IMPROVING THE SUSTAINABILITY OF RIVER SYSTEMS THROUGH THE REMOVAL OF DAMS ON THE SAUGEEN RIVER, SOUTHWESTERN ONTARIO

by

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We accept this thesis as conforming
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CHAPTER ONE – STUDY BACKGROUND

Thesis Questions

What are the factors that are preventing the removal of dams on the Saugeen River in Southwestern Ontario, Canada, and how can they be overcome to facilitate potential improvements to the sustainability of river systems?

River Systems and Sustainability

A river can be considered a system, one in which the key principles of wholeness, emergent properties, hierarchy and feedback (A. Hodge, Royal Roads University, lecture handouts, 2000) are evident and can be used to describe that system. River systems consist of many components such as watercourses, floodplains, infrastructure, urban areas, wildlife, people, etc. which, when combined as a whole, create something that is more than the sum of the individual components. Properties will emerge from the relationships between the component parts, such as the property of interdependence between a community and the river that flows through it. These properties are of a higher level than the properties of the individual components and will assist in describing the river system. A hierarchy of systems will exist within the river system and will tend to be nested together. For instance, a wetland system could exist within a floodplain system both of which are components of a larger river system. These systems will provide feedback and control to each other that will facilitate adjustments to address the supports and stresses that each will experience.

River systems can also be considered as a series of ecosystems. Dale (2001) defines an ecosystem as "a collection of interacting biological entities combined with the physical environment in which they live" (p. 177). The ecosystems within a river system will include a number of natural resources, one of the greatest of which is the surface water flowing within the creeks, streams, and rivers that form the backbone of the system. The individual people, communities, businesses, organizations, and governments that exist along the river are other important components of the system. While these groups and individuals can exploit the resources, creating stresses on the ecosystems of the river, they also have the ability to restore these ecosystems, thereby improving the river. A river system where the restorative activities of humans are equal to or greater than the stresses of human activity can be considered sustainable.

The term sustainable has been used in the above discussion. What is a sustainable river system? The ecological definition of sustainable, according to the Canadian Oxford Dictionary, is that which "conserves an ecological balance by avoiding depletion of natural resources" (Barber, 1998, p. 1462). Hodge (1996) has modified an earlier definition to suggest that sustainability refers to "the persistence over an apparently indefinite future of certain necessity and desired characteristics of both the ecosystem and the human sub-system within" (p. 268). The Brundtland Commission of 1987 defines sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission of Environment and Development, 1987, p. 8). These definitions would suggest that a sustainable river system is one in which the ecological aspects and needs of

a river and all its component parts, as well as the needs of the human society associated with that river, are not compromised now, or in the future.

The Problem

The organization called American Rivers defines a dam simply as "any barrier which impounds or diverts water" (American Rivers, 2000, p. 2). While various definitions of a dam will be discussed in greater detail later in this work, this simple description is sufficient to suggest that a dam changes the very essence of what a river is, "a copious natural stream of water flowing in a channel to the ocean or a lake" (Barber, 1998, p. 1245). A human made barrier, such as a dam, constructed across a natural system, such as a river, can create stresses on the ecosystems within the river system. The sustainability of that system can be called into question if the stresses become too great.

As the Saugeen River watershed of Southwestern Ontario was being settled, dams and mill operations provided an important and reliable source of power for a growing and vibrant agricultural economy. Without this early type of infrastructure, the development of the region would have been at a much slower rate. The majority of the mill dams still remain; however many of the mills are gone. None of these existing mills use water to power their operations. A few of the mills have been converted to generate hydroelectric power on a private basis. Some of the dams within the watershed provide recreational opportunities. None can be considered flood control structures; however some do provide ice management benefits.

It is not for today's society to question the sustainability of the actions of those that settled the Saugeen River watershed and built dams several decades ago. It must be asked if the continued existence of these structures today makes for a sustainable river system. If the answer is no, and there is much in the literature to suggest that the negative impacts associated with dams like those in the Saugeen River watershed far outweigh the benefits, then action must be taken. To remain inactive on this issue would be unsustainable. While dams do provide some benefits to individual dam owners, and society as a whole, they are also the cause of significant negative environmental, social, and economic impacts on river systems.

Many of the problems related to dams could be alleviated if the dams were removed. Generally speaking, society has not made the connection between dam removal and the minimization and elimination of the negative impacts of dams. Extensive efforts are being made in other jurisdictions to facilitate the removal of dams which are of a much larger and more beneficial nature than those of the Saugeen River watershed. Why are these efforts not being made within the Saugeen River watershed? What are the factors that are preventing the removal of dams on the Saugeen River and how can they be overcome? By answering these questions, it may be possible to improve the sustainability of the Saugeen River system.

Barriers to Dam Removal

There are several possible factors, either existing or perceived, that are preventing dams within the Saugeen River watershed from being removed.

Environmentally, dams may be seen as having little impact on a river system, having been in place for such a long period of time. It could be the thinking of some that the river has adapted to their existence and whatever damage that has been done took place long ago. Leaving a dam in place may be better than the potential environmental damage caused in the attempt to remove it. Some may think that the environmental degradation seen in reservoirs can be addressed in other ways such as dredging activities or modifying dam structures.

One of the main social factors that may be preventing dams from being removed is that many people consider the reservoirs they create to be aesthetically pleasing. In addition, many may lack the knowledge of the negative aspects of a dam or the knowledge required to undertake a dam removal project. Some may believe that dams should be maintained because of their ability to control or prevent environmental hazards such as floods. Removal may also be hindered by the fact that some dams also serve as other forms of infrastructure such as roadways or pedestrian walkways. Environmental regulations that control work in or near rivers, as well as government bureaucracy, could be considered an obstacle to removing a dam. Finally, society could simply be apathetic towards the removal of dams or lack leadership or direction.

Some dams have recreational value in the reservoirs they create. This value may decline if the structure is removed; however many people may not realize that a dam removal project also creates recreation opportunities. Those that participate in sport fishing may view dams as structures that legitimately separate different fish species, and as such, may

object to their removal. Dams may also be seen as old structures with historic value, symbolizing the progress of communities. These sentiments can act as barriers to the removal of a dam.

Sufficient funding to support a dam removal project may not be available to the individual or group desiring to do a project. In addition to being an expensive undertaking, a dam removal project may also result in the removal of an existing or potential revenue source such as the sale of hydroelectric power.

CHAPTER TWO – DAMS of the SAUGEEN RIVER WATERSHED

History

The early settlers of Southern Ontario used the water resources they found to their advantage. In most cases the location of settlements were determined by the ability of the watercourses in the area to provide reliable sources of water power for mill operations. The government commissioned surveyors to establish a route from the community of Fergus, north to the Georgian Bay area in 1837, which would become the first major road within the Saugeen River watershed area (Edwards, 1979). The surveyors were given instructions to describe all river crossings in great detail and to note and report all potential mill sites (Department of Planning and Development, 1953). Town plots were established near these potential mill sites, and communities developed soon thereafter. The vast majority of urban centres within the Saugeen River watershed today are located on watercourses and have, or have had, at least one mill and an associated dam. The early establishment of mills in this region was important. Firstly, saw mills were required to supply lumber for the many new buildings being constructed in the area (Department of Planning and Development, 1953). There was then a need for flour and woollen mills as agricultural operations were being established (Department of Planning and Development, 1953).

Dams were a necessary part of these mill operations and were constructed on the Saugeen River and its many tributaries. Dam and mill construction started in earnest in the 1850's, and while many of the first wooden dams were no match for the spring floods of the Saugeen River, many were rebuilt as more substantial structures (Department of Planning and Development, 1953).

The construction of dams was considered to be a necessary part of the industrial development and was likely undertaken with little or no regard for the health or sustainability of the natural environment. While the concept of sustainable development is one that many parties aspire to when considering new development proposals today, it represents a way of thinking that was probably non-existent when the settlers of the Saugeen River watershed were looking for reliable sources of power.

What is a Dam?

The Canadian Oxford Dictionary defines a dam as "a barrier constructed to hold back water and raise its level forming a reservoir or preventing flooding" (Barber, 1998, p. 353). The number of dams within the Saugeen River watershed meeting this definition is unknown. These would include the mill dams described above as well as the many smaller impoundments, on-stream ponds, by-pass ponds, and spring fed ponds not associated with a watercourse, constructed primarily by private landowners for reasons of aesthetics, recreation, or to provide a source of water for irrigation or fire protection. Some people may not consider many of these smaller impoundments, with little or no ability to control water levels, to be dams or water control structures. An inventory of

dams in the Saugeen River watershed, undertaken in 1991 by the Saugeen Valley Conservation Authority (SVCA), defines a dam as "any impoundment supported by a water control structure of some sort and therefore holding back water" (Saugeen Valley Conservation Authority, 1991, p. 8). This inventory gathered information on 181 structures that met this definition (Saugeen Valley Conservation Authority, 1991).

The International Commission on Large Dams defines a large dam as one that is 15 or more metres in height from the foundation or one that is between 5 and 15 metres high with a reservoir capacity of more than 3 million cubic metres (World Commission on Dams, 2000). None of the existing structures within the Saugeen River watershed would meet this definition (Saugeen Valley Conservation Authority, 1982, 1991, 2001).

The Draft Ontario Dam Safety Guidelines defines a dam as "a barrier across a river, lake, pond or stream, intended to hold back water in order to raise its level, or create a reservoir or divert the flow of water, and includes works (appurtenances) incidental to, necessary for, or in connection with the barrier." (Ontario Ministry of Natural Resources, 1999, p. 1-4) This definition goes on to state that structures that are included in the Provincial Dam Safety Program are dams that fall within any one of the following applicable criteria: 1) dams that extend more than 3 meters above the original stream bed, 2) dams that are more than 2 metres above the original stream bed with reservoir surface areas of 2 hectares or more and, 3) dams, the failure of which could cause loss of life or property damage in excess of $100,000; or dams which could cause high environmental impact in the event of failure (Ontario Ministry of Natural Resources, 1999). Most of the

old mill dams in the Saugeen River watershed would fit under these criteria, as would several other structures constructed for reasons other than providing a source of water power. For the purposes of this study, the Ontario Dam Safety Guidelines definition will be used. This definition refers to structures that have been constructed on existing waterways or bodies of water. It does not refer to structures that have been constructed in headwater areas or at locations to impound spring water. These types of dams are not included in this study.

Saugeen River Watershed Dams

In order to undertake this study, it was necessary to gather information on the dams within the Saugeen River watershed. Existing dam inventories, undertaken by the SVCA in 1982 and 1991, were reviewed. In addition, most dam locations within the watershed that could potentially meet the subject definition, were inspected. These inspections were undertaken in the fall of 2001. The information compiled from the inspections and existing inventories was used to prepare an updated general inventory of larger dams in the watershed.

The number of dams in the Saugeen River watershed that meet the subject definition is 52. A list of these dams by sub-watershed can be found in Appendix A. The Saugeen River system has many sub-basins and a reference list of dams that more accurately reflects the drainage pattern of the watershed would be more appropriate than simply listing the structures by sub-watershed. This more descriptive list, which can be found in Appendix B, starts at the mouth of the river and lists the dams in the order in which they

are located on the Main Saugeen River and as they are located on tributaries that enter the Main Saugeen River. When a tributary is encountered entering the main river, the dams on that tributary are listed prior to commencing further upstream on the main river. Each time a tributary is encountered, an indentation is made on the reference list. By studying this list, the number of dams one will encounter from a given starting point, when moving upstream or downstream, can be determined. A reference list of this nature would be advantageous when planning dam removal projects that will benefit entire river systems.

The 52 dams that meet the chosen definition range in approximate height from 3 metres to 10.5 metres, as estimated from the original watercourse bed to the top of the dam, not including railings, walkways or other accessories to the dam. At one time, 40 of these structures supplied water power to mill operations. There are no mills today that are operated by water power within the Saugeen watershed on a regular basis. Seven dams within the watershed are used to produce hydro electric power on a small scale and at least one additional dam is in the process of being brought into service for this purpose. These hydro producing dams are all privately owned. Dam ownership will be discussed in greater detail in chapter four. Many dams appear to be providing recreational benefits and some have aesthetic value. None of the 52 dams were designed to prevent or control flooding; however a small number of dams in the watershed do provide minimal assistance in preventing floods by breaking up ice or by controlling ice movement and thereby prevent the formation of ice jams. Table 2.1 shows the different uses of large dams in the Saugeen watershed.

Table 2.1 Uses of large dams within the Saugeen River watershed

Dam Use	Number of Dams
Recreation (private)	18
Recreation (public)	11
Hydro electric power	8
Public trails	7
Municipal roadways	2
Fisheries management	2

Note: Dams may be of no use or provide more than one use.

The condition of the 52 dams was graded on a scale from good to very poor. The results of this grading can be found in Table 2.2. This table shows that a significant number of dams are in poor and very poor condition. Some appear to have been abandoned by their owners.

Table 2.2 Conditions of large dams within the Saugeen River watershed

Grade	Description of Grade	Number of Dams
Good	-very well maintained -dam in excellent condition -no structural problems -operational	18
Fair	-adequately maintained -minor problems evident -no structural problems -dam likely operational	15
Poor	-extensive maintenance work required -several problems evident -minor structural problems -dam may not be operational	7
Very Poor	-no recent maintenance evident -dam deterioration evident -serious structural problems -dam not operational	12

CHAPTER THREE – LITERATURE REVIEW

Concerns of Public Interests

Many organizations, interest groups, networks and coalitions have been formed throughout the developed world to work towards the protection and restoration of natural resources. Much of their work focuses on river systems. Many of these groups have similar views concerning dams. They generally feel that the environment and society would be better served if fewer dams existed. Simply put, "dams harm rivers" (Lindloff and Johnson, 2000, p.1-4).

The opposition to dams is shown in some of the general comments made by some environmental groups. A joint report prepared by a number of American based environmental organizations states that "few human actions have more significant impacts on a river system that the presence of a dam" (Maclin and Sicchio, 1999, p. vii). The International Rivers Network (2001) feels that "Dams wreak havoc on native fisheries and river ecosystems" (p. 1). The River Recovery Program in British Columbia has received significant public support "as residents witnessed the serious environmental and social costs of dams" (Outdoor Recreation Council of British Columbia, 2001, p. 1). The European Rivers Network is of the opinion that "a dam is not eternal" and that dam decommissioning will be a great opportunity for the restoration of rivers in the upcoming years (Epple, 2000, p. 4). A report jointly prepared by the River Alliance of Wisconsin

and Trout Unlimited states that “tremendous damage is done to a river when humans clog these flowing arteries of life with dams.” (Lindloff and Johnson, 2000, p. ii).

The reasons for these formidable views are many and varied. The main reasons appear to be of an environmental nature; however other reasons of a social, and economic nature have also helped to shape the opinions and actions of these groups.

Environmental Impacts

The basic function of any dam is to create a head of water that usually results in an artificial impoundment that is deeper, wider and more slowly moving than the river that was once there. In simple terms, dams fragment and block rivers, preventing them from carrying out their natural function (Lindloff and Johnson, 2000). Blocking a river changes the ecosystem and destroys the natural processes that depend on that system (Maclin and Sicchio, 1999).

Dams harm water quality, in that they negatively affect water temperatures, dissolved oxygen content, turbidity and salinity (Lindloff and Johnson, 2000). Other groups in their publications share these claims. A dam can alter nutrient cycles, disrupt temperature regimes and dissolved oxygen levels thereby affecting all aspects of aquatic life, including fish (International Rivers Network, 2001 and Canadian Dam Association, 2000). The National Wildlife Federation also shares this view when they claim that dams in Washington State harm endangered salmon and steelhead by slowing river flows and increasing both temperature and dissolved nitrogen levels (Hollister, 2001). Dams are

responsible for the warming of the water and the accumulation of sediments and nutrients, leading to the degradation of ecosystems and water quality (Epple, 2000). The end result of these new conditions created by dams is summed up by the claim that dams have caused, or contributed to, many species becoming threatened, endangered or extinct (Lindloff and Johnson, 2000). According to the group Idaho Rivers United, the primary reason that all five species of Snake River salmon are approaching extinction is the eight federally owned dams that exist between the streams where the salmon are born and the Pacific Ocean (Masonis, Yates, Weiss, Wise and Soderstrom, 1999).

Dams change a river's ability to move sediment and other nutrients downstream (Lindloff and Johnson, 2000; Stott and Smith, 2001). This position is expanded upon by the statement that dams prevent the movement of many materials such as sediments, gravel, woody material and nutrients (Maclin and Sicchio, 1999; Stott and Smith, 2001). The sediment that accumulates in a reservoir is also a place for heavy metal and other pollutants to accumulate (American Rivers, 2001a).

When rivers are deprived of sediments they seek to recapture this loss by eroding downstream banks (Pottinger, 2000; Stott and Smith, 2001). This erosion can lower the channel bed of the river, which may create less complexity of habitats within the river channel and reduce the possibility of ecological interaction between the river and floodplain, leading to the isolation of wetlands and wooded areas (Stott and Smith, 2001). The loss of sediment can also mean a loss of soil being deposited on floodplain lands, resulting in a loss of soil productivity and depth (Pottinger, 2000).

River outlets can be enriched ecosystems where fish populations depend on the volume and timing of nutrients and fresh water (Pottinger, 2000). The changes to flows and nutrient loads caused by dams have resulted in a decline of the fisheries in water bodies such as the Gulf of Mexico and the San Francisco Bay (Pottinger, 2000). Dams deprive coastlines of sediment that can act to protect the shorelines from erosion through the formation of beaches (Booth, 2001).

Dams are also destructive to fish habitat. In an effort to exploit the fall of a river, dams are often built at locations where high river gradients are in existence (Lindloff and Johnson, 2000). These locations are also prime locations for fish spawning habitat resulting in the destruction of habitat when dams are built (Lindoff and Johnson, 2000). Following construction, the sediment that accumulates behind a dam buries fish spawning habitat (American Rivers, 2001a).

Dams block or inhibit the passage of fish in both an upstream and downstream direction (Grossman, 1999; Canadian Dam Association, 2000) resulting in dramatic declines in fish populations and the actual elimination of some salmon runs in British Columbia (Stott and Smith, 2001). The fluctuating water levels in reservoirs and the altered timing of flows downstream of dams disrupt the reproductive cues and behaviour of many fish species (Maclin and Sicchio, 1999; Stott and Smith, 2001; Canadian Dam Association, 2000). Drought conditions can cause conflicting demands on water between the hydroelectric industry, who want to retain as much water as possible for the generation of

hydro power later in the season, and conservation groups that want adequate flows to be released for fish populations (McFall, 2001). Delayed releases of water can significantly change water temperatures that can be lethal to fish (Hollister, 2001). The variations in flow resulting from dam operations can destroy fertilized eggs, kill young fish and prevent spawning fish from ascending the river (Stott and Smith, 2001). The controlling of flows by dams can also decrease the amount of interaction between a river and the floodplain by reducing or eliminating seasonal flooding events that rejuvenate wetland habitats and sustain estuarine ecological habitats (Stott and Smith, 2001).

Elizabeth Grossman sums up the environmental implications of dams when she states "dams alter and block the natural flow of rivers, interfering with fish migration, often destroying native fish populations. They change water temperatures and degrade water quality; both damaging to vegetation and wildlife. Dams hold back silt, debris and other nutrients that create healthy environments for river species" (Grossman, 1999, p. 2).

Social Impacts

Simply by existing, dams pose a threat to the safety of the public by altering the water currents that can kill swimmers, anglers and boaters (Lindloff and Johnson, 2000). A dam is typically designed to last approximately 50 years (Lindloff and Johnson, 2000). Many dams are a threat to public safety as they have passed their life expectancy, are no longer used for their original purpose, and have fallen into a state of disrepair (Johnson, 1997). Many small dams are not regulated or inspected by any government agency (Maclin and Sicchio, 1999) thereby offering no regulatory incentive to keep these

structures in good repair. In addition, many small dams have been abandoned and are in very poor condition, making them even more dangerous (Maclin and Sicchio, 1999).

A second aspect of dam safety is the possibility of dam failure. The failure of a dam could damage property and threaten lives downstream (Maclin Sicchio, 1999). Other groups expand on the potential problems of a dam failure when they state that a dam failure can be devastating to people, animals, property and habitat (Lindloff and Johnson, 2000; Stott and Smith, 2001).

Historically, society has looked at dams as symbols of achievement. They provided the power necessary to build an industrial economy. To some extent they still enjoy this status today, particularly those dams that produce hydroelectric power, which in some parts of North America account for the majority of electric power being produced. However, the view of society towards dams may be changing. This is the view of the International River Network that has stated: "They were once considered temples of engineering prowess but are now viewed more critically" (International Rivers Network, 2001, p. 1). The State of Maine is one jurisdiction where the social status of dams is being viewed in a critical manner. Governor Babbit of Maine is of the opinion that "Dams are not like the pyramids of Egypt. They should be judged by the health of the river to which they belong" (Grossman, 1999, p. 2).

Dams do provide recreational opportunities and can therefore be considered important. Thirty three percent of dams in the United States exist for recreational purposes (Maclin

and Sicchio, 1999). In some situations dam removal proposals have raised objections due to the recreational importance (Stott and Smith, 2001). A river system without dams can be a healthier river system that can provide more extensive recreational opportunities and assist in the revitalization of a community (Lindloff and Johnson, 2000).

Dams are a part of North America's history. A significant number of dams were constructed to provide water power as communities were becoming established and as such, many dams tend to be very old structures. Their age gives them historic value that translates into a reluctance on the part of the community to modify or remove these structures (Stott and Smith , 2001).

North American society enjoys a strong link with the natural environment. This link is particularly strong with watercourses and even stronger when those rivers include rapids and waterfalls. These linkages can be quickly severed as these features represent locations of high river gradient offering ideal locations for the construction of dams (Lindloff and Johnson, 2000). This general view is shared by others who state that dams impact negatively on the aesthetics and character of a natural setting (Maclin and Sicchio, 1999; Stott and Smith, 2001). Dams are often associated with large tracts of privately owned land, making the river inaccessible to the public (Maclin and Sicchio, 1999).

Economic Impacts

Dam ownership involves a substantial amount of financial responsibility (Lindloff and Johnson, 2000). Many dams are old, unsafe and require extensive amounts of money for

maintenance (Maclin and Sicchio, 1999). Dam maintenance and repair is costly, especially if the dam is no longer generating revenue. Since many dams are publicly owned, this financial burden falls upon tax payers (Lindloff and Johnson, 2000). The owners of dams are also financially responsible for any damage to land and property resulting from a dam failure (Stott and Smith, 2001).

It has been argued that dams that generate revenue through the sale of hydroelectric power are an economic benefit to society. As a dam ages; however its efficiency in generating power decreases while its operation and maintenance costs increase, making continued operation less cost effective (Stott and Smith, 2001; Maclin and Sicchio, 1999). In addition, the economic benefits may not be what they seem to society, as in many areas government subsidies are offered to hydroelectric producing companies making the actual price paid for the power produced by dams substantially lower than the costs of producing that power (Grossman, 1999). In addition, the amount and value of the hydroelectric power generated at some dams is considered by some groups to be negligible. For example, the former generating capacity of the Edwards Dam was 0.1% of the total capacity generated in the state of Maine (Cohen, 1999).

When assessing the costs and benefits of a dam, many items tend to be overlooked in terms of indirect economic costs. One example of this is the loss of sediment to a river system when dams are constructed. A river will seek to recapture lost sediment, and in so doing increase the amount of erosion on river banks, putting productive land, bridges and other structures of considerable value at risk (Pottinger, 2000).

Dam Operations, Modifications, and Removal

Those structures that still benefit society should undergo operational changes to reduce the negative impact on rivers (Maclin and Sicchio, 1999; Stott and Smith, 2001; Lindloff and Johnson, 2000). Careful planning and operation of facilities can minimize the negative environmental impacts of dams (Canadian Hydropower Association, 2001). The Ontario Waterpower Association agrees that dams should be operated for multiple objectives including ones of an environmental nature (Ontario Waterpower Association, 2001). One way to do this is to implement operating parameters which recognize the value of water to multiple users and interests by utilizing a water use plan developed by a variety of stakeholder groups (Stott and Smith, 2001). The Canadian Dam Association (2000) agrees when they state that water management plans for dams should be used to balance the use of water resources. This association also feels that operational scenarios should be optimized to provide water at important times for environmental and other uses (Canadian Dam Association, 2000).

Modifications to dams can be viewed as a way to address the many negative environmental impacts that dams create and should be incorporated into existing structures (Lindloff and Johnson, 2000). Fish passage structures such as fish ladders or fish ways can be used to facilitate the migration of fish around barriers (Canadian Dam Association, 2000). These structures are not without their problems. Fish sometimes have trouble finding the entrance to these passages and often die when exposed to the high water temperatures within them (Machlin and Sicchio, 1999). Modifications can also be made to turbines by preventing the entrance of fish or by making them safer for

fish by having the turbines run slower and with wider clearances (Canadian Dam Association, 2000). Discharge facilities can be designed to address concerns such as downstream erosion, water temperature or the accumulation of sediment within the reservoir (Canadian Dam Association, 2001).

Many groups and organizations have concluded that the removal of many dams is a logical way towards improving the health and sustainability of a river system. The organization known as Idaho Rivers United has concluded that "the surest and probably only way to recover" five endangered species of salmon and steelhead trout on the Snake River is to remove four dams in the lower section of the river (Masonis et al. 1999, p. 1). Lindloff and Johnson (2000) see the removal of dams as an action that will benefit public safety, the financially burdened dam owner, and the river. Mark Angelo of the River Recovery Program in British Columbia has stated that: "There is a need to identify those dams in the province that are no longer useful or provide only marginal benefit – and the decommissioning or removal of some of these structures will create some wonderful habitat restoration opportunities" (Outdoor Recreation Council of British Columbia, 2001, p. 1). The perceptions of those involved with dams are changing as they "increasingly see selective dam removal as an important and very economic river restoration tool" (Johnson, 1997, p. 1). In some cases improved habitat conditions and the return of fish populations have occurred rapidly (International Rivers Network, 2001; Epple, 2000). The benefits of dam removal projects have included increased fish access to river habitat, as well as water quality improvements, which have lead to the restoration

of threatened and endangered species (Lindloff and Johnson, 2000; Maclin and Sicchio, 1999).

It should be noted that the removal of a dam is not appropriate in every situation. Less than 1% of dams in the United States are even being considered for removal (Maclin and Sicchio, 1999). By removing those dams that pose a threat to public safety, and where the costs out weigh the benefits, society can restore the environmental and economic benefits associated with free flowing rivers (Maclin and Sicchio, 1999).

Several successful dam removal projects have been documented that have not only improved the health of river systems but have alleviated dam safety concerns (Maclin and Sicchio, 1999). The removal of dams for public safety reasons is simply good public policy (Corso, 1999). Culturally, it has been found that the removal of dams improve riverside recreation by creating new land for parks and by improving the aesthetics of the river (Maclin and Sicchio, 1999; Canadian Dam Association, 2000; Lindloff and Johnson, 2000).

Part of the social aspects of dams is how they are viewed by public agencies. One of the main reasons that dam removal projects and programs have enjoyed such momentum in the United States is due to the policies and actions of the Federal Energy Regulatory Commission (FERC). In many required relicencing reviews of American dams FERC came to the conclusion that the environment would be better served by free flowing rivers and did not reissue licenses, but ordered removal, as the environmental benefit of

removal far out weighed the economic benefit of hydroelectric power (Corso, 1999). FERC has also ordered the removal of dams for public safety reasons (Corso, 1999).

The removal of dams can save taxpayers money by eliminating ongoing maintenance fees and liability costs (Maclin and Sicchio, 1999). Dam removal projects can also be a catalyst for the economic recovery of a local economy through increasing tourism (Cohen, 1999). An example of this can be seen in Maine with the removal of the Edwards Dam on the Kennebec River. It is estimated that the removal of this structure will generate about $48 million worth of economic benefits from increased sport fishing alone (Natural Resources Council of Maine, 2001). It is also estimated that 41% of the economic benefit from sport fishing will remain in the region (Natural Resources Council of Maine, 2001).

Dam removal is now considered a reasonable and often cost effective method of river management and restoration (American Rivers, 2001b) particularly if all costs are taken into account (Stott and Smith, 2001). Although dam removal projects can be costly, in some cases exceeding the cost of construction (Booth, 2001), it is often three to five times less costly than repairing the dam (Lindloff and Johnson, 2000). An example that surpasses this average can be found on the Baraboo River in Wisconsin where the removal of a 3 metre high dam costs $30,000, while the estimated costs of repairing the same structure was $300,000 (Lindloff and Johnson, 2000).

There are some legitimate reasons for dams to remain in place. Some dams are economically viable and provide benefits to society (Lindloff and Johnson, 2000) such as providing an inexpensive supply of hydroelectric power (McClure, 2000; International Rivers Network, 1998). In these cases, making the structures more efficient, as well as undertaking modifications to lessen negative impacts, may make more sense than removal (Lindloff and Johnson, 2000).

The threat of further environmental damage, such as the release of contaminated sediment, could act as an obstacle to a dam being removed (Lindloff and Johnson, 2000; Booth, 2001). Another obstacle to removing dams is the lack of knowledge about how to undertake such a project as well as the uncertainty as to whether the proposal will work (International Rivers Network, 1998). Dam removals can be expensive (Booth, 2001) and a lack of funding for a project can be one of the most significant factors in preventing a project from proceeding (International Rivers Network, 1998).

A final obstacle that may prevent the removal of a dam can be found in the perceptions of the community. Some communities may view a dam and associated reservoir as having recreational value or the structure as having some cultural or historic value (Stott and Smith, 2001). Dams with true historic value should probably not be removed (Stott and Smith, 2001).

Concerns of Science

Much of the supporting literature recognizes the many benefits of dams. These benefits include: inexpensive and efficient power generation, effective flood control, navigation, water supply and recreation (Bednarek, 2001; Graf, 2001). Although society has benefited from dams, it has done so at a great cost. Pejchar and Warner (2001) and Fearnside (1999) feel that the benefits of dams have been routinely exaggerated and the costs underestimated. Society has paid the price of these benefits largely at the expense of environment, but a social, and economic price has also been paid.

Environmental Impacts

Dams can have a significant environmental effect on a river system. The continuity of the river is fragmented by the altering of the natural cycles of flow and the transforming of biological and physical characteristics of the river channels and floodplains (Bednarek, 2001). Ward and Stanford (1989) describe rivers as open systems with interactive pathways along four dimensions: longitudinal, lateral, vertical, and temporal. They suggest that man's influence on rivers, including the construction of dams, has been to reduce interactions along spatial pathways and to alter natural time scales (Ward and Stanford, 1989).

Longitudinal Pathways

Ward and Stanford (1989) describe the longitudinal pathway as being from headwaters to outlet in a system where downstream communities are a function of upstream processes and where upstream transfers also occur. Human activities disrupt the natural

patterns of temperature, discharge, water chemistry, organic resource, and habitat heterogeneity along longitudinal profiles (Ward and Stanford, 1989).

Dams are barriers across this longitudinal system. These barriers fragment the continuity of a river (Bednarek, 2001), slowing water velocities and causing sediment to settle and fill reservoirs, limiting their capacity to store water (Bednarek, 2001; Kanehl, Lyons and Nelson, 1997). This can cause the water being released by a dam to have a low sediment content, causing downstream erosion, as rivers attempt to regain their sediment equilibrium (Bednarek, 2001). This capability of transporting an increased sediment load can cause a lowering of the elevation of the river bed, loss of land, and the degradation of fish and wildlife habitat below a dam (Hesse, Schmulbach, Carr, Keenlyne, Unkenholz, Robinson and Mestl, 1989). In addition to blocking the movement of sediments, the physical barrier of a dam also blocks nutrients, preventing them from being transported downstream to coastal waters (Ward and Stanford, 1989).

The quality of the water in a river system is also transferred along longitudinal pathways. Dams can result in severe water quality problems including: shallowing from rapid sedimentation, nutrient enrichment, and the accumulation of contaminants (Born, Genskow, Filbert, Hernandez-Mora, Keefer and White et al., 1998). Born et al. (1998) continues by stating that reservoir conditions of a highly eutrophic nature can lead to algae blooms and excessive growth of aquatic vegetation, resulting in a decline in sport fisheries and other recreational activities. Another way in which dams adversely affect the quality of water is by entraining air bubbles in plunge basins below dams, resulting in

the water to be super saturated with air (Ward and Stanford, 1989; Ebel et al., 1989) which can cause gas bubble disease in fish (Ebel, Becker, Mullan and Raymond, 1989).

With respect to fish, a barrier across the longitudinal dimension will adversely affect the fishery and alter the ecology of the lotic ecosystem (Ward and Stanford, 1989). Not only can the construction of a dam completely obstruct the migration of the vast majority of fish (Ward and Stanford, 1989; Kanehl et al., 1997; Born et al., 1998), but it can also contribute to the loss of suitable habitat for aquatic life (Born et al., 1998), or significantly alter the habitat of fish species within the river system (Kanehl et al., 1997). This was also found when it was determined that the Index of Biotic Integrity, which is a function of species richness and composition, trophic and reproduction function, and fish abundance and condition (Lyons, 1992), decreased considerably on rivers with impoundments and flows affected by the operations of hydro electric dams (Lyons, Piette, Niermeyer, 2001).

One of the causes of species disappearance in anadromos fish populations is the isolation of headwater spawning and rearing grounds (Petts, Imhof, Manny, Maher and Weisberg, 1989). An example of this can be found on the Columbia River where dams blocked return runs and eliminated all habitat for anadromos fish production above the dams (Ebel et al., 1989). Dams with regulated flows are detrimental to lotic ecosystems (Petts et al., 1989) whereby they can convert lotic habitats into lentic habitats (Kanehl et al., 1997) where lake adaptive species flourish and displace riverine species (Bednarek, 2001). The prevention of the free passage of small segments of migratory fish

populations can have a long term negative impact on the genetic diversity and fitness of that population (Pellett, Van Dyke and Adams, 1998). Dams also prevent the recolonization of isolated reaches when stocks are depleted by environmental degradation or catastrophic events (Pellett et al., 1998). The physical degradation of a river bed below a dam can also destroy fish habitat and affect fish production (Hesse et al., 1989).

The number of dams within a river system also has a significant effect on the longitudinal dimensions of that system. Reiger, Welcomme, Steedman and Henderson (1989) classify a stream on which dams exist to be an extensively modified watercourse, which can result in modified fish stocks, the disappearance of larger fish species, and the disappearance of long distance migrant species. They further classify watercourses with large, and/or several, dams to be completely modified watercourses with a change of the fish stock resulting from the loss of some fish species due to the reduced availability of river area, and the increase of other species which thrive or are tolerant of reservoir environments. Lyons et al. (2001) agree with this assessment when they state that fish assemblages in highly fragmented rivers are more susceptible to the daily peaking from hydro dams than assemblages in less fragmented rivers or rivers with fewer dams.

Lateral Pathways

The lateral dimension not only includes the form and dynamics of the channel itself but also the interactions between the river and the catchment, especially the riparian/floodplain zone (Ward and Stanford, 1989).

Dams can reduce the number of overbank floods in a river system and thereby reduce lateral changes of sediment nutrients and organisms between aquatic and terrestrial areas (Junk, Bayley and Sparks, 1989). Born et al. (1998) refer to this as the loss of conductivity of the ecological components of a river system, which includes the spatial decoupling of rivers and their floodplain wetlands. Petts et al. (1989) state that rivers regulated by dams eliminate the hydrogeological and geomorphological dynamics of the system, which isolates the river from the alluvial plain, and changes fish populations. Bednarek (2001) claims that operations of this nature lead to a decline in the diversity of fauna. Ward and Stanford (1989) have observed that natural flooding maintains the riparian zone in a productive early successional stage and suggest that a river regulated by dams enables non-riparian species to invade the riparian zone. Rivers with more constant flows, like those found in regulated rivers, promote the potential domination of organisms that would otherwise be displaced by floods (Bednarek, 2001). These types of changes to the aquatic and riparian ecosystems caused by dams can also adversely affect the endangered species on which they depend (Graf, 2001).

Vertical Pathways

Rivers have vertical pathways that allow for riverine-groundwater linkages (Ward and Stanford, 1989). The establishment of reservoirs can change the height of the groundwater table where areas of aggradation upstream of a reservoir can increase the elevation of the water table, and areas of degradation below dams can decrease the elevation of the water table (Ward and Stanford, 1989). This can have a negative affect

on the survival of fish that depend on off channel habitats that retain water during dry seasons (Ward and Stanford, 1989).

Temporal Pathways

All of the above noted pathways have a temporal dimension. Human activities disrupt natural temporal patterns that have structured riverine ecosystems and operate over a hierarchy of time scales (Ward and Stanford, 1989).

The affect that a dam has on the temporal pathways of a river system can be seen by considering the operations of a hydroelectric dam and the resulting changes to the flooding cycles of the river system. Hydroelectric dams store spring runoff to use later in the year when more electricity is needed, thereby reducing flows at one time of year and increasing flows at another (Bednarek, 2001). This practice can eliminate the flood pulse effect, or the periodic inundation of floodplain land (Swanson and Sparks, 1990), altering the lateral dimension by reducing the amount of sediment deposited in the floodplain (Junk et al., 1989), the longitudinal dimension by reducing flows when they are needed for the purposes of fish migration (Ebel et al., 1989) and the vertical dimension by altering the time and extent of groundwater recharge and discharge (Ward and Stanford, 1989).

Temporal changes brought about by dams can have a significant affect on fish.
Dam construction and operations create reservoirs that can inundate spawning areas used by anadromous fish and significantly delay the seaward migration of smolts (Ebel et al.,

1989). Ebel et al. (1989) continue this line of thinking by stating that when anadromous fish are delayed in a reservoir habitat, their mortality rates will increase as they are susceptible for a longer period of time to the predatory fish whose populations are encouraged in this type of habitat.

Social Impacts

Simply by existing, dams create a threat to public safety. Firstly there is a threat to lives and property downstream of a dam should the dam be poorly designed, not be operated properly, or fail. A significant number of dams are a safety hazard (Born et al., 1998). Graf (2001) states that 32% of all dams in the United States pose a significant or high downstream hazard. The Federal Emergency Management Agency (1999) reports that there are approximately 23,772 dams with high and significant hazards in the United States National Inventory of Dams. As dams become older they become more of a concern. Dams in Ontario are becoming less reliable due to general deterioration and lack of maintenance (Ontario Ministry of Natural Resources, 1999). Compounding this problem in Ontario is the fact that development has occurred within floodplains, including areas below dams, necessitating the implementation of regulations to prevent development in these areas (Ontario Ministry of Natural Resources, 1999).

Dams are also a safety risk to those that are working or recreating in their immediate vicinity. This risk can be more extensive when a dam is in a state of disrepair or when it is accessible to the public. An indication of the dangers associated with dam can be found by reviewing the Verdict of Coroner's Jury regarding a tragedy that took place on

August 12th 1998, at the Parkhill Dam in the City of Cambridge, Ontario. On that day, a 12 year old boy playing on the dam drowned, as did the police diver attempting to retrieve his body (Ontario Ministry of the Solicitor General, 2000). The Coroner's Jury made several recommendations geared to reducing the risks associated with dams including: fencing, signage, modifications to the dam, and education programs on dam safety (Ontario Ministry of the Solicitor General, 2000).

Residents of a community can have a strong social attachment to a dam that has been in place for several years. They regard the structures as having historic or nostalgic value, the removal of which can be controversial and difficult (Born et al., 1998). The removal of a dam can be perceived as a loss of fish and wildlife habitat as well as a loss of potential hydroelectric generation even if the structure has not generated power in many years or would require major expenditures to do so (Born et al., 1998).

Economic Impacts

Dam and reservoir maintenance, reconstruction and rehabilitation can be a very high and repetitive expense (Born et al., 1998). The cost of maintaining a dam may well exceed the current value of the structure (Kanehl et al., 1997). Born et al. (1998) also found that when estimated repair costs, which some dam owners find to be quite prohibitive, are compared to the cost of completed dam removal projects, they were generally found to be three times greater.

The potential for an accident or dam failure can also be viewed as a economic issue for dam owners. Dam owners can be held financially responsible for losses suffered because of a dam. Examples of this would include personal injuries suffered at a dam or environmental or property damage experienced by a landowner as a result of a dam failure (Born et al., 1998). When such incidents do occur, dam owners are often burdened by high deductibles associated with dam liability insurance policies (Born et al., 1998).

Dams can also affect the value of property. Born et al. (1998) feel that many landowners are of the opinion that lake front property is worth more than river front property; however he also cites a study undertaken by the Michigan Department of Natural Resources which shows that the value of river front property was at least equal to or greater than the value of properties fronting onto lakes and reservoirs. The values of some properties have been shown to decrease when they contain a dam that requires extensive repair or removal (Born et al., 1998).

Dam Operations, Modifications, and Removal

The problems created by dams can be overcome through changing the operations of a dam, modifying the structure or removing it. Graf (2001) feels that river fragmentation, brought about by dams, can be reduced by changing operating rules, reengineering of some dams, and the removal of antiquated and unsafe dams.

Operations

Bednarek (2001) feels that it is possible to mitigate some of the impacts within a dammed river through operational changes. An example of a change in dam operation can be seen in the timing and extent of water release from a dam. Hesse et al. (1989) feel that dams can be used to enhance ecosystem habitat diversity by establishing dam operating procedures that are based on well researched timing, length and frequency release requirements. Bednarek (2001) agrees that diversity would be increased if flows were altered to resemble unimpounded river systems. On rivers where fish production is dependant on a flood regime, releases of water from dams could be altered in such a way that they simulate the seasonal floods that would occur naturally and thereby enhance fish production (Ward and Stanford, 1989; Ebel et al., 1989). This practice would also reestablish some original habitat conditions that would slow the loss of endangered native species of fish and other aquatic organisms (Jobin, 1998). Controlled flooding would also help maintain side channels and backwaters as well as release organic matter stored in sediments and territorial environments, allowing more energy to flow through food webs (Hesse et al., 1989; Graf, 2001). Jobin (1998) refers to this practice of simulating natural flooding as recreating primeval hydrology.

Modifications to the operations of a dam may also include the maintenance of fish stock through the release of young fish (Pavlov and Vilenkin, 1989). Not all fish stocking and hatchery initiatives have been successful. Jobin (1998) feels that hatchery breeding produces poor survivors that compete with hardy native species for habitat, food and spawning sites. Pejchar and Warner (2001) feel that some hatcheries, that have been built

to mitigate the impact of dams on fish populations, have eroded the genetic integrity of those populations. Ebel et al. (1989) suggests that fish be collected and transported around dams; however many of these attempts have not been successful.

Modification

Modifying a dam to address environmental concerns can be considered; however they are often not successful and at times have caused further damage (Jobin, 1998). Fish ladders are largely ineffective (Jobin, 1998), often poorly designed and contribute to fish mortality (Pejchar and Warner, 2001). Jobin (1998) suggests that ineffective fish ladders should be eliminated and effective bypass systems installed. Bednarek (2001) references an environmental impact statement for a dam removal project which states that adding fish passages to a dam did not significantly improve fish populations because several species were either too large or too small to use the device. Pavlov and Vilenkin (1989) see the construction of fish passages as a way to reconstruct the migratory cycles of anadromous and semi-anadromous species in rivers with regulated flows. Jobin (1998) suggests that hydroelectric facilities be installed on low dams with technology that allows fish to pass in either direction. Further, he suggests that this practice could generate revenue for other aspects of habitat restoration. It has been suggested that revenues generated in such a manner could assist in the financing of a dam removal program within a given watershed (J. Coffey, SVCA, personal communications, 2001).

Several modifications to dams can be implemented in an attempt to reduce the negative environmental affect that they have. Changes designed to address the impact of dams on

water temperature could include the installation of a system whereby withdrawals of water could be made through low flow outlets set at different elevations of the reservoir to achieve the desired temperatures in the tail waters (Bednarek, 2001) or to be used to pass dead algae as they settle to the bottom of reservoirs (Jobin, 1998). Jobin (1998) also suggests that abandoned industrial lands adjacent to dams and reservoirs could be used for the installation of facilities that would improve the negative affects of dams such as sand filters, settling basins and nurseries for aquatic life.

Ebel et al. (1989) make several suggestions related to the modifications of dams to reduce smolt mortalities including the installation of spillway deflectors to reduce the supersaturation of air in the water below dams, and the installation of fingerling bypasses to direct smolts away from turbine intakes.

Removal

Jobin (1998) feels that one of the viable alternatives to the rehabilitation of old industrial dams is the removal of the structure. The frequency of removal is increasing as governments and citizen groups have demonstrated economically and ecologically that dam removal projects may have a positive net benefit to society (Pejchar and Warner, 2001). A combination of issues, such as the general condition of dams, the timing of government relicencing programs, and increased public awareness has made dam removal a realistic alternative when considering the fate of a dam (Doyle, Stanley, Luebke and Harbour, 2000).

There are many benefits associated with dam removal. Firstly, dam removal may provide major benefits to fish populations, habitat and biotic integrity (Kanehl et al., 1997; Born et al., 1998) and should be considered for ecosystem restoration benefits alone and not just public safety benefits (Born et al., 1998). These improvements may take only a few years and even shorter if removals are associated with bank stabilization and cover projects (Kanehl et al., 1997). Dam removal will also reconnect the riparian and aquatic habitats by returning flows that inundate terrestrial areas (Bednarek, 2001).

Dams can be removed for socioeconomic reasons such as when power production becomes inefficient or when there is a risk of structural failure (Bednarek, 2001). The removal of a dam can also eliminate an ongoing financial burden (Born et al., 1998). Pejchar and Warner (2001) feel that all non-essential dams, that is, dams that are abandoned or exist for recreational purposes only, should be investigated to assess the feasibility of removal. Not only will the removal of these hazardous structures provide benefits for human communities and natural ecosystems but they will also be a restoration symbol that will act as a catalyst that will bring about further improvements to the environment (Pejchar and Warner, 2001).

CHAPTER FOUR – CONDUCT OF RESEARCH STUDY

Research Methods

One of the simplest methods of determining the factors that are preventing the removal of dams on the Saugeen River is to ask what the barriers are of those that are involved with dams. Data were gathered by interviewing three types of individuals that have an interest in dams and river systems. The first group of people were representatives of regulatory agencies that are responsible for the legislation, government policy and regulations concerning dams. The second group of people were owners of dams in the watershed including representatives of different levels of government responsible for publicly owned dams as well as private dam owners. The third group were groups and individuals that use rivers systems and are affected by the existence of dams. This group is known as the general stakeholders. Finding a wide variety of views from a wide variety of individuals involved with dams was the objective in conducting interviews with many representatives from these three groups.

Regulatory Agencies

There are several pieces of legislation that could affect dam modifications or dam removal projects in Ontario. Federally, there is the Fisheries Act and the Navigable Waters Protection Act while applicable provincial legislation includes: the Lakes and Rivers Improvement Act, the Ontario Water Resources Act, the Environmental Protection

Act, the Provincial Public Lands Act, and the Conservation Authorities Act (Fisheries and Oceans Canada, 2001).

There are three main regulatory agencies that are involved in dam projects in the Saugeen River watershed. They are the Federal Department of Fisheries and Oceans (DFO), the Ontario Ministry of Natural Resources (MNR) and the Saugeen Valley Conservation Authority (SVCA).

In Ontario, the Federal Department of Fisheries and Oceans is responsible for the management and protection of fish habitat as outlined in Section 35 of the federal Fisheries Act (Fisheries and Oceans Canada, 2001). Under this legislation only the Minister of Fisheries and Oceans may authorize the harmful alteration, disruption or destruction of fish habitat (Fisheries and Oceans Canada, 2001). DFO has entered into agreements with the Conservation Authorities of Ontario to review project proposals under section 35 of the Fisheries Act. Dam modification, removal and even some dam operations may require the involvement of the DFO.

The Ontario Ministry of Natural Resources (MNR) administers the Lakes and Rivers Improvement Act "to provide for the use of waters for the lakes and river of Ontario and to regulate improvements in them" (Province of Ontario, 1991, p. 939). This act also protects the interests of riparian owners, and provides for the use, management and perpetuation of the fish and wildlife that are dependent of the river (Province of Ontario,

1991). A rarely used section of this legislation allows the minister to order repairs, reconstruction or removal of a dam (Province of Ontario, 1991).

The Saugeen Valley Conservation Authority is a partnership of the 15 municipalities that exist within the Saugeen River watershed and the Province of Ontario. It was established in 1950 under the Ontario Conservation Authorities Act "…to establish and undertake in an area over which it has jurisdiction a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal or minerals." (R.S.O., 1990, Chapter c.27), (Province of Ontario, 1999, p. 10). This legislation also gives the Authority the responsibility of regulating filling within river valleys, construction activities within floodplains, and the altering of watercourses. Permission under these regulations is required by any landowner wishing to modify or remove a dam anywhere within the Saugeen River system.

Experienced and knowledgeable staff from each of these three regulatory bodies, directly involved with dams and/or the implementation of regulations in the Saugeen River watershed were interviewed. Four individuals in total were interviewed from these three regulatory agencies.

Two of the above-noted agencies, the MNR and the SVCA, own dams in the Saugeen River watershed; however as part of these regulatory agency interviews, they were questioned as regulators, not dam owners.

Dam Owners

Dam owners, whether they be individuals or agencies, are generally those that will have the most control over the future of a dam as well as being those that will be most affected by any changes concerning a dam. Interviewing a representative group of dam owners is an important component of this study. There are three main groups of dam owners in the Saugeen River watershed. They are government agencies such as the MNR or the SVCA, local municipalities, and private owners. Table 4.1 shows the breakdown of dam owners.

Table 4.1 Dam ownership in the Saugeen River watershed

Type of Owners	Number of Dams	Number of Different owners
MNR/SVCA	6	2
Municipalities	8	7
Private	38	36
Total	52	45

The choice of persons interviewed from the three types of owners shown in Table 4.1 was made by selecting dams with varied uses and in different conditions. Ten interviews were conducted based on information concerning 10 different dams. When dams owned by government agencies and municipalities were selected, further variety was brought into the selection process by choosing different types of people within those organizations including senior staff and elected officials. A sample group of this nature, where members of the sample are carefully selected based on some characteristic such as the type and condition of their dam, is called a nonprobability sample and is a group that the surveyor considers to be typical (Salant and Dillman, 1994). An alternate method of

selecting dam owner interviewees would be to select people randomly from the population of dam owners to establish a sample group.

The nonprobability method of selecting a variety of dams and dam owners was chosen for various reasons. Firstly, information was being sought regarding the broad issue of determining the barriers to dam removals based on the views of dam owners with respect to the structure they own. These structures have different ownership situations, different uses, are in various states or conditions of repair and have different impacts of a environmental, social or economic nature. Randomly selecting participants in the survey may omit some information arising from these differences. Choosing potential respondents based on these differences helped to reveal a wider variety of views.

Secondly, when the survey population is low, such as 52 dam owners, little is gained by sampling (Salant and Dillman, 1994). The surveyor may as well interview the total population of 52 dam owners that, in this situation, would reveal all views and opinion but would not likely disclose many new views or opinions.

Thirdly, nonprobability sampling is appropriate in situations of exploratory research intended to generate new ideas that will be investigated further in the future (Salant and Dillman, 1994). Any potential dam removal program or specific project will require further investigation prior to being implemented.

General Stakeholders

General stakeholders are groups and individuals that make use of river systems and whose activities are affected by the existence or operations of dams. Stakeholders include fisher people, boaters, naturalists, and businesses that cater to these individuals as well as those that own property adjacent to a river on which dams exist. Leaders of fishing and sportsman clubs were interviewed as was the coordinator of an eco-tourism agency. One landowner living in the vicinity of a dam was also interviewed. A total of four individuals were interviewed to assess the general views of stakeholders.

A summary of respondents from the regulatory agencies, dam owners and general stakeholders is provided in Tables 4.2a, 4.2b and 4.2c. All those who were asked to participate in an interview agreed without hesitation. One individual could not be contacted and an alternate was found.

Table 4.2a Summary of respondents – regulatory agencies

Interview #	Agency	Respondents
1	regulatory agency A	regulatory staff
2	regulatory agency A	regulatory staff
3	regulatory agency B	regulatory staff
4	regulatory agency C	regulatory staff

Note: A, B, and C refer to the three different regulatory agencies surveyed and are not identified to protect the confidentiality of the respondents

Table 4.2b Summary of respondents – dam owners

Interview. #	Ownership	Use of Dam	Condition of Dam	Respondents
5	government agency	-minor recreation	-good	management staff person
6	government agency	-extensive recreation	-fair	management staff person
7	government agency	-none	-very poor	management staff person
8	municipality	-none -public walkway	-very poor	elected official
9	municipality	-minor recreation -road	-very poor	senior staff
10	municipality	-minor recreation -fish management	-good	senior staff
11	municipality	-minor recreation	-fair	elected official
12	private	-hydro producing -minor recreation	-good	Owner
13	Private	-none	-very poor	Owner
14	private	-minor recreation -potential hydro	-fair	Owner

Table 4.2c Summary of respondents – general stakeholders

Interview #	Group	Respondents
15	Fishing Club	President
16	Sportsman Club	Vice President
17	Eco-tourism agency	Coordinator
18	Adjacent landowner	

Data Gathering Instruments

The data were gathered by conducting 18 in-person or telephone interviews with the respondents described in the Table 4.2a, 4.2b, and 4.2c. Two very similar sets of interview questions were prepared. One set of questions was asked of the representatives

of the regulatory agencies and the general stakeholders while the other was asked of the dam owners. The differences between the two are slight wording alterations that directed the government agency representatives and general stakeholders to answer the questions in the context of the Saugeen River watershed while dam owners were asked to answer the questions in the context of the dam that they own. The two sets of interview questions can be found in Appendix C.

The questions are close-ended with ordered choices where each choice represents a gradation of a single concept (Salant and Dillman, 1994). This type of question is quite specific and as such less demanding for the respondent to answer and the interviewer to analyse (Salant and Dillman, 1994).

The first question asked respondents how they view the importance of a number of benefits provided by dams. This question started the interview in a positive manner and tended to get respondents talking about the reasons dams exist. Questions two, three and four asked respondents about the seriousness of the negative environmental, social and economic impacts of dams. Questions five, six, and seven asked how important certain factors are in preventing dam removal projects from proceeding. When asking the questions related to dam removals, it was important to explain to the respondents that a removal project for their specific dam or any dam was not being proposed.

CHAPTER FIVE – BARRIERS to CHANGE

Survey Results

The results of the surveys are shown in tabular form and have been organized according to the survey questions. These questions were related to the importance of the benefits of dams, the seriousness of the negative aspects of dams, and the importance of the barriers preventing the removal of dams.

Importance of Benefits

Tables 5.1a and 5.1b presents the results of survey questions number one that asked respondents to rank the importance of the benefit of dams.

Table 5.1a Survey results for question one: summarized by group

Benefits	Very Important			Somewhat Important			Not Important		
	RA	DO	GS	RA	DO	GS	RA	DO	GS
Hydroelectric power	1	2	1	2	3	1	1	5	2
Recreation	0	3	2	0	4	1	3	3	1
Water supply	0	2	0	2	0	1	2	8	3
Flood control	1	3	3	1	2	0	2	5	1
Fish species separation	1	3	3	3	0	1	0	6	0
Total responses	3	13	9	8	9	4	8	27	7
Potential responses	20	50	20	20	50	20	20	50	20
Percent responses	15	26	45	40	18	20	40	54	35

Notes: RA: Regulatory Agencies: 4 interviews
DO: Dam owners: 10 interviews
GS: General stakeholder: four interviews
-numbers indicate the number of responses
-some respondents did not provide responses for all benefits
-percentages have been rounded off

Table 5.1b Survey results for question one: summarized by benefit

Benefits	Very Important			Somewhat Important			Not Important		
	TA	PA	%	TA	PA	%	TA	PA	%
Hydroelectric power	4	18	22	6	18	33	8	18	44
Recreational	5	18	28	5	18	28	7	18	39
Water supply	2	18	11	3	18	17	13	18	72
Flood control	7	18	39	3	18	17	8	18	44
Fish species separation	7	18	39	4	18	22	6	18	33

Notes: TA: Total responses from all groups
PA: Potential responses from all groups
%: Percent of potential responses
-some respondents did not provide responses for all benefits
-percentages have been rounded off

The results of question one, as shown in Table 5.1a show that, although all the groups confirmed that dams in the Saugeen River watershed are perceived as having some benefits, their importance is generally not considered high by those who were interviewed. The regulatory agencies had only 15 % of their responses within the very important range thus indicating that generally dam benefits are of somewhat or no importance to this group. It is interesting to note that 54 % of the responses from dam owners, those that would likely benefit the most from dams, were in the not important range. This may be due to the fact that owners were asked what benefits their specific dams offered, which in many situations may not be numerous and of no great importance. The general stakeholder respondents were from groups that could be split in favour or against the existence of dams. This is reflected in their responses with 45 % of the possible responses in the high importance range and 35 % in the not important range.

Table 5.1b summarizes the responses by benefit and also shown the generally low ranking of benefits with the percent of responses within the very important range being from 11 to 39 % and the percent of responses within the not important range being from 33 to 72 %. The benefits that ranked the highest were flood control and fish species separation with each having receiving 39 % of the potential responses within the very important range. The flood control ranking is somewhat surprising in that dams in the Saugeen River watershed have very little actual benefit in terms of flood control. The lowest ranking benefit was water supply with 11 % of the possible responses being very important and 72 % being not important. The benefit of dams having the capacity to generate hydroelectric power also ranked relatively low with 22 % of the potential responses being within the very important range and 44 % being within the not important range. Some of these low responses may again be due to the fact that dam owners were responding with respect to their own dams.

The generally low rankings of the benefits by the three groups, and the resulting opinion that dams in the Saugeen River watershed are of little importance, may call into question the magnitude of the benefits that would support the continued existence of dams.

Seriousness of Problems

The results of questions two, three and four, which ask the respondents about the seriousness of the environmental, social and economic problems of dams respectively, can be seen in Table 5.2a and 5.2b.

Table 5.2a Survey results for questions two, three, and four: summarized by group

Problems	Very Serious			Somewhat Serious			Not Serious		
	RA	DO	GS	RA	DO	GS	RA	DO	GS
Impact on water quality, temp.	4	1	3	0	5	0	0	3	1
Negative affect on aquatic life	4	0	2	0	2	1	0	7	1
Barrier to the passage of fish	4	2	3	0	2	0	0	5	1
Destruction of fish habitat	3	0	2	1	2	1	0	8	1
Sediments accumulation	4	4	2	0	2	0	0	4	1
Threat to public safety	2	3	1	1	3	2	1	4	1
Threat of dam failure	2	2	3	2	2	0	0	5	1
Maintenance costs	4	0	3	0	3	0	0	7	1
Financial liability	4	7	1	0	0	1	0	3	1
Total responses	31	19	20	4	21	5	1	46	9
Potential responses	36	90	36	36	90	36	36	90	36
Percent responses	86	21	56	11	23	14	3	51	25

Notes: RA: Regulatory agencies: 4 interviews
DO: Dam owners: 10 interviews
GS: General stakeholder: four interviews
-numbers indicate the number of responses
-some respondents did not provide responses for all benefits
-percentages have been rounded off

Table 5.2b Survey results of questions two, three, and four: summarized by problem

Problems	Very Serious			Somewhat Serious			Not Serious		
	TA	PA	%	TA	PA	%	TA	PA	%
Impact on water quality, temp	8	18	44	5	18	28	4	18	22
Negative affect on aquatic life	6	18	33	3	18	17	8	18	44
Barrier to the passage of fish	9	18	50	2	18	11	6	18	33
Destruction of fish habitat	5	18	28	4	18	22	9	18	55
Sediments accumulation	10	18	56	2	18	11	5	18	28
Threat to public safety	6	18	33	6	18	33	6	18	33
Threat of dam failure	7	18	39	4	18	22	6	18	33
Maintenance costs	7	18	39	3	18	17	8	18	44
Financial liability	12	18	67	1	18	6	4	18	22

Notes: TA: Total responses from all groups
PA: Potential responses from all groups
%: Percent of potential responses
-some respondents did not provide responses for all benefits
-percentages have been rounded off.

It is clear from the results of questions two, three and four, shown in Table 5.2a, that the representatives of the regulatory agencies overwhelmingly consider the negative impacts of dams to be very serious. Eighty six percent of the potential responses from this group were in the very serious range with only 3 % in the not serious range. In contrast to these results were the responses from the dam owners interviewed who generally felt that the negative impacts caused by their dams are not serious. This group had 21 of their potential responses in the very serious range and 51 % in the not serious range. This may be due to the fact that they are responding with respect to only their dams and not dams in general. It could also be that they feel their own dams are being maintained and operated properly and as such are not causing problems. The general stakeholder respondents also feel that the negative impacts of dams are generally very serious. Fifty six percent of the responses from this group were in the very serious range while the not serious range had a percent of 25 %.

The problems that were deemed by most respondents to be serious were financial liability, sediment and nutrient accumulation, and barrier to the passage of fish with the percent of potential responses being 67, 56, and 50 % respectively. The problem deemed to be the least serious was destruction of fish habitat with 55 % of respondents feeling that this problem was not serious. Forty four percent of the respondents felt that both the negative effects on aquatic life and maintenance costs were also not serious problems.

The seriousness of the negative impacts of dams, as generally depicted by at least two of the three groups feeling that some of the negative impacts of dams were very serious,

indicate a need for some action to mitigate these impacts. This action could be the removal of some dams.

Importance of Factors Preventing Dam Removals

Questions five, six, and seven asked respondents about the environmental, social and economic barriers that are preventing dam removal projects from proceeding. The survey results for these questions can be found in Tables 5.3a and 5.3b.

Table 5.3a Survey results for questions five, six and seven: summarized by group

Factors Preventing Dam Removals	Very Important			Somewhat Important			Not Important		
	RA	DO	GS	RA	DO	GS	RA	DO	GS
Dams separate fish species	1	1	0	2	2	0	1	7	4
Dams control floods	2	2	0	1	2	0	1	6	3
Potential environmental problems	3	1	2	0	2	0	1	7	2
Dams are aesthetically pleasing	3	3	2	0	2	1	1	5	1
Lack of awareness of negative impacts of dams	4	5	2	0	3	0	0	1	2
Dams provide other infrastructure (roads, trails)	1	2	1	3	0	0	0	8	3
Dams provide a supply of water	0	1	1	2	0	0	2	9	3
Regulatory permits required	0	3	3	2	0	1	2	7	0
Dams have historic value	2	2	3	1	5	0	1	3	1
Apathy (removal not an issue)	3	3	1	1	1	2	0	6	1
Lack of direction or knowledge regarding dam removal	2	3	1	1	1	1	1	6	2
Provide recreational opportunities	0	3	1	2	2	0	2	5	3
Lack of funds to finance a dam removal project	3	9	4	1	0	0	0	1	0
Dams produce hydro electric power	1	3	2	2	1	0	1	6	2
Potential to produce hydro	1	2	2	2	2	0	1	6	2
Total responses	26	43	25	20	23	5	14	83	29
Potential responses	60	150	60	60	150	60	60	150	60
Percent responses	43	28	42	33	15	8	23	55	48

Notes: RA: Regulatory agency: four interviews
DO: Dam owner: ten interviews
GS: General stakeholder: four interviews
-numbers indicate the number of responses
-some respondents did not provide responses
-percentages have been rounded off

Table 5.3b Survey results for questions five, six, and seven: summarized by factors

Factors Preventing Dam Removals	Very Important			Somewhat Important			Not Important		
	TA	PA	%	TA	PA	%	TA	PA	%
Dams separate fish species	2	18	11	4	18	22	12	18	67
Dams control floods	4	18	22	3	18	17	10	18	56
Potential environmental problems (sediment release)	6	18	33	2	18	11	10	18	56
Dams are aesthetically pleasing	8	18	44	3	18	17	7	18	39
Lack of awareness of negative impacts of dams	11	18	61	3	18	17	3	18	17
Dams provide other infrastructure (roads, trails)	4	18	22	3	18	17	11	18	61
Dams provide a supply of water	2	18	11	2	18	11	14	18	78
Dam removal will require regulatory permits	6	18	33	3	18	17	9	18	50
Dams have historic value	7	18	39	6	18	33	5	18	28
Apathy (removal not an issue)	7	18	39	4	18	22	7	18	39
Lack of direction or knowledge regarding dam removal	6	18	33	3	18	17	9	18	50
Dams provide recreational opportunities	4	18	22	4	18	22	10	18	56
Lack of funds to finance a dam removal project	16	18	89	1	18	6	1	18	6
Dams produce hydro electric power	6	18	33	3	18	17	9	18	50
Dams have potential to produce hydro electric power	5	18	28	4	18	22	9	18	50

Notes: TA: total responses from all groups
PA: Possible number of responses from all groups
%: Percent of possible responses
-some respondents did not provide responses for all benefits
-percentages have been rounded off

From the results shown in Table 5.3b, general statements can be made about the importance of each of the factors preventing dam removals. When assessing which barriers are important and will need attention when trying to improve the sustainability of river system through dam removals, it is advantageous to take into account the results of

both the somewhat important and very important columns of Table 5.3b. When 50 % or greater of the respondents deemed a barrier to be somewhat or very important, it is likely that this barrier will need to be addressed when planning and implementing a watershed dam removal program. The barriers that scored 50 % or higher, when the percentages of these two columns were combined, are listed in Table 5.4.

Table 5.4 Important barriers preventing the removal of dams, Saugeen River watershed

Barrier	Very and Somewhat Important %
Lack of funds to finance a dam removal project	95
Lack of awareness of negative impacts of dams	78
Dams have historic value	72
Dams are aesthetically pleasing	61
Apathy (dam removal is not an issue)	61
Lack of direction or knowledge regarding dam removal	50
Dam removal will require regulatory permits	50
Dams produce hydro electric power	50
Dams have potential to produce hydro electric power	50

Although this procedure for determining important barriers to dam removal projects is somewhat subjective, it does provide insight into the potential obstacles that organizers of a dam removal program can expect to face. Being prepared for these obstacles may be the factor that determines the success of the programs and in turn the improved sustainability of the river system. It is important not to disregard the barriers that have not been deemed to be important under the above-noted criteria. These factors may still be significant barriers in some situations.

CHAPTER SIX – AGENDA for CHANGE

The change that is desired is improved sustainability of the Saugeen River system through the removal of dams within that system. The first stage in working towards this desired state is to develop an action plan that will guide program coordinators, dam owners, conservation agencies, funding agencies, and local decision makers through the process.

Leadership:

It would be very difficult for one person, agency or organization to bring about significant environmental change on their own through the development and implementation of an action plan. Partnerships have become a necessary part of environmental work. When a number of groups or individual come together to work towards a common goal, leadership is required. The lead agency best suited to guide the process of improving the sustainability of the Saugeen River system through the removal of dams for the benefit of all watershed stakeholders, is the Saugeen Valley Conservation Authority. This agency has the jurisdiction, legislative mandate, expertise, established partnerships, and many of the required resources to take on such a role. Exemplary leadership, on the part of the SVCA, will help to ensure success. The practices of exemplary leaders should be kept in mind when developing the action plan. The five practices of exemplary leadership are: 1) challenging the process, 2) inspiring a shared vision, 3) enabling others to act, 4) modelling the way, and 5) encouraging the heart (A. Schults, Royal Roads University, lecture notes, 2002).

When well established norms and processes are challenged, good leadership is required if new ideas are to become the new way of thinking. This is particularly true with respect to dam removal. Accepting the idea that dam removal can be positive will require a major shift in the thinking of several dam owners. Patient, well informed leadership will be required to guide those being challenged.

Others must be motivated or inspired to share the vision of a more sustainable river system that may provide more opportunities and benefits to our society. Once more stakeholders take ownership of this vision, through education and demonstrated success, it will be easier to inspire others and undertake additional work.

Leadership is also enabling others to act. It is important for leaders to provide participants with the necessary tools that will enable them to bring about change. In the case of dam removals, the tools required to take away the barriers preventing the removal of these structures must be made available by the lead agency. The SVCA can be a source of information for owners facing these obstacles.

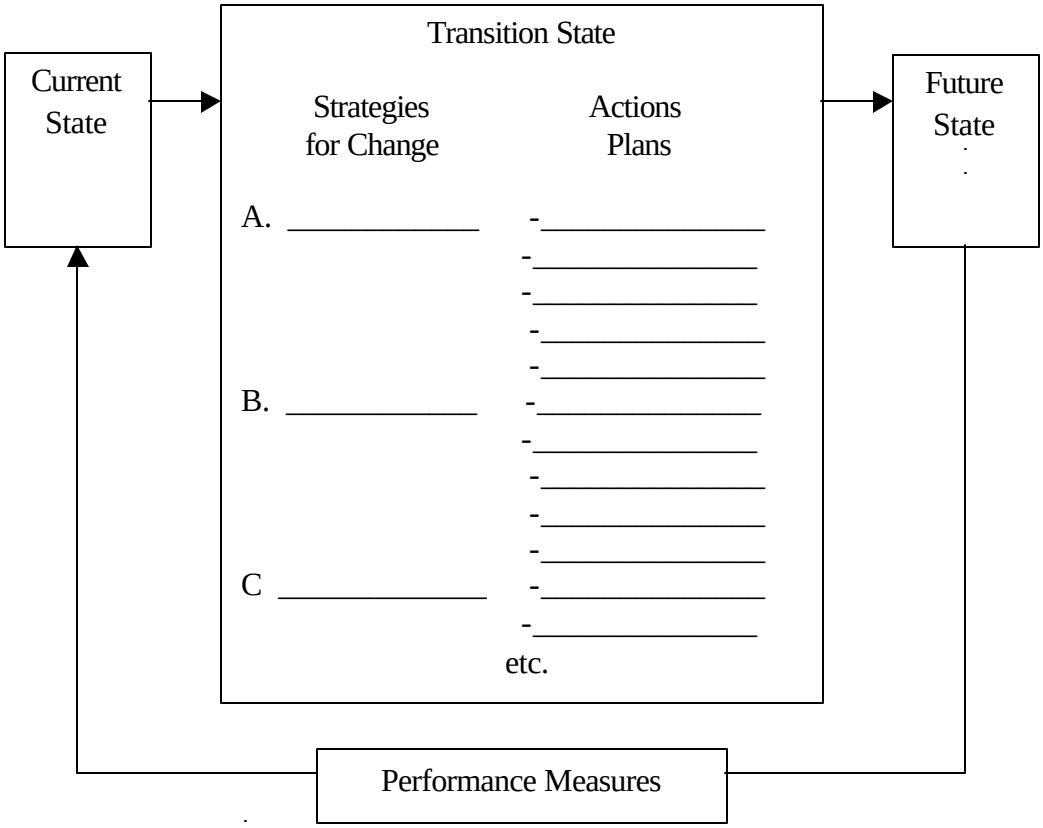
The lead agency should also act as a model and live the values being promoted. In the case of dam removals this could be done by showing success is possible by actually undertaking a project. This will improve local expertise on how to undertake such a project and make future success more likely.

The leader must also encourage groups and individuals and instil in them a sense that improving river system sustainability through the removal of dams, is the right thing to do for present and future generations.

Action plan

The firm of Greenfield (2002) has developed a transition plan for working towards a desired change outcome or a future state. This plan is shown in Figure 6.1. The appropriate place to start in this cyclical process is to develop a vision of the desired future state. Performance measures must then be determined so that partners or stakeholders will know when the desired state has been achieved. The current state must be assessed and used as a base line when measuring performance indicators. Several strategies for change and a number of actions to bring about each of the change strategies should then be developed and acted upon in an attempt to bring the current state closer to the future state. The performance measures will provide an indication of how successful the action items have moved the process towards the desired future state. It is important to note that this is a cyclical process that is always developing new strategies and actions to reach the desired state. It should also be noted that the desired state is not a constant. It may change as an even better future is desired.

Figure 6.1 The transition planning process



(Greenfield, 2002) -reproduced with permission

Future State

The desired future state is a sustainable river system where the environmental, social and economic aspects of the river, and all its component parts, are not compromised now or in the future by dams.

Performance Measures

Several performance measures can be used to determine if the desired future state has been reached. These measures will be of an environmental, social, and economic nature.

The environmental measures could include monitoring of water flows, water quality, fish populations and invertebrates. Desired performance levels could be established by estimating what the quality of these various parameters would be without dams. These levels could be determined by evaluating monitoring data from watercourses in the area where dams are not prevalent and have minimal impact. When dam removals have improved these parameters to the level that has been estimated to be acceptable, then the desired future state has been reached. All of the above-noted environmental monitoring could be used to develop a general watershed health report that could be published regularly and used to assess the success of the program.

The social performance measures could simply be the number of dams in the watershed. A list of candidate dams would be prepared following a detailed assessment of all structures in the watershed where removal would be beneficial to the sustainability of the watercourse and where removal is feasible. When it can be said that all candidate dams have been removed, then the desired future state has been reached. Another social performance measure may be the number of recreational opportunities that would not have been possible with dams. Those measuring this indicator would have to agree upon a percentage increase in these activities that would indicate success in the program. A

percentage increase in these activities of perhaps 100% may be acceptable and may indicate that the desired state has been reached.

An economic performance indicator may be the health of the local economy. When recreational opportunities are created as a result of the removal of dams, improvements to the local economy may follow. Parameters such as total sales in a region, number of jobs created, or unemployment rates, could be monitored. When an agreed upon increase in the economy, that can be accredited to the removal of dams, has been achieved, then the desired future state has been reached. It may be advantageous to assess only a small part of the economy, such as the business sector that caters to recreational activities, to measure this performance. It could be argued, however, that increasing recreational opportunities has the potential to improve the entire economy of a region.

Current State

Generally speaking, the current state of the river system with respect to dams is one where dams are numerous, many are of little or no benefit, some are in very poor structural condition and have negative impacts of an environmental, social and economic nature.

Base line information of all the performance measures should be established. Many of the environmental performance measures mentioned above can be assessed now through existing monitoring programs or though programs that are in the process of being developed.

In addition to establishing base line values, a more detailed assessment of dams within the watershed is required. This assessment would culminate in a list of candidate dams that was previously mentioned in the performance measures discussion above. This assessment should determine the extent of the negative impacts of dams on a site-by-site basis, on a sub watershed basis, and on a watershed basis. The assessment should also determine the structural condition of each dam as well as the value of the existing and potential benefits it provides. An extensive update of dam inventory information in the Saugeen River watershed has been proposed by the SVCA. Much of this information could be gathered during that update. Also of importance will be the determination of the immediate and long term benefits that will be realized with the removal of each structure. These may be highly variable and will assist in establishing a priority setting exercise.

Another component of determining the current state would be to recognize the barriers to dam removals in the Saugeen River watershed. A list of these important barriers was provided in Table 5.5.

Transition State/Recommendations

Transforming these barriers into strategies for change and assigning action items for each strategy will assist in moving from the current state into the desired future state of a more sustainable river system. The strategies and actions can be found it Tables 6.1a to 6.1h. It is important to understand that a successful dam removal project will require extensive planning and research not necessarily mentioned in the actions listed below. The actions are geared more to promoting a proposed program to ensure that communities take

ownership of the issue and act on it. The strategies and associated actions are listed according to the importance of the barriers as determine by the surveys discussed in previous chapters.

Table 6.1a Strategy for change number one – funding

Barrier	Lack of funds to finance a dam removal project.
Strategy #1	Develop innovative and flexible funding strategies for long term program implementation.
Actions:	-motivate local stakeholders to develop and direct local fundraising campaigns to raise money for specific dam removal projects -coordinate regional environmental agencies to establish regional and national fundraising campaigns to finance specific dam removal projects -lobby all levels of government to provide funding for ongoing studies and inventories as well as administrative costs for lead agencies -seek out the financial support of local businesses and corporations that will benefit from a more sustainable river system -undertake projects in a cost effective manner -use financial resources in the areas were the most benefit will be realized

Table 6.1b Strategy for change number two - awareness

Barrier	Lack of awareness of negative impacts of dams.
Strategy #2	Build awareness of the environmental, social, and economic implications of dams on a river system and the benefits of removal.
Actions:	-contact local universities to recommend research topic related to the implication of dams in the Saugeen River watershed and benefits of removal -encourage local schools to study the impact of local dams and the benefits of removal -make all monitoring information and studies on dams available to the public -convince local municipalities, governments, conservation groups, etc. of the benefits of removal -set up display information at local fairs and festivals * -speak to local community groups on the issue * -offer prizes for school science fair projects related to the impacts of dams and the benefits or removal *

Note: * action for more than one strategy

Table 6.1c Strategy for change number three - history

Barrier	Dams have historic value.
Strategy #3	Incorporate innovative ways for a community to recognize and incorporate the historic value of dams into a dam removal program.
Actions:	-encourage local schools to research the history of the local dam and make the research available to the community -commission a local historian to write a history of the dam and provide it to schools and libraries -encourage local schools or colleges to produce a video of the dam and make it available to the community -ask the community to find physical ways to remember the dam (monuments, murals, plaques etc.) and implement them after the dam has been removed.

Table 6.1d Strategy for change number four - aesthetics

Barrier	Dams are aesthetically pleasing.
Strategy #4	Shift community thinking to accept the beauty of the physical benefits of a more sustainable river system.
Actions:	-provide information (photos, videos) on other dam removal and reservoir rehabilitation projects to show how aesthetically pleasing they can be -provide information of the potential increases in recreational activities that could result from a dam removal program -organize field trips to other dam removal projects -after a dam has been removed give the responsibility of site beautification to the local horticultural society -make a dam removal project part of an overall community beautification project

Table 6.1e Strategy for change number five - apathy

Barrier	Apathy (dam removal is not an issue).
Strategy #5	Make improved river sustainability a local issue.
Actions:	-undertake a study on the potential environmental, social and economic benefits of a specific or regional dam removal project -provide information on successes realized by other communities -establish healthy competitions between communities with dams -set up display information at local fairs and festivals * -speak to local community groups on the issue * -offer awards for school science fair projects on dams removals *

Note: * action for more than one strategy

Table 6.1f Strategy for change number six - direction and knowledge

Barrier	Lack of direction or knowledge regarding dam removal.
Strategy #6	Provide the knowledge and educational tools to assist communities in educating themselves with respect to dam removals.
Actions:	-designate a local resource agency to direct and coordinate a dam removal program -develop a library of resource information and information kits at a local agency office and make it available to schools, researchers and community groups interested in undertaking a dam removal project -form a technical committee made up of experts from agencies to provide knowledge and expertise on dam removal -offer the service of experts to sit on local steering committees -coordinate the removal of a dam involving local groups as a demonstration project and learning exercise -provide project planning and coordination services to local groups

Table 6.2g Strategy for change number seven - regulations

Barrier	Dam removal will require regulatory permits.
Strategy #7	Make the regulatory agencies part of the solution.
Actions:	-invite regulatory agency representatives to sit on technical and local steering committees -invite regulatory agencies to be involved in the planning and implementation of a dam removal program and specific dam removal projects -encourage regulatory agencies to undertake research studies on the issue -ask regulatory agencies to assist in the financing of a dam removal program

Table 6.2h Strategy for change number eight – hydroelectric power

Barrier	Dams produce, or have the potential to produce, hydroelectric power.
Strategy	Determine how much of a benefit hydroelectric power is in the Saugeen River watershed.
Actions:	-research existing hydroelectric producing dams in the area -offer to assist dam owners wishing to decommission and remove hydroelectric producing dams. -offer dam owners an assessment of the potential for hydroelectric power generation for presently non producing dams -provide information to dam owners on the full cost of generating hydroelectric power including environmental costs

Conclusion

These actions could form the basis of a long term dam removal program for the Saugeen River. Such a program would ideally be driven by the watershed community which would take ownership of the issue and make use of the leadership, resources and expertise of a lead agency. Partnerships of this nature will assist in transforming the river system of the Saugeen into one that is not negatively affected by dams and as a result will move to a more sustainable state.

> "Men may dam it and say that they have made a lake, but it will still be a river. It will keep its nature and bide its time, like a caged animal alert for the slightest opening. In time, it will have its way; the dam, like the ancient cliffs, will be carried away piecemeal in the currents."
>
> -Wendell Berry
>
> (Lindloff and Johnson, 2000, p. iii)

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Appendix A

List of Dams by Watercourse

List of Dams by Watercourse

Main Saugeen River (MSR) - 8 dams
MSR 1 Denny's Dam
MSR 2 Truax Dam
MSR 3 Walkerton Hydro Dam
MSR 4 Maple Hill Dam
MSR 5 Hanover Dam
MSR 6 Lower Durham Dam
MSR 7 Middle Durham Dam
MSR 8 Upper Durham Dam

North Saugeen River / Hamilton Creek (NSR) - 10 dams
NSR 1 Lockerby Dam
NSR 2 McQuire Dam
NSR 3 McClure Dam
NSR 4 Chesley Co-op Dam
NSR 5 Scone Dam
NSR 6 Peabody Dam
NSR 7 Dam Downstream of Williamsford
NSR 8 Williamsford Dam
NSR 9 Holland Centre Dam
NSR 10 Lilly Oak Dam

Teeswater River (TWR) – 6 dams
TWR 1 Johnson Dam
TWR 2 Stark Mill Dam
TWR 3 Pinkerton Dam
TWR 4 Cargill Dam
TWR 5 Little Dam
TWR 6 Dam North of Belmore

Rocky Saugeen River (RSR) - 5 dams
RSR 1 Aberdeen dam
RSR 2 Lind Dam
RSR 3 Jankel Dam
RSR 4 Hayward Falls Dam
RSR 5 Dam Downstream of Markdale

South Saugeen River (SSR) – 2 dams
SSR 1 Ayton Dam
SSR 2 Mount Forest Dam

Beatty Saugeen River (BSR) - 1 dam
BSR 1 Orchard Dam

Otter Creek (OTC) - 4 dams
OTC 1 Otter Creek Dam
OTC 2 Mildmay Park Dam
OTC 3 Mildmay Co-op Dam
OTC 4 Unnamed

Carrick Creek (CKC) – 1 dam
CKC 1 Unnamed

Norman Reeves Creek (NRC) - 1 dam
NRC 1 Holstein Dam

Meux Creek (MEC) – 1 dam
MEC 1 Neustadt Dam

Main Saugeen River Tributary A (MSR trib a) – 2 dams
MSR trib a 1 Unnamed
MSR trib a 2 Unnamed

Main Saugeen River Tributary B (MSR trib b) – 3 dams
MSR trib b 1 Unnamed
MSR trib b 2 Unnamed
MSR trib b 3 Unnamed

Main Saugeen River Tributary C (MSR trib c) – 1 dam
MSR trib c 1 Unnamed

Main Saugeen River Tributary D (MSR trib d) – 1 dam
MSR trib d 1 unnamed

Rocky Saugeen River Tributary A (RSR trib a) – 1 dam
RSR trib a 1 Barhead dam

Rocky Saugeen River Tributary B (RSR trib b) - 1 dam
RSR trib b 1 Markdale Dam

Teeswater River Tributary (TWR trib) – 1 dam
TWR trib 1 Chepstow Dam

Beatty Saugeen River Tributary (BSR trib) - 1 dam
BSR trib 1 Unnamed

South Saugeen River Tributary (SSR trib) – 1 dam
SSR trib 1 Unnamed

Norman Reeves Creek Tributary (NRC trib) – 1 dam
NRC trib 1 Unnamed

Total number of dams - 52

Appendix B

List of Dams by Watercourse Order

List of Dams by Watercourse Order

Dam #

Main Saugeen River (MSR) - 8 dams

1 MSR1 Denny's Dam

North Saugeen River / Hamilton Creek (NSR) - 10 dams

2 NSR 1 Lockerby Dam
3 NSR 2 McQuire Dam
4 NSR 3 McClure Dam
5 NSR 4 Chesley Co-op Dam
6 NSR 5 Scone Dam
7 NSR 6 Peabody Dam
8 NSR 7 Dam Downstream of Williamsford
9 NSR 8 Williamsford Dam
10 NSR 9 Holland Centre Dam
11 NSR 10 Lilly Oak Dam

Teeswater River (TWR) – 6 dams

12 TWR 1 Johnson Dam
13 TWR 2 Stark Mill Dam
14 TWR 3 Pinkerton Dam
15 TWR 4 Cargill Dam

Teeswater River Tributary (TWR trib) – 1 dam

16 TWR trib 1 Chepstow Dam
17 TWR 5 Little Dam
18 TWR 6 Dam North of Belmore

Main Saugeen River Tributary A (MSR trib a) – 2 dams

19 MSR trib a 1 Unnamed
20 MSR trib a 2 Unnamed
21 MSR 2 Truax Dam
22 MSR 3 Walkerton Hydro Dam

Otter Creek (OTC) - 4 dams

23 OTC 1 Otter Creek Dam
24 OTC 2 Mildmay Park Dam
25 OTC 3 Mildmay Co-op Dam
26 OTC 4 Unnamed
27 MSR 4 Maple Hill Dam

South Saugeen River (SSR) – 2 dams

Beatty Saugeen River (BSR) - 1 dam

Beatty Saugeen River Tributary (BSR trib) - 1dam

28 BSR trib 1 Unnamed
29 BSR 1 Orchard Dam

Norman Reeves Creek (NRC) - 1 dam

30 NRC 1 Holstein Dam

Norman Reeves Creek Tributary (NRC trib) –1

31 NRC trib 1 unnamed

Carrick Creek (CKC) – 1 dams
Meux Creek (MEC) – 1 dam
MEC 1 Neustadt Dam
CKC 1 Unnamed
SSR 1 Ayton Dam
SSR 2 Mount Forest Dam
South Saugeen River Tributary (SSR trib) – 1 dam
SSR trib 1 Unnamed
MSR 5 Hanover Dam
Rocky Saugeen River (RSR) - 5 dam
RSR 1 Aberdeen dam
RSR 2 Lind Dam
RSR 3 Jankel Dam
RSR 4 Hayward Falls Dam
Rocky Saugeen River Tributary A (RSR trib a) - 1 dam
RSR trib a 1 Barhead Dam
RSR 5 Dam Downstream of Markdale
Rocky Saugeen River Trubutary B (RSR trib b) – 1 dam
RSR trib b 1 Markdale Dam
MSR 6 Lower Durham Dam
MSR 7 Middle Durham Dam
MSR 8 Upper Durham Dam
Main Saugeen River Tributary B (MSR trib b) – 3 dams
MSR trib b 1 Unnamed
MSR trib b 2 Unnamed
MSR trib b 3 Unnamed
Main Saugeen River Tributary C (MSR trib c) – 1 dam
MSR trib c 1 Unnamed
Main Saugeen River Tributary D (MSR trib d) – 1 dam
MSR trib d 1 Unnamed

Appendix C

Agency/Stakeholder Group Representative Survey

Dam Owner Survey

Agency and Stakeholder Group Representative Survey
Interview Questions

Interview # ____ **Agency/Group: _____**

Position: _____

I am in the process of doing a research paper on dams within the Saugeen River watershed. Part of my research is to determine the attitudes and views of a representative group of people that have some involvement with dams. I will do this by asking a number of survey questions related to dams.

You do not have to participate in this survey and you may terminate the survey at any time. Your name will not appear anywhere in the results of my research. Are you willing to participate in the survey?

I would ask you to answer the question in the context of dams within the Saugeen River Watershed.

Question No. 1

As you know, dams provide many benefits. As I mention a number of these benefits I would ask you to indicate how important you feel these benefits are to our society as a whole. The choices I would like you to consider are very important, somewhat important, not important at all.

Benefit	Very Important	Somewhat Important	Not Important
Hydro electric power generation			
Creating recreational opportunities			
Providing a supply of water			
Flood control			
Separating fish species in a river system			

It has been suggested, and much research has shown, that dams create negative impacts of a environmental, social and economic nature. I would now like to ask how serious you think some of these problems are.

Question No. 2

Do you think the following environmental problems caused by dams are very serious, somewhat serious, or not serious at all?

Environmental Problem	Very Serious	Somewhat Serious	Not Serious
Negative impact on water quality and temp.			
Negative affect on aquatic life			
Barrier to the passage of fish			
Destruction of fish habitat from operations			
Accumulation of sediments and nutrients in the reservoir.			

Question No. 3

Do you think that the following social problems resulting from dams are very serious, somewhat serious, or not serious at all?

Social Problems	Very Serious	Somewhat Serious	Not Serious
Threat to public safety			
Threat of dam failure			

Question No. 4

Do you think that the following economic problems caused by dams are very serious, somewhat serious, or not serious at all?

Economic Problems	Very Serious	Somewhat Serious	Not Serious
Maintenance costs			
Financial liability			

It has been suggested that the problems associated with dams could be alleviated, and river systems improved, if dams were removed. There have not been many dam removal projects in the Saugeen watershed. I would now like to get your views on the factors that are preventing dam removal projects.

Question 5

How important are the following environmental factors in preventing a dam removal project from proceeding? Your choices are very important, somewhat important, or not important.

Environmental Factor	Very Important	Somewhat Important	Not Important
Separation of fish species			
Dams control floods			
Potential the a dam removal project could create environmental problems (silt spill)			

Question 6

How important are the following social factors in preventing a dam removal project from proceeding?

Social Factor	Very Important	Somewhat Important	Not Important
Dams are aesthetically pleasing			
Lack of awareness of negative impact			
Serve other infrastructure purposes(roads)			
Obligation to supply water to others			
Regulations, permits, bureaucracy			
Historic value of a dam			
Apathy (dam removal is not an issue)			
Lack of direction or knowledge			
Provides recreational opportunity			

Question 7

How important are the following economic factors in preventing a dam removal project from proceeding?

Economic Factors	Very Important	Somewhat Important	Not Important
Lack of an adequate funding source			
Loss of an existing revenue source			
Loss of a potential revenue source			

Thank you for participating.

Dam Owner Survey
Interview Questions

Interview # ____ **Individual: _____**

Dam: _____

I am in the process of doing a research paper on dams within the Saugeen River watershed. Part of my research is to determine the attitudes and views of a representative group of people that have some involvement with dams. I will do this by asking a number of survey questions related to dams.

You do not have to participate in this survey and you may terminate the survey at any time. Your name will not appear anywhere in the results of my research. Are you willing to participate in the survey?

I would ask you to answer the question in the context of the dam that you own.

Question No. 1

As you know dams provide many benefits. Which of the following benefits is provided by your dam and how important do you feel these benefit are? Do you consider it to be very important, somewhat important, not important at all.

Benefit	Very Important	Somewhat Important	Not Important
Hydro electric power generation			
Creating recreational opportunities			
Providing a supply of water			
Flood control			
Separating fish species in a river system			

It has been suggested, and much research has shown, that dams create negative impacts of an environmental, social and economic nature. I would now like to ask how serious you think some of these problems are with respect to you dam.

Question No. 2

Which of the following environmental problems are being caused by your dam and do you consider these problems to be very serious, somewhat serious, or not serious at all?

Environmental Problem	Very Serious	Somewhat Serious	Not Serious
Negative impact on water quality and temp			
Negative affect on aquatic life			
Barriers to the passage of fish			
Destruction of fish habitat from operations			
Accumulation of sediment and nutrients in the reservoir			

Question No. 3

Which of the following social problems are being caused by your dam and do you consider these problems to be very serious, somewhat serious, or not serious at all?

Social Problem	Very Serious	Somewhat Serious	Not Serious
Threat to public safety			
Threat of dam failure			
Prevent some recreational activities			

Question No. 4

Which of the following economic problems are being caused by your dam and do you consider these problems to be very serious, somewhat serious, or not serious at all?

Economic Problems	Very Serious	Somewhat Serious	Not Serious
Maintenance costs			
Financial liability			

It has been suggested that the problems associated with dams could be alleviated, and river systems improved, if dams were removed. There have not been many dam removal projects in the Saugeen watershed. I would now like to get your views on the factors that are preventing dam removal project.

Question 5

How important are the following environmental factors in preventing a dam removal project from proceeding?

Environmental Factor	Very Important	Somewhat Important	Not Important
Separation of fish species			
Dam controls floods			
Potential that a removal project would create environmental problems (silt spill)			

Question 6

How important are the following social factors in preventing a dam removal project from proceeding?

Social Factor	Very Important	Somewhat Important	Not Important
Dam is aesthetically pleasing			
Lack of awareness of negative impact			
Serve other infrastructure purposes (roads, walkways,)			
Obligation to supply water to others			
Regulations, permits, bureaucracy			
Historic value of a dam			
Apathy (dam removal is not an issue)			
Lack of direction or knowledge			
Loss of recreational opportunity			

Question 7

How important are the following economic factors in preventing a dam removal project from proceeding?

Economic Factors	Very Important	Somewhat Important	Not Important
Lack of adequate funding source			
Loss of an existing revenue source			
Loss of a potential revenue source			

Thank you for participating.