Bow River Phosphorus Management Plan

2014

BOW RIVER PHOSPHORUS MANAGEMENT PLAN

Taking Action to Manage Phosphorus Together

Bow River Phosphorus Management Plan

April 4, 2014

EXECUTIVE SUMMARY

Heightened nutrient levels in the Bow River downstream of Calgary have long been a concern. In the 1970s and 1980s, high nutrient levels resulted in excessive aquatic plant growth resulting in low dissolved oxygen and occasional fish mortality. An interim policy on effluent limits was released by Alberta Environment in 2008. This policy required that a regional nutrient load reduction plan be developed for reaches at risk of exceeding water quality guidelines. At the same time the Government of Alberta was transitioning to an environmental management approach that addresses the cumulative effects of resource management decisions and considers the environmental, economic and social implications of development for an entire region.

In 2011, Alberta Environment and Sustainable Resource Development (ESRD) invited contributing parties in the affected reach of the Bow River to initiate a voluntary, collaborative process to address phosphorus loadings, not just from point sources such as the wastewater treatment plants, but from non-point sources as well.

The Bow River Phosphorus Management Plan (BRPMP) is a **strategic plan** to address sources of phosphorus in the middle reach of the Bow River between the Bearspaw and Bassano Dams. It is the culmination of work by contributing parties from government and non-government, urban and rural sectors, and a wider constituency of subject matter experts who contributed on task teams to define the issue, establish goals and objectives, and recommend strategies and actions to manage phosphorus in the Bow River.

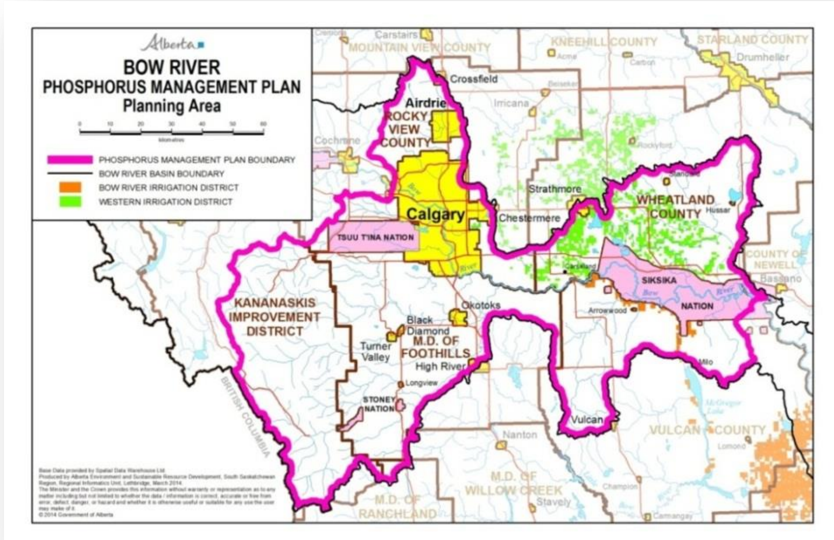
The BRPMP seeks to enable management actions to meet social, economic and environmental outcomes now and into the future. This is a proactive, place-based, knowledge-driven and adaptive plan with collective action by, and accountability of, contributing parties.

The Bow River Phosphorus Management Plan Area

The Bow River flows through the natural sub-regions of the Rocky Mountains, Foothills Parkland, Foothills Fescue and Mixed Grass (GOA 2006) and encompasses an area of 12,481 square kilometres (1,248,147 hectares or 3,084,227 acres). This amounts to just two percent of Alberta's total area, yet approximately one third of the population of Alberta lives in the planning area, making this a high risk area for phosphorus loading in the province.

The planning area includes:

- the urban areas of Calgary, Airdrie, Strathmore, Okotoks, High River, Turner Valley and Black Diamond;
- the rural municipalities of MD of Foothills, Rocky View County, Wheatland County and Kananaskis Improvement District; and
- the lands of Stoney Nation – Eden Valley, Tsuu T'ina Nation and Siksika Nation.
- the lands and canals of the Western and Bow River Irrigation Districts



Where Does Phosphorus Come From?

Phosphorus is a naturally occurring element. In water, it occurs as dissolved phosphorus or in particulate form bound to suspended soil particles. On land, it occurs naturally in soil and is taken up by plants as they grow. Phosphorus is also introduced, for example, through the application of chemical fertilizers.

Sources of phosphorus in the Bow River basin include: plant material, soil, animal waste, treated wastewater effluent, fertilizer in runoff water, sediment from eroding riverbanks, and dust fall (atmospheric deposition). Airborne phosphorus originates from sources such as industry and vehicle emissions, forest fires, and from wind picking up dust, soil and fertilizer and becomes part of the stormwater runoff. Phosphorus captured by wind and falling precipitation is not well studied in this area but is a source of the total phosphorus in the planning area.

Planning Context

The BRPMP objective to manage to the current water quality conditions aligns with the Surface Water Quality Management Framework (SWQMF) that has been developed under the draft South Saskatchewan Regional Plan. The current water quality conditions are assessed using median concentrations measured monthly at several locations in the Bow River over the period of years from 2008-2011. These median values are essentially the same as the trigger values in the SWQMF for the Bow River. The trigger thresholds for phosphorus in the Bow River were established based on the water quality observations from 2004-2009 and are considered acceptable conditions. The actions contained within the BRPMP are a proactive management approach to avoid exceeding the trigger thresholds into the future. Because the SSRP requires that water quality be monitored and assessed annually, the results will be available to inform the implementation phase of the BRPMP. The SWQMF is expected to be legislated under the *Alberta Land Stewardship Act* in 2014.

PRIORITY OBJECTIVES, STRATEGIES

Outcome
- **Phosphorus inputs to the Bow River are managed to provide a healthy aquatic ecosystem while meeting the needs of those who rely on clean water.**

Primary Objective
- **To help manage current water quality conditions in the Bow River through control of phosphorus inputs.**

Supporting Objectives
- **Supporting Objectives and Strategies**

Improve understanding and change behavior to reduce phosphorus entering the Bow River.

1.0 Strategy: Provide accessible public education programs to all jurisdictions.

Increase knowledge about phosphorus sources, the planning area, and phosphorus management practices.

2.0 Strategy: Explore opportunities to address the cumulative effects of phosphorus in the long term.
3.0 Strategy: Monitor and evaluate water quality conditions in the Bow River basin to establish a baseline and investigate risk to the aquatic environment and potential management actions if phosphorus levels trend upward.
4.0 Strategy: Complete accurate inventory of landscape mapping to determine risk and establish baseline conditions.
5.0 Strategy: Conduct research and fill data gaps to advance knowledge in phosphorus management and mitigation options.
6.0 Strategy: Use models to anticipate new phosphorus loadings as growth occurs in the planning area, and to test current and future scenarios.
7.0 Strategy: Evaluate and align policies.

Reduce additions of phosphorus

8.0 Strategy: Facilitate the adoption of livestock manure nutrient best management practices to reduce phosphorus build up and runoff loss potential.
9.0 Strategy: Reduce urban additions of phosphorus.

Reduce the movement of phosphorus to the river.

10.0 Strategy: Achieve the goal of no further net loss of wetlands in the planning area.
11.0 Strategy: Work toward achieving wetland restoration objectives for the planning area.
12.0 Strategy: Maintain and improve riparian area function.
13.0 Strategy: Reduce sediment loading from regional drainage and return flow channels.
14.0 Strategy: Minimize erosion and control sediment movement

Remove excess phosphorus from water before it reaches the river.

15.0 Strategy: Reduce amount of phosphorus per capita entering the Bow River PMP planning area.
16.0 Strategy: Establish regional watershed targets.
17.0 Strategy: Maximize the effectiveness of Wastewater Treatment Plants to reduce outputs of phosphorus.
18.0 Strategy: Review lagoon Code of Practice and regulations to allow for maximum phosphorus removal.
19.0 Strategy: Ensure quality assurance of current practices for lagoon operations.

Next Steps: Establishing an Implementation Committee

ESRD will take an active role in providing leadership for the establishment and ongoing efforts of the Implementation Committee. Similar to the composition of the Steering Committee, it is anticipated that the Implementation Committee will be largely composed of contributing parties as key implementers (i.e., organizations and individuals who can play an active role in helping to move the actions forward).

The Implementation Committee will make recommendations for renewal of the BRPMP as it progresses and as new information becomes available. Consideration will be given to aligning this with the review period of the South Saskatchewan Regional Plan, which requires annual progress reporting, a five-year formal report and ten-year renewal.

Education and outreach were identified as critical to the successful implementation of the BRPMP. ESRD will establish an Education and Outreach Working Group to move this forward. Provided strong linkages and the element of cross-over exist, this work could be conducted concurrently with the work of the Implementation Committee and in conjunction with the Performance Measures Working Group.

The success of the Implementation Committee and the two working groups will be dependent on the collective action of all contributing parties.

Endorsing the BRPMP

Each of the contributing parties represented on the Steering Committee has demonstrated a commitment to the process of developing the BRPMP. The BRPMP itself recommends strategies and actions that will only be successful if every sector takes responsibility for those elements of the BRPMP over which they have influence.

Endorsement and enrollment of the BRPMP demonstrates that each organization supports the BRPMP in principle, and is willing to work towards the implementation of those strategies and actions relevant to their sector.

As part of the collective responsibility demonstrated in the creation of the BRPMP, the Steering Committee invites each contributing party to indicate their support by endorsing the BRPMP.

In their endorsement of the BRPMP, Steering Committee members are invited to provide a statement of response indicating the perspective of their sector/organization regarding phosphorus management, and what they are prepared to support as the plan is translated into an implementation plan. It is anticipated that Steering Committee members will be enrolling and engaging their respective communities during discussions about this version of the BRPMP, and recording their interests and commitments to actions and strategies that pertain to them in their reach of the Bow River.

It is worth emphasizing that this is not a final plan, but rather reflects an iterative process of planning, implementing, assessing and adapting.

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1. INTRODUCTION

Heightened nutrient levels in the Bow River downstream of Calgary have long been a concern. In the 1970s and 1980s, high nutrient levels resulted in excessive aquatic plant growth resulting in low dissolved oxygen and occasional fish mortality. In the past, the high nutrient levels were primarily managed by placing concentration limits on point source discharges. The decision in 2005 to discharge treated wastewater from Strathmore to the Bow River was a turning point when the Government of Alberta began to look at regulated activities as a whole, with other activities, rather than individually. The environmental approval for the activity was successfully appealed in 2007 to the Environmental Appeals Board, who in their ruling emphasized that such decisions ought to be managed in light of their cumulative environmental impacts, particularly given that water quality guidelines were being exceeded.

An interim policy on effluent limits was released by Alberta Environment in 2008 that affected discharges from mechanical wastewater treatment plants at Calgary, Heritage Pointe and Strathmore. This policy required that a regional nutrient load reduction plan be developed for reaches at risk of exceeding water quality guidelines. At the same time, the Government of Alberta was transitioning to an environmental management approach that addresses the cumulative effects of resource management decisions and considers the environmental, economic and social implications of development for an entire region. This approach looks at the impact of all the activities in that region, not just the regulated activities, and encourages proactive decisions regarding air, land, water and biodiversity.

In 2011, Alberta Environment and Sustainable Resource Development (ESRD) invited contributing parties in the affected reach of the Bow River to initiate a voluntary, collaborative process to address phosphorus loadings, not just from point sources such as the wastewater treatment plants, but from non-point sources as well.

"The objective of the Bow River Phosphorus Management Plan is to help manage current water quality conditions in the Bow River through control of phosphorus inputs."

1.1 A Strategic Plan

The Bow River Phosphorus Management Plan (BRPMP) is a **strategic plan** to address sources of phosphorus in the middle reach of the Bow River between the Bearspaw and Bassano Dams. It is the culmination of work by contributing parties from government and non-government, urban and rural sectors, and a wider constituency of subject matter experts who contributed on task teams to define the issue, establish goals and objectives, and recommend strategies and actions to manage phosphorus in the Bow River.

A strategic plan for phosphorus management:

- Envisages a desired future for water quality and provides key direction for attaining desired future conditions.
- Answers the question: what are our objectives and how will we achieve them?
- Offers a vision and broadly maps out how it will be attained through a set of strategies and actions.

The BRPMP seeks to enable management actions to meet social, economic and environmental outcomes now and into the future. This is a proactive, place-based, knowledge-driven and adaptive plan with collective action by, and accountability of, contributing parties.

1.2 An Adaptive Plan

The BRPMP provides the strategic direction for developing an implementation plan. As strategies and actions are implemented, and as research, pilot projects and modelling provide new information, the BRPMP will be adapted to reflect new understandings.

In the adaptive management cycle, a plan becomes a living document that is evaluated and adjusted as information about the success of the implementation of strategies is determined. Adaptive management is a formal process for continually improving management practices by learning from their outcomes (Taylor, et al. 1997) (**Figure 1**).

Contributing parties are the organizations and individuals whose use of resources, or release of phosphorus to the environment, impacts the risk of cumulative effects.

Collective action is the bringing together of contributing parties and decision makers to design and implement a solution.

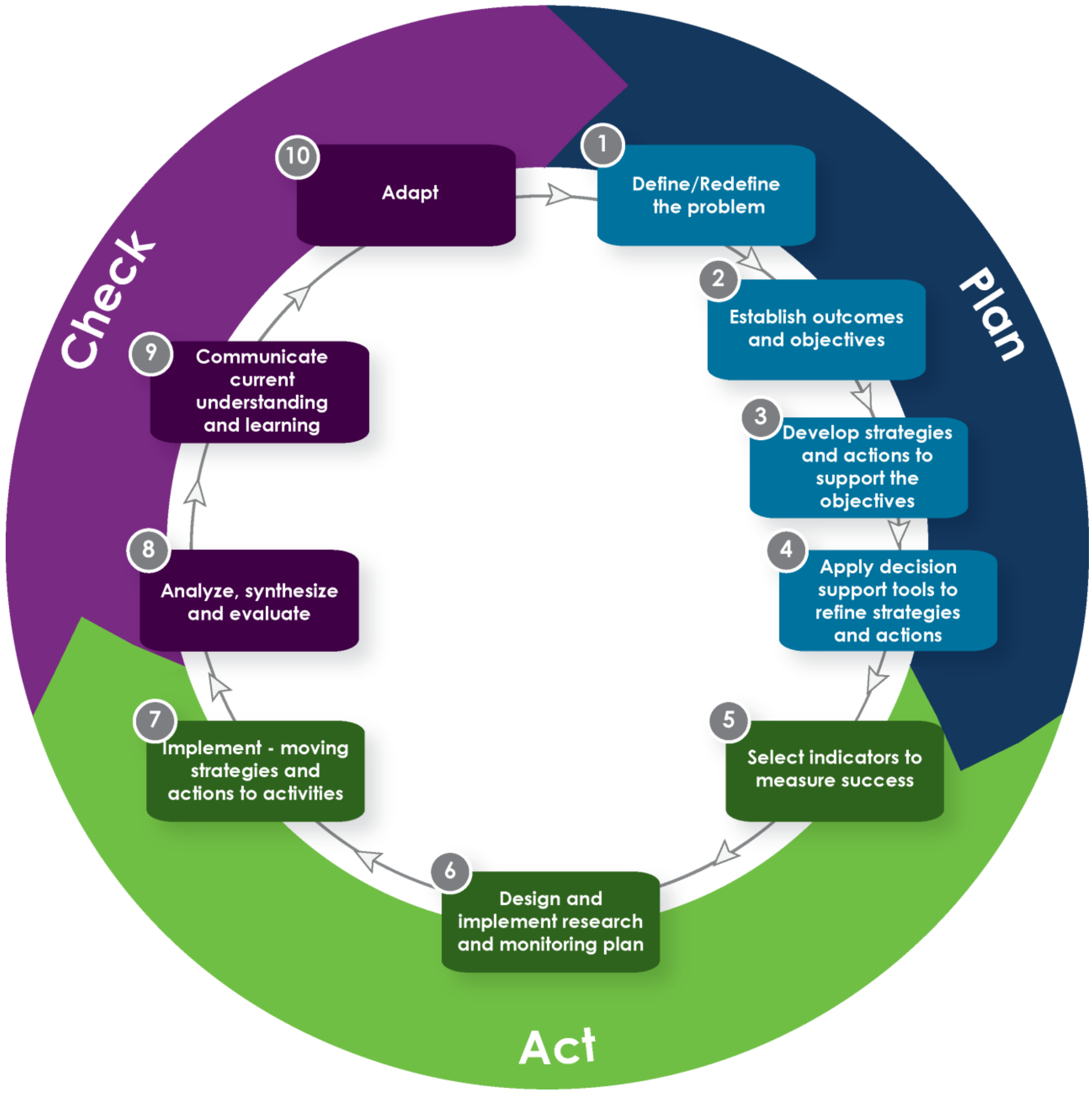

Figure 1: Adaptive Management Plan Cycle: The BRPMP completes the first phase in the adaptive management cycle where the issue has been defined as excess phosphorus loading to the Bow River. Outcomes and objectives have been identified as well as strategies and actions to achieve them. With the completion of this phase, implementation of the actions will begin, success indicators will be identified and a monitoring plan developed. Concurrent with a multi-year implementation plan, learnings will be shared with contributing parties so that management actions can be adjusted as needed.

1.3 Comprehensive Approach Needed

The BRPMP is an opportunity to coordinate both point and non-point source efforts so that phosphorus loadings can be managed effectively and efficiently using a regional and cumulative approach. In cooperation with contributing parties in the planning area, ESRD began the development of the BRPMP at a time when, although phosphorus was not at a critical level, it was recognized that high levels occurred in the past and caused water quality issues in this reach of the river.

Using a cumulative effects approach means that water quality is managed in the context of a planning area and considers all the relevant sources that affect water quality in that area. The need for such an approach is also supported by the Environmental Appeals Board, which, in a 2008 ruling on discharging treated wastewater to the Bow River, requested that inputs to the river be managed with consideration of the cumulative environmental impacts. This requires addressing both point and non-point sources.

To ensure phosphorus is managed at acceptable levels, new and existing plans that address growth should consider the direction recommended in the Bow River Phosphorus Management Plan.

The development of the BRPMP included a cross-section of contributing parties and decision makers who have an influence on the management of phosphorus in this reach of the Bow River. The planning process led to a comprehensive assessment of the current water quality conditions in the Bow River, a better understanding of the potential risks and sources of phosphorus in the planning area, and the development of sector-specific management strategies and actions to implement into the future.

Working proactively to develop appropriate management actions is a prudent approach as management actions take time to implement and systems take time to respond to those actions.

The Bow River Phosphorus Management Plan was initiated because of water quality concerns and elevated levels of phosphorus in the reach of the Bow River between Bearspaw Dam and Bassano Dam. Recent management efforts have resulted in improved conditions. This plan is a *proactive* response to maintain these improved water quality conditions.

1.4 Endorsing and Enrolling in the Bow River Phosphorus Management Plan

Each of the contributing parties represented on the Steering Committee has demonstrated a commitment to the process of developing the BRPMP. The BRPMP itself recommends strategies and actions that will only be successful if every sector takes responsibility for those elements of the BRPMP over which they have influence.

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It is worth emphasizing that this is not a final plan, but rather reflects an iterative process of planning, implementing, assessing and adapting.

BRPMP Steering Committee: Front row - Shirley Pickering, Todd Faith, Bob Miller, Scott Fediow, Jesse Parker. Back row - Sarah Schumacher, Janna Casson, Tracy Scott, Yin Deong, Erwin Braun, Richard Phillips, Mark Bennett, Ron Axelson, Sharon McKinnon, Rob Simieritsch, Tim Dietzler. (Some members are missing from the photo; see full Steering Committee list in Acknowledgements).

2. THE ISSUE

The Bow River basin sustains many and diverse land uses, including a growing population; industrial and commercial activities, such as oil and timber extraction; agriculture such as irrigated and dry land crop production and livestock operations; and highly prized aesthetics and recreation opportunities. Many of these land uses are expected to grow or intensify in the future and good water quality is required to support these land uses and activities.

Land Use Pressures:

- Agriculture intensity
- Acreage development
- Commercial lands
- Forestry
- Oil and gas
- Recreation
- Urban industrial
- Urban residential

In 2012 the population in the planning area was estimated at 1.3 million, and is projected to grow to 2.28 million by the year 2041 (GOA 2012). Growth and intensification without mitigation actions will lead to increased phosphorus loading and water quality degradation.

The impact of increased phosphorus in a water body is the excessive growth of aquatic plants and algae. Excessive plant growth affects water movement along canals and intake pipes, can negatively affect recreation such as angling and boating, and causes nuisance odours. Excessive plant and algal growth can also result in low dissolved oxygen concentrations, causing stress in the aquatic ecosystem and leading to greater likelihood of fish mortality. During times of low river flows, the warm, shallow, nutrient-rich waters can experience low dissolved oxygen concentrations. Although water quality has improved greatly since the fish kills seen throughout the 1960s to 1980s, the periodic occurrence of these conditions can still stress the fish in the river. The growth of blue-green algae and the risk of toxin release poses a serious health risks to humans, livestock and pets.

The reach between Bearspaw and Bassano Dams was chosen for a prototype project because it is the most densely populated area in the Bow River basin, is subject to increasing population pressure, and has experienced elevated levels of phosphorus in the past, with related water quality challenges such as low dissolved oxygen. The area offers an opportunity to learn from the cumulative effects of phosphorus from multiple sources. Though the planning area does not include the upstream portion of the Bow River, the impact of any phosphorus loading increases in that portion will affect this planning reach, and might therefore be an area of future study and planning.

2.1 The Bow River Phosphorus Management Plan Area

The Bow River flows east from the Rocky Mountains in Alberta and becomes part of the Saskatchewan River, ultimately draining into Lake Winnipeg (**Figure 2**). The planning area for the BRPMP covers about half the area of the Bow River basin and extends from below the Bearspaw Dam to upstream of the Bassano Dam (**Figure 3**). It includes the watersheds of the Elbow River, Nose Creek, Fish Creek, the Sheep and Highwood Rivers, Crowfoot Creek and West/East Arrowwood Creeks.

Why This Reach?

- Land use pressure
- Increasing population pressure
- Public concern to maintain water quality despite growth pressures

It also includes part of the lands and canals of the Western Irrigation District and the Bow River Irrigation District.

The Bow River flows through the natural sub-regions of the Rocky Mountains, Foothills Parkland, Foothills Fescue and Mixed Grass (GOA 2006) and encompasses an area of 12,481 square kilometres (1,248,147 hectares or 3,084,227 acres). This amounts to just two percent of Alberta's total area, yet approximately one third of the population of Alberta lives in the planning area, making this a high risk area for phosphorus loading in the Province.

The planning area includes:

- the urban areas of Calgary, Airdrie, Strathmore, Okotoks, High River, Turner Valley and Black Diamond;
- the rural municipalities of MD of Foothills, Rocky View County, Wheatland County and Kananaskis Improvement District; and
- the lands of Stoney Nation – Eden Valley, Tsuu T'ina Nation and Siksika Nation.

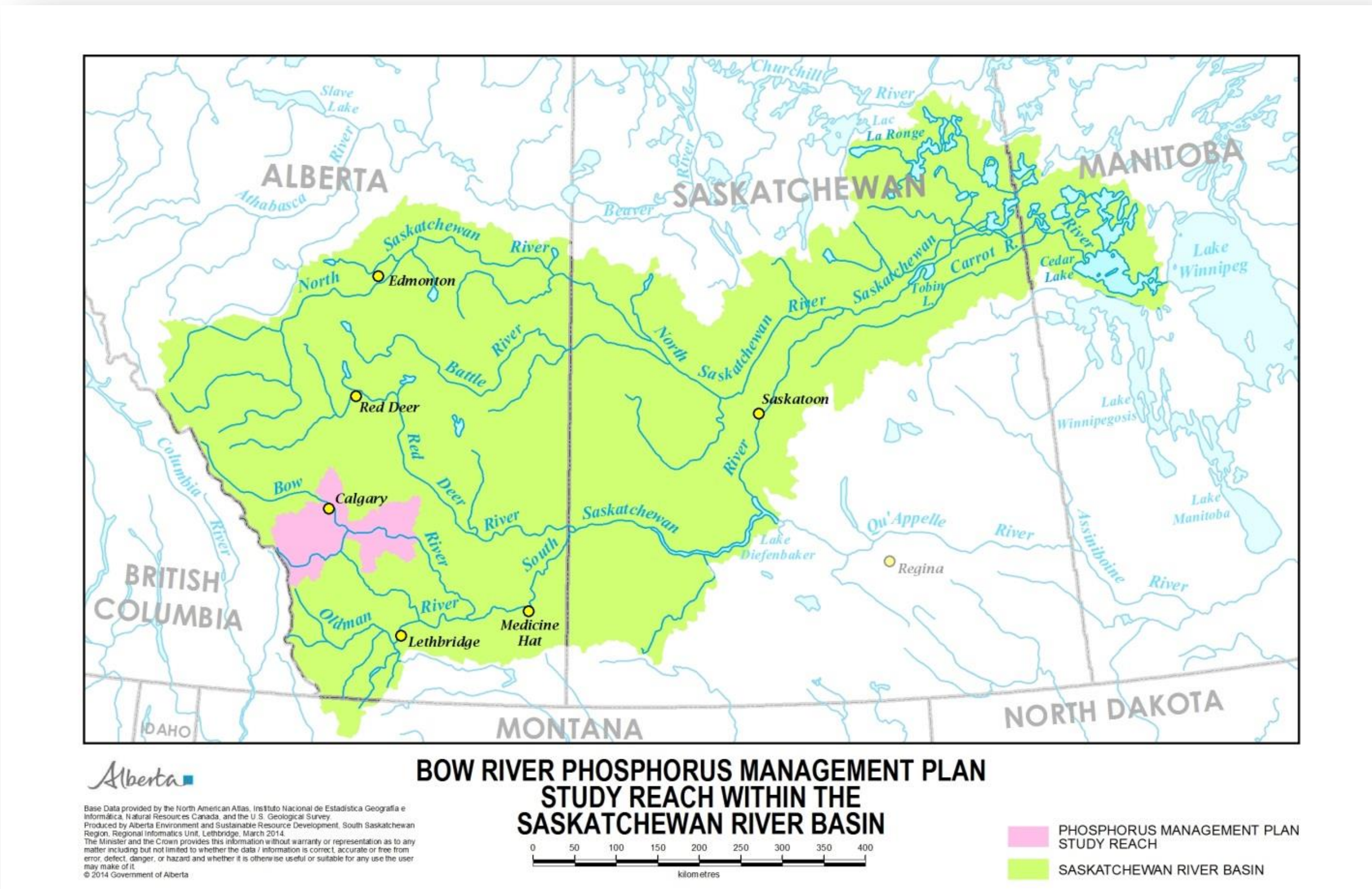


Figure 2: Bow River Phosphorus Management Plan area within the Saskatchewan River Basin

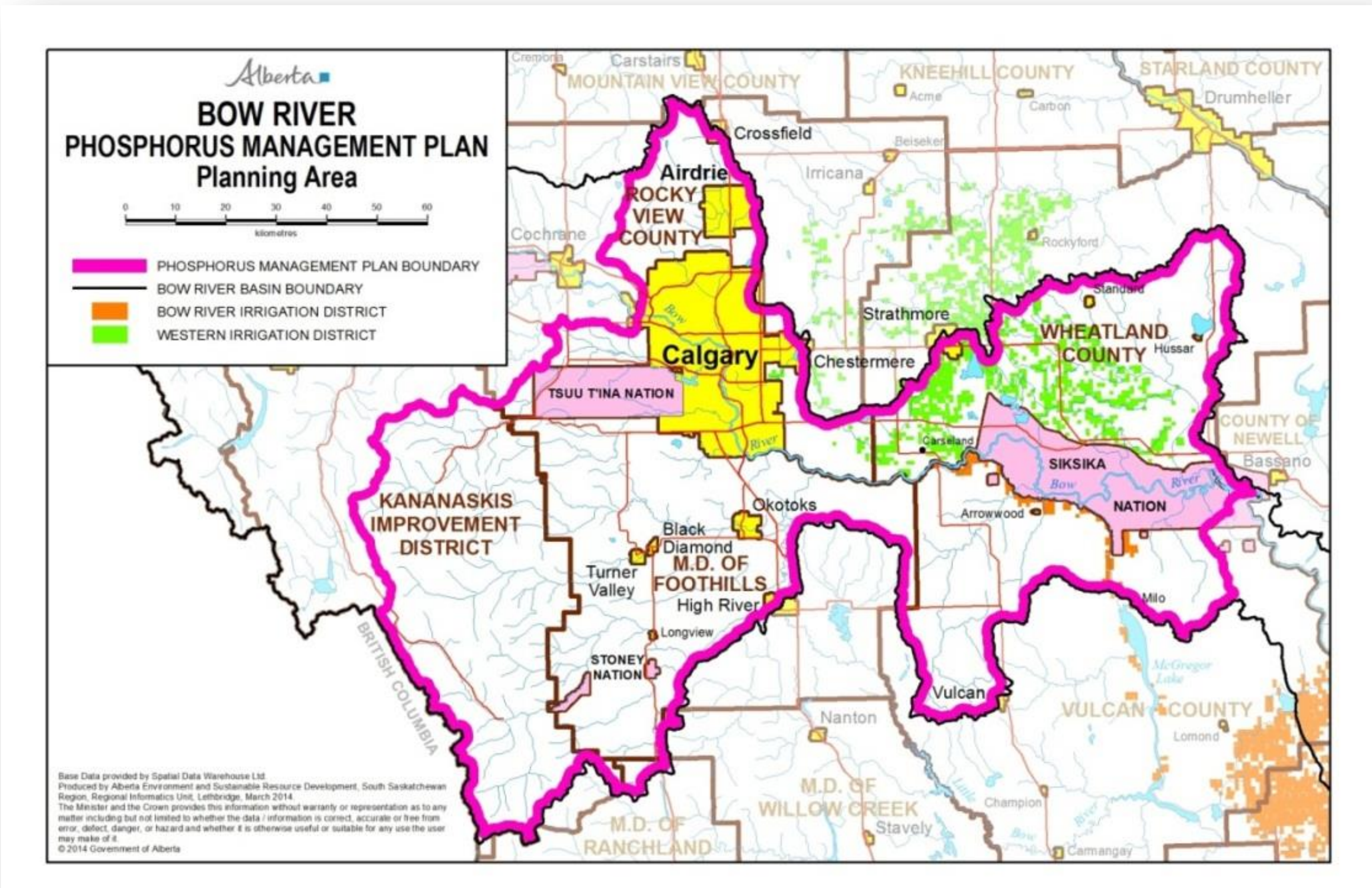


Figure 3: Bow River Phosphorus Management Plan area

2.2 How Did We Get Here?

The Government of Alberta began regulating direct discharges of phosphorus in the early 1980s. These efforts were focused on wastewater treatment plants. In previous decades, phosphorus loading was not regulated and concentration levels in the river were much higher than today. Compared to 30 years ago, phosphorus discharges from wastewater treatment plants have been reduced by up to seven times (**Figure 4**), despite doubling of the population. This improvement in wastewater treatment has contributed to lowered phosphorus concentrations in the river, which are currently at acceptable levels most of the time.

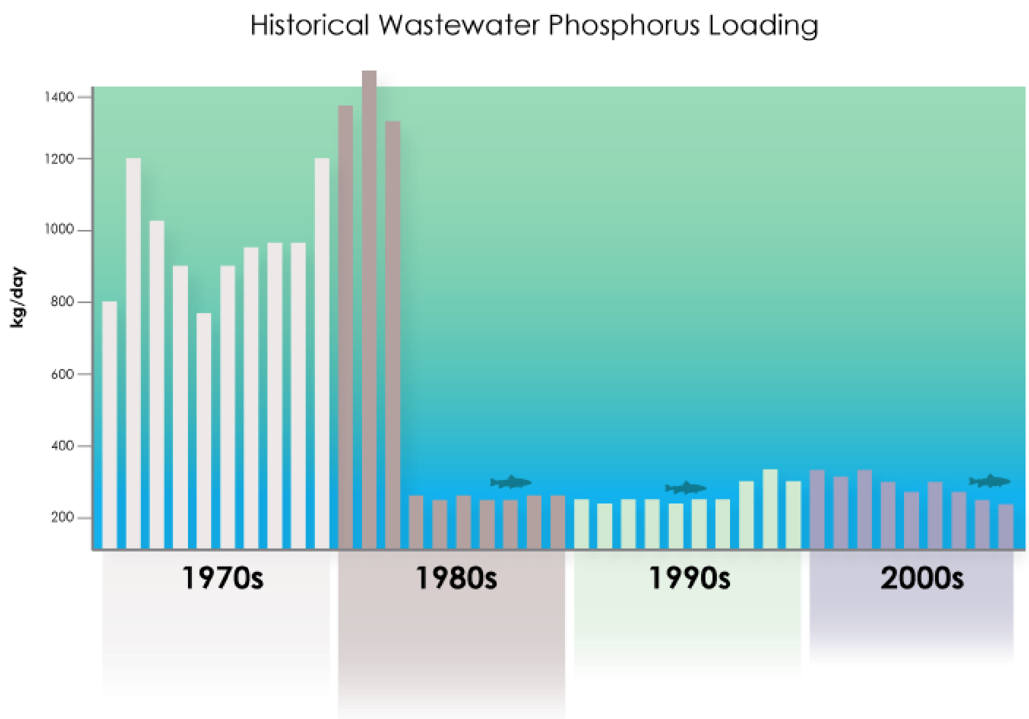


Figure 4: Historical Wastewater Phosphorus Loading in the Bow River at Calgary (Source: The City of Calgary)

The Government of Canada introduced a strategy to reduce phosphorus loadings in 1989 through the *Phosphorus Concentration Regulation,* which set allowable levels of phosphorus concentrations in laundry detergent (2.2% elemental phosphorus).[1] The regulation was amended in 2010 to include additional cleaning products. Other agencies are also taking action to reduce phosphorus inputs to watersheds. Manufacturers of lawn maintenance fertilizer are marketing phosphorus-free fertilizers with the message that phosphorus is important only for the initial root development of a new lawn.

[1] *Phosphorus Concentration Regulations* (SOR/89-501) http://www.ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=17

In 2008, ESRD introduced an Interim Effluent Limits Policy, which allowed for the setting of interim effluent limits for existing facilities in affected reaches of the Bow River at the time of an approval renewal. This approach included limiting loadings and lowering end-of-pipe concentrations of specific substances, including phosphorus, where possible. The implementation of this policy has contributed further to reduced phosphorus loads from wastewater treatment plants. In support of the policy approval holders are required to have an action plan for managing future loading and a plan for continuous improvements to ensure the limits are met into the future. Nevertheless, with increasing population, phosphorus loadings will continue to increase based on the current level of effluent treatment.

Within this Bow River reach, there are local efforts that help to manage phosphorus from the various sources, including municipal bylaws and planning initiatives related to stormwater management; education and extension efforts to promote improved agricultural practices; and research, funding and implementation of beneficial/best management practices (BMP in Glossary). These initiatives will need to continue, and to be supported by new initiatives to preserve the current water quality of the Bow River into the future.

As our communities continue to grow, it is imperative that phosphorus is managed to ensure a healthy aquatic ecosystem while meeting the needs of those who rely on clean water.

2.3 Why is This Work Important?

Managing phosphorus from a regional and cumulative approach underscores the need for water quality to be managed in the context of a planning area and considers all the relevant sources that affect water quality in that area. The BRPMP planning area is experiencing significant population growth, with a corresponding increase to activities that impact water quality.

Figure 5 illustrates the gap between the effect projected population growth could have on phosphorus loading in the Bow River and the acceptable levels and aquatic health we enjoy today.

Why is this work important?

Phosphorus levels in the Bow River have long been a concern.

While all is well for now, what happens when we add in our expected population growth over the next 30 years?

Increased population drives:

- Urban development
- Agriculture intensification
- Increased food production
- Activity on the land
- Landscape modifications
- Increased wastewater

The BRPMP Steering Committee focused its work on answering the question, "How can we work together to close the gap?"

New and existing plans that address growth should consider and align with the strategic direction of the BRPMP.

For more information on the context for developing the Bow River Phosphorus Management Plan and cumulative effects management in Alberta, refer to **Appendix A.**

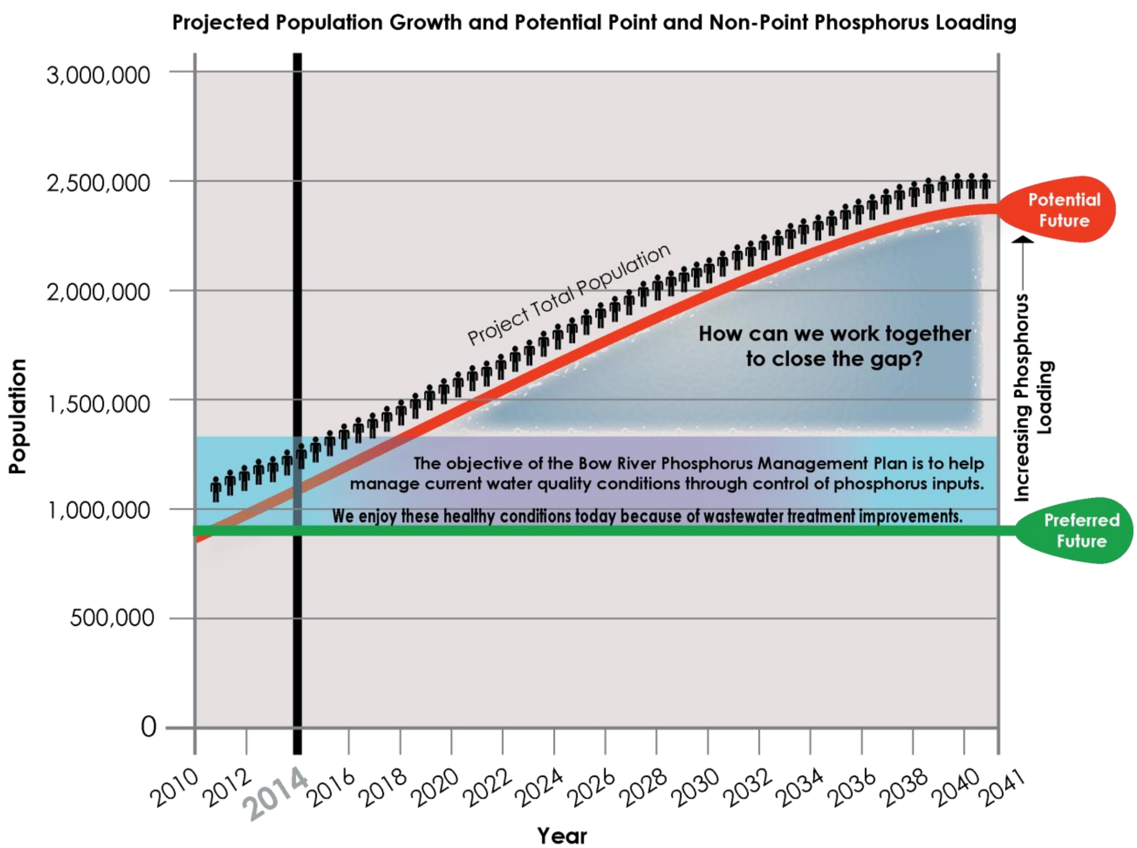


Figure 5: Schematic of projected population growth and potential increase of phosphorus loading

3. APPROACH TO PLANNING

3.1 Water for Life

In 2003, with the introduction of the provincial policy *Water for Life: Alberta's Strategy for Sustainability*, the Government of Alberta established provincial outcomes for water:

- safe, secure drinking water;
- healthy aquatic ecosystems; and
- reliable, quality water supplies for a sustainable economy.

The Water for Life Strategy also established partnerships, including Watershed Planning and Advisory Councils, to encourage collaboration in watershed management and to help achieve the provincial outcomes. The Bow River Basin Council, which is the Watershed Planning and Advisory Council for the Bow River basin, developed watershed outcomes for the most sensitive uses of the Bow River, and established site-specific water quality objectives to achieve the outcomes. These are described in detail in the Bow Basin Watershed Management Plan (BRBC 2012).

These provincial and local outcomes and objectives provided the initial direction for the development of the BRPMP.

3.2 Land Use Framework and Alberta Land Stewardship Act

The Alberta Land-Use Framework was introduced by the Government of Alberta in 2008 (GOA 2008) to address regional issues through a cumulative effects approach, with regulatory backing from the *Alberta Land Stewardship Act* (GOA 2009). This *Act* enables the development of regional plans, and includes a commitment to setting regional thresholds for water quality. Environmental management frameworks are the tools being used to set **limits, triggers** and **targets** (see section 11: Glossary for definitions).

The environmental management frameworks reflect the principles of cumulative effects management by establishing:

- regional objectives that we want to achieve;
- monitoring, evaluating and reporting of performance to assess conditions and achievement of the objectives;
- targets as the desired condition;
- triggers as early signals for proactive response; and
- limits as clear boundaries in the system not to be exceeded.

A Surface Water Quality Management Framework (SWQMF) has been developed under the draft South Saskatchewan Regional Plan to further support the outcome for healthy aquatic ecosystems. The SWQMF identifies trigger thresholds and limits for water quality constituents, such as nutrients and bacteria. Phosphorus is assigned a trigger threshold only, not a limit, due to its characteristic as non-toxic but influential on overall water quality. ESRD has the responsibility under provincial legislation to conduct an investigation and a risk assessment should a trigger threshold be consistently exceeded.

The BRPMP objective to manage to the current water quality conditions aligns with the SWQMF in the draft South Saskatchewan Regional Plan (SSRP). The current water quality conditions are assessed using median concentrations measured monthly at several locations in the Bow River over the period of years from 2008-2011. These median values (Table 1) are essentially the same as the trigger values in the SWQMF for the Bow River. The trigger thresholds for phosphorus in the Bow River were established based on the water quality observations from 2004-2009 and are considered acceptable conditions. The actions contained within the BRPMP are a proactive management approach to avoid exceeding the trigger thresholds into the future. The SSRP requires that water quality be monitored and assessed annually; the results will inform the implementation phase of the BRPMP.

The SWQMF is expected to be legislated under the *Alberta Land Stewardship Act* in 2014. For information on environmental management frameworks see **Appendix B.**

3.3 The Bow River Phosphorus Management Plan

The BRPMP was initiated by ESRD as a prototype for the implementation of environmental management frameworks and an approach for cumulative effects management in Alberta. Specifically it explores a potential management response to a phosphorus trigger exceedance in the Bow River, should this occur in the future. ESRD invited contributing parties and a cross-section of decision makers who have an influence on the management of phosphorus in this reach of the Bow River to participate and form a Steering Committee.

The reach between Bearspaw Dam and Bassano Dam had experienced elevated levels in the past and it was decided that the focus be placed on this area to test a cumulative effects approach for phosphorus management.

BRPMP Task Teams:

- Communication Task Team
- Data Task Team
- Rural Non-Point Task Team
- Urban Non-Point Task Team
- Urban Point Task Team

Task Teams were assembled to tackle the technical issues such as data acquisition and assessment, and sector related management practices. Modelling and mapping tools were utilized to understand various land use scenarios and practice change. For details on the planning process, governance, and communications strategy see **Appendix C.**

The process led to a comprehensive assessment of the current water quality conditions in the Bow River and a better understanding of the potential risks and sources of phosphorus in the planning area. This led to the development of management strategies and actions for contributing parties to implement into the future.

3.4 Principles, Outcome and Objectives of the BRPMP

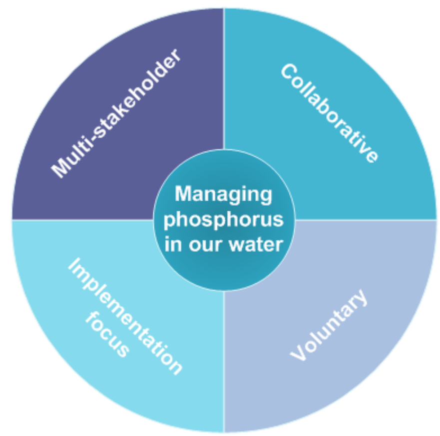


Figure 6: Key principles of the BRPMP

The following key principles of this planning initiative (**Figure 6**) were adopted by the Steering Committee and will be important in the implementation of the strategies and actions:

1. Addressing phosphorus in our water requires a regional approach to manage cumulative effects;
2. The planning process is collaborative, involving all sectors that contribute phosphorus to the Bow River;
3. All sectors will practice stewardship to manage phosphorus from the various sources, with a focus on implementation of the priority strategies and actions; and
4. The planning process is knowledge-based and adaptable to respond to new information.

The management of phosphorus is a cumulative effects issue, and because many of the contributing parties are not regulated, participation in the process is voluntary.

This desired outcome that was seen to rest on the key principles was identified:

"Phosphorus inputs to the Bow River are managed to provide a healthy aquatic ecosystem while meeting the needs of those who rely on clean water."

It is expected that through the achievement of the desired outcome, other water quality outcomes will be realized:

- Healthy aquatic environments ensure aquatic life is not at risk of being exposed to lowered dissolved oxygen levels;
- Water withdrawal systems and intakes are free from blockages by plant materials;
- Water quality is appropriate for recreation, irrigation of crops and livestock watering; and
- Aesthetics of the river are maintained.

In order to translate the broad outcomes into more specific quantifiable statements the following ultimate objective was adopted:

"The objective of the Bow River Phosphorus Management Plan is to help manage current water quality conditions in the Bow River through control of phosphorus inputs."

It is anticipated that the ultimate objective will be achieved through the following supporting objectives:

1. Improve understanding and change behaviour to reduce phosphorus entering the Bow River;
2. Increase knowledge about phosphorus sources, the planning area, and phosphorus management practices;
3. Reduce additions of phosphorus;
4. Reduce the movement of phosphorus to the river; and
5. Remove excess phosphorus from water before it reaches the river.

4. WATER QUALITY CONTEXT

4.1 Where Does Phosphorus Come From?

Point Source loadings from wastewater lagoons and treatment plants are driven by treatment technology and population growth.
Phosphorus enters a water body through a well-defined point of origin and/or discharge often stemming from a single source or conduit.

Non-point source loadings are related to types of land-uses such as stormwater, agricultural, cropping, and livestock management practices.
Phosphorus enters a water body from diffuse points of discharge and has no single point of origin.

(Alberta Water Council 2013)

Phosphorus is a naturally occurring element. In water, it occurs as dissolved phosphorus or in particulate form bound to suspended soil particles. On land, it occurs naturally in soil and is taken up by plants as they grow. Phosphorus is also introduced, for example, through the application of chemical fertilizers.

Sources of phosphorus in the Bow River basin include: plant material, soil, animal waste, treated wastewater effluent, fertilizer in runoff water, sediment from eroding riverbanks, and dust fall (atmospheric deposition). Airborne phosphorus originates from sources such as industry and vehicle emissions, forest fires, and from wind picking up dust, soil and fertilizer and becomes part of the stormwater runoff. Phosphorus captured by wind and falling precipitation is not well studied in this area but is a source of the total phosphorus in the planning area.

Phosphorus loading to the river comes from both point and non-point sources. These sources reach the river by discharging pipes, overland flow, and tributary streams, as well as the headwaters portion upstream of the planning area.

Point sources from wastewater treatment plants and lagoons are driven by treatment technology and population growth. Non-point source loadings are related to types of land-uses. Urban areas that discharge high stormwater flows will tend to generate higher phosphorus loadings compared to areas with lower stormwater flow. Agricultural practices related to fertilizer application, cropping and livestock management can also affect phosphorus loadings.

Modification or alteration of landscape features like wetlands and riparian areas can also affect phosphorus loading. Addressing both point and non-point sources of phosphorus is critical for improving water quality and reducing loading to the Bow River including the reaches downstream of the planning area. It is important to note that the amount of both phosphorus and water in the uplands and headwaters of the planning area must be considered, even though this plan is focused on the middle reach of the Bow River. In this planning phase, the upstream portion has not been a concern but should be closely monitored for changes to phosphorus loading in the future.

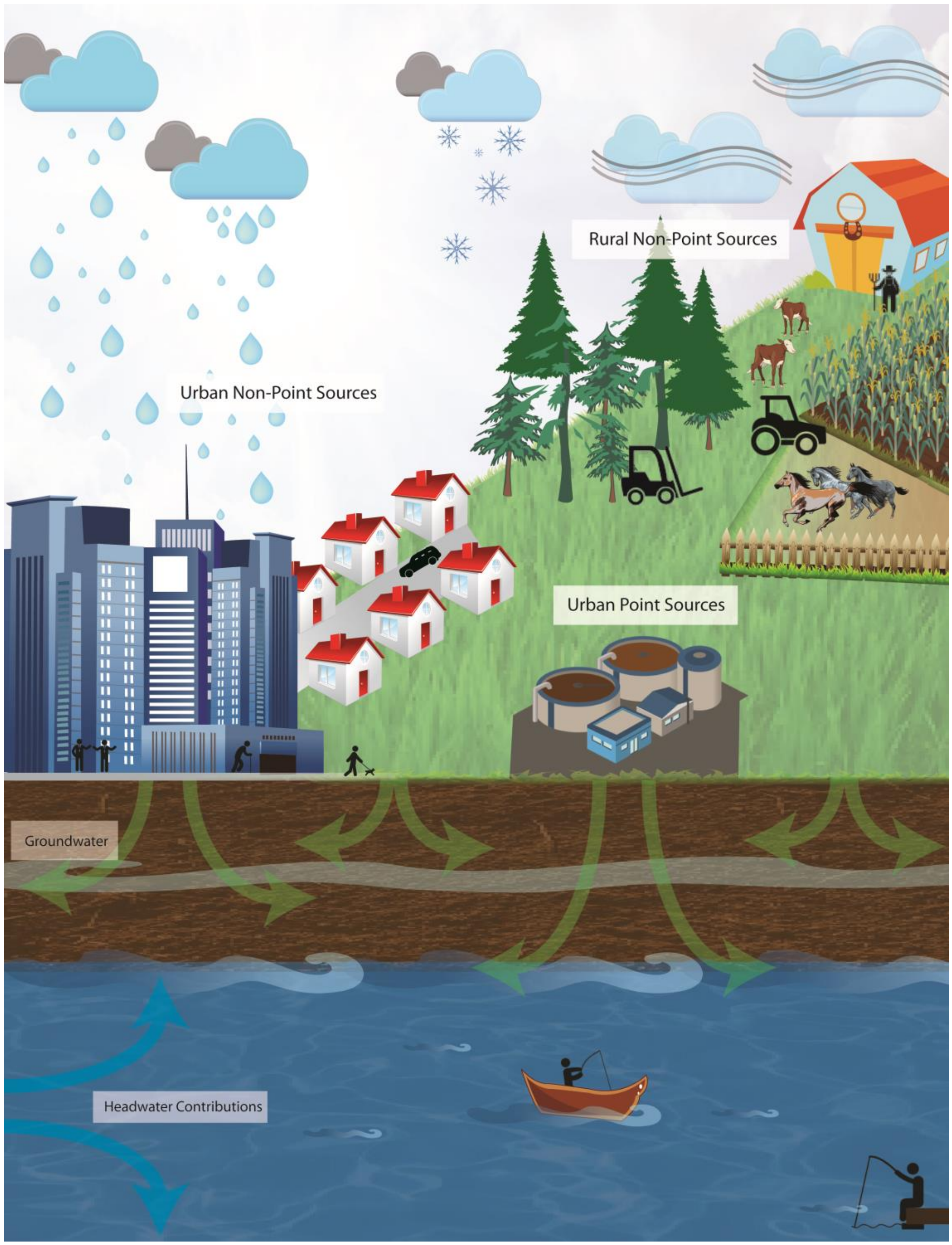


Figure 7: Sources of Phosphorus in the Bow River basin

Point sources

Point sources in the planning area include effluent from wastewater treatment plants and sewage lagoons. There are eight wastewater treatment plants and six lagoons that discharge effluent to the planning area (for locations of these wastewater treatment facilities, see the Wastewater Treatment Plants map in **Appendix D)**. Mechanical wastewater treatment plants are a regulated activity in Alberta, and treatment plants in the planning reach are required to remove phosphorus to a specified level. Lagoons that discharge effluent do not have this requirement but are subject to sampling for total suspended solids and chemical biological oxygen demand prior to discharge.

Point Source - Wastewater Treatment Plant

Non-point sources

Non-point sources of phosphorus enter the streams and rivers in the planning area through overland flow and stormwater runoff from rural and urban areas. Runoff from precipitation picks up phosphorus in fertilizer and pet waste, in leaf fall and dust fall, from manure on agricultural lands and from exposed soil. Phosphorus also enters the river through naturally occurring erosion and sediment transport, which can be exacerbated by land-use activities and degraded land cover.

Land use and land cover have a significant influence on the source and movement of phosphorus. The planning area comprises both rural and urban areas and includes land uses and activities such as recreation, forestry, oil and gas, agriculture, small acreage farms, country residential and urban industrial, commercial and residential lands. Measures to mitigate the effects of non-point source contributions are currently voluntary, though The City of Calgary manages stormwater as an effluent within their wastewater approval.

Urban Non-Point Source

Non-point sources are inherently difficult to measure and this leaves a gap in our understanding of the relative contribution of phosphorus to the Bow River. With further monitoring of tributary streams, stormwater, and diffuse runoff, the sources of phosphorus will be better understood over time.

Understanding all the sources of phosphorus is a difficult and imperfect task. With the results of ambient water quality monitoring, the Data Task Team estimated the total annual load of phosphorus from known sources in **Figure 8**. With data from The City of Calgary and ESRD it is estimated that a significant percentage of phosphorus enters the river from non-point sources, either through the tributaries or from land draining directly to the Bow River.

The amount of phosphorus entering the river differs between open water and ice cover seasons. Non-point source inputs from runoff are highly varied according to seasonal precipitation, with higher amounts occurring during spring snowmelt and rainfall events. In the winter, when both land and water are at least partially frozen, there is very little runoff, and the amount of phosphorus entering the river overland is much less than in the open water seasons. Although more phosphorus enters the river in spring and summer, the lower volume of water flow in winter can cause phosphorus concentrations to be higher in the river during these ice cover months.

Point source inputs from wastewater treatment effluent remain relatively steady year round, and during the open water months, wastewater treatment plants account for about 21% of phosphorus loading into the planning reach of the Bow River. The story told by the graphs in **Figure 8** is that the regulated sector – i.e., wastewater treatment plants – accounts for only a portion of the phosphorus in the Bow River reach, while non-point sources account for a significant proportion of phosphorus inputs, especially during open water months where up to 78% of the phosphorus is from sources other than wastewater treatment plants.

It is understood that phosphorus enters the Bow River throughout the river basin, including above and below the planning area. While more information is required to fully understand the urban and rural pathways of phosphorus to the Bow River, it is important to undertake management actions to proactively prevent future elevated levels of phosphorus in the Bow River.

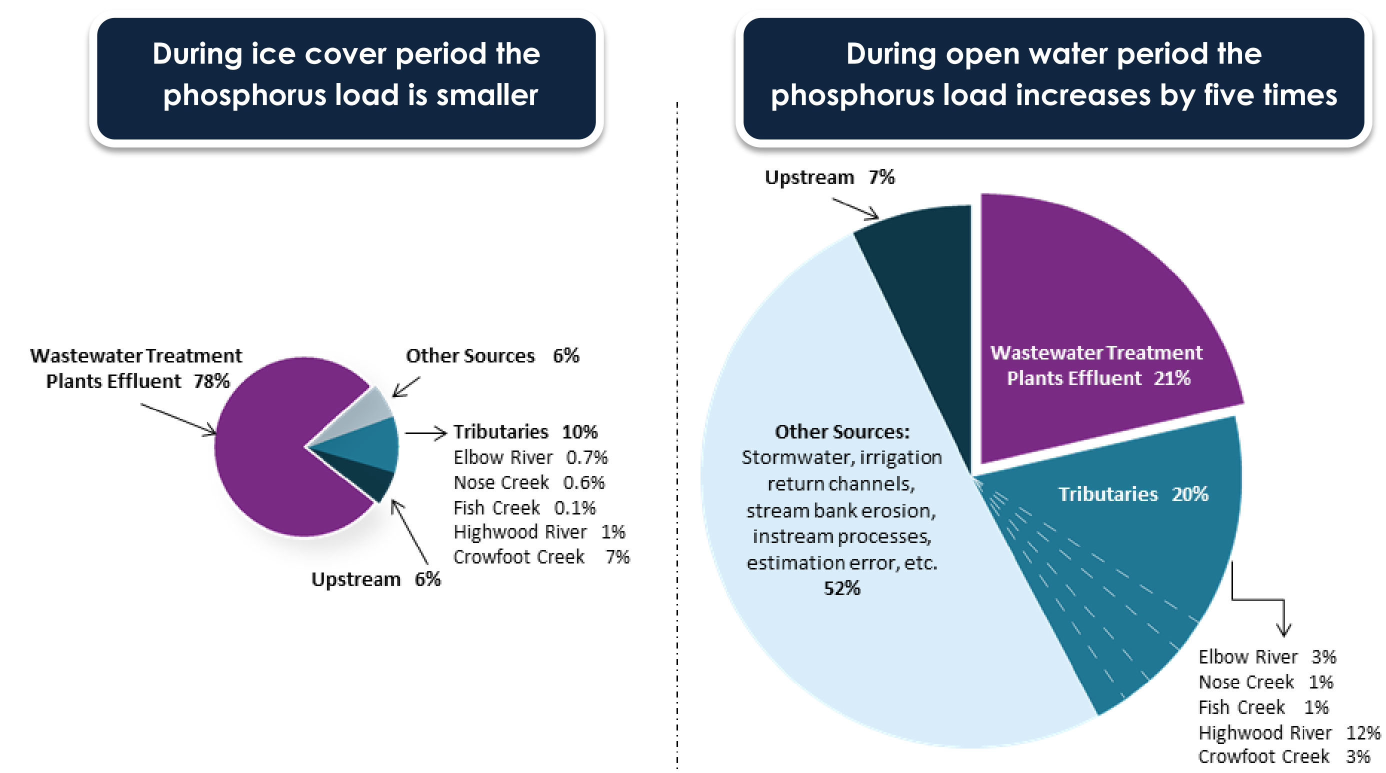


Figure 8: Total phosphorus loads to the Bow River from below Bearspaw Dam to Bassano Dam - median seasonal phosphorus load for Ice Cover months (January–March, November-December) on the left and Open Water months (April–October) on the right. Note the difference in phosphorus loading during open water is five times that of ice cover period. (Source: J. Dixon, The City of Calgary)

4.2 Effects of Excess Phosphorus

What are the effects of excess phosphorus?

Aquatic plants grow in and around water bodies in the presence of sunlight and nutrients. Phosphorus is one of the critical nutrients in aquatic systems, and an overabundance of phosphorus can result in excessive plant and algal growth. Periphyton, the algae that attaches to rocks and other material at the bottom of the river, and macrophytes, the submerged larger plants rooted into sediment, can thus flourish in areas with high phosphorus concentration.

These plants and algae grow and produce oxygen through photosynthesis. Excess nutrients in the river encourage plant growth, which increases oxygen production (photosynthesis) during the day and oxygen consumption (respiration) during the night. If the concentration of oxygen becomes too low at night, fish stress and/or mortality can result, as depicted in the schematic in **Figure 9**.

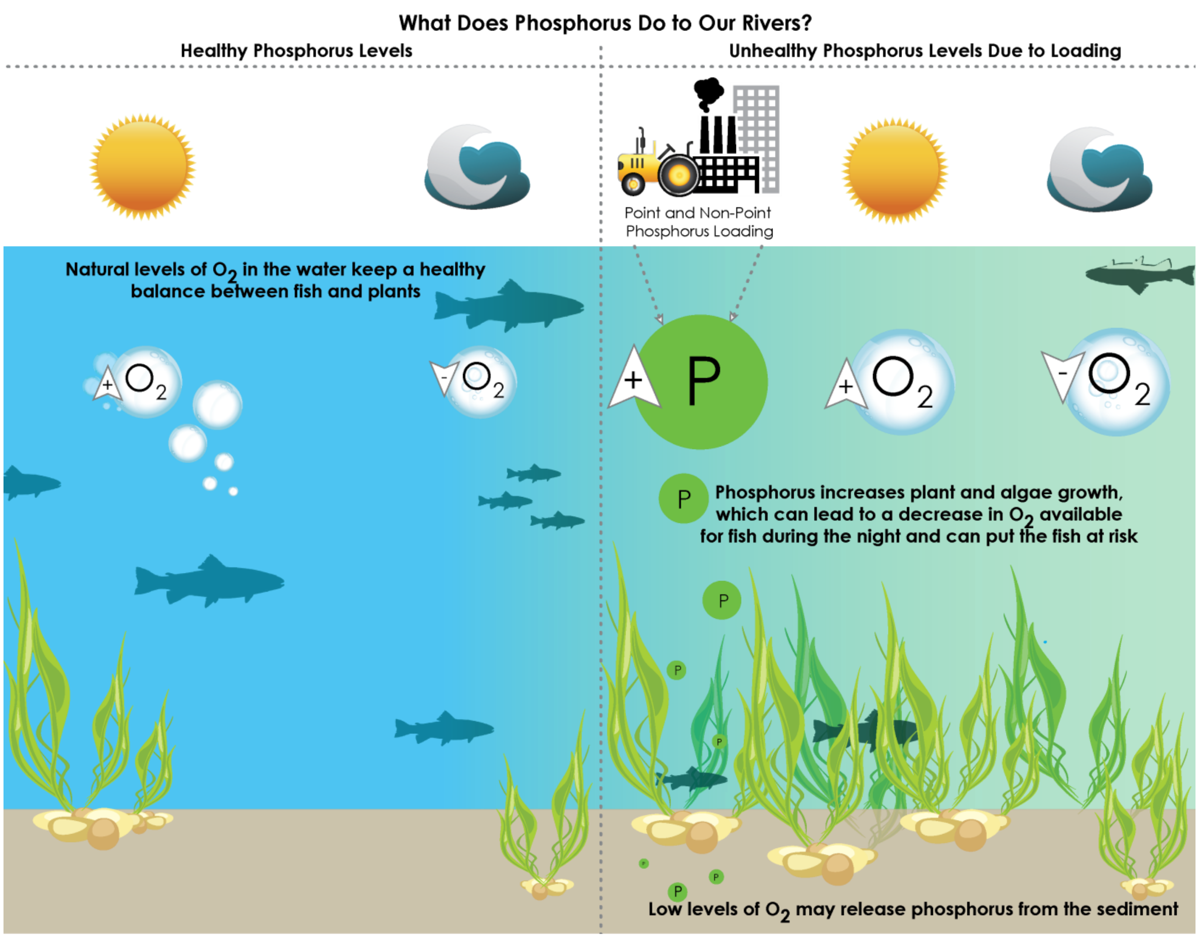


Figure 9: Effects of Phosphorus - The left side of this schematic shows a balance of aquatic plants, nutrients and oxygen in a water body; - the right side illustrates the effects of too much phosphorus in a water body resulting in abundance of aquatic plants and a decrease in oxygen availability at night.

An increase in plant and algal growth can also result in, but is not limited to:

- problems for irrigation and livestock watering where intakes can become blocked;
- decreased flow capacity in irrigation pipes and canals;
- decline in overall water quality as organic plant matter decays and detaches into the water; and
- negative effects on recreation opportunities (boating, angling) and aesthetics.

The economic, social and environmental impacts of these effects include, but are not limited to:

- increased cost and effort to mitigate the effects, for example:
    - wastewater treatment plant upgrades;
    - increased drinking water treatment;
    - canal intake management and treatment;
- increased risk to aquatic ecosystems; and
- decreased aesthetic and recreational value of the river reach.

4.3 Current Water Quality Conditions

Where are we now?

The most recent assessment of water quality conditions in the Bow River includes data from multiple sources. **Figure 10** shows the current median phosphorus concentrations over an eight-year period (2004-2011) from the data for total phosphorus in **Table 1**. The details of this assessment are reported in the Bow River Phosphorus Management Plan, Water Quality Data Analysis (CPP-Hutchinson 2013). A summary is also provided in **Appendix E.**

Current water quality is considered sufficient to maintain a healthy aquatic ecosystem while meeting the needs of those that rely on good quality water in this reach of the Bow River. To ensure phosphorus concentrations remain at acceptable levels and that water quality is acceptable, effective actions must be in place to manage additional inputs into the future.

Conditions at each of these sites will be monitored regularly and assessed annually by ESRD, with the median concentration for each of the monitoring sites compared against the trigger values of total phosphorus and total dissolved phosphorus in the South Saskatchewan Region SWQMF. This will be reported annually by ESRD. If phosphorus levels begin to trend upward, this will trigger an investigation and mandatory actions may be required.

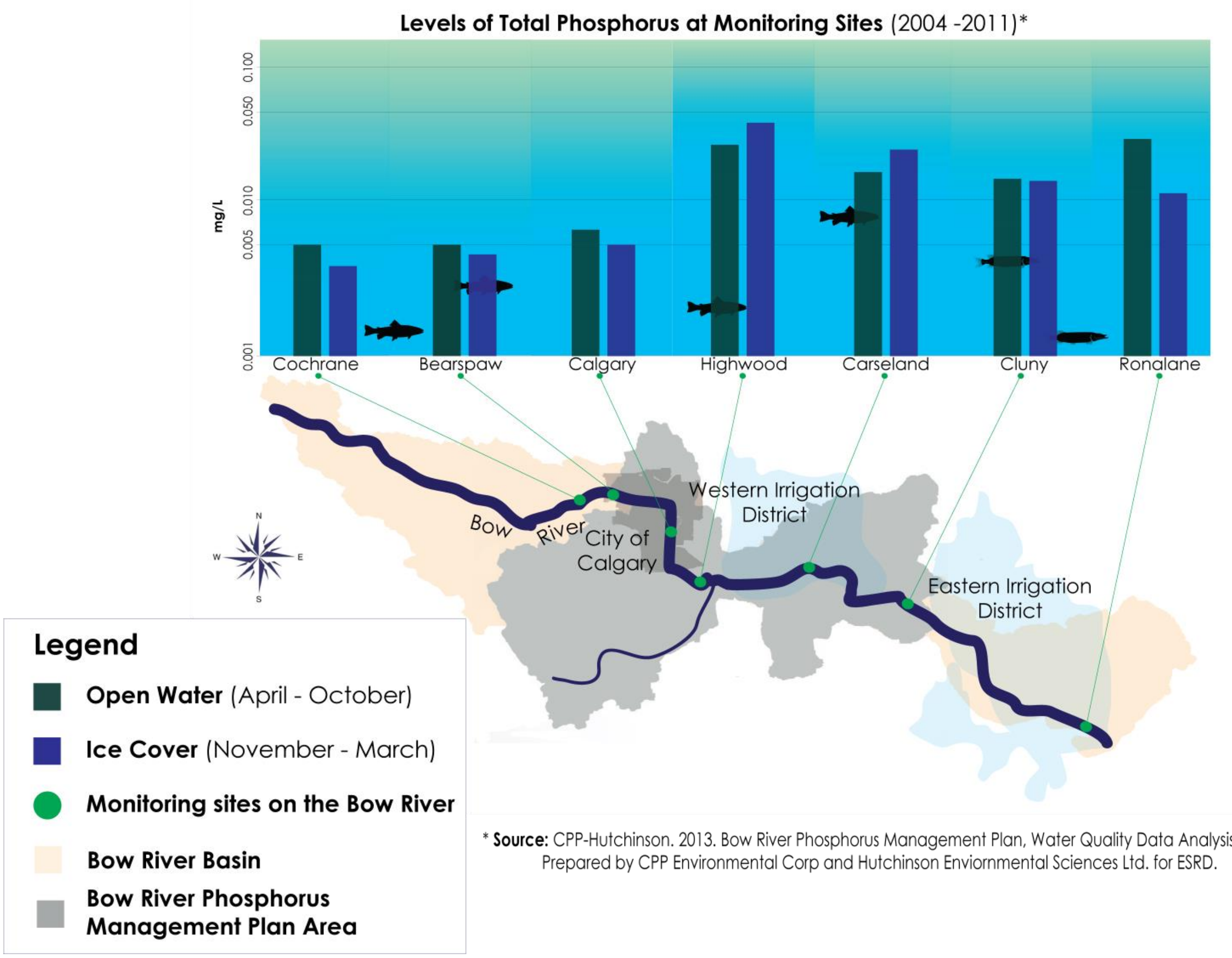


Figure 10: Median phosphorus concentrations at monitoring locations in the Bow River

Table 1: Water Quality Conditions in Open Water and Ice Cover for the period 2004-2011 including Total Phosphorus, Total Dissolved Phosphorus and Periphyton where available. (Source: CPP-Hutchinson 2013)

Water Quality Conditions (2004-2011)	Ice Cover		Open Water		
	Median (mg/L)		Median (mg/L)		Median (mg/m²)
Station Name	**Total Dissolved Phosphorus**	**Total Phosphorus**	**Total Dissolved Phosphorus**	**Total Phosphorus**	**Periphyton**
Cochrane	0.002	0.004	0.002	0.005	18
Bearspaw Dam	0.001	0.004	0.001	0.005	-
Calgary	0.001	0.005	0.001	0.007	-
Highwood River	0.018	0.041	0.010	0.028	-
Carseland	0.015	0.027	0.006	0.019	65
Cluny	0.011	0.017	0.005	0.018	51
Ronalane	0.006	0.012	0.005	0.024	44

4.4 Future Scenarios

Where are we going?

To understand where we are going into the future, a variety of modelling and decision support tools are needed. Some were tested in the process of developing the strategies and actions in the BRPMP. These included risk assessment, benefit-cost analyses, and water quality modelling. As the BRPMP is implemented and evaluated, water quality modelling of various scenarios will be a key input for making necessary adjustments into the future.

Modelling scenarios are used to better understand the impact of phosphorus inputs and management actions on the Bow River. The scenarios development is used to assess how altering the river flows and/or changing the amount of phosphorus entering the Bow River affects the concentration of phosphorus in the river. Several scenarios related to population growth, technology change, land use and intensity changes, as well as changes in headwater inflows, are being examined. The impacts of these scenarios are being assessed using the Bow River Water Quality Model (BRWQM) which shows the impact of various drivers on water quality.

Other tools such as Investment Framework for Environmental Resources (INFFER) were tested in the deliberation of strategies and actions. More work is required to inform the assumptions used in this tool and to better determine the most effective actions to implement from a benefit to cost ratio perspective.

For a description and preliminary results of the scenario modeling and INFFER, refer to **Appendix F**.

5. PRIORITY OBJECTIVES, STRATEGIES AND ACTIONS

The objectives, strategies and actions to manage phosphorus were developed by sector-specific Task Teams for urban point, rural non-point, and urban non-point sources.

In keeping with the principles of the BRPMP, actions were sought from all sectors. The resulting strategies and actions address inputs from multiple sources. The Task Teams used tools such as risk analysis, watershed mapping, and expert knowledge to assess and recommend a suite of strategies and actions that would best manage the amount of phosphorus entering the Bow River. A summary of the priority strategies, actions, timelines and agency participation can be found in **Appendix G**. Other strategies and actions that were considered by the Task Teams but did not receive priority ranking are in **Appendix H.** These should be reviewed in future by the Implementation Committee.

The Urban Point Source Task Team addressed phosphorus management in the operations of mechanical wastewater treatment plants and wastewater lagoons. This team identified population growth as the most important threat to point sources of phosphorus. Wastewater treatment plants in the planning area have in place a total loading objective which requires their effluent concentration to comply with an agreed upon phosphorus load, even as population increases. Therefore, many of the actions from urban point sources are already underway. Additional actions put forward in this plan go above and beyond the regulatory requirements of the ESRD approval.

The Rural Non-Point Source Task Team identified specific threats in rural areas of the planning area and assessed the risk according to the scale of occurrence and the likelihood that it will increase phosphorus in the Bow River. This team had diverse land uses to consider such as agricultural lands, forested lands and transportation infrastructure. Watershed maps were developed to better describe the land cover, land use and topography. The top threats determined were the loss of wetlands, degradation of riparian areas, disturbance linear features, and improper manure management. See maps describing rural land use in **Appendix I**.

The Urban Non-Point Source Task Team viewed the management of phosphorus as a "treatment train" for stormwater from the rooftop to the river. The treatment train refers to all the practices that could be in place along the path that runoff waters take from the roof to the river. Reducing the sources of phosphorus is the most effective strategy, followed by the implementation of best management practices that reduce stormwater runoff through onsite capture and retention, and removal or sequestering of excess phosphorus prior to release to the river. The introduction of new initiatives in low impact development will be important to manage phosphorus from urban non-point sources.

Complementary benefits will be realized in the management of phosphorus. For example, any increase in wetland storage potential, from restored wetlands, could improve flood control and increase habitat to support biodiversity. Also, the implementation of stormwater practices (low impact development) addresses other water quality concerns such as suspended sediment.

The ultimate objective of the Bow River Phosphorus Management Plan is to ***help manage current water quality conditions in the Bow River through control of phosphorus inputs***. The supporting objectives, the strategies and the actions on the following pages were developed to achieve this goal.

Outcome, Objectives, Strategies and Priority Actions to Manage Phosphorus Loading to the Bow River:

Outcome
- **Phosphorus inputs to the Bow River are managed to provide a healthy aquatic ecosystem while meeting the needs of those who rely on clean water.**

Primary Objective
- **To help manage current water quality conditions in the Bow River through control of phosphorus inputs.**

Supporting Objectives
- **Supporting Objectives and Strategies**

Improve understanding and change behavior to reduce phosphorus entering the Bow River.

1.0 Strategy: Provide accessible public education programs to all jurisdictions.

- **1.1** Create education sub-team of BRPMP Implementation Committee to coordinate education activities and develop common messaging for various audiences.
- **1.2** By jurisdiction, determine the status and content of good housekeeping/pollution prevention programs and bylaws.
- **1.3** Educate the public about household phosphorus contributions and provide alternatives to current practices.
- **1.4** Coordinate rural education programs.
- **1.5** Develop and coordinate urban public education programs.
- **1.6** Support stormwater practitioners and associated disciplines with education, tools and training to plan, design, implement, operate and maintain storm drainage systems.
- **1.7** Share innovative solutions and best practices among wastewater treatment personnel.

Increase knowledge about phosphorus sources, the planning area, and phosphorus management practices.

2.0 Strategy: Explore opportunities to address the cumulative effects of phosphorus in the long term.

- **2.1** Develop policy to distribute load allocations among contributing parties and develop policy tools to address cumulative effects issues.
- **2.2** Ensure use of best practices among wastewater treatment facilities.

3.0 Strategy: Monitor and evaluate water quality conditions in the Bow River basin to establish a baseline and investigate risk to the aquatic environment and potential management actions if phosphorus levels trend upward.

- **3.1** Continue to monitor water quality at Long-Term River Network sites and The City of Calgary sites, report results annually to BRPMP Implementation Committee, evaluate and enhance monitoring where appropriate.
- **3.2** Conduct water quality sampling at appropriate locations on tributaries, such as the Sheep and Highwood Rivers and West/East Arrowwood and Crowfoot Creeks.
- **3.3** Conduct water quality sampling in irrigation district supply water and regional return flow.
- **3.4** Implement appropriate stormwater monitoring, and report on findings.

4.0 Strategy: Complete accurate inventory of landscape mapping to determine risk and establish baseline conditions.

- **4.1** Initiate a proof of concept in a small watershed to develop a process for identifying Critical Source Areas, i.e., areas contributing the most runoff and phosphorus.
- **4.2** Complete accurate inventory and health assessments of current, drained and altered wetlands and riparian areas in the planning area.
- **4.3** Update mapping of land layers, precipitation, etc., and integrate inventories into Geographic Information System (GIS); Update landscape mapping from Canada Farm Census; Track inventories and health assessments and create a database of beneficial/best management practices (BMP) implementation for non-point sources of phosphorus.

5.0 Strategy: Conduct research and fill data gaps to advance knowledge in phosphorus management and mitigation options.

- **5.1** Foster and coordinate research opportunities related to phosphorus management and mitigation (e.g., new technologies).
- **5.2** Disseminate research to relevant stakeholders.
- **5.3** Refine information used to populate the assumptions for the Investment Framework for Environmental Resources (INFFER) for Benefit: Cost ratio. Apply INFFER to Rural Non-Point actions using refined data.
- **5.4** Evaluate urban and rural stormwater BMPs for their ability and efficiency to treat phosphorus.
- **5.5** Conduct research on the effectiveness of wetlands in the planning area to manage phosphorus.

6.0 Strategy: Use models to anticipate new phosphorus loadings as growth occurs in the planning area, and to test current and future scenarios.

- **6.1** Update and refine water quality modelling to take into account phosphorus management activities.
- **6.2** Update and refine stormwater modelling to take into account phosphorus management activities.
- **6.3** Evaluate the contribution of urban stormwater BMPs on private land.

7.0 Strategy: Evaluate and align policies.

- **7.1** Conduct a regulatory review to evaluate municipal legislative and policy options to address issues related to small acreage development and land and livestock management.
- **7.2** Conduct a regulatory review to evaluate municipal legislative and policy options to address implementing urban BMPs on private land.
- **7.3** Remove regulatory barriers to the use of innovative BMPs for rainwater, stormwater and wastewater, including reuse of same.

Reduce additions of phosphorus.

8.0 Strategy: Facilitate the adoption of livestock manure nutrient best management practices to reduce phosphorus build up and runoff loss potential.

- **8.1** Complete risk assessments for commercial livestock operations and encourage adoption of practices to mitigate risk associated with: manure application; confined feedlot operations livestock feeding; and seasonal feeding and bedding sites; Promote BMP implementation in high priority areas.

9.0 Strategy: Reduce urban additions of phosphorus.

- **9.1** Investigate the feasibility and desirability of a phosphorus fertilizer restriction for both private and public realms for various urban contexts.
- **9.2** Work with industries to control loadings to wastewater treatment facilities.

Reduce the movement of phosphorus to the river.

10.0 Strategy: Achieve the goal of no further net loss of wetlands in the planning area.

- **10.1** Ensure developers and land owners adhere to current legislation and the new Alberta Wetland Policy and Wetland Mitigation Process.
- **10.2** Utilize current tools (including legislation and enforcement) and incentive programs to preserve wetlands, and if necessary develop new conservation tools.

11.0 Strategy: Work toward achieving wetland restoration objectives for the planning area.

- **11.1** Promote wetland restoration in areas where wetland losses have been high.
- **11.2** Promote current incentive programming.
- **11.3** Develop new conservation and restoration tools

12.0 Strategy: Maintain and improve riparian area function.

- **12.1** Utilize extension programs, policy, codes of practice and conservation tools to promote protection and restoration of riparian areas in the planning area, starting in priority areas; incorporate buffers and stormwater management facilities upstream into landscape planning and development.
- **12.2** Increase the adoption of livestock grazing and off-stream watering BMPs.

13.0 Strategy: Reduce sediment loading from regional drainage and return flow channels.

13.1 Create inventory of natural channels subject to erosion risk and prioritize areas to be addressed.

13.2 Increase the adoption for erosion control measures to reduce sediment transport from agricultural lands.

13.3 Convert canals to pipelines where possible to reduce return flow from irrigated lands.

14.0 Strategy: Minimize erosion and control sediment movement

14.1 Require the adoption of Erosion and Sediment Control (ESC) BMPs during construction and repair activities and coordinated compliance of ESC.

14.2 Require ESC designers and inspectors to obtain professional certification. Consider this in the revision of the Municipal Government Act.

14.3 Identify and reclaim unused & unofficial recreation trails.

14.4 Enhance enforcement of responsible recreation trail use.

Remove excess phosphorus from water before it reaches the river.

15.0 Strategy: Reduce amount of phosphorus per capita entering the Bow River PMP planning area.

15.1 Initiate pilot projects to remove phosphorus from lagoons.

16.0 Strategy: Establish regional watershed targets.

16.1 Establish and enforce runoff volume targets for development in all watersheds in the planning area.

16.2 Establish and enforce phosphorus loading targets for development in all watersheds in the planning area.

17.0 Strategy: Maximize the effectiveness of Wastewater Treatment Plants to reduce outputs of phosphorus.

17.1 Seek opportunities to implement upstream phosphorus management actions to reduce phosphorus inputs in the planning area.

17.2 Examine the feasibility and best timing to introduce new strategies for removing P from wastewater.

18.0 Strategy: Review lagoon Code of Practice and regulations to allow for maximum phosphorus removal.

18.1 Review Code of Practice for lagoons.

19.0 Strategy: Ensure quality assurance of current practices for lagoon operations.

19.1 Have lagoon operators work together to determine optimal times for releasing effluent from lagoons.

6. IMPLEMENTATION

6.1 Establishing an Implementation Committee

ESRD will take an active role in providing leadership for the establishment and ongoing efforts of the Implementation Committee. Similar to the composition of the Steering Committee, it is anticipated that the Implementation Committee will be largely composed of contributing parties as key implementers (i.e., organizations and individuals who can play an active role in helping to move the actions forward). Along with serving as a catalyst for moving the plan forward, a key task of the Implementation Committee will be the development of an implementation work plan (i.e., a road-map with activities to help move the plan forward). However, the implementation of strategies and actions can begin before the completion of such a work plan.

The Implementation Committee will make recommendations for renewal of the BRPMP as it progresses and as new information becomes available. Consideration will be given to aligning this with the review period of the South Saskatchewan Regional Plan, which requires annual progress reporting, a five-year formal report and ten-year renewal. Reporting should allow some flexibility in approach but should be directed to all agencies identified for the implementation of strategies and actions, and other interested parties. ESRD will administer the reporting on a public website.

Education and outreach were identified as critical to the successful implementation of the BRPMP. ESRD will establish an Education and Outreach Working Group to move this forward. Provided strong linkages and the element of cross-over exist, this work could be conducted concurrently with the work of the Implementation Committee and in conjunction with the work of the Performance Measures Working Group, whose task is described in Section 7: Evaluation, Adjusting and Reporting.

Next Steps:

1. **Build on the knowledge of the Steering Committee and Task Teams**
2. **Encourage contributing parties to commit to implementation of strategies and actions relevant to their sector**
3. **Strike an Implementation Committee with a balance of interests**
4. **Develop an implementation plan and road map to move the BRPMP forward**
5. **Identify opportunities for pilot technologies to be explored**
6. **Explore and secure new sources of funding**
7. **Establish an education and awareness working group**

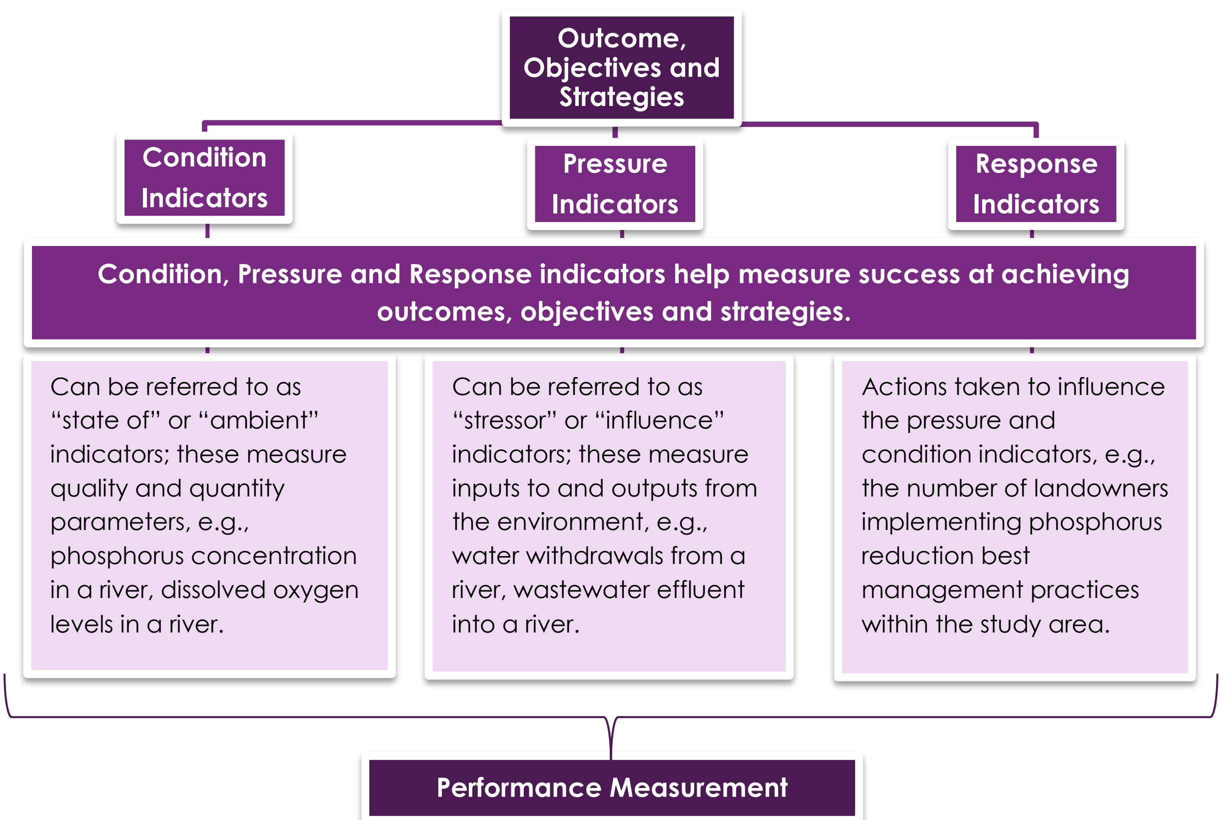
The success of the Implementation Committee and the two working groups will be dependent on the collective action of all contributing parties.

7. EVALUATION, ADJUSTING AND REPORTING

7.1 Performance Measures

The Performance Measures Working Group was created to support the selection of indicators to monitor the success of the BRPMP, and also to contribute to the development of a system to sustain the on-going monitoring, evaluation and reporting of the indicators selected. This working group will report to the Implementation Committee and is made up of members from the Government of Alberta as well as non-government sectors.

Performance measurement involves assessing and tracking progress towards a desired outcome and is often measured using a full suite of indicators including condition, pressure and response indicators.



Effective environmental management actions are those that produce the desired change in the targeted conditions, pressures and responses. The BRPMP and the strategies and actions it contains are all examples of management actions. Together, the condition, pressure and response indicators help us to measure how successfully our management actions are achieving outcomes and objectives. The goal is to select a representative suite of condition, pressure, and response indicators which consider environmental, social and economic factors and meet the needs of decision makers. It is helpful to identify targets for the indictors selected to enable better understanding of changes over time toward or away from the stated outcome, objectives and strategies.

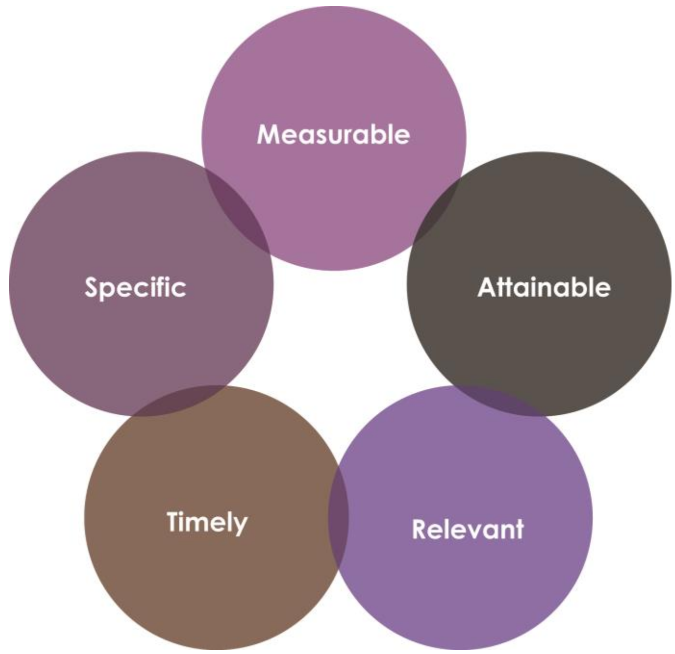
7.2 Candidate Indicator Examples

The Performance Measures Working Group is researching potential indicator candidates for the BRPMP. The growing database of candidate indicators has a cross-section of characteristics. The following are examples of possible indicator candidates from this database and a preliminary assignment of the characteristics. These indicators as well as many more from the database will be further evaluated during the implementation phase.

Table 2: Candidate Indicator Examples

Example Indicator	Condition Pressure Response	Environmental Social Economic	Outcomes (Short, Medium, Long Term)	Qualitative Quantitative
Phosphorus (Total and Total Dissolved)	Condition	Environmental	Med-Long Term	Quantitative
Nitrogen (Total Nitrogen/Nitrate)	Condition	Environmental	Med-Long Term	Quantitative
Macrophyte/Periphyton	Condition	Environmental	Med-Long Term	Quantitative
Dissolved Oxygen	Condition	Environmental	Med-Long Term	Quantitative
Total Suspended Solids	Condition	Environmental	Med-Long Term	Quantitative
Riparian Health	Condition	Environmental	Med-Long Term	Qualitative
Loss of Wetlands	Pressure	Environmental	Med-Long Term	Qualitative
Erosion & Sediment Control	Response	Social	Short Term	Qualitative
Agricultural BMP Adoption Rates	Response	Social	Short-Med Term	Qualitative
Watershed Scale: Sustainable Program Support	Response	Economic	Short-Med Term	Quantitative

The indicator selection process described in **Appendix J** will be used by the Performance Measures Working Group to assist in selecting a representative suite of indicators to measure the success of the BRPMP. A major component of the selection process will be the application of SMART criteria (Specific, Measureable, Attainable, Relevant, and Timely).



Specific

- Will the indicator provide sufficient information and knowledge to be useful to decision makers?
- Does the indicator link closely to a strategy or outcome?

Measurable

- Can we measure the indicator?
- Is there a monitoring, evaluation and reporting system in place to support the indicator, or will one have to be created?
- Has a target already been identified for the indicator?

Attainable

- If the indicator is measureable, is the data accessible over the long-term?
- Will the monitoring, evaluation and reporting be affordable over the long-term?
- Will the target audience be amenable and responsive to the indicator?

Relevant

- Does the indicator relate to the study area?
- How many times was each particular indicator suggested? If an indicator is suggested for more than one purpose, perhaps it should be strongly considered.

Timely

- Can the indicator be monitored, evaluated and reported in a timely manner to be useful to decision makers?

8. ENDORSEMENTS AND CONTRIBUTING PARTIES' RELATIONSHIP TO BRPMP

The following organizations make up the Steering Committee of the Bow River Phosphorus Management Plan. Their signatures represent a commitment by their organization to pursue the strategies and actions relevant to their activities and to implement the actions that their organization is capable of achieving over the next several years. For best results, collaboration and coordination among organizations is encouraged and coordinated through the BRPMP Implementation Committee.

Table 3: Steering Committee Endorsements

Organization	Name and Title	Signature(s)
Agriculture and Agri-Food Canada	Francois Eudes, Acting Research, Development and Technology Transfer Director	
Alberta Agriculture and Rural Development	Sean Royer, Executive Director Environmental Stewardship Division	Via Email on Jan. 29, 2015
Alberta Environment and Sustainable Resource Development	Robert Stokes, Executive Director, Resource Integration Planning Branch & Martin Foy, Executive Director, South Saskatchewan Region	
Bow River Basin Council	Mike Kelly, Chair of the BRBC Board of Directors	
Calgary Regional Partnership	Colleen Shepherd, Executive Director	
City of Airdrie	Paul Schulz, City Manager	
City of Calgary	Rob Spackman, Director, Water Resources	
Corix Wastewater Treatment Operators (Heritage Pointe)	Todd Faith, Operations Supervisor	
Crop Sector Working Group	Sharon McKinnon	Via Email on Jan. 4, 2015
Irrigation Districts	Erwin Braun, General Manager, Western Irrigation District	
Municipal District of Foothills	Harry-Riva Cambrin – Chief Administrative Officer	
Rocky View County	Nona Housenga, Manager Legislative Services	
Rural Non-Government Organizations - represented by Ducks Unlimited Canada	Milana Simikian, Provincial Policy Specialist	Via Email on Jan. 12, 2015
Town of Okotoks	Rick Quail, Municipal Manager	
Town of Strathmore	Michael Ell, Mayor	
Urban Non-Government Organizations - represented by Alberta Low Impact Development Partnership	Leta van Duin, Executive Director	
Watershed Stewardship Groups – represented by Highwood Public Advisory Committee	Shirley Pickering, Chair, Bow River Basin Council Watershed Stewardship Coordinating Committee	
Wheatland County	Glenn Koester, Reeve	

Comments:

Alberta Environment and Sustainable Resource Development: *"As the sponsoring agency to the Bow River Phosphorus Management Plan, ESRD is indebted to a number of people who worked through the process to develop a plan that will help Alberta address the cumulative effect of phosphorus on this* *reach of the Bow River. Through this process we learned a great deal, including the value of working together with partners to solve a problem that can impact our society, our environment and our economy. This prototype project also helped us understand how we can address any future exceedances in the Surface Water Quality Management Framework under the South Saskatchewan Regional Plan. To date, we are maintaining an acceptable level of phosphorus and with the collective implementation of the strategies and actions; we hope to continue to work to achieve our outcome as our society and economy grow. We are committed to leading the implementation phase and we recognize that we can't do it alone. Thank you for your past and continued support toward our shared success. "*

Alberta Low Impact Development Partnership: *"The Alberta Low Impact Development Partnership Society will continue to facilitate knowledge-sharing, education, and pooling of resources to equip the urban non-point-source sector to achieve the outcome of the Bow River Phosphorus Management Plan."*

City of Calgary: *"The City of Calgary endorses the BRPMP and will continue to support phosphorus management through its Total Loading Management Plan strategies, programs, and projects to meet The City's total loading objective for phosphorus."*

9. ACKNOWLEDGEMENTS

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Stakeholder Advisory Group organizations: Agriculture and Agri-food Canada, Alberta Agriculture and Rural Development, Alberta Irrigation Projects Association, Alberta Low Impact Development Partnership, Alberta Wilderness Association, AMEC, Battle River Watershed Alliance, Bow River Basin Council, Bow River Irrigation District, Calgary Regional Partnership, Calgary River Valleys, City of Airdrie, City of Edmonton, Corix, Cows and Fish, Crop Sector Working Group, Department of Fisheries and Oceans Canada, Ducks Unlimited Canada, Eastern Irrigation District, EnCana, Environment and Sustainable Resource Development, EPCOR, EXP Consultants, Glencoe Golf and Country Club, Intensive Livestock Working Group, Land Stewardship Centre, Matrix Solutions Consultants, MPE, Municipal District of Foothills, Natural Resources Conservation Board, O2 Design Consultants, Rocky View County, Siksika First Nation, Spray Lake Sawmills, Stoney First Nation, The City of Calgary, Town of Chestermere, Town of Okotoks, Town of Strathmore, Alberta Transportation, Trout Unlimited Canada, Tsuu T'ina First Nation, University of Alberta, University of Calgary, Urban Systems Ltd, Watershed Stewardship Groups, Western Irrigation District, Western Sky Land Trust Society, Wheatland County.

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11. GLOSSARY

(Sources: http://environment.gov.ab.ca/info/library/8043.pdf; Canadian Council of Ministers of the Environment, and others)

Accountability – the obligation to demonstrate and take responsibility for performance based on agreed expectations. Accountability answers the question – "who is responsible to whom and for what?" Sharing responsibility with others, or delegating it to them, does not eliminate Ministerial accountability for the environment.

Action – an organized event or series of events that is led by an organization to achieve an objective, accomplished through specific activities.

Adaptive Management – a dynamic system or process of task organization and execution that recognizes the future cannot be predicted perfectly. Planning and organizational strategies are reviewed and modified frequently as better information becomes available. Adaptive management applies scientific principles and methods to improve management activities incrementally as decision-makers learn from experience, collect new scientific findings, and adapt to changing social expectations and demands.

Biomass – the total mass of living biological material (organisms) at a given time, in a given area.

BMP – refers to a Beneficial Management Practice or Best Management Practice. These are essentially the same but depending on the practice, the location or the issue there may be several options available, which if adopted, may address a concern. While the term 'best' implies that there is only one practice to address a concern, the term 'beneficial' describes a situation where several different practices could be adopted, either individually or in combination to address a concern. The effectiveness of the practices is also site-specific. What might be considered a best or beneficial practice in one location may not be the best solution in another location. The amount of impact or benefit a practice can provide fluctuates based on the specific conditions where it is adopted.

Collective Action – the bringing together of contributing parties and where appropriate, decision makers etc., to design and implement a solution.

Contributing Parties – are organizations and individuals whose use of resources, or release to the environment, impact the parameter or contributes to this risk of cumulative effects.

Critical Source Area – a location on the landscape where phosphorus coincides with an active hydrologic transport mechanism.

Cumulative effect – a change in the environment caused by multiple interactions among human activities and natural processes that accumulate across space and time.

Cumulative effects assessment – a systematic process of identifying, analyzing, and evaluating cumulative effects.

Cumulative effects management – the identification and implementation of measures to control, minimize or prevent the adverse consequences of cumulative effects.

Geographic Information System – a computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the earth's surface. GIS can be used for handling various types of maps. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map, and layers of data are organized to be studied and to perform statistical analysis.

Goal – the result or achievement toward which effort is directed; aim; end.

Indicator – a direct or indirect measurement of some valued component or quality in a system, including an ecosystem or organization. For example, an indicator can be used to measure the current health of the watershed or to measure progress toward meeting an organizational goal.

Input - the anthropogenic or natural addition of phosphorus to the receiving water body.

Limit – a limit represents a level at which the risk of adverse effects on environmental quality is becoming unacceptable. Limits consider current science, are quantitative, meaningful and future-focused.

Mitigation – the act of making less severe.

Non-Point Source – non-point source pollution is contamination that enters a water body from diffuse points of discharge and has no single point of origin; it often has origins and discharges that are small, widespread and difficult to pin point.

Objective – the desired end result or goal in well-defined, measurable terms achievable within a certain timeframe. Objectives translate the broad outcomes into more specific quantifiable statements.

Outcome – the result of either planned or unplanned actions. For planning purposes, "outcomes" are the desired endpoint and should guide the development and implementation of related programs. Outcomes can be broad and long-term in nature or focused. They are used in both direction setting and performance measurement. Used interchangeably with Goal.

Point Source – point source pollution is contamination that enters a water body that has a well-defined point of origin and/or discharge; it often stems from a single source/conduit.

Riparian area – includes any land that adjoins or directly influences a water body and includes floodplains and land that directly influences alluvial aquifers. Typical examples include the green ribbons of lush vegetation that grow on floodplains and watercourse banks. They usually are distinctly different from surrounding lands because of unique soil and vegetation characteristics that are influenced by the presence of water above the ground and below the surface. Water is present due to a water body or elevated water table such as in a seep or spring.

Source – the place or thing from which phosphorus originates.

Source control – the management of phosphorus at or near the location where it originates.

Stakeholder – an individual, organization, or government with a direct interest in a particular process or outcome.

Stormwater - water discharged from a surface as a result of rainfall or snowfall.

Strategy – a perspective, position, or plan developed and undertaken to achieve goals. It is the bridge between policy and concrete actions that outlines how a policy will be implemented to achieve its goals.

Target – an indicator value that is representative of the desired environmental condition. The target is established with consideration of social, economic and environmental trade-offs. It may be short-term or long-term in nature as they continue to evolve in response to changing context and information. Targets may be defined qualitatively or quantitatively but should be established so that system performance can be measured against it.

Treat – to apply any method, technique, or process (including neutralization and stabilization) that is designed to change the physical, chemical, or biological character or composition of a substance, including water.

Trigger – triggers are set in advance of limits as early warning signals. They represent the points at which a management response will occur. The management response is intended to be place-based and would depend on the circumstances.

Triple Bottom Line – a decision-making, planning and reporting framework that provides a more comprehensive decision-making approach to help organizations identify the social, economic, and environmental (SEE) impacts of their decisions. In government, TBL thinking is being used to:

- Achieve the objectives of sustainable community development,
- Identify the full range of costs and benefits of decisions, and
- Minimize harm to its citizens, economy and environment.

Vision – a clear, compelling and achievable picture of the preferred future.

Wastewater Treatment – any of the mechanical or chemical processes used to modify the quality of waste water in order to make it more compatible or acceptable to man and his environment.

Water quality – the chemical, biological and physical characteristics of water, usually with respect to its suitability for a particular purpose.

Wetland - land that has the water table at, near, or above the land surface, or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to the wet environment" (Tarnocai, 1980 in GOA 2012b). If the rooting zone extends below the water table, the area is a wetland (National Wetlands Working Group, 1988). (From Stepping Back from the Water (GOA 2012b)