant pointed out, unlike human health related issues that when raised, have no problem acquiring funds to help mitigate a problem, there are limits with regards to funding for environmental issues. As such, while it is safe to say that almost any program can become more efficient, given the fact that 66% of the participants in the interviews (eight of which are government level program managers) identified lack of funding to be an issue, I side with their experience and judgment that lack of funding for NPS related programs is a genuine barrier to achieving improvements.

5.1.5 Uncertainties with the Science

Research has indicated that farmers and conservationists/environmentalists view the same issues quite differently (Burgess et al, 2000). When asked to identify all barriers to achieving NPS nutrient reductions, 32% of participants in the questionnaire survey identified "uncertainties with the science". Further, a specific question asked the participants whether or not they had confidence in scientists when they heard agricultural activities identified as the main contributors of non-point source nutrients to surface waters and that nutrients in excess can

dramatically reduce water quality and ecosystem health. A total of 44% of those who responded to the question (including 3 out of 3 producers with 1 "*no opinion*") answered that they did not have confidence in what scientists were stating. For an issue in which a significant barrier to achieving meaningful nutrient reductions may be a lack of support from private landowners, such a level of distrust is significant due to the logical realization that landowners will not choose to aid in solving a problem if they do not think a problem exists.

While skepticism from society on all sorts of issues is nothing new, Maddock (2004) identifies that "there is growing skepticism and distrust of government agency science used in environmental regulation" (page 219). Maddock blames this on what she refers to as "regulatory science" which is defined as "science conducted for regulation and the policy formation process" (page 219). Further, the specific issue of NPS pollution can be difficult for landowners to understand. As Haycock and Muscutt (1995) point out, the NPS issue in some cases can be "considered to be a figment of scientists imagination" (page 313) and many of the landowner respondents to this study appear to fall in line with this. Such concern is understandable given the politically charged nature of policy formation caused by the combination of various actors, their own interests and the science involved in the process.

Another area that has caused uncertainty among landowners is the use of modelling to predict not only the impacts of continued nutrient loading, but the level of corrective measures required. Awareness by rural landowners and their municipal level governments (many of whom have spent their entire lives on the lands now of concern) as to the importance of modelling in the formation of many environmentally related standards (i.e. TMDLs) only heightens the skepticism. Lastly, it was noted by the researcher during casual conversations conducted over the course of the research (i.e. RRBC Conference) that the view held by many

from the U.S. side of the RRDB was that the high natural fertility of the RRDB itself was THE major reason for the increased nutrient levels within LW and for its ongoing degradation. Of course this is known to be incorrect. A 2010 paper by Bunting et al. studied the ecosystem state change in LW during the 20th century via paleo-limnological core samples from the lake's south basin. The authors identified that prior to 1900, the lake was mesotrophic with baseline P around the 15-20 μg L^{-1} level. Between 1900 and 1990, P and N levels increased up to 50% and since 1990, have increased even more. The cause in the changes was attributed to agriculture within the LW watershed.

Whether or not deserved, the literature supports the results in this study which have identified distrust in science and/or scientists as being a genuine barrier to achieving NPS nutrient reductions. What the literature does not cover is whether or not the distrust identified is genuine or whether it is a distrust of moral and ethical convenience related to actions which some producers may fully and coherently understand are degrading water quality. The potential for such a circumstance is best described by Upton Sinclair who wrote "It is difficult to get a man to understand something when his salary depends upon his not understanding it."

5.1.6 Negative Economic Impacts of Implementing Solutions

The most common argument against the use of regulatory measures to protect the natural environment or the incorporation of sustainability measures is that there will be a net economic decrease via reduced productivity and competiveness, either individually, as a business operation or collectively, caused by instituting such measures. As seen in the results of this study whereby more than one-quarter of participants in the questionnaire survey identified this

as a concern, agricultural related issues are not immune to this concern. However, is this argument accurate?

In a 2005 study, Jaffe et al. examined this question. The results of the study indicated that there was little evidence to support the hypothesis that environmental regulations either positively or negatively impacted a nation's economy. Similarly, Adler (2002) points out that when PS regulatory requirements were first being established, government and regulators "faced predictions of economic doom, but those significant industrial changes have been accomplished thus far with no major national economic disruption, and in fact evidence indicates that those changes have enhanced rather than impaired the U.S. economy" (page 86) while Meyer (date unknown) identified that "economic analyses strongly suggest that no lasting macro-economic gains will be forthcoming (from environmental de-regulation)" (page 1).

It must be noted though that the specific BMP of maintaining buffer strips between the managed land and a waterway, if ever turned into a legal requirement, would indeed result, under certain circumstances, in the exact issue of concern (i.e. reduced economic output). Currently, as well as during unpredictable cycles, commodity prices become high enough whereby they spur producers into maximizing the agricultural output of their lands. This results in treed areas being cut and burned, poor quality land being brought into production as well as the removal of grassed buffer strips and riparian areas for the same reason. With the positive impact of buffer strips and riparian areas on the reduction of NPS nutrient losses to surface waters well known, should a regulation be instituted making certain buffer strips and riparian areas a requirement, producers would lose out on the extra productivity during the times of high commodity prices. Research for this project supported this whereby not only did an interview

participant state that “as commodity prices increase, producers put more low quality land (i.e. highly erodible, low nutrients etc.) into production”, but a landowner stated;

> *Farming has changed significantly in the last 20 years, but the last 3 years, or so, there are a large amount of farmers tearing down tree windbreaks. Land is changing hands and the biggest farmers are buying it. They are the ones with the largest machinery and so leaving a fallow strip next to a row of trees or going around a clump of trees where a farmyard used to be is wasting money and/or too inconvenient.*
>
> *…. attempting to persuade landowners to allow for a (wider than required) grass strip to be planted along a legal ditch system…., but no progress was made due to crop revenues being much higher than grass strip revenue.* (D. Omdahl, personal communication, February 24, 2014)

Under circumstances whereby producers would not maximize their economic output via the maintenance of natural areas on their lands (i.e. keeping buffer strips and riparian areas out of production), a solution that would both compensate landowners and promote such sustainable management could be the use of government subsidies to reduce the difference between the potential earned vs. actually earned. Use of such a system would be easily implemented as it would simply be calculated by using the commodity price at the time multiplied by the acreage of land kept from production multiplied by the average production per acre.

Therefore, while it is clear that the concern for the creation of negative economic impacts caused by government command and control measures (regulations) to reduce NPS nutrient addition is more perceived than reality, it is not entirely unfounded under very specific circumstances.

5.1.7 Interference by Special Interest Groups

> *In the idealized democratic society, economic policy is determined by "one man, one vote." But in all real societies, special interest groups play an important role in the process that determines economic policy* (Grossman and Helpman).

All countries, no matter whether rich or poor, have special interest groups that try to influence government and policy development. Further, seemingly few issues exist that do not have special interest groups attempting to provide influence. The common form by which special interest groups try to influence government and policy development in western democracies is through paid lobbyists, funded by the groups and organizations they represent which range from pro-environment/conservation organizations to oil and gas related groups, tax reform groups and agriculture groups. However, for whatever the reason(s), special interest groups are especially pervasive and powerful in the U.S. As of early 2012, Washington D.C had approximately 12,663 registered federal lobbyists (Grier, 2012) while total annual spending on lobbying the U.S. federal government was approximately $3.3 billion. The number of individuals involved “in non-covered lobbying activities such as grassroots initiatives and advertising may be seven times that high” (Shalal-esa, 2009). Of the ten biggest special interest groups in the U.S., three (the mining industry, the oil and gas industry and agri-business) are groups that by their very nature, routinely threaten the health of water resources. None of the top ten are groups that protect water resources or the environment as a whole.

While the success of anti-regulatory special interests over the years with regards to influencing and diminishing the reach of existing or proposed legislation is deemed to be due to disparities in both power and financial resources between those groups and the ones

representing the greater public good (Adler, 2013), 33% of participants in this study thought that agricultural special interest groups had a negative impact on the creation/improvement of environmental legislation related to water quality, 22% thought they had a positive view while 44% thought they had both a positive and negative influence.

A common target of special interest groups over the years has been the *CWA* and its goal to protect the health of U.S. waters. While many argue that the actions of special interests are necessary to prevent the implementation of unnecessarily stringent regulations, referencing current data on the health of U.S. lakes and rivers once again weakens such an argument. So common has the targeting of the *CWA* been over the years that a participant of Verweij's 2000 study who worked for the EPA estimated that "90% of all water regulations developed since the 1970s have been challenged in court" (page 1025). While special interest groups in favour of environmental protection and resource conservation have been successful (via the use of lawsuits) in ensuring clear requirements of the *CWA* are adhered to and enforced, it pales in comparison to the success that the largest special interest groups have had over the years in minimizing the extent and effectiveness of the *CWA*.

Because it is thought that increased regulation of NPS pollution would threaten to erode the sectoral autonomy of agricultural operations, Laitos and Ruckriegle (2013) sum up the efforts of agricultural special interests by saying "the agricultural industry has long been exempt from many of the costs of water pollution abatement, and will not willingly acquiesce to a new level of regulation that seems only to benefit downstream interests" (page 1052). However, the efforts of special interests to undermine government attempts to address NPS nutrient pollution can be seen in specific instances.

For example, special interests can be credited with getting the original exclusion for agricultural runoff from the *Act* when it was first developed, opposition from a coalition of agricultural and industry groups achieved the abolishment of proposed TMDL related regulations in 2003 via influencing Congress to prohibit the EPA from spending any money on the proposed regulations and initiating a number of lawsuits challenging the regulation itself (Adler, 2014). The U.S. National Pork Producers Council initiated a lawsuit on behalf of the approximately 450,000 AFOs in the U.S. and achieved a partial abolishment of proposed changes to the *CWA* requiring CAFOs to develop and implement nutrient management plans and submit them as part of their NPDES permit application (Angelo, 2013). More routine efforts have seen the continued fight by special interests to maintain current agriculturally related exclusions, the continued opposition by agricultural special interests to the application of TMDLs (Adler, 2002) and "the subversion of [CWA] statutory goals at administrative, judicial and legislative levels" (Adler, 2013, page 759). Perhaps the most well-known instance of special interests fighting against the *CWA* and one that is currently still active is the on-going lawsuits by a group of organizations that include the American Farm Bureau Federation, the National Association of Home Builders, the National Corn Growers Association, the National Pork Producers Council, the Fertilizer Institute and the US Poultry & Egg Association to fight a TMDL plan by the EPA to clean-up the water flowing into Chesapeake Bay.

Although the study's findings did not necessarily align with the reality of how special interests have and will continue to influence not only current, but proposed implementation of the *CWA* and other water protection measures, they nonetheless substantiated that special interests do have a role to play in the attempts to address NPS nutrient loading to the RRDB.

5.1.8 Legislative Weaknesses

5.1.8.1 The Clean Water Act

The use of legislation in governance is meant to achieve what is thought to be an overall benefit to greater society. Legislation related to environmental issues is no different, for without it, individuals, private business and even government itself would be free to pollute and destroy the natural environment (and cause adverse impacts to humans) without the risk of consequences, which are usually levied in the form of financial penalties but can involve, in the most egregious cases, prison. The creation in 1972 of the United States *Federal Water Pollution Control Act*, more commonly known as the *Clean Water Act* (*CWA*), was no different. Although the history of its development and changes made over the last 40 years (including delayed implementation of programs and various types of purposeful subversions) make for an interesting read, for the sake of this thesis, focus will be solely on the *Act's* mandate and the tools it has to carry out that mandate.

Given the *Act's* objective to "restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and non-point pollution sources" and given data on the water quality of lakes and rivers in the continental U.S. which indicates, amongst other things, that 53% of the nation's assessed river miles are impaired in at least one respect and 42% of assessed water bodies were in biologically poor condition (Adler, 2013), the *Act* has clearly failed to meet its objective. While participants in both the questionnaire surveys and the semi-structured interviews were asked either directly or indirectly about the *CWA*, the results were not as expected since few identified or linked weaknesses of the *Act* with the state of U.S. water quality as related to NPS pollution. Even more surprising was that greater than 50% of

interview participants thought that the *CWA* in its current form could protect waters from NPS pollutants.

Under Section 301(a), the CWA makes any discharge of any pollutant to a waterway unlawful. Key definitions within the *Act*, identified under Section 502, that determine its efficiency are;

> Discharge of a Pollutant and Discharge of pollutants- *means (A) any addition of any pollutant to navigable waters from any point source;*
>
> Navigable Waters- *the waters of the United States, including the territorial seas;*
>
> Point Source- *means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture;*
>
> Pollutant- *means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water;*
>
> Pollution- *means the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water. (U.S. CWA)*

As can be seen, weaknesses of the *Act* begin with its definitions. For instance, the discharge of a pollutant covers only discharges from “point sources” and discharges to “navigable waters”. The term “navigable waters” is vague and has caused much debate. Historically, the EPA has interpreted the term “waters of the United States” very broadly to include waters that are not navigable such as small rivers, streams and intermittent streams

which have caused significant legal challenges (Angelo, 2013). However, the U.S. Supreme court in separate rulings (Rapanos v. United States and Carabell v. United States) has more narrowly defined the definition of "navigable waters", thus making the jurisdictional reach of the *CWA* further limited. The definition of "point source" not only explicitly excludes agricultural sources but is defined in such a way that it exempts large categories of polluters from being covered by the *Act* (Adler, 2013). The *CWA* further identifies agricultural and silvicultural activities (including runoff from fields, crop and forest lands) as non-point sources of pollution (Laitos and Ruckriegle, 2013). As such, the *Act* is severely limited in its ability to address NPS pollutants. This conclusion is supported via a 2014 report from the Commission for Environmental Cooperation (CEC) related to a submission from private parties asserting that the U.S. was failing to effectively enforce the *CWA* against coal-fired power plants for discharge. The report detailed the response to the submission by the U.S. EPA which stated that the *CWA* "provides no authority to regulate non-point sources of pollutants" and that "Congress has not authorized the U.S. EPA to regulate or compel states to regulate or otherwise control non-point sources of pollution" (page 2). Further, the U.S. Tenth Circuit Court of Appeals identified that "[i]n the Act, Congress has chosen not to give the EPA the authority to regulate non-point source pollution" (Laitos and Ruckriegle, 2013).

In assessing the core sections of the *Act* related to pollution, its main mechanism to limit water pollution falls under section 402- *The National Pollutant Discharge Elimination System* (NPDES) which is a program to regulate sources of water pollution. The problem with section 402 is that it only covers PSs, not NPSs of pollution. Section 303 of the *Act* requires states to establish water quality standards for all individual lakes, rivers and streams that considers all uses and at a minimum, protects the water body's existing uses via an "anti-degradation

policy,". States must submit their proposed standards to the EPA for approval, and if they fail to meet the intended requirements either during the planning or active management phase, the EPA will take over the state's standard-setting function for receiving waters. Section 303(d) of the *CWA* requires states to identify all waters that do not meet the water quality guidelines (otherwise known as the impaired water list) and subsequently establish a priority ranking of the water bodies on that list as well as a Total Maximum Daily Load (TMDL) for all pollutants preventing or expected to prevent attainment of the standards. A TMDL identifies how much of an individual pollutant a specific water body can handle without exceeding the water quality standard and requirement to consider "all pollutants" allows for inclusion of NPS pollution.

However, while establishing an individual water body's TMDL is important, as Angelo (2013) identifies, the challenge is determining the allocation of the pollutants between all polluters (PS and NPS). For the sources identified as NPSs, Adler (2002) identifies that "the EPA through the *CWA* lacks the authority to forcefully develop and/or implement NPS control measures if the states fail to do so" (page 80). Overall, when it comes to assessing the value of the *Act's* Section 303, the *Center for Progressive Reform* identifies that "TMDLs are nothing more than a paper exercise in which states and EPA identify sources responsible for ongoing water pollution and calculate how much additional control is needed from which sources in order for WQS (water quality standards) to be attained and maintained. The real battle involves whether and how new pollution controls will actually be implemented" (Adler, 2014 from http://www.progressivereform.org/perspTMDLs.cfm). A further weakness of Section 303(d) and one that relates strongly to the nutrient loading with the RRDB is the requirement that a TMDL must contain a margin of safety and consider "seasonal variations". This could allow a

loophole by which agricultural and other land management practices responsible for causing higher than natural nutrient levels, are allowed to continue.

Section 319 of the *CWA- Non-point Source Management Program*, was created during the 1987 amendments to the *Act* and meant to be a replacement for the failed Section 208, which gave oversight of NPS water pollution to the states without any ability to control it. Section 319 requires states to create and submit reports to the EPA identifying "those navigable waters within the State which, without additional action to control non-point sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of this Act" (CWA). The required reports must include the identification of BMPs to reduce NPS pollution loading; the identification of programs to achieve implementation of BMPs; a schedule with milestones for program implementation; certification by the state's attorney general that the laws of the state provide adequate authority to implement the NPS management plan; and the identification of assistance and funding sources. Acquisition of financial assistance by states is dependent upon making "satisfactory progress" (Laitos and Ruckriegle, 2013). Whether a state chooses or not to prepare and/or implement a management plan under Section 319, there is no requirement for the plans to contain enforceable measures (Laitos and Ruckriegle, 2013). Overall, according to Laitos and Ruckriegle (2013), "Section 319 has continued to rely on an ineffective voluntary approach to agricultural non-point source pollution that has failed to reduce pollution levels" (page 1045).

The *CWA* gives states the responsibility to regulate agricultural non-point sources of water pollution. However, water quality data from across the U.S. indicates the states' have failed to perform this duty effectively (Laitos and Ruckriegle, 2013). While Andreen (2004) views the cause of the *CWA*s failure to address NPS pollution as being due to NPS pollution

being “treated as something as an afterthought, a troublesome area to be primarily left in the hands of local and state governments” (page 593), there are other theories. Adler (2013) postulates that failure of the *CWA* is due to (amongst other things) unrealistic expectations, influence of special interests, a managing organization (the EPA) unwilling to pursue the original intentions of the legislation, and poor policy meant to meet the *Act*’s objectives while Verweij (2000) simply states that the *CWA* was badly designed and badly implemented.

5.1.8.2 The Boundary Waters Treaty

Similar to gaining insight related to the *CWA*, project participants (interviewees only) were asked about potential weaknesses of the *BWT*. While results were comparable to those related to the *CWA* (56% did not think weakness of the *BWT* placed trans-boundary waters at risk), it is not as much as a surprise seeing as the workings of the *BWT* are most likely not an interest to those targeted for this project due to the likelihood of it being seen as too political a process, existing at too high a level or something similar. However, given the *BWT* is the main legal agreement between Canada and U.S. for trans-boundary waters, it is important to understand how water of reduced quality from one signatory has been allowed to cross the border and negatively impact a resource of the other signatory.

Disputes between Canada and the United States related to trans-boundary water resources occurred early and often in the evolution of the two countries and played an important role in the development of what is deemed to be a revolutionary legal agreement known as the *International Boundary Waters Treaty Act* (*Boundary Waters Act* or *BWA* or the *Treaty*) of 1909. While “often cited as a model of success” (Fischendler and Feitelson, 2005) for other nations looking to formalize agreements over trans-boundary waters, review of the literature

assessing the *BWT* raises doubts about whether or not the *Treaty* has the capacity to deal with contemporary water quality issues such as those involving NPS pollution.

In a 2008, Ma et al assessed three major aspects of the *BWT,* each of which was assessed using specific criteria. The major aspects and criteria used in the assessment were i) enforcement capability, ii) treaty implementation; and iii) dispute settlement mechanisms. Given the assessment criteria used, the results of the study indicated that the *BWT* unsatisfactorily addresses the enforcement capability aspect (failing all four of the criteria), unsatisfactorily addresses the treaty implementation aspect (failing all three of the criteria) and only satisfactorily addresses the dispute settlement mechanism aspect (failing only one of three of the criteria). Further, the study also compared the *BWT* against three other trans-boundary water agreements. Of the four agreements (including the *1998 Rhine Convention*, the *1995 Mekong River Basin Agreement*, the *1992 UN ECE Helsinki Convention*), the *BWT* exhibited the worst performance according to the authors.

Some of the results from the Ma et al study are supported by others. Papers by DeWitt (1993); Flanders (2006); and Signorelli (2011) all concur with Ma's assessment for a lack of enforcement capability within the *Treaty* while Sadler (1986) and DeWitt (1993) agree with Ma's critique of the *BWT*s implementation mechanisms by identifying that issues are referred to the IJC "only when the national interests align" (Sadler page 372) which thus limits its usefulness. Perhaps most importantly, DeWitt (1993) identifies that the *Treaty* itself was "never intended to be an environmental treaty, but rather a navigation and irrigation treaty" (page 325). This potentially explains why the *BWT* lacks an explicit definition of pollution (Signorelli, 2011) which in turn has led to problems due to what Caldwell (1984) identifies as "ambiguities and differences between the parties to the treaty over the interpretation of the phrase 'polluted

on either side to the injury of the health or property of the other'" (page 854). This causes Caldwell to speculate "what constitutes pollution and who determines when health or property have been injured and by what criteria?" (page 854).

Proponents of the *BWT* point to the cooperation between Canada and the U.S. related to the clean-up of the Great Lakes in the 1970s and early 1980s as well as its influence over the current design of the Garrison Diversion as an example of the *Treaty's* success. However, unlike the case of LW, the Great Lakes were a shared resource between multiple provinces and states and had much more significant economic influences, which created a "will" to cooperate with each other and solve the problem. Further still, the problem facing the Great Lakes at the time related mostly to PS pollution, not NPS pollution. It is interesting to note that the Great Lakes (particularly Lake Erie) are again experiencing decreased water quality, this time caused by NPS nutrient pollution. Although the same shared interests to act remain the same, it will be interesting to see whether the *BWT* can again be the catalyst to achieving water quality improvements. The *Treaty's* influence over the Garrison Diversion occurred during the project's planning phase. Had concerns about inter-basin transfers and degraded water quality been made after the original designs construction was completed, it would be doubtful that we would be talking about the diversion as *BWT* a success today.

Of the identified recommendations on how to improve the *Treaty*, the common recommendation amongst the authors previously identified related to, as Ma et al (2008) stated, endorsing "the decisions of the IJC as legally binding. Any decisions made by the IJC should be final and must be implemented by both Contracting Parties" (page 1086). In a 2005 study, authors Norman and Bakker identified that many water managers consider the non-binding structure of the IJC as part of the problem for non-compliances. The reason why this lack of

enforcement capability is important regarding the U.S. portion of the RRDB and its water quality impacts on LW is because *Article IV* of the *BWT* states that;

> *It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other* (*BWT, 1909*).

Given the current nutrient levels in the Red River at the Manitoba/U.S. border, it is clear that *Article IV* of the *BWT* is being broken, yet the *Treaty* has no mechanism for holding either signatory legally accountable. Comparatively, the occurrence of such events are covered by the European Union's *Water Framework Directive* which can hold member states liable for damages towards the community if a member state fails at its obligations (Keeson et al, 2008).

Overall, while the *Treaty* was a head of its time and has served its purpose by being quite successful (DeWitt, 1993), a contemporary issue (NPS pollution) has not only resulted in the *Treaty* clearly being violated, but it has identified that the methods within the *Treaty* meant for dispute resolution are clearly unreliable. With that said, as was pointed out to me in the development of this thesis, assessing the *BWT* only through the black and white views of academic literature may not be the fairest way of assessing it given the inability of such literature to consider the *Treaty* through the larger scope of North American (and more specifically), Canadian and U.S. geopolitics and historic Canada-U.S. relations. Such consideration is fair but outside the scope of this study. However, the reality of diplomatic relations between countries on environmental issues is best articulated by Sadler (1986) who said "however friendly the governments, bilateral discussions on water and environmental problems are conducted on the basis of national interests" (page 367). With such a reality in

mind, weaknesses in trans-boundary legal regimes such as the *BWT* will continue to be exposed and taken advantage of where sovereign nations see convenient.

5.1.9 Is a Form of Hydro-Hegemony at Play within the Lake Winnipeg/Red River Drainage Basin Issue?

As can be readily seen through the history of the *BWT* or current security efforts, trans-boundary cooperation between Canada and the U.S. has been well established for many decades. While successes with trans-boundary waters have occurred, new forms of water related disputes (as evident in the circumstances surrounding the role of the U.S. portion of the RRDB in the continued degradation of LW) have seen success become elusive. Given the quantity and nature of the barriers previously identified to be at play with regards to why a reduction of NPS nutrients within the Minnesota and North Dakota portions of the RRDB have not been achieved, one may not give any more consideration to the issue. However, those barriers are likely not able to account for every factor at play. As such, a component of water resource conflict theory commonly known as “hydro-hegemony” and the relatively new framework developed to explain it, may be able to explain gaps left by the barriers identified in this study as to why nutrient reductions have not been achieved.

In 2006, authors Zeitoun and Warner assessed trans-boundary water disputes of varying intensities and systematically theorized a new framework to explain the resolution of certain disputes that was based on dispute dynamics. The framework simply theorized that outcomes involving competition over water resources at the river basin level are not resolved by explicit “water wars” (as was once commonly theorized) but are more generally determined in favour of the most powerful nation state or actor involved in the conflict/dispute via a combination of water resource control strategies and tactics.

More specifically, Zeitoun and Warner identified i) power relations between riparian nations, ii) the riparian position itself of a nation within the river basin and iii) the potential of a nation to exploit water resources as the three main determinants of a water-based conflicts outcome. Examples used by the authors to support their framework included that of Egypt's hegemonic position over other co-riparians on the Nile River or Israel's hegemonic position over Palestinians on the Jordan River. Given Zeitoun and Warner's framework, it is proposed that "hydro-hegemony" could also be used to at least partly explain the results of trans-boundary water quality disputes involving what Bernauer (2002) identified "uni-directional externalities" (page 6) or more specifically for this thesis, uni-directional water quality issues. Further, if it is accepted that the issue studied in this thesis can actually be considered to be a low intensity, unrecognized conflict (like I do), then the hydro-hegemonic framework may be even more appropriate to explain the lack of successful nutrient reductions from Minnesota and North Dakota given that the impacts to LW have been ongoing for more than 20 years.

In the case of the uni-directional issues facing LW and the water quality coming from the U.S. portion of the RRDB, all three of Zeitoun and Warner's determinants of a water-based conflicts outcome exist in favour of Minnesota and North Dakota. First, there is no debating that in terms of power relations, the U.S. as a nation on a macro-scale, whether economically, militarily or other, holds the significant power position over Canada. Recognition of this power position expectedly trickles down to the state and county level. Second, both Minnesota and North Dakota, being located upstream within the RRDB, hold the stronger riparian position over Manitoba. Third and last, both Minnesota and North Dakota have the potential to exploit the water resources within the RRDB. In Zeitoun and Warner's original framework, the exploitation factor referenced a nation state having the technological capabilities and/or financial resources

to construct dams and other water appropriation systems. Regarding LW and the nutrients originating from the U.S. portion of the RRDB, the potential to exploit the water resource is created by the presence of an immense scale of agricultural activities which in turn exploit the waters of the RRDB for the deposition of excess nutrients and other pollutants.

However, while the frameworks three main determinants fit with the circumstances of the LW/U.S. RRDB issue, four important differences must be identified with regards to Zeitoun and Warner's framework and how it is related to this study. First, the original framework was crafted via assessments of real-world water quantity disputes. Second, the disputes occurred in notably water-stressed areas. Third, the disputes involved countries in notably volatile areas of the world with a history of other, non-water-related conflict. The circumstances surrounding this study are completely different and involve water quality versus water quantity, a subject area heavily concerned with flood management versus water scarcity and two countries who share the longest un-defended border in the world and a deep rooted, positive diplomatic history versus countries with a deep rooted, negative diplomatic history. The fourth and perhaps most important difference that must be noted references Zeitoun and Warner's identification of how hegemons use purposeful strategies and tactics to maintain and define their position over the water resource. Although such purposeful behaviour does occur by both Canada and the U.S. on a myriad of other issues (behaviour that may simply be a natural component of trade relations), the hegemonic actions proposed to be exhibited by Minnesota and North Dakota regarding the RRDB nutrient issue are far less a deliberate government policy than they are a by-product of the nature of NPS nutrient pollution itself, the isolated location (from a U.S. perspective) of LW and the result of two individual states (Minnesota and North Dakota) looking out for their own interests. In other words, while the failure to implement meaningful measures to date to reduce

NPS nutrient loading to the RRDB have been deliberate, the lack of effort has not been to purposely gain an advantage over the resource.

Lastly, two further points must be addressed regarding how the hydro-hegemonic framework can be related to the nutrient loading of the RRDB. When discussing the role of "power" in trans-boundary relations via linkages to varied types of power and how they manifest themselves, Zeitoun and Warner use Dahl's (1965) definition to define "power" as "A's capacity to make B do what B would otherwise not do" (page 442). However, I would argue that "power" could also be defined as; the ability of A to simply not do what B wants/needs it to do due to A's strategic advantages over B. This scenario has the ability to exist for the LW issue (and potentially other Canada/U.S. trans-boundary issues) thanks to a weak trans-boundary agreement (the *BWT*), weak internal legislation for water quality (the *CWA*), and a low prioritization from both a Canada and U.S. federal government diplomatic perspective.

Discussed earlier in this paper, the *BWT* and the establishment of the *IJC* and its various boards work to resolve what have historically been disputes involving water quantity issues. Even the creation of the RRBC was founded on cooperation for flood management within the RRDB. However, while the identification of "water quality" as an issue of concern has made its way into the RRBC's and other sub-watershed management plans within Minnesota and North Dakota, there is no real prerogative for the reduction of nutrients. Zeitoun and Warner identify that "cooperation" such as the boards and commissions previously listed can act to unwillingly mask power asymmetries, which can again partly explain the lack of reductions. This is not to say that the U.S. sits in the power position with regards to all trans-boundary waters shared with Canada, only that it does so in regards to the RRDB and all the multi-stakeholder boards, working groups and cooperation between Canada/U.S. and Manitoba/Minnesota/North Dakota

does not change that asymmetry. However, Zeitoun and Warner also point out that a hydro-hegemon may choose either a negative or positive form of hydro-hegemonic leadership (positive in this case being stronger efforts to make nutrient reductions). Therefore, this gives worth to the efforts of the trans-boundary basin groups.

As identified by Zeitoun and Allan (2008), international water relations are complex, rarely transparent or easily quantifiable. The issue between Manitoba, Minnesota and North Dakota regarding nutrients in the RRDB is no different. Therefore, even with such important differences between the theory of hydro-hegemony, Zeitoun and Warner's water quantity based trans-boundary framework and the water quality based trans-boundary issue between Manitoba and Minnesota/North Dakota, the hydro-hegemony framework can still be used to at least partially explain not only the lack of response by Minnesota and North Dakota in the past to addressing the issue of nutrients within their portion of the RRDB, but also the extent of current and potential future responses.

5.2 Chapter Summary

After an assessment of the major barriers to successfully decreasing NPS nutrient losses to surface waters that were identified from the interviews and surveys, all are supported via theoretical (or other) data from the literature and other sources. Further, it is clear from reading the water resource literature that other factors not identified by this study's field work may also have a role to play in preventing meaningful nutrient reduction from the U.S. portion of the RRDB.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

At the turn of the millennium, North Americans are faced with the paradox that many activities on which the North American economy is based impoverish the environment on which our well-being ultimately depends. Much has been done over recent decades to put the human relationship with the natural environment on a more sustainable footing. Yet we are still far from achieving that goal, and it is clear that the scale of effort is insufficient to meet the challenge (Commission for Environmental Cooperation, 2001)

6.1 INTRODUCTION

Although numerous treaties and management strategies have been created in an attempt to either prevent or repair trans-boundary water related problems and/or disputes, increased water requirements for increasing populations, uncertainty related to global climate change and the acknowledged importance of preserving freshwater ecosystems, could all be potential causes of future water related disputes. While such risks are mutual, according to Bernauer (2002) "uni-directional externalities are at the heart of many international river management problems".

While they share the longest undefended border on Earth, the many trans-boundary waters shared between Canada and the United States have at times been the source of dispute between the two countries. Although the *Boundary Waters Treaty* was created to help mediate disputes related to trans-boundary waters between the two countries, modern times have not only revealed potentially new causes for trans-boundary water related disputes, but weaknesses in Canadian and American water law. Further, the polycentric management systems currently

used to facilitate the management of water resources, while commonly idealized, also have inherent weaknesses.

Caught between these legal and process-related weaknesses is LW, the tenth largest body of freshwater in the world. Experiencing increasing levels of eutrophication for over twenty years, LW is in the rare situation of being wholly located within one politically sovereign jurisdiction while being impacted by nutrients originating in several different political jurisdictions, a significant portion of which are sourced from the portion of the RRDB located in Minnesota and North Dakota in the United States. While it is thought that significant nutrient reductions could be achieved by Minnesota and North Dakota if they were to be fully committed to such a goal, given the difficulties to achieving nutrient reductions as well as the asymmetrical pay-off of success, it is uncertain whether reductions can be realistically achieved, which leaves the long term health of LW in question.

In an attempt to more closely examine the trans-boundary relationship between the health of LW and the nutrients originating from the U.S. portion of the RRDB, the economic, legal and social landscapes of both Minnesota and North Dakota were assessed to identify whether or not they were favourable to reduce the nutrient loading within their portion of the basin.

6.2 Conclusions- Nutrient Management Within the Red River Drainage Basin and the Future of Lake Winnipeg

Agricultural producers provide a vital global service in the production of food. In the provision of this service, they also provide a living for themselves and their families, provide positive economic impacts to their local, state and national economies all the while performing

no action that is unconstitutional or illegal. However, it is undeniable that many agricultural practices are extremely detrimental from an environmental perspective, especially with regards to water. Yet little has been achieved to date in reducing such impacts, especially those caused by agricultural NPS pollutants. This study of whether or not meaningful reductions of NPS nutrients can be achieved within the Minnesota and North Dakota portions of the RRDB was initiated due not only over concern about the continued impacts from agricultural operations on the long-term health of the world's tenth largest lake, but to the situation faced by the lake in being wholly located within one politically sovereign jurisdiction while being impacted by several different political jurisdictions.

Although the objectives of the research were met, it is unknown whether long-term improvements to LW's water quality must involve nutrient reductions from the United States and more specifically, from the U.S. portion of the RRDB. I acknowledge the possibility that legislative, policy and land management changes within Manitoba only may have the ability to achieve the desired water quality improvements and that nutrient reductions from the U.S. portion of the RRDB may not be necessary. It may be more likely that realistic reductions in either the Manitoba portion of the LW drainage basin or the U.S. portion of the RRDB may not be enough individually and that a combination of reductions will be required to start reversing LW's increasing level of eutrophication. Further, even if all new anthropogenic nutrient additions to LW ceased tomorrow, the nature in which nutrients are stored and recycled within a lakes system will ensure a plentiful, non-limiting supply for the lakes primary producers for a significant period of time into the future and thus allow continued degradation of the lake's ecosystem.

The objectives of this project and the associated conclusions are;

Objective 1- *Identify whether or not actions (regulatory, policy or other) have been taken to date by responsible authorities within the United States portion of the RRDB that may already be contributing to reduced nutrient loading.*

Conclusion 1- The results indicated that U.S. federal departments with oversight of NPS nutrients along with the state of Minnesota and to a lesser extent the state of North Dakota, have taken actions over the past 20 years in attempt to address the long standing problem of agricultural NPS pollution, including nutrients, within their jurisdictions. However, given the water quality data for the Red River at the Canada/U.S. border, the actions taken to date have seemingly not resulted in the reduction of nutrients.

Objective 2- *Identify all existing barriers that have prevented action from being taken in the face of a known problem.*

Conclusion 2- Participants in the questionnaire survey and semi-structured interviews identified 14 barriers that were deemed to prevent reductions of agriculturally sourced NPS nutrients from being achieved. However, after cross-referencing those 14 barriers with the literature, only eight of the 14 barriers were deemed to hold significant validity. They were; i) the difficulty of addressing NPS pollution, ii) a lack of cooperation from private landowners, iii) anti-government intervention, iv) a lack of funding for NPS related programs, v) uncertainties with the science, vi) negative economic impacts of implementing solutions, vii) interference by special interest groups and viii) legislative weaknesses of the *Clean Water Act*. Further, the literature identified two additional barriers (legislative weakness of the *Boundary Waters Treaty* and the influence of U.S. hydro-hegemony within the RRDB) as also having the potential to play a role in preventing reductions.

Objective 3- *Identify actions that could be taken by responsible authorities and/or stakeholders within the United States portion of the RRDB to reduce nutrient loading* and;

Conclusion 3- When combining the results from the surveys and interviews, the main and most realistically implementable and successful actions that could be taken to reduce nutrient loading were identified as; i) increase funding for nutrient management related programs, ii) increase the flexibility of such programs to allow a better fit with the differing requirements of individual producer/land owner operations, iii) reduce the bureaucracy of such programs and iv) make such programs less restrictive.

Objective 4- *To make recommendations aimed at identifying solutions to breaking any barriers identified.*

Conclusion 4- The research identified four key strategies (increased public education, more efficient management of programs, learning from others and stronger government leadership) to break the existing barriers and gain more success in achieving nutrient reductions (*see Section 6.3 for full description of recommendations)*. While not part of the four key strategies, it must be pointed out that proactive uses of existing technology combined with the development of innovative modelling such as the work being performed by the *International Water Institute* may create the ability to break down many of the most serious barriers. Further, other future advances such as the development of genetically modified, low-nutrient crop strains could have a similar impact.

6.2.1 Summary

The research question related to this project asked whether or not meaningful nutrient reductions could be achieved within the Minnesota and North Dakota portions of the RRDB. While federal and state policy related to the issue of non-point source nutrient pollution has evolved and actions meant to address the issue have been taken, results have seemingly not been achieved. Although I see nutrient reductions within the U.S. portion of the RRDB being attainable in an absolute sense (i.e. reductions that are insignificant from an ecological health perspective but a reduction nonetheless), for the various reasons identified and discussed, the goal currently put forward by Manitoba of a 50% reduction in P within Lake Winnipeg (from 100 ug/L to 50 ug/L), if applied to the RRDB, is unlikely to be achievable. The curious aspect of what seems to be such a significant goal is that even if reached, Daniel et al (1998) identify that total P levels above 20 ug/L "are considered critical values above which eutrophication is accelerated" (page 252). The Manitoba goal is a full 30 ug/L above this critical threshold.

Further, even if a goal for lesser, but still meaningful reductions are established for the RRDB itself, I am in agreement with those participants in this project who believe that such reductions are unattainable unless measured against a significantly long temporal scale (i.e. decades or longer). The simple reason for such a pessimistic outlook is that the key to achieving reductions is the voluntary willingness of producers (private landowners) to more sustainably manage their operations. However, like their Manitoba counterparts, for the majority of producers on the U.S. side of the RRDB, the importance of "economics" is trumping the importance of environmental stewardship. As such, assuming that meaningful nutrient reductions in the U.S. portion of the RRDB must be achieved in order to aid in reversing LW's

ongoing eutrophication, the fate of LW may be destined to have other jurisdictions (i.e. the U.S. portion of the RRDB) hydro-hegemonic influence over incoming water quality dictate potentially disastrous ecological conditions to the lake and make its long-term health uncertain.

6.3 Recommendations- The Path Towards Reductions

It is incredibility difficult to persuade someone to believe in and provide assistance for an issue that they cannot touch, feel, see or which otherwise does not impact them. When assessing U.S. action on the significant level of nutrients originating from the Minnesota and North Dakota portions of the RRDB and their impacts on LW, this “out of sight out of mind” circumstance cannot be forgotten or its importance minimized.

Given the frequent nature by which anthropogenic eutrophication impacts the earth’s freshwater resources, significant resources are being expended by governments, academic institutions and other organizations around the world in an effort to address the problem. As such, wholly original ideas as to how nutrient reductions could be achieved within the U.S. portion of the RRDB were difficult to develop. Instead, because not all the barriers to reducing NPS nutrient losses from lands to surface waters within the RRDB that were identified in this study can be addressed and because some of these barriers are deemed to be more important than others, more generalized recommendations were developed. This section not only provides realistic recommendations as to which barriers need to be further addressed, but identifies other considerations that may help to achieve NPS nutrient reductions within the RRDB.

6.3.1 More Efficient Management of Programs

As shown from the results of the questionnaire surveys and semi-structured interviews, existing programs whose purpose is to aid in the management of water quality within Minnesota and North Dakota do not operate as efficiently as they could. Given the tough economic times and varying levels of prioritization whereby the available funding may not be as available for these types of issues, increasing the efficiency of existing programs is important.

While the common improvements identified in this study included making the application requirements less bureaucratic and less restrictive, such changes would potentially see an increase in the number of program participants but not necessarily achieve increases in program efficiency per se. As such, of the improvements suggested and/or identified, three have been deemed to not only be realistically implementable but be able to realistically increase the efficiency of existing programs aimed at helping landowners reduce NPS nutrient losses from their land. The first is increased flexibility of the programs themselves. Participants identified that the existing programs were too rigid and did not allow for program managers to customize program parameters to the individual needs of a producer and his lands. If changed to become more flexible, the same program and same level of funding should be able to achieve more reductions.

The second improvement is for programs to become more incentive-based (i.e. linking incentives/subsidies to the use of BMPs) or as one participant identified it, “change to an outcomes oriented process”. Currently, as explained to me during my research, once a producer is approved for participation in a program, the metrics required to achieve subsidization were not deemed to be enough. While a requirement for increased metrics may frighten away some

producers from participating in a program, it would at least ensure that the financial resources being utilized were achieving the most success possible.

The third and last suggested improvement that could help improve the efficiency of existing programs aimed at helping landowners reduce NPS nutrient losses from their land is for program managers (i.e. official government departments/agencies CDs and WDs) to become more proactive. It was identified that the use of programs are said to be dominated by producers both knowledgeable of the application process and willing to give the time needed to complete the application process. While successes can still be achieved with such producers, those unaware of what programs exist or those unwilling to navigate the bureaucratic hurdles may have lands which, under the incorporation of the right combination of BMPs, would allow for greater nutrient reductions to be achieved. As such, more success is thought to be achievable if program managers actively begin to recruit the owners of such lands into programs.

If the executive levels of government that are responsible for the creation of these programs either make such changes themselves and implement them from the top down or allow the on the ground program facilitators to unilaterally make such changes when needed, an increased efficiency in existing programs may be achieved under the same funding levels and would result in an overall decrease of NPS nutrient losses to surface waters.

6.3.2 Increased Public Education

The importance of not only continuing the education of the general public and landowners regarding the significant impacts of NPS nutrients on water quality, but increasing it, cannot be over-stated. While the science as to the identification of agriculturally sourced NPS nutrients and their impact on water quality has been known for more than three decades, those

who have doubt about the science still exist. On average, participants from Minnesota and North Dakota were only moderately aware of LW's on-going degradation and slightly less so of the role being played by their states in the degradation. These two findings serve as the main starting point as to why continued and expanded education programs within Minnesota and North Dakota related to NPS nutrients are so important.

To further substantiate the importance of education programs is an experience I had while at the 2014 *Red River Basin Commission Conference*. During a casual conversation with a government conservation programs manager, they described an anecdotal story about working with a producer to try and have them start incorporating more BMPs in to the producer's operation. The programs manager stated that the producer advised him that his operations were already highly efficient in the use of fertilizer and that no producer is purposefully wasteful because to be wasteful results in reduced profits. The producer then asked if the program manager could point out other industries that were equally as efficient in similar operations. The reply by the conservation programs manager acknowledged producers were indeed quite efficient in their use of fertilizer, but that any inefficiency, when multiplied by thousands of farms, equals significant levels of nutrients being lost to surface waters and significant water quality and ecological degradation, which was the reason to keep seeking ways to improve. Such a view may indicate that while there is acknowledgement by some producers of agriculturally sourced NPS nutrients being a problem, a real understanding of the scope of the problem may be missing.

While the use of BMPs can have positive impacts on reducing NPS nutrient losses (Kramer et al, 2006; Sharpley et al, 2000 and Sharpley et al, 2001), they have other benefits as well that if not improve the profitability of a producers operation, certainly help to maintain it

(i.e. maintenance and/or planting of wind rows to prevent soil erosion). Overall, BMPs can help replace lost agricultural activity that cost billions of dollars a year to replace through the use fertilizers and chemicals (Duda and Johnson, 1985). However, not all BMPs work in every situation. For example, the use of conservation tillage, a commonly used BMP that amongst other benefits is deemed to reduce soil erosion and water run-off, can be less effective in providing this service in cold dry regions than other BMPs (Tiessen et al, 2010).

The role of citizens to the successful addressing of the NPS nutrient problem cannot be underestimated. Although producers may eventually lose their concerted ability to fight-off state imposed measures to aid in improving water quality due to increasing urbanization and the loss legislative influence from rural areas, such an occurrence is uncertain to occur and a long time away. More practical, it is assumed that given personal ethics and morals, both producers and non-producers alike within Minnesota and North Dakota would be supportive of reducing NPS nutrient levels as long as they could be convinced that the science surrounding the issue is genuine. The only way to achieve this is through the maintenance and expansion of educational programs. The use of such a strategy can be considered part of what Tietenberg (2008) identifies as “disclosure strategies”, the third wave of pollution control instruments.

The way forward to maintaining, and where needed, increasing public education about NPS nutrients lies in both Minnesota’s and North Dakota’s already established system of CDs and WDs. First, managers and technical staff already have the basic foundation about the general subject matter (i.e. land and water management). This enables them to deliver their general mandates. Second, the websites of the Minnesota Soil and Water Conservation Districts and North Dakota Soil Conservation Districts both identify educational services as part of their operations. While it is thought that both the Minnesota Watershed Districts and North Dakota

Water Resource Districts also offer some level and/or type of educational services as part of their operations, if they do not provide such a service at this time, it would not be difficult to initiate. Nevertheless, it is this existing or potential provision to provide land and soil education services that is the key to gaining increased public support from producers and non-producers alike, to increase ways to address the NPS nutrient problem.

The caveat to increasing public education on the issue of NPS nutrients is how to distribute the information to a wider audience other than to those producers/non-producers who are interested. Like many other subjects, it is likely that the individuals and groups who have received educational services on the topic are not necessarily the ones who need it. Instead, similar to a recommendation identified in Section 6.3.1, managers and technical staff need to more actively target educational programs to those producers whose lands are likely contributing NPS nutrients to surface waters and whose world-views may place them in the skeptic category regarding the issue of NPS nutrients and their influence on reduced water quality.

Given such a general tactic and acknowledging a CDs/WDs limited budgetary capacity to provide educational services, an opportunity is created for Manitoba to potentially help its own cause by providing assistance to aid the above groups in furthering public and landowner education with regards to NPS nutrients and LWs ongoing degradation. If content of NPS nutrient related educational services is an issue, the various CDs and WDs in Minnesota and North Dakota could look towards *The Lake Winnipeg Research Consortium Inc.*, which produces annual science and education reports detailing the latest findings on LW (Lake Winnipeg Research Consortium Inc.). Further, Manitoba itself could go a step further and fund all costs associated with having selected CD staff, WD staff, producers and non-producers from

the Minnesota and/or North Dakota portion of the RRDB take part in the *Lake Ecology Field Program* on board the *Consortiums* research ship M.V. Namao in order to better help non-scientists understand the science and reality of how current land management activities are driving the destruction of the world's 10th largest lake.

6.3.3 Learning from Others- Don't Waste Time and Resources "Reinventing the Wheel"

The anthropogenic eutrophication of freshwater resources has been deemed by David Schindler as "the earth's most widespread water quality problem" (Page 1, 2012). While such a classification is not meant to comfort Manitobans regarding the ongoing degradation of LW, it serves to provide a profound notice of how common the issue actually is. The benefit of such commonality is that a significant amount of work has and is being done world-wide on the problem. Of all these other areas, perhaps the closest, most similar and most recognized current case is that of the Great Lakes and in particular, Lake Erie.

While close in surface area to the size of LW, the use and importance of Lake Erie in economic terms dwarfs that of LW. Lake Erie provides drinking water for 11 million people and cooling waters for over 20 power plants (IJC Presentation). The lake also serves more than 300 marinas in Ohio alone, sustains 40% of all Great Lakes charter boat operations and a $1.5 billion/yr. sport fishery (IJC Presentation). However, as stated by the IJC (2014) "Lake Erie is once again severely threatened. …. The recent accelerating decline of this lake, manifested as impaired water quality, massive, summer-long algal blooms, hypoxia and fish kills, has focused binational attention on the need for urgent actions to reduce external inputs of phosphorus." (page 2). The result of this degradation was the 2012 amendment of the original 1972 *Great Lakes Water Quality Agreement* (GLWQA).

Because of Lake Erie's bi-national importance, significant attention and resources are being provided in order to try and address the problem. Since 2010, the U.S. government's *Great Lakes Restoration Initiative* has been funded for $1.3 billion, with numerous projects related to Lake Erie (IJC, 2014). Comparatively, Canada's federal government under Phase I of the Lake Winnipeg Basin Initiative from 2008-2012 invested $17.7 million to help clean up the lake while Phase II was funded for $18 million from 2012-2017 (Environment Canada). In 2012, the IJC created the *Lake Erie Ecosystem Priority* (LEEP) initiative which is designed to provide advice to governments on how to restore the lake's ecosystem. Most recently, a result of the LEEP has been the creation of *A Balanced Diet for Lake Erie: Reducing Phosphorus Loadings and Harmful Algal Blooms* (2014). Similar to the finding of this study, the report identified that "despite the widespread implementation of BMPs, …… the overall proportion of TP [total phosphorus] loadings to the lake attributable to non-point sources has been increasing, especially from agriculture. Modeling has confirmed that while agricultural BMPs are having some effect in reducing the export of TP from watersheds to the lake, BMPs need to be much more widely implemented to substantially reduce nutrient yields" (page 73) and that "several decades of [relying primarily on incentive-based programs and influence-based models] have not reduced agricultural non-point sources of nutrients to Lake Erie" (page 74).

More importantly, the 2014 study identified recommendations to lower nutrient loading into Lake Erie. Among them were increased use of regulatory mechanisms (i.e. ban the use of fertilizer from agricultural operations on frozen ground or ground covered by snow and mandatory training for fertilizer industry actors), accelerated use of the 4R Fertilizer Stewardship Framework (Right Source, Right Rate, Right Time and Right Place), use of one-on-one on-farm visits to encourage the adoption of specific nutrient management practices and the

linkage of the cost and availability of crop insurance purchases and premiums to farm conservation planning and implementation.

Overall, while certain attributes of the RRDB may require unique solutions and management strategies in order to achieve meaningful nutrient reductions, water and land managers at all levels within Manitoba, Minnesota and North Dakota would be wise to pay close attention to the on-going developments (failures and successes) related to management of trans-boundary water quality issues on the Great Lakes and especially Lake Erie. Other important on-going cases to observe would include the efforts to address NPS pollutant concerns for both the Chesapeake Bay and Puget Sound. Scrutinizing and learning from these examples (and others) will undoubtedly offer important lessons about not only what is and is not working in attempts to lower NPS nutrient loading to water bodies, but how any such solutions were navigated through the contentious atmosphere surrounding the agricultural industry, their associated special interest groups and private property rights.

6.3.4 Stronger Leadership from Government

> *Water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society*. (Rogers and Hall, 2003)

Although the U.S. federal government and the state governments of Minnesota and North Dakota have exhibited varying levels of environmental governance to address NPS nutrient losses to surface waters, given the health of waters within and leaving the U.S., the efforts clearly have not been enough. Some may argue that due to the difficulty in addressing

agriculture and other NPS pollutants, it can be deemed a "wicked policy issue" which alleviates government from taking criticism due to such issues being the result of “multiple and dynamic linkages and interactions between different levels and scales” (Ferreyra et al, 2008 page 306). However, lack of commitment to enforce the protection of its waters, a lack of resources and adaptive oversight, a glacial like pace in the creation of water quality criteria and management plans as well as a lack of appetite to push back against special interests, all have contributed to this situation and all of which put the responsibility for the poor water quality of natural lakes and rivers in the U.S. clearly at the hands of government.

Such an obvious lack of commitment translates to a lack of action seeing that more measures to address the problem could be implemented than have been. Although such a lack of government action may be supported by those with anti-government/small government world-views, Orbach (2013) identifies the flawed nature of such a position. Orbach identifies that support for government inaction (i.e. small government) is typically based on the perception that such action results in the violation of an individual’s rights (i.e. environmental regulation violates polluters’ rights or restrictions on tobacco sales infringe rights of businesses). However, Orbach points out that government inaction on some issues actually results in the same outcome (i.e. government inaction on environmental issues violates the rights of those affected by pollution or inaction on tobacco infringes on non-smokers rights). As such, government inaction on water quality can be explained at its core as government misidentifying (or purposefully considering) the rights of some (i.e. polluters) as being absolute and/or more important compared to others, which is troubling (Orbach, 2013).

Making the current state of government leadership on the NPS pollution issue even more negative is that when government does choose to play a role, it has a tendency to contradict and

undermine itself, thus reducing its own credibility and efficacy. The biggest example of this is identified by (Laitos and Ruckriegle, 2013) who point out that the U.S. Congress "seems content in delegating this [the NPS pollution] issue to state and local officials, who have proven to be unwilling to take tough measures that might address the water pollution problems that stem from [agricultural operations]" (page 1070). Other examples of failed governance on the issue include holding other industries accountable for water pollution yet not only sparing, but subsidizing agriculture to produce pollution (Adler, 2013), promoting national farm policies that promote bad policy such as excess crop production and the use of low quality lands (Adler, 2002), the wasting of financial resources trying to reduce NPS pollution by treating only symptoms of the issue at a cost of billions of dollars per year (Duda and Johnson, 1985) and ignorance to the estimated $6 billion per year of off farm damages caused by sediment originating from agricultural lands from not using BMPs (The *Conservation Foundation*, as reported by Duda and Johnson, 1985).

To further highlight the failure of government leadership related to water resource management, DeWitt (1993) identifies a history of the U.S. government not responding consistently to the IJC while Norman and Bakker (2005) in their assessment of trans-boundary water governance between Canada and the U.S. identified an example that indicated a lack of commitment by the U.S. federal government related to the *BWT*. Specifically, during the height of the dispute between Manitoba and North Dakota regarding the Devils Lake outlet, the U.S. federal government allowed North Dakota to act unilaterally and outside the allowances of the *BWT* (similar to what is being done with Red River water quality crossing the border). While the history of the Devils Lake dispute between Manitoba and North Dakota provides a lesson in federal, state and provincial politics as well as a record of diplomatic blunders on both sides of

the border (and perhaps offers a case of hydro-hegemony in action), the lack of leadership shown by Washington set a bad precedent and only resulted in the marginalization of a long-held legal framework.

What causes the lack of strong government leadership on the issue of NPS pollution to be more puzzling is that history has shown that strong leadership from government on environmental issues can exist (especially in G8 and G20 countries). An example of such leadership is the *Agreement Between the Government of Canada and the Government of the United States of America on Air Quality*, 1986 which not only contributed to reductions in acid rain (amongst other air quality issues) but was designed to reaffirm Principle 21 of the *Stockholm Declaration* which identifies that "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction" (IJC, 2014). Other examples of historic government leadership related to protection of the environment can be seen via the creation of the 1987 *Montreal Protocol*, the current design of the Garrison Diversion, the successful reduction of PS pollutant releases to water bodies as well as many others.

In the case of the Garrison Diversion, as it was originally designed, it unintentionally created conflict between North Dakota and Manitoba/Minnesota. Part of the conflict stemmed from the fact that the project would see return flows from some of the irrigation works be "discharged into rivers flowing northward across the international boundary into Canada" (Caldwell, 1984, page 845). However, the U.S. federal government followed recommendations

made by the IJC against the wishes of North Dakota resulting in a significant downsizing of the project in order to address the concerns over return flows (Caldwell, 1984).

With the above in mind and given that more than 40 years has passed since the U.S. Senate first recognized NPS nutrients as a serious threat to U.S. water quality, the obvious question is how can stronger leadership in government be expected and achieved given the its failure to date and given the significant distrust of government in the U.S. by many of its citizens? Unfortunately, there is no prescription for how to get stronger leadership in government, especially given what seems to be the increasing marginalization of knowledge-based governance (i.e. decision making) by governments of all levels in both the U.S. and Canada. In the case of the NPS pollution issue, while increased educational programs are primarily meant to get more cooperation on the issue from producers, a positive unintended consequence may be that once armed with the knowledge and data on the issue, producers (and non-producers alike) would be more supportive of government becoming more involved in addressing the issue, making the repercussions for those in government who want to govern based on knowledge and data less severe. For those members of the public (and those elected officials which they intimidate) who may still see private property rights and personal freedom as being mutually exclusive to government protection of the natural environment, I point to a response by Garrett Hardin (1968) who once said while talking about certain infringements;

> *Every new enclosure of the commons involves the infringement of somebody's personal liberty. Infringements made in the distant past are accepted because no contemporary complains of a loss. It is the newly proposed infringements that we vigorously oppose; cries of "rights" and "freedom" fill the air. But what does "freedom" mean? When men mutually agreed to pass laws against robbing,*

> *mankind became more free, not less so. Individuals locked into the logic of the commons are free only to bring on universal ruin; once they see the necessity of mutual coercion, they become free to pursue other goals. I believe it was Hegel who said, "Freedom is the recognition of necessity"* (page 1248).

Overall, the agricultural industry has been talking for years about voluntarily addressing NPS pollution, but it has not worked. Further, as has been shown, even given the difficult nature of addressing NPS pollutants, a lack of government interest in the issue, a lack of government will to address the issue and the promotion of contradictory and wasteful policies have all contributed to a lack of success in reducing NPS nutrients within the RRDB. If meaningful reductions are to ever be achieved, stronger leadership by government must be shown. While addressing the issue seriously requires addressing the barriers identified, most of that work can only be done through stronger government leadership and the use of a variety of methodologies that include but are not limited to the use of increased regulation for mandatory best-management practices, state permitting programs to limit agricultural discharges, land acquisition programs to protect riparian areas and increased funding of incentive-based programs for producers to achieve what other initiatives cannot (Angelo, 2013). Those who view government involvement as a negative will not like this conclusion, but the status quo, which can only be described as government inaction, has failed to protect water quality within the U.S.

6.3.5 Lessons Learned- Future Studies on Canada/U.S. Trans-Boundary Waters

Although the objectives of this thesis were met, the experience of creating and moulding the research methodology used and the difficulty in recruiting participants for the survey portion

of the study identified potential ways in which similar future studies could be improved. In particular, improvements on how to study the central research question were identified as well as new areas of potential, but related research.

An acknowledged weakness in my findings is the low number of recruits for the survey component on which much of the results are based. Given the 19 participants for the survey component and the calculated 10 percent return, the results cannot understandably be given the same weight and level of meaning as a higher percent return. As such, the identified ways for improvement strongly correlate to how participant numbers for future surveys may be increased. First, use of a "top down" approach to recruit survey participants failed to meet my own expectations (the reason for use of this approach was explained in section 3.3.4). While potential reasons for the failure were also previously given, second thought about adding "middle-men" and lengthening the overall recruitment process has raised doubts about my decision to use such an approach. Instead, given the numbers of CDs and WDs within the U.S portion of the RRDB, direct contact with the individual district managers is now thought to have been able to recruit at least as many if not more participants to the study.

Second, while trying to recruit participants from the government departments of interest as well as from the CDs and WDs was necessary, I focused on them too much. Increased representation from both producers and non-producers outside of the government/CD/WD circles is necessary. Such recruitment could be achieved through more laborious recruiting methods such as cold calls, canvassing door-to-door or canvassing in shopping malls or outside restaurants in the small farming towns that are common throughout Minnesota and North Dakota. The drawback to the use of such methods would be that the survey questions would

need to be shortened so as to not scare off potential participants which in turn may not enable a researcher to gather as detailed information.

Third, given the trans-boundary nature of the issue, collaboration with one of the many post-secondary institutions within Minnesota and North Dakota is thought to potentially be able to produce significant increases in participation and thus more accurate results. The reason for this is due to the belief that Americans would be more open and more willing to participate in such a study if it was being conducted by American students from American post-secondary institutions. Further, use of American students would open a whole network of opportunities by which to recruit participants (i.e. family, friends and neighbours of the researchers, their family, friends and neighbours etc.).

Another mistake made in the methodology used for this study relates to the decision to try and recruit only one person from each of the federal/state department of interest (as explained in section 3.3.2). While I still maintain that the decision was correct, it caused me to dismiss the United States Department of Agriculture's *Natural Resources Conservation Service* (NRCS) from being part of the study. Formed in 1935 as the *Soil Conservation Service* (SCS) to help better manage farmland and forests, the service was renamed to its current form in 1994 to "better reflect the broadened scope of the agency's concerns" (USDA). Today, the NRCSs mandate is similar to that of the USDAs and covers soil and water (including water quality). I should have viewed the NRCS as separate from the USDA and included it in the study.

The real potential benefit of having involved the NRCS in this project would have been its network of local service centers. Minnesota and North Dakota alone have a combined total of over 140 local NRCS service centers (USDA). Similar to the CDs and WDs, the managers and staff of NRCS local service centers could have been an extremely knowledgeable and useful

source of on the ground data. Further, not only could they have potentially facilitated contact with producers who would be more likely to have participated in the study, but they themselves may have been willing to participate in the interview and/or survey components of the research. As such, not including the NRCS was a missed opportunity.

When it comes to the potential for related studies, the issue of U.S. sourced nutrients and their impact on LW (or other issues involving uni-directional externalities between Canadian/U.S. trans-boundary waters) is an understudied topic as explained in section 1.5. As such, three areas of study have been identified as improving the understanding of the issue. The first would allow a researcher to contribute to the on-going debate in the literature by assessing what the motivating factors are for producers within the RRDB to incorporate sustainable farming practices into their operations, especially those practices related to water quality. The second would allow a researcher to contribute to the literature by further investigating how genuine the distrust in science/scientists is of the producers within the entire RRDB (Canadian and U.S. portions) or whether that distrust is simply an excuse for their potential lack of stewardship. The third and last potential area of study for researchers looking for a topic of study related to Canada/U.S. trans-boundary waters would be an assessment of how climate change, via regional projections for increases/decreases in temperature, precipitation etc. could affect the shared trans-boundary waters (of note, only one of 29 participants in this study even mentioned the issue of climate change as a problem to trans-boundary waters in the future). Specifically, in the case of water quality, will projected regional reductions in water quantity have the potential to create water quality issues via the creation of increased concentrations? If so, what are the legal repercussions for such occurrences?

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APPENDIX A- SURVEY CONSENT FORM

Natural Resources Institute
70 Dysart Rd,
Winnipeg, Manitoba
Canada, R3T 2M6
General Office (204) 474-I7170
Fax: (204) 261-0038
http://www.umanitoba.ca/academic/institutes/natural_resources

Research Project Title:

Policy, Actions and Results: Can Nutrient Reductions be Achieved within the Minnesota and North Dakota Portions of the Red River Drainage Basin

Researcher: Mark Dettman

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Proposed Script for Written/Verbal Recruitment of the Research Participants for Interviews:

My name is Mark Dettman and I am a Master's level graduate student at the Natural Resource Institute at the University of Manitoba in Winnipeg, Manitoba, Canada. The research project, which was developed on my own and is currently self-funded, aims to examine the economic, legal and social components of trans-boundary environmental governance in the specific context of Red River Drainage Basin water quality and its influence on Lake Winnipeg. Currently, considerable resources are directed from federal and provincial/state governments in an attempt to address the issue. However, potential negative economic impacts to Minnesota and North Dakota from implementing proposed solutions combined with legal and process related weaknesses raise doubts as to whether or not improvements to water quality within the U.S. portion of the Red River Drainage Basin can be achieved.

The results of the research will attempt to identify whether or not water quality improvements can be made within the U.S. portion of the Red River Drainage Basin given existing strategies and frameworks, after which recommendations would be available to decision makers. The survey will take between 15-30 minutes to complete. If you have any questions, you may relay them to me through you Conservation District manager or contact me yourself.

Only my university advisors and I will have access to the information that you share with me, and your identity will protected. However, given the requirement to explain the methods used in this study and the groups involved, it may be possible for a person or group to identify the participants of the study. With that said, the risk of this occurring is deemed to be less than that taken by the participants in everyday life.

The information that I learn from the survey(s) will be kept in a secure file on my password protected computer at my residence. Additionally, I will be using a set of codes to keep your identity confidential. However, if you prefer to be openly identified, please let me know.

Please feel free to ask for clarification or information at any point before, during or after the survey. Your participation in this study is voluntary and you are free to withdraw at any time. If this decision is made during the survey, please advise of the decision. If the decision is made after completion of the survey, please contact the researcher directly via the method of choice.

In case of any questions or concerns, you can contact me or my advisors:

Mark Dettman
Telephone: [redacted]
Email: dettmanm@myumanitoba.ca

Prof. Thomas Henley
Telephone: 204-474-6169
Email: Thomas.Henley@ad.umanitoba.ca

Dr. John Sinclair
Telephone: 204-474-8374
Email: John.Sinclair@ad.umanitoba.ca

SEE NEXT PAGE----------

Your consent to participate in this survey indicates that you have understood, to your satisfaction, the information regarding participation in the research project and agree to participate as a subject.

In no way does this waive your legal rights nor release the researchers or any involved institutions from their legal and professional responsibilities.

You are free to withdraw from the study at any time, and/or refrain from answering any questions you prefer to omit, without prejudice or consequence.

Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The Joint Faculty Research Ethics Board has approved this research. If you have any concerns or complaints about this project you may contact any of the above named persons or the **Human Ethics Secretariat at (204) 474-7122**. A copy of this consent form has been given to you to keep for your records and reference.

Thank you very much for your participation in this project.

Mark Dettman

_____

Participants Name Printed

_____ _____/_____/_____ (dd/mm/yyyy)

Participants Signature Date

_____ _____/_____/_____ (dd/mm/yyyy)

Researchers Signature Date

APPENDIX B- INTERVIEW CONSENT FORM

UNIVERSITY OF MANITOBA

Natural Resources Institute
70 Dysart Rd,
Winnipeg, Manitoba
Canada, R3T 2M6
General Office (204) 474-I7170
Fax: (204) 261-0038
http://www.umanitoba.ca/academic/institutes/natural_resources

Research Project Title:

Policy, Actions and Results: Can Nutrient Reductions be Achieved within the Minnesota and North Dakota Portions of the Red River Drainage Basin

Researcher: Mark Dettman

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Proposed Script for Written/Verbal Recruitment of the Research Participants for Interviews:

My name is Mark Dettman and I am a Master's level graduate student at the Natural Resource Institute at the University of Manitoba in Winnipeg, Manitoba, Canada. The research project, which was developed on my own and is currently self-funded, aims to examine the economic, legal and social components of trans-boundary environmental governance in the specific context of Red River Drainage Basin water quality and its influence on Lake Winnipeg. Currently, considerable resources are directed from federal and provincial/state governments in an attempt to address the issue. However, potential negative economic impacts to Minnesota and North Dakota from implementing proposed solutions combined with legal and process related weaknesses raise doubts as to whether or not improvements to water quality within the U.S. portion of the Red River Drainage Basin can be achieved.

The results of the research will attempt to identify whether or not water quality improvements can be made within the U.S. portion of the Red River Drainage Basin given existing strategies and frameworks, after which recommendations would be available to decision makers. Interviews will take between 30 and 60 minutes. If you have any questions at any time, please don't hesitate to ask. If you need to take a break during the interview, please let me know.

Only my university advisors and I will have access to the information that you share with me, and your identity will protected. However, given the requirement to explain the methods used in this study and the groups involved, it may be possible for a person or group to identify the participants of the study. With that said, the risk of this occurring is deemed to be less than that taken by the participants in every day life.

The information that I learn during the interview(s) will be kept in a secure file on my password protected computer at my residence. Additionally, I will be using a set of codes to keep your identity confidential. However, if you prefer to be openly identified, please let me know.

Please feel free to ask for clarification or information at any point before, during or after the interview. Your participation in this study is voluntary and you are free to withdraw at any time. If this decision is made during the interview, please advise of the decision. If the decision is made after completion of the interview, please contact the researcher directly via the method of choice.

In case of any questions or concerns, you can contact me or my advisors:

Mark Dettman
Telephone: [redacted]
Email: dettmanm@myumanitoba.ca

Prof. Thomas Henley
Telephone: 204-474-6169
Email: Thomas.Henley@ad.umanitoba.ca

Dr. John Sinclair
Telephone: 204-474-8374
Email: John.Sinclair@ad.umanitoba.ca

SEE NEXT PAGE----------

Your consent to participate in these interviews indicates that you have understood, to your satisfaction, the information regarding participation in the research project and agree to participate as a subject.

In no way does this waive your legal rights nor release the researchers or any involved institutions from their legal and professional responsibilities.

You are free to withdraw from the study at any time, and/or refrain from answering any questions you, without prejudice or consequence.

Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The Joint Faculty Research Ethics Board has approved this research. If you have any concerns or complaints about this project you may contact any of the above named persons or the **Human Ethics Secretariat at (204) 474-7122**. A copy of this consent form has been given to you to keep for your records and reference.

Thank you very much for your participation in this project.

Mark Dettman

_____

Participants Name Printed

_____ _____/_____/_____ (dd/mm/yyyy)

Participants Signature Date

_____ _____/_____/_____ (dd/mm/yyyy)

Researchers Signature Date

APPENDIX C- QUESTIONNAIRE SURVEY

TO PARTICIPANTS- The origin of this research is founded in the topic of environmental governance as it relates to trans-boundary water resources. Specifically, the research aims to examine the economic, legal and social components of trans-boundary environmental governance in the context of Red River Drainage Basin water quality and its influence on Lake Winnipeg. There are two reasons for my interest in this subject. The first is that trans-boundary water issues are historically studied from a water quantity perspective and not a water quality perspective. The second is that Lake Winnipeg is removed geographically from the border and not a shared resource between Canada/U.S. (like the Great Lakes) yet is heavily impacted by activities outside of Manitoba. With that said, it is acknowledged that there may be a perceived bias in the research given its origin. I have tried to create questions that are neutral in perspective but integral to the research question. However, should you have issue with the nature of any questions, please feel free to identify your concerns to me to at your convenience.

INSTRUCTIONS- The survey consists of two (2) parts, totalling thirty-six (36) questions. However, not all questions are required to be answered. Part I is to be completed by **ALL** participants. Part II is to be completed **ONLY** by those who are a Land Owner/Producer (Crops or Livestock). If you are a Land Owner/Producer, please answer Parts I **AND** II. Lastly, participants are **NOT REQUIRED** to identify themselves by name on the survey and if you do, your name will not appear in the thesis.

Part I- General Questions (for all participants)

1. In what state do you reside (check one)?

- Minnesota ____
- North Dakota ____

2. In what state do you work (check one)?

- Minnesota ____
- North Dakota ____
- Both ____

3. What is your primary profession (check one)?

- Land owner/producer- crops and/or livestock ___
- Work for/own private business ___
- Civil servant (municipal/state/federal government) ___
- Work for non-government organization (NGO) ___
- Retired ___
- Other (please name) _____

4. Could federal and/or state programs aimed at helping land owners reduce non-point source nutrient loss from their lands to surface waters be improved (check one)?
Yes___ or No ___ No Opinion___

5. If Yes to question 4, how could the programs be improved (check all that apply)?

- Increased funding ___
- Less restrictive for applicants (i.e open to more applicants) ___
- Less complicated/bureaucratic (i.e less paper work) ___
- More flexible so as to better suit each individual landowner ___
- Other (please name) _____

6. Do you think US states have any obligation to ensure that water leaving their political boundaries is not degraded for downstream users (check one)?
Yes___ or No ___ No Opinion___

7. Can you identify any barriers/obstructions (economic, legal, social or other wise) that impede more aggressive reduction of non-point source nutrient loss to surface waters in your state (check all that apply)?

- Negative economic impacts of implementing solutions ___
- Weaknesses within the Clean Water Act ___
- Complexity/difficulty of the problem itself ___
- Inherent social views against increased government intervention ___
- Lack of over all public support ___
- Uncertainties with the science related to non-point source nutrient loss ___
- Technological weaknesses ___
- Lack of funding for programs ___
- Not enough private landowners providing cooperation to achieve results ___
- Interference by special interest groups ___
- Other (please name) _____
- None ___
- No opinion ___

8. How important should consideration of the impact to the economy be when legislators create policy/legislation etc. to protect land and water resources (check one)?

- Very important (the economy should be the priority) ___
- Important ___
- Moderately important ___
- Not important (the quality of the environment is more important) ___
- No opinion ___

9. As an individual, when you hear scientists identify agricultural activities as the main contributors of non-point source nutrients to surface waters and that nutrients can dramatically reduce water quality and ecosystem health, do you have confidence that what is being said is true (check one)?
Yes___ or No ___ No Opinion___

10. What do you think your states overall management goal with regards to nutrient levels in water bodies should be (check one)?

- No management goal (i.e. it is what it is, don't worry about it) ___
- Reduce nutrient levels to pre-settlement levels ___
- Reduce nutrient levels to enable the removal of a nutrient impaired water body from the EPA impaired waters list ___
- Reduce nutrient levels to ensure the protection of aquatic ecosystem health ___
- No opinion ___
- Other (please name) _____

11. How would you rate your own awareness on a scale of 1-5 (1 being the lowest and 5 being the highest) of the water quality issues facing Lake Winnipeg in Manitoba, Canada (check one)?

- 1 ___
- 2 ___
- 3 ___
- 4 ___
- 5 ___

12. How would you rate your own awareness on a scale of 1-5 (1 being the lowest and 5 being the highest) that approximately 1/3 of the nutrients (which have a significant impact on water quality) entering Lake Winnipeg originate in the U.S. portion of the Red River Drainage Basin (check one)?

- 1 ___
- 2 ___
- 3 ___
- 4 ___
- 5 ___

13. Are the current financial incentives offered to landowners from federal/state programs for incorporating nutrient-management related BMPs in to their activities enough to attract and/or keep landowners in the programs (check one)?
Yes___ or No ___ No opinion ___

14. What measures would you support being implemented within your state to ensure downstream water users were not negatively impacted by activities occurring in your state (check all that apply)?

- None ___
- Increased regulation and enforcement related to land management practices ___
- Increased financial incentives for landowners/producers ___
- Increased use of existing state/county budgets to implement more programs ___
- Increased taxes to help pay for implementation of more programs ___
- Other (please name) _____
- No opinion ___

15. Are there any actions that you see being easily implemented within your state (that aren't already being implemented) that could decrease NPS nutrient loss from land to surface waters in the Red River Drainage Basin (please list/explain)?

_____
_____
_____
_____

16. The degradation of Lake Winnipeg through increasing nutrient levels has been on-going for almost 20 years. Yet data indicates little to no improvement in nutrient levels within the lake's drainage basin. Can you identify what some of the barriers to successfully reducing nutrient levels may have been (please list/explain)?

_____
_____
_____
_____

17. Do you think that urban populations have unfairly high expectations of rural land owners/producers with regards to the conservation/protection of the natural environment (check one)?
Yes___ or No ___ No opinion ___

18. Currently, the International Red River Board is working to establish water quality criteria for the Red River at the border. Assuming that the nutrient criteria (phosphorus and nitrogen) to be established will be significantly lower the current levels, do you think reductions to meet the new criteria can realistically be achieved (check one)?
Yes___ or No ___ No opinion ___

19. If No to Question 18, why not (check all that apply)?

- Too complex/difficult an issue to solve ___
- Poor leadership on the issue ___
- Use of BMPs as main tool won't achieve enough reductions ___
- Too complex an issue for people to understand and support ___
- Weaknesses in federal/state water quality related legislation ___
- Won't get enough voluntary cooperation from landowners ___
- Not enough money available for programs ___
- Weakness with the science and/or technologies related to solutions ___
- Interference by special interest groups ___
- Other (please name) _____

20. As a citizen of your state, how would you classify the resources (i.e. money & personnel) committed by your state to addressing/improving water quality issues (check one)?

- Too much ___
- Too little ___
- About right ___
- No opinion ___

21. Have you experienced or heard of any actions taken by Manitoba that would negatively impact your support for trying to improve water quality within the Red River Drainage Basin (check one)? Yes___ or No ___ No opinion ___

22. Does the incorporation of BMPs related to agricultural operations succeed in reducing non-point source nutrient loss to surface waters (check one)? Yes___ or No ___ No opinion ___

**** If you are NOT a Land Owner/Producer (Crops or Livestock), you have finished the questionnaire. THANK YOU FOR YOUR TIME AND PARTICIPATION**

PART II Continued Next Page

Part II- Questions for Land Owner/Producers (Crops or Livestock)

23. As a land owner/producer, do you apply fertilizer (manure or synthetic fertilizer) to your land(s) (check one)? Yes___ or No ___

24. If Yes to Question 23, are there any specific variables that influence your application of manure or synthetic fertilizer (check all that apply)?

- Weather (i.e. forecasted rain) ___
- Ground conditions ___
- Regulations ___
- Winter applications ___
- Price ___
- None ___
- Other (please name) _____

25. If Yes to question 23, would you support the creation and enforcement of any new regulatory measures related to controlling the application of manure or synthetic fertilizer on private lands (check one)?
Yes___ No ___ No Opinion___

26. If Yes to Question 23, for your use of fertilizer, do you try and match the amounts applied with the outputs in produce (check one)? Yes___ or No ___

27. If No to question 26, why not (check all that apply)?

- Don't want to ___
- Never thought of it ___
- Too difficult ___
- Unreliable results ___
- Doesn't provide any benefits ___
- Other (please list) _____

28. As a land owner/producer (crops), do you test nutrient levels in the soil to determine your soil nutrient requirements (check one)?
Yes___ or No ___

29. If No to question 28, what has prompted you not to test (check all that apply)?

- Don't want to ___
- Takes too much time ___
- Is too complicated ___
- Is too costly ___
- Doesn't provide any benefits ___

- Other (please name) _____

30. As a land owner/producer, do you use Nutrient Management Plans for your operations (check one)?
Yes___ or No ___

31. If Yes to question 30, do you (check one);

- Create and manage the plan completely by yourself ___
- Get assistance by state or private organizations ___

32. If No to question 30, why not (check all that apply)?

- Don't want to ___
- Takes too much time ___
- Is too complicated ___
- Is too costly ___
- Doesn't provide any benefits ___
- Other (please name) _____

33. As a land owner/producer, do you perform any conservation management activities on your land (check all that apply)?

- Conservation tillage ___
- Maintenance of riparian areas ___
- Reduced tillage ___
- Use of buffer strips ___
- Precision agriculture methodologies ___
- Direct injection of fertilizer ___
- Use of cover crops ___
- Terracing ___
- Other (please name) _____
- None ___

34. As a land owner/producer (crops or livestock), how big of a loss in annual profit would you be willing to accept in order to decrease the amount of nutrients lost from your land/operations to surface waters (check one)?

- None ___
- 0.5% per year ___
- 1-2.5% per year ___
- 2.5-5% per year ___
- Other _____
- No opinion ___

35. As a land owner/producer (livestock), do you try and match the dietary inputs of phosphorus with the needs of livestock (check one)? Yes___ or No ___

36. If No to question 35, why not (check all that apply)?

- Never thought of it ___
- Too difficult ___
- Doesn't provide any benefits ___
- Other (please list) _____

****THANK YOU FOR YOUR TIME AND PARTICIPATION**

APPENDIX D- INTERVIEW SCHEDULE

#	Question
1	Land activities are known to be the main source of NPS nutrients to surface waters. Can the *Clean Water Act* (CWA) in its current form protect surface waters from NPS nutrient additions (Yes/No, Please explain)?
2	The CWA specifically exempts agricultural storm water runoff from being considered a point source of nutrients to water. Given this exemption, do you think the Act can realistically achieve its objective to "*restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and non-point pollution sources* …" (Yes/No, Please explain)?
3	Do you think the manner in which the CWA defines and regulates Animal Feeding Operations reduces the effectiveness of NPS nutrient control (i.e. allows exemptions related to agricultural storm water runoff; small CAFOs are not regulated unless designated as a **significant** contributor of pollutants etc.) (Yes/No, Please explain)?
4	The CWA requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish Total Maximum Daily Loads (TMDLs) for such waters. Would giving impaired waters that cross state or national borders higher priority exclusive of their TMDL via more funding etc., help achieve faster water quality improvements on those water bodies (Yes/No, Please explain)?
5	The promotion of BMPs (compared to legislation/regulation) seems to be the main choice of federal/state agencies regarding the control of NPS nutrient losses from land to water. Why do you think this is?
6	Special interest groups on all sides of an issue are known to try to influence public policy and legislation. Do agricultural special interest groups (i.e. commodity groups such as American Sugarbeet Growers Association or the National Cattlemen's Beef Association etc.) play a positive or negative role in the creation/improvement of environmental legislation/regulations related to water quality (Please explain)?
7	In your opinion, can federal and/or state programs aimed at helping land owners reduce NPS nutrient loss to surface waters be improved and if so, how?
8	Information related to state (Minn/ND) draft nutrient reduction strategies indicate that increased regulation (either new or expanded) is not a component of either strategy. Why do you think this is?
9	The EPA and both Minn & ND promote the use of the "watershed approach" to addressing WQ issues. A component of the watershed approach is using integrated management strategies such as Integrated Water Resources Management to involve all stakeholders in the decision-making process. However, the literature identifies many inherent weaknesses with such management systems. Do you perceive any strengths or weakness in using such systems (Yes/No, Please describe)?
10	Some view the increasing reliance on integrated management strategies as a manner in which government can abdicate responsibility on difficult and/or controversial issues. Do you agree with this view (Yes/No, Please explain)?

11	Can you identify and discuss any key measures (i.e. policy, programs, guidelines etc.) developed by your organization that specifically address the issue of NPS nutrient loss to surface waters?
12	How much influence do you think economic implications have for establishing/achieving your organizations environmental mandate and policies (-are economic factors very important, important, moderately important or not important)?
13	Is the above mentioned influence of economics based on the assumed/measured support of the states greater populace or is it solely a government developed position capable of changing with whatever government is in power?
14	How would you rate your department's/organization's awareness of the water quality issues facing Lake Winnipeg in Manitoba, Canada on a scale of 1-5 with 1 being the lowest and 5 being the highest?
15	The degradation of Lake Winnipeg caused by increasing nutrient levels has been on-going for almost 20 years. Yet data indicates no improvement in either lake nutrient levels or those within US portions of the Red River Drainage Basin. Can you identify what some of the barriers to successfully reducing nutrient levels may have been?
16	Can any part of this inability to achieve nutrient reductions over the last 20 years within the U.S. portion of the Red River Basin be attributed to Manitoba (Yes/No, Please explain)?
17	The EPA indicates that the Red River was assessed as polluted in 2012. However, a January 2014 review of the EPA's data on its "*How's My Water Way?*" website indicated that there are no *Polluted Runoff Control Projects* or *TMDL Cleanup Plans* listed for the Red River and "nutrients" do not show up as a pollutant. Can you discuss why this may be?
18	The U.S./Canada, via the Boundary Waters Treaty, uses the International Joint Commission (IJC) to "*prevent and resolve disputes between the United States of America and Canada*". Given that IJC recommendations on an issue are not legally binding, do you think that its lack of "power" places trans-boundary waters on both sides of the border at risk from a water quality perspective (Yes/No, Please explain)?
19	Do you think the CWA adequately considers and protects the quality of waters flowing out of the U.S. (Yes/No, Please explain)?
20	Do you think that jurisdictions within the Lake Winnipeg Drainage Basin but outside of Manitoba will seriously undertake NPS nutrient reductions if Manitoba is not addressing it within their own jurisdiction (Yes/No, Please explain)?
21	Currently, the International Red River Board is working to establish WQ criteria (including nutrients) for the Can/U.S. border. Assuming the nutrient levels to be established will be below the current levels, do you think that existing federal and state programs will realistically achieve the required reductions (Yes/No, Please explain)?
22	Can you think of any barriers (Federally or with Minnesota/North Dakota) that would inhibit reductions of NPS nutrients additions to the Red River Drainage Basin?
23	Is there anything that you think we missed talking about in regards to how water quality within the Red River Drainage Basin is/can be protected from agricultural/land sourced NPS nutrients?

APPENDIX E- ADDITIONAL TABLES

Table 4: Total Number of Conservations Districts and Water Districts Within Minnesota's and North Dakota's Portion of the Red River Drainage Basin

Minnesota Soil and Water Conservation Districts	Minnesota Watershed Districts	North Dakota Soil Conservation Districts	North Dakota Water Resource Districts
Becker County	Boise de Sioux	Barnes County	Barnes county
Beltrami County	Joe Rivers	Cass County	Grand Forks County
Big Stone County	Middle-Snake-Tamarac Rivers	Cavalier County	Maple River
Clay County	Red Lake	Eddie County	Nelson County
Clearwater County	Roseau River	Foster County	North Cass
East Otter Tail County	Sand Hill river	Grand Forks County	Pembina County
East Polk County	Two Rivers	Griggs County	Ransom County
Grant County	Wild Rice	Nelson County	Richland County
Itasca County		North Central	Rush River
Kittson County		North McHenry	Sargent County
Koochiching County		Pembina County	Southeast Cass
Mahnomen County		Pierce County	Steele County
Marshall County		Ramsey County	Traill County
Norman County		Ransom County	Walsh County
Pennington County		Richland County	
Red Lake County		Rolette County	
Roseau County		Sheridan County	
Stevens County		South McLean	
Travers County		Steele County	
West Otter Tail County		Stutsman County	
West Polk County		Towner County	
Wilken County		Trail County	
		Walsh County Three Rivers	
		Wells County	
		Wild Rice	

Table 5: Breakdown of Available Conservation Districts and Water Districts within Minnesota and North Dakota as well as the Total Potential Participants

	Organization	**Total Number of Districts Within the Red River Drainage Basin**	**Estimated Total Potential Participants Per District for Survey** (low and high)	**Estimated Total Number Potential Participants Available for Recruitment** (low and high)	**Total Number of Districts Within the Red River Drainage Basin Actually Targeted**	**Estimated Total Number Potential Participants for Survey** (low and high)
Minnesota	Soil and Water Conservation Districts	23	4-6	92-138	11	44-66
	Watershed Districts	8	4-6	32-48	8	32-48
North Dakota	Soil Conservation Districts	25	4-6	100-150	12	48-72
	Water Resource Districts	14	4-6	56-74	7	28-42
		Total	**Total**	**Total**	**Total**	**Total**
		70	NA	280-410	38	152-228

APPENDIX F- ADDITIONAL FIGURES

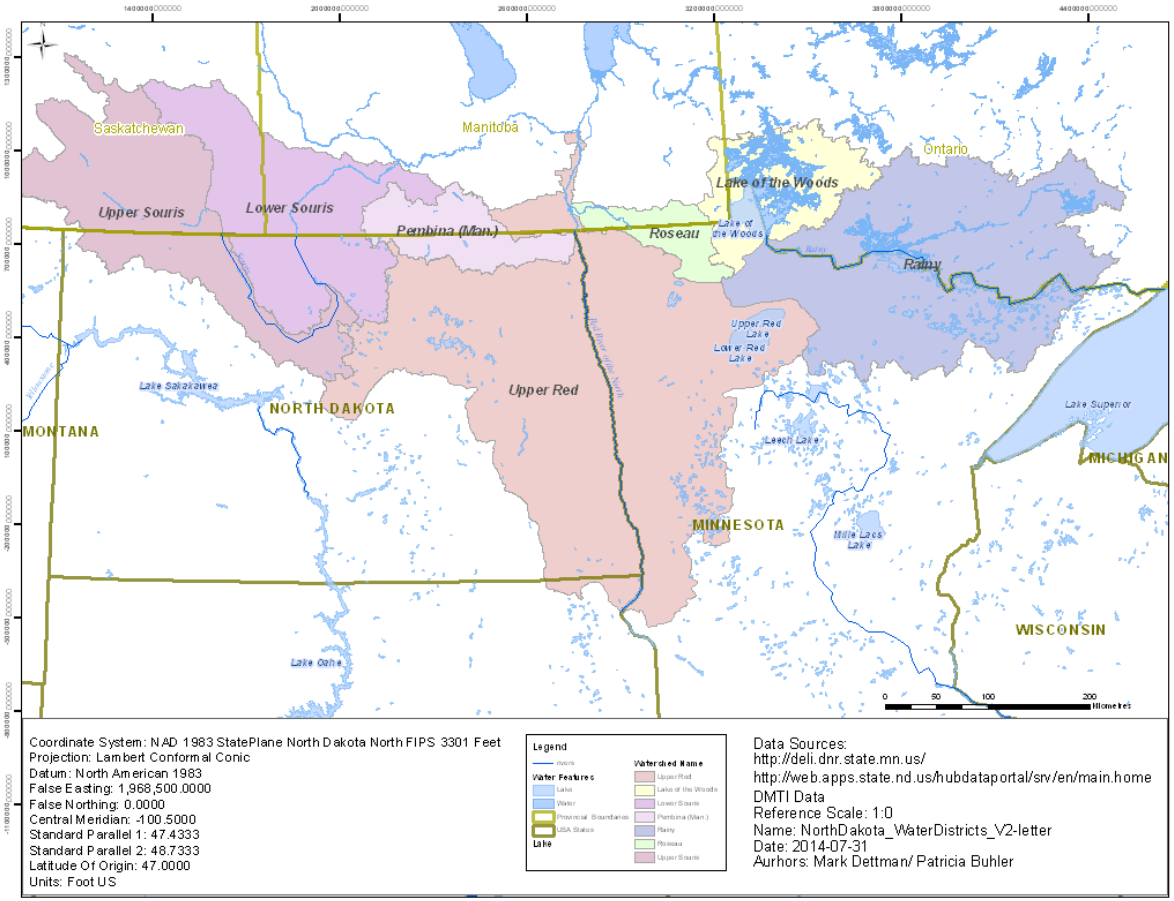

Figure 10: Map Showing the Extent of Lake Winnipeg's Five Main Drainage Basins and the Proportion of the Red River Drainage Basin located in the United States

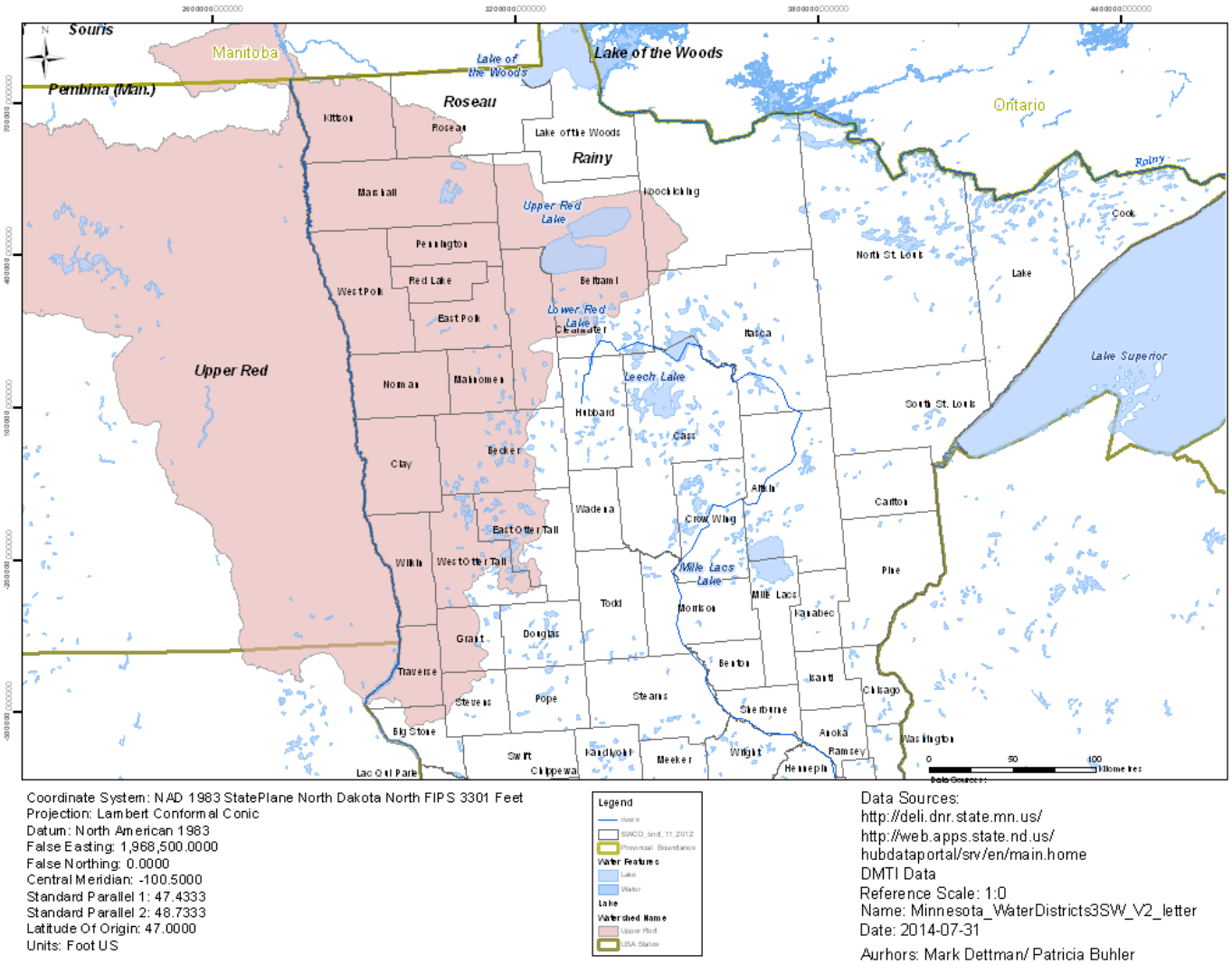

Figure 11: Map Showing the Boundaries of the Minnesota *Soil and Water Conservation Districts* as they Relate the Red River Drainage Basin

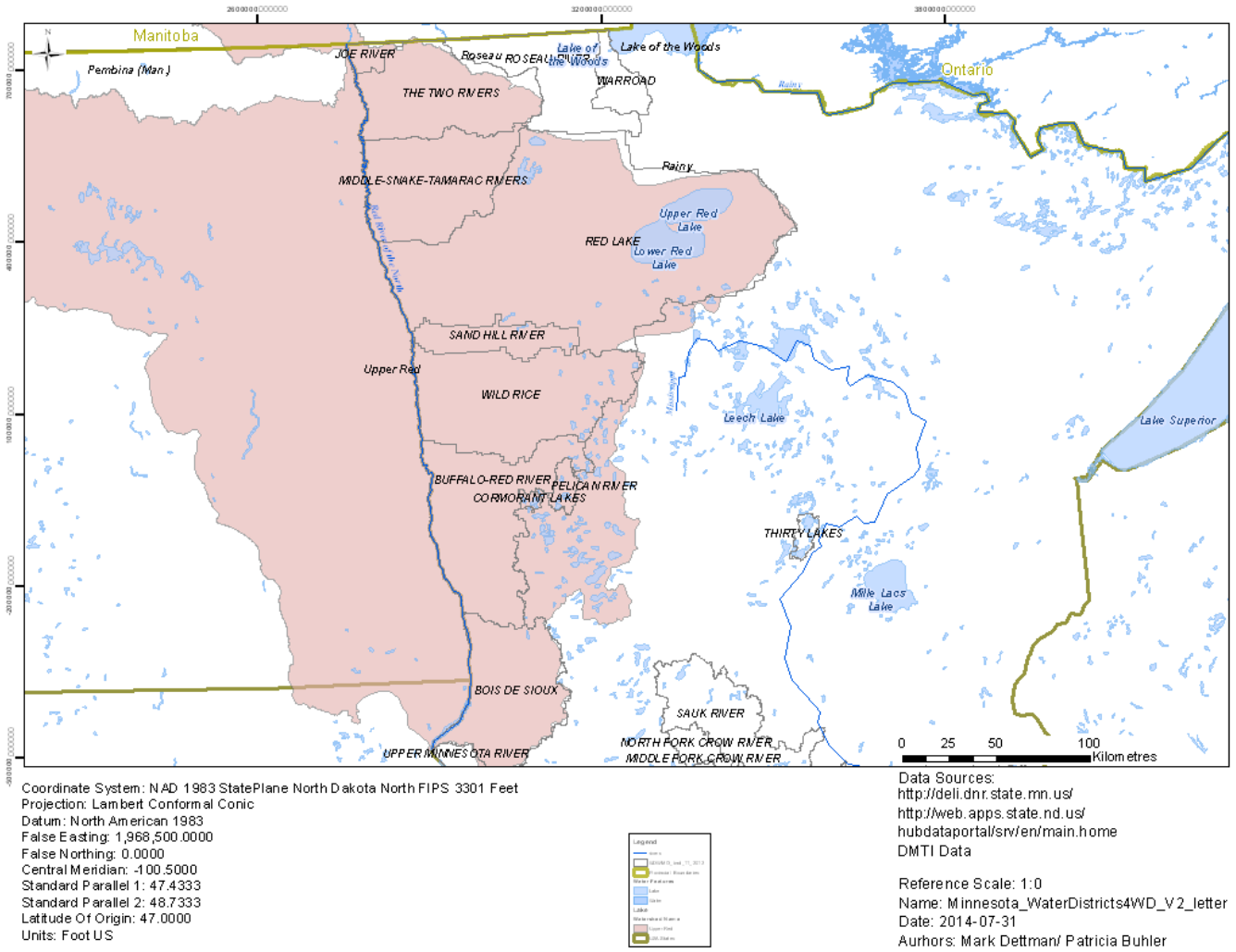

Figure 12: Map Showing the Boundaries of the Minnesota *Watershed Districts* as they Relate the Red River Drainage Basin

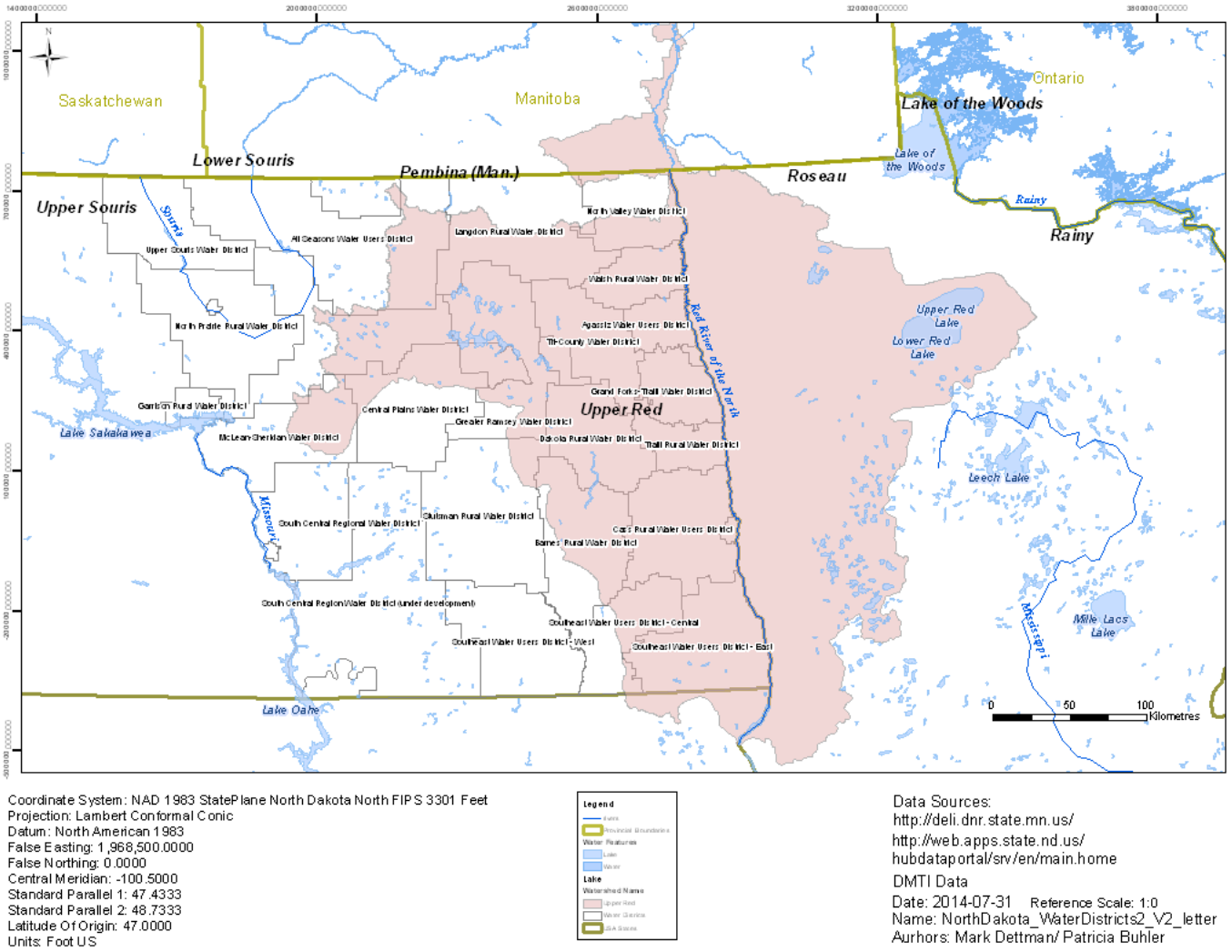

Figure 13: Map Showing the Boundaries of the North Dakota *Water Resource Districts* as they Relate to the Red River Drainage Basin

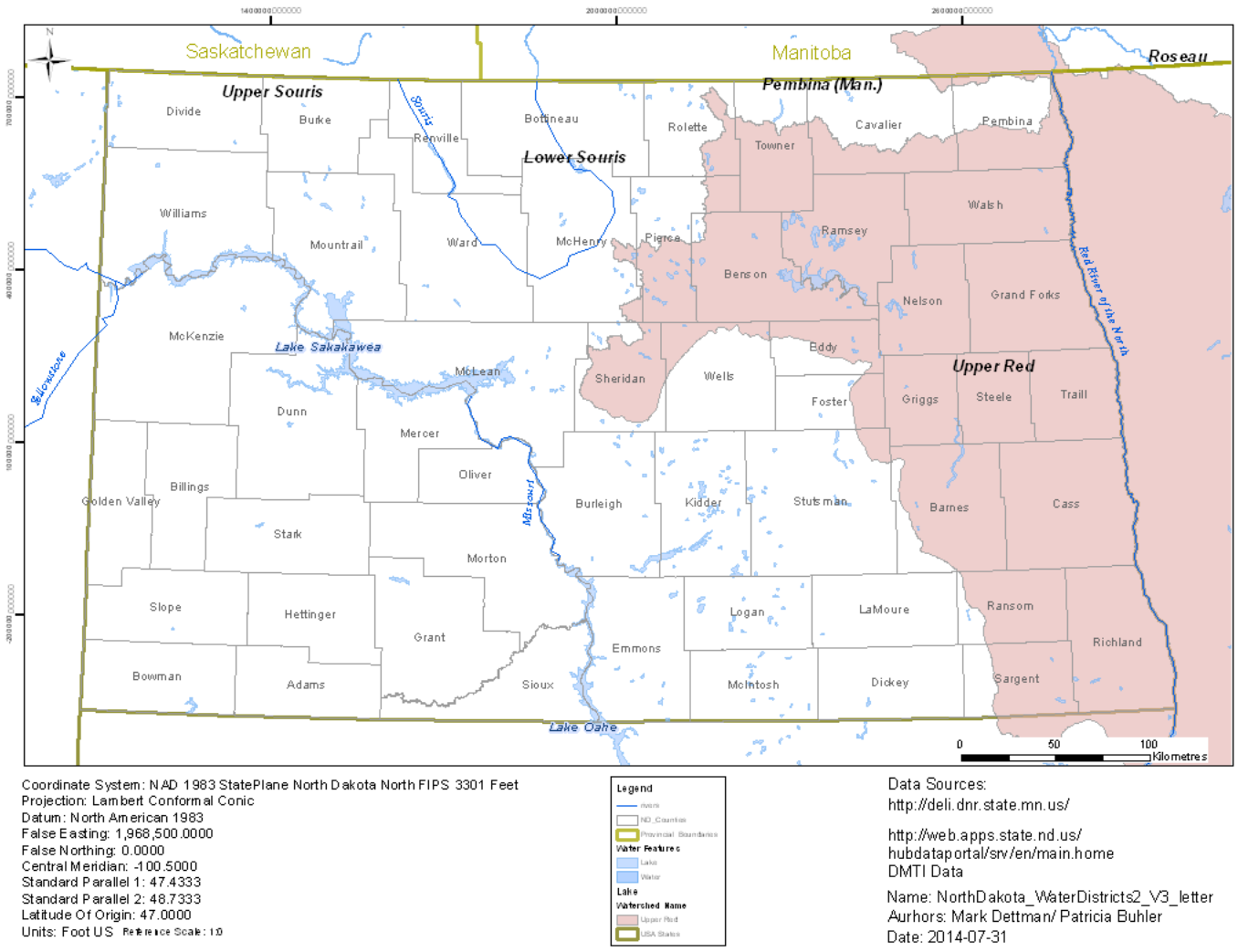

Figure 14: Map Showing the Boundaries of the North Dakota *Soil Conservation Districts* as they Relate to the Red River Drainage Basin

APPENDIX G- PRE-STUDY INTERVIEWS

In order to support that the study was a worth-while undertaking, some clarifications were needed during the proposal phase about the day-to-day operations and linkages of some organizations within Minnesota and North Dakota deemed to be integral to the validity of the research question. Due to the desired information not being available within the organizations literature or from their web sites, I used "cold calls" to the organizations of interest and a casual conversation/interview. The organizations and people interviewed were;

Leanne Buck	Executive Director, Minnesota Association of Soil and Water Conservation Districts Association. Interview conducted Friday January 11, 2013
Ray Bohn	Executive Coordinator, Minnesota Association of Watershed Districts. Interview conducted Friday January 4, 2013
Justin Demarais	District Technician, Ramsey County Soil Conservation District. Interview conducted Friday January 11, 2013
Mike Dwyer	Executive Vice President, North Dakota Water Users Association. Interview conducted Friday January 4, 2013.
Kristine Larson	Watershed Coordinator, Grand Forks County Soil Conservation District. Interview conducted Friday February 8, 2013
Lance Yohe	Executive Director, Red River Basin Commission. Interview conducted Friday January 11, 2013

APPENDIX H- RAW DATA FROM SURVEYS AND INTERVIEWS

Survey Question	Answer Summary (out of 19 participants)
1	15 MN, 4 ND
2	13 MN, 4 ND, 2 Both
3	12 government, 3 Private Business, 4 Landowner
4	14 Yes, 3 No opinion, 1 NA
5	-
6	17 Yes, 2 No opinion
7	-
8	11 Important, 4 Moderately important, 4 Very important
9	9 Yes, 7 No, 3 No opinion
10	10 Protection of aquatic health, 6 Removal from EPA impaired waters list, 1 Special, 1 No opinion, 1 NA
11	9-3's, 5-2's, 2-1's, 2-4's, 1-5
12	7-3's, 4-4's, 3-2's, 2-1's, 2-NA special, 1-5,
13	16 No's, 2 Yes, 1 No opinion
14	-
15	-
16	-
17	11 Yes, 4 No's, 4 No opinion
18	7 No opinion, 7 Yes, 4 No, 1 Maybe
19	15 NA, 4 Replies---
20	8 Too little, 7 About right, 4 No opinion
21	13 No, 4 No opinion, 2 Yes
22	13 Yes, 4 No opinion, 1 No, 1 NA
23	OUT OF 4---- 4 Yes
24	OUT OF 3----
25	OUT OF 4---- 3 No opinion, 1 Yes
26	OUT OF 4---- 4 Yes
27	OUT OF 4---- 4 NA
28	OUT OF 4---- 4 Yes
29	OUT OF 4---- 4 NA
30	OUT OF 4---- 4 Yes
31	OUT OF 4---- 3 By myself, 1 Get assistance
32	OUT OF 4---- 4 NA
33	OUT OF 4---- 3 conservation tillage, 3 direct injection of fertilizer, 2 reduced tillage, 2 riparian area protection, 2 use of buffer strips, 2 use of precision ag/1 use of cover crops
34	OUT OF 4---- 4 None
35	OUT OF 4---- 4 NA
36	OUT OF 4---- 4 NA

NA = NOT ANSWERED

Interview Question	Answer Summary (out of 9 participants)
1	5 Yes, 2 No, 1 Maybe, 1 NA
2	5 No, 2 Yes, 1 Maybe, 1 NA
3	4 Yes, 3 No, 2 NA
4	5 Yes, 2 No, 2 Maybe
5	5- more social palatable, 2 b/c of difficulty in enforcing for the issue, 1 b/c of special interests, 1 b/c more flexible than regs
6	4 Both, 3 Negative, 2 Positive
7	9 Yes
8	4 less socially acceptable, 2 b/c of special interests, 1 b/c of weaknesses with the CWA, 1 b/c of difficulty in regulating the issue, 1 NA
9	6 Strengths only, 1 Weaknesses only, 1 Both, 1 NA
10	5 No, 3 Yes, 1 NA
11	-
12	6 Very, 2 Important, 1 Moderately
13	5 Population, 3 Both, 1 NA
14	4- 4's, 2- 3.5's, 2-3's and 1-2
15	9 different responses
16	5 Yes, 4 No
17	4 NA, 2 focus has been on tributaries, 2 all background work not completed, 1 Surprise
18	5 No, 3 Yes, 1 Maybe
19	4 Yes, 2 No, 2 NA, 1 special
20	7 Yes, 1 No, 1 Maybe
21	4 No, 2 Yes, 3 special
22	9 Yes--- 6 lack of money, 5 lack of landowner support, 1 political will, 1 public support on the issue, 1 lack of public education, 1 lack of flexibility in programs, 1 voluntary nature of solutions
23	NA

NA = NOT ANSWERED

APPENDIX I- CALCULATIONS OF AVERAGE COMMERCIAL WALLEYE CATCH IN LAKE WINNIPEG FROM 2001-2011

Year	Total LW Commercial Catch (kg)
2010-2011	6,379,666*

Year	Total LW Commercial Walleye Catch (kg)
2010-2011	4,498,370*

Year	% Total LW Commercial Walleye Catch of Total LW Commercial Catch
2010-2011	4498370/6379666 x 100 = 71%*

Year	Total LW Commercial Catch (kg)	Assumed % Total LW Commercial Walleye Catch of Total LW Commercial Catch in 2010-2011	Total Walleye Catch (kg)
2001-2002	6237950	0.71	4428944
2002-2003	6204150	0.71	4404946
2003-2004	6543300	0.71	4645743
2004-2005	6380100	0.71	4529871
2005-2006	6397500	0.71	4542225
2006-2007	6355550	0.71	4512440
2007-2008	6201618	0.71	4403148
2008-2009	6818695	0.71	4841273
2009-2010	6763585	0.71	4802145
2010-2011	6379666	0.71	4529562

2001-2011 Total LW Commercial Walleye Catch (kg)	2001-2011 Total Annual Average LW Commercial Walleye Catch (kg)
41,110,736	4,111,073

Data compiled using Table 4 and Table 5 from *A Profile of Manitoba's Commercial Fisheries* (Manitoba Conservation and Water Stewardship, 2012)

* refers to actual collected data

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