



**Workbook
for Developing Lake
Watershed Management Plans
in Alberta**



Workbook for Developing Lake Watershed Management Plans in Alberta

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VISION

The Alberta Lake Management Society's (ALMS) vision for lake management:

“Albertans enjoying the benefits of healthy lake and aquatic environments, with an understanding of the responsibilities needed to achieve this vision.

Albertans appreciate and work within an ecological framework to ensure a sustainable future for healthy lake and aquatic ecosystems.”

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1.0

Introduction



In Alberta, the process to manage watersheds is complex, with multiple levels of government and a variety of user groups to consider. Lake watershed management planning must take into consideration broad interests, the needs of the local community, and the needs of the general public. ALMS has created this workbook and supporting reference material as a decision support tool and procedural guide for citizens interested in protecting and managing their lake. We hope this will help stewards protect lakes by better enabling them to tap the resources required for achieving their goals.

Lake watershed management planning is a strategic processes that is intended to help lake stewards develop and implement actions to maintain or improve lake ecosystems. This includes managing human activities on land that may impact aspects of lake water quality and quantity and also the associated fish, vegetative and wildlife communities. The plan will collaboratively focus stewardship activities as well as regulations and policies that can be applied to restore and maintain the health of the lake watershed as a whole.

By using a consistent process, the creation of lake watershed plans can not only link science, opportunities, processes and potential partners in a shared plan to get specific results for each lake, but also allow for greater synergies across the parties involved with lake watershed management in Alberta.

This workbook is divided into nine main sections and aligns with the 16 steps for watershed management planning recommended by the Government of Alberta.

- **Section 2** outlines in greater depth background to more fully understand the need for and the intent of the document.
- **Section 3** sets the regulatory and policy context for lake management in Alberta.
- **Sections 4 through 6** provide a 'how to' on developing a Lake Watershed Management Plan for your basin. They cover steps 1 through 10 of the 16 recommended for developing a watershed management plan.
- **Section 7** provides guidance on how to implement a plan once it is developed. Steps 11 to 13.
- **Section 8** describes appropriate monitoring to determine if lake outcomes are being realized on the ground or whether the plan needs to be adapted. Steps 14 to 16.
- **Section 9** gives some final thoughts on lake watershed management planning in Alberta.
- **Section 10** is a list of references and resources grouped by topic.



2.0

The Context for Lake Management in Alberta

Lakes are important natural resources and with an estimated 800 lakes in Alberta, an integral part of Alberta's landscape. Moreover, Alberta's lakes are diverse; the Lakeland region has clear lakes with sandy beaches, in the prairies and parkland regions lakes are warm, green and shallow, the Boreal yields brown water lakes, and in the mountains lakes are clear and cold. Recently, manmade lakes have been added to the landscape as reservoirs and for stormwater controls in urban environments. Each of these lakes support different ecosystems and uses that Albertans benefit from, including many economic, social, cultural, and environmental goods and services provided naturally through these unique, complex ecosystems. As a source of recreation, lakes support boating, fishing, swimming, and simple aesthetic enjoyment. They have economic value in tourism, real estate, and also through supply of water for municipal, industrial, and agricultural use. Lakes in themselves are complex ecosystems in which the lives of plants and animals within them and bordering them are all delicately intertwined.

The quality of our lake resources is the cumulative result of the people and their activities within a lake's watershed. In Alberta, recent increased economic growth has resulted in rapid population growth and related development - some lake communities have experienced nearly 40% increases in population in the last

decade. Current projections are that population growth and development will continue and pressure will continue to increase on lakes as more people look for recreational sites and property. As well, people are choosing lakeside as a permanent versus seasonal living arrangement more often. We are seeing additional development in lake watersheds such as deforestation, road building, resource extraction, changes in agricultural practices, and the increase in country residential homes. With both increased development and changes in residency styles come mounting pressure on shorelands and lakes and they cannot be expected to assimilate all impacts forever. The need to manage lakes as a limited resource requiring purposeful planning and action is real and immediate.

What are the risks to lakes?

- Eutrophication: The Algae Takes Over
- Sedimentation: The Lake Fills In
- Acidification: Air Pollution Affects Lakes
- Toxic Contamination: Excess Chemicals Contaminate Lakes
- Invasive species: Out-compete native species





Lake characteristics are defined by the surrounding watershed and often the land-uses within the watershed. Land cover and land use in a lake’s watershed directly affect the quality and quantity of water entering a lake. For example, with the risk of oversimplifying, the quantities of pollution (nutrients and sediment) transported from a square kilometre of urban land are several times that transported from an equivalent area of agricultural or crop land, which in turn are several times greater than the amount transported from an undisturbed area (e.g. forest). These changes can be attributed to both the addition of new sources to the land base (e.g. fertilizer) as well as the alteration of cover which affects volume and speed of water runoff, allowing greater transport of materials from the landscape. One or both of these processes can be occurring simultaneously. As an example, research has shown that with as little as ten percent development in a lake’s watershed we can begin to see effects in the lake in terms of increased nutrient and sediment inputs.

Lakes, and the watersheds that sustain them, need to be systematically and purposefully managed over time if they are to sustain their long-term health and viability. Lake management requires the collective resources of citizens, municipal and provincial governments as well as local commercial enterprise.

Neglect often results in negative impacts, water quality declines, lost fisheries and ultimately lost revenues and a degraded quality of life. There are many tools to manage for specific lake outcomes and no one tool will work for each lake. That said, it is recognized that it is far more economical and efficient to take proactive steps to manage lakes and their watersheds before problems arise rather than to restore already impaired lakes. It is recognized that management at the watershed scale is the most effective and long-term solution for protecting a lake. In-lake treatments to address an existing problem, although also used, are more expensive and more uncertain for long-term management. This is illustrated in Figure 1.


Before beginning to ‘fix’ or protect a lake it is important to plan and answer these important questions:

- What do you know about the lake now? (present conditions)
- How has it changed? (trends)
- What do you want your lake to look like? (agreed-upon outcomes)
- What should you do to ensure that your lake and its watershed will continue to support current and future uses? (strategies and actions)
- How will you know when you’ve succeeded? (monitoring)

Answering these questions and clearly outlining a vision for a lake as well as a path forward that are based on sound ecological principles is the most effective way to develop a lake watershed management plan. Specifically, a lake watershed management plan will provide a process through which stakeholders can identify issues impacting the lake, including water quality and aquatic

Where you want to be ↑	Watershed Scale Source Activity Control	Eliminate or reduce sources which generate pollutants.	e.g. Fertilizer ban
	Transport Reduction	Capture and remove or convert pollutants before they enter target resource	e.g. Treatment wetlands
	Instream/Inlake Treatments	Enhancing internal processes for pollutant inactivation	e.g. Aeration
	Ecosystem Restoration	Repair damage to resources when controls fail	e.g. Fish habitat restoration
↓ Where you want to avoid being			

Figure 1. Diagram showing the relative ease of implementation of four different nutrient reduction and eutrophication prevention strategies. Green are easiest, red the most difficult and expensive to implement.



ecosystem health, identify goals and targets, as well as develop and implement mitigation strategies.

Fortunately much of the limnological and hydrological science is in place to support planning activities. This workbook is intended to link science, opportunities, processes and potential partners that are specific to lake watershed management in Alberta. ALMS has documented these resources in this workbook so groups intent on developing watershed management plans for their lakes would have a reference document to follow. Over time, our hope is that it will be easier to develop lake watershed management plans with stated objectives, actions and performance indicators using this workbook as a starting point. ALMS hopes that this workbook will lead to the creation of lake watershed management plans that will help achieve specific outcomes based on both local and regional priorities.

Lake watershed management planning may be considered as sub-basin planning, which under Alberta's Water for Life Strategy fits in the role of Watershed Stewardship Groups (WSGs). WSGs may be the initiators of lake watershed management planning initiatives and can act as the organizers of the collaboration between all levels of government, industry, and community stakeholders

Although no two lakes are the same, a consistent planning process will provide for more consistency among lake watershed management plans, which may aid governments and other stakeholders in assessing, supporting, and implementing plans. ALMS expects that this document will adapt and evolve as advancements occur in policies, plans, and stewardship activities

Eutrophication: The process by which lakes and ponds become enriched with dissolved nutrients, either from natural sources or human activities. Nutrient enrichment may cause an increased growth of algae and other microscopic plants, the decay of which can cause decreased dissolved oxygen levels. Decreased oxygen levels can kill fish and other aquatic life. Alberta Environment 2008.

Eutrophication is a problem and a priority for many recreational lakes and this workbook reflects the desire and need to tackle this common problem. However ALMS recognizes that different regions in Alberta may have lake priorities other than controlling over-enrichment. For example, in northern Alberta, the potential for acidification is an important concern and in high alpine lakes, atmospheric deposition of other contaminants (e.g. mercury) is a concern. Management of cumulative impacts at the watershed scale is necessary for lakes facing all of these types of pressures and this workbook will provide general strategies for lake watershed management that can be used to address many Alberta lake concerns.



Watershed Planning in Alberta

The intent of the following sections is to provide a solid understanding of the current regulatory and policy frameworks that affect the creation and implementation of lake watershed management plans. Existing legislation and planning activities need to be examined to ensure that management plans reflect and are consistent with municipal and provincial land use plans; that they are achievable, and that lake outcomes can be realized during the plan implementation phase.

The approach to watershed management in Alberta mirrors a general trend in Canada, which places a very strong emphasis on the creation of partnerships, multi-stakeholder councils and other forms of collaborative or adaptive co-management in environmental governance. While there has not been any change in the constitutional powers held by either of the provincial or federal governments (see Table 2 for a list of regulations), there is a trending shift from historical top down government regulatory

approaches to adaptive co-management of natural resources. The traditional regulatory system has not been effective in preventing degradation of natural resources anywhere around the world.

The link between land use (e.g. agriculture, roads, residential development) within a watershed and water quality and aquatic health has been clearly identified. For that reason, watersheds are considered an appropriate unit for bringing together different stakeholders in collaborative, watershed management processes. Collaborative planning wherein the province, municipalities, private businesses, land owners and other interested parties form interactive networks to address common resource issues is neither easy nor straightforward.

Lake watershed management plans relate directly to other types and scales of planning initiatives already underway across Alberta. Some of the governance tools applicable in Alberta of

Water vs. Watershed Management Planning

Enabled by Alberta's Water Act, water management planning sets clear and strategic direction regarding how water should be managed. Typically led by the provincial government, water management planning focuses primarily on water licensing and allocations, although land use practices and other issues of watershed management can be addressed through water management plans.

In comparison, watershed management planning broadens the scope of management to consider all activities that potentially impact water quality and quantity, thus considering the inter-connectedness of ecosystem components. In fact, a completed water management plan can complement, or be considered a key component, of a watershed management plan, and vice versa. Unlike a water management plan however,

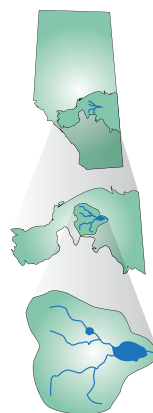
a watershed management plan carries no regulatory authority; **being advisory in nature, its potential comes only from each of the associated authorities approving and adopting the recommendations and enacting them into their own policies and practices.**

This expansion from water to watershed management acknowledges that many decisions concerning land use that affect water quality, quantity, and aquatic ecosystems are outside the jurisdiction of the Water Act and other legislation. As such, watershed management planning requires collaboration and cooperation between all stakeholders who have an interest in or responsibility for these matters.

importance to developing lake watershed management plans that are consistent with provincial policy and planning are:

- Water For Life (including Alberta Water Council's recommendations with respect to policies, and Watershed Planning and Advisory Councils' Watershed Management Plans)
- Regional land use plans and cumulative effects management under Alberta Land Stewardship Act and the Land Use Framework; and
- Municipal and inter-municipal development planning

ALMS envisions lake watershed management planning to complement and inform these larger-landscape scale activities. As well, the work being done by watershed stewardship groups (WSGs) at both the local and regional level will be integral in implementing lake watershed management plans co-created through collaborative planning processes (Figure 1).



Provincial Policy

Alberta Water Council

Integrated Watershed Management Plans

Watershed Planning and Advisory Council

Lake Watershed Management Plans

Watershed Stewardship Group

Figure 1. This diagram demonstrates how a lake watershed management plan may fit into planning at other scales. At the provincial scale, Alberta Land Stewardship Act and strategies like Water for Life set the stage for regional plans. Regional plans put frameworks in place to track environmental health and trends. All sub-regional (i.e. lake watershed) plans need to align with their regional plan. Just as watersheds are nested into larger watersheds, lake planning initiatives are part of something bigger.

3.1 ALBERTA'S WATERSHED PLANNING SYSTEM



Water For Life: Alberta's Strategy For Sustainability (Water For Life) was introduced as government policy in 2003. Water For Life sets out goals and a mechanism for watershed and water management in Alberta. This applies directly to lakes, because lakes are key components of watersheds. For information on Water For Life go to: www.waterforlife.alberta.ca

Water For Life operates at the provincial level through the Alberta Water Council (AWC), at the regional level through the Watershed Planning and Advisory Councils (WPACs) (Figure 2), and at the lake or local watershed level through WSGs. Table 1 outlines the focus and products of each agency. Specifically, WSGs take community-level action to conserve and manage local water resources.

This workbook will be most effective at the local level, implemented by a WSG, where dedicated lake users are the lake's strongest advocates. WSGs can leverage resources and personnel from regional WPACs, and interact with the AWC. WPACs and WSGs will likely have similar challenges and similar desired lake outcomes. If a lake watershed management plan has been developed, it may be used to inform the WPAC Integrated Watershed Management Plan (IWMP) and vice versa.

The Water For Life website provides tools which WSGs can access to help with lake watershed management planning outlined in this workbook. These tools include:

- State of the Watershed Handbook
- Guide to Reporting on Key Indicators Used in State of the Watershed Reports
- Guide to Watershed Management Planning in Alberta
- Protocol for Watershed Management Planning in Alberta

This workbook is intended to complement these tools developed by Alberta Environment and Sustainable Resource Development (AESRD), focusing on the tools and processes that will work best for lake watersheds. Finally, Alberta Water Council's website provides policy interventions and recommendations that apply to all watersheds in Alberta, and is also a good source of current information and knowledge from lake communities across Alberta



Acronym	Agency	Focus
AWC	Alberta Water Council	Provincial Policy Recommendations (www.albertawatercouncil.ca)
WPAC	Watershed Planning and Advisory Councils	State of the Watershed Reports for major river basins Integrated Watershed Management Plans (For details and maps of each WPACs in Alberta http://www.waterforlife.alberta.ca/543.html or http://www.albertawpac.ca/)
WSGs	Watershed Stewardship Groups (Includes Lake Groups)	Grassroots stewardship activities Small scale watershed (i.e. lake) planning State of the Watershed Reports for individual lakes (example La La Nonne Watershed Stewardship Society) For a listing of groups visit http://stewardshipdirectory.com/

Table 1. Partnerships under Water for Life Strategy and their mandated activities.



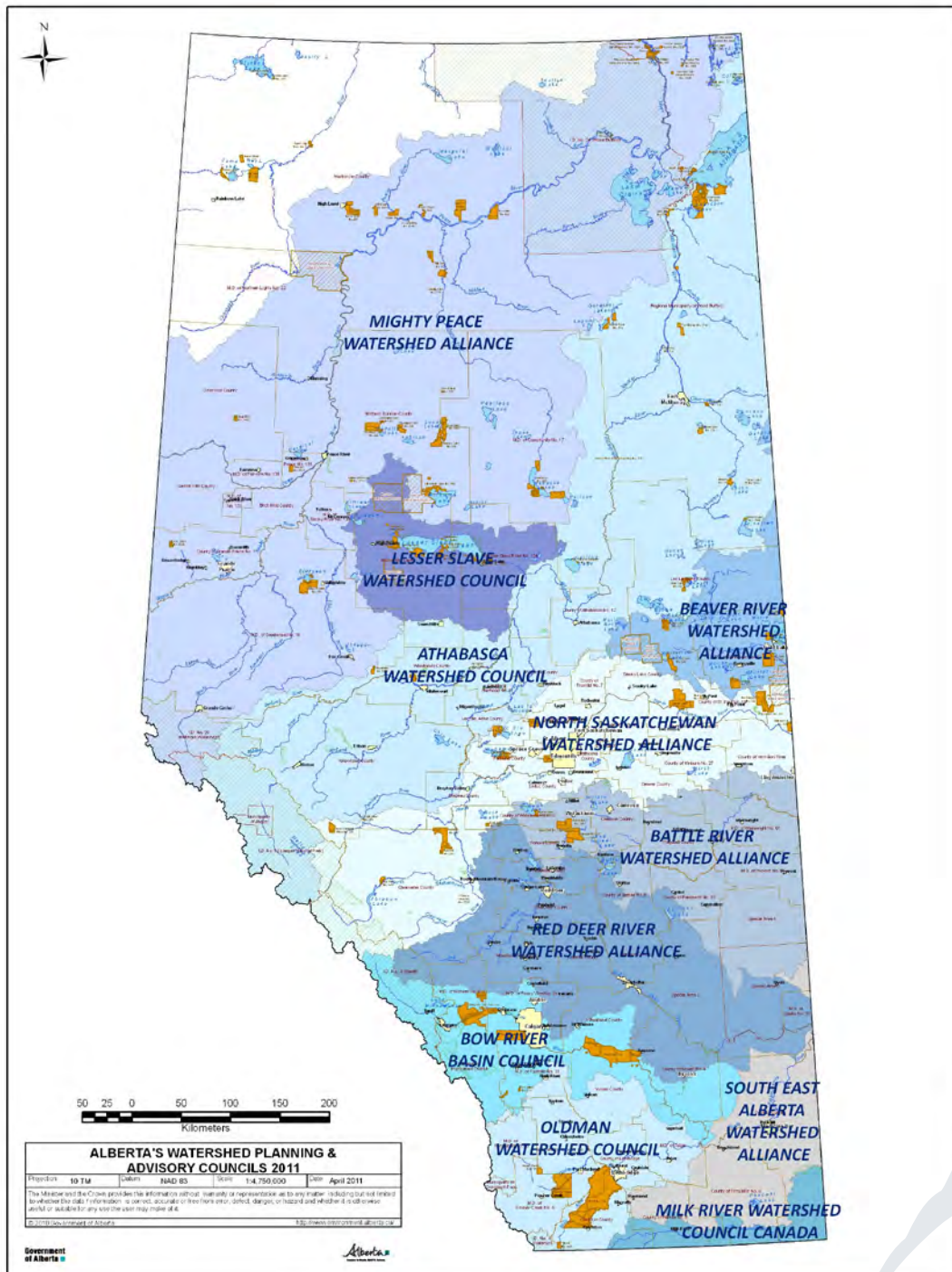


Figure 2. Map of Watershed Planning and Advisory Council Boundaries in Alberta.

3.2 CUMULATIVE EFFECTS MANAGEMENT AND LAND-USE FRAMEWORK

A key mandate for the Government of Alberta is to address the cumulative effects of human activities on the environment. The province has formalized this approach through an Integrated Resource Management System, outlining environmental, economic, and social outcomes for seven regions. This is high level planning: broad scale with broad outcomes. An example of an outcome of the Lower Athabasca Regional Plan is “Landscapes are managed to maintain ecosystem function and biodiversity.”

The Government of Alberta initiated cumulative effects management with the release of the *Land-use Framework* (LUF), followed by the Alberta Land Stewardship Act (ALSA). Both LUF and ALSA divide the province into seven regions that to some extent follow the boundaries of Alberta’s seven major river basins.

ALSA is concerned with:

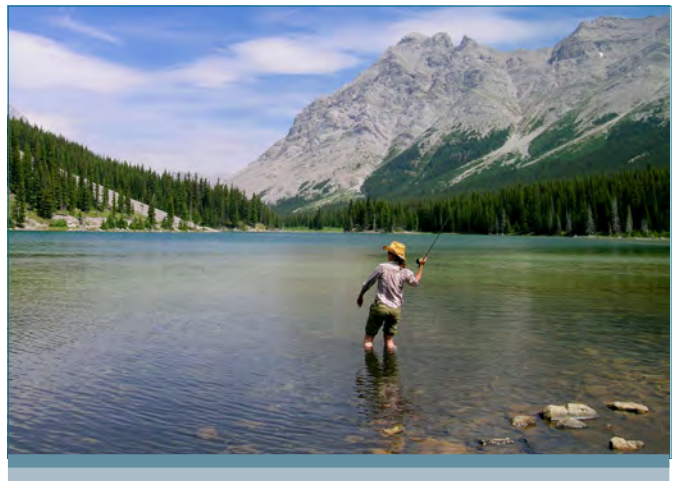
- landscape level planning;
- cumulative effects management; and
- establishing limits, targets and thresholds to control cumulative impacts on the ecosystem before irreversible harm can occur

Cumulative effects management is:

- Outcomes-based: clearly defined desired end-states.
- Place-based: meeting the differing needs of regions within the province.
- Performance management-based: using adaptive approaches to ensure results are measured and achieved.
- Collaborative: shared stewardship and using a shared knowledge base.
- Comprehensively implemented: using both regulatory and non-regulatory approaches.

All of these components are intended to work together towards maintaining healthy ecosystems, a thriving society, and a vibrant economy.

As part of the Land-use Framework and regional planning (e.g. the Lower Athabasca Regional Plan has been developed, and the South Saskatchewan Regional Plan is underway) management frameworks are being developed to manage surface water quality and quantity in each region. These regional frameworks manage cumulative effects by establishing triggers and limits that prompt management actions. They are adopted as regulations under ALSA and therefore have legal authority. Current State of the Watershed Reports and Watershed Management Plans are being used to develop outcomes around healthy watersheds and to establish triggers and limits for water quality and quantity within the regional land use planning context. If a lake watershed management plan has been developed, it may be used to inform the regional land use plan and its associated management frameworks.



Municipal district plans and development practices can have a long lasting effect on local lake management (Figure 4). Municipal governments shape the physical and environmental future of lake watersheds because they control development and land-use in lake watersheds.

Through good planning, bylaws, policies and careful development practices within lake watersheds, municipalities can help enhance and protect the integrity of the natural environment and health of a lake.

Three excellent resources for understanding the role of municipalities in watershed management are:

- *Lake Stewardship Workbook 2008. Alberta Association of Summer Villages.*
- *Municipal Guide: Planning for a Healthy and Sustainable North Saskatchewan River Watershed* by Giselle Beaudry for the North Saskatchewan Watershed Alliance. 2006.
- *Pigeon Lake Model Land Use Bylaw. 2013. Pigeon Lake Watershed Association. www.plwa.ca*

Below is a list of municipal tools that are available for lake watershed planning compiled based on the three references cited above.

Planning and Development

- Municipal Development Plans
- Inter-municipal Development Plans
- Environment Reserves
- Land Use Bylaws/Building Development Setbacks
- Area Structure Plans/Area Redevelopment Plans
- Concept Plans

As well, under section 60 of the Municipal Government Act, municipalities may create policies and bylaws for the “direction, control, and management” of local water bodies within their jurisdiction as long as they are consistent with provincial and federal laws and regulations.

Water, wastewater, and stormwater

- Source water protection*
- Management and treatment of stormwater
- Treatment and distribution of potable water
- Collection and treatment of wastewater
- Reuse of greywater
- Low impact development strategies and technologies that retain storm water onsite

Infrastructure and property considerations addressed by municipalities as partners under other provincial legislation

- Regional corridors and green spaces
- Transportation corridors (manage and control roads and their development)
- Public access to water bodies
- Road construction and maintenance
- Regional waste disposal, management and landfill placement
- Agricultural operations
- Wood lots and restrictions on clear cutting within development setbacks
- Oil and gas industry location and practices

Land Use Bylaws

- Zoning
- Environmental reserve
- Pollution prevention (nutrients, fertilizers, pesticides, chemicals, etc)
- Water Conservation
- Section 60 water body management

Conservation Tools under ALSA

- Transfer of Development Credits
- Conservation Easements
- Conservation Offsets
- Best Management Practices Incentive Programs

Agriculture operations

- Land use bylaw provisions
- Ag Service boards
- Section 7 bylaws to regulate use of fertilizers and pesticides
- Local enforcement of provincial regulations (i.e. Weeds)
- Environmental farm plans

*Source water protection planning is an important process for all levels of government: municipal, provincial, and federal. The planning process would parallel watershed management planning quite closely and there may be a lot of similar concerns and actions depending on the source of the drinking water. In Alberta, the Drinking Water Safety Plan requires a risk assessment of source water.



Figure 4. Municipal boundaries in Alberta.
Source: Wikipedia http://en.wikipedia.org/wiki/List_of_municipal_districts_in_Alberta



Recreation

- Can request boating restrictions
- Bylaws to regulate recreational use of municipal lands

Watershed Management

- Identify issues and objectives at a local level
- Data collection and analysis
- Synthesis and Planning
- Decision making on subdivision and development proposals
- Implementation of plans at a local scale
- Monitoring and Reporting feedback for adaptive planning processes
- Stewardship and education of community
- Sponsorship of local WSG programs (Yellow Fish Road; tree planting; shoreline cleanups, lake water quality monitoring, etc.)

MUNICIPAL FOCUS AREAS:

Wetlands and Riparian Areas

Recognizing the importance of wetlands and riparian areas to lake ecosystem health, municipalities can take a proactive role in protecting these resources from development. Statutory planning documents and bylaws should be reviewed and updated in advance of any development proposals to ensure that they include policies, strategies, maps and guidelines for protecting and managing wetlands and riparian lands within the municipality. See Stewart 2008 for a review and recommendation of the regulatory tools available to municipalities for protecting wetlands and riparian areas. As well as the document titled *Stepping Back from the Water: A beneficial management practices guide for new development near water bodies in Alberta's settled region* (AESRD 2012) is a valuable source for information on how municipalities can establish riparian land development setbacks to protect water quality in adjacent water bodies. Also see the Pigeon Lake Model Land Use Bylaw (Stewart, 2013).

CASE STUDY

Lac La Biche County included provisions for riparian protection in their Municipal Development Plan and in their Lakeshore Policy and Environmental Reserve Environment Policy. Riparian setback distances were calculated using scientific methods resulting in site-specific and defensible riparian development setbacks to prevent pollution entering the county's lakes. These setbacks ranged in distance, depending on the site, reaching a maximum distance of 50m from the lake shore.

Sewage treatment for small, on-site septic systems

Of high concern for many lake stewards, small on-site sewage treatment and discharge falls under the Provincial the *Safety Codes Act and the Building Code Regulation* but ensuring standards are met and following up with problems fall to the local municipal government and health authority (as outlined in Beaudry 2006).

- *Municipal Affairs* sets sewage standards which set out design standards, installation standards and material requirements
- *Municipal governments* are primarily responsible for ensuring standards are met but municipal development policies/bylaws can also be used to set standards.
- *AESRD and the local health authority* are responsible for handling problems or complaints regarding private septic systems



Agriculture

Several other pieces of provincial legislation control agricultural operations and municipalities have limited roles in regulating agricultural operations that have the potential to impact lakes (livestock operations (of various sizes) and cropping operations). The Province, under the *Agricultural Operations Practices Act (AOPA)*, regulates confined feeding operations (CFOs) over a certain size. Municipalities are able to create municipal development plans that describe areas of the municipality that are not to be used for CFOs, and this information is used by the Natural Resources Conservation Board (NRCB) to site intensive livestock operations. Municipalities have no regulatory power over CFOs once they are in place. Municipalities do, however, have jurisdiction over intensive livestock operations smaller than those regulated under AOPA.

CASE STUDY

Wetaskiwin County's MDP excludes CFOs from the area within one mile of Pigeon Lake. It further describes an additional area, contiguous to and beyond the exclusion zone, within which CFOs are allowed but are subject to "very strict requirements respecting run-off." These requirements are developed by the County in co-operation with the NRCB. County of Wetaskiwin Municipal Development Plan.

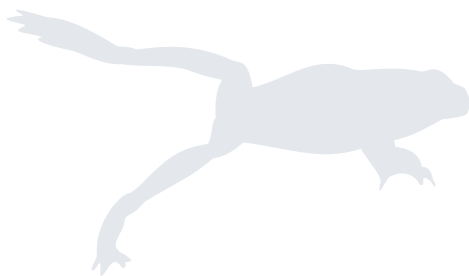
Intermunicipal Development Planning

Coordination among municipalities would be a high priority for an effective lake watershed management plan. Collaboration is key to producing a comprehensive, efficient and robust regulatory and policy system in the entire lake watershed. Intermunicipal Development Plans for municipalities that share shorelands around a lake are recommended under the Alberta Land Use Policies.

More information on municipal planning and development is available on the Alberta Municipal Affairs website at: <http://www.municipalaffairs.gov.ab.ca/>

CASE STUDY

Buffalo Lake is a unique situation in Alberta where the lake water levels are controlled and a shoreline right-of-way is owned by the Provincial government. An Integrated Shoreland Management Plan for Buffalo Lake (BLISMP) was approved in 2009. Shortly after, in 2010, an Inter-municipal Development Plan (IDP) was developed by the five municipalities surrounding the lake to address issues on private land adjacent to the right-of-way. This IDP provides direction on land-use, appropriate activities, and development on private lands around the lake. It supports and complements the policy direction outlined in the BLISMP. It is a good example of how a centralized plan could be used to deal with development pressures around a lake surrounded by multiple municipalities. Go to www.blmt.ca or visit the websites of involved municipalities (Lacombe, Stettler, and Camrose Counties or the Summer Villages of Rochon Sands or White Sands).



3.4 LAWS AND LEGISLATION

There are many policies, laws, regulations, guidelines and codes of practice in Alberta that are relevant to lake watershed management. Table 2 below provides an overview of relevant federal and provincial legislation to be aware of and to consider when developing lake watershed management plans.

These laws and their associated regulations, codes of practice, and implementation guidelines become most relevant when implementing plans.

Table 2: Federal and Provincial Legislation Affecting Lake Management

Legislation	Dept. Responsible	Purpose
Canada Water Act, R.S.C. 1985, c.C-11	Environment Canada	The federal government may enter into agreements and projects with the provincial government, which could include wetland conservation. Currently is used to enable joint flood control and agricultural water projects.
Canada Shipping Act, 2001, 2001, c.26.		Regulates all aspects of recreational boating. Minister of Transport is responsible for administration of the Act.
The Fisheries Act (Canada), R.S.C. 1985 c.F-14.	Fisheries and Oceans Canada (DFO)	Defines “deleterious substances” and regulates activities that might result in the ‘harmful alteration, disruption or destruction of fish habitat.’ Recently amended.
Migratory Birds Convention Act 1994, 1994, c.22	Environment Canada, Canadian Wildlife Service	Regulates activities that could harm migratory birds or their nests, and prohibits deposits of certain materials that might be harmful in water frequented by migratory birds.
The Navigable Waters Protection Act, R.S.C. 1985 c.N-22	Transport Canada	Regulates uses and activities of water that may interfere with navigation on navigable waters. Recently amended to limit application to identified navigable waters.
The Species at Risk Act, S.C. 2002, c.29	Environment Canada (lead), Fisheries and Oceans (Aquatic Species at Risk)	Prohibits the destruction of critical habitat for species at risk. Provides stewardship opportunities of critical habitat. Prohibits killing, harming or harassing endangered species as defined.
Alberta Land Stewardship Act, S.A 2009, c. A-	Alberta Environment and Sustainable Resource Development	Provides for consistency by plans and decision making in land use planning and human activities on both private and public lands pursuant to Regional Land Use Plans. The shorelands adjacent to lakes are required to be developed in consistency with the Regional Land Use Plan for the watershed within which the lake is located.
Environmental Protection and Enhancement Act, R.S.A. 2000, c. E-12.	Alberta Environment and Sustainable Resource Development	Regulates municipal water, wastewater and urban storm drainage systems, groundwater wells, private wastewater systems, waste management, pesticides, etc. Provides for conservation easements. See also: Pesticide Sales, Handling, Use and Application Regulation, Alta. Reg. 24/1997 Environmental Protection and Enhancement Act - Code of Practice for Pesticides.
Surveys Act, R.S.A. 2000, c.S-26.	Alberta Surveyors	The legal bank of a wetland is established by surveyors pursuant to the Act. The legal bank establishes the delineation of bed and shore of permanent and naturally occurring water bodies owned by the Province.
Land Titles Act, R.S.A. 2000, c.L-4.		Provides for boundary changes when the “natural boundary” changes through erosion or accretion when the title to lands is a “natural boundary”. Public lands are excluded from titles: also see Law of Property Act, R.S.A. 2000, c.L-7 for ownership of gravel and marl in lakeshore areas.
Municipal Government Act, R.S.A. 2000, c.M-26.	Alberta Municipal Affairs	Provides for municipal bylaw passing powers, (Part 2) municipal “direction, control and management” of natural water bodies, (section 60), and planning and development of all private and municipal lands within municipal boundaries. (Part 17). The MGA governs municipal corporations. Also see the Safety Codes Act, R.S.A 2000, c. S-1., which appends the Plumbing Code Regulation Alta Reg. 119/2007 and the Alberta Building Code Regulation Alta Reg. 111/2007. The Subdivision and Development Regulation, Alta Reg. 43/2002 also affects development of private lands. Also see municipal statutory plans, the Land Use Bylaw, and other municipal bylaws that
Public Lands Act, R.S.A. 2000, c. P-40.	Alberta Environment and Sustainable Resource Development	Regulates the use and development of provincial public lands, including the beds and shores of all permanent and naturally occurring water bodies in Alberta.
Water Act, R.S.A. 2000, c.W-3.	Alberta Environment and Sustainable Resource Development	Section 3: “The property in and the right to the diversion and use of all water in the Province is vested in Her Majesty in right of Alberta except as provided for in the regulations.” Diversion and use of water is regulated. Water management planning is a component of the legislation. Disturbance of water bodies (such as draining and filling of wetlands) is an activity under the Act that requires an approval.
Weed Control Act, R.S.A. 2000, c.W-5.	Provincial/ Municipality	Municipalities are delegated authority to pass local bylaws to control prohibited noxious and noxious weeds on municipal lands and on certain public lands such as highway corridors.
Wildlife Act, R.S.A. 2000 c.W-10.	Alberta Environment and Sustainable Resource Development	Prohibits unauthorized activity on specified public or private land that could harm a nest or den of certain listed wildlife. Migratory birds identified under federal law are identified in this legislation.

1 Adapted from work done in association Jay White of © Aquality Environmental Consulting, Ltd. which was revised for the purpose of several subsequent research papers and see also Judy Stewart, Buffalo Lake Integrated Shoreland Management Plan: Review for Implementation Report “Cooperation, Coordination, Integration” Internal Document, Government of Alberta, Prairie Region-Alberta Sustainable Resource Development, 2008

3.5 WHAT IS A LAKE WATERSHED MANAGEMENT PLAN AND HOW DO WE CREATE ONE?

Lake watershed management plans, in the context of this document, are intended to help lake stewards protect lake ecosystems through setting of ecological outcomes for each lake. This includes managing human activities on land that may impact aspects of lake water quality and quantity and also the associated fish, vegetative and wildlife communities. The plan itself will collaboratively focus stewardship activities and regulations and policies that can be applied to restore and maintain the health of the lake watershed as a whole.

It is important that the plan embraces the goals of the Water for Life Strategy, aligns with basin plans at the higher level and, where possible, has similar indicators. Planning should follow current Government of Alberta watershed planning documents (visit <http://www.waterforlife.alberta.ca>) and incorporate Integrated Watershed Management Plans (as they are created by each Watershed Planning and Advisory Council), tailored to the watershed of your lake at the smaller landscape scale (Figure 2).

A lake watershed management plan (LWMP):

- Encourages partnerships between concerned citizens, including lakeshore owners, watershed residents, local and provincial government, resource management agencies and special interest groups.
- Summarizes information on how the lake functions and its current condition (water quality etc.).
- Identifies concerns that people feel are important to address.
- Sets realistic goals, objectives, and actions to achieve desired outcomes.
- Identifies needed funds, resources, and personnel to implement and monitor the plan.

Diagrammed on the facing page (Figure 5) are the recommended stages involved in developing a lake watershed management plan. These stages also correspond to the process recommended by the Government of Alberta in their Guide to Watershed Management Planning in Alberta. They are further detailed in sections 4 through 8. Both the Guide and this Workbook can be used to inform the development of a lake management plan, they are designed to be compatible.

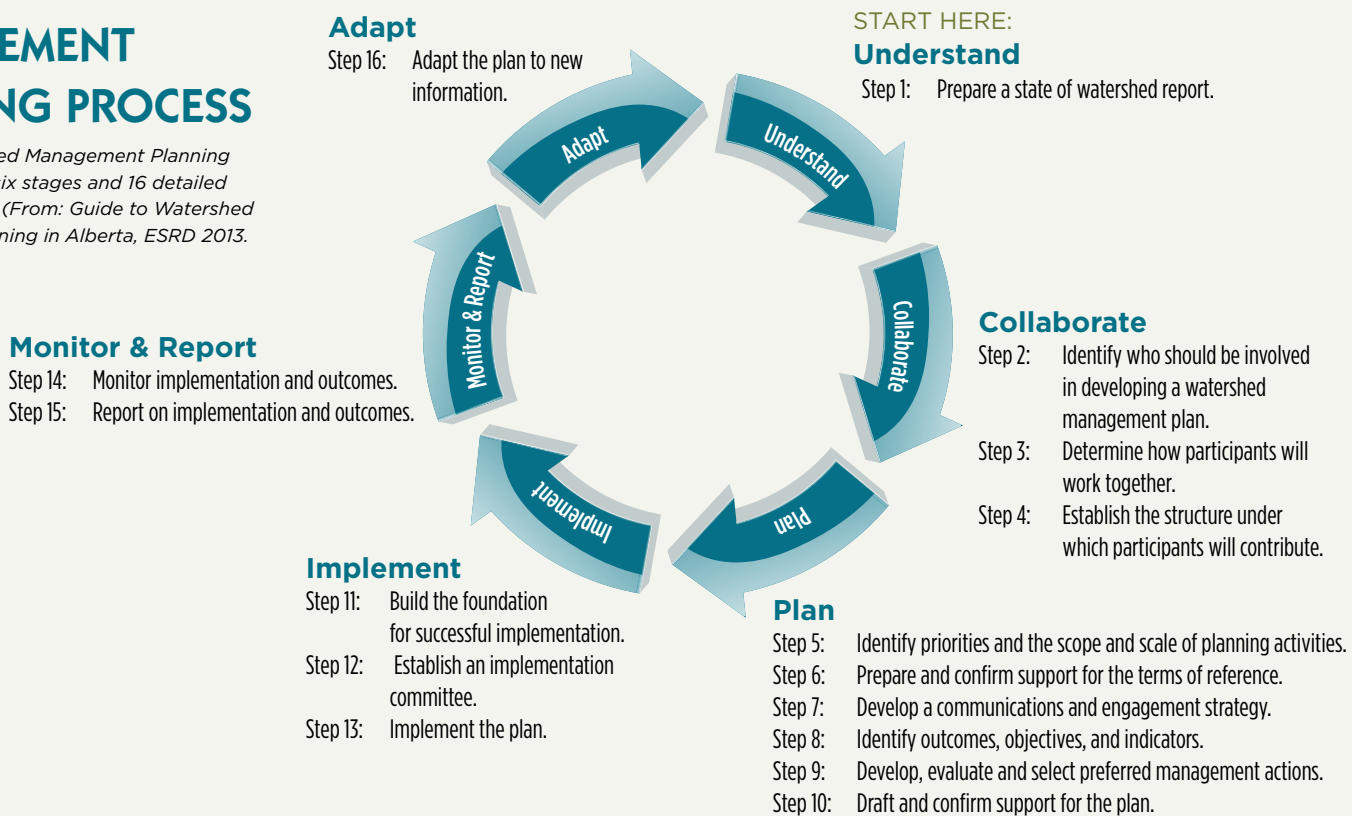
The process outlined in this workbook is not intended to be prescriptive. The contents of the lake watershed management plan ultimately produced will reflect the complexities of the lake system and its watershed, the diversity of stakeholders within the watershed, and the scale of the problem.





WATERSHED MANAGEMENT PLANNING PROCESS

Figure 5. Watershed Management Planning Process showing six stages and 16 detailed steps of planning. (From: Guide to Watershed Management Planning in Alberta, ESRD 2013.



FOOD FOR THOUGHT

In a discussion paper prepared for the Pigeon Lake Watershed Association the Environmental Law Centre recommended four ways to improve consistency in regulation of activities affecting lake watersheds. These options include:

- Amalgamating watershed municipalities;
- Pursuing an inter-municipal development plan and creating

an inter-municipal planning commission and inter-municipal subdivision and development appeals board under the Municipal Government Act (MGA);
Entering into a memorandum of understanding among all municipal bodies, provincial, federal and first nations governments, or

- Advocating for a substantive watershed plan to be incorporated into the regional plan under the Alberta Land Stewardship Act (ALSA).

To read the report visit: pigeon lake watershed stewardship society webpage www.plwa.ca

4.0

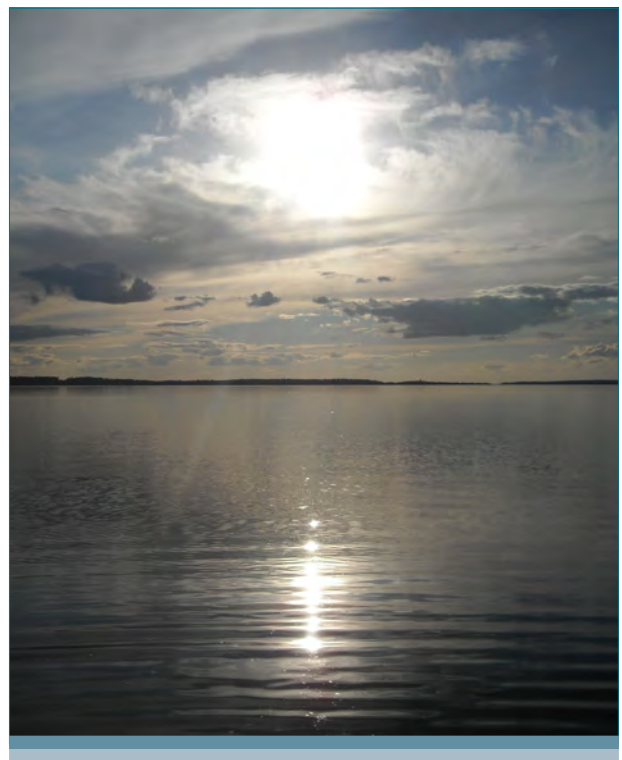
Understand: Understanding Conditions in the Watershed

Effective planning starts with an understanding of the ecological, social, economic and demographic factors influencing a lake. Although an initial issue may have brought the group together in the first place, it is necessary to ensure that all members of the steering committee understand the processes and factors that affect lakes and their management. Understanding the historical and current conditions, along with projected future conditions, will also help establish effective goals and outcomes and identify the appropriate actions to address the interest group's concerns. Start with basic information about lakes and watershed management, which can be found in Appendix I and further resources in Appendix II.

As well it is necessary to ensure alignment of the lake management plan with other planning initiatives. Collect and review all pertinent resource plans before beginning to develop a lake management plan. These plans will provide some of the data needed, and may identify goals, objectives and actions appropriate for the lake. Resource that may contain site-specific plans include, but are not limited to:

- Municipal land use plans (municipal development plans, bylaws or area structure plans)
- Comprehensive local water management plan (AENV)
- Lake assessment studies (check the Atlas of Alberta Lakes for studies and AENV)
- Fisheries management plans (SRD)
- Integrated Watershed Management Plans (WPAC)
- Regional Land Use Plans (SRD)

If there is a lot of existing information available about the lake and its watershed, the identification of issues and setting a vision for the watershed may be completed at this point in the planning process. If information is lacking, issue identification and a general vision should still be developed, but it may be necessary to gather more information before a final vision for the lake can be achieved. Specifically, after a 'State of Watershed' (section 5.0) is developed then re-evaluation of the issues and their priority and refinement of the vision can occur.





4.1 DEVELOP AN INITIAL VISION

Sample vision statement:

The natural watershed processes and functions of Lake X will be restored to reduce nutrient and sediment loading, and make the lake more attractive to anglers and other water recreational activities on and around the lake.

A vision is a descriptive statement about the desired future state of the lake and its watershed. It can be emotive and is a source of inspiration, but it is also a general statement relating to what the group hopes to accomplish over the long term and it should be achievable and consistent with the historical state of the lake. In Alberta a vision statement should reflect a commitment to seek an appropriate balance among environmental, social and economic needs by managing the lake and its watershed to achieve WFL goals:

- Safe, secure drinking water;
- Healthy aquatic ecosystems; and
- Reliable, quality water supplies for a sustainable economy

Developing a vision will require review and refinement through input of all lake watershed stakeholders and is an important step in the process of developing a Lake Watershed Management Plan.

In cases where the lake and its watershed have been well studied, with a State of the Watershed report completed, establishing the working committees, identification of issues and setting a vision for the watershed may be completed at this point in the

CASE STUDY

Summer villages at Baptiste, Island and Skeleton Lakes have formed the Baptiste, Island, and Skeleton Lakes Watershed Management and Lake Stewardship Council (BISL). BISL's vision for Baptiste Lake is to "maintain a healthy lake and watershed, recognizing the importance of living within the capacity of the natural environment and providing sustainable recreational, residential, agricultural, and industrial benefits".

See Carlson, 2008.

planning process (go to Section 5.0). In cases where information is insufficient to move forward in determining a clear vision for the lake and its watershed, a general vision should still be developed, but it is necessary to first develop a State of Watershed (SoW) Report.

This can be a difficult process, but there are several resources available to guide a lake group through this strategic planning step. Visit the Land Stewardship Centre at <http://landstewardship.org/organizational-basics/> for suggestions of governance tools.



4.2 STATE OF WATERSHED REPORTING (STEP 1)

Undertaking a State of the Watershed (SoW) Report will help to evaluate watershed health and provide necessary background information on which to base the lake watershed management plan. It is a comprehensive document that summarizes the ecological, social, economic and demographic factors influencing a lake and is specific to the characteristics of each lake's watershed. The SoW Report will help to identify key issues to be addressed to protect or restore lake health. The initial assessment will not only identify priority issues and opportunities, it will also identify baseline conditions from which to measure change and progress toward the achievement of goals and desired outcomes within a lake watershed management plan.

Once written, a SoW report should be regularly revisited. As new information is learned and conditions change, successive SoW versions may be regarded as report cards with which to measure progress.

It is recommended that Alberta Environment's guide for completing SoW reports entitled *State of the Watershed Reporting Handbook: A Guide for Developing State of the Watershed Reports in Alberta (2008)* be followed. The guide can be used for assessing the data needs for your SoW report as well as finding many sources of available data. Traditionally focused more heavily on numerical data, the inclusion of alternate types of information has increased. Métis and First Nation Traditional Environmental Knowledge (TEK) has become a valuable source of understanding for lake management.

The first step in the development of a SoW report is to map the watershed and its major land-uses and land cover types. Next, identify the key indicators of watershed health because this will help focus data collection efforts. There are several examples of lake health indicators in the Handbook and those chosen for Lac La Nonne (2006), Lac La Biche (2004), Moose (2006), Skeleton (2008), Sylvan (2005), Wizard (2013), Wabamun (2013) and Pigeon (2008) Lakes. Indicators are detailed further in Table 3 below. Items that are

marked with an asterisk (*) are considered key, long-term, indicators by Alberta Environment and Sustainable Resource Development. Their document *Guide to Reporting on Common Indicators in SoW Reports (2012)* identifies criteria and sets direction for consistent reporting on a subset of watershed health indicators commonly found in state of the watershed reports. It is important to include documentation behind how the indicators were chosen. For example, Alberta Environment published an indicators summary for the South Saskatchewan Basin called *Indicators for Assessing Environmental Performance of Watersheds in Southern Alberta (2008)*. The indicators chosen guide the next steps of data and information collection.

CASE STUDY

Owing to its proximity to Edmonton, the lake's sheltered situation, and the recreational opportunities it offers, Wizard Lake is one of the busiest small recreational lakes in central Alberta. In the past, several lake management plans were created for the lake but none provided for integrated management across the whole watershed. The Wizard Lake Watershed and Lake Stewardship Association recognized that this failure was due to a lack of a cohesive body of information on the lake. They prioritized a State of the Watershed Report to summarize all currently available watershed information and then lead into the development of an integrated watershed management plan that aligns with the Water for Life strategy and current regulations.



If some of the necessary data are not available for a particular lake, a tailored sampling program could be undertaken either independently or in cooperation with a government agency or with a non-profit such as ALMS (water quality) or Cows and Fish (riparian health).

Once the necessary data have been collected for each indicator, the indicators themselves should be evaluated for current state. The data should reveal whether or not the health indicator is in an acceptable/marginal/unacceptable, excellent/fair/poor, etc. status of a desired condition. Some indicators will have institutionally-defined values that define watershed conditions, such as Federal Water Quality Guidelines for drinking or recreational contact.

For other indicators ratings, objectives or targets (e.g. where we want to be statements) and thresholds (e.g. when its time to stop) may need to be developed locally based on historic baseline conditions and the expectations and desired outcomes of the stewardship group. These indicators can then be used to focus and evaluate the lake watershed management plan goals, objectives, and actions.

Specifically, a visit to Alberta Environment and Sustainable Resource Development (AESRD) surface water quality data website would be the first step in assembling a lake database. Sediment quality data, biota, lake level data, lake inflow and outflow water quality, and flow data should all also be requested at the same time. ALMS has sampled over 80 lakes in its history so check the table of LakeWatch reports for water quality data. Other government departments such as Alberta Health may also have relevant lake data (i.e. algal bloom advisories, bacteriological data). AESRD Fish & Wildlife, Alberta Conservation Association, the local Fish and Game chapter, and Fisheries and Oceans Canada should all be consulted for fish and fish habitat data. Information searches typically start with a literature survey (i.e. Google Scholar), and should also include grey literature such as consultant reports or survey data.





Table 3. Recommended indicators of lake watershed health, for use in developing targets and thresholds in a lake watershed management plan. Adapted from the State of the Watershed Reporting Handbook (AENV 2008). Starred items (*) are key indicators listed in the Guide to Reporting on Common Indicators (AESRD 2012).

Indicator	Assessment Role of Indicator Metric	Measurement	Potential Data Source
Water Quality			
* Lake Trophic Status	Provides a general assessment of a lake's productivity or fertility.	Based on the following collective or individual measures: <ul style="list-style-type: none"> • Total phosphorus (Qg/L) • Chlorophyll a (Qg/L) • Secchi-disk visibility (m) 	Historical: Atlas of AB lakes, Data may have been collected by AESRD or ALMS.
* Nutrients	Provides a general measure of nutrient concentrations in lakes and streams and may be used to assess non-point source nutrient contamination	Dissolved and total Phosphorus, Total nitrogen, nitrate/nitrite, ammonia. All in Qg/L.	Historical: Atlas of AB Lakes Current: ALMS or AESRD
Dissolved oxygen	Provides insight into potential factors influencing the distribution and abundance of aquatic species, as well as other critical chemical processes, including the release and adsorption of pollutants in sediments. Also reflects degree of mixing of lake water.	<ul style="list-style-type: none"> • Concentration of dissolved oxygen (mg/L) • Percent saturation 	Historical: Atlas of AB Lakes, ALMS or AESRD
Water temperature	Provides insight into the distribution and abundance of aquatic species.	Water temperature (°C)	Historical: Atlas of AB Lakes Current: ALMS or AESRD
pH	Provides information on the chemical balance and biological state of the ecosystem.	Relative acidity of water	Historical: Atlas of AB Lakes Current: ALMS or AESRD
Sediment contamination	Provides information on sediment supply and contaminant dynamics, as many nutrients and contaminants adhere strongly to sediment.	<ul style="list-style-type: none"> • Total suspended solids (TSS) • Turbidity (Secchi depth) 	Historical: Atlas of AB Lakes Current: ALMS or AESRD
Landscape Indicators			
* Lake Level Index	Shows the status of individual lakes from year to year. This information can assist in interpreting related observations of changes in water quality, fisheries, or recreational opportunities as lake levels change over time.	Lake level elevation relative to a standard level (m above sea level)	AESRD or Water Survey of Canada Hydrometric Data
Landscape Indicators			
Wetland inventory	Reflects land use conversion from a natural to a "developed" state and identifies potential alterations to local hydrological patterns and water quality.	<ul style="list-style-type: none"> • Historical wetland area • Current wetland area • Wetland type 	Historical: air photo interpretation Current: Ducks Unlimited
* Riparian health	Reflects type and extent of human disturbance and degree of natural ecosystem function contributing to lake health.	<ul style="list-style-type: none"> • Width of vegetated zone • Species composition, age structure, and percentage of tree canopy cover within the riparian area • Extent of impervious area • Bank condition 	Cows and Fish – Protocols for Lentic Wetland Health



Indicator	Assessment Role of Indicator Metric	Measurement	Potential Data Source
Landscape Indicators			
Land Cover	Identifies habitat types within the watershed	Impervious area, bare area, and vegetated area by type.	AESRD
* Land Use	Extent and location of natural and human disturbed areas. Percentage of land in natural state is an excellent indicator of watershed health.	<ul style="list-style-type: none"> Identify areas where pre-settlement conditions still exist. Percentage of industrial, commercial, residential, agricultural, protected area, forest etc within watershed boundary. Attempt to include future development and watershed stressors 	AESRD, Air photo interpretation, Alberta Historical Landuse and Landscape Data Library, Municipal plans
Fertilizer/Pesticide application rates	Provides measure of water quality degradation risk via contaminated runoff	Fertilizer application rates as measured in census	Canada Agricultural Census Data (2006)
Livestock Density	Provides a measure of water quality degradation risk via contaminated runoff and effluent.	Livestock units per unit area	Canada Agricultural Census Data (2006)
* Linear Development	Provides a general measure on extent of human disturbance and fragmentation.	Km/Km ² of roads, utility corridors, and seismic lines.	AESRD
Biological Indicators			
* Fish Populations	Index of Biotic Integrity Reflects the quality and amount of aquatic habitat.	Subset of the following fish species richness, composition, abundance, and condition metrics: <ul style="list-style-type: none"> Total number of fish species Numbers of specific native, intolerant, and sensitive fish species Percentage of fish that are omnivores, insectivores, and carnivores Percent of individuals that are hybrids Percent of individuals that are diseased or deformed 	AESRD Fish and Wildlife, Alberta Conservation Association, Department of Fisheries and Oceans Canada.
Macrophyte Community (aquatic plants)	May reflect level of eutrophication, or other condition within water body	Species composition and abundance	AESRD
Blue-green algae outbreaks	Reflects level of water body eutrophication, and provides frequency and level of potential risk to human, animal, and ecosystem health	<ul style="list-style-type: none"> Chlorophyll a (Qg/L) Microcystin (Qg/L) Record of cyanobacterial blooms 	AESRD or Alberta Health Services

4.3 ADDITIONAL TECHNICAL STUDIES

Understanding lake watershed health may require lake-specific technical information that is not routinely collected. These should be included within a SoW report to fully understand and diagnose the causes of the lakes' issues.

4.3.1 Water Budgets

Using data on watershed hydrology and lake levels develop a water budget for the lake watershed. This would require the assistance of professionals to calculate the summation of inputs (ground water, inflowing creeks/storm-water drainage, surface runoff, and direct precipitation) and outputs (ground water, outflow creeks, and evaporation including future variations due to climate). It is also important to incorporate the licensed water diversions, specifically returned flows and consumption into the water budget. Ultimately this may help to calculate a sustainable water withdrawal rates in the face of decision-making regarding future water allocations. Water balances are also fundamental to the development of nutrient budgets.

If lake levels are a major concern water allocation decisions may need to be looked at. Future allocations could be based on the water balance by incorporation of this information into a water management plan under the Water Act. Approved water management plans, such as the Approved Water Management Plan for the South Saskatchewan River Basin, must be considered by the Director operating under the Water Act when making decisions about water allocation and approving disturbance of water bodies, such as wetlands and lakes. The Framework for Water Management Planning was created under directory provisions of the Water Act along with a Strategy for Protection for the Aquatic Environment.

If, following an assessment of the lakes' water budget, it appears that unsustainable diversions are already occurring, the water management plan could focus on opportunities to retire some water licenses during the renewal process and develop a water conservation objective for a lake. In addition, educational programs would be required to increase water conservation and manage demand for water in the watershed (Unger 2008).



4.3.2 Nutrient Budgets

A detailed budget will help focus management efforts on nutrient sources that would be easiest to control for the greatest benefit, particularly phosphorus. At minimum it helps to identify internal/external and point/non-point sources of nutrients. It also helps lake users understand what they can realistically expect from efforts to reduce nutrient loading from the lake's watershed.

Nutrient budgets are data-intensive and would require the skills of a professional. Nutrient budgets are commonly determined in two primary ways: by direct measurement of water quality for tributaries feeding into the lake or by estimation from other regional studies. Combined with stream flow data, this information can be used to calculate nutrient loadings. Some of this data may have been

collected through other programs and there may be available data on water and sediment quality in the lake and water quality for in-flowing tributaries. Historical data from streams sampled to study the impacts of agriculture on water quality or historical nutrient budgets in the Atlas of Alberta Lakes could also be used.

Accurate determination of a nutrient budget by direct measurement is monitoring-intensive, requiring nearly constant measurement of water flow and frequent measurement of nutrient concentration in all or most incoming and outgoing water. As well, nutrient budgets require accurate estimates of the mass of nutrients (usually total phosphorus) throughout the water column of the lake. It is especially important to have data from storms because if high nutrient concentrations from single events go unmeasured the budget will be largely inaccurate. Groundwater samples may be difficult and/or expensive to collect. Flow rates are hard to determine precisely without expensive automated equipment, especially during storm events. Consequently, nutrient budgets are often determined by loading estimates based on land uses and by models based on existing data. In any event, nutrient loadings from groundwater are included with other internal sources such as internal release from sediments.

For example, a phosphorus budget might be constructed by measuring or estimating the amount of phosphorus that enters a lake in year from precipitation, runoff, sewage, groundwater and the bottom sediments and comparing to the total phosphorus measured in the lake water (i.e. change in TP mass observed in lake minus runoff and atmospheric inputs with remainder assumed to be sediment and groundwater additions). Once a budget is calculated a computer model of the system can be created. The model would be used to develop scenarios to see how changes in nutrient inputs might be reflected in the lake.

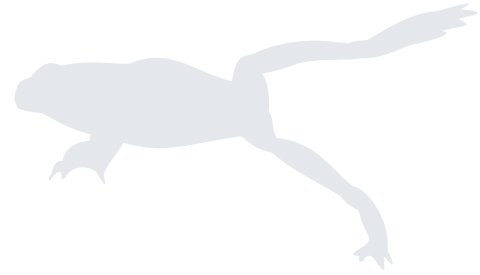
Some sources of nutrients, like leaking septic systems, are very difficult and expensive to measure and, as such, several Alberta lake nutrient budgets make the assumption that a small proportion of phosphorus (4%) within sewage and effluent from cottages and camps is entering the lake (see the Atlas of Alberta Lakes). Until newer research is done then this estimate will likely be used.

CASE STUDY

Wabamun Lake. Phosphorus concentrations for runoff and precipitation and lake water were measured during the 2008 open water season and used in conjunction with extensive historical data at the lake to produce a representative water and total phosphorus budget (AENV 2011).

- Lake sediments (43%)
- Precipitation falling directly onto the lake surface (44%)
- 2008 (dry year) runoff (3%)
- Industrial return flows (3%)
- Groundwater (5%)
- Domestic sewage (1%)

Further, see how Wabamun Lake phosphorus budgets compares to other lakes in Alberta as well as the high variation between wet and dry years (Table 4)



Alberta Lake	Time Period	Runoff (%)	Atmospheric Deposition (%)	Sediments/Other (%)	Domestic Sewage (%)	Diversions (%)	Ground-water* (%)	Mean Chlorophyll-a (mg/L)
Burnstick	1995	90	6	-	4	-	-	2.6
Gull	1999-00	31	11	52	7	-	-	7.5
Isle	1996	49	2	42	7	-	-	38.6
Lesser Slave	1991-93	28	7	65	-	-	-	40.3
Lower Mann	Various	12	1	69	18	-	-	96.5
Moose	Various	61	6	32	1	-	-	20.6
Pakowki	1996	9	2	90	-	-	-	34.6
Pine	1992	36	4	55	6	-	-	22.2
Ste. Anne	1996	36	4	55	5	-	-	43.8
Sandy	Various	21	6	73	1	-	-	82.5
Sylvan	2005	32	20	11	13	-	24	4.4
Thunder	1992-96	13	8	55	-	24	-	28.8
Upper Mann	Various	21	1	55	24	-	-	37.0
Wabamun	1980-82	23	13	55	1	6	2	11.3
Wabamun	2008	3	44	43	1	3	5	11.3
Wizard	Various	35	4	46	15	-	-	22.7
Mean	-	31	8	50	8	2	-	32.9

Table 4. Nutrient budgets derived for 16 lakes located throughout central and northern Alberta (summarized in Alberta Environment 2011).

In developing a lake watershed management plan the feasibility of reducing nutrient loadings from each source in the nutrient budget should be evaluated. Evaluate cost, effectiveness, feasibility and environmental acceptability of various management approaches. Realistically, actual reductions in nutrient supply may be relatively small because the natural nutrient supply in Alberta lakes is fairly high. In addition, internal nutrient loading and recycling may continue to hamper lake recovery even after watershed sources are controlled. The relative importance of external versus internal nutrient sources is important to assess (see Table 4). Many recreational lakes were probably never pristine and clear, so at most they can only be “improved” to their original level of productivity, but lake users would see a difference in the quality of their lake if even this reduction could be achieved.

It should be stressed that the need to calculate a nutrient budget should not prevent action in the watershed. The absence of data on loading sources and quantification of reductions through best management practices (BMPs) should not be used to delay implementation of BMPs or policy and regulatory controls. For any water quality improvement project – or even to maintain the lake’s present condition – there is really no alternative but to tackle the difficult job of reducing the lake’s nutrient supply. Further, lakes with high phosphorus contributions from sediments can take several decades to decrease in productivity even if external additions are strictly controlled, so it is critical to get started now.



4.3.3 Sediment Analysis

Often, little or no long-term data exists for a lake, which makes it difficult to know if or what historical changes have occurred to the lake and its watershed. Understanding the natural range of variability for a lake can be used to set realistic management goals (e.g. control of blue-green algae may be difficult in a historically productive lake). Insight into historical trends can be conducted with a paleolimnological study of the lake sediments. This can provide a record of how the lake has been disturbed by both natural and anthropogenic processes and provide a reference for its natural water quality conditions. It will require hiring a professional to take one or more sediment cores and analyzing the layers. Professionals can also calculate the sedimentation rate. In Alberta, Universities are the best source to partner with on these research projects.

Example: Several recreational lakes have had sediment cores analysed for changes in water quality or quantity over time. For a summary of the findings and a complete list of the lakes studied, read a *Summary of Paleolimnological Studies Conducted in Alberta* (Alberta Environment 2007).



4.3.4 Social/demographic Trends

Look at the economic activities taking place within the watershed and consider how they can be sustained, or even improved, with successful lake and watershed management. Examine the attitudes of people living in (or using the resources of) the lake's watershed. Do the majority perceive a resource problem? What is the present and projected population of the watershed, and where is it concentrated? An economic analysis of further lake degradation and the impact to cottage, agricultural, and other industries that directly or indirectly rely on a healthy lake can help emphasize the importance of lake watershed management.



5.0

Collaborate: Working Together for Watershed Management

The lake watershed management planning process often starts with a group of individuals who are concerned with an aspect of their lake. These issues can be varied, such as water quality concerns or lakeshore development. In Alberta this group is often a Watershed Stewardship Group (WSG) but the entire lake

watershed management process will require input and involvement from many people in order to be successful.



5.1 IDENTIFYING WHO SHOULD BE INVOLVED (STEP 2)

A multiple committee format is outlined below that could be used for a large lake with many stakeholders, jurisdictions, and citizens at the table, each of whom will have different contributions to the planning process. A smaller lake may not need to have all of the committees. While not being prescriptive, a consistent naming and structure of the committees will be important in identifying where various stakeholders and government representatives fit into the planning process.

5.1.1 Steering Committee

In many cases, one lake steering committee could be the stewards of the entire planning process. A WSG may find that they have adequate representation within the existing group with only a few outside additions. The steering committee is the core group responsible for the development and stewardship of the lake watershed management planning process. These stakeholders will act as a focal point for knowledge, stewardship, and initiatives. These are the people who care about the long-term health of the lake - no one agency can represent the lake as well as a group.

Key Roles:

- Develop and approve the Terms of Reference for the planning process.
- Define plan components and schedule of work to address these components.
- Compile information acquired for each component.
- Write the Lake Watershed Management Plan.

- Help determine and find resources needed to develop and implement the plan.
- Facilitate involvement and support, as needed, from other groups and committees.
- Document and track progress and keep all members advised on progress.
- Monitor implementation of the plan and evaluate progress.
- Approve a communication plan and inform the watershed community including elected officials and appropriate decision makers.
- Make decisions in consultation with other stakeholders.

The size of the steering committee may vary but it needs to be workable. It is critical that this group include members representing diverse perspectives and talents in order to fulfill all the necessary functions of an organization (see Alberta Agriculture's A Guide for Creating Effective Land and Water Stewardship: Community Partnerships). In the beginning stages of the planning process this group may include only a subsection of the stakeholders in the watershed. It would then be the responsibility of the steering committee to identify missing stakeholders and ensure that they are included in the planning process.

The activities of the steering committee require that its members have the time to dedicate to make the effort successful; many groups have formal rules of attendance for voting and



participation. The typical steering committee member may need to dedicate one to three years (or more) toward the effort. It is a good idea to set target completion dates for committee work so that there is defined time commitment for members.

To be eligible for many grants and other funding sources it is necessary to be a registered not-for-profit society under the Societies Act. A new society could be started or the work could be done within an existing WSG, local community group, or with a municipality that agrees to take on the lake watershed management planning activities. The Alberta Stewardship Network has good resources on its website <http://www.landstewardship.org/organizational-basics/> for how to start a group.

It is also the job of the steering committee to educate themselves and the larger community on the sources and dimensions of the lake and watershed concerns and to identify, study, and recommend possible solutions.

The work of the steering committee must be fair, objective, and impartial for it to be accepted and put into action by the larger community.

5.1.2 Stakeholder Advisory Group

The stakeholder advisory group is comprised of a broader group of people who have a vested interest in the management of the lake and its watershed but may not have time or interest to be steering the process. It is made up of identified agencies and community stakeholders affected by the plan and/or needed to help resource and implement the plan. In fact, in the Guide to Watershed Management Planning In Alberta (ESRD 2013) this committee is termed the implementation committee.

It is important to include people or organizations that may not believe there is a need to develop a lake watershed management plan. It is absolutely crucial to have their buy-in and allow all sides with an interest in the lake resource to be heard in order to have a plan successfully implemented in the future. In addition to the local community stakeholders, we would expect to have broad

stakeholder representation that would include Industry, NGOs, Government of Alberta, and other governments as outlined in AWC's Strengthening Partnerships: A Shared Governance Guide for *Water for Life* Collaborative Partnerships report (2008) and listed in Table 3.

Table 5. Recommended Stakeholders and some example groups that could be invited depending on their activity and interest in the lake's watershed.

Industry	NGO'S	Government of Alberta	Other Governments
<ul style="list-style-type: none"> • Oil & Gas companies operating locally • Synergy Groups • Agricultural Associations (livestock, irrigated crops, other crops) • Forestry Companies operating locally • Chamber of Commerce • Local businesses 	<ul style="list-style-type: none"> • WPACs • other WSGs • Alberta Conservation Association • Fish and Game Associations • ALMS • Cows and Fish • Nature Alberta • Ducks Unlimited 	<ul style="list-style-type: none"> • AB Agriculture and Rural Development • AB Environment and Sustainable Resource Development • AB Health and Wellness • AB Tourism, Parks and Recreation • AB Community Development 	<ul style="list-style-type: none"> • Municipalities (summer villages, counties, towns and cities) • First Nations • Métis Settlements • Federal –Agriculture & Agri-food, Fisheries and Oceans, Transportation

Key Roles:

- Members would provide advice, consultation, or information as required. Attendance at every meeting is not required.
- Meetings would be held with wider stakeholder groups at key milestones throughout the project.

In practice, stakeholder advisory groups may be constrained in the choices available and question the necessity for complete representation from each sector. The organizing principle, however, is to ensure an appropriate balance among the diverse interests within a watershed in the development of watershed assessments and plans.



5.1.3 Technical Committee

Depending on the scope of the issues facing the lake watershed, it may be necessary to form a technical committee. The intention of this committee is to provide direction in terms of scientific assessment and management options. It is not necessary that technical experts be involved in each step of the planning process, but it is important that they be used as a resource when issues arise that are out of the scope of knowledge of the stakeholder or steering committees. The steering committee should formally request assistance from municipal, provincial, and possibly federal governments to appoint staff to a technical committee. The ENGO community may also be able to provide technical help if requested. The technical committee will advise and assist the steering committee on all technical issues.

5.1.4 Making Contact

For Alberta Government Ministries that you want to involve (i.e. Agriculture, Health and/or Environment and Sustainable Resource Development) start by contacting the regional office nearest you (check local phone book or visit Alberta.ca) or call the information line: (area code) 310-0000. This also applies to help from Alberta Community Development (within Alberta Culture), who may be able to help facilitate the planning process for Watershed Stewardship Groups.

For local industry or NGOs find out who the local community liaison is by contacting head offices, general information numbers, or email addresses on web pages.

Is a consultant necessary?

Consultants can be hired to involve people with special expertise that may not be available through the technical committee or stakeholder advisory group. They can have a large or small role in developing the lake watershed management plan. When considering whether to hire a consultant, it is helpful to first answer some key questions, including:

- What will the consultant to do?
- What skills, expertise, and experience must the consultant have to complete the required tasks?
- When does it need to be done?
- How will the steering committee interact with the consultant?
- Will they provide staff support, stakeholder or community

participation, review, or other input?

If it is decided to hire a consultant, a Request for Proposals (RFP) will need to be written and circulated widely. The RFP must be designed so that the responses will provide all the information that is needed to select and hire a consultant.

A consultant should be considered a resource but recommendations for a path forward should come from the planning committees, collectively. Avoid asking a consultant what to do, this diminishes the group's ownership and sense of responsibility for the lake management plan and the ability to make other decisions.

Engaging First Nations

First Nations are rights-holders as well as stakeholders in many watersheds in Alberta; they have rights to water, land, and subsistence that must be respected. First Nations must therefore be consulted in the watershed planning process, and should be engaged as early as possible. Each Nation has a Consultation Office with Consultation officers/managers. Consultation officers/managers are the first point of contact for each Nation, act as the liaison between interested parties and the First Nation, and communicate with the governance level (Chief and Council). Consultation Offices may be reached through the Nation's individual websites, Administrative offices, or via the Government of Alberta Website Consultation contacts.



5.2

DETERMINE HOW PARTICIPANTS WILL WORK TOGETHER (STEP 3)

People will come to the table from different starting points and involving everyone and finding ways to respect and address the concerns will also help to speak to the concerns of the broader community that shares those concerns and interests. While it may make initial contacts or meetings more difficult, considering all sides will lead to better solutions and implementation. Excluding some interests and viewpoints may jeopardize completion of the plan and lead to development of new groups who push other agendas.

It is recommended that decisions are made and agreed to by consensus. Indeed, this is a critical component of successful watershed management planning, as the decisions made with all stakeholders in agreement are stronger and easier to implement. More information on consensus decision-making can be found in the *Consensus Decision Making Toolkit* (2010) on the Alberta Water Council webpage.



PRINCIPLES AND PRACTICES OF SUCCESSFUL STEERING COMMITTEES

- Focus on the concerns identified, rather than assigning blame.
- Resolve from the beginning to work toward common goals and understanding.
- Are willing to set aside differences while working on areas where solutions seem possible.
- Treat all members of the committee with respect.
- Recognize that resource damage of the past and present are often unintentional, and often result from lack of knowledge or information.
- Work for consensus, so that everyone will be committed to the actions proposed.
- Make field trips and site visits to clarify problems and solutions and increase team cohesion.
- Focus on specific, constructive actions that work, not on global environmental problems.
- Know that nothing inspires people like success, get a few decisions made as soon as possible.
- Have some fun and appreciate the contributions of all involved in a tangible way.



5.3 ESTABLISH THE STRUCTURE UNDER WHICH PARTICIPANTS WILL CONTRIBUTE (STEP 4)

Consider how the various committees or groups will work together. Figure 6 is a picture of how the committees may interact and work together within the broader watershed community. The size of the circle depicts the approximate number of people involved in each circle and they are overlapping to indicate that individuals may reside in all of the circles (i.e. Table 5). Recommended Stakeholders and some example groups that could be invited depending on their activity and interest in the lake's watershed, if they lived in the watershed) and participate in multiple committees as part of planning process. The technical committee is shown as an arrow indicating that it has relatively few people and is independent yet interacts with the other groups. This picture may look different depending on the lake and people involved, but however it looks the roles and responsibilities of each committee as well as the relationship and structure between the various committees should be agreed to and described in the terms of reference.



Figure 6. Diagram of suggested governance structure for developing a lake watershed management plan.





CASE STUDY

The Pigeon Lake Watershed Association (PLWA) appointed a Steering Committee to provide recommendations on the development and implementation of their Watershed Management Plan (WMP). The Steering Committee includes representatives from Alberta Agriculture and Rural Development, Alberta Environment and Sustainable Resource Development, the Association of Pigeon Lake Municipalities that includes all summer villages and the Counties of Leduc and Wetaskiwin, Battle River Watershed Alliance, PLWA, and ALMS. Committee members were also asked to identify other stakeholder groups to participate on the Steering Committee.

They intend to implement their watershed management plan in a number of phases, over a period of years. The committee that should be involved in a specific stage of the process is shown in brackets.

1. Engaging the public and stakeholder advisory group for input into the plan. (steering committee)
2. Identifying critical areas in need of management and identifying management tools and techniques (technical sub-committees)
3. Development and endorsement of a draft WMP and an implementation plan by stakeholders (steering committee & stakeholder advisory group)
4. Implementation by stakeholders of mitigation measures agreed to (stakeholder advisory group)
5. Ongoing monitoring, reporting, review and evaluation of plan implementation and progress (steering committee)



6.0

Drafting the Lake Watershed Management Plan

Data collected and State of the Watershed (SoW) reports written thus far are critical to understand the severity of the lake's problems and figure out what has caused them but the lake watershed management plan, developed collaboratively, is now the place to detail the strategy to address the issues that stakeholders want to focus on in the lake's watershed. To the right is a sample Table of Contents for a Watershed Management Plan (from the Guide to Watershed Management by Environment and Sustainable Resource Development 2013). Sections 5 to 8 describe all of the steps that must be taken to finalize this document.



Section	Suggested Content
Background	Why undertake a watershed management plan
Vision	Describes a desired future state
Planning Linkages	Legislated plans governing the area Existing water, land, resource, wildlife, settlement or other relevant plans
Watershed & the Water Resource	Description of the watershed or reference to a state of the watershed report How the water is used in the watershed
Planning Process	Approach taken to organizing a watershed plan Scope of issues, risks and challenges
Engagement & Communications	Who are the participants When and how input was gathered from implementers, stakeholders and the public.
Outcomes & Actions	Agreed-upon outcomes and objectives to get there Performance measures (e.g., additional indicators) Recommended management actions and rationale
Implementation, Monitoring & Renewal	Timelines, roles, and responsibility for implementation Performance monitoring Communication to stakeholders and implementers Strategy for renewal and reporting on progress
References & Appendices	Previously-endorsed terms of reference Glossary, sources, citations, etc.

Table 6. Sample Table of Contents for a Watershed Management Plan (from the Guide to Watershed Management ESRD 2013).



6.1 IDENTIFY AND PRIORITIZE ISSUES AND OPPORTUNITIES THROUGH STAKEHOLDER ENGAGEMENT (STEP 5)

Most efforts to improve the quality of a lake and its watershed begin with an identified concern or problem. Some of these issues may have been identified in the State of the Watershed report but it is also necessary to involve all stakeholders in selecting which issues and opportunities to focus on.

Involve the advisory group members, which has broad stakeholder representation, by having them identify and list all concerns and opportunities regarding the watershed's natural resources and economic trends that have an impact on quality or use.

Another excellent way to identify issues and critical areas in need of management is through a watershed community survey. This is a good way to learn of the community's views and priorities on the key issues and concerns that must be addressed in the management plan. NALMS (2001) and other sources provide resources on how to conduct effective community surveys. The survey must target all key stakeholders in the lake community and canvass enough people to be statistically valid. Often mail-in surveys or digital surveys (i.e. Google Docs or SurveyMonkey.com) should be complemented by phone interviews to ensure results are representative of public opinion. Opinion survey is a complex science, and help may be needed. Provincial government agencies and universities have sometimes assisted community groups in the past.

CASE STUDY

In 2003 a survey was conducted at Lac La Nonne (Watershed Edge Resource Group 2004) in response to concerns over water quality and lake health. The survey was geared to watershed stewardship and was sent to 1400 landowners and 251 were returned. The majority of respondents felt that water quality had deteriorated with time, 31% said water quality was poor, 51% said very poor. When asked to rank conditions or activities perceived to impact watershed health the results were:

- Low water level
- Application of agricultural fertilizers and/or other chemicals
- Livestock grazing and manure management
- Cottage septic/wastewater systems
- Application of lawn fertilizers/chemicals
- Upstream on farm/private/municipal drainage
- Annual agricultural cropping practices
- Water allocations or withdrawals
- Lakeshore cottage/beach development
- Clearing of riparian and shoreline areas
- Removal of aquatic or lakeshore vegetation
- Local oil and gas activity
- Erosion/sedimentation/runoff
- Recreational activities (boating, swimming, others)
- Others (including road construction, high volume public traffic, inflow/outflow obstructions)



The stakeholder advisory group should be asked to assess and prioritize the identified issues from the State of the Watershed and from the surveys. Use criteria such as:

- Is the group able to change the situation?
- Is the group motivated enough to address the concerns?
- Will the costs outweigh the benefits?
- Is it going to improve or maintain the ecological health of the lake and its watershed?

The Guide to Watershed Management Planning in Alberta (2013) outlines several tools to help select the priority issues to be addressed in the watershed management plan. The Guide stresses to not tackle all concerns at one time! A watershed management plan is a continuous cycle, so choose to address priority problems over time or focus on specific watershed areas initially. Allow for regular re-confirmation of priorities before starting new projects.



6.2

PREPARING AND CONFIRMING SUPPORT FOR THE TERMS OF REFERENCE (STEP 6)

The terms of reference is the first product of the steering committee and it states the objectives, process, and structure that will guide the development of the lake watershed management plan. It clearly outlines the most important issues and priorities in the watershed as understood by the stakeholders. The terms of reference should include (but are not limited to):

- Description of lead organization, its history and general intent of the watershed plan
- Watershed characteristics
- Vision statement or objectives of the planning process
- Watershed issues of major concern and priorities for plan
- Scope and content of the lake management plan
- Roles and Responsibilities
- Engagement Process
- Lake Watershed Management Plan Process and Components
- Process for plan endorsement and approval
- Estimated human and financial resources required to complete plan

This terms of reference needs to be approved or endorsed by the group leading the initiative (typically the watershed stewardship group) and members of the stakeholder advisory group. Approval of the plan's terms of reference is important because it is confirmation of support of the plan and its intended actions within the watershed.



6.3 DEVELOP AN ENGAGEMENT STRATEGY (STEP 7)

Detail how you will inform and engage the various committees, their networks, as well as the broader watershed community throughout the various stages and projects involved in the lake watershed management plan. Plan to inform, consult, involve and/or invite collaboration with the various stakeholders.



CASE STUDY

The Pigeon Lake Watershed Management Plan used the principles of the International Association of Public Participation (IAP2) to inform their engagement strategy. They planned that the level and type of engagement will vary at different points during the lake watershed management planning process. Stakeholders can determine the degree to which they would like to be involved in the development of the Pigeon Lake Watershed Management Plan. Table 7 describes levels of engagement for the PLWAMP which was based on a simplified version of the IAP2 Spectrum of Public Participation (iap2canada.ca).

Table 7. Levels of Stakeholder Engagement during the development of the PLWMP, based on a simplified version of the IAP2 Spectrum of Public Participation (IAP2 2006).

	Level 1		Level 2	Level 3
	Inform	Consult	Involve	Collaborate
Stakeholder Engagement Goal	As many stakeholders as possible are kept aware of the PLWMP process, opportunities to be involved, information available, outputs and progress.	As many stakeholders as possible are given input and feedback opportunities during the PLWMP process.	As many stakeholders as possible have opportunities to interact, question and discuss PLWMP content and recommendations.	Through direct involvement, a cross section of watershed stakeholders support the module recommendations and can explain the thinking behind them.
Promise to Stakeholders	You will be kept informed.	You will have input and feedback opportunities. Survey results will be made available.	Through in-person dialogue you will have the opportunity to influence the thinking and outputs of the PLWMP modules.	You will have an opportunity to join committees or make other substantial contributions to the PLWMP process.
Opportunities to be Involved	Visit the PLWMP website Sign-up to receive PLWMP communication	Complete surveys Submit comments Attend public information sessions	Public engagement through: i. Panels ii. Discussion/Focus Groups iii. Workshops iv. Webinars	WMP Steering Committee and module subcommittees



6.4

IDENTIFYING OUTCOMES, OBJECTIVES, AND INDICATORS (STEP 8)

6.4.1 Refining a vision statement

This is the time where in the lake watershed management planning process it is necessary to revisit the group's vision for the lake in light of new knowledge of the lake ecosystem and its watershed. The vision might not necessarily change, but often can be refined to be more specific and related to concerns that were identified and prioritized. A vision should be inspirational but achievable.

Contained within or alongside the vision statement are the desired outcomes for the lake watershed management plan. Outcomes are a statement of the overall, long-term results the plan is intended to achieve. They need to be clear, free of jargon, and measurable.

Previous vision statement:

The natural watershed processes and functions of Lake X will be restored to reduce nutrient and sediment loading, and make the lake more attractive to anglers and other water recreational activities.

Revised vision statement:

The watershed is healthy and nutrient loading is not significantly above pre-disturbance levels. The health and quantity of aquatic plant community in the lake are good and getting better. The lake is attracting anglers and other water recreational activities on and around the lake.

After this has been done, the lake watershed planning process can focus on setting clear objectives and indicators that are necessary to achieve the outlined outcomes.

6.4.2. Setting Objectives

In order to achieve the outcomes outlined in the vision, a combination of short and long-term objectives are created. Effective objectives describe specific results or steps to be taken, they should be both measurable and achievable.

Include objectives for each outcome outlined in the vision statement, but focus the objectives to the areas that will have the largest benefit and where the committee's input will make the biggest difference to the lake watershed.

CASE STUDY

The Sylvan Lake Watershed Management Plan Committee, comprised of representatives from municipal governments surrounding the lake, hosted a workshop to engage Sylvan Lake Watershed stakeholders in their vision and desired outcomes for the watershed. They asked "In 2020, in an ideal future, Sylvan Lake is/has..." and came away with an extensive list of desired outcomes.

The outcomes were ranked, shortlisted and a few prioritized for the focus of the watershed management plan. The outcomes were:

- 1) Environmentally Healthy Lake and Watershed
- 2) Planned Diverse Recreation
- 3) Collaborative Planning

Their vision: Sylvan Lake and its watershed are a healthy, treasured resource where a responsible, collaborative planning approach achieves a balance between development, nature, and recreation.

Table 8. Including a mix of short and long term objectives helps sustain interest in lake management goals. Achievable results and continued awareness are the hallmarks of a functional plan.

Short term Objectives
Stop stream bank erosion near pastureland
Eliminate sewage leakage from septic systems on lakeshore property
Long term Objectives
Within ten years, external nutrient loading will be reduced by 40 to 60 percent.
Decrease the severity of summer algal blooms
Protect and restore wetland and riparian areas surrounding lake

Limitations in the amount of time people can contribute and the available budget should be considered when choosing objectives for the lake watershed management plan. Objectives must be articulated as clearly as possible to motivate the larger watershed community to buy into the lake watershed management plan and take the actions needed.

6.4.3. Selecting Indicators and Targets

Because objectives should be specific and measurable they should incorporate indicators and targets. Indicators should be selected that can be monitored or measured to determine progress towards the objectives. Each indicator can have targets that describe the future state or condition of the indicator. Potential indicators and targets are likely readily available from those selected for the State of Watershed report. Indicators may also come from other regional cumulative effects management systems managed by the provincial government. Good scientific advice may be needed for indicator monitoring program design and data analysis.

Indicators may be directly or indirectly connected to the outcome. For example, if one outcome of the plan is to achieve and maintain acceptable water quality in the lake, direct indicators could include measurements of chemical data. Volunteer monitoring programs such as LakeWatch can help provide basic monitoring of lake water quality in a cost-effective manner. Indirect indicators could include the percentage of shoreline area requiring erosion control or the percentage of cottage owners using best available technology for sewage disposal. Ideally, indicators are measurable and have an achievable target associated with success. In some cases, measurable indicators are not possible and so progress

should be summarized descriptively.

It is important to set realistic targets and timeframes for achieving actions and objectives in order for watershed planning to be successful. At this stage, include some targets that can be realized quickly to build confidence in the process. This helps maintain the momentum needed to accomplish larger, longer-term projects. Phasing targets is a good approach if changes are going to take a long time. Table 7 provides some examples of short and long-term objectives with associated indicators and targets.

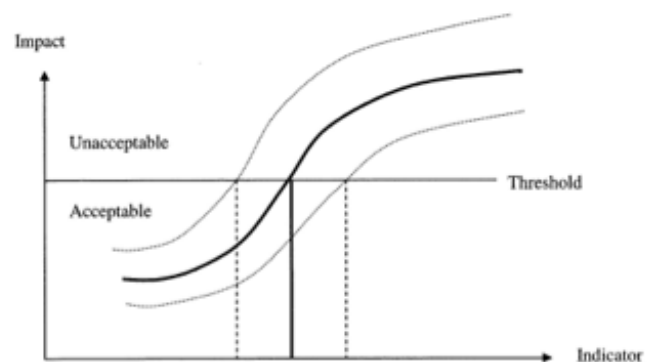


Figure 7. Diagram showing change in indicator in response to an increased impact and how you might set targets, limits and thresholds.



Table 9. Examples of indicators and targets associated with short and long-term objectives.

Short-term Objectives	Indicator	Target
Stop stream bank erosion near pastureland	Turbidity	Reduce turbidity readings during baseflow to 10 JTU
Eliminate sewage leakage from septic systems on lakeshore property	Water quality tests or professional inspections of systems	Identify and eliminate any malfunctioning systems
Long-term Objectives	Measurable Result	Action
Within ten years, external nutrient loading will be reduced by 40 to 60 percent.	Annual concentration of P and N	Average summer P concentrations will be reduced to 30 ug/L (+/- 10 ug/L).
Decrease the severity of summer algal blooms	Microcystin concentrations	Reduce concentrations of microcystin and have fewer beach advisories.
Protect and restore wetland and riparian areas surrounding lake	Riparian Health Score	Greater than 60% of shoreline scored as 'Healthy'.

CASE STUDY

Sylvan Lake Management Committee, when developing their Cumulative Effects System for the lake, developed a formal process of reporting and vetting plan outcomes, indicators and thresholds at each stage in the planning process. This ensured that the respective municipalities had adequate time to comment and to understand the plan recommendations.



6.5 DEVELOPING, EVALUATING, AND SELECTING MANAGEMENT ACTIONS (STEP 9)

Planning now enters a stage where management actions should be developed, evaluated and selected to achieve the objectives and ultimately realize the vision for the lake. This process evaluates the feasibility of all possible approaches and technologies that can help to meet the objectives of the lake watershed management plan. Consider all aspects, including technical, financial, political or social considerations, permits and fees, and the feasibility of implementation, and weigh all alternatives relative to one another. A systematic matrix table that lists all important points for each alternative is a good way to ensure all aspects are considered.

Although there is no limit to the number or types of lake management actions, they typically fall into the following categories:

- Change to or consistent enforcement of policy and regulation
- Best management practices
- Planning, zoning, conservation
- Knowledge and education
- Research and technology

For technological solutions experienced scientific advice is very helpful because there are some companies that sell “quick fixes” for some issues that may be inappropriate or are not cost effective for your lake. Always ask about well-documented (i.e. published) examples of the use of such technology for the specific type of lake management problem in consideration. There are a number of resources available to guide lake stewardship groups through this step, including the lake management guidance manual from the North American Lake Management Society (NALMS) entitled *Managing Lakes and Reservoirs* (2001). There are also more detailed scientific texts that deal specifically with steps taken to decide on management alternatives, such as Cooke et al. (2005), and Ryding and Rast (1989). Teichreb (2012) provides a summary of the benefits and drawbacks of commonly used in-lake treatments and techniques to control blue-green algae blooms in Pigeon Lake and specifically notes whether they are practical or legally allowed in Alberta. NALMS also provides numerous other resources on their website (www.nalms.org) and listings of Certified Lake Management Professionals with demonstrated experience in this field, including several that live and work in Canada.

It is critical to devote time to a thorough evaluation of management alternatives. Technical options need to be weighed from environmental, economic, and social perspectives. Socio-

economic considerations should always be factored in when evaluating management strategy options. Stakeholder advisory group members can offer insights and concerns about the costs and social acceptability of various options. An open dialogue is critical to selecting alternatives that members will support and implement. In addition, stakeholders can identify opportunities for collaboration or leveraging with existing programs and projects in the watershed.

A consistent approach to watershed management would include a process of prioritization, prescription and programming when pursuing regulatory and policy options for a lake watershed (Unger 2008).

- **Prioritize** focus areas or activities that have significant impacts on environmental outcomes.
- **Prescribe** regulations in a consistent manner across the watershed to address priorities.
- **Develop programs** for adoption of best management practices (of unregulated activities).

6.5.1 Selecting a course of action

Working collaboratively and deciding by consensus, it is now time to make a decision on the actions that will be taken to support the objectives. Prioritize actions based on the likelihood that they can be accomplished within a specified timeframe and their importance in achieving the outcomes and objectives.

The management plan should list specific actions, the timeline for each action such as watershed projects or in-lake treatment techniques, who will be responsible for coordinating and completing these actions, and an estimate of the cost for the action. Before including such actions in the plan, consider basic questions such as: Is there a reliable funding source for this type of project? Does the agency or individuals have the experience and authority? Are they willing to get involved?





Table 10. Example of actions necessary to achieve the short term and long-term objectives of the lake watershed management plan.

Short-term Objectives	Action	Timeline	Roles and Responsibility	Estimated Cost
Stop stream bank erosion near pastureland	Help install a solar powered stock watering system well away from the shore.			
Long-term Objectives	Action			
Decrease the severity of summer algal blooms	Identify areas of nonpoint nutrient release and educate watershed residents on risks through open houses, seminars, and information sharing			
Protect and restore wetland and riparian areas	Work with agencies to restore damaged areas. Work privately/ publicly to increase conservation of these areas.			



6.6 DRAFTING AND CONFIRMING SUPPORT FOR THE PLAN (STEP 10)

Once the outcomes, objectives, indicators, and actions have been agreed to by the steering committee, the stakeholder advisory group and the technical committee, it is time to compile all the information into a draft document. Also include the next steps such as how the plan will be implemented, monitored, and adapted over time.

6.6.1 Communicating the plan recommendations

Plan recommendations need to be clearly communicated to and accepted by stakeholders in the watershed community to be effective. The wider watershed community can be informed and engaged through a variety of ways, for example informal consultation, public forums, open houses, traditional media, social media and websites. An excellent resource that outlines the key considerations for communicating your plan to the watershed community is: *Building Community Support for your Project*, by Alberta Agriculture (1999).

Each sector on your stakeholder advisory committee should be asked to formally approve the actions outlined in the plan and agree to implement the recommendations. It should be agreed beforehand that endorsing a watershed management plan makes participants accountable to one another to deliver the plan.

Communicating and gaining endorsement from municipalities and the Alberta Government will be key to ensuring that the decision-making tools of these governments (both regulatory and non-regulatory) are supportive of the plan's outcomes and action plan.

Be sure to leave enough time and participant energy to circulate the document and process feedback to the draft plan.





CASE STUDY

In 2006, after two years of collaboration, the Moose Lake Watershed Society released its Moose Lake Watershed Management Plan (MLWMP). It has five main objectives: 1) improve wildlife & fish habitat, 2) improve riparian health & wetland management, 3) increase public awareness & land stewardship, and 4) improve water quality within the Watershed, 5) incorporate the Lake Management Plan into municipal planning documents.

To achieve objective one the group decided to work to protect a key fish spawning habitat on the west side of the lake. The society undertook extensive planning (mapping) and stewardship (garbage clean-up, trail maintenance) activities in order to convince the provincial government to designate 13 sections of Crown land in part provincial park and part provincial recreation area. The combination of park types was to serve the dual purposes of protecting the natural and recreational resources of the area. The society hosted extensive public consultations, got support from the surrounding municipalities prior to submitting a proposal to the provincial government.

Objective five has been critical to achieving many of the other objectives; The MD of Bonnyville has used the MLWMP as guideline for several municipal

initiatives. The document has been taken as a general management plan and implemented county wide using both regulatory and non-regulatory projects to achieve the five objectives.

In 2007 they created and began enforcing a Municipal Lands Bylaw, which includes the protection of the Environmental Reserves, as well as a Private Sewage Disposal Bylaw which establishes a process for assessing septic failure and potential threats to the lakes. They partner with other municipalities and organizations to control invasive, and dangerous, plant species including Himalayan Balsam and Water Hemlock in riparian areas.

Education is key to many of the objectives as well. The MD of Bonnyville posts information signs on all environmental reserves surrounding lakes and on tributaries flowing to Moose Lake. Shoreline health sessions are offered by the MD to educate landowners. Each year Grade 5 classrooms take a field trip to Moose Lake to learn about lakes and their watershed as part of the Walking with Moose program.

Note* Moose Lake, has not experienced increases in phosphorus concentrations or decreases in clarity based on long-term monitoring records (Casey 2011).

Implementation

Once your group has developed a detailed action plan you will need to take specific steps to turn the recommendations into reality.

7.1 WORKING WITH APPROPRIATE INDIVIDUALS, ORGANIZATIONS AND JURISDICTIONS TO IMPLEMENT THE PLAN (STEP 11)

Identify who is responsible for coordinating and completing each action (i.e. Table 7). Ideally, the assigned actions will be carried away by the different the sectors outlined in Table 3 (government, industry, community, ENGOs, as well as members of the watershed stewardship group) for implementation. Where actions belong to multiple sectors, new working groups might be created and assigned various tasks. The diligent efforts to include appropriate decision-makers and authorities as part of the planning process from the beginning will pay off now because, collectively, the members of the lake watershed management planning committees

will have the authority to implement plan actions. Watershed management plans form recommendations to governments and although the plan has no legal authority, the advice it provides may be used to inform decisions by municipal, provincial, federal, and First Nations governments. Therefore, a strategy is necessary to ensure that governments are aware of the recommendations and consider them in all their decisions on an ongoing basis.



7.2 ESTABLISHING THE IMPLEMENTATION COMMITTEE (STEP 12)

In lake watershed management plans the members of the steering committee will continue to play a strong role in facilitating and tracking implementation actions. This includes the actions they were responsible for as well as tracking other committees and sector's actions and progress made towards achieving the plan's outcomes.

A regular reporting mechanism could be set up to provide regular evaluation of the plan as well as any necessary adaption of plan recommendations. Ongoing communication is essential to successful implementation and achieving outcomes.



7.3 IMPLEMENTING THE PLAN (STEP 13)

Once a plan has been approved by all affected sectors and officially endorsed and released by the steering committee, then implementation can begin in full.

Start by looking at the actions that were outlined in the plan. Where agreed to, some actions may have already been initiated. Actions should be developed as individual, discrete projects that can get done and achieve results. The projects can be large and comprehensive, or made smaller by staging projects over time or into modules that are developed one at a time.

7.3.1. Fundraising to Implement Actions

This is one step which community groups may find intimidating, but experience with programs such as the Pine Lake Restoration Program suggests that there are excellent funding opportunities in this province for well-thought out projects. Below is a summary of some of the funding available, it is not intended to provide an exhaustive list of funding alternatives and contacts, but to indicate which sources have funded such work in the past. These include:

Community fundraising – since residents have a direct stake in the success of lake and watershed management projects, they are often willing to contribute financially. The value of their real estate directly reflects the quality of their lake. For years residents of Pine Lake contributed thousands of dollars annually to restoration efforts there. Funds raised from this source may be limited only by the energy and creativity of the stewardship communities.

Foundations and funding organizations – such as the Royal Bank Blue Water Project, TD Friends of the Environment, Evergreen, Wildrose Foundation, Alberta Ecotrust, Alberta Conservation Association, or Alberta Stewardship Network

Government funding – Data collection support from Alberta Environment and Sustainable Resource development or grants such as the Environment Canada EcoAction Community Funding.

Industry Sources - in particular any industries active in the watershed in question, and programs such as Shell Environmental Fund. Support for lake and watershed activities can be an attractive way to build goodwill for an industry. Conservation offsets or creative sentencing may also require companies to support environmental projects.

County and other municipal sources - since land use around lakes is largely regulated under the Municipal Government Act, municipal governments have a stake in watershed management programs and many have generously supported lake management activities in the past.

If funding needs go beyond the sources listed above you can try searching databases of funding sources for private donor and foundations to apply to. Some include the Canadian Subsidy Directory, BigOnline Database Canada, and also the Canadian Directory to Foundations and Corporations, by Imagine Canada.





CASE STUDY

Pine Lake is a small intermittently-stratified, eutrophic lake (surface area = 3.98 km²; mean depth 5.3 m) southeast of Red Deer, Alberta. Pine Lake was subject to severe cyanobacterial blooms. Public concern over deteriorating water quality prompted the Alberta government to initiate a lake restoration program in 1991.

Alberta Environment conducted a detailed diagnostic of the lake and a phosphorus budget was developed. The Pine Lake Restoration Society, an organization with representatives from the farming, commercial resort, and cottage communities, implemented a four-year work plan of watershed projects and in-lake treatment that addressed nutrient loading from all sources in 1995. Then watershed projects were developed at critical areas in the watershed to reduce external phosphorus loading. To remove internal loading, phosphorus released from lake sediments, a hypolimnetic withdrawal system was installed in 1998, and later a treatment wetland was installed downstream of the hypolimnetic discharge creek. A monitoring program was implemented to assess the benefits of the watershed projects and hypolimnetic withdrawal system in 1999 and initial results are summarized in a report that is available online (Sosiak 2002) and within Lakewatch reports.

The program has resulted in tangible improvements in lake water quality. Total dissolved phosphorus levels have decreased in Pine Lake since the hypolimnetic withdrawal system began operation in 1999. Dissolved oxygen concentrations have improved in winter. In 2000 alone, chlorophyll a approached the goal of the restoration program, a natural level of algal productivity. But the program cannot be considered a complete success because nuisance algal blooms continue to occur after wet periods. Also, there was insufficient water to operate the system during a drought in two of seven years since 1999, and water levels sometimes fell below target elevations. Larger weights have been added to sections of the hypolimnetic withdrawal pipeline that lost weights and floated. Results to date provide no evidence of significant adverse impacts of hypolimnetic discharge on water quality in Ghostpine Creek.

This was the first program of its type in Alberta, the most extensive, and has served as a model for other Alberta communities since. The Restoration Society is still in operation, continues to monitor water quality, and are considering further lake and watershed projects designed to reduce phosphorus to an even lower level.

8.0

Monitoring Progress (Step 14)

The development of a lake watershed management plan provides the guidance needed to implement activities, but the plan cannot be static. Monitoring the performance of your management actions is essential to understanding whether your goals have been met, and whether further actions are needed.

Monitoring and evaluating the implementation and effectiveness of a lake watershed management plan allows:

- i. Assessment of progress towards the goals and objectives of the plan;
- ii. Identification of problems and opportunities;
- iii. Collection of critical information required when performing a 5 or 10 year review of the plan.

Monitoring allows successes to be acknowledged and celebrated, and provides an early opportunity to identify impediments to progress so that adjustments can be made. For example, further management actions, or changes to existing treatments, are sometimes required to restore highly productive lakes.

8.1

REPORTING ON IMPLEMENTATION AND OUTCOMES (STEP 15)

Monitoring the progress of a plan can be achieved in numerous ways. It can take the form of documenting progress taken through actions identified in the plan, “did we do what we said we would do in the plan?” and is essentially a check mark exercise. Although this seems simple, it is an important step, since it is a record of both developments and achievements. Monitoring can also provide continuous feedback on how well selected indicators are working towards the ultimate goal of improved lake health, “did the practice accomplish what it was intended to accomplish?” An easy way to keep track of progress is to develop a chart that shows all the actions and the timeframes over which they should occur. Keep in mind that monitoring has little value if it provides wrong information or information at the wrong time. Information that has been collected must be processed, evaluated and presented to the committees in a usable format and in a timely manner. Regular review of both types of monitoring data will allow reporting on whether the plan is on track or not.

Most plans will contain many actions that will take place over different time frames and contribute to different aspects of the

plan. It may not be possible to monitor progress towards all goals all of the time. When developing the monitoring and evaluation component of the planning process, it is important to prioritize both targets and timing. Monitoring and evaluation requires the following steps:

- i. Identify the relevant time frames for monitoring progress towards each objective
- ii. Identify which actions are most important for achieving success towards the objective in each relevant time frame
- iii. Identify the indicators and targets that will be used to monitor progress
- iv. Prioritize which indicators will be monitored based on information needs, costs, resources etc.
- v. Identify who is responsible for conducting the monitoring
- vi. Establish the timeframe for completing the monitoring
- vii. Report results to stakeholders
- viii. Review the progress and modify plan accordingly



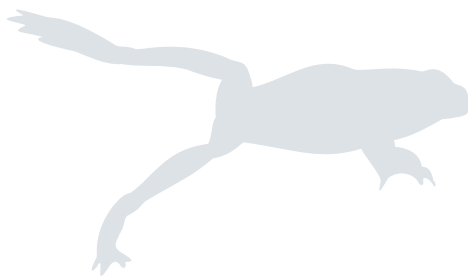
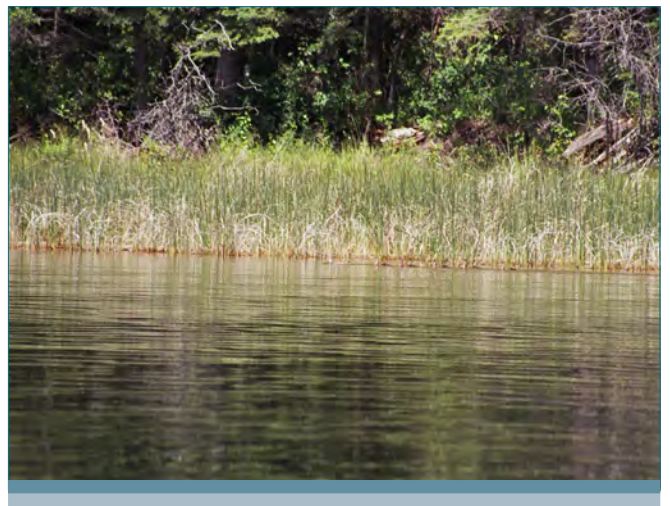
Development of a checklist will promote planning and provide a benchmark against which to measure results. Progress should be regularly reported to everyone involved in the plan and to the watershed community to maintain accountability and credibility of

the plan implementers. It will also keep everyone motivated to act to achieve the vision for the lake.



8.2 ADAPTING THE PLAN TO NEW INFORMATION (STEP 16)

What has the monitoring results of the plan and of the indicators shown? Is there a need to modify the plan? It is important that the lake watershed management plan does not just sit on a shelf. Information gaps should be addressed, action items need to be managed, completed, and evaluated to best address the needs of the lake. Always keep in mind the vision: if the actions taken are not bringing the lake closer to that vision, then the plan needs to be modified. Consider updating both the state of the watershed and the lake watershed management plans at regular intervals to make sure that the actions taken were achieving the desired outcomes and to evaluate what work still needs to be done.



9.0

Conclusion

The quality of our lake resources is the cumulative result of the people and their activities within the lake's watershed and with ever increasing pressures upon our lakes they cannot be expected to assimilate all impacts forever. The need to manage lakes as a limited resource requiring purposeful planning and action is real and immediate. Lake management requires the collective resources of citizens, municipal and provincial governments as well as local commercial enterprise. Neglect often results in negative impacts, water quality declines, lost fisheries and ultimately lost revenues and a degraded quality of life. Lake rehabilitation is a **very** costly venture with an uncertain outcome.

Stakeholder-initiated steering committees have been an effective method for developing plans. These efforts may be expected to

require a year or more to prepare and up to several subsequent years to enact changes in the daily lives of watershed residents. Cooperation, collaboration, and a willingness to change are the prime ingredients of the successful ventures. Finger pointing and recrimination will quickly ruin the best of intentions. Formalized lake watershed plans should be acknowledged by and incorporated into provincial, municipal, or other units of government operations—particularly those of the planning and zoning departments. Chipping away at the problems does work and everyone can do something, no matter how small the efforts may seem.



References and Resources (arranged by topic)

Regulatory Tools and Guidelines

Alberta Association of Summer Villages. 2008. Lake Stewardship Guide. Available at: <http://www.albertasummervillages.org/summer-villages/lake-stewardship/lake-stewardship-guide>

Beaudry, G. 2006. Municipal Guide: Planning for a Healthy and Sustainable North Saskatchewan River Watershed. Prepared for the North Saskatchewan Watershed Alliance. Available at: www.nswa.ab.ca/old_site/pdfs/muni_guide1.pdf

Government of Alberta. 2012. Stepping back from the Water: A Beneficial Management Practices Guide for New Development near Water Bodies in Alberta's settled region. Available at: environment.gov.ab.ca/info/library/8554.pdf

Stewart, JM. 2008. Municipal Tools to Protect Wetlands and Riparian Lands in Alberta's White Zone. LLM Thesis. Faculty of Law, University of Calgary.

Stewart, JM. 2013. Model Land Use Bylaw Lakeshore Provisions for Conservation and Management of Riparian Lands and Uplands to Minimize Nutrient Loading and Pollution of Pigeon Lake. Prepared for the Pigeon Lake Watershed Management Plan Steering Committee. Available at: www.plwa.ca.

Unger, J. 2008. PLWA Discussion Document: Regulatory and policy actions for a healthy Pigeon Lake watershed Phase II. Environmental Law Centre. Available at http://www.pigeonlakewatershedassociation.com/download/uploads/documents/0000/4595/Phase_II_Discussion_Document.pdf Accessed June 2011

Watershed Planning

Alberta Environment. 2000. Framework for Water Management Planning. ISBN 0-7785-1737-3. http://environment.alberta.ca/documents/Framework_for_water_management_planning.pdf

Alberta Water Council. 2008. Strengthening Partnerships: A shared Governance Framework for Water for Life Collaborative Partnerships. Available at: <http://www.albertawatercouncil.ca/Portals/0/pdfs/SharedGov%20-%20Strengthening%20Partnerships%20FINAL.pdf>

Alberta Water Council. Recommendations for a watershed management planning framework for Alberta. Available at: <http://www.albertawatercouncil.ca/Portals/0/pdfs/SharedGov%20-%20Watershed%20Management%20Plan%20FINAL.pdf>

Environment Protection Agency. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. Available at: http://water.epa.gov/polwaste/nps/handbook_index.cfm

Government of Alberta. 2013. Guide to Watershed Planning in Alberta. Available at: www.wfl.ab.ca

Government of Alberta. 2013. Protocol for Watershed Management Planning in Alberta. In progress.

State of the Watershed Reporting

Alberta Environment. 2008. Handbook for State of Watershed Reporting: A Guide to Developing State of the Watershed Reports in Alberta. Available at: <http://environment.gov.ab.ca/info/library/8044.pdf>

Alberta Environment and Sustainable Resource Development. 2012. Guide to Reporting on Common Indicators in State of the Watershed Reports. Available at: <http://environment.gov.ab.ca/info/library/8713.pdf>

Alberta Environment. 2008. Indicators for Assessing Environmental Performance of Watersheds in Southern Alberta. Available at: <http://environment.gov.ab.ca/info/library/7945.pdf>



Baptiste Lake State of the Watershed. 2008. Prepared by: M. Carlson, ALCES Group. Available at: http://www.southbaptiste.com/download_files/State%20of%20Baptiste%20Lake%20Watershed%20report.pdf

Island Lake State of the Watershed. 2011. Prepared by: M. Carlson, ALCES Group.

Lac La Biche State of the Watershed. 2004. Aquality Environmental Consulting. Available at: http://aquality.ca/uploads/news/id56/Aquality_LL_B_SoW_2004.pdf

Lac La Nonne State of the Watershed. 2006. Prepared by: Aquality Environmental Consulting. Prepared for: Lac La Noone Stewardship Society http://www.laclanonnewatershed.com/LLN_SoW_Report.pdf

Moose Lake State of the Watershed. 2006. Prepared by: Aquality Environmental Consulting. Prepared for: Moose Lake Water For Life Committee. Available at: http://md.bonnyville.ab.ca/downloads/residents/mooselake_watershed/environmental_inventory_report_may2005.pdf

Pigeon Lake State of the Watershed Report. 2008. Prepared by: Aquality Environmental Consulting. Available at: www.plwa.ca

Skeleton Lake State of the Watershed Report. 2008. Prepared by: Aquality Environmental Consulting. Prepared for: Skeleton Lake Stewardship Society. Available at: http://www.skeletonlake.com/info/Skeleton_SoW_with_App_B.pdf

Sylvan Lake Water Quality Assessment and Watershed Management Considerations. 2005. Prepared by: AXYS Environmental Consulting Ltd. in Association with North/South Consultants Inc. and Westwater Environmental Ltd. Prepared for: Lacombe County. Available at: http://www.lacombecounty.com/index.php?option=com_docman&task=doc_download&gid=296&Itemid=15

Wabamun Lake: A Review of Scientific Studies and Environmental Impacts. 2004. Prepared for Alberta Environment. Available at: <http://www.wwmc.ca/pdf/Lake%20Wabamu%20-%20A%20Review%20of%20Scientific%20Studies%20and%20Environment.pdf>

Wabamun Lake State of the Watershed Report. 2013. Prepared by Aquality Environmental Consulting. Prepared for: Wabamun Watershed Management Council. Available at: <http://www.wwmc.ca/pdf/WWMC%20State%20of%20Watershed%20Report%202013.pdf>

Wizard Lake State of the Watershed Report. 2013. Prepared by Aquality Environmental Consulting. Prepared for: Wizard Lake Watershed and Lake Stewardship Associations. Available at: <http://www.wizardlake.ca/state-of-the-watershed-report.html>

Lake Restoration and Management

Cooke, G.D., E.G. Welch, S.A. Peterson, S.A. Nichols. 2005. Restoration and management of lakes and reservoirs. Third Edition, Taylor and Francis Group, New York.

NALMS. 2001. Managing lakes and reservoirs. Prepared by the North American Lake Management Society and Terrene Institute in cooperation with Off. Water Assess. Watershed Prot. Div., U.S. Environ. Prot Agency, Holdren, C.W., W. Jones, and J. Taggart (eds.) Madison WI.

Ryding, S.O. and W. Rast. 1989. The control of eutrophication in lakes and reservoirs. UNESCO, ISBN 1-85070-257-8

Wagner, K.J. 2004. The Practical Guide to Lake Management in Massachusetts. Prepared for the Department of Environmental Protection and Department of Conservation and Recreation Executive Office of Environmental Affairs, Commonwealth of Massachusetts. (available online at www.mass.gov/dcr/watersupply/lakepond/downloads/practical_guide.pdf)



Teichreb, C. 2012. Lake and Watershed Management Options for the Control of Nuisance Blue-Green Algal Blooms in Pigeon Lake, Alberta. Available at: <http://environment.gov.ab.ca/info/home.asp>

Alberta Lake Information

Alberta Environment. 2007. Summary of Paleolimnological Studies Conducted in Alberta. Available at: <http://environment.gov.ab.ca/info/library/7868.pdf>

Alberta Environment. 2011. Wabamun Lake phosphorus budget during the 2008 runoff and open water season.

Available at: <http://www.environment.gov.ab.ca/info/posting.asp?assetid=8340&categoryid=5>

Casey, R. 2011. Water Quality Conditions and Long Term Trends in Alberta Lakes. Alberta Environment and Water. Available at: <http://environment.gov.ab.ca/info/library/8544.pdf>

Mitchell and Prepas. 1990. Atlas of Alberta Lakes. University of Alberta Press, Edmonton Alberta. Available at: <http://sunsite.ualberta.ca/Projects/Alberta-Lakes/>

Waters Edge Resources Group. 2004. Results of the Lac La Nonne Watershed Stewardship Survey – Spring 2003. April 2004. Waters Edge Group, Barhead Alberta 15 pp.

Alberta Lake Watershed Management Plans

Buffalo Lake Integrated Shoreline Management Plan. 2010. Government of Alberta. Available at: <http://blmt.ca/wp-content/uploads/2011/05/BLIMPS-Book-May11-2011.pdf>

Lac La Biche Watershed Management Plan. 2008. Aquality Environmental Consulting. Available at: http://www.laclabichedcounty.com/files/labiche/watershed_management_plan.pdf

Skeleton Lake Watershed Management Plan. 2010. Aquality Environmental Consulting. Prepared for the Skeleton Lake Stewardship Association. Available at: http://www.aquality.ca/uploads/news/id103/Aquality_Skeleton_Lake_WMP.pdf

Moose Lake Watershed Management Plan. 2007. Aquality Environmental Consulting. Prepared for: Moose Lake Water For Life Committee. Available at: http://md.bonnyville.ab.ca/downloads/residents/mooselake_watershed/mngmt_plan_apr30_2007.pdf

Pine Lake Restoration Program. 1994. A. Sosiak, Alberta Environment. Available at: <http://environment.gov.ab.ca/info/library/7887.pdf>

Initial results of the Pine Lake restoration program. 2002. A. Sosiak. Science and Standards, Alberta Environment. 87 p.

Stewardship, Governance and Communication

Alberta Agriculture and Rural Development. 2002. Building Community Partnerships: A Guide for Creating Effective Land and Water Stewardship. Available at: [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/aesa3354](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/aesa3354)

Alberta Agriculture and Rural Development. 1999. Building Community Support for your Project. Available at: [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex1336](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1336)

Alberta Water Council. 2010. Consensus Decision-making Toolkit. Available at: <http://www.albertawatercouncil.ca/LinkClick.aspx?fileticket=71lxDsIzFkc%3d&tabid=59>

International Association of Public Participation. 2006. IAP2 Spectrum of Public Participation. Available for purchase at: www.iap2.org or www.iap2canda.ca.

Land Stewardship Centre of Canada. Alberta Stewardship Network, Organizational Basics. Available at: <http://landstewardship.org/organizational-basics/>



Glossary of Terms

Alberta Environment. 2008. Glossary of terms related to water and watershed management in Alberta. 1st Edition. Available at: <http://environment.gov.ab.ca/info/library/8043.pdf>



