Wheatland County Water Resources

Perspectives of the Agricultural Producers

June 2015

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MIISTAKIS INSTITUTE

Prepared for: Wheatland County

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EXECUTIVE SUMMARY

Wheatland County, located in the grassland natural region of Alberta, has a diverse agricultural community. Dominate land uses include crops and cattle and calf operations with a smaller number of acres dedicated to irrigated crops, feedlot operations, urbanization and oil and gas development. The county places a high value on conserving its natural capital and has developed extension programming focused on promoting and supporting best management practices within the agricultural community for maintaining and restoring water resources. To guide program development, educational outreach and policies relating to water resources, Wheatland County wishes to better understand the perspective of agricultural producers regarding water resources.

To understand agricultural producers' knowledge, concerns and activities as they relate to water resources in Wheatland County producers were asked to respond to a survey. There were 103 completed surveys, representing a statistical confidence of 90% with a 7.6% margin of error, reducing the ability to confidently apply the results of this survey to the broad population of agricultural producers in Wheatland County.

TOP 10 KEY FINDINGS FROM SURVEY RESULTS:

1. Wheatland County agricultural producers, who participated in the survey, show a strong level of agreement (99% agreement) that it is important to protect water quality in the County, even if it slows economic development (87% agreement).

2. Wheatland County agricultural producers, who participated in the survey, are concerned about water resources in the County with at least 70% of producers reporting some level of concern about :
    - declines in overall water quality;
    - the health of riparian areas;
    - the level of phosphorus in waterways;
    - wetland loss and degradation due to development;
    - the blockage of irrigation and livestock watering intakes from phosphorus caused algae blooms; and,
    - the health of Eagle Lake and the Bow River.

3. Wheatland County agricultural producers, who participated in the survey, show an good general understanding of what activities impact water resources within the County:

- over 80% of respondents rate industrial activity, urban waste water, poorly designed septic systems, confined feeding operations and urban storm water as affecting water quality; and,
- over 75% of respondents rating development, fertilizer application, livestock access to riparian and wetland systems as affecting water quality.

4. When applicable, the majority (80%) of Wheatland County agricultural producers, who participated in the survey, are implementing some type of beneficial management practices (BMPs) to maintain water resources within the County, including:
    - crop rotation;
    - adhering to spray avoidance times and buffers;
    - maintaining septic systems;
    - developing manure management plans;
    - winter site management;
    - soil testing to determine nutrient load; and
    - sealing un-used ground water wells.

5. Half of Wheatland County agricultural producers, who participated in the survey, reported restoring a wetland or riparian area on their farm, and a number of benefits were noted such as improved biodiversity, improved plant growth and reduced erosion.

6. Half of Wheatland County agricultural producers, who participated in the survey and have beavers on their land reported they co-exist with beavers.

7. Over half of Wheatland County agricultural producers, who participated in the survey, reported the following barriers to implementing BMPs: time constraints, lack of resources, and costs.

8. There are divergent views within Wheatland County agricultural producers, who participated in the survey, with the majority (74.5 %) not confident that there is evidence of climate change and around the general knowledge of perceived impacts:
    - 58% are concerned climate change will impact water quality; and
    - 27% are concerned climate change will lead to an increase in flooding and drought events.

9. Water quantity was not extensively addressed in this survey, but was noted as second biggest concern by Wheatland County agricultural produces who participated in the

survey. This is a key data gap in the survey results that is important to consider particularly in light of climate change predictions with respect to water resource use and management in Wheatland County.

10. While some survey participants were aware of programing to help agricultural producers maintain and/or improve water resources, the majority of programs seem under-utilized. As a next step, it would be helpful to develop an understanding of why these programs are under-utilized for re-structuring or new development of outreach messages around water resource programming for agriculture. Also an understanding of what incentives or resources would enable more producers to restore or improve damaged wetlands and riparian areas would be helpful.

Of the producers who answered the survey, the majority are aware of water resource issues within the County. The majority are also actively working to maintain and improve water resources within the County. However, there are still areas where knowledge and implementation of BMPs could be improved. Areas for improvement include: 1) increasing the understanding about the impacts of climate change, 2) stressing the importance of climate change adaptation practices, 3) increasing the understanding of the role beavers can play in maintaining water quality and facilitating water storage, and 4) promoting practices that enable co-existence with beaver. Water resources in the County would benefit from a greater number of producers acting to improve and /or restore wetlands and riparian areas.

INTRODUCTION

Water is of critical importance to support for agricultural communities and for food security. The agricultural community has a complex and important relationship with water, playing the role of stewards as well as being one of the biggest consumers of water. We all share the reality that water availability and quality are changing as the demand for food production, industry, development and water consumption grow and we face uncertainty of a changing climate. Innovation and the adoption of best management practices to conserve and protect water resources are now necessary.

Wheatland County, located in the grassland natural region of Alberta, has a diverse agricultural community. Dominate land uses include crops and cattle and calf operations with a smaller number of acres dedicated to irrigated crops, feedlot operations, urbanization and oil and gas development. The county places a high value on conserving its natural capital and has developed extension programming focused on promoting and supporting best management practices within

the agricultural community for maintaining and restoring water resources. To guide program development, educational outreach and policies relating to water resources, Wheatland County wishes to better understand the perspective of agricultural producers in the county regarding water resources.

In order to understand the current knowledge, attitude, behaviour and needs of producers and acreage owners toward sustainable water management in Wheatland County, requested the Miistakis Institute conduct a county-wide survey of agricultural producers. Wheatland County identified the following objectives to guide the survey of agricultural producers' perceptions and attitudes toward water conservation:

1. Understand the demographics of Wheatland County survey respondents.
2. Determine the *knowledge level (public perception)* of Wheatland County agricultural producers with regard to:
    - Water issues (including phosphorus, riparian and wetland health and water quality).
    - Best water management practices
3. Determine the *attitudes (level of concern)* of Wheatland County agricultural producers with regard to:
    - Water issues (including phosphorus, riparian and wetland health and water quality).
    - Best water management practices
4. Determine the current water management behaviors being carried out by Wheatland County agricultural producers
5. Determine existing barriers and incentives for implementing best water management practices for agricultural producers of Wheatland County

BACKGROUND

Wheatland County is in south-central Alberta to the east of Calgary (Figure 1). The county is 4,663 km^2 in size and supports a total population of 8,164 residents. There are a number of communities, hamlets and villages that are administered by Wheatland County as well as four that are within the Wheatland Country boundary but are not administered by the county. These include the town of Strathmore (11,335) and villages of Hussar (187), Rockyford (349) and Standard (380).

Wheatland County occurs in the mixed grass prairie natural region, a transition zone between Aspen Parkland and Dry Mixed Grassland. Although the majority of Wheatland County is prairie, badlands occur in the northeastern corner of the county.

The county is in the South Saskatchewan River basin, with the Red Deer River forming the northeastern boundary and the Bow River forming the southern boundary. The area is drained by numerous streams, including Crowfoot Creek and Parflesh Creek of the Crowfoot Watershed draining into the Bow River and Serviceberry Creek and the Rosebud River of the Rosebud Watershed draining into the Red Deer River.

The County supports a diverse agricultural community, with 782 farms, 60% of which report growing crops, such as wheat, barley and canola and smaller acres of lentils, peas, mustard, flax and triticale. In addition, 55% of the farms support cattle and calf operations, including maintenance of native pasture or growth of perennial tame forage. In addition there are 1,100 km of irrigation canals within the County that support crops and livestock.

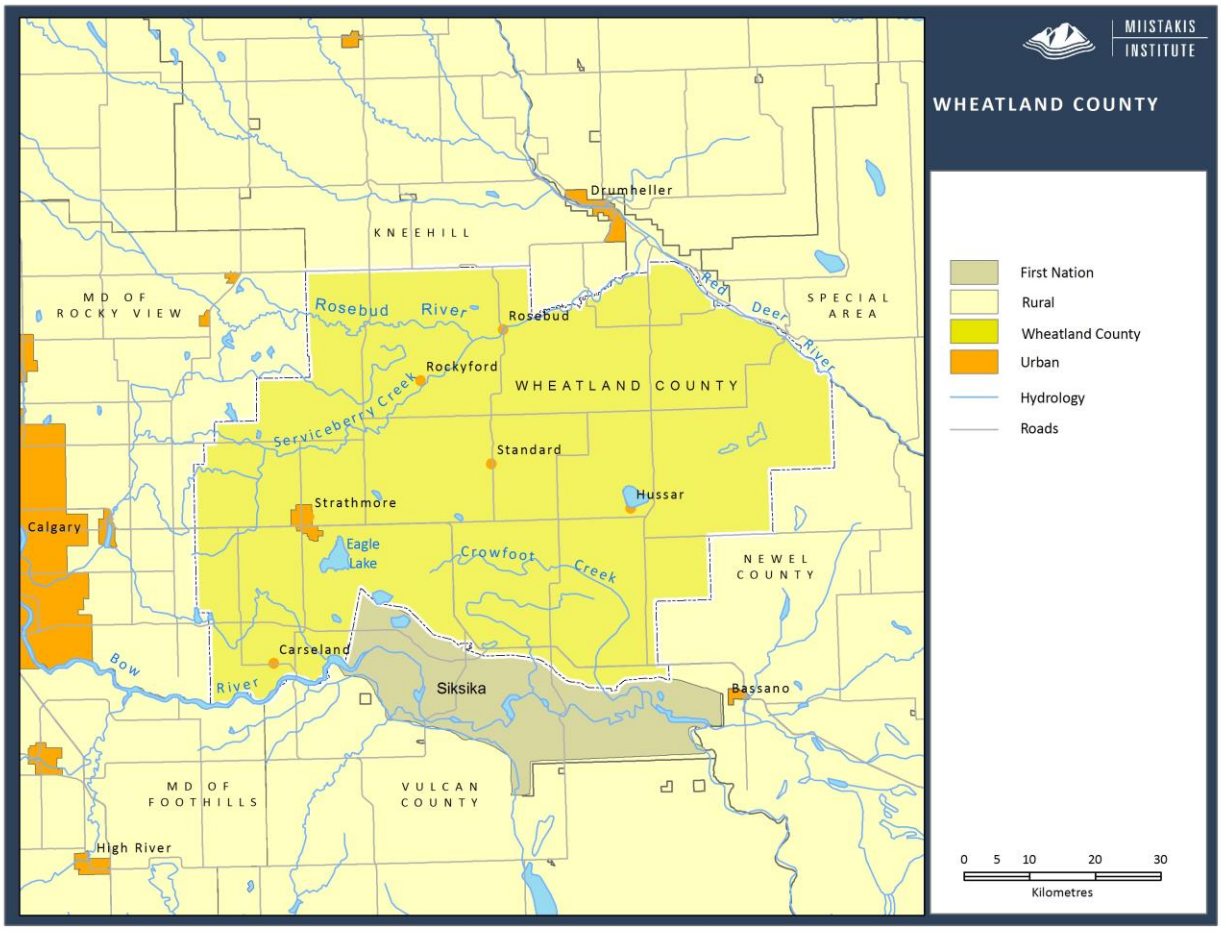

Figure 1: Wheatland County

METHODS

A survey was used to acquire information about agricultural producers' knowledge and concerns toward water resources, water management activities and barriers/incentives to adopting beneficial management practices (BMP) in Wheatland County. The survey consisted of fixed scale (closed ended) questions and, when necessary, open ended questions. Landowners living in hamlets and towns were not the focus of this survey and were removed from the survey by the first question which asked participants to identify themselves as agricultural producers or not. Only agriculture producers were requested to continue to survey. Acreage owners who identified as acreage owners are included in the survey. While the size of farming operations was not considered, larger operations were targeted through a mail out process.

The total number of reported farms (782) based on Statistics Canada 2011 census data, was used to determine 258 survey responses were needed to ensure results represent the agricultural producers of Wheatland County at a 95% confidence interval and 5% margin of error.

The survey was developed in on-line and hard copy formats. Prior to making the survey available a draft was reviewed by representatives from Wheatland County and other water resource practitioners as requested by Wheatland County. Edits were made for accuracy and clarity of questions. The survey was promoted by Wheatland County through posting the survey link on their website, advertisements in county-based newsletters and through word of mouth. In addition, hard copy surveys were mailed to 420 agricultural producers selected randomly using the Wheatland County tax roll database from landowners farming over 160 acres.

RESULTS

As described in the methods section, 258 surveys were needed to meet a statistical confidence where results would be representative of producers in Wheatland County. Unfortunately, there were only 103 completed surveys, representing a statistical confidence of 90% with a 7.6% margin of error, reducing the ability to apply the results of this survey to the broader population of agricultural producers in Wheatland County. Agricultural producers responding to the survey predominately identified themselves as producing dryland crops and/or producing hay and/or running cow calf operations (Figure 2).

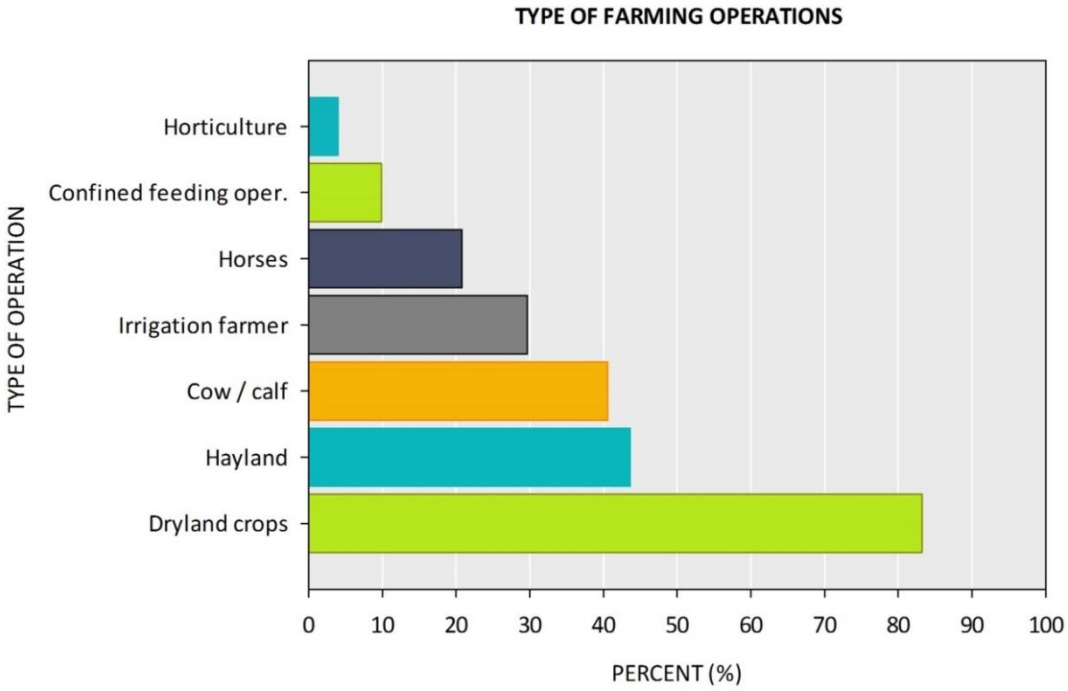

Figure 2: Percent of producers representing different types of farming operations

The majority of survey respondents were between the age of 50 to 70 years of age (Figure 3).

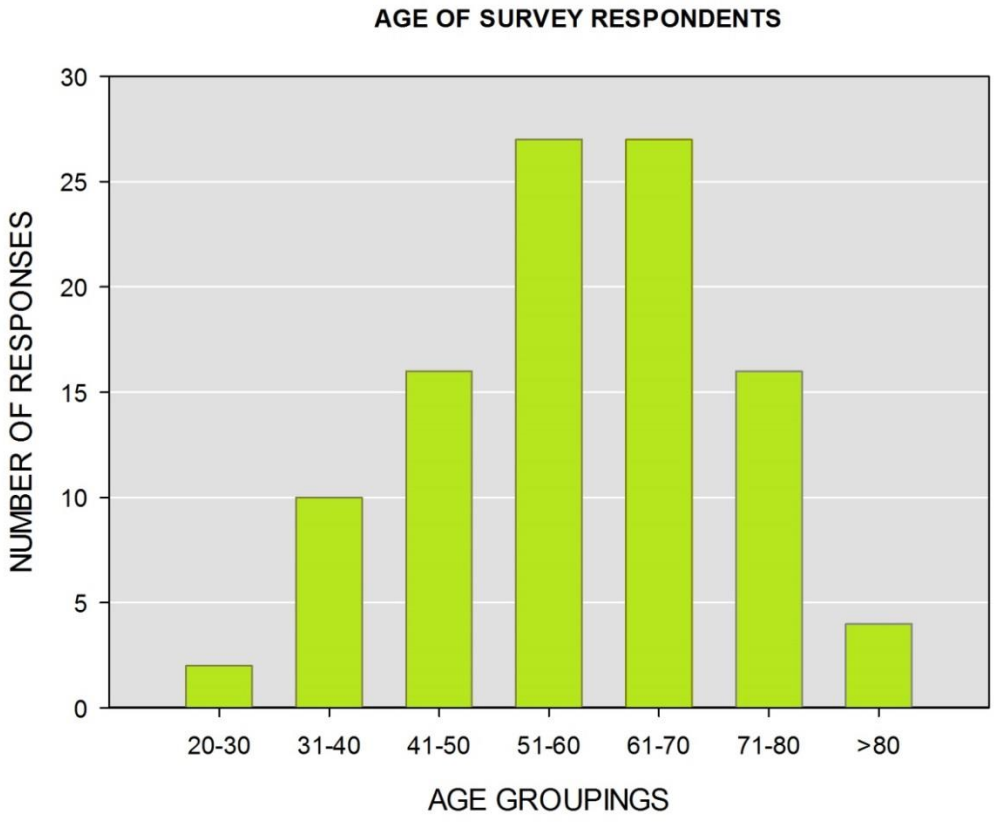

Figure 3: Number of responses per age groupings in Wheatland County

Agricultural producers knowledge of water resources

Agricultural producers were asked about their perceptions of water resources in Wheatland County, with a specific focus on wetland and riparian systems, phosphorus and water quality. Survey participants were asked to rate their level of agreement (using a scale from strongly agree to disagree) with a series of statements about the role of wetlands and the impact of wetlands to farming operations. Figure 4 highlights a high level of agreement with over 80% of participants strongly agreeing or agreeing to statements that indicate wetlands improve water quality, play a role in water storage, provide protection from floods and provide critical habitat for plants and animals.

There was less agreement on the impact of wetlands to farm productivity, where 28% felt maintaining wetlands reduces farm productivity, 28% were neutral on this statement and 44% felt maintaining wetlands did not reduce farm productivity.

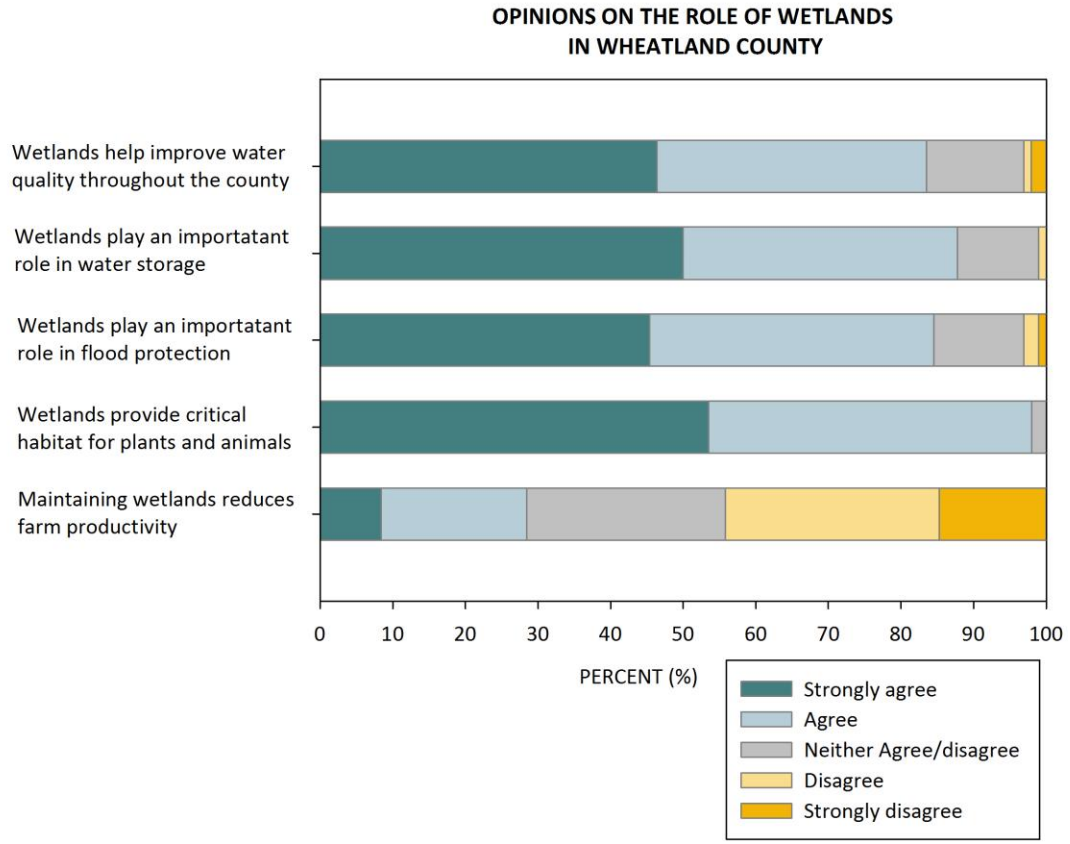

Figure 4: Perceptions on the role of wetlands in Wheatland County

Survey participants were asked if the following statement was true or false, "Under the Alberta Water Act it is illegal to drain a wetland." The majority of respondents (82%) think this statement is true, while 18% thought it was false.

Survey participants were asked to rate their level of agreement (using a scale from strongly agree to disagree) around a series of statements about the role of riparian areas and the impact of wetlands to farming operations. Figure 5 highlights a high level of agreement with over 75% of participants strongly agreeing or agreeing with statements that indicate riparian areas provide improved water quality, are important for flood control, and provide valuable wildlife habitat.

There was less agreement on the impact of riparian areas on farm productivity as:

- 20% felt riparian areas reduce farm productivity, 30% were neutral on this statement and 50% felt riparian areas did not reduce farm productivity;
- 37% felt farming or grazing on riparian areas increase the value of their farm, 33% were neutral on this statement and 29% don't think farming and grazing areas increase the value of their farm.

In addition, survey participants were divided on the statement that "riparian areas upstream affect flooding on my land", 47% agreed, 29% were neutral on this statement, and 24% disagree.

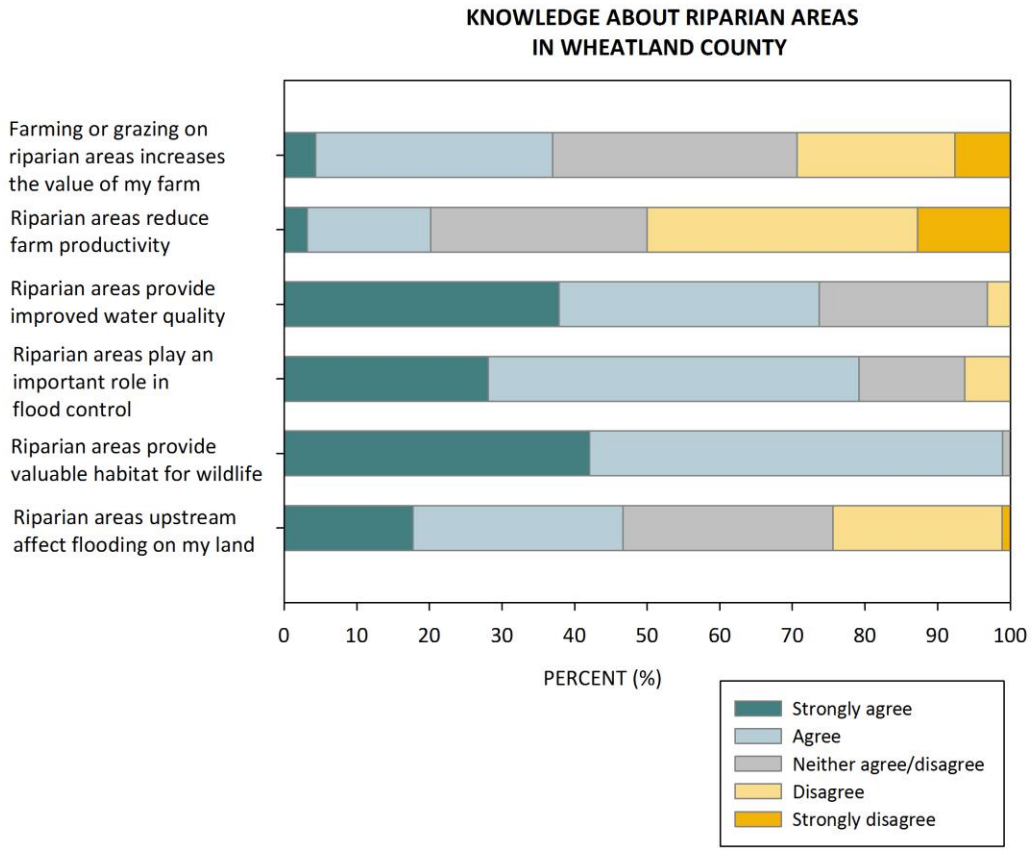

Figure 5: Perceptions on the role of riparian areas in Wheatland County

Survey participants were asked to select what the top three contributing sources of phosphorus loads in water are in Wheatland County. The top three sources of phosphorus loads identified by survey participants were commercial fertilizers, urban run-off and domestic animal manure (Figure 6).

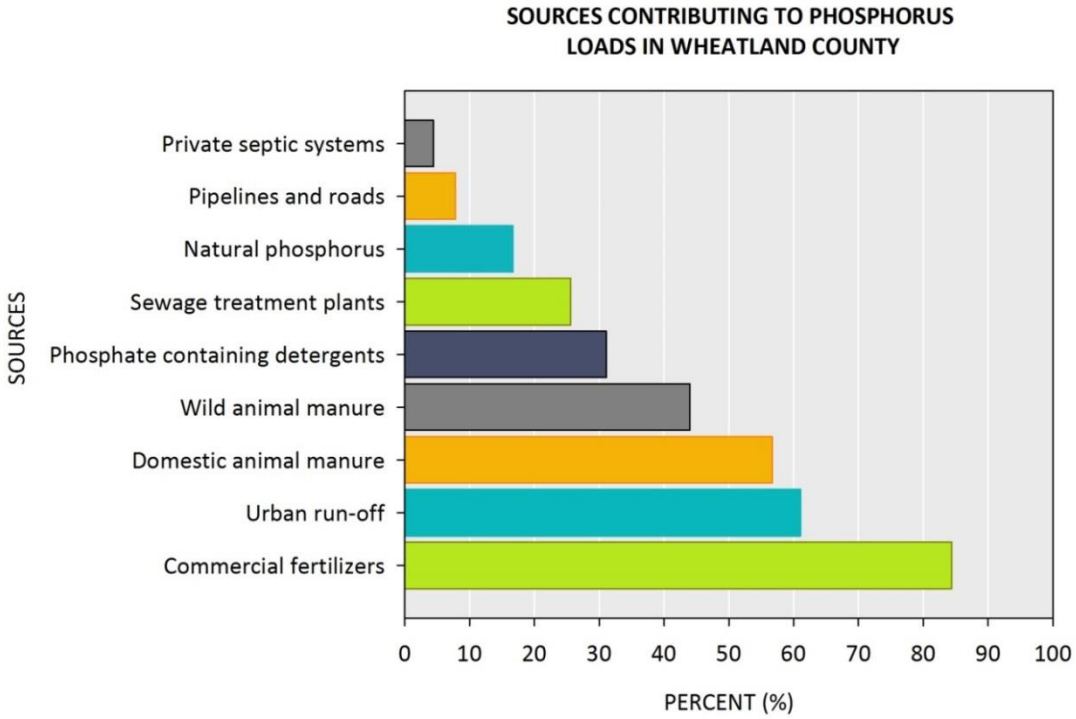

Figure 6: Perception of the main sources responsible for phosphorus loads in Wheatland Count

To further understand perceptions around management practices and their impacts on phosphorus loads participants were asked if specific activities impacted phosphorus levels in Wheatland County. At least 50% of survey participants felt that each of these activities: applying animal manure, irrigation and return flows, minimizing soil erosion, restoring wetlands, and draining wetlands impact phosphorus loads in waterways (Figure 7).

Survey participants were asked to identify if specific practices impact water quality (Figures 8 and 9). Results show over 60% of survey participants felt the activities listed impacted water quality, although there are large group indicating a neutral response. More than 30% of respondents felt neutral about the impacts of pesticide disposal, winter site management, waste disposal and irrigation practices.

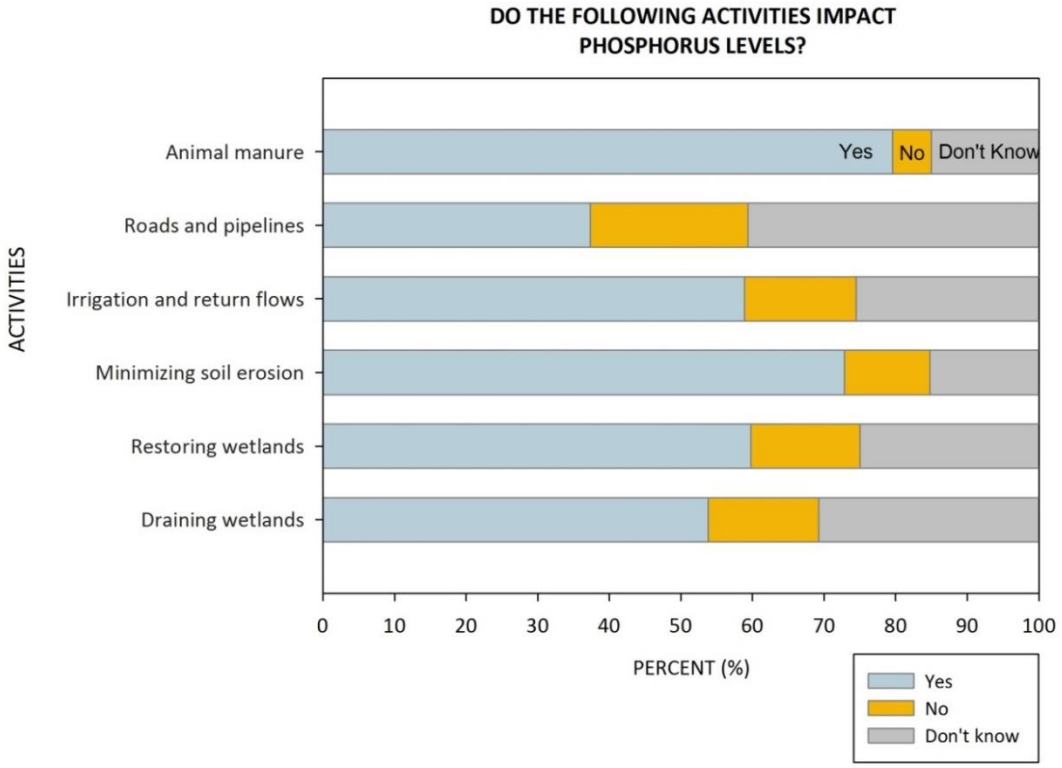

Figure7: Activities impacting phosphorus loads

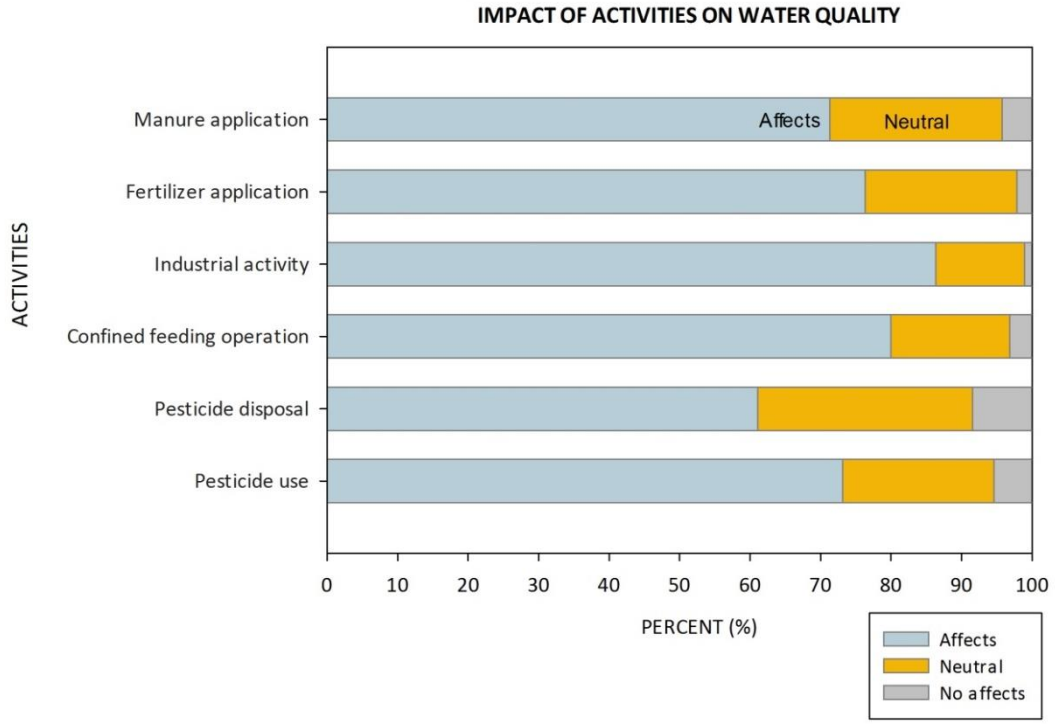

Figure 8: Impacts of specific activities on water quality part 1.

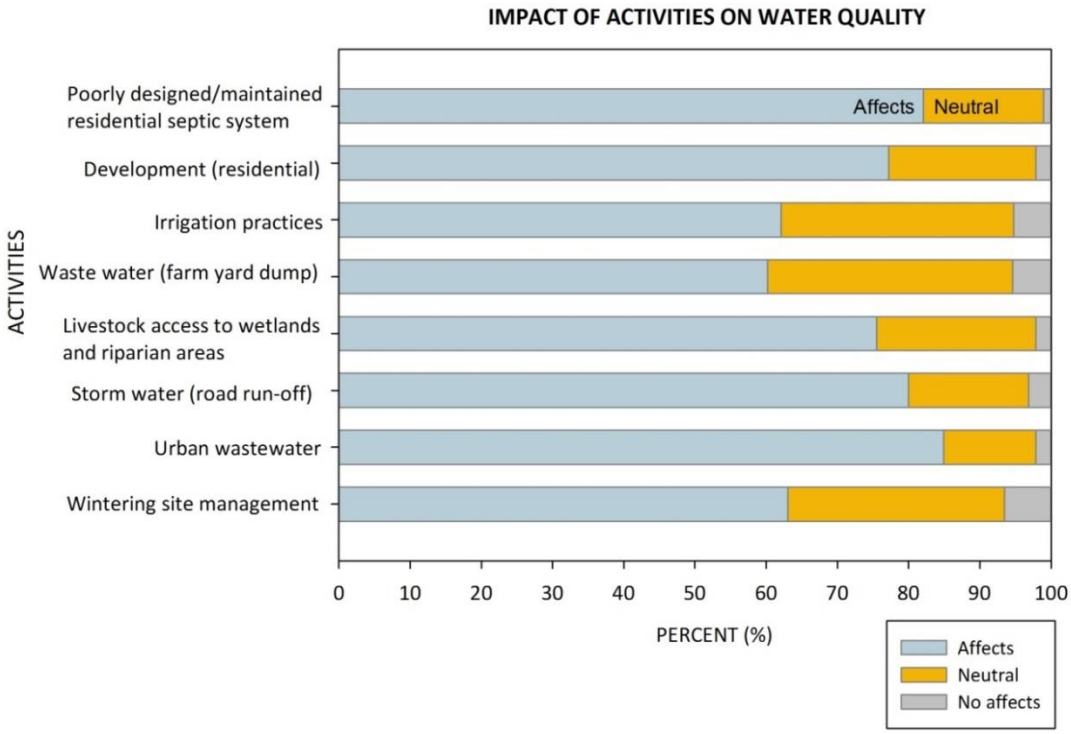

Figure 9: Impacts of activities on water quality part 2.

To better understand agricultural producers perception of impacts on water quality, survey respondents were asked to rate their level of agreement on specific statements about water quality (Figures 10 and 11). There was a high level of agreement, based on the number of particpants who selected strongly agree and agree to the importance of protecting water quality, even in the face of reducing economic development. In additon, over 70% of particants agree that cattle gain more weight when provided with higher quality water through off-site troughs (Figure 10).

There was less agreement around the impacts of crops and hay operations on water quality.

- 52% of participants strongly agree and agree that run-off from crops negatively impact water quality, while 28% were neutral to the statement and 20% strongly disagree or disagree with the statement.
- 24% of particpants strongly agree and agree that run-off from hay operations negatively impact water quality, while 35% were neutral to the statement and 41% strongly disagree or disagree with the statement.

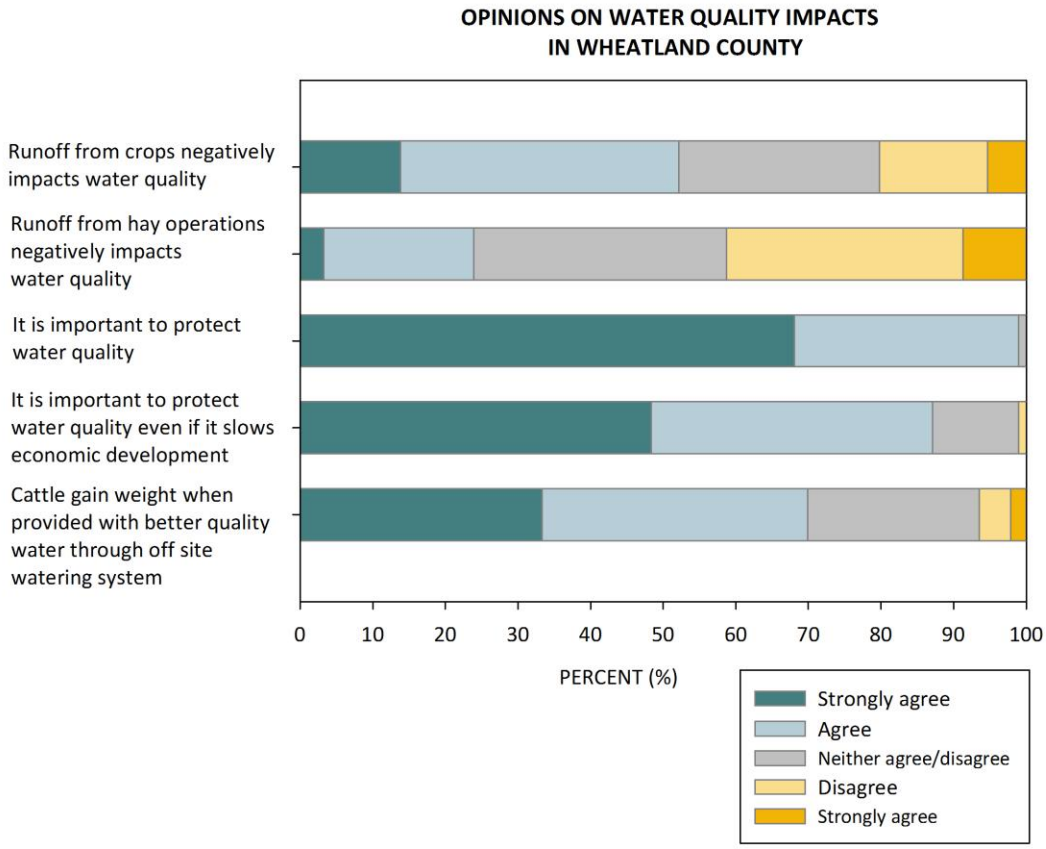

Figure 10: water quality impact statements and level of agreement in Wheatland County

In addition, there were divergent opinions on the impacts of climate change.

- 53% of participants strongly agree or agree that climate change will have an impact on water quality; 20% were neutral and 22% strongly disagree or disagree with this statement.
- 50% of participants were neutral that flood and drought will occur more frequently in the future, 27% strongly agree or agree and 24% strongly disagree or disagree with this statement.
- 8% of participants strongly agree or agree that there is NOT sufficient evidence to know whether climate change is occuring or not, 27% were neutral and 25% strongly disagree or disagree with this statement.

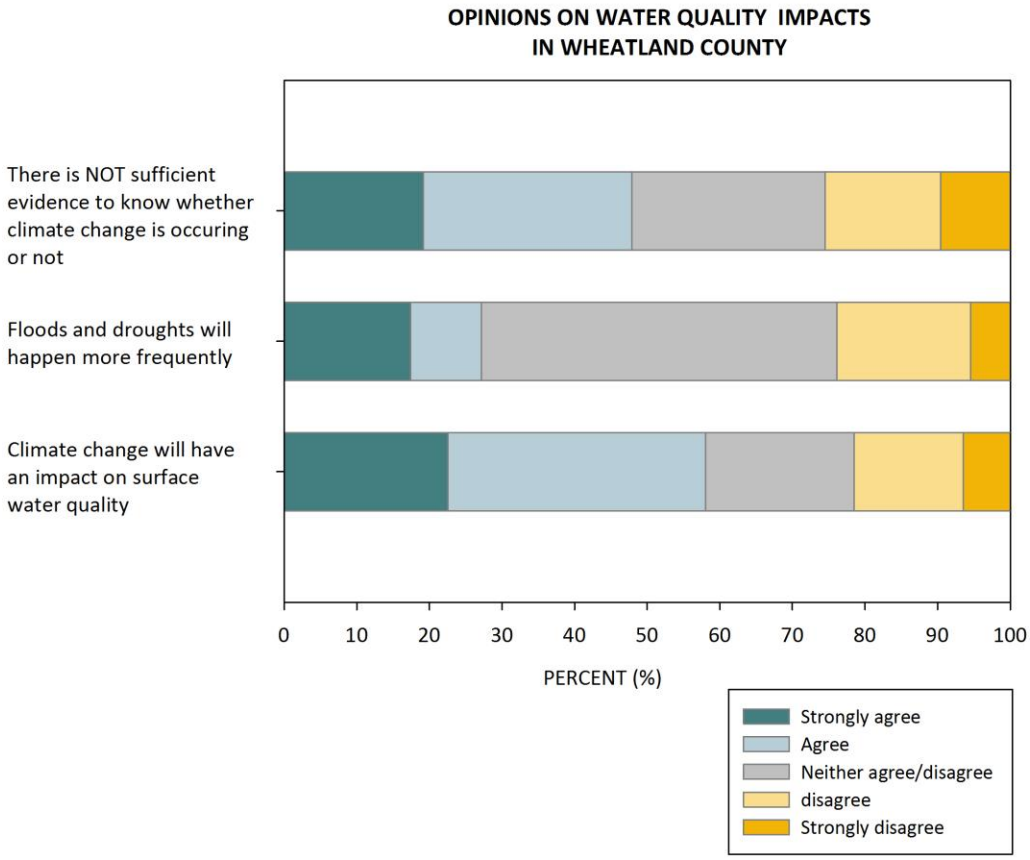

Figure 11: Opinion on climate change impacts in Wheatland County.

Agricultural producers concerns about water resources

Agricultural producers were asked about their level of concern regarding water resources in Wheatland County, including specific concerns around the role of wetland and riparian systems, phosphorus and water quality.

Agricultural producers were asked to identify their top three water concerns in Wheatland County through an open ended survey question. The responses were assessed using qualitative software and common themes were identified and the frequency of responses was tallied. The dominant concern expressed by participants was about water quality, followed by water quantity, and acreage and urban development impacts on water (Figure 12). Water quality concerns were further broken down by a number of participants into 1) improper farm management practices (including feedlot run-off, application of manure on farms, pesticides and fertilizer application, and poor livestock management), 2) industrial impacts, 3) urban run-off, 4) erosion, 5) drinking water quality and 6) too many and poorly maintained septic fields (Figure 13).

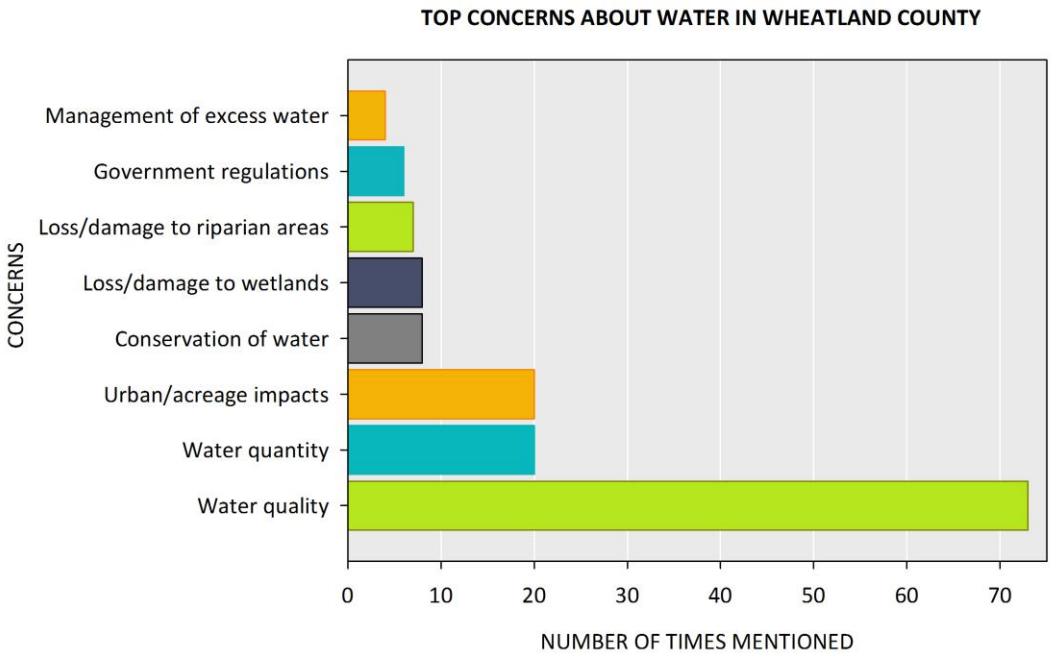

Figure 12: Top concerns about water identified by Wheatland County agricultural producers

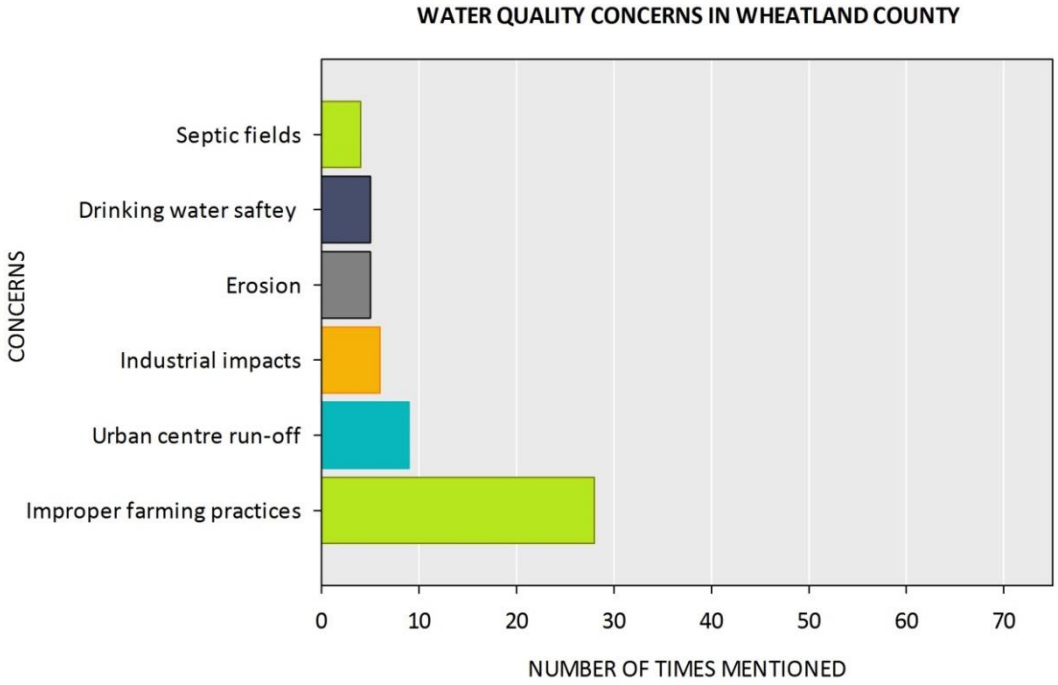

Figure 13: Break down of water quality concerns identified by Wheatland County agricultural producers

Over 60% of the participants indicated some level of concern for the number of wetlands lost to development, number of wetlands lost to agriculture, health of riparian areas, and downstream erosion (Figure 14). Just fewer than 50% were concerned about fish populations. The following illustrates the percentage of participants reporting some level of concern, were neutral, or not concerned.

- 71% of participants reported some level of concern about the number of wetlands lost or impaired by development, 22% were neutral and 7% were not concerned.
- 59% of participants reported some level of concern about the number of wetlands lost or drained for agricultural purposes, 27% were neutral and 14% were not concerned.
- 77% of participants reported some level of concern about the health of riparian areas, 20% were neutral and 3% were not concerned.
- 48% of participants reported some level of concern for fish populations, 41% neutral and 10% were not concerned.
- 61% of participants reported some level of concern for downstream erosion, 34% were neutral and 4% were not concerned.

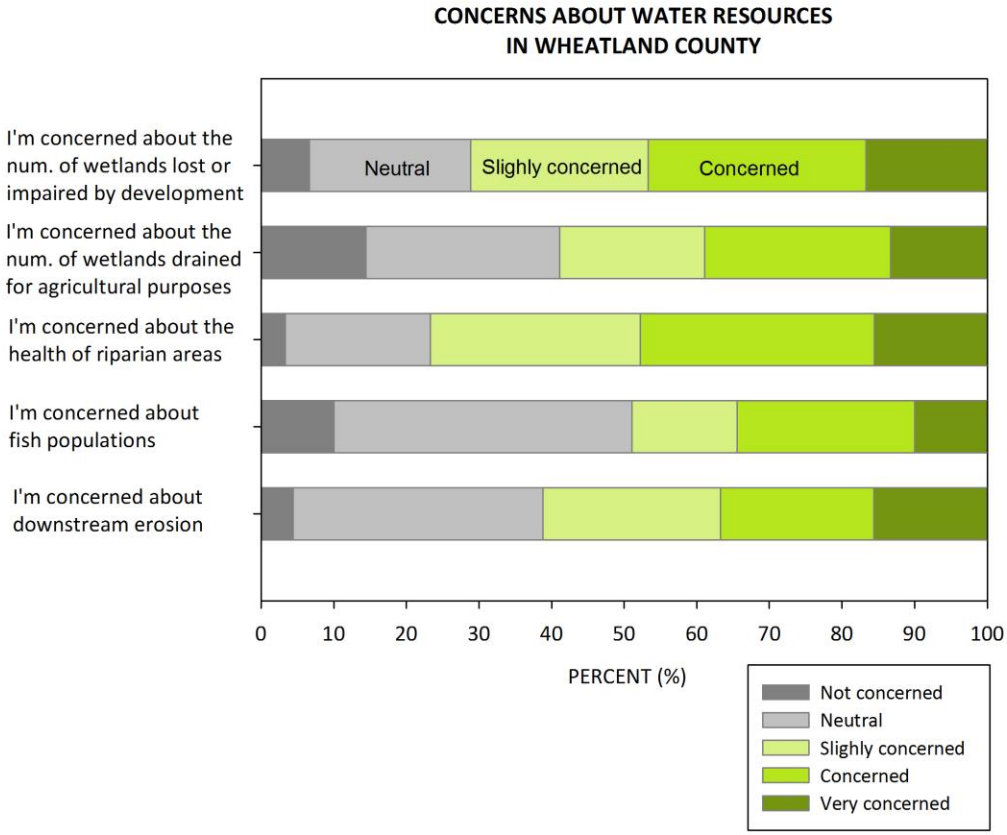

Figure 14: Level of concern about water resources in Wheatland County.

Participants were also asked about their level of concern in relation to phosphorus loads in Wheatland County water resources and the majority of report some level of concern:

- 75% of participants reported some level of concern about the level of phosphorus in waterways, 24% were neutral and 1% was not concerned.
- 70% of participants reported some level of concern about the effort associated with mitigating impacts of an increased phosphorus load in waterways in Wheatland County, 29% were neutral and 0% was not concerned.

In addition, participants were asked about their level of concern regarding the impacts of high phosphorus loads in water in Wheatland County (Figure 15). The majority of participants expressed some level of concern for the following impacts as a result of high phosphorus levels:

- 71% of participants reported some level of concern about the blockage of irrigation and livestock watering intakes, 23% were neutral and 5% were not concerned.
- 64% of participants reported some level of concern about decreased flow capacity in irrigation pipes and canals, 27% were neutral and 9% were not concerned.
- 82% of participants reported some level of concern about declines in overall water quality, 15% were neutral and 3% were not concerned.
- 64% of participants reported some level of concern about altered habitat for aquatic organisms, 30% were neutral and 5% were not concerned.
- 47% of participants reported some level of concern about reduced recreational opportunities and aesthetics, 37% were neutral and 17% were not concerned.

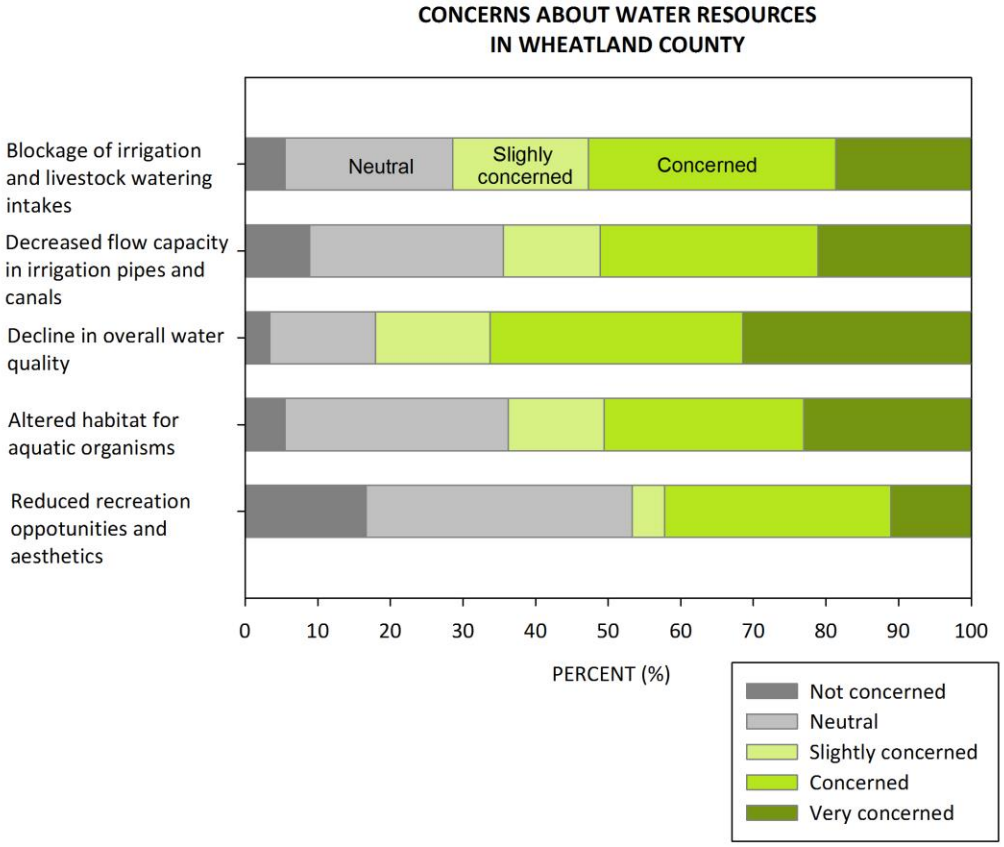

Figure 15: Opinion on the level of concern of impacts from high phosphorus loads.

Participants were asked more specifically about their level of concern about the water quality of specific water bodies in Wheatland County. There was concern expressed for all major water bodies in Wheatland County with over 50% of participants concerned about the water quality in

Eagle Lake, Serviceberry Creek, Rosebud River, Crowfoot Creek, Bow River and Red Deer River (Figure 16). Few people were not concerned, but a number reported they didn't know.

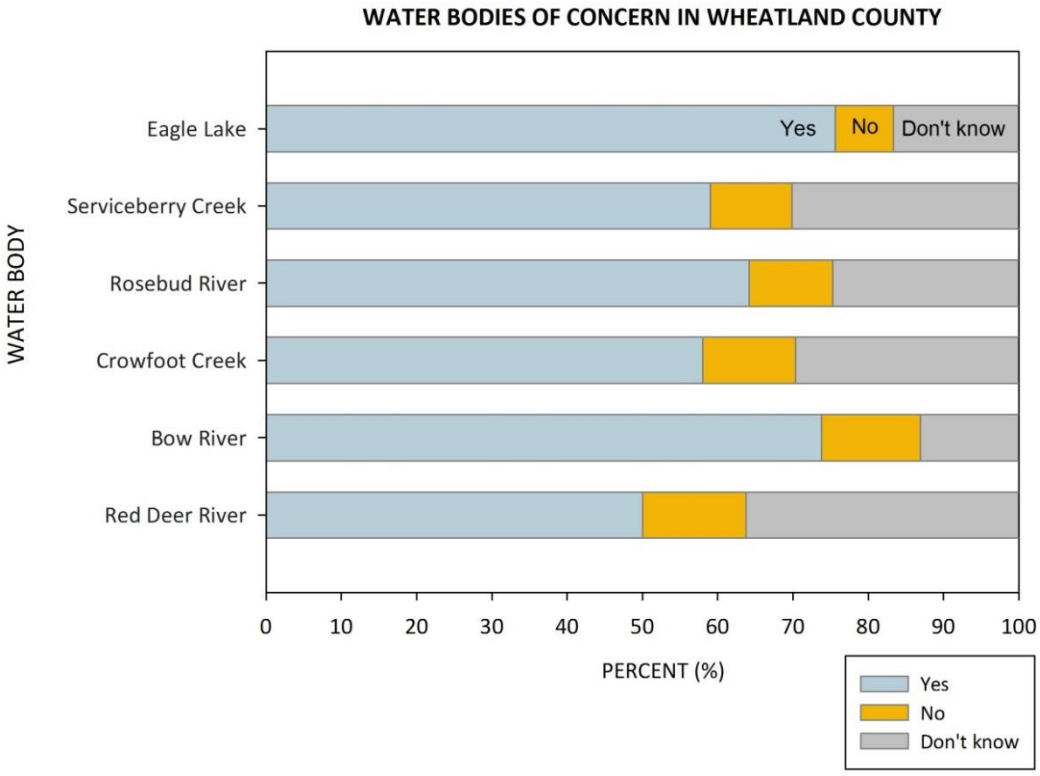

Figure 16: Water bodies of concern in Wheatland County

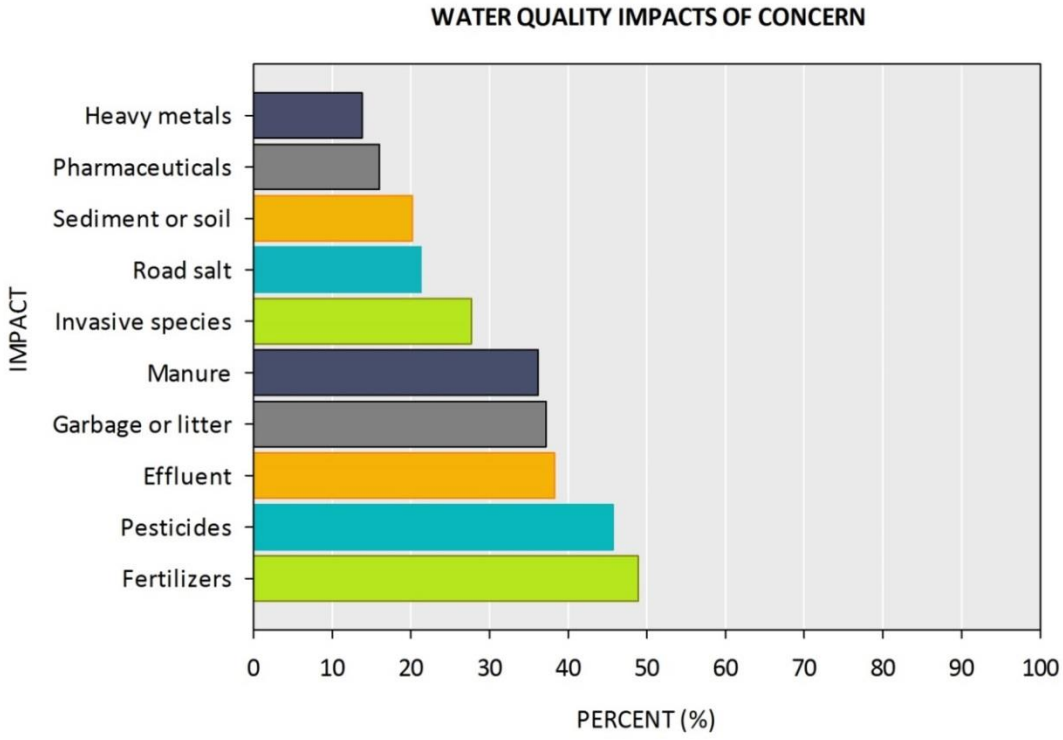

Figure 17: Water Quality impacts of concern in Wheatland County

Participants were asked to select their top three concerns for water quality in Wheatland County based on a specified list. Figure 17 shows fertilizers, pesticides and effluent are the top three water quality impacts of concern.

Assessment of water management practices

Riparian and wetland management activities

Seventy seven percent (77%) of participants report having a wetland or riparian area on their farm. Of these individuals:

- 10% report draining a wetland predominately to increase acres of crop and
- 51% report restoring a wetland or riparian area; of which 32% received some form of funding support, while 67% did not receive funding.

The participants who reported restoring a wetland and/or riparian areas were asked if they perceived any benefits as a result of the restoration. Figure 18 highlights the most commonly recorded themes from an analysis of 32 independent responses. The top three benefits perceived by the participants were increased biodiversity, plant growth and reduced erosion. A number of themes were only mentioned once, such as improved recreation, improved forage for cattle, increased hay production, increased profit due to reduced time spent trying to grow in wet areas, decreases in water temperature.

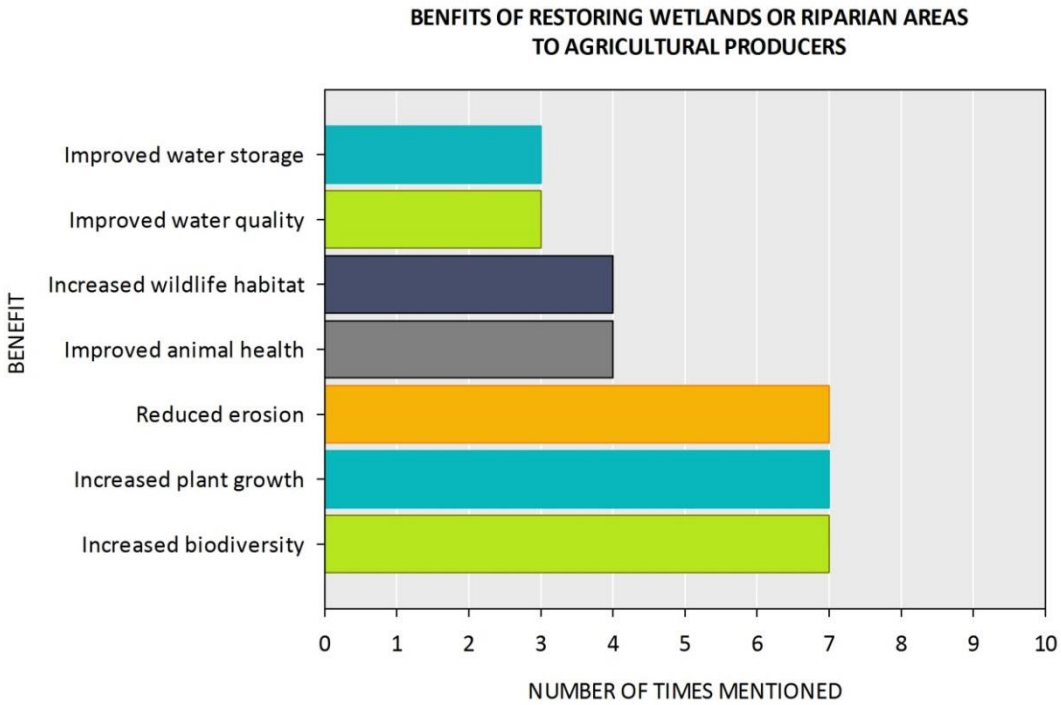

Figure 18: Participants perceived benefit of restoring a wetland or riparian area in Wheatland County

GENERAL WATER MANAGEMENT ACTIVITIES

Participants were asked to identify what specific water management activities they do or identify if the activity is not applicable to their operation (Figures 19, 20 and 21). Non applicable responses were removed to determine percentages. The water management activities that are applicable and are employed by a high majority survey respondents included:

- 98% of participants reported they rotate crops (to increase soil organic matter);
- 94% of participants reported they follow spray avoidance times (before or after rain, bare ground, wind over 30km/hour, >10 m from water bodies)
- 93% of participants reported regularly maintaining their septic system;
- 89% of participants reported developing a manure management plan;
- 87% of participants reported winter site management activities (portable shelter, feeding system, fencing);
- 86% of participants reported soil testing before applying fertilizer to determine nutrient load; and,
- 79% of participants reported sealing un-used ground water wells.

There was only management activity identified as applicable that less than 50% of respondents reported doing; 49% of participants who have beavers report efforts to co-exist.

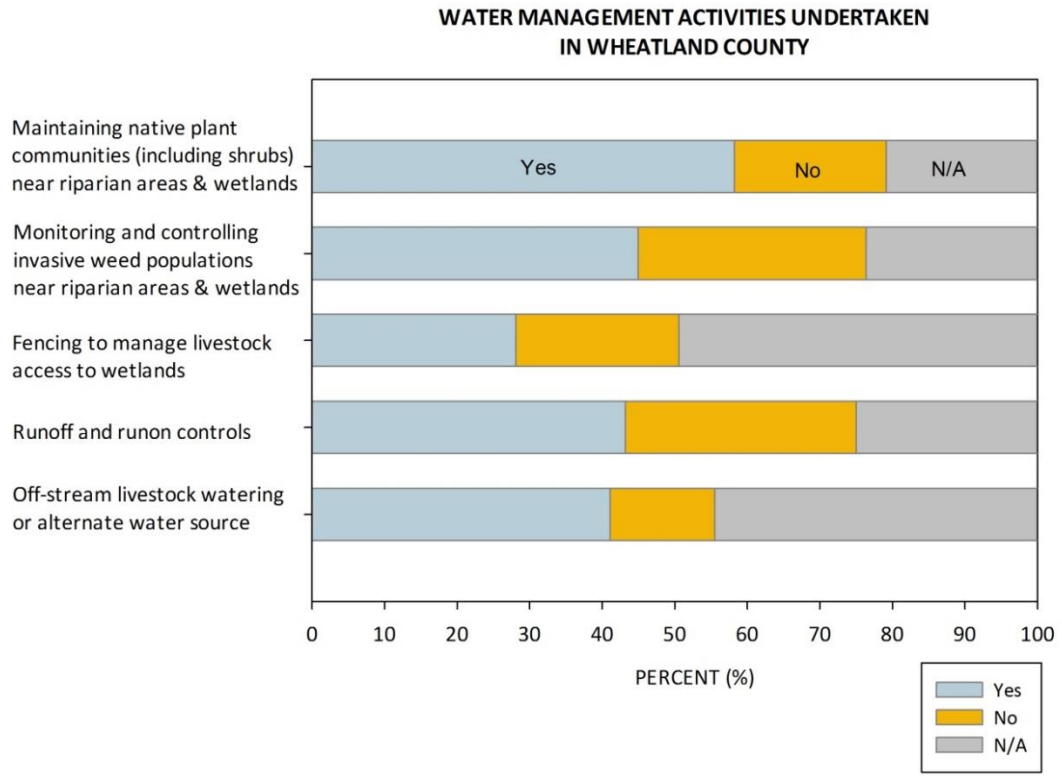

Figure 19: Water management activities in Wheatland County part 1

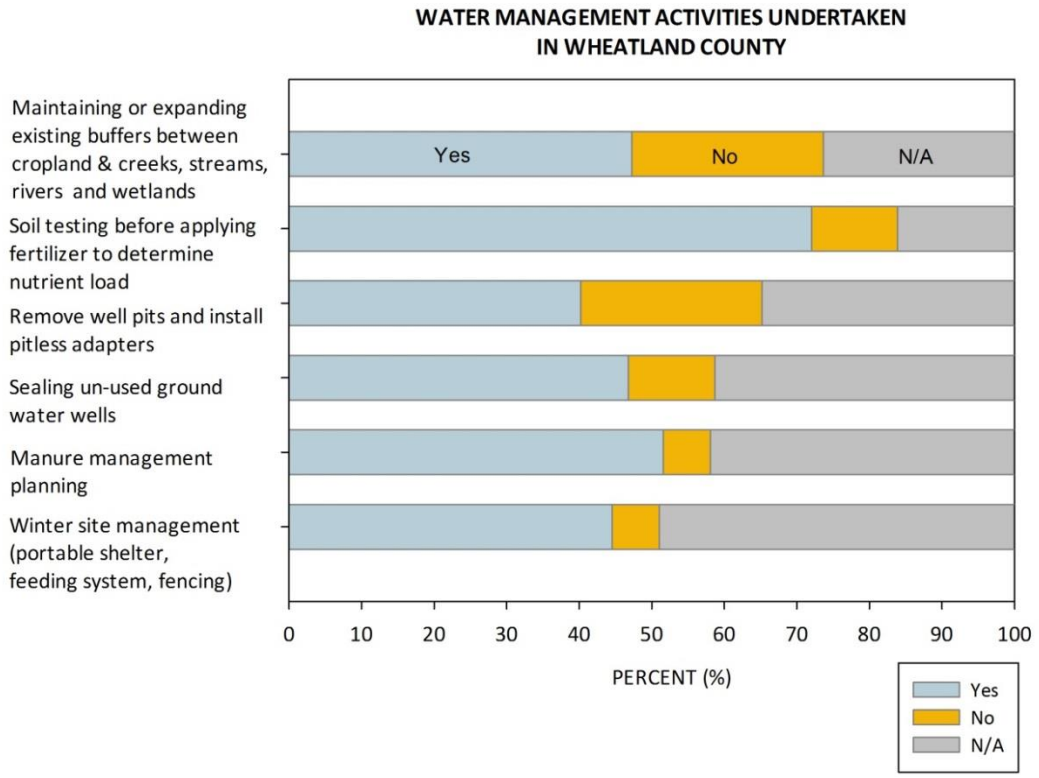

Figure 20: Water management activities in Wheatland County part 2

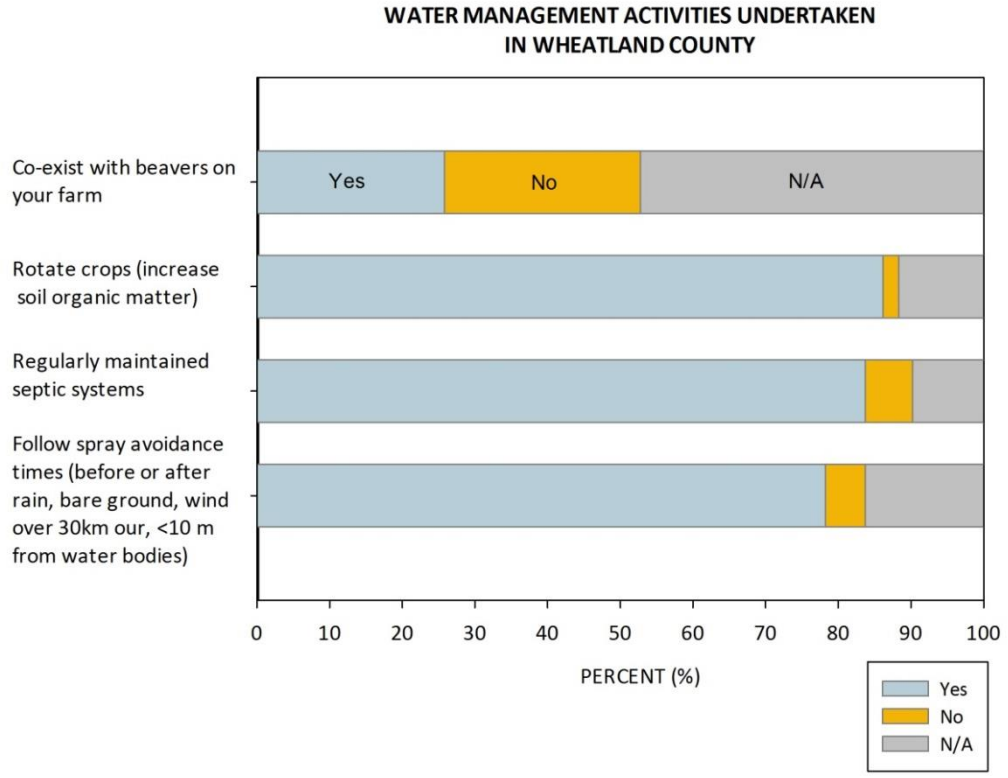

Figure 21: Water management activities in Wheatland County part 3.

Participants were asked to identify barriers to implementing water management activities. Costs associated with the management activities, lack of resources, and time required to under-take the activities were the top three barriers to implementation identified (Figure 22).

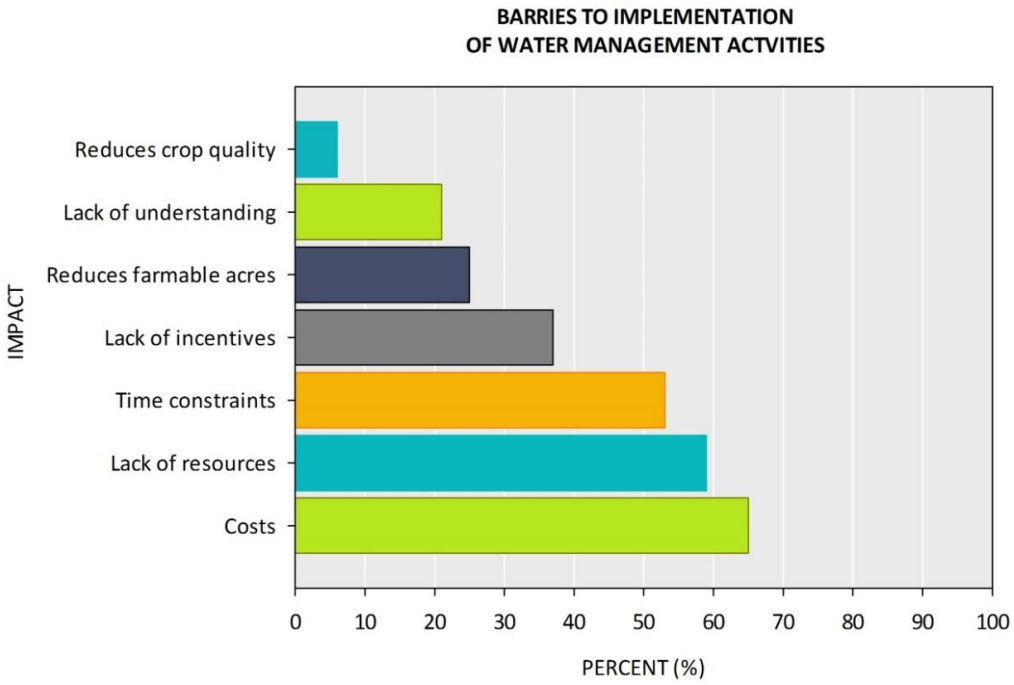

Figure 22: Barriers to implementation of water management activities

LEARNING ABOUT WATER MANAGEMENT AND PROGRAMMING

Survey participants were asked which funding programs they had participated in to improve water management on their farms. Figure 23 shows the results and indicates less than 50% of participants who deemed a program applicable have participated in such a program. The top three programs for participation include two federal programs and a program run by a non-profit organization.

- 40% of survey respondents had participated in the *Growing Forward: On-Farm Stewardship* program, which cost shares projects that will have a direct impact on water quality, including grazing management, manure and livestock facilities management, improved pest management, fuel and used oil storage, and innovative stewardship solutions.
- 30% of survey respondents had participated in the *Growing Forward: On-Farm Water Management* program, which provides technical assistance to the producer to develop a Long-term Water Management Plan and cost shares projects relating to the plan that improve water supply.
- 30% of survey respondents report participating in a Ducks Unlimited conservation program.

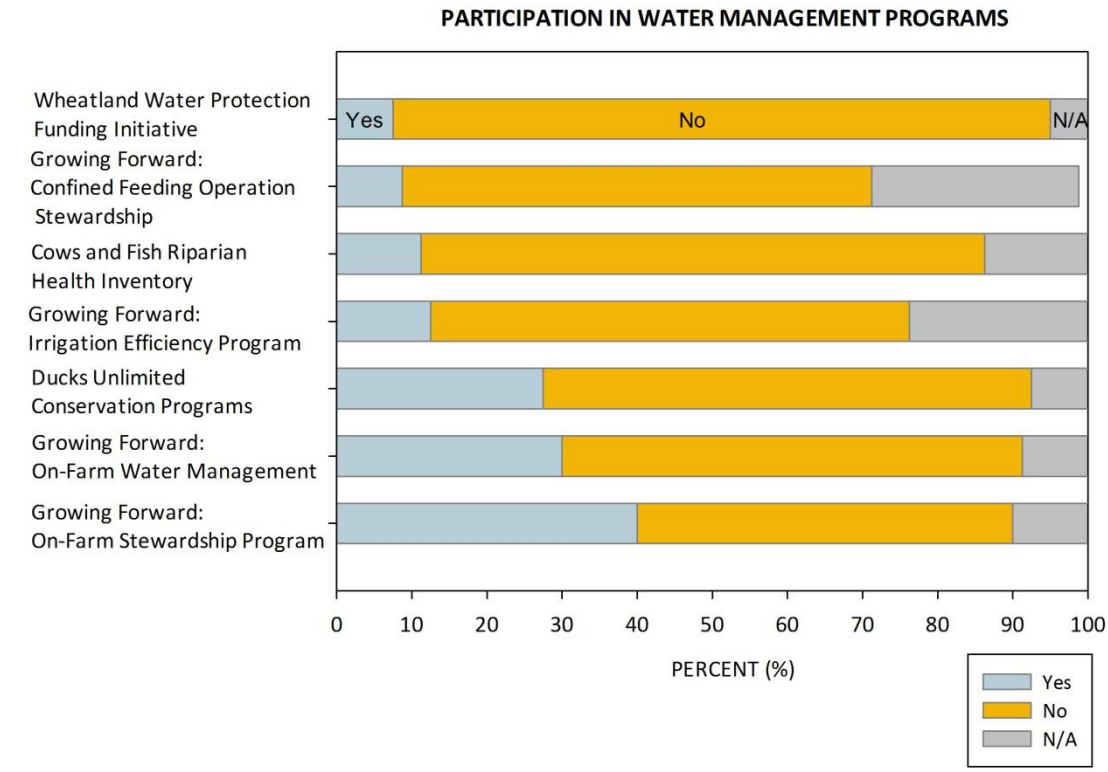

Figure 23: Participation in Funding Programs focused on aspects of water management

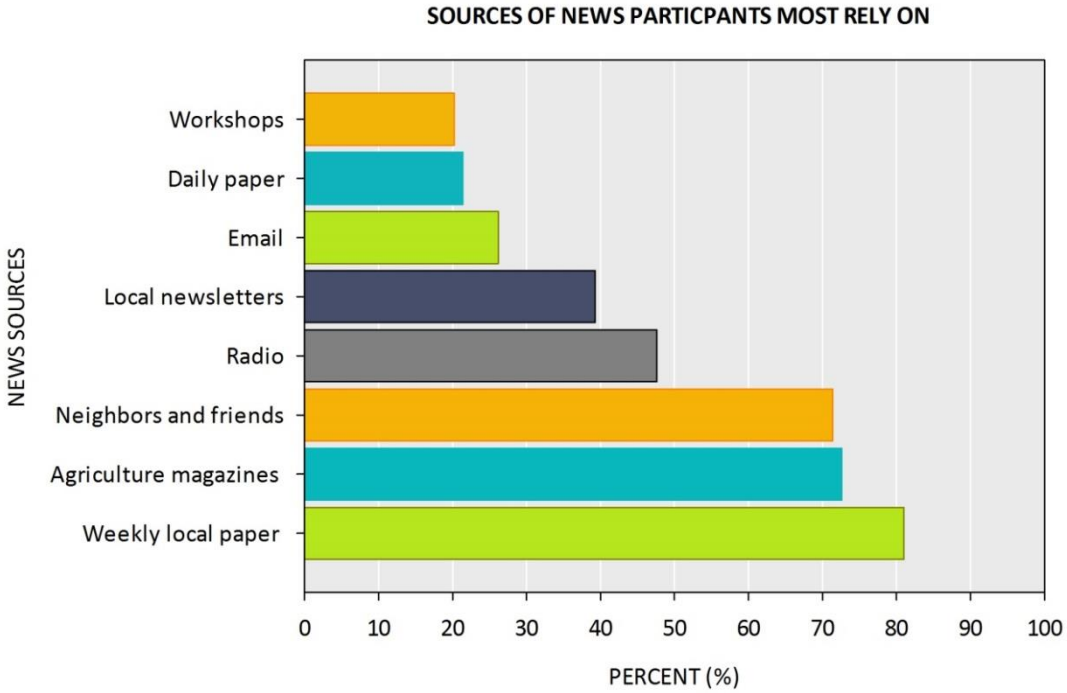

Figure 24: Sources of news perferred by survey respondents

The most preferred times for participants to attend a workshop are on the weekday in the morning, afternoon or evening (Figure 25).

Survey participants were asked to identify the sources of information they rely on most. Figure 24 indicates that the top three sources are, local weekly newspapers, such as the Strathmore Standard, agriculture magazines such as the Canadian Cattlemen magazine and through word of mouth from friends, family or neighbours.

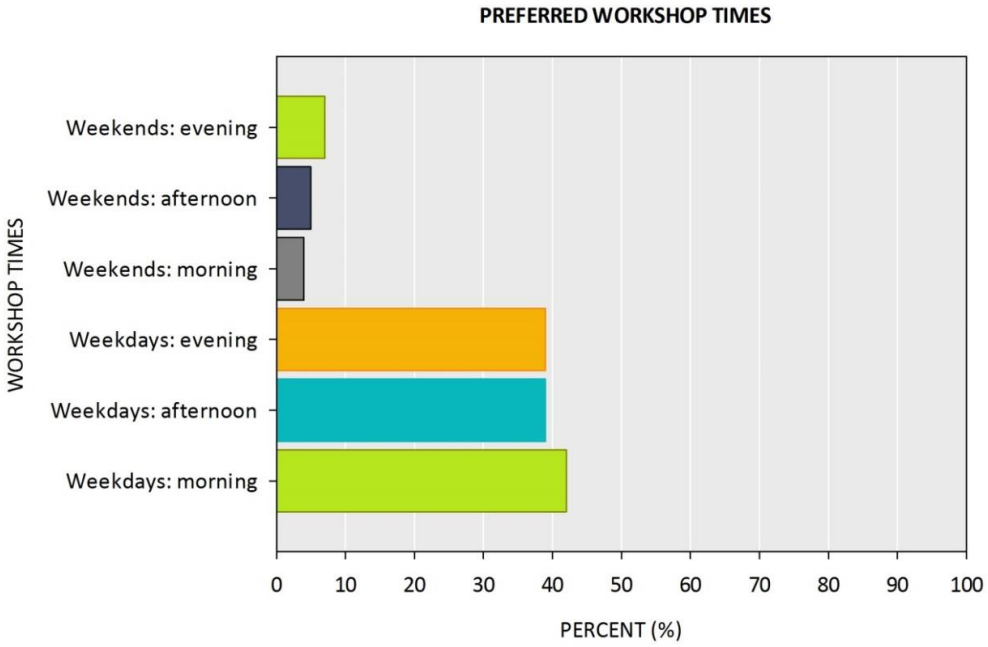

Figure 25: Preferred workshop times

DISCUSSION

What is the state of water resources in Wheatland County?

Agriculture is the dominant land use in Wheatland County. Survey respondents reported involvement in diverse types of agriculture; the four top production types were dryland crops, hay crops, cow-calf operations, and irrigators. Agricultural operations need access to water resources of good quality and reliable quantity within the county. Growing competition for water, land, and other resources as well as the uncertain impact of climate change and climate variability will place increased stresses on water resources and agricultural production.

There are numerous studies that consider the quality of water resources in Wheatland County. Wheatland County falls within two larger watersheds, the Red Deer River Watershed and Bow River Watershed; both these watersheds have State of the Watershed reports developed. Key issues for the sub-watersheds occurring within Wheatland County are "fair" conditions for nutrient loads, specifically phosphorus, and in some cases nitrogen. Causes of high nutrient loads include point sources such as wastewater effluent from urban centers and non-point sources

from agricultural operations such as fertilizer and manure applications (Aquality Environmental Consultants 2009, Bow River Basin Council 2010). In addition, spill water from the Western Irrigation District (WID) runs into Serviceberry and Crowfoot Creeks and Rosebud River. Understanding the quality of water resources is only part of the equation when it comes to improving current conditions. Land managers have a significant influence on water condition; therefore, survey questions were designed to help determine producers' knowledge, concerns and management actions toward conserving and restoring water quality, with a specific emphasis on phosphorus.

Water quantity is also an important variable to agriculture, especially in the face of climate uncertainty. The flow rate for the Bow River near Cluny was rated as "in a diminishing state" in 2009, meaning flow rates were lower than natural levels. Flow rates in the Red Deer River Watershed system have not been rated (Bow River Basin Council 2010). Although water quantity is an important consideration and was rated as the second biggest concern by survey respondents, our survey did not focus specifically on water quantity. This is a limitation of the survey from the perspective of understanding producer's knowledge, concerns and management practices.

Wetland and riparian area health is also important with respect to water quality and quantity. Cows and Fish surveyed the riparian health along the Crowfoot and Rosebud River systems and scored them healthy but with problems (Spicer-Rawe, K. 2012, 2013). There is very little information on the state of wetlands in Wheatland County, a broader study of the grasslands natural region, found a reduction in both the number of wetlands and wetland area over a 16 year period (Watmought and Schmoll 2007). Despite the lack of baseline information, wetland restoration has been identified as a key strategy to contribute to improving water quality and quantity in the region. Therefore some of the survey questions were geared toward understanding the producers' knowledge, concerns and management actions toward conserving and restoring riparian and wetland areas.

Findings from the survey are discussed in three sections; water quality, climate change and wetland and riparian systems. Although all these aspects of water are interconnected for simplicity we present the perceptions and attitudes, concerns and management actions relating to each of these water areas.

Water Quality

PERCEPTIONS AND ATTITUDES TOWARD WATER QUALITY

There is strong agreement from respondents in Wheatland County that it is important to protect water quality, even if it impacts economic development. There is an appreciation of the benefits from maintaining high quality water to agriculture, for example, 70% of producers agreed that livestock benefit in terms of weight gain from access to higher quality water. This is supported in the literature where Willms et al. (2000) showed that cattle weight gain can be impacted by low quality water, and that cattle drinking clean water delivered to a trough gained more weight over cattle drinking directly from a water body where cattle impact the shoreline and contaminate the water. At the same time survey respondents also understood that agriculture and other developments have an impact on water resources in the County.

Survey respondents had a good understanding of the type of activities that impact water quality in the county. Over 80% of respondents rated industrial activity, urban waste water, poorly designed septic systems, confined feeding operations, and urban storm water as affecting water quality. Over 75% of respondents rated development, fertilizer application, livestock access to riparian and wetland systems as affecting water quality. Over 60% of producers felt pesticide disposal, manure application, wintering site management, waste disposal and irrigation practices effect water quality. In addition, half of the producers felt run-off from crops impacted water quality, while the majority of producers did not think run-off from hay crops had an impact. Although these results suggest a high level of knowledge on impacts to water systems, agricultural producers identified non-agricultural sources as having the most effect on water quality. Continued efforts to provide up to date information on impacts to water resources would be beneficial to producers.

Increased phosphorus loads have a significant impact on water quality. Historically phosphorus in the Bow River through Wheatland County and surrounding jurisdictions was high and caused excessive aquatic plant growth reducing dissolved oxygen in the system and impacting fish populations (Bow River Phosphorus Management Plan 2014). Efforts to reduce point source (loadings from wastewater lagoons and treatment plants) influxes of phosphorus have made a substantial difference to the health of the Bow River. As the human population continues to grow in the region, continuous effort will be made to keep this source of phosphorus in safe levels. More difficult to measure and perhaps control are the non-point sources of phosphorus. These sources are related to land use, including agricultural practices

The survey respondents have a strong understanding of the non-point sources of phosphorus in Wheatland County such as commercial fertilizers, urban run-off and animal manure. Many also recognize certain management activities can influence phosphorus levels in the system. However there are areas where more information to agricultural producers could help further understanding of how phosphorus enters and moves across the landscape to waterways and water bodies (e.g., over 60% did not think or didn't know that roads and pipeline have a roll in phosphorus loading).

CONCERNS ABOUT WATER QUALITY

Water quality was identified as the main concern of survey respondents in Wheatland County. Specifically respondents identified improper farming techniques, urban run-off and industrial activity as their top three concerns. Improper farming techniques mentioned included feedlot run-off, application of manure on farms, pesticide and fertilizer application, and poor livestock management. In addition, survey respondents were provided with a list of characteristics that impact water quality and the top three of concern were pesticides, fertilizers and effluent.

Specific to phosphorus, a majority of producers were concerned about the level of phosphorus in the waterways, particularly with respect to blockage of irrigation and livestock watering intakes, decreased flow in irrigation pipes and canals, poor aquatic habitat, and reduced recreational opportunities. A majority were concerned about efforts that would be required to mitigate the impact of phosphorus.

A water quality rating system was implemented downstream of the Carseland Dam and near Cluny along the Bow River. The system rates water characteristics on scale of 0-100 where 100 is the best condition and provides a description of cautionary, fair, good to natural (Bow River Watershed 2010). Dissolved oxygen, bacteria and nitrogen were all rated as good at both sites, while total suspended solids was rated as fair at Carseland but good near Cluny. Total phosphorus and total dissolved phosphorus were rated as fair at both sites, with phosphorus levels at Carseland improving over earlier years as a result of reduced point source loads. Water quality sampling on Serviceberry Creek indicated higher than acceptable concentrations of phosphorus and nitrogen (Aquality Environmental Consulting Ltd. 2009). Suspended solids, nitrogen and phosphorus levels are caused by municipal effluent and from land uses such as urban run-off and agricultural practices such as manure and fertilizer application.

Survey respondents have a good understanding of the impacts of agricultural practices and urban centers on water quality, and their concerns are consistent with the water quality testing that has been carried out.

WATER BODIES OF CONCERN

Survey participants were asked which water bodies within Wheatland County they were concerned about. At least half of respondents are concerned about each of the major water bodies in Wheatland County, the top three were Eagle Lake, Bow River and Rosebud River. The number one water body of concern, expressed by 75% of respondents was Eagle Lake. Eagle Lake is a popular recreational spot within the County, particularly for sport fishing. Within the Eagle Lake Area Structure Plan the County states the water quality of the lake is important as it relates to a high quality recreational experience. According to the Lake Atlas of Alberta, Eagle Lake's "high phosphorus concentrations, heavy blue green algae blooms and low depth indicate the Lake is hyper-eutrophic." Hyper-eutrophic means the lake is high in nutrients which can be from multiple non-point sources such as agricultural run-off, irrigation run-off and residential sewage resulting in frequent algae blooms. In 2013 and 2014 Eagle Lake was placed under a public health advisory due to intensive cyanobacterial blooms, where swimming and water consumption from the lake were banned.

The Bow River was the second most mentioned water body of concern as expressed by 74% of survey respondents. A water quality index developed by AESRD 2012-2013, rated the Bow River as good at the Carseland Weir and near Cluny, where nutrients were rated as fair and bacteria as marginal, while metals and pesticides were rated as excellent and good respectively. The Rosebud River was the third most mentioned water body of concern as expressed by 64% of survey respondents. In the Red Deer River State of the Watershed Report, phosphorus content was rated as poor and nitrogen concentrations as fair for the Rosebud River sub-watershed (Aquality Environmental Consulting Ltd 2009).

Survey respondents are appropriately concerned about the larger water bodies in the County. Non-point sources of nutrients from agriculture are impacting the ecological health of the water resources and water quality, indicating the importance of continued promotion and adoption of best management practices by producers.

MANAGEMENT PRACTICES TO IMPROVE WATER QUALITY

The majority of survey respondents (80-100%) report undertaking water management practices where applicable to maintain water quality, including, crop rotation, adhering to spray avoidance times and buffers, maintaining septic systems, developing manure management plans, winter site

management, soil testing to determine nutrient load, and sealing un-used ground water wells. Additional activities implemented by 60-75% included maintenance of plant cover, off-stream watering of livestock, maintaining or increasing buffer between crops and streams and wetlands, managing invasive species along riparian and wetland areas, implement fencing projects to reduce livestock access to wetlands, runoff and run-on controls, removal of pit walls, and install pitless adapters. Many of these practices are identified in the Bow River Phosphorus Management Plan as strategies to reduce additions of phosphorus and reduce movement of phosphorus to the river. While more BMPs can be implemented by more agricultural producers, the results indicate a high level of implementation of key strategies to maintain water quality within the County.

Lastly, almost half of survey respondents indicated they co-exist with beavers, while half do not. This question was asked to determine the level of support for maintaining beavers on the landscape within the County. Over the last 100 years beaver populations were significantly reduced in North America, as the species is considered a pest (Baker and Hill 2003). However, many regions are starting to understand and appreciate the role beavers can play in maintaining and restoring watershed health (Kemp et al. 2012). Beavers are considered an ecosystem engineer because of their ability to modify the landscape and influence both biotic and abiotic features in the environment (Rosell et al. 2005). Lately many regions have been exploring beavers as a watershed management tool because of their ability to promote water storage, restore ecological function of degraded habitat, increase and improve fish and wildlife habitat and aid in development of wetlands (Hood and Bayley 2008, Walker et al. 2011 and Pollock et al. 2011). For this opportunity to be supported in Wheatland County education and outreach about the important function of beavers in the watershed is needed, along with best management practices for addressing beavers in conflict with landowners or the county.

Over all, the majority of survey respondents have a high level of understanding of the importance of maintaining water quality in the County and they understand how agriculture can impact water quality. Most survey respondents were appropriately concerned about key water bodies with in the region and about the main factors impacting water quality from agricultural production and urban centers. In addition, the majority of survey respondents are implementing best management practices to reduce agricultural impacts on water quality. Unfortunately, the number of survey respondents was not sufficient to ensure the sample is representative of all agricultural producers in Wheatland County. It could be that the producers who responded were more concerned about water resources and therefore took the time to fill in the survey. Nevertheless, the results indicate good awareness of water quality issues and challenges within the County.

Wetland and Riparian Areas

Perceptions and attitudes toward wetland and riparian areas

Wetland and riparian areas in Wheatland County are important natural capital. Wetland and riparian systems play an important role in many ecosystem services that people in Wheatland County benefit from, including flood control, water storage, water purification, phosphorus mitigation, and supporting a diverse array of plant and animal species (Turner et al. 2008). Survey responses indicate there is a shared agreement amongst agricultural producers that wetlands (80% agree) and riparian areas (75% agree) play these important identified roles. The results indicate a high level of understanding about the role of wetlands and riparian areas to maintaining healthy water resources in Wheatland County.

Survey responses indicate there is not shared agreement around the impact of maintaining wetlands to farm productivity; with 28% of producers thinking wetlands reduce farm productivity, 20% are not sure and 44% think wetland do not reduce farm productivity. Similarly, there was not agreement around the impact of riparian areas on farm productivity, with 20% thinking riparian areas reduce farm productivity, 30% were neutral and 50% think riparian areas do not reduce farm productivity. The producers' perception of the impact of wetlands and riparian areas on farm productivity are important considerations when establishing incentives to promote best management practices. If there is a perception that wetlands and riparian areas are costing producers' productivity, producers may not have the incentive to maintain or restore damaged wetland and riparian systems.

Concerns about wetland and riparian areas

Survey respondents were asked a series of statements to better understand their concerns about wetlands and riparian areas in Wheatland County. The highest numbers of participants (77%) were concerned about riparian areas, followed by 71% of participants who were concerned about the number of wetlands being lost or impaired by development. There was also concern (59% of survey respondents) of wetland loss or drainage from agriculture producers.

Wetlands and riparian health are two indicators used in state of the watershed reporting initiatives, for the Red Deer River Watershed Alliance (Aquality Environmental Consulting 2009). Components of the Rosebud sub-watershed (within the Red Deer River watershed) and Carseland to Bassano sub-watershed (within the Bow River watershed) fall within Wheatland County. Indicator measurements for wetlands include loss in number and area of wetlands, which are not well understood specifically for Wheatland County. A study of wetland area and number of

wetlands lost over a sixteen year period (1985-2001) for the grasslands natural region reported a 1-4% loss in wetland area and a 5-9% loss in the number of wetlands, thus supporting the notion of wetland acreage loss and a reduction in the total number of wetlands (Watmough and Schmoll 2007). The majority of survey respondents were concerned about the loss of wetlands.

Indicator measurements for riparian areas have been generated using Cows and Fish riparian health assessment methodology. Riparian health assessments were carried out for both the Rosebud River and Crowfoot Creek, where a number of sites were surveyed. The average score for both river systems was healthy but with problems (Spicer-Rawe 2012, 2013). The majority of survey respondents were concerned about health of riparian systems in Wheatland County.

The Cows and Fish program made a number of management recommendations for maintaining and restoring riparian areas in Wheatland County including "maintaining native plant communities, especially existing shrub communities, in addition to monitoring and controlling invasive weed populations; improvements to livestock grazing and watering access (e.g. off-stream watering systems); and maintaining or expanding existing buffers between cropland and the creek" (Spicer-Rawe 2013). When applicable to their operation, at least 55% of survey respondents report undertaking the above activities. The order of implementation from highest number of producers participating to the lowest was maintenance of plant cover, off-stream watering of livestock, maintaining or increasing buffer between crops and streams and wetlands, managing invasive species along riparian and wetland areas and implement fencing projects to reduce livestock access to wetlands. There is an opportunity to improve outreach and education around these management actions to promote improved riparian and wetland condition in Wheatland County.

MANAGEMENT PRACTICES TO IMPROVE WETLANDS AND RIPARIAN AREAS

Wheatland County recognizes the importance of maintaining healthy wetlands and riparian areas and to restore wetlands that have been drained or damaged in order to maintain as much good quality water as possible as exhibited in ag service board projects. In the case of Wheatland County many of the opportunities for restoration occur on private lands. To better understand the attitude of producers towards wetland and riparian restoration survey respondents were asked a series of questions to better understand management actions relating to the restoration of wetland and riparian areas.

Seventy seven percent of survey respondents report having either a wetland or riparian area on their property. Of those individuals with wetland and riparian areas on their operations, 90% of

respondents had not drained a wetland, while 10% had drained a wetland. All but one of the individuals who report draining a wetland stated the reason was to increase crop production. Overall, the majority of survey respondents (82%) felt it was illegal to drain a wetland, but 18% thought it was not, indicating value in continued education around wetland policy in Wheatland County. Under the Alberta Water Act (2014) approval in the form of a permit is required from Alberta Environment Sustainable Resource Development to drain/damage a wetland, even on private land.

Half of the survey respondents reported restoring a wetland or riparian area. They noted a number of perceived benefits including increases in biodiversity, increases in plant growth, reduction in erosion, increase in wildlife habitat and improvements to animal health. Many of these benefits are supported by the strategies in the BRPMP. In addition, 32% reported receiving some kind of financial support to assist with the costs of restoration. We did not test if financial incentives were a direct motivator, but when survey respondents were asked if they would restore more wetlands and riparian areas in the future, 68% said they would, 7% noted only if there was cost sharing opportunities. There are opportunities for private landowners to restore and enhance wetlands and riparian areas though various Growing Forward Programs, Ducks Unlimited Conservation Program and Wheatland Water Funding Protection Initiative. Results indicate these programs are not heavily utilized indicating an opportunity for more education around these opportunities.

Climate Change

Respondents were asked specific questions about their perceptions around climate change. Opinions were highly divergent about whether or not climate change is occurring, and the impact climate change to surface water, and to flood and drought frequency.

Just under half of the respondents felt there is not sufficient evidence to support the notion that climate change is occurring, while an additional 27% neither disagree nor agree that there is not sufficient evidence to support climate change. This leaning is not supported in the literature, as stated in the Intergovernmental Panel on Climate Change (IPCC) latest climate summary for policy analysts, "*Human influence on the climate system is clear, and recent anthropogenic emissions of green-house gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The*

atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen" (IPCC 2014 p. 2).

In addition, respondents were asked about their level of agreement on climate change impacts to surface water, to flooding and to drought. Twenty four percent of respondents do not think there will be an increase in frequency of extreme weather event such as flooding and droughts, while 49% neither agree nor disagree with the notion that droughts and floods will occur more frequently. Again, this notion is not reflected in the literature, where predictions for Alberta's grassland natural region include increased temperatures, changes in rainfall patterns, increased glacier snow melt which all will contribute to changing conditions on the ground. A report on climate change and Alberta's natural regions noted that drought is difficult to predict, but "the trend towards generally drier conditions across much of Alberta implies that severe dry spells will become more frequent in the future and affect more of the province. In addition, several studies predict that climatic variability will increase under global warming; implying that extreme wet and dry years could become more common on the prairies" (Schnieder 2013, Mladjic et al. 2011).

Lastly producers were asked about their perception of impacts of climate change on surface water and 58% of respondents felt there would be impacts on surface water while, again showing divergent opinion on future impacts of climate change.

Although it is difficult to predict with certainty the impacts climate change on agricultural producers, expanding the knowledge and dialogue around climate change is important. Communities have adapted to impacts of weather and climate variability for generations through implementation of a range of practices including irrigation, crop diversification, disaster management and water management, but climate change poses a bigger challenge, one outside our range of past experiences.

CONCLUSION

Overall, this survey indicated that agricultural producers who participated in the survey have a high level of understanding of the importance of protecting water resources, including water quality, wetlands and riparian areas in Wheatland County, even at the expense of economic development. At the same time, survey respondents also understand that agriculture and other developments have an impact on water resources in the County. There was a high level of agreement amongst producers who responded to the survey that water quality is affected by industrial activity, urban development and agricultural operations; although survey respondents rated all non-agricultural impacts higher than agricultural impacts such as confined feedlot

operations, fertilizer application and allowing livestock access to wetland and riparian areas. In all cases, less than 8% of survey respondents think the agricultural practices do not affect water quality in the County.

The survey indicated that respondents have a strong understanding of the non-point sources of phosphorus in Wheatland County such as commercial fertilizers, urban run-off and animal manure. Many also recognize certain management activities can influence phosphorus levels in the system. However, there are areas where information to agricultural producers could help further understanding of how phosphorus enters and moves across the landscape to waterways and water bodies.

Survey respondent were most concerned about water quality in Wheatland County, and their concerns are consistent with the water quality testing that has been carried out which shows fair conditions for phosphorus and in some areas higher than desirable levels of nitrogen. The water body of most concern was Eagle Lake, a popular recreational hotspot within the county that is regularly closed to swimming due to green algae blooms. More specific to phosphorus, a majority of producers were concerned about the level of phosphorus in the waterways, particularly with respect to blockage of irrigation and livestock watering intakes, decreased flow in irrigation pipes and canals, poor aquatic habitat, and reduced recreational opportunities. A majority were concerned about efforts that would be required to mitigate the impact of phosphorus.

A majority or respondents were also concerned about riparian and wetland systems in the County, although more were concerned about wetland losses from development over wetland losses from agriculture. To address these concerns more than half the survey respondents were actively managing their farms to improve riparian and wetland condition. The top three management activities undertaken were off-stream watering, maintaining plant cover and maintaining or expanding the buffer between crops and riparian and wetland areas. There is an opportunity to improve outreach and education around these management actions to promote more broadly improved riparian and wetland condition in the County.

In addition, for survey respondents who reported having a wetland and riparian area, less than 10% report draining a wetland on their farm, and 55% have restored a degraded wetland or riparian area, of which 34% received financial support. Most said they would restore more wetlands and riparian areas in the future. Further exploration on how to engage additional landowners in restoration activities could be beneficial to the County to improve and build resilience of water resources.

In this survey, we did not explore agricultural producer opinions around incentives to promote BMPs and restore wetlands and riparian areas. Understanding incentives and needs of producers to implement BMPs and restore wetlands and riparian areas may be important in the future as the County strives to build water resiliency to reduce the risk of changing conditions. There were divergent opinions around the impact of wetlands and riparian areas on farm productivity, with some producers feeling their productivity and bottom line is impacted by maintaining wetlands and riparian systems. Incentive systems may play a role in engaging a border spectrum of producers in water restoration activities.

Results indicated low participation for most of the available water conservation programing with the most participation for the Growing Forward Program on Farm Stewardship Program where 40% of respondents report participating. When asked about the barriers to implementing BMP's and restoring water systems, the top three were costs, lack of resources and time constrains. There is an opportunity to improve awareness about existing programs to support producers in the implementation of BMPs and restoration of water resources.

Lastly, there are divergent opinions amongst survey respondents around climate change, specifically regarding if there is scientific evidence that it is occurring, and if the predicted changing environmental conditions will lead to impacts on surface water and increased frequency of droughts and floods. The IPCC states that climate change is occurring and environmental changes are predicted, although there is uncertainty as to the level of impact the environmental changes may cause. However, failure to plan for the predicted environmental changes due to climate change could result in significant environmental, economic and social consequences in the future. Although communities have adapted to impacts of weather and climate variability for generations through implementation of a range of practices including irrigation, crop diversification, disaster management and water management, climate change poses a bigger challenge, one outside our range of past experiences. Climate change adaptation needs to be in the community dialogue to ensure water security into the future.

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Additional Resources

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Atlas of Alberta: http://sunsite.ualberta.ca/Projects/Alberta-Lakes/characteristics3.php

My Wild Alberta: Public Health Advisory issues for Eagle Lake
http://mywildalberta.com/Fishing/SafetyProcedures/BlueGreenAlgae.aspx

Alberta Environment 2013: http://esrd.alberta.ca/water/programs-and-services/surface-water-quality-program/documents/TrophicStateAlbertaLakesPhosphorus-Feb2