

**Case Study:**  
**An examination of agricultural surface water use for crop  
irrigation in Kings County, Nova Scotia**



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By

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## **Abstract**

In 2007, the primary body for managing and protecting our water resources, Nova Scotia Environment (NSE), was directed to develop a comprehensive water resource management strategy for the province. This strategy acknowledges that water is directly related to sustainability, as well as to the health of humans and ecosystems. As such, the provincial water strategy will seek to answer questions regarding water quantity and allocation. Understanding how much water is available and the demands of this supply is crucial in determining a comprehensive management plan.

One of the largest water use sectors in the Annapolis Valley is the agricultural industry and studies have indicated that within this community little is known regarding water use. This presents a problem, as an important element of effective water resource management is allocation. This case study examines agricultural surface water usage within Kings County, Nova Scotia in order to provide insight into the current monitoring and compliance challenges. The methods employed to achieve the objectives of the case study involved conducting semi-structured, in person, one-on-one interviews with participants representing each group. Specifically, the case study identifies and describes the challenges faced by farmers, NSE inspectors, and NSE policy makers in determining water usage; identifies and describes solutions for addressing these challenges; identifies recommendations for further action; and links the results of this research to its broader context which is the current development of a provincial water strategy.

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# **1. Introduction**

## **1.1 Background**

Water is a resource that is essential for ecosystem function and health, as well as economic and social-well being. Despite an illusion of abundance, available freshwater resources constitute less than one percent of our global water inventory (Pidwirny, 2006). This limited supply of freshwater must meet the demands of a growing population while supporting industry and development. Over a twenty-year period between 1972 and 1996, Canada's water withdrawal rate increased by nearly ninety percent (Environment Canada, 2006). This trend of increasing water extraction in Canada has yet to be addressed on a national level; however, some provinces are beginning to realize the importance of developing a long-term management plan.

Nova Scotia Environment (NSE) is currently developing a comprehensive water management strategy to address such things as water protection, quality, quantity, and allocation (NSE, 2007). Arguably, the largest water use sector in Nova Scotia is the agricultural industry, primarily concentrated in the Annapolis Valley, and a successful water management strategy must adequately address the issue of water allocation within this community.

## **1.2 Research Problem**

In Nova Scotia, water users requiring the extraction of greater than 23,000 litres of surface water per day must obtain a permit to withdraw water and this encompasses most agricultural water users. The primary body responsible for creating provincial water policies, issuing water withdrawal permits, and monitoring water use is NSE, and NSE inspectors are the individuals responsible for ensuring that the conditions of these permits are met. Additionally, site specific

terms and conditions of water withdrawal permits state that the water user shall record daily water use volumes and maintain these records for the duration of the approval.

Despite these requirements, both on the part of the water user and the policy enforcer, studies have indicated that there is a lack of understanding within the agricultural community regarding actual water usage (AGRA Earth & Environmental Limited, 2000). One factor that may contribute to this lack of information is the exemption of the agricultural industry from paying for water use. The removal of financial responsibility could possibly affect the incentive to comply with the terms and conditions of the approval that require water users to maintain water use records. In order to ensure the fair and sustainable allocation of water resources, specifically within the agricultural community, it is essential to know how much water is required and how much water is being used.

### **1.3 Research Goal and Objectives**

The goal of this research was to examine agricultural surface water usage within Kings County, Nova Scotia in order to provide insight into the current compliance and monitoring challenges. Specifically, the objectives of the research were:

1. To describe the challenges for both farmers and NSE policy makers and enforcers in determining water usage within the agricultural community;
2. To describe potential solutions for addressing these challenges;
3. To identify recommendations for further actions;
4. To link the results of this research to its broader context, the current development of a provincial water strategy.

## **1.4 Rationale**

The provincial water strategy that NSE is currently developing seeks to address, among other things, issues relating to water quantity, monitoring, regulation, and compliance. Agricultural water use is one of the largest water consumers across Canada, including Nova Scotia (Bjornlund et al., 2007). The success of any water management strategy heavily depends upon the participation of the largest water users and consumers (Bjornlund et al., 2007). Research studies regarding agricultural water use have been primarily quantitative, illuminating the fact that within the agricultural community little is known about actual water usage (Agriculture and Agri-Food Canada, 2003). This case study presents a qualitative analysis of the research problem, providing insight into why there are challenges in determining water use within the agricultural community and how these challenges might be considered barriers to participation in the new provincial water strategy.

## **1.5 Significance of Research**

As population continues to increase the demand for food production will increase. Subsequently, this may lead to an increase in crop irrigation as the agricultural industry strives to meet these demands. Compounding this problem is the impact that climate change is expected to have on the occurrence and severity of droughts (Dryden-Cripton, et al., 2007). Already, the Kings County region has experienced water shortages during the growing season. With competing water demands, the sustainable allocation of surface water is important not only for the agricultural industry but for society as a whole as water is linked to human and ecosystem health (NSE, 2007). Additionally, in order to sustainably allocate water resources we need to know not only the demand of the water supply but also how much water is available and how much



water is being used. With agricultural water use ranking as one of the highest water users it is important to more accurately determine demand, availability, and use within this industry.

This case study will contribute to a greater understanding of the challenges in determining water use within the agricultural community. This is significant, as the participation of the agricultural community is important to the successful implementation of a water strategy in Nova Scotia.

## **1.6 Scope**

The scope of this case study is defined by two important factors. The first factor is the predominant use of surface water for crop irrigation in the Annapolis Valley. Surface water is the primary source of water used for the irrigation of crops in Kings County and the demand for this water peaks during the parts of the year when stream flow is at its lowest (Timmer, 2003). The second factor influencing the scope of the case study is the timeframe that is allotted for the completion of an undergraduate thesis. In an effort to maintain the integrity, validity, and reliability of the results the amount of research that is undertaken must be manageable and appropriate for the given timeframe.

Therefore, this case study focuses only on surface water withdrawal for the irrigation of crops; it does not encompass water used for livestock or other agricultural practices, nor does it investigate groundwater withdrawals. Additionally, this case study examines the issues surrounding water quantity not quality. Therefore, the primary policy that this case study deals with is section 66, division I of the Activities and Designation Regulations under the *Environment Act* as this is the regulation that governs surface water withdrawal approvals.

## 2. Literature Review

Although Canada still lacks a national water policy, provincial water management plans are on the rise and policy trends are beginning to emerge. Similar to other provinces, Nova Scotia currently has regulations, guidelines, and a monitoring framework to address water quality and quantity issues; however, some provincial governments are realizing the importance of developing a more comprehensive and sustainable approach to water management. This is the case in Nova Scotia where the development of a provincial water management strategy is presently underway (NSE, 2007).

Agriculture is an important industry in Nova Scotia, particularly in the Annapolis Valley, and it is also one of the largest water use sectors in this region (Timmer, 2003). In the Pereaux watershed, situated in Kings County, Nova Scotia, eighty-six percent of total water use has been allocated to the agricultural industry (Timmer, 2003). This water use trend is not unique to this province, as across Canada the agricultural sector is one of the largest water consumers (Bjornlund et al., 2007). Consequently, the success of any water management strategy depends upon the willingness of the agricultural community to participate in the implementation of that policy (Bjornlund et al., 2007).

Despite the effort being made by some provincial governments to overhaul their water policies, there has been little research completed in the way of analysing the success or failure of existing policies. Similarly, there has been minimal research into the ability of the existing policies to adequately manage agricultural water use in particular. This lack of analysis poses a problem as it may

increase the likelihood of implementing policies that simply do not achieve the goals that have been outlined in specific water strategies. Successful water management policies require the effective use of policy tools and instruments (Gouvernement du Quebec, 2002).

Nationally, water policies have relied on regulation as the primary means of addressing water management, and regulations pertaining to water extraction are typically enforced by provincial environment departments (Boutin, 2005). Provincial policies relating to water use vary for instance in Nova Scotia a water withdrawal permit is required if water extraction exceeds 23,000 L/d, while in Prince Edward Island a permit is required if extraction exceeds 45,460 L/d (Agricultural Irrigation Policy, 1995; J. Kinkead Consulting, 2006). Additional variation exists regarding water use fees. In Nova Scotia agricultural water users are exempt from paying the fee associated with water withdrawal permits; however, in British Columbia the agricultural industry is charged a rate of fifty-five cents per one-thousand cubic meter of water used for irrigation (Government of British Columbia, n.d.). Despite these variations there are similar themes among the various provincial water policies.

A common theme among the provincial water policies is the issue of allocation, as provinces recognize the importance of balancing water use and multiple water demands in order to achieve sustainable water use (Benninghoff et al., 1999). An important element of water allocation is the knowledge of how much water is available and how much water is in demand. This information is essential in order for water users and water managers to make important decisions regarding water consumption. However, a national analysis of agricultural water supply issues completed in 2003 indicates that in all ten provinces there is a lack of information on the supply of and

demand for water, and that this is a contributing constraint in successful water management (Agriculture and Agri-Food Canada, 2003).

This lack of information exists despite the requirement in most jurisdictions for water users to indicate the amount of water that is required for their activities, such as irrigation, and for water regulators to ensure that water use is effectively monitored. In fact, in Canada most provincial regulators have failed to require agricultural water users to meter their water, and to record and report on their water withdrawals (J. Kinkead Consulting, 2006). Therefore, although provincial water policies may have programs and policies in place to ensure the sustainable and fair allocation of water resources, specifically among the agricultural sector, the ineffective and inconsistent use of these policy tools has led to the existence of partial and rough estimates of water use (J. Kinkead Consulting, 2006).

Current research indicates that climate change will have an impact on water use as the occurrence and severity of droughts and water shortages is expected to increase (Dryden-Cripton, et al., 2007). An increase in drought and water shortages will inevitably impact the amount of water required and the amount of water consumed for irrigation. Already, between 1972 and 1996 Canada's water withdrawal rate increased by almost ninety-percent, with agriculture consuming approximately 3,040 million cubic meters of freshwater in 1996 alone (Environment Canada, 2006).

Agricultural production consumes a large quantity of water, and the cost of this extraction is far reaching; however, so too are the benefits. Farmers within the agricultural industry are aware that the water that they extract for crop production will benefit society as a whole. Therefore,

there are members within the agricultural industry who feel as though the cost of increased water management, such as efficient irrigation systems and conducting individual studies outlining water requirements and water use impacts, should not be borne by the producer themselves. In an effort to remove the emphasis from the farmer having to prepare extensive water use plans, the Water Management Plan for the province of British Columbia has created Water Allocation Plans (Braybrook & Bryden., 1995). These Water Allocation Plans identify water demands within separate watershed areas and water licence decisions are based upon these plans (Braybrook & Bryden., 1995). This highlights the necessity of understanding the variety of factors that influence water management decisions within the agricultural community in order to develop water strategies and policy instruments that will be effective (Bjornlund et al., 2007).

Nova Scotia is currently developing a provincial water strategy that is based on a three-pillar approach (NSE, 2007). One of these pillars aims to address water quality and quantity; specifically, groundwater and surface water activities (Nova Scotia's Water Resources Management Strategy, 2007). When addressing water quantity issues it is important to recognize the success and failure of current monitoring frameworks. Research has suggested that the main shortcomings of Nova Scotia's current monitoring framework involve databases that are incomplete with respect to surface and groundwater sources; monitoring programs that are insufficient; and, water permitting and approval processes that are at best, ineffective (Agriculture and Agri-Food Canada, 2003). Other constraints that were identified that relate to Nova Scotia's water supply are seasonal water shortages; limited local and technical capacities; and, regulatory and licensing issues (Agriculture and Agri-Food Canada, 2007).

The goals and objectives of this project are aimed at providing insight into the current compliance and monitoring challenges associated with agricultural surface water use. Therefore, it is useful to understand the factors that affect compliance and successful regulation. In 2007 a book was published entitled *Handbook of Environmental Protection and Enforcement* (Farmer, 2007). A section of the book describes the principles and nature of regulation, specifically identifying the factors that motivate compliance and the factors or barriers that encourage non-compliance (Farmer, 2007, p. 6). The author explains that combinations of economic, social, personal, managerial, and technological factors influence compliance (Farmer, 2007, p. 7). For example, lack of funds, technology, and enforcement can all have an impact on whether or not compliance is achieved. Additionally, the author noted that successful regulations must be enforceable, consistent, straightforward, and impose no unnecessary costs (Farmer, 2007, p. 12-13).

Research has shown that there are challenges regarding allocation of water resources, including participation and attitudes associated with the agricultural community and the ineffectiveness of current monitoring frameworks. Provinces such as Manitoba, Alberta, and Quebec have developed provincial water strategies to address water management issues, while Nova Scotia is currently developing their own water management strategy. Identifying the challenges associated with determining water usage within the agricultural community is an important part of a successful water management strategy as it will elucidate the variables that affect water use in one of the largest water consumption industries in the province.

### **3. Methodology**

#### **3.1 Case Study**

*“The purpose of case study is not to represent the world, but to represent the case”  
- Stake (1994, p. 245)*

This research employs a case study approach, which is described by Yin (2003, p. 23) as investigating “a contemporary phenomenon within its real-life context”. Specifically, the contemporary phenomenon in question is agricultural surface water use in Kings County, Nova Scotia, involving water users, policy enforcers, and policy makers. The larger, real-life context is the current development of a provincial water strategy that seeks to address water-related issues relating to regulation, compliance, and monitoring, and to answer questions regarding the quantity of water available and how it will be sustainably allocated (NSE, 2007). As a qualitative approach, the case study is grounded in constructivist theory; therefore, the objective of this research method will be to engage participants by means of employing broad, open-ended questions in order to gain an understanding of how the participants view the research problem (Creswell, 2003).

**Table 3.1:** Actor groups involved in the case study, including the number of participants to be chosen from each group, and the rationale for including them in the study.

Actor Groups	Number of Participants	Rationale
Farmers who withdraw surface water for the purpose of crop irrigation	6	Crop irrigation in Kings County is predominantly achieved by means of withdrawing surface water
Inspectors with Nova Scotia Environment	4	These are the individuals who are responsible for enforcing the regulations that govern surface water use in Nova Scotia
Nova Scotia Environment policy makers	2	These are the individuals who are responsible for decision-making that relates to policy creation

Agricultural surface water use in Kings County involves three primary actor groups: farmers who withdraw surface water for the purpose of crop irrigation, NSE inspectors (policy enforcers), and NSE policy makers (Table 3.1). The method used for obtaining participants from each actor group was purposive sampling, whereby each individual was strategically chosen based upon my previous experiences with each group. My knowledge of specific individuals in each actor group allowed me to select participants whose opinions provided a diverse view of the issue examined. Additionally, the greater number of farmers included in this case study allowed more emphasis to be placed upon their perspectives. This is deemed appropriate given the importance of their full participation in water management. In order to confirm participation in the study a letter was sent to potential participants explaining the purpose of the study and their role should they choose to take part in the case study.



The primary method of data collection was semi-structured interviews and for each actor group an interview guide was used (Appendix A). At least two questions were posed to all three actor groups in order to allow themes to emerge among the groups. The remaining questions were specific to each group and centred around three primary concepts: attitudes, local knowledge, and values.

The location of the interviews was chosen in part by the participants and each interview lasted approximately one hour. All interviews were conducted individually and prior to the interviews participants were provided with an opportunity to ask questions regarding the research and to express any comments or concerns. At the conclusion of the interview, participants were asked again if they had any questions, comments, or concerns. Participants were also provided with a copy of the informed consent form (Appendix B). No follow-up interviews were necessary.

The nature of this case study does not allow for statistical analysis; therefore, the primary method of data analysis involves a method outlined by Creswell (2003). Following organization and preparation of the collected data, coding of the data took place. This involved reviewing the material and assigning codes to ‘chunks’ of data, thereby creating categories. Once all the data was reviewed and codes were assigned, the material was further examined to determine what patterns or themes were present. Once the themes were clearly identified, the final step was to interpret these themes in order to draw conclusions regarding the data that was collected.

### 3.2 Validity and Reliability

The traditional quantitative notions of validity and reliability do not apply to qualitative research methods; therefore, it is necessary to reconsider how validity and reliability can be achieved within a case study context. Typically, quantitative research is valid when it measures what it initially set out to measure, while reliability is achieved if the results of the research can be replicated in other studies using the same techniques and analysis (Palys, 2003). However, results generated from case studies are unique to the particular case that is being studied; therefore, replicability of results from one case to another is impossible (Bailey, 1997).

Reliability, within the context of qualitative research, is achieved through transferability; that is to say, reliability is achieved if the process used to achieve the results in one case study can be applied to similar case studies. The use of semi-structured interviews is the primary method of data collection within this case study, a process that can be easily transferred to future case studies.

Validity, within the context of qualitative research, is achieved if the results present a credible description or explanation of the phenomenon being studied and triangulation can help to achieve this goal (Bailey, 1997; Merriam, 1995). Specifically, triangulation can increase the credibility of the findings if multiple perspectives of a particular issue are obtained (Bailey, 1997). The method used in this case study involved interviewing individuals representing the three sides of agricultural water use in Kings County. In addition to obtaining the perspectives of the three groups involved in agricultural water use, the results are further validated via my knowledge of the community, as I have resided in the area for twenty-eight years, and through

my own observations, as my employment with NSE has allowed me to work closely with members of the agricultural community, NSE inspectors, and policy makers.

### **3.3 Limitations**

The limitations associated with this study are primarily inherent in case study research. The findings of the research will be associated with the particular groups and issues involved with agricultural water use in Kings County. Therefore, the applicability or the generalizability of the results to other counties and regions is not possible. Additional limitations involve the scale of the research and the available timeframe to complete the research. For example, the case study focuses on surface water use for agricultural crop irrigation, whereas water use within the agricultural community can include groundwater sources and may be used for livestock. The nature of the case study being an honours thesis means that the timeline to complete the research is pre-established, and thus limits the extent to which the subject can be explored. Finally, an important limitation to note is participants' knowledge of my past and present association with NSE. This association could contribute to the reluctance of both NSE employees and members of the agricultural community to divulge information, or could introduce bias, both in my role as the researcher and in the participants' roles as subjects.

### **3.4 Ethical Considerations**

This case study primarily involved interviewing people. Prior to completing these interviews, an application for ethics review was submitted for approval to the Dalhousie Environmental Programmes, Faculty of Science. Participants were fully informed about the study details, and prior to the commencement of interviews, informed consent was sought (Appendix B). Additionally, participants were notified of their right to refuse answering questions and of the

option to withdraw from the case study at any point. Furthermore, participants were given the option of receiving a copy of the final report. Finally, confidentiality of participants was guaranteed; however, participants were made aware that anonymity cannot be assured as a result of the case study involving a small number of people within a small community.

## 4. Findings and Analysis

The findings of this case study are based upon the responses and opinions of the research participants representing the three primary actor groups associated with agricultural surface water use in Kings County. 100% of the 12 individuals that were invited to participate in the case study agreed to participate; however, as a result of scheduling conflicts one interview was unable to take place. Therefore, the total number of participants interviewed was 11 (Table 4.1).

**Table 4.1:** Actor groups involved in the case study, including the total number of participants invited to participate in the case study, the response rate, and the total number of participants interviewed.

Actor Groups	Number of Participants Invited	Response Rate	Number of Interviews
Farmers who withdraw surface water for the purpose of crop irrigation	6	100%	5
Inspectors with Nova Scotia Environment	4	100%	4
Nova Scotia Environment policy makers	2	100%	2
<b>Total Number of Interviews</b>			<b>11</b>

The location of the interviews was chosen by the participants, each interview lasted approximately one hour, and no follow-up interviews were required. All interviews were conducted individually, and prior to and following the interviews, participants were provided with an opportunity to ask questions regarding the research project and to express any comments or concerns they may have had.

The following sections present the findings and discuss the general themes that emerged from the research. Specifically, these sections respond to objectives one and two of this research project.

## 4.1 Challenges in Determining Water Usage

The first objective of the research was to identify and describe the challenges for both farmers and NSE policy makers and enforcers in determining water usage within the agricultural community. A significant finding of the research was that out of the five themes that emerged, three of these themes were consistent across all actor groups (Table 4.2).

**Table 4.2:** Themes that emerged as challenges, showing which themes applied to each actor group.

THEMES	FARMERS	NSE ENFORCERS	NSE POLICY MAKERS
Cost	✓	✓	✓
Time	✓	✓	✓
NSE Response to Water Management	✓	✓	✓
NSE Resources		✓	✓
Perceived Unlimited Water Resources	✓		

### 4.1.1 Cost

100% of all respondents, regardless of the actor group to which they belong, reported that cost was a challenge in determining water usage in the agricultural community. This response was indicative of two primary costs. The first is the cost associated with farmers metering their water use (Figure 4.1.). Each water meter would cost approximately \$2000 and most farmers have multiple irrigation sites. Therefore, the total cost to meter all water sites would be significant.



**Figure 4.1:** Water meter that is typically used to monitor water used for irrigation.

The second cost is that associated with a Category 3 surface water withdrawal. The current surface water withdrawal process is risk-based, assigning water withdrawal applications to one of three categories depending on the type of surface water withdrawal that the applicant requests (Table 4.3). A Category 3 surface water withdrawal is considered the highest risk and a professional engineer or geologist must complete a detailed study of the withdrawal site. This cost could total in the thousands of dollars, with the potential that the request to withdrawal water may be denied. Although this second cost does not directly affect a farmer's ability to monitor and report water use, it is viewed as a barrier to participating in water management.

**Table 4.3:** Three categories of surface water withdrawal and the information that must be submitted with the applications (NSE, 2006).

Category	Step 1: What Category does your Application Fall Under?	Step 2: What Information Must I Submit With My Application?
1	<p>A) Renewal of existing or recently expired approval (as determined by NSEL).</p> <p>B) Withdrawal from offline ponds fed by groundwater that are less than 4 m deep and greater than 60 m from watercourse; or greater than 4 m deep and greater than 150 m from watercourse.</p>	<ul style="list-style-type: none"> <li>▪ Information to show that your withdrawal falls into this category.</li> <li>▪ Map of withdrawal site including nearby watercourses.</li> <li>▪ Must show that the amount of water requested is required.</li> <li>▪ Information to show how the water will be used (e.g. How many acres will be irrigated? At what rate of pumping? For how long?).</li> <li>▪ All requirements of existing approvals, or approvals which expired in 2005/2006 should be in possession of the Department.</li> </ul>
2	<p>A) Withdrawal from 3rd order and higher streams, and the withdrawal is relatively small</p> <p>B) Withdrawal from all offline ponds fed or potentially fed by groundwater which do not fall into Category 1</p>	<ul style="list-style-type: none"> <li>▪ A Qualified Person who has a degree in hydrology, geology, aquatic ecology, limnology, biology, physical geography, environmental science, water resource management, or engineering must:</li> <li>▪ Confirm that the proposed withdrawal meets the criteria for this category;</li> <li>▪ Outline the withdrawal rate, location, timing, proper intake design, monitoring, and site specific requirements;</li> <li>▪ Show that the amount of water requested to withdraw is required.</li> <li>▪ Provide information to show how the water will be used (e.g. How many acres will be irrigated? At what rate of pumping? For how long?).</li> <li>▪ For withdrawals greater than 1 million L/d, occurring twice per week or more, the qualified person must use modelling or other water balance assessment methods to demonstrate that the total amount of water extracted in any month will not exceed 5% of the net input (inflow) into the lake or pond in that month.</li> </ul>
3	All other withdrawals that do not fall into category 1 or 2	<ul style="list-style-type: none"> <li>▪ A P.Eng or P.Geo must complete a detailed study on impact assessment and water availability, level of study depends on potential impacts, but should generally follow the Department's Surface Water Withdrawal Guide (May 2004).</li> </ul>



Farmers explained that cost is a significant challenge for them. The horticultural industry exists in a free market and farmers are unable to control the price that they receive for their produce. Therefore, additional costs that farmers accrue are not easily retrievable, if at all. Further compounding this problem is that agriculture exists in a global market; therefore, farmers from this region are in competition with farmers from around the world. This can have serious implications; for example, a farmer from Kings County who spends thousands of dollars conducting a water study is in competition with a farmer from California whose water use is subsidized by the government.

#### **4.1.2 Time**

Time was another common response among all actor groups. 58% of respondents, regardless of actor group, reported that time demands were a challenge in determining water usage. An important note here is that NSE inspectors and policy makers who reported time as being a challenge were identifying not with the time demands of their own workload but with that of the farmers. Specifically, the time constraints that were reported by NSE inspectors and policy makers were the same as those reported by farmers.

The 60% of farmers who reported time as being a challenge were primarily referring to the additional time that would be required to record and maintain water data and the time already spent meeting other requirements, such as food safety. Some farmers explained that the water meters (Figure 4.1) only keep a running total and not a start-stop total of water use. Therefore, in order to record accurate daily water use the farmers would need

to manually record the meter value at all irrigation sites when they start and stop irrigating.

#### **4.1.3 NSE Response to Water Management**

The third theme that emerged as a challenge in determining water usage in the agricultural community was the response of NSE to water management. This theme captures many ideas that were reported from all three actor groups.

36% of respondents reported that there was no incentive for farmers to participate in water management programs and to record and maintain water use data. Essentially, farmers must expend additional time and money to record and maintain this data without receiving any benefits for doing so. Indeed, accruing costs without the ability to receive any form of compensation does not make good business sense for the farmer.

The connection between incentive and NSE response to water management emerges from another idea reported from all three actor groups. 36% of respondents reported that NSE is not proactive when it comes to promoting water management in the agricultural community. Specifically, 45% of respondents reported that there was a lack of education and awareness regarding regulations and the importance of water management. Similarly, 45% of respondents reported that there was a lack of enforcement.

Proactiveness, education, and enforcement are the responsibility of NSE and each of these things affect the willingness of the farmers to participate in water management schemes. For example, if NSE was more proactive in educating farmers and enforcing those who do not comply then this could potentially create more incentive for water

management. Also, additional incentive could potentially increase participation in water management.

Finally, 36% of respondents noted that the application and approval process for surface water withdrawals is onerous. Therefore, this becomes a deterrent for farmers to participate in the process.

#### **4.1.4 NSE Resources**

A theme that emerged as being a unique challenge for NSE inspectors and policy makers is lack of resources. 100% of respondents from the NSE actor groups reported either a lack of enforcement tools or a lack of water data as a challenge in determining water usage within the agricultural community.

Regulations require water users to obtain an approval if they are extracting 23,000 or more litres of water per day. Also, the terms of the conditions of the approval state that the water user must record and maintain water use records. However, as some NSE inspectors explained, proving that an individual is withdrawing 23,000 litres of water per day is impossible without adequate measurement tools, such as a water meter. Equally difficult would be verifying the accuracy of water use records, as there is no system in place that could back up the data that the farmers provide.

NSE is responsible for the fair and sustainable allocation of surface water. However, 66% of NSE inspectors and policy makers reported that there is a lack of surface water data. This is indicative of a lack of water data collection and distribution tools, such as hydrometric stations, stream gauges (Figure 4.2), and GIS computer models.



**Figure 4.2:** Stream gauge located on the Pereaux River, Kings County, Nova Scotia.

#### **4.1.5 Perceived Unlimited Water Resources**

The notion of perceived unlimited water resources is a theme that is unique to farmers. 60% of farmers reported that the most likely reason that water monitoring is not a common practice in the agricultural community is that farmers rely on traditional knowledge and habit. Most farmers have been irrigating from the same water sources for several decades and their experience informs them of how much water is available, when they must irrigate, and how much water they must use. In a sense, irrigation has become second nature to farmers and the need to monitor their water use has been absent.

Related to the idea of traditional knowledge is the fact that over the years farmers have not observed significant changes in the water supply. In fact, 80% of farmers reported that they observed no changes in water supply and 40% reported that the need to irrigate fluctuates over time and depends on weather conditions. This leads to a perceived notion

of unlimited water resources. Although farmers see the need for water management, 40% reported that water is currently not a limiting factor and therefore water monitoring is not a priority.

## 4.2 Solutions for Addressing Challenges in Determining Water Usage

The second objective of the research was to identify and describe solutions for addressing the challenges associated with determining water usage in the agricultural community. Again, a significant finding of the research was that the four themes that emerged were consistent across all three actor groups (Table 4.4).

**Table 4.4:** Themes that emerged as solutions, showing which themes applied to each actor group.

THEMES	FARMERS	NSE ENFORCERS	NSE POLICY MAKERS
Cost Saving Measures	✓	✓	✓
Education	✓	✓	✓
Improved Approval Process	✓	✓	✓
Continued Water Management	✓	✓	✓

### 4.2.1 Cost Saving Measures

45% of all respondents, regardless of actor group, reported that a potential solution to mitigate the challenge of costs in determining water usage could be to examine such things as funding and cost-sharing opportunities. Funding and cost-sharing could help alleviate financial barriers by assisting farmers with the purchase of water meters or by loaning or providing farmers with water meters. Additionally, to alleviate the financial cost of individual farmers completing a Category 3 surface water withdrawal study, farmers as a group could look into completing the studies together. For example, if multiple farmers require the completion of a Category 3 study then this group could

collectively hire a professional to complete all of the studies. Completing the studies in this manner may reduce the overall cost to the individual farmer or it may assist the group of farmers in obtaining funding for a resource person to support them in this endeavour.

Currently, the onus is on the individual farmer to expend costs in order to prove that their surface water withdrawal will not impact the watercourse and the environment.

Moreover, in completing high-risk studies such as Category 2 and 3, farmers are essentially providing the province with information about particular watercourses.

Recalling that a challenge for NSE is a lack of resources, such as water data tools, a suggested solution was for NSE to explore funding opportunities in order to acquire tools, such as hydrometric stations. In this scenario, the financial burden would at least be partially removed from both the farmer and NSE. Additionally, the onus would now be on the province to collect information about watercourses that are vested in the crown.

#### **4.2.2 Education**

45% of all respondents, regardless of actor group, reported that education is a potential solution. This response is indicative of two educational opportunities – education regarding the importance of water management and education regarding the current rules and regulations surrounding surface water withdrawals.

Recall that two challenges that were identified as barriers to determining water usage were time and traditional knowledge involving a perception of unlimited water resources. Each of these challenges can be addressed through education about the importance of water management.

Examining traditional knowledge and the perception of unlimited water resources we see that among farmers, and perhaps this could be stretched to include the public as a whole, water is currently not viewed as a limiting factor. To clarify this point let us compare food safety to water use. Generally speaking, food safety and quality is of great concern among the public and if food safety standards are not met there are immediate risks and consequences. These risks and consequences affect not only public health but also the farmer's business. Therefore, meeting food safety requirements is a top priority for the farmer.

On the other hand, water use is not a great concern among the public. It is difficult to visualize 23,000 or more litres of water and it is also difficult to conceptualize the long-term effects of high water use. Consequently, monitoring water use is a low priority as no immediate risks and consequences are experienced by the public or the farmer. This creates a situation whereby monitoring and recording water use data can appear meaningless.

Educating the public and farmers on the impacts of high water use could potentially extinguish the perception that water resources are resilient to long-term impacts.

Education that focuses on the importance of water management as a proactive, long-term approach to sustaining and protecting water resources could also move water monitoring higher up the priority list and could possibly encourage farmers to delegate time towards water monitoring.

Continued efforts aimed at educating the agricultural community about the rules and regulations of the surface water withdrawal process is another educational initiative.

NSE respondents reported that annual educational sessions with the agricultural community might be helpful in achieving awareness of rules and regulations. Some farmers reported that increased communication with inspectors might be useful as well.

#### **4.2.3 Improved Approval Process**

55% of respondents, regardless of actor group, reported that improving the approval process for surface water withdrawals through such things as better communication, clarification of requirements, and assigning a dedicated resource person could mitigate some challenges.

Improving communication between farmers and NSE inspectors could alleviate some confusion surrounding the approval process and assist in clarifying the requirements of the process. Some farmers reported that the current process is onerous and that the requirements are not immediately clear, while others reported that they feel uninformed about outstanding applications. Increased communication between inspector and farmer could improve the rapport between the two actor groups and help generate an atmosphere that encourages compliance.

NSE respondents also noted that assigning a dedicated resource person to manage agricultural water withdrawals in the Environmental Monitoring and Compliance (EMC) division in Kentville would be useful. As one third of Nova Scotia's farmland is in the Annapolis Valley, assigning a resource person for this purpose would be beneficial to the approval process.



#### **4.2.4 Continued Water Management**

Although the three actor groups may have different visions of water management, all agreed that some form of water management is necessary. Specifically, watercourses are vested in the crown and it is the responsibility of the province to ensure the sustainable use and protection of these resources. Therefore, NSE policy makers and inspectors reported that continued water management is important and necessary not only for this reason but also because water resources are limited.

60% of farmers reported that water management, with some form of government oversight is needed. Some farmers explained that government oversight in water management could mitigate conflicts among multiple users with competing interests and assist in sustaining water management efforts. Additionally, although some farmers are wary of government involvement, they expressed a commitment to environmental stewardship.

## **5. Conclusions and Recommendations**

### **5.1 Summary of Research**

Through investigating agricultural surface water usage in Kings County, Nova Scotia with respect to the three primary actor groups involved, insight was gained into current compliance and monitoring challenges. Specifically, challenges and solutions were identified for farmers, NSE policy makers and enforcers. Based on the analysis of these findings, the following sections present the conclusions and respond to objectives three and four of this project. Specifically, the results of this research are linked to its broader context, the current development of a provincial water strategy, and recommendations for future actions are described.

### **5.2 Conclusions**

The findings of this case study support the notion that there are challenges in determining water usage within the agricultural community. Specifically, the participants in this case study provide evidence that there are barriers that affect participation in and enforcement of water monitoring. Notably, there was similarity across all three actor groups with respect to the challenges and potential solutions that they identified. This similarity occurred despite the potential for contradictory viewpoints.

Farmers want to be good stewards of the environment. However, similar to other businesses or industries, management schemes must make good business sense. This is also true of water management. That means that the costs of participating in water management cannot exceed the benefits of participating. Currently, there is a lack of incentive to participate in provincial water management schemes. Most participants reported that the current surface water withdrawal approval process is onerous and it can be costly, both in dollars and time. As the literature

alluded to in section 2, effective regulations must be straightforward and impose no unnecessary costs (Farmer, 2007, p. 12-13).

NSE is committed to water management and believes that protecting water resources is necessary and important. Additionally, NSE enforcers and policy makers were able to identify with farmers and the barriers and challenges that they face in monitoring water use. However, their ability to achieve consistency and compliance with the surface water withdrawal regulation is hampered by a lack of resources and enforcement tools. According to the literature cited in section 2 successful regulations must be, among other things, enforceable and consistent (Farmer, 2007, p. 12-13).

### **5.3 Implications of Research to Provincial Water Strategy**

The scope of this case study did not address all water uses across all agricultural practices. Additionally, limitations outlined in section 3.3 apply to the results. However, the findings present valuable insight into current compliance and monitoring challenges associated with agricultural surface water use.

If left unaddressed, there is a potential that the barriers and challenges identified in this case study could become barriers to engaging actor groups in the new provincial water strategy. In order to achieve an effective environmental strategy it is important to identify barriers and to design a strategy that mitigates or eliminates these barriers (McKenzie-Mohr, 1999). The challenges and solutions identified by the actor groups in this case study contribute to the first part of this process. Achieving the resources and the means to address the compliance and monitoring challenges associated with agricultural surface water use could lead to greater stakeholder engagement and participation in the provincial water strategy.

## **5.4 Recommendations**

All three actor groups involved in this case study identified challenges in determining water usage within the agricultural community and potential solutions to address these challenges. In an effort to achieve full participation in the current surface water withdrawal process and the future provincial water strategy, consideration should be given to the following recommendations:

- 1. Identification of cost saving measures:** Identifying ways to reduce financial barriers could potentially lead to greater participation in water management, while at the same time achieving the goal of collecting water data. Currently, the province lacks information on its own water resources. Therefore, cost-saving measures could involve the province acquiring funding to develop information on its water resources or farmers receiving funding in order to carry out water monitoring initiatives.
- 2. Education:** Continued educational efforts on the part of NSE aimed at increasing awareness about the surface water withdrawal regulation could help clarify any confusion surrounding the process. Additionally, educational efforts focused on increasing awareness about the impacts of long-term water use, aimed at both the general public and the agricultural community, could help in making water monitoring a higher priority.
- 3. Identification of possible incentives:** Currently there is a lack of incentive for farmers to participate in water monitoring efforts. Primarily, this is a result of immediate increases in costs, both in dollars and time, without reception of immediate benefits. Incentives can provide motivation for individuals to become more engaged in an activity (McKenzie-Mohr, 1999).

- 4. Dedicated resource person(s):** One-third of Nova Scotia's farmland is situated in the Annapolis Valley; therefore this is an area of medium to high intensity farming. Dedicating a resource person(s) to deal primarily with the agricultural community could result in a number of benefits. First, it could improve communication between NSE and farmers as the resource person(s) would be committed to serving the agricultural community. Secondly, it could improve consistency in education and enforcement efforts. The resource person(s) would become familiar with the needs and efforts of the agricultural community, while the agricultural community would have a regular contact person within NSE.
- 5. Future research:** This study identified that NSE has difficulty enforcing the current surface water withdrawal process. Primarily, this is reflective of a lack of enforcement tools and water data tools, such as hydrometric stations. Further research aimed at how to achieve enforceable water regulations within the agricultural community could help NSE achieve full participation and compliance.

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## Appendix A: Interview Question Guides

### INTERVIEW QUESTION GUIDE: FARMERS

**Interviewer:** Paula Francis (Researcher)

**Interviewee #:** \_\_\_\_\_

**Date:** \_\_\_\_\_

#### QUESTIONS:

1. What do you feel are the biggest barriers and obstacles to determining water usage within the agricultural community?
2. What suggestions would you provide for removing these barriers and obstacles?
3. Do you think that water monitoring is a common practice within the agricultural community? Why or why not?
4. Are water policies effective within the agricultural community? Why or why not?
5. Have you observed changes in water availability? Do you irrigate more now than in previous years?

#### NOTES:



**INTERVIEW QUESTION GUIDE: NSE INSPECTORS**

**Interviewer:** Paula Francis (Researcher)

**Interviewee #:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**QUESTIONS:**

1. What do you feel are the biggest barriers and obstacles to determining water usage within the agricultural community?
2. What suggestions would you provide for removing these barriers and obstacles?
3. Do you feel that the current policy relating to surface water withdrawal is effective? Why or why not?
4. How important are water policies in Kings County? Do you feel that water policies are necessary?

**NOTES:**

**INTERVIEW QUESTION GUIDE: NSE POLICY MAKERS**

**Interviewer:** Paula Francis (Researcher)

**Interviewee #:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**QUESTIONS:**

1. What do you feel are the biggest barriers and obstacles to determining water usage within the agricultural community?
2. What suggestions would you provide for removing these barriers and obstacles?
3. Are there opportunities within the department to assist farmers with removing these barriers?
4. Do you feel that the current policy relating to surface water withdrawal is effective? Why or why not?
5. How important are water policies in Kings County? Do you feel that water policies are necessary?

**NOTES:**

## Appendix B: Recruitment and Informed Consent Form – Farmers



### **Case study: An examination of agricultural surface water use for crop irrigation in Kings County, Nova Scotia to provide insight into current compliance and monitoring challenges**

My name is Paula Francis and I am an Environmental Science Honours student at Dalhousie University in Halifax. For the past two summers I have been employed by Nova Scotia Environment (NSE) in Kentville at which time I worked on the Pereaux Pilot Project and various other tasks related to agricultural water use. It was during this time that I would have met with you and most likely visited some of your irrigation sites.

The purpose of this letter is to invite you to participate in a study that I am conducting to fulfill the requirements of an undergraduate honours thesis. The purpose of the study is to examine current compliance and monitoring practices in order to identify barriers to effective water resource management in Kings County. The study also aims to explore ways that these practices can be improved and its findings may be used in the development of a provincial water strategy which is under the direction of NSE. Specifically, the research focuses on *surface water* use for *crop irrigation*; therefore, I am inviting individuals to participate in this study who use surface water for crop irrigation and who I feel would provide knowledgeable insight into this issue.

If you volunteer to participate in this study, you would be asked to participate in an interview (lasting approximately one hour). The location of the interview will be chosen based on your convenience; however, you will not be compensated for the time spent in the interview. As a participant, you would be asked questions regarding the following issues:

- Surface water withdrawal policy in Nova Scotia
- Barriers and obstacles to determining water usage within the agricultural community
- Opinions, values, and knowledge related to water use and water policy

Participation in this study is optional, and if you do volunteer, you are free to withdraw at any time without any consequences. Additionally, you may also choose to exclude your data from the study, or refuse to answer specific questions during the interview without judgement or punishment. It is also possible to withdraw your consent to participate at any time without penalty.

Participants will be identified by their organization or community, but not by their individual name. Every effort will be made to ensure confidentiality of all contributions you make to this project. All written information will not be connected to any individual identifying information, and personal information will be retained only for the duration of the research process to provide opportunity for feedback.

This study has been reviewed and has received ethics clearance through the Environmental Programmes, Faculty of Science, Dalhousie University. If you have any questions regarding your rights as a research participant, please contact: Office of Research Ethics Administration, Henry Hicks Academic Administration Building, Dalhousie University, Halifax, Nova Scotia, B3H 4H6  
Tel: (902) 494-1462 Fax: (902) 494-1595 Email: [research@dal.ca](mailto:research@dal.ca)



## INFORMED CONSENT

I have read the information provided for the study *Case study: An examination of agricultural surface water use for crop irrigation in Kings County, Nova Scotia* as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Date: \_\_\_\_\_

\_\_\_\_\_  
Name of Participant

\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Name of Witness

\_\_\_\_\_  
Signature of Witness

If you have any concerns,  
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## Recruitment and Informed Consent Form – NSE



### **Case study: An examination of agricultural surface water use for crop irrigation in Kings County, Nova Scotia to provide insight into current compliance and monitoring challenges**

As you may be aware, I am currently completing an Environmental Science Honours degree at Dalhousie University in Halifax and the purpose of this letter is to invite you to participate in a study that I am conducting to fulfill the requirements of an undergraduate honours thesis. The purpose of the study is to examine current compliance and monitoring practices in order to identify barriers to effective water resource management in Kings County. The study also aims to explore ways that these practices can be improved and its findings may be used in the development of a provincial water strategy which is under the direction of your department. Specifically, my research focuses on *surface water* use for *crop irrigation*; therefore, I am inviting individuals who enforce and create surface water policies and who I feel would provide knowledgeable insight into this issue.

If you volunteer to participate in this study, you would be asked to participate in an interview (lasting approximately one hour). The location of the interview will be chosen based on your convenience; however, you will not be compensated for the time spent in the interview. As a participant, you would be asked questions regarding the following issues:

- Surface water withdrawal policy in Nova Scotia
- Barriers and obstacles to determining water usage within the agricultural community
- Opinions, values, and knowledge related to water use and water policy

Participation in this study is optional, and if you do volunteer, you are free to withdraw at any time without any consequences. Additionally, you may also choose to exclude your data from the study, or refuse to answer specific questions during the interview without judgement or punishment. It is also possible to withdraw your consent to participate at any time without penalty.

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## INFORMED CONSENT

I have read the information provided for the study *Case study: An examination of agricultural surface water use for crop irrigation in Kings County, Nova Scotia* as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Date: \_\_\_\_\_

\_\_\_\_\_  
Name of Participant

\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Name of Witness

\_\_\_\_\_  
Signature of Witness

If you have any concerns, please contact:

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