APPENDIX A

INFORMATION, SAMPLE POLICIES, BYLAWS, STANDARDS OR GUIDELINES

***NOTE TO USER: The examples are intended to provide general examples based on information available at the time of printing. Please refer to the actual source for details (websites have been provided where available). If there are any errors or misinterpretations of your jurisdiction's or department's information, please contact Mark Bennett of the BRBC at Mark.Bennett@calgary.ca to correct the information. This will also help ensure that the information remains as factual and up-to-date as possible.

A1: LAND USE

ECOSYSTEM SERVICES

- Ecosystem services (ES) are the benefits that nature provides to people. Examples include the ability of forest to regulate carbon and mitigate climate change, or the filtration and purification of water by wetlands, or the flood attenuation provided by healthy riparian lands adjacent to streams and creeks. Ecosystem services are crucial to long-term, human well-being and economic success.
- Ecosystems, and the biodiversity contained within them, provide a stream of goods and services which are essential for society's well being.

SERVICE	DESCRIPTION	EXAMPLE
ECOSYSTEM SERVICES		
Water Regulation	Role of natural land cover in regulating runoff and river discharge	Drainage and natural irrigation, medium for transport
Erosion Control and Sediment Retention	Retention of soil, on site, within an ecosystem	Prevention of soil loss by wind or runoff; storage of silt in lakes or wetlands; protecting water quality
Pollination	Movement of floral pollinators	Provisioning of pollinators for the reproduction of plant populations
Water Supply	Storage and retention of water by watersheds (includes surface and subsurface)	Provisioning, storage and retention of water by watersheds, reservoirs, and aquifers
Recreation	Opportunities for rest, refreshment, and recreation	Eco-tourism, sport fishing, hiking, boating, climbing
Food	That portion of gross primary production extractable as food.	Production of fish, game, stock (beef, pork, fowl etc.), crops (grains), nuts, fruits by hunting, gathering, subsistence farming or fishing.

(Source: Descriptions and examples modified from Costanza et al., 1997)

- Sustainable use of ecosystem services requires that all values be taken into consideration cumulatively. Ecosystem services assessment can provide a tool to help us reflect economic, social and environmental values into the decision making process. Better communication of environmental values, as well as the costs and benefits of alternative use of ecosystems to decision makers and the general public is crucial to guide balance decision-making.

EROSION AND SEDIMENT CONTROL - BOW BASIN EXAMPLES

Rocky View County [1]

- During site preparation and/or construction of roads and buildings, care shall be taken to prevent and mitigate potential impact from erosion and sedimentation.

[1] http://www.rockyview.ca/Default.aspx?tabid=686

Prior to undertaking any site preparation, the developer of the works shall submit to the Municipality as part of the stormwater management plan an erosion and sedimentation control plan that includes:

- Map showing topography, overland flow routes, soils, drainage, final grading, stockpiles, zones of erosion potential, stream dimensions and stream flow data, any special feature, and the sensitivity of the downstream environment where flows could leave the site;
- Details and extracts of objectives and conditions in any Overland Drainage Plan and/or Site Drainage Plan;
- Dust control measures and location, height and removal of stockpiles;
- An indication of the degree of erosion and sediment control measures anticipated, based on the site erosion potential and downstream impact;
- Details of "good housekeeping" practices to be implemented;
- Procedures for monitoring and maintaining the erosion and sedimentation controls, including methods of removing and disposing of sediment from any sediment traps;
- Details of contingency plan for failure of control elements during extreme runoff events.

City of Calgary [2]

The City of Calgary's Drainage Bylaw 37M2005 identifies sediment as a Prohibited Substance and prohibits discharge of sediment-laden drainage from construction sites and operational activities. The specified penalty for a first offence is $3000, and serious cases may result in a mandatory court appearance and charges of up to $10,000 per offence. The City of Calgary requires preparation of an erosion & sediment control report and drawings all construction sites with an overall size equal to or greater than 2.0 ha. At the discretion of The City, and based on the degree of risk, smaller sites 0.4 to 2.0 ha in overall size may also need to submit a report and/or drawings. In 2010, The City started requiring that ESC reports and drawings be developed and signed by a Professional Engineer registered in Alberta (P.Eng.), Certified Professional in Erosion and Sediment Control (CPESC) or Professional Agrologist (P.Ag.). The City released templates and guidance manuals for ESC reports and drawings (available at www.calgary.ca/waterservices/esc). The discharge of sediment-laden water (or water containing other contaminants) from construction sites, utility projects and other facilities to storm is prohibited. In order to discharge impounded water from a parcel of land to storm sewer, the landowner or their representative must obtain a drainage / dewatering permit and must ensure that water quality and quantity is suitable. The Drainage Bylaw 37M2005 is the City of Calgary document governing these requirements. The City of Calgary's ESC process depends on many groups (City staff – regulatory and project managers, contractors, consultants, developer/owner, other regulators). The City of Calgary. Water Resources Business Unit, is responsible for ensuring the ESC mandate of the Corporation is met, and for running our ESC program. Staff also work closely with Bylaw Officers dedicated to Water Resources/Water Services to carry our inspection, education and enforcement. There is a week long program of training put on for City staff and industry every March.

EROSION AND SEDIMENT CONTROL - BRITISH COLUMBIA EXAMPLES

Township of Langley [3]

The Township of Langley adopted the Erosion and Sediment Control (ESC) Bylaw in 2006 to protect their fisheries, creeks and storm drains from the harmful effects of dirt and mud generated during construction. Developers are required to create detailed plans, hire site monitors, and obtain ESC permits before they start to construct any civil works. The Bylaw required construction sites over 2000m2 to create an erosion and sediment control plan for all phases of development and construction until 90% of the final ground cover (paving, roofs, landscaping, etc.) is in place. When the plan is accepted by the Township, it forms part of a legally binding ESC permits. The ESC permit is required prior to any grubbing, grading, land clearing or filling. The Township's ESC Bylaw is performance based. All sites are required to meet specified discharge water quality standards.

[2] Graham Tait, Erosion Control Coordinator, City of Calgary, May 9, 2011, Personal Communication.
[3] https://langley.civicweb.net/Documents/DocumentList.aspx

City of Abbotsford [4, 5, 6]

The City of Abbotsford has adopted an Erosion and Sediment Control (ESC) Bylaw to help reduce the amount of sediment-laden water entering the City draining system. The Bylaw required the implementation of Best Management Practices on construction sites to ensure that site discharge water quality standards are met. The Bylaw applied all site where development activities are occurring which may cause sediment or sediment-laden water to enter the City drainage system.

All construction sites greater than 2000m2 are required to submit an ESC submission, hire an ESC Supervisor, develop an ESC plan and inspect, monitor and report on the ESC facilities. The City's ESC Bylaw is performance based. All sites are required to meet specified discharge water quality standards.

INTEGRATED LANDSCAPE MANAGEMENT – BOW BASIN EXAMPLES

Bow Corridor Ecosystem Advisory Group - Recreational Opportunities Working Group [7]

The Bow Corridor Ecosystem Advisory Group (BCEAG) is a senior level advisory group formed to address development issues in the Bow Corridor. BCEAG's partnering agencies include the Town of Canmore, Municipal District of Bighorn, Provincial Government, Banff National Park and Town of Banff. Working in a multi-jurisdictional partnership, BCEAG prepares integrated recommendations for consideration by the member agencies.

The Recreational Opportunities Working Group (ROWG) was a working group of BCEAG that reported directly to BCEAG. ROWG was instrumental in establishing a trail system that provides linkages through the entire study area with minimal use of roads. In addition, ROWG supported the provision of an effective trail system that discourages proliferation of new unplanned trails while establishing and recognizing a "sustainable" network of trails.

Ghost-Waiparous Access Management Plan [8, 9]

An access management plan was developed to provide opportunities for motorized recreational use in the Ghost-Waiparous area while maintaining the area's natural resources. The Access Management Plan was released in May 2006. The Ghost Stewardship Monitoring Group works with Sustainable Resource Development, demonstrating that diverse interests could come together to achieve a common vision: sustainable motorized recreational trails in the Ghost Forest Land Use Zone.

Public Land Use Zone [10]

A Public Land Use Zone (formally referred to as a Forest Land Use Zone) is an area of land to which legislative controls are applied to solve specific land use problems or conflicts. A Public Land Use Zone can be used to:

1) protect areas containing sensitive resources such as wildlife and their habitats, vegetation, soils and watershed; and

2) separate or control conflicting recreational activities. Parts of Kananaskis Country are designated as a Public Land Use Zone.

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[4] http://www.abbotsford.ca/Assets/Abbotsford/Dev+Services+-+Planning+and+Environment/environmental/ESC+Bylaw+-+Best+Management+Practices.pdf
[5] http://www.abbotsford.ca/Assets/Abbotsford/Dev+Services+-+Planning+and+Environment/environmental/Responsibilities+of+the+ESC+Supervisor+Handout.pdf
[6] http://www.abbotsford.ca/economic_development_and_planning_services/environment/erosion_and_sediment_control/overview_Erosion_and_sediment_control.htm
[7] http://www.biosphereinstitute.org/?q=r-haw-bceag
[8] http://www.srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/GhostPLUZMapsPublications.aspx
[9] http://www.srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/GhostPLUZMapsPublications.aspx
[10] http://www.srd.alberta.ca/RecreationPublicUse/RecreationOnPublicLand/PublicLandUseZones/Default.aspx

Calgary Regional Partnership [11, 12]

- CRP is an association of 15 communities from Banff to Strathmore, Crossfield to Nanton, with Calgary and other municipalities in between representing 1.2 million residents of unique landscape. The Partnership is a strong coalition of municipalities that understands the synergistic relationship of local governments in the region.

- Cluster development (or conservation development) is a site design technique that concentrates dwelling units in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. The minimum lot sizes, setbacks and frontage distances for the residential zone are relaxed in order to create the open space at the site. Open space designs have many benefits in comparison to the conventional subdivisions that they replace: they can reduce impervious cover, stormwater pollutants, construction costs, grading, and the loss of natural areas.

- In an effort to address the lack of commercial and industrial growth in the Calgary region, CRP member communities joined forces to undertake a long term strategy aimed at developing business clusters which hold potential for the region.[13]

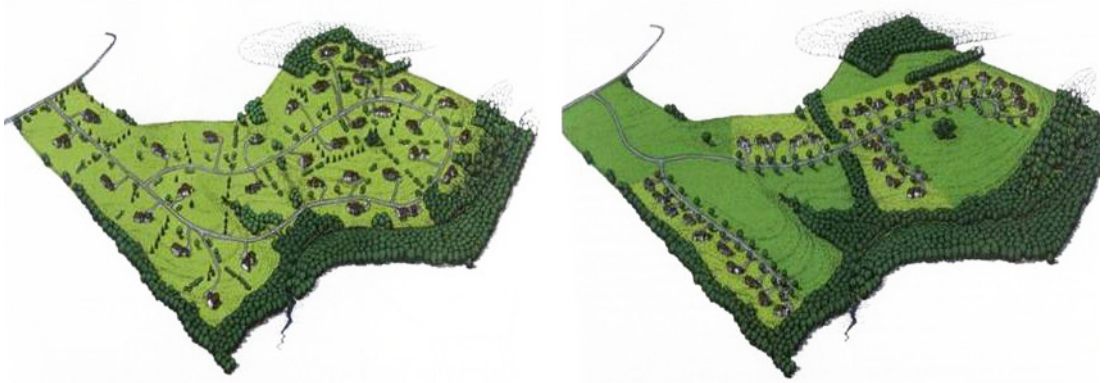

Figure 1: Conventional Development (left) vs. Cluster Development (right)

(Source: United States Environmental Protection Agency, Open Space Design)

Southern Foothills Community Stewardship Initiative [14]

The Southern Foothills Community Stewardship Initiative is a regional citizens' initiative to discuss local priorities and recommendations for the landscape and watersheds of Alberta's southern foothills. The intent of the initiative is to inform land-use planning and stewardship processes at the municipal, regional and provincial levels — such as the Alberta Land-use Framework, the South Saskatchewan Regional Plan, municipal development plans and regional conservation planning — to contribute to building the long-term, regenerative capacity of the landscape.

INTEGRATED LANDSCAPE MANAGEMENT – ALBERTA EXCLUDING BOW BASIN EXAMPLES

Chungo Creek Industrial Access Management Area [15]

Working together, representatives from forestry and oil and gas industries, the Alberta Research Council, the Department of Energy, and the Department of Sustainable Resource Development, identified the obligations and directions for specific development within the Chungo Creek area.

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[11] http://www.calgaryregion.ca/crp/media/65853/what%20is%20crp.pdf
[12] http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=83
[13] http://www.calgaryregion.ca/crp/media/52711/crp%20rural%20community%20adaptation%20grant%20proposal.pdf
[14] http://www.water-matters.org/story/420
[15] http://www.srd.alberta.ca/LandsForests/IntegratedLandManagement/ILMSuccessStories.aspx

Growing Forward (Alberta Agriculture and Rural Development) [16]

Two of the Stewardship Plan programs are Integrated Crop Management, and Manure Management. Producers develop a work plan that identifies mitigating actions that will address their highest environmental risks and will reduce or minimize their impact on the environment. Producers can apply for grant funding for projects that will help them achieve actions identified in their work plan.

Buffalo Lake Integrated Shoreline Management Plan [17]

The government of Alberta is working with several municipalities as well as the public to protect the shoreline of Buffalo Lake, which is located fifty-five kilometres northeast of Red Deer. Stakeholder engagement in the management plan process has resulted in a plan that suits many user needs and protects the riparian area.

Foothills Landscape Management Forum Berland Smoky Access Plan Area [18]

Through the collaboration between the energy and forestry industries and Alberta Sustainable Resource Development, a primary access plan has been identified for the Berland Smoky area. Work is underway to develop a regional access plan for secondary road and pipeline access to complement the primary access plan.

Kakwa Copton Industrial Corridor Plan [19]

Collaboration between 13 resource companies and the government of Alberta is expected to reduce the cumulative effect of resource development in the Kakwa Copton region by up to 45 percent. This unique effort resulted in the development of the Kakwa Copton Industrial Access Corridor Plan, which will also be used by other companies who require access to the area in the future.

Reducing the Footprint of Seismic Exploration [20]

Today, low-impact seismic is the standard for seismic exploration. The use of GPS technology, smaller and more powerful equipment and heli-portable programs have revolutionized the way seismic programs are conducted. The average width of a low impact seismic line has changed from eight meters wide prior to 1980, to the present two meters in width. This kind of width in a non-linear pattern has greatly reduced the impact and thus the footprint on the landscape.

PERFORMANCE MANAGEMENT – BOW BASIN EXAMPLE

Bow River Basin Council [21]

In conjunction with the BRBC Web-based State of Watershed project, the Bow Basin Watershed Management Plan is built on an environmental performance management system. This system is based on the identification of outcomes, indicators (e.g., water quality objectives, riparian health, etc.), thresholds, targets, strategies for implementation, and associated timelines for management actions, monitoring, and evaluation.

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[16] http://www.growingforward.alberta.ca/index.htm
[17] http://blmt.ca/wp-content/uploads/2011/05/BLIMPS-Book-May11-2011.pdf
[18] http://www.srd.alberta.ca/LandsForests/IntegratedLandManagement/documents/Foothills_Landscape_Management_Forum_Berland_Smoky_Access_Plan.pdf
[19] http://www.srd.alberta.ca/LandsForests/IntegratedLandManagement/documents/IntegratedLandManagement-SuccessStory-KakwaCoptonIndustrialAccessCorridor.pdf
[20] http://www.srd.alberta.ca/LandsForests/IntegratedLandManagement/documents/ReducingtheFootprintofSeismicExploration-Aug20-2010.pdf
[21] http://www.brbc.ab.ca/

PERFORMANCE MANAGEMENT – PROVINCIAL GOVERNMENT EXAMPLE

Government of Alberta [22]

- The Government of Alberta is moving towards a Cumulative Effects Management System (CEMS). Within this system, various tools, resources and relationships will work together to comprehensively manage activities that affect the environment, economy and society in a particular place. It is an adaptive management system that follows a "plan-do-check" approach to setting, meeting and evaluating place-based outcomes.
- The South Saskatchewan Regional Plan Water Quality Framework (under development) is an example of cumulative effects in action.
- The foundation of a functioning system is knowledge and performance management, having the best information possible to set outcomes, continuously assess them, and determine when management actions are required.

IMPACT DEVELOPMENT – PROVINCIAL EXAMPLES

Alberta Low Impact Development Partnership [23]

The Alberta Low Impact Development Partnership (ALIDP) is composed of municipalities, developers and builders, academic institutions, professional engineers, landscape architects, architects, planners and biologists, and interested individuals trying to find a better balance between residential and industrial development and protection of our streams, lakes and wetlands. The Partnership does this via the resources on its website and putting on educational events, promoting the implementation of practical LID techniques and strategies with the aim of mimicking the hydrologic cycle, and retaining storm runoff on-site and minimizing runoff rates and volumes into receiving water bodies.

Land Use and Cover

Stormwater management is evolving, moving beyond the assessment of the design and operation of drainage systems during extreme events to truly integrated water management by also incorporating the responses during day-to-day storm and runoff events, needed to minimize erosive and water quality impacts on receiving water bodies. This had led to the implementation of Low Impact Development techniques including added topsoil depths, rain gardens, permeable pavement, rainwater harvesting, stormwater capture and re-use, green roofs, etc. Guidelines and manuals relevant to Alberta and pertaining to the design, construction, and operation & maintenance of these features are being prepared by several municipalities in Alberta including the Cities of Calgary and Edmonton.

A2: RIPARIAN LANDS

URBAN AND DEVELOPMENT FOCUS - BOW BASIN EXAMPLES

Template of Land Use Bylaw Regulations, Bow River Basin Council [24]

The Template of Land Use Bylaw Regulations was developed by the Bow River Basin Council in 2008. The document is intended to provide guidance to municipalities on protecting water resources, wetlands, riparian lands and reserve lands within Alberta Municipalities. The document recommends a setback of 100m from the bank of a major waterbody or watercourse, a minimum of 30m from the bank of any other waterbody or watercourse. The use of Qualified Environmental Professional [25] is recommended in some instances.

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[22] http://environment.alberta.ca/0891.html
[23] http://alidp.org/
[24] http://www.brbc.ab.ca/pdfs/080507Land_Use_Bylaw_Template_April_30_2008_Final.pdf
[25] An applied scientist or technologist with detailed knowledge of the aquatic environment, soils, vegetation and wildlife species, hydrology and geotechnique (biologist, agrologist, geotechnical engineer, erosion and sediment control specialist, etc.), acting alone or together with another qualified environmental professional. The person must be in good standing as a registered professional with an association constituted under an Act, and must conduct themselves in accordance with the ethics set out by their association or be subject to disciplinary action by that association. The qualified environmental professional (s) must act in their area of expertise a nd must exercise professional due diligence in providing their advice.

General Information for Municipalities [26]

- The Municipal Government Act defines the conditions under which a municipality may acquire "reserve lands" during the subdivision of a parcel of land. Under Section 664, subdivision approval authorities may require establishment of an environmental reserve if those lands consist of:
  – A swamp, gully, coulee, or natural drainage course;
  – Land that is unstable or subject to flooding; or
  – A strip of land not less than six metres in width, abutting the bed and shores of any lake, river, stream, or other body of water for the purpose of preventing pollution or providing public access to and beside the bed and shore.
- Under Section 671 environmental reserve lands are lands which must be left in their natural state or used as a public park or for public to access the area. A municipality can develop guidelines to dedicate environmental reserve strips adjacent to water bodies (setbacks) in excess of 6 metres when it can be demonstrated that such takings are required to prevent pollution in adjacent water bodies, or is needed to ensure public access.
- Section 640 enables building development setback land use bylaw provisions on land subject to flooding or subsidence or that is low lying, marshy or unstable or on land adjacent to or within a specified distance of the bed and shore of any lake, river, stream or other body of water. A "building" includes anything constructed or placed on, in over or under lands, but does not include a highway or road or a bridge that forms part of a highway or road.

City of Brooks [27]

The City of Brooks has variable setbacks from permanent water bodies that range from as little as 6 m to more than 40 m. The Municipal Development Plan identifies that sensitive and important water and landscape features and ecosystems will be identified and set aside for environmental protection. In the past, the City has protected many of its water bodies through the use of municipal reserve and environmental reserve dedication.

City of Calgary Environmental Reserve Setback Guidelines [28, 29]

- The City of Calgary Environmental Reserve Policy contains base setbacks up to 50 m depending on stream order (size of stream) and which allows for adjustments according to slope, hydraulic connectivity, and vegetation cover.
- The City of Calgary has a variable width setback policy for the taking of Environmental Reserve adjacent to waterbodies in subdivision. Base setback width increases with stream order and currently varies from 6-50m. A base setback width of 30m is applied to wetlands. The setback width is adjusted by factors such as slope, hydraulic connectivity and presence of native vegetation.
- Note: The hydraulic connectivity provision is something we are investigating. The policy makes reference to groundwater meeting the GUDI standard – we have retained ARC to provide some advice on how to better define the presence of hydraulically connected groundwater in terms of appropriate setbacks to prevent pollution of the adjacent waterbody – this work is still underway.

MD of Bighorn [30]

The Municipal Development Plan for the MD of Bighorn contains 30 m development setback to ensure protection of watercourses, water bodies and their banks. Applications can be made to the MD of Bighorn for relaxation of this setback. Any major development or subdivision that is located near a water course may require environmental assessment prior to consideration of the subdivision or development. In some instances, before subdivision or development of land is allowed, the MD of Bighorn may require that the proponent of the subdivision or development prepare an Area Structure Plan (ASP), at the expense of the proponent. The ASP will normally include direction to guide subdivision and development, including among other requirements, a groundwater impact assessment.

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[26] http://www.qp.alberta.ca/documents/Acts/m26.pdf
[27] http://www.brooks.ca/attachments/169_07.11ToamendtheMunicipalDevelopmentPlanBylawNo0019.pdf
[28] http://www.calgary.ca/UEP/Water/Pages/Watersheds-and-rivers/Upper-Elbow-Watershed-Report.aspx
[29] http://www.calgary.ca/CSPS/Parks/Pages/Planning-and-Operations/Managing-our-natural-areas.aspx
[30] http://mdbighorn.ca/filestorage/348/1457/MDPwebsite.pdf

MD of Foothills [31]

Proposed revisions to the Municipal Development Plan will support science-based setbacks. Applicants will be required to determine appropriate setbacks from water bodies by considering slope, vegetation and other factors.

Rocky View County [32]

The County will rely on science-based standards to develop setback requirements for riparian lands adjacent to watercourses and water bodies. Bylaws include requirements for protection from hazards where land is situated adjacent to or includes the banks of any watercourse, and where the slope of the bank adjacent to any watercourse is in excess of 15%. Development restrictions are in place for Bragg creek and the Elbow River.

Town of Cochrane [33]

The Town of Cochrane has land-use bylaws affecting development within flood risk areas and adjacent to river escarpments, steep slopes, top of bank, and toe of slope. The Town has land use bylaw provisions that conserve and manage riparian lands (no development is permitted in riparian lands), wetlands (including a wetlands policy) and environmentally sensitive lands or hazardous lands. The Town's also has naturescaping provisions (e.g., 100% of required landscape areas in commercial areas must be naturescaped). The land use bylaw also requires storm drainage management at the time of development permit and subdivision. The Town's snow storage policy has been helpful in ensuring that salt laden snow is stored away from drainage channels.

Nose Creek Watershed Partnership [34]

- The Nose Creek Watershed Water Management Plan recommends the riparian setback width be determined on a site-specific basis using the following criteria and selecting the largest of the three setback requirements for implementation:
  - the 1:100 year floodplain width; or
  - the meander belt width (20x the bank full width); or
  - where the slope of the bank adjacent to the watercourse is > 15%, an additional setback from the top of bank will be added to the riparian setback width to provide a stable slope allowance.
- The Nose Creek Watershed Partnership has completed periodic riparian health assessment of Nose Creek and West Nose Creek since 2000, a riparian photo log project in 2007, and several riparian rehabilitation projects over the years.

URBAN AND DEVELOPMENT FOCUS - ALBERTA EXCLUDING BOW BASIN EXAMPLES

Leduc County [35]

A riparian setback matrix model will be used to establish environmental reserves and/or conservation easements. The overall goal is to delineate and protect sensitive areas. The riparian setback matrix model is currently being applied as a pilot project for the Pigeon Lake and Wizard Lake Area Structure Plans.

City of St Albert [36]

The City of St Albert has a 50m setback from the top of bank of Carrot Creek. There also are 50% Municipal Reserve credits for protection of lands between the 1:25 year flood line and 1:100 year flood line provided other amenities (e.g., trail surfacing) are provided (see Intermunicipal Development Plan (IDP) Bylaw 7/2001).

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[31] http://www.mdfoothills.com/council/resource_library.html
[32] http://www.aref.ab.ca/resourcelibrary/documents/Riparian%20Interim%20Background%20Report.pdf
[33] http://www.cochrane.ca/municipal/toc/webcms.nsf/AllDoc/C8C08E92FEC0EEE387256FB20077C0C7?OpenDocument
[34] http://www.nosecreekpartnership.com
[35] http://www.leduc-county.com/long-range-planning/types-of-statutory-plans/area-structure-plans
[36] http://www.stalbert.ca/bylaws

City of Edmonton Draft Guidelines for Determining Environmental Reserve (ER) Dedication for Wetlands and Other Water Bodies [37]

City of Edmonton draft policy contains greatest extent of all environmental reserve components: floodplain, unstable lands, pollution prevention (fixed minimum width of 30 m), and public access needs. See also: *Background Report: Rationale for Guidelines for ER Dedication for Wetlands and other Water Bodies*. City of Edmonton, Office of Natural Areas. 2006.

City of Lethbridge [38]

The City of Lethbridge has adopted a River Valley Area Redevelopment Plan intended to provide direction to guide the development of the Oldman River Valley area within the City of Lethbridge. This plan establishes parameters within which various options may occur. Within this broad framework it is intended that the Plan will provide adequate protection for the river valley and its users. Protection of the river valley resource will be achieved through the development of land use control measures, land use by-law and development guidelines.

City of Spruce Grove [39]

The City will not permit development in areas which are unstable or within defined floodplains, unless it can be shown to the City's satisfaction that development would not be a significant risk.

Industrial Heartland Complementary Area Structure Plans – River Valley Setbacks [40a, 40b, 40c, 40d , 40e]

The Alberta Industrial Heartland Association has as its members Strathcona County, the City of Fort Saskatchewan, Sturgeon County and Lamont County. The association is working with Alberta Environment on a cumulative effects management plan for the Industrial Heartland which has a strong existing industrial base, and significant proposed industrial development. Complementary area structure plans are in place, which contain minimum 30 m and 50 m setbacks from the top-of-the-valley breaks along major river valleys. See also: Strathcona County, Sturgeon County.

Lac la Biche County [41]

Lac La Biche County adopted a Riparian Setback Matrix Model as a methodology for determining appropriate setbacks. The model requires the services of a qualified professional and assessment of site specific factors to determine the appropriate setback required for a given site. The model was designed to include four biophysical parameters: slope, bank height, groundwater influence, and vegetation type.

Lacombe County [42]

The County shall, as a condition of subdivision approval, require an environmental reserve or environmental reserve easement of not less than 30 metres in width from the high water mark of water bodies and/or the top of bank of watercourses to the lot line. A greater setback may be required by the County based on the recommendations of a geotechnical study undertaken by a qualified professional. As a condition of development permit approval where there is no subdivision, a comparable setback of 30 metres (98 feet) shall be required from the high water mark of water bodies and/or the top of bank of watercourses to the building.

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[37] http://www.edmonton.ca/environmental.aspx
[38] http://www.lethbridge.ca/Doing-Business/Planning-Development/Documents/River%20Valley%20ARP.pdf
[39] http://www.sprucegrove.org/government/bylaws_policies.htm
[40a] http://www.strathcona.ca/files/Attachment-PDS-ASP-Heartland-65-2001.pdf
[40b] http://www.sturgeoncounty.ab.ca/Portals/0/pdfs/Documents/Bylaws/2007/BYLAW%201118%20-%20ALBERTA'S%20INDUSTRIAL%20HEARTLAND%20AREA%20STRUCTURE%20PLAN.pdf
[40c] http://www.fortsask.ca/downloads/documentloader.ashx?id=24588
[40d] http://www.lamontcounty.ca/images/stories/2.1_land_use_concepts___planning_parameters.pdf
[40e] http://www.industrialheartland.com/images/stories/reports/casp%20in%20pdf.pdf
[41] http://www.aspb.ab.ca/pdfs/2009-conference-presenations/Session_5-4_White_The-Riparian-Setback-Matrix-Model.pdf
[42] http://www.lacombecounty.com/index.php?option=com_content&view=category&layout=blog&id=160&Itemid=63

Strathcona County [43]

Strathcona County's Municipal Development Plan, Bylaw 1-2007 sets out a number of environmental management objectives, along with the following setback requirements to protect lands and water resources adjacent to watercourses: a) The North Saskatchewan River, a minimum 50 metre setback from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances; b) Old Man Creek and its tributaries, a minimum 36 metre setback from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances as determined by the Approving Authority; and c) All other lakes, water bodies and watercourses, a minimum 30 metre setback from the top of bank where no buildings or structures will be allowed, except under unique and appropriate circumstances. Top of bank is defined as the top of the valley crest.

Sturgeon County [44]

Sturgeon County has a 30 metre setback from the valley crest. No permanent structures are permitted within the 1:100 year floodplain, excepting residential development that demonstrates the lands are suitable. No permanent structure will be permitted within the 1:100 year floodplain of the Manawan, Sandy, Gladu and Big Lakes. In addition, Sturgeon County will require a 50 m (164 ft) lot setback from the top of the bank of the North Saskatchewan and Sturgeon River Valleys to provide for an environmental buffer and recreation corridor. This should consist of 30 m (98 ft) Environmental Reserve (ER) dedication as required by the MDP, with the balance of 20 m (66 ft) taken as Environmental Reserve (ER), Municipal Reserve (MR) and / or conservation easement. The 30 m (98 ft) generally commences from the 1:100 year flood line unless a discernable top of bank exists beyond this. The embankment is often a geotechnical constraint and therefore the 50 m (164 ft) setback should generally commence beyond this. To enable the determination of top of bank setbacks, each industry proponent shall undertake a top of bank survey for the North Saskatchewan River and Sturgeon River as a condition of the development permit.

PROVINCIAL INITIATIVES

Alberta Water Council Riparian Land Conservation and Management Policy [45]

In October 2010, the Alberta Water Council initiated a new working group – the Riparian Land Conservation and Management Policy project. The project stems from an identified need for overarching provincial policy and consistency in management approaches at various scales for riparian lands.

RURAL FOCUS – BOW BASIN EXAMPLE

Nose Creek Watershed Water Management Plan [46]

As part of its recommendation for riparian protection for agricultural lands, the plan recommends existing riparian vegetation be maintained or restored. Grazing of livestock is permitted if best management practices (BMPs) are implemented, including restrictions on timing, stocking rate and the provision of offstream watering.

Glenbow Ranch Provincial Park Livestock Watering Enhancements

Implementing recommendations identified in riparian health assessments completed by Cows and Fish, the GOA is working with the grazing lease holder to shift watering practices from riparian and wetland areas within the park to developed watering stations. One of the four projects includes a cistern collection system from the spring and using solar panels to pump the water to a hardened watering station. The project also included a long term rehabilitation and monitoring plan to repair erosion and reestablish the native grasslands along the embankments.

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[43] http://www.strathcona.ab.ca/departments/Planning_and_Development_Services/Zoning_planning_policies/municipal-development-plan-bylaw.aspx
[44] http://www.sturgeoncounty.ca/library/CountyBylaws/tabid/693/Default.aspx
[45] http://awchome.ca/Projects/RiparianLandConservationandManagementPolicy/tabid/150/Default.aspx
[46] http://www.rockyview.ca/Default.aspx?tabid=400

Cattle Setback Program [47]

Farmers of the Elbow Watershed (FEW) are dedicated to improving water quality and the natural landscape of the Elbow River watershed by expanding the current infrastructure of farm fences and water supplies for cattle. This new program will allow local ranchers to access funds for fencing projects that isolate cattle from direct access to water areas, thereby reducing the risk of environmental problems. Not to be underestimated is the concurrent benefit of protecting areas of natural habitat in the Elbow watershed.

Ranchers of the Jumping Pound [48]

In order to address riparian health concerns and increased scrutiny as a result of living in close proximity to a large town and city, the Ranchers of the Jumping Pound continually adapt and improve their riparian grazing management practices. Effective management tools used, as evidenced by improvements in riparian health from assessment conducted by Cows and Fish, have included a combination of temporary electric and permanent fencing, salting and feeding to minimize impact to the riparian area.

Butters Family Ranch [49]

The Butters family ranch west of Cochrane, in the Ghost River watershed. Many years of livestock grazing coupled with beaver activity resulted in most of the woody vegetation, especially willows, to disappear from Robinson Creek. Robinson Creek has streambanks vulnerable to erosion, particularly without the roots of woody plants to hold them together. To allow woody plants to regenerate, Erik Butters has used temporary electric fencing to exclude cattle from the riparian area, while grazing the upland portion of the pasture. He has successfully used this, both for summer and winter grazing, to provide both growing season rest and to eliminate any browsing, trampling or rubbing during the dormant season.

Ghost Watershed Alliance Society [50]

The Ghost Watershed Alliance Society have been working on an ecosystem-based watershed management plan which will include identifying sensitive landscape types such as riparian lands and wetlands and recommending these areas as a Network of Protected Landscapes. The Society is also working on a Riparian Health Assessment project with Cows & Fish.

RURAL FOCUS – PROVINCIAL EXAMPLE

Growing Forward (Alberta Agriculture and Rural Development) [51]

The purpose of the Grazing and Winter Feeding Management Program within the Growing Forward Initiative is to provide financial support to Active Producers that implement approved Work Plan Projects that Eligible projects may include, for example, alternative watering systems, fencing to protect sensitive areas, riparian area health assessments and management.

Watershed Stewardship Group Initiatives [52, 53]

- Watershed Stewardship Groups gather and share information and take action to improve and protect their local watershed. Diverse in their membership and their activities, these groups may:

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[47] http://www.erwp.org/index.php/events-and-projects/projects/past
[48] http://www.landstewardship.org/resources/agency/179/
[49] http://www.cowsandfish.org/riparian/caring.html
[50] http://www.ghostwatershed.ca/GWAS/Home.html
[51] http://www.growingforward.alberta.ca/index.htm
[52] http://www.brbc.ab.ca/index.php?option=com_content&view=article&id=110&Itemid=215
[53] http://www.waterforlife.alberta.ca/documents/wfl-enabling_partnerships.pdf

- Work with individual landholders and local communities to raise awareness and gather information on water quality, quantity, usage and surface-ground water interactions in their local watershed.
- Identify goals and priorities for further actions.
- Provide local knowledge and advice to municipal, Aboriginal, and other governments, stakeholders, conservation groups, and the public.
- Provide input to Watershed Planning and Advisory Councils for state of the watershed reports and watershed management plans.
- Solicit advice, technical information and other support from governments, conservation organizations and other agencies.
- Carry out stewardship activities such as riparian area health assessments, water quality and quantity monitoring, educational field days, demonstration sites, habitat planting and restoration programs, etc.
- Encourage and promote the use of best management practices.

- The community-based approach is a constructive forum to effectively work with landowners (and others) as it facilitates more interaction, better relationship building and greater acceptance and adoption of new information.[54] Consistently, people that are part of watershed or community groups acquire new information at a greater rate, and make more management changes based on the information and interaction than do people not part of these groups.[55]

Nose Creek Rehabilitation Project[56]

Used bioengineering, live staking and trees and shrub planting to enhance riparian lands (and provide erosion protection) in the Nose Creek watershed. Volunteers were used to complete the restoration projects. Ten projects have been completed to date.

RURAL FOCUS - MANITOBA AND BRITISH COLUMBIA EXAMPLES

Province of Manitoba[57]

The Riparian Tax Credit is designed to encourage farm operators to upgrade their management of lakeshores and river and stream banks and it recognizes those who have already done so. This property tax credit is the first program of its type in Canada. Benefits are available to farmers and livestock producers who make a 5-year commitment to protect a strip along a waterway on agricultural land. Over time, this approach should benefit the rural economy and contribute to safeguarding water quality throughout rural Manitoba.

Province of British Columbia[58, 59, 60]

Under the Range Planning and Practices Act, approved range management plans must be developed for grazing on all crown lands. These plans must be consistent with government objectives for water, namely to maintain or improve water resources, and to maintain and promote healthy riparian and upland areas, riparian vegetation providing shade, and desired plant communities. There are also limitations on range developments within community watersheds and provisions regulating range practices as they might affect riparian lands, uplands, fish habitat, and resource features.

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[54] Source: Bateman, N. G. 2004. Cows and Fish staff interaction evaluation report. Alberta Riparian Habitat Management Society. Report No. 25. Lethbridge, Alberta. 172 pp. http://www.cowsandfish.org/publications/documents/StaffInteractionEvaluationReport2004report025.pdf

[55] Source: Bateman, N. G. 2004. Cows and Fish staff interaction evaluation report. Alberta Riparian Habitat Management Society. Report No. 25. Lethbridge, Alberta. 172 pp. http://www.cowsandfish.org/publications/documents/StaffInteractionEvaluationReport2004report025.pdf

[56] http://nosecreekpartnership.com/projects

[57] http://www.gov.mb.ca/finance/tao/riparian

[58] http://www.for.gov.bc.ca/hfd/pubs/Docs/Bro/Bro87.pdf

[59] http://www.agf.gov.bc.ca/range/publications/documents/manage1.htm

[60] http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/19_19_2004#part1

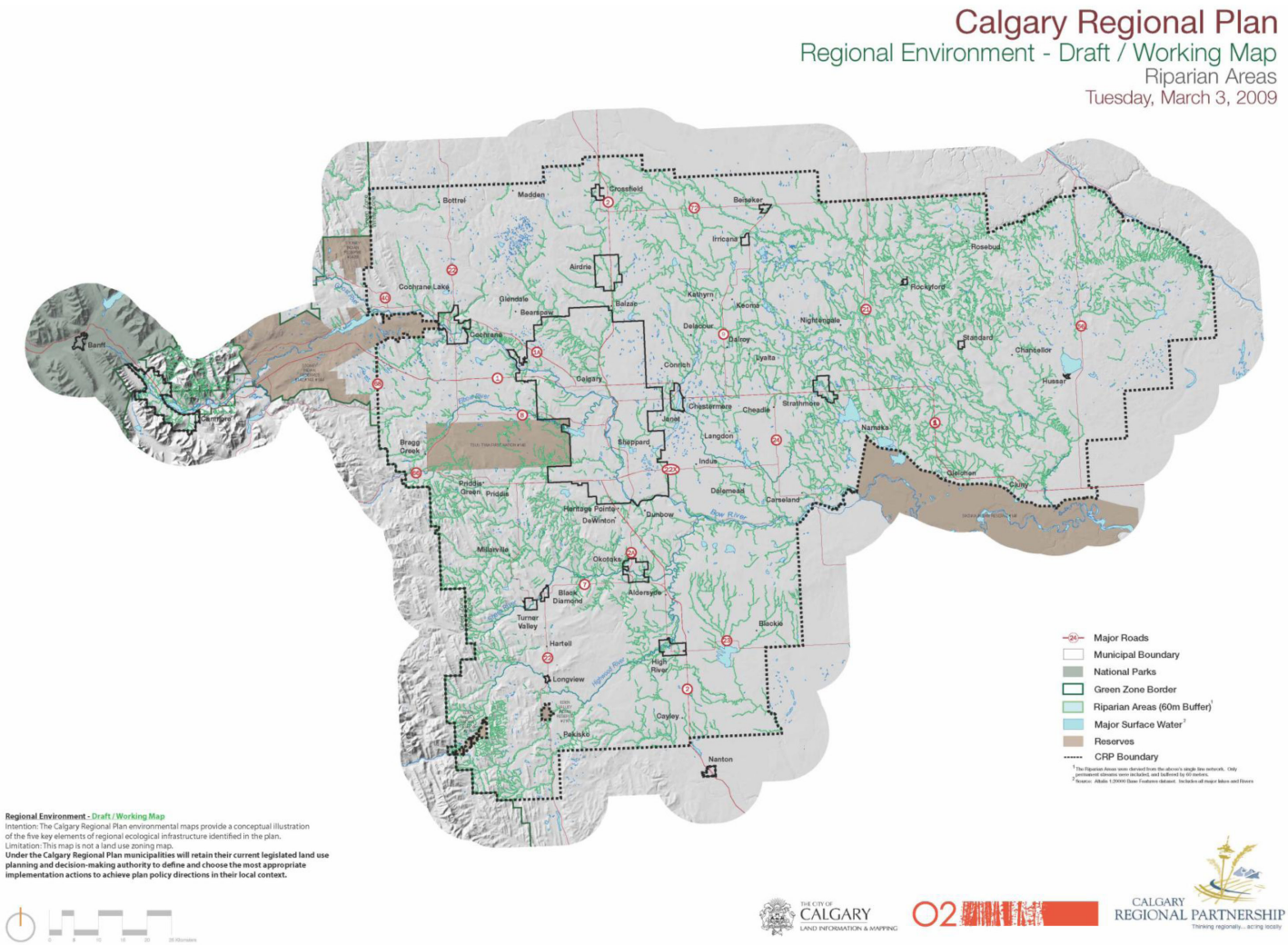

Figure 2: Calgary Regional Draft Environmental Plan, Riparian Areas
(Source: Calgary Regional Partnership)

A3: WETLANDS

BOW BASIN EXAMPLES

General Information

Mitigation is a hierarchical process which is employed to achieve sustainable development of Alberta's wetland resources. Any proposed development project, that directly or indirectly affects wetlands must be approved by Alberta Environment under the authority of the provincial Water Act. This approval process is conducted through a mitigation sequence, consisting of three steps: 1. Avoiding impacts to the wetland; 2. Minimizing impacts where avoidance can not be achieved; and 3. Compensation for impacts that can not be avoided or minimized.

The procurement of wetland conservation solutions to both government regulators and industry is increasing within Alberta. Ducks Unlimited Canada (DUC) conducts a very specific role in this process. DUC has no regulatory authority and approvals are under the sole discretion of Alberta Environment. DUC is a pre-authorized wetland restoration agent, implementing compensatory wetland restoration projects to offset impacts to Alberta's wetland resources at the request of water act proponents. DUC is governed by protocols and procedures of Alberta Environment to deliver,

report and maintain compensation projects as stipulated in the Provincial Wetland Restoration Compensation Guide (February 2007). Proponents are not required to execute their restoration proposals thru DUC and are fully open to submit restoration options from other agencies or on their own accord to satisfy regulatory conditions as dictated by Alberta Environment. A majority of water act applications utilize DUC as their compensation agent to expedite their applications due to our pre-authorized designation, long history and experience with wetland ecosystems.

Rocky View County [61]

The County will rely on science-base standards to develop setback requirements for wetlands. In addition, when a development is proposed that affects a wetland with County jurisdiction, the applicant must demonstrate the mitigation of negative impacts on the wetland, in descending order of preference:

- Avoid loss or degradation of wetlands;
- Minimize loss or degradation, where avoidance is not fully achieved. The applicant must make a reasonable case to the County why the proponent cannot achieve avoidance.
- Compensate for loss or degradation. As a last resort, when loss or degradation of a wetland is unavoidable or cannot be minimized.

City of Calgary [62]

The City of Calgary approved a Calgary Wetland Conservation Plan in 2004. Some of the key principles include:

- Efforts shall be made to avoid the impact from development on Calgary Wetlands that are environmentally significant and/or contribute to water quality and quantity, and that can be integrated into urban development while maintaining their ecosystem survivability and sustainability.
- The City of Calgary shall ensure that there is No Net Loss of Calgary Wetlands after efforts have been made to avoid impact from development.
- Calgary Wetlands shall be managed to ensure their long-term sustainability.

Town of Cochrane [63, 64, 65]

The Town of Cochrane has land-use bylaws affecting development within flood risk areas and adjacent to river escarpments, steep slopes, top of bank, toe of slope, and wetlands.

Fish Creek Provincial Park Engineered Wetlands Project [66]

A series of engineered wetlands were created in Fish Creek Provincial Park by the City of Calgary to address stormwater outflows that were going directly into Fish Creek and the Bow River. The project has resulted in retaining more water in the valley which was lost due to previous agricultural modifications and then subsequent residential development around the park. The engineered wetlands have also enhanced recreational opportunities and have diversified the wildlife habitat within the park.

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[61] http://www.aref.ab.ca/resourcelibrary/documents/Riparian%20Interim%20Background%20Report.pdf
[62] http://www.calgary.ca/CSPS/Parks/Pages/Planning-and-Operations/Protecting-Calgarys-wetlands.aspx
[63] http://www.cochrane.ca/municipal/toc/webcms.nsf/AllDoc/C8C08E92FEC0EEE387256FB20077C0C7?OpenDocument
[64] http://www.cochrane.ca/municipal/toc/webcms.nsf/AllDoc/5A3366A3F0D5243E872575750079A247/$File/A%20WETLANDS%20AND%20RIPARIAN%20AREAS%20CONSERVATION%20PLAN.pdf
[65] https://www.cochrane.ca/municipal/cochrane/cochrane-website.nsf/AllDoc/95B966F0CF8D96658725729D0061C760/$File/Wetlands%20Policy.pdf
[66] http://www.albertaparks.ca/fish-creek/park-research-management/engineered-wetlands.aspx

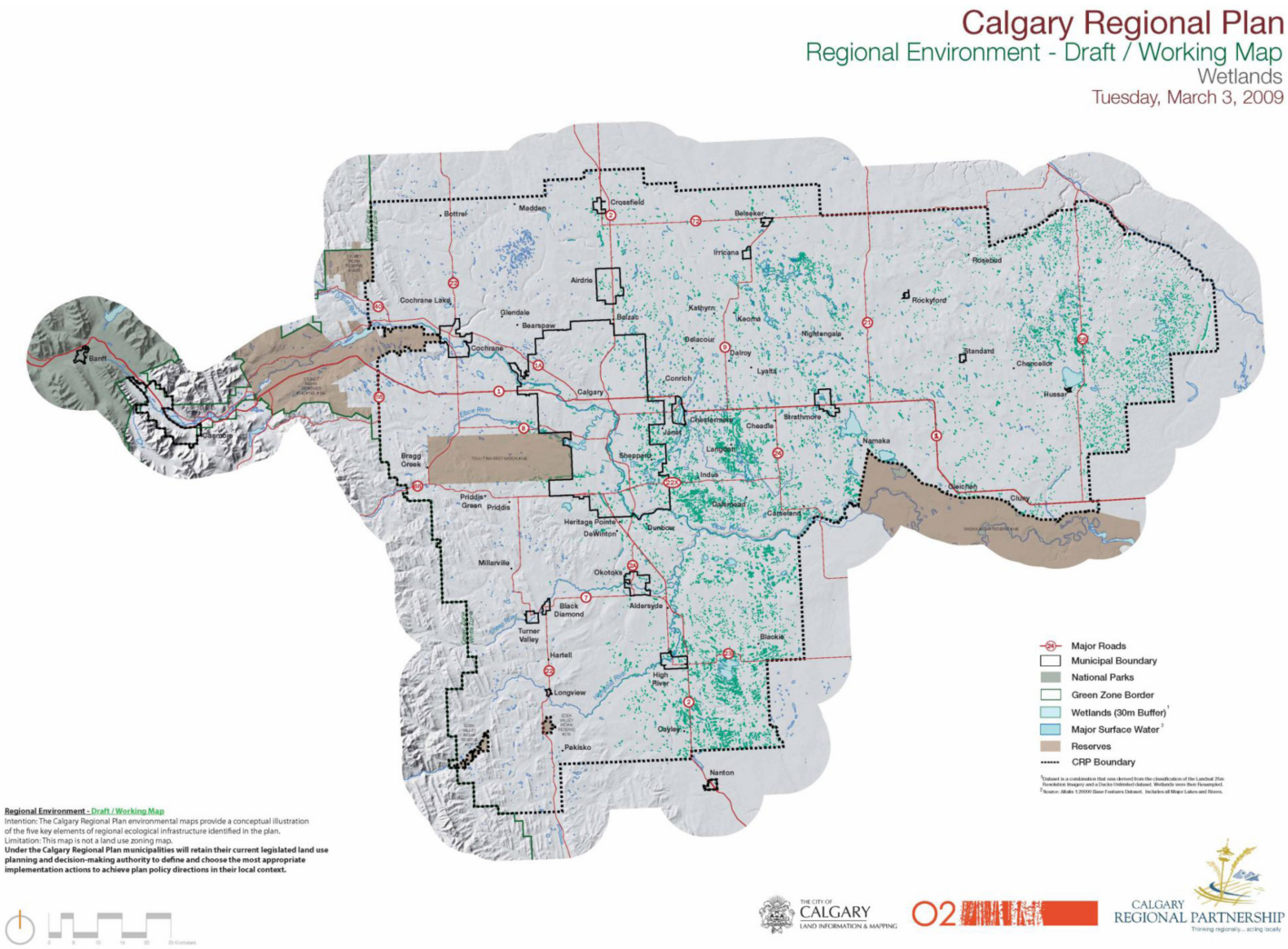

Figure 2: Calgary Regional Draft Environmental Plan, Wetland Areas
(Source: Calgary Regional Partnership)

ALBERTA EXCLUDING BOW BASIN EXAMPLES

Industrial Heartland Wetland Project [67, 68]

Using a site assessment tool (RAM) and GIS wetland value and health assessments, wetlands within the Industrial Heartland were assessed in order to identify priority areas (e.g., core areas and buffer zones, reserve networks to represent entire landscapes, large wetlands with mixed terrain, wildlife dispersal corridors and hydrological linkages.) This provides information to support wetland management at the site and landscape level.

PROVINCIAL INITIATIVES

Alberta Water Council [69, 70]

The Alberta Water Council prepared a document in 2008 titled *"Alberta Water Council: Recommendations for a New Alberta Wetland Policy".* This document describes a Wetland Mitigation Decision Framework which proposes in order of preference:

[67] tbd
[68] http://environment.alberta.ca/01768.html
[69] http://www.albertawatercouncil.ca/Projects/WetlandPolicy/tabid/103/Default.aspx
[70] http://www.albertawatercouncil.ca/Portals/0/pdfs/WPPT%20Policy%20web.pdf

- Avoid loss or degradation of wetlands;
- Minimize loss or degradation, where avoidance is not fully achieved. The proponent must make a reasonable case to the regulator why the proponent cannot achieve avoidance.
- Compensate, as a last resort, for loss of wetland area or for wetland degradation.

Alberta Wetland Compensation Guide [71]

Wetlands fall under the Water Act. Within that Act, an interim policy, *Wetland Management in the Settled Area of Alberta,* [72] provides direction on how to manage and protect wetlands. The interim policy dates back to 1993 and focuses on settled lands, known as the White Area. It does not address crown land—also known as the Green Area.

Alberta Land Trusts [73]

Land trusts, also known as land conservancies, are charitable organizations committed to the permanent protection of lands with natural, recreational, scenic, historical or agricultural value. Land trusts can be local or regional in focus. Land trusts accept donations and bequests of land or conservation agreements and in some cases may purchase land or conservation agreements. The land is then permanently protected to preserve its conservation, heritage or agricultural values. Land trusts are supported with memberships and donations from generous residents in the community they serve. Examples of Land Trusts in the Bow Basin include: Western Sky Land Trust, Alberta Land Trust Alliance, Foothills Land Trust, Southern Alberta Land Trust Society, and the Nature Conservancy of Canada.

A4: Headwaters and Other Hydrologically Significant Areas

MD of Foothills Environmentally Significant Areas [74, 75]

The purpose of the project was to develop a planning tool that could be used by the M.D. of Foothills Environment Committee and Planning Departments to identify natural resources and ecosystem components of environmental, economic and social importance, that may be sensitive to the potential impacts of proposed developments (i.e., to develop a GIS methodology to evaluate and map the relative environmental sensitivity of lands throughout the M.D).

[71] http://www3.gov.ab.ca/env/water/reports/Prov_Wetland_Rest_Comp_factsheet.pdf
[72] http://www3.gov.ab.ca/env/water/reports/1wmsa.pdf
[73] http://www.clta.ca/en/faqs/
[74] http://proceedings.esri.com/library/userconf/proc02/pap1198/p1198.htm
[75] http://www.mdfoothills.com/residents/planning/environment/environmentally_significant_land.html

APPENDIX B

UP-DATED PHASE ONE WATER QUALITY OBJECTIVES AND INDICATORS

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Attached Algae (Periphyton) Biomass – defined as chlor a	Bow River Above Park Boundary	WQO: 47 mg/m^2 maximum value during open water season.	Harvie Heights Fall measurements (Sept – Oct) 1999-2006 2002-2006 30 9 (243) ^{max} (44) ^{max} (197.6) ^{90} - includes data prior to treatment plant upgrades (32.9) ^{90}	• Objective supports the Park Canada mandate to maintain near pristine conditions in park areas. • Objective is an experimentally derived value based on data from 1998-2006 upstream of the Banff town site (Bowman 2006). This is the value that represents the transition from good to fair rankings according to Parks Canada (Bowman 2003). • Decline in algal growth with recent wastewater treatment upgrades. • Objective may not be met in some locations due to recent occurrence of invasive strain of Didymosphenia geminata. Research recommended on reasons for its recent occurrence and growth.	14, 15
Dissolved Oxygen	Bow River Above Park Boundary	WQO: CCME with protection of spawning and incubation. (CCME 1999) • 9.5 mg/L for spawning and incubation • 6.5 mg/L for acute daily minimum.	Year round Upstream Lake Louise 1973-2002 Monthly : 11.5 (9.5) ^{10}	• CCME provides a high-level of protection for saturated conditions.	2
Macrophytes	Bow River Above Park Boundary	WQO: No macrophyte biomass that adversely affects users.	Insufficient data, rare or absent	• Numerical relationships between biomass and DO are poorly understood and need to be established. For example, higher macrophytes biomass may naturally occur in standing or slower moving water.	14
Nitrate (nitrate + nitrite (as N))	Bow River Above Park Boundary	WQO: 0.13 mg/L during growing season.	Year round Harvie Heights 73-02 monthly 0.08 (0.13) ^{90}	• 0.13 is based on 90th percentile from the 1983 to 2002 at the downstream monitoring station. • Trying to maintain this reach at its current trophic state.	27, 35
Pathogens as indicated by E. coli	*Bow River Above Park Boundary*	*WQO: Meet recreational guideline – no single value to exceed 400 E.coli/100 mL or < 200 E. coli/100 mL (geometric mean 5 samples/30 d).*	*Insufficient data*	• *E. coli objectives were not originally provided in some cases in Phase One. Where this occurred, the agreement was to use CCME Guidelines.*	5, 28
Pathogens as indicated by Total Coliforms	Bow River Above Park Boundary	WQO: Should not exceed 20,000 counts (total coliforms) per 100 mL at intake for drinking water treatment plant.	Year Round Coliforms/100 mL Harvie Heights 73-02 monthly 13 per 100 mL (310) ^{90}	• The instantaneous objective of < 20,000 counts/100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water.	28

NOTE TO USER: Italicized sections indicate updates added during Phase Two.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Pathogens – Giardia	Bow River Above Park Boundary	WQO: Not set for this reach. However, Giardia is an important issue, and agencies should continue to monitor for Giardia and attempt to identify sources.	Insufficient data	• Insufficient data to make an objective, as it is not currently monitored. • Groundwater is currently being used as the drinking water source for this reach. • Wildlife are the prime vectors of Giardia transmission in this reach.	3
Pesticides and Degradation Products	Bow River Above Park Boundary	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (provisional objective) (CCME 1999).	Insufficient data	• Provisional objective was set as there is currently no ongoing monitoring available at this time to set an objective. • No current use of surface water for municipal water supplies however drinking objective included to consider to protect downstream users.	37, 38, 39, 41, 42
Total Ammonia	Bow River Above Park Boundary	WQO: Should not exceed CCME guideline for protection of aquatic life (CCME 1999). To apply outside mixing zone (AENV 1995).	Year Round Harvie Heights 87-02 monthly 0.011 (0.044) [90]	• Designed to protect aquatic life and considers the influence of both temperature and pH on the toxicity of ammonia.	27, 28
Total Dissolved Phosphorus	Bow River Above Park Boundary	WQO: 0.005 mg/L TDP.	Year round Harvie Heights 73-02 monthly 0.006 (0.016) [90]	• Based on trying to maintain or improve the existing water quality. • Recent (2002 – 2003) water treatment improvements have decreased TDP concentrations at Harvie Height's site to below 0.005 mg/L (Humphries pers. comm.). • It is expected that recent treatment plant upgrades will allow this water quality objective to be met.	27, 28
Total Organic Carbon	*Bow River Above Park Boundary*	*WQO: Should not exceed 3.0 mg/L (instantaneous).*	*Year Round* *Cochrane* *00-06* *Monthly* *0.82* *(1.51)* [90]	• *Value excludes periods of snowmelt runoff, mountain runoff, and significant precipitation events.* • *TOC is generally lower in these upper reaches.* • *Increasing TOC levels in the source water has affected the treatment process of water at many surface water treatment plans. TOC > 3 mg/L result in increased coagulant and chlorine demands, and gets worse as TOC levels get higher. (UEWG 1999).* • *Total Organic Carbon objectives were not originally provided in Phase One. For the Bow River above Park Boundary, the agreement was to use the same value for Bow River below Park Boundary.*	
Total Phosphorus	Bow River Above Park Boundary	WQO: 0.012 mg/L TP.	Year round Harvie Heights 73-02 monthly 0.012 (0.025) [90]	• Based on trying to maintain or improve the existing water quality in the mountain parks to a natural state, protected under federal legislation. • Values may be exceeded during freshet conditions. • Recent upgrades to the WWTPs (post 2002) have improved receiving water quality.	27, 28
Total Suspended Solids	Bow River Above Park Boundary	WQO: CCME (CCME 1999).	Year Round Harvie Heights 73-02 monthly 2.0 (11.2) [90]	• To maintain existing water quality for aquatic life.	27, 52, 54

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Water Temperature	Bow River Above Park Boundary	WQO: Should not exceed 18°C at any time or a 7-day mean of 15°C (added)	Year Round, °C Harvie Heights 73-02 monthly 5.0 (11.0) ^{90} (16.3) ^{max}	• To protect most sensitive native fish, namely bull trout • 7-day mean based on Taylor & Barton 1992.	2, 27
Riparian Condition [75]	Bow River Above Park Boundary	TARGET: maintaining a "healthy" rating using Cows and Fish rating system.		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy"➔ "healthy with problems"➔ "healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy".	45, 47, 49, 57, 59
Soil Erosion [76]	Bow River Above Park Boundary	TARGET: The erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has direct connection to a water body (no buffer, no interception). Applies to all construction sites and endures for the life of the project (during and post construction phases).		• For new developments permitted within the defined boundaries, Operating Ground Rules are in place to minimize erosion and sedimentation (ASRD). • An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	49, 50, 51
Attached Algae (Periphyton) Biomass – defined as chlor a	Bow River Below Park Boundary	WQO: 150 mg/m^2 maximum value during open water season	Open Water Cochrane monthly 1995-2006 21 (83) ^{90} (154.3) ^{max}	• A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998).	15
Dissolved Oxygen	Bow River Below Park Boundary	WQO: CCME with protection of spawning and incubation (CCME 1999). • 9.5 mg/L for spawning and incubation • 6.5 mg/L for acute daily minimum.	Open Water Cochrane, 87-06 Monthly: 10.2 (8.9510) (7.61) ^{min}	• CCME provides a high-level of protection for saturated conditions.	2, 27, 28
Macrophytes	Bow River Below Park Boundary	WQO: No macrophyte biomass that adversely affects users.	Insufficient data	• Numerical relationships between biomass and DO are poorly understood and need to be established. For example, higher macrophytes biomass may naturally occur in standing or slower moving water.	14

[75] Healthy riparian condition filters nutrients and minimizes the runoff of sediments into receiving water bodies.
[76] Erosion is caused when soil particles are dislodged and transported by water falling on or running across bare soil or vegetated areas that are unable to resist the force of the flowing and falling water. If eroded material is transported to water bodies sedimentation occurs which reduces water quality after and during storm events.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Nitrate (nitrate + nitrite (as N))	Bow River Below Park Boundary	• WQO: 0.267 mg/L • WARNING LEVEL: 0.163 mg/L • WQOs, warning levels and targets for nitrate apply during the growing / open water season.	Open water Cochrane 87-06 monthly 0.067 (0.112) 90	• The value of 0.267 mg/L was obtained from Sosiak 2004 as the nitrate + nitrite level that corresponds to nuisance growth of periphyton in the Bow River basin. • The warning level was developed based on the 90th percentile level for the period 1987 – 2006.	27, 28
Pathogens as indicated by E. coli	Bow River Below Park Boundary	WQO: Meet recreational guideline – no single value to exceed 400 E.coli/100 mL or < 200 E. coli/100 mL (geometric mean 5 samples/30 d).	Year Round coliforms/100 mL Cochrane 94-06 monthly 1 per 100 mL (14) 90	• 400 E. coli/100 mL is the CCME re-sampling guideline. (CCME 1999)	28
Pathogens as indicated by fecal coliforms	Bow River Below Park Boundary	WQO: Meet 100 fecal coliforms/100 mL (no single value to exceed objective) at the point of withdrawal.	Year Round Coliforms/100 mL Cochrane 91-05 monthly 2 per 100 mL (20) 90	• Irrigation guidelines set by CCME. (CCME 1999) • It is recognized, that the WQO values may be briefly exceeded for short periods of time during storm events. • The intention though, is to maintain in-stream concentrations at or below current levels.	28
Pathogens as indicated by Total Coliforms	Bow River Below Park Boundary	WQO: Should not exceed 20,000 counts (total coliforms) per 100 mL at intake for drinking water treatment plant.	Year Round Cochrane 00-06 monthly 66 per 100 mL (435) 90	• The instantaneous objective of < 20,000 counts/100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water.	28
Pathogens – Giardia	Bow River Below Park Boundary	WQO: Should not exceed 100 cysts per 100L (instantaneous) for the Bearspaw Water Treatment Plant.	Insufficient data	• This is the level above which will require in excess of 5-log reduction at the Bearspaw Water Treatment Plant (AENV 2006b). • Higher levels of Giardia require new water treatment processes for small water supply systems in the Basin. Over time, as approvals come up for renewal, small water supply systems may be required to upgrade to treat higher levels of Giardia.	3
Pesticides and Degradation Products	Bow River Below Park Boundary	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (CCME 1999).	Data not readily available	• Provisional objective as there is currently no ongoing monitoring available at this time to set an objective. • Protects drinking water and aquatic ecosystems. • < 1/10 of federal drinking water guidelines used to provide a safety margin to protect against compounds for which there is no treatment.	37, 38, 39, 41, 42
Total Ammonia	Bow River Below Park Boundary	WQO: Should not exceed 0.04 mg/L in the river for municipal water supply, and should not exceed CCME guideline for protection of aquatic life (CCME 1999). To apply outside mixing zone (AENV 1995).	Open water Cochrane 87-06 monthly 0.010 (0.020) 90	• Protects municipal water supply from unacceptable chlorine demand. • Based on experience at Glenmore Water Treatment Plant. • This is more restrictive than the current CCME guideline. • Designed to protect aquatic life and takes into account the influence of both temperature and pH on the toxicity of ammonia.	27, 28

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Dissolved Phosphorus	Bow River Below Park Boundary	WQO: 0.005 mg/L TDP during the growing season for aquatic plant	Open Water Cochrane 87-06 monthly 0.002 (0.005) ^{90}	• Based on trying to maintain or improve the existing water quality. • Objective is the 90th percentile (1987-2006) open water concentrations in the Bow River at Cochrane.	27, 28
Total Organic Carbon	Bow River Below Park Boundary	WQO: Should not exceed 3.0 mg/L (instantaneous).	Year Round Cochrane 00-06 Monthly 0.82 (1.51) ^{90}	• Value excludes periods of snowmelt runoff, mountain runoff, and significant precipitation events. • TOC is generally lower in these upper reaches. • Increasing TOC levels in the source water has affected the treatment process of water at many surface water treatment plans. TOC > 3 mg/L result in increased coagulant and chlorine demands, and gets worse as TOC levels get higher. (UEWG 1999)	
Total Phosphorus	Bow River Below Park Boundary	WQO: 0.014 mg/L TP.	Open Water Cochrane 87-06 Monthly 0.004 (0.014) ^{90}	• Based on trying to maintain or improve the existing water quality. • Objective is the 90th percentile (1987-2006) open water concentrations in the Bow River at Cochrane.	27, 28
Total Suspended Solids	Bow River Below Park Boundary	WQO: CCME (CCME 1999).	Year Round Cochrane 87-06 monthly 1.0 (6.0) ^{90}	• To maintain existing water quality for aquatic life.	27, 50, 52, 54
Water Temperature	Bow River Below Park Boundary	WQO: Should not exceed 22°C at any time or a 7-day mean of 18°C.	Open Water Cochrane 87-06 monthly 10.4 (15.07) ^{90} (18.02) ^{max}	• To protect most sensitive native fish, namely mountain whitefish. • Maximum values are based on Taylor & Barton 1992.	2, 16, 27
Riparian Condition	Bow River Below Park Boundary	TARGET: Maintaining a “healthy” rating using Cows and Fish rating system.		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., “unhealthy” ➔ “healthy with problems” ➔ “healthy”). If the river and/or reach previously rated as “healthy”, the target remained as “healthy”. In all cases, the long-term goal is “healthy”.	45, 47, 49, 57, 59
Soil Erosion	Bow River Below Park Boundary	TARGET: An erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has direct connection to a water body (no buffer, no interception). Applies to all construction sites and endures for the life of the project (during and post construction phases).		• For new developments that are permitted within the defined boundaries, Operating Ground Rules are in place to minimize erosion and sedimentation (ASRD). • An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	45, 48, 50, 51, 52

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Attached Algae (Periphyton) Biomass-defined as chlor a	Bow River Central	• WQO: No periphytic algal biomass that adversely affects users. • Target: 150 mg/m^2 maximum value during open water season	Open Water Carseland 87-98 monthly 205 (469) ^{90} (682) ^{max} 99-06 monthly 121 (242) ^{90} (432) ^{max}	• A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998). • Currently exceeded around Stier's ranch. • Last 6 years there have been declines in periphyton biomass therefore this target was considered appropriate.	14
Dissolved Oxygen	Bow River Central	• WQO: 5.0 mg/L (acute daily minimum), 6.5 chronic (7 day running average) • WARNING LEVEL: 5.5 mg/L (acute daily minimum) • TARGET: 6.0 mg/L (acute daily minimum), 8.0 mg/L [77] (acute daily minimum) for spawning and incubation from October to end of May from WID Weir to Hwy 22, 9.5 mg/L upstream of WID Weir from Oct. to end of June.	Open Water Monthly Carseland 87-05: 10.1 (9.0) ^{10} (7.7) ^{min} Hourly Above Highwood 2006: 8.49 (5.53) ^{10} (4.08) ^{min}	• 5.0 mg/L is the Alberta guideline, which provides a threshold for aquatic effects and a margin of safety. • 5.5 mg/L is the warning level used for the Highwood River. • The Calgary Total Loading Management Plan adopted a trigger value of 340 kg/day for total phosphorus (CoC 2005). It is based on maintaining the surface water quality guideline of 5.0 mg/L dissolved oxygen as a cross-sectional average across the Bow River just upstream of the confluence of the Highwood River at a frequency of compliance of 99.91%. • 8.0 mg/L is to protect brown trout spawning in this reach [5 mg/L + 3 mg/L (safety margin (CCME 1999)] • 9.5 mg/L to protect rainbow trout spawning in this reach. • During spawning periods, there is a recognized need to have a higher level of DO in the water column to ensure 5.0 mg/L within gravel for eggs and incubation.	2, 6, 7, 17, 24, 27, 28
Macrophytes	Bow River Central	WQO: No macrophyte biomass that adversely affects users.	AENV Macrophyte sites, M1-M8, g/m^2 1979-1996: Median: 503 Range: 0-3897 2006: Median: 71.0 Range: 0-1273	• Numerical relationships between biomass and DO are poorly understood and need to be established. For example, higher macrophytes biomass may naturally occur in standing or slower moving water. • Trying to relate measured macrophyte biomass in this reach to problems in irrigation district canals.	14
Nitrate (nitrate + nitrite (as N))	Bow River Central	• WQO: 1.5 mg/L • WARNING LEVEL: Need to better understand the limiting factor for macrophytes and periphyton growth before assigning a warning limit. • TARGET: Eliminate levels that cause nuisance aquatic plant growth. • WQOs, warning levels and targets for nitrate apply during the growing / open water season.	Open Water Carseland 87-05 monthly 0.622 (1.146) ^{90}	• WQO of 1.5 mg/L nitrate was the concentration in the City of Calgary Total Loading Management model (Golder 2007) that corresponded to 5 mg/L DO for the period April to September 30. • Nitrate + nitrite levels will be typically well below this objective except for occasional outliers during the open water season and levels may be exceeded during the winter. • The model assumes that some form of nitrification is occurring at the Fish Creek WWTP. This objective may need to be revisited as improvements around the WWTP occur over time and as findings from related research recommendations become available.	6, 7, 24, 27, 28, 29, 31

[m] Healthy riparian condition filters nutrients and minimizes the runoff of sediments into receiving water bodies.
[n] Erosion is caused when soil particles are dislodged by water falling on or running across bare soil or vegetated areas that are unable to handle the force of the flowing water. Receiving water bodies adjacent to eroded stream banks tend to have poor water quality after storm events.
[77] Based on brown trout population.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Pathogens as indicated by E. coli	Bow River Central	• WQO: Meet recreational guideline – no single value to exceed 400 E.coli per 100 mL or < 200 E. coli per 100 mL (geometric mean 5 samples/30 d). • TARGET: Meet recreational guideline of < 200 E. coli per 100 mL (geometric mean 5 samples/30 d).	Year Round Carseland 94-05 monthly 23 per 100 mL (205) [90]	• Pathogen indicator loads are significant. • It is recognized that E. coli in the Bow Central can be above recreational guidelines following storm events. • Further research required to establish warning level. • E. coli objectives were not originally provided in some cases in Phase One. Where this occurred, the agreement was to use CCME Guidelines.	8, 28, 32
Pathogens as indicated by fecal coliforms	Bow River Central	WQO: Meet 100 fecal coliforms per 100 mL (no single value to exceed objective) at the point of withdrawal	Year Round Carseland 87-05 monthly 91 per 100 mL (590) [90]	• Irrigation guidelines set by CCME (CCME 1999). • The WQO values can be briefly exceeded for short periods of time during storm events. • Fecal coliforms at this site have declined greatly (medians < 62) since disinfection installed at both Calgary wastewater treatment plants in 1997.	8, 28
Pathogens as indicated by Total Coliforms	Bow River Central	WQO: Should not exceed 20,000 counts (total coliforms) per 100 mL at intake for drinking water treatment plant.	Year Round Carseland 87-94 monthly 870 per 100 mL (2900) [90]	• The instantaneous objective of < 20,000 counts/100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water. • Total coliforms are not typically monitored here.	8, 28
Pathogens – Giardia	Bow River Central	WQO: Should not exceed 100 cysts per 100L (instantaneous) for the Bearspaw Water Treatment Plant.	Insufficient data	• This is the level above which will require in excess of 5-log reduction at the Bearspaw Water Treatment Plant (AENV 2006b). • Higher levels of Giardia require new water treatment processes for small water supply systems in the Basin. Over time, as approvals come up for renewal, small water supply systems may be required to upgrade to treat higher levels of Giardia.	3, 8, 28
Pesticides and Degradation Products	Bow River Central	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (CCME 1999).	Breakdown of data by reach not available (Anderson 2005) [78]	• Protects drinking water and aquatic ecosystems. • < 1/10 of federal drinking water guidelines used to provide a safety margin to protect against compounds for which there is no treatment.	31, 37, 38, 39, 41, 43, 44
Total Ammonia	Bow River Central	• WQO: The lower of US EPA or 0.2 mg/L ammonia during the growing season for growth of aquatic vegetation. To apply outside mixing zone (AENV 1995). • TARGET: CCME (CCME 1999)	Open Water Carseland 87-05 monthly 0.040 (0.160) [90]	• 0.2 mg/L total ammonia was a fully-mixed concentration in the City of Calgary Management model (Golder 2007) that corresponded to 5 mg/L DO. • The model assumes that some form of nitrification is occurring at the Fish Creek WWTP. This objective may need to be revisited as improvements around the WWTP occur over time and as findings from related research recommendations become available. • Objectives are based on toxicity thresholds and aquatic plant growth.	7, 24, 27, 28, 31

[78] Over entire Bow basin, (Anderson 2005; Table 4c) found 180 of 406 samples exceeded irrigation guidelines (mainly Dicamba and MCPA), 12 of 406 samples (mainly, 2,4-D and chlorpyrifos-ethyl exceeded aquatic life guidelines, and no exceedences of guidelines for drinking water or livestock watering.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Dissolved Phosphorus	Bow River Central	• WQO: 0.015 mg/L TDP during the growing season for aquatic plants • Provisional objective: 0.054 mg/L for winter season	Open Water Carseland 83-05 monthly 0.016 mg/L (0.037)[90] With Enhanced P Removal monthly 2004: 0.008 2005: 0.006 Winter season 84-06 0.032 (0.054)[90]	• Objective based on protecting DO and nuisance aquatic plants. • Cross-sectional average TDP concentration that maintained DO levels above 5.0 mg/L in City of Calgary Total Loading Management model (Golder 2007) using data from the April to Sept time period. • Provisional objective is the 90th percentile based on historical data. • Lower [TDP] have been observed with recent wastewater treatment upgrades.	7, 24, 27, 28, 31
Total Organic Carbon	Bow River Central	• WQO: Should not exceed 5.0 mg/L (instantaneous) • TARGET: Should not exceed 3.0 mg/L (instantaneous).	Year Round Carseland 87-05 monthly 1.90 (3.11)[90]	• Increasing TOC levels in the source water has affected the treatment process of water at many surface water treatment plans. TOC > 3 mg/L result in increased coagulant and chlorine demands, and gets worse as TOC levels get higher (UEWG 1999). • Values exclude periods of snowmelt runoff, mountain runoff, and significant precipitation events.	9
Total Phosphorus	Bow River Central	• WQO: 0.028 mg/L • TARGET: Eliminate levels that cause nuisance aquatic plant growth. • Provisional WQO: 0.075 mg/L during winter season	Open Water Carseland 83-05 monthly 0.038 (0.095)[90] *Open Water* *Carseland* *99-10* *Monthly median, open water season* *0.028*[79] With Enhanced P Removal monthly 2004: 0.023 2005: 0.021 Winter season Carseland 84-06 0.052 (0.075)[90]	• Objective is based on protecting DO and the target relates to controlling the growth of aquatic plant growth. The TP objective was inferred from the TDP objective using observed TP:TDP ratios. • Based on TLM model (Golder 2007) using an average TDP concentration during Apr. to Sept. that maintained DO above 5.0 mg/L and a TDP:TP ratio of approx. 55%. • Although there is currently no CCME guideline for phosphorus, the Bow River water quality objective is in the middle of the "trigger range" of TP concentration (0.020-0.035 mg/L) that CCME 2004 recommends for mesotrophic rivers (those with moderate levels of productivity), above which management action and investigation is required. It is also within the range of TP levels (0.018 – 0.030 mg/L) that corresponded to nuisance growth of periphyton in studies reviewed in Sosiak 2004. • The WQO may be exceeded during storm events due to particulate phosphorus. • With the addition of alum treatment, concentrations have declined in the last couple of years. • Provisional objective is the 90th percentile based on historical data	7, 24, 27, 28, 31

[79] Wendell Koning, Personal Communication, May 10, 2011.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Suspended Solids	Bow River Central	• WQO: If the background [80] concentration is: – < 25 mg/L conditions must not exceed an SEV value of 6 – > 25 mg/L conditions must not exceed an SEV value of 7- (CCME 2002, Caux et al 1997) – > 250 mg/L (CCME 2002) applies (conditions should not increase more than 10% above background levels when background is > 250 mg/L) • Calculation of the SEV value must be taken from fully mixed zone. • WARNING LEVEL: Visible plume entering river during base river flow. • TARGET: CCME (CCME 1999), increase compliance frequency with objectives.	Year Round Carseland 87-05 monthly 5.0 (26.9) [90]	• There are different objectives to consider natural and anthropogenic TSS variation along the river. • When the background is less than < 250 mg/L, the objectives are based on SEV values derived from Newcombe and Jensen 1996. The approach relates the biological fish response to duration of exposure and suspended sediment concentration. The SEV values selected ensures that only a moderate level of physiological stress is endured by fish in this reach during 1 and 7 day exposure periods. • SEV objectives are based on ASRD and DFOs' mandates which strive to ensure that fish and their habitats support success in all life stages. SEV exposure periods for 1 and 7 days were used to protect fish during storm events. • It is recognized that the objectives may be temporarily exceeded during spring freshet and storm events. • Warning narrative similar to what is used by the City of Calgary.	18, 27, 28, 30, 31, 33, 50, 52, 53
Water Temperature	Bow River Central	• WQO: Should not exceed 22°C at any time or 7 day mean > 18°C at frequencies greater than natural exceedences. • TARGET: See footnote at bottom of page. [81]	Open Water Carseland 87-05: Monthly 12.4 (17.1) [90] (20.2) [max] Above Highwood 2006: hourly 17.37 (19.81) [90] 22.49 [max]	• Bow River (and tributaries) in this area contain Rainbow Trout, Mountain Whitefish, Brown Trout, Bull Trout (not common) and Cutthroat Trout (not common). Acute temperatures for Bull Trout, Cutthroat Trout and Mountain Whitefish are all 22°C, as described in Taylor and Barton, 1992. The 24°C value used from the Highwood Management plan is not suitable for widespread application in Bow River Central area. • Temperatures above 26°C can be lethal to rainbow trout (Hokanson et al 1977). • Need to also consider the interplay between oxygen & temperature.	2, 7, 17, 24, 27

[80] Two general approaches are considered acceptable to define background concentrations of water quality variables which involve (CCME 2002 pg20, Site-specific guidance): i) utilization of historically-collected water quality data for site (i.e., prior to the commencement of activities that could have substantially altered water quality conditions); or ii) monitoring contemporary water quality conditions at one or more stations located upstream of contaminant sources.

[81] Changes to the Bow Central Water Temperature Targets (see table below). Optimum Temperature Ranges (°C from Literature).

CHANGES TO THE BOW CENTRAL WATER TEMPERATURE TARGETS

Species	Egg Incubation	Egg Incubation Timing	Fry	Juvenile	Adult	Spawning Migration	Spawning Timing
Rainbow Trout	7-12	Apr 1-Jun 15	7-12	15-20	12-18	2-16	Apr 1-Jun 15
Brown Trout	2-10	Sept 15-Mar 31	7-15	7-19	12-19	<9 (to initiate)	Sept 15-Nov 15
Mountain Whitefish	~4	Sept 15-Mar 31	~12	~12	Unavailable	~3 (<6 to initiate)	Sept 15-Nov 15

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Riparian Condition	Bow River Central	TARGET: a "healthy" rating using Cows and Fish rating system		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy" ➔ "healthy with problems" ➔ "healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy".	45, 47, 49, 57, 59
Soil Erosion	Bow River Central	TARGET: An erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has direct connection to a water body (no buffer, no interception). Applies to all construction sites and endures for the life of the project (during and post construction phases).		• An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	30, 31, 45, 47, 50, 51, 52
Attached Algae (Periphyton) Biomass-defined as chlor a	Bow River Lower	• WQO: No periphytic algal biomass that adversely affects users. • Target: 150 mg/m^2 maximum value during open water season	Open Water Ronalane 87-05 monthly 53 (109) ^{90} (493) ^{max} last exceeded 150 mg/m^2 in 1987	• A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998).	14
Dissolved Oxygen	Bow River Lower	WQO 5.0 mg/L (acute daily minimum), 6.5 chronic (7 day running average)	Open Water Ronalane 87-05 2000 monthly hourly 10.1 8.79 (8.0) ^{10} (6.93) ^{10} (3.7) ^{min} (5.75) ^{min}	• These values support the species of concern (e.g., sturgeon) and the main sport fish (e.g. Walleye, Northern pike).	2, 24, 27, 28
Macrophytes	Bow River Lower	WQO: No macrophyte biomass that adversely affects users.	Peak macrophyte biomass of 105 g/m^2 below Bassano Dam during 1994-97 synoptic surveys (WRS 2004)	• Numerical relationships between biomass and DO are poorly understood and need to be established. For example, higher macrophytes biomass may naturally occur in standing or slower moving water. • Trying to relate measured macrophyte biomass in this reach to problems in irrigation district canals.	14
Nitrate (nitrate + nitrite (as N))	Bow River Lower	• WQO: 1.5 mg/L • WARNING LEVEL: Need to better understand the limiting factor for macrophytes and periphyton growth before assigning a warning limit. • TARGET: Eliminate levels that cause nuisance aquatic plant growth. • WQOs, warning levels and targets for nitrate apply during the growing / open water season.	Open Water Ronalane 87-05 monthly 0.166 (0.596) ^{90}	• WQO of 1.5 mg/L nitrate was the concentration in the City of Calgary Total Loading Management model (Golder 2007) that corresponded to 5 mg/L DO for the period April to September 30. • Although the City of Calgary model was not designed for this reach, it is assumed that the model's predicted limit is appropriate and it has been applied to this reach as well. • Nitrate + nitrite levels will be typically well below this objective except for occasional outliers during the open water season and levels may be exceeded during the winter. • The model assumes that some form of nitrification is occurring at the Fish Creek WWTP. This objective may need to be revisited as improvements around the WWTP occur over time and as findings from related research recommendations become available.	24, 27, 28

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Pathogens as indicated by E. coli	Bow River Lower	WQO: Meet recreational guideline – no single value to exceed 400 E. coli per 100 mL or < 200 E. coli per 100 mL (geometric mean 5 samples/30 d).	Year Round Ronalane 94-05 monthly 6 per 100 mL (43) [90]	• 400 E. coli per 100 mL is the re-sampling guideline (CCME 1999).	28
Pathogens as indicated by fecal coliforms	Bow River Lower	WQO: Meet 100 fecal coliforms per 100 mL (no single value to exceed objective) at the point of withdrawal.	Year Round Ronalane 87-05 monthly 10 per 100 mL (109) [90]	• Irrigation guidelines set by CCME (CCME 1999). • The WQO values can be briefly exceeded for short periods of time during storm events.	28
Pathogens as indicated by Total Coliforms	Bow River Lower	WQO: Should not exceed 20,000 counts (total coliforms) per 100 mL at intake for drinking water treatment plant.	Year Round Ronalane 87-94 monthly 66 per 100 mL (580) [90]	• The instantaneous objective of < 20,000 counts per 100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water. • Total coliforms are not typically monitored here.	28
Pathogens – Giardia	Bow River Lower	WQO: Not set for this reach. However, Giardia is an important issue, and agencies should continue to monitor for Giardia and attempt to identify and reduce sources.	Insufficient data	• Insufficient data to make recommendation. We need to first determine Giardia counts in surface water reaches that can be effectively treated by different methods. • Higher levels of Giardia require new water treatment processes for small water supply systems in the Basin. Over time, as approvals come up for renewal, small water supply systems may be required to upgrade to treat higher levels of Giardia.	3
Pesticides and Degradation Products	Bow River Lower	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (CCME 1999).	Breakdown of data by reach not available (Anderson 2005) [82]	• Protects drinking water and aquatic ecosystems. • < 1/10 of federal drinking water guidelines used to provide a safety margin to protect against compounds for which there is no treatment.	37, 38, 39, 41, 42
Total Ammonia	Bow River Lower	• WQO: The lower of US EPA or 0.2 mg/L ammonia during the growing season for growth of aquatic vegetation. To apply outside mixing zones (AENV 1995). • TARGET: CCME (CCME 1999)	Open Water Ronalane 87-05 monthly 0.010 (0.072) [90]	• 0.2 mg/L total ammonia was a fully-mixed concentration in the City of Calgary Total Loading Management model (Golder 2007) that corresponded to 5 mg/L DO. • Although the City of Calgary model was not designed for this reach, the model predicted limit is appropriate and has been applied to this reach as well. • The model assumes that some form of nitrification is occurring at the Fish Creek WWTP. This objective may need to be revisited as improvements around the WWTP occur over time and as findings from related research recommendations become available. • Objectives are based on toxicity thresholds and aquatic plant growth.	24, 27, 28

[82] Over entire Bow basin, (Anderson 2005; Table 4c) found 180 of 406 samples exceeded irrigation guidelines (mainly Dicamba and MCPA), 12 of 406 samples (mainly 2,4-D and chlorpyrifos-ethyl exceeded aquatic life guidelines, and no exceedences of guidelines for drinking water or livestock watering.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Dissolved Phosphorus	Bow River Lower	• WQO: 0.015 mg/L TDP during the growing season for aquatic plants • Provisional objective: 0.025 mg/L for winter season	Open Water Ronalane 83-05 monthly 0.007 mg/L (0.017) 90 Winter season 84-05 0.007 (0.025) 90	• Objective based on protecting DO and reducing nuisance aquatic plant growth. • Although the City of Calgary model (Golder 2007) was not designed for this reach, the model's predicted limit is appropriate and has been applied to this reach as well using avg. conc. During Apr. to Sept. • Based on TLM model (Golder 2007) using average TDP concentration during Apr. to Sept. that maintained DO above 5.0 mg/L and TDP:TP ratio of approx. 55%. • Provisional objective is the 90th percentile based on historical data.	24, 27, 28
Total Organic Carbon	Bow River Lower	• WQO: Should not exceed 5.0 mg/L (instantaneous) • TARGET: Should not exceed 3.0 mg/L (instantaneous).	Year Round Ronalane 87-05 monthly 2.55 (4.20) 90	• Increasing TOC levels in the source water has affected the treatment process of water at many surface water treatment plans. TOC >3 mg/L result in increased coagulant and chlorine demands, and gets worse as TOC levels get higher. (UEWG 1999) • Values exclude periods of snowmelt runoff, mountain runoff, and significant precipitation events.	
Total Phosphorus	Bow River Lower	WQO: 0.05 mg/L TARGET: Eliminate levels that cause nuisance aquatic plant growth.		• Total Phosphorus objectives were not originally provided in Phase One. Where this occurred, the agreement was to use Alberta Surface Water Quality Guidelines.	
Total Phosphorus	Bow River Lower	• WQO: No recommendation for TP. TDP is believed to be the better WQO for this reach. • TARGET: Eliminate levels that cause nuisance aquatic plant growth.	Open Water Ronalane 83-05 monthly 0.027 (0.095) 90 Winter season 1984-2006 0.020 (0.041) 90 With Enhanced P Removal monthly 2004: 0.031 2005: 0.019	• Total phosphorus in this reach is predominantly particulate phosphorus which can increase above this level with concurrent algae production. For this reason, total dissolved phosphorus is the better indicator for this reach.	24, 27, 28
Total Suspended Solids	Bow River Lower	• WQO: If background [83] concentration is: – < 25 mg/L conditions must not exceed an SEV value of 6 – > 25 mg/L conditions must not exceed an SEV value of 7- (CCME 2002, et al 1997) – > 250 mg/L (CCME 2002) applies (conditions should not increase more than 10% above background levels when background is > 250 mg/L) • Calculation of the SEV value must be taken from fully mixed zone. • WARNING LEVEL: Visible plume entering river during base river flow. • TARGET: CCME (CCME 1999), increase compliance frequency with objectives	Year Round Ronalane 87-05 monthly 9.6 (80.0) 90	• There are different objectives to consider natural and anthropogenic TSS variation along the river. • When the background is less than < 250 mg/L, the objectives are based on SEV values derived from Newcombe and Jensen 1996. The approach relates the biological fish response to duration of exposure and suspended sediment concentration. The SEV values selected ensures that only a moderate level of physiological stress is endured by fish in this reach during 1 and 7 day exposure periods. • SEV objectives are based on ASRD and DFOs' mandates which strive to ensure that fish and their habitats support success in all life stages. SEV exposure periods for 1 and 7 days were used to protect fish during storm events. • It is recognized that the objectives may be temporarily exceeded during spring freshet and storm events. • Warning narrative similar to what is used by the City of Calgary.	27, 50

[83] Two general approaches are considered acceptable to define background concentrations of water quality variables which involve (CCME 2002 pg20, Site-specific guidance): i) Utilization of historically- collected water quality data for site (i.e., prior to the commencement of activities that could have substantially altered water quality conditions); or ii) Monitoring contemporary water quality conditions at one or more stations located upstream of contaminant sources.

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Water Temperature	Bow River Lower	WQO: 1) Should not a) exceed 22°C at any time; or b) exceed a 7 day mean > 18°C for the Bow River between Carseland Weir and Bassano Dam at frequencies greater than natural exceedences. 2) Should not exceed 29°C at any time or a 7-day mean > 24°C for the Bow River between Bassano Dam and the South Saskatchewan River confluence at frequencies greater than natural exceedences. • WARNING LEVEL: ABOVE BASSANO DAM: A warning level of 24°C should be used as a signal to stop all angling until such time as temperatures fall below 24°C for a period of 2 consecutive days.	Open Water Ronalane — Bow City 87-05 — 1998 Monthly — Hourly 15.7 — 20.38 (20.9) 90 — (23.97) 90 (25.9) max — (28.8) max	• Lake Sturgeon occur in this reach and are considered a species of concern in Alberta. • The original WQO acute water temperature values of 29°C suggested in Phase One are based on Walleye. Walleye are not present in the reach between Carseland Weir and Bassano Dam. This section is actively managed for Rainbow Trout, Brown Trout and Mountain Whitefish, for which appropriate values have been provided. It is recognized that there are currently exceedences of 22°C and a 7 day mean of >18°C; the intent is to ensure no additional frequency of exceedences.	2, 24, 27
Riparian Condition	Bow River Lower	• TARGET ABOVE BASSANO DAM: a "healthy" rating using the Cows and Fish rating system • TARGET BELOW BASSANO DAM: a "healthy with problems" rating using the Cows and Fish rating system		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy"➔ "healthy with problems"➔"healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy".	45, 47, 49, 57, 59
Soil Erosion	Bow River Lower	TARGET: An erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has direct connection to a water body (no buffer, no interception). Applies to all construction sites and endures for the life of the project (during and post construction phases).		• An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	45, 48, 50, 51
Attached Algae (Periphyton) Biomass - defined as chlor a	Elbow River Central	WQO: 150 mg/m^2 maximum value during open water season	Open Water Sarcee Bridge 88-89 monthly 105.1 (143.1) 75 (174.4) max Not currently monitored	• A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998).	14
Dissolved Oxygen	Elbow River Central	WQO: CCME (CCME 1999) with protection of spawning and incubation. • 9.5 mg/L for spawning and incubation • 6.5 mg/L for acute daily minimum.	Open Water Weaselhead 00-06 monthly 9.7 (8.5) 10 (7.0) min	• CCME minimum for adult and juvenile cold-water fish • Requires fishery inventory to determine spawning areas.	2, 28

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Nitrate (nitrate + nitrite (as N))	Elbow River Central	• WQO: 0.267 mg/L • WARNING LEVEL: 0.132 mg/L • WQOs, warning levels and targets for nitrate apply during the growing / open water season.	Open Water Weaselhead 97-06 monthly 0.065 (0.129) [90]	• Protects against stimulation of excessive algal growth to protect municipal water supplies. • Nitrogen may be entering the reach as a result of long-range transport. • The value of 0.267 mg/L was obtained from Sosiak 2004 as the nitrate + nitrite level that corresponds to nuisance growth of periphyton. • The warning level was developed based on the 90th percentile level for the period 1992 – 2006.	27, 28, 35
Pathogens as indicated by E. coli	Elbow River Central	WQO: Meet recreational guideline – no single value to exceed 400 E.coli per 100 mL or < 200 E. coli per 100 mL (geometric mean 5 samples /30 d).	Open water [84] Weaselhead 94-06 monthly 28 per 100 mL (167) [90]	• 400 E. coli per 100 mL is the CCME re-sampling guideline (CCME 1999).	28, 32
Pathogens as indicated by fecal coliforms	Elbow River Central	WQO: Meet 100 fecal coliforms per 100 mL (no single value to exceed objective) at the point of withdrawal.	No baseline data currently available	• Irrigation guidelines set by CCME (CCME 1999). • The WQO values can be briefly exceeded for short periods of time during storm events.	28
Pathogens as indicated by Total Coliforms	Elbow River Central	WQO: Should not exceed 20,000 counts (total coliforms) per 100 mL at intake for drinking water treatment plant.	Open water [85] Weaselhead 93-06 monthly 444 per 100 mL (2420) [90]	• The instantaneous objective of <20,000 counts per 100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water.	28, 34
Pathogens – Giardia	Elbow River Central	WQO: Should not exceed 100 cysts per 100 L (instantaneous) at the intake for Glenmore Water Treatment Plant.	Year Round cysts/100 L Weaselhead 97-05 24 (172) [90]	• This is the level above which will require in excess of 5-log reduction at the Glenmore Water Treatment Plant (AENV 2006b). • Giardia is more of a concern on the Elbow than the Bow, as levels are typically higher on the Elbow River. For this reason, the treatment facility has a clearwell to increase the chlorine contact time. • Higher levels of Giardia require new water treatment processes for small water supply systems in the Basin. Over time, as approvals come up for renewal, small water supply systems may be required to upgrade to treat higher levels of Giardia.	3, 28
Pesticides and Degradation Products	Elbow River Central	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (CCME 1999).	Insufficient data	• Provisional objective as there is currently no ongoing monitoring available at this time to set an objective. • Protects drinking water and aquatic ecosystems. • < 1/10 of federal drinking water guidelines used to provide a safety margin to protect against compounds for which there is no treatment.	31, 37, 38, 39, 41, 42, 44
Total Ammonia	Elbow River Central	WQO: Should not exceed 0.04 mg/L in the river for municipal water supply, and should not exceed CCME guideline for protection of aquatic life (CCME 1999). To apply outside mixing zones.	Open Water Weaselhead 97-06 monthly 0.010 (0.020) [90]	• Protects municipal water supply from unacceptable chlorine demand. • Based on experience at Glenmore Water Treatment Plant. • This is more restrictive than the current CCME guideline. • Designed to protect aquatic life and takes into account the influence of both temperature and pH on the toxicity of ammonia. • This objective does not represent a value to protect the river against excessive growth of aquatic plants.	27, 28

[84] Most available data from Apr.-Sep., although some years include Mar., Oct. and Nov. data
[85] Mostly Apr.-Sep., although some years include Mar., Oct. and Nov. data

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Dissolved Phosphorus	Elbow River Central	• WQO: 0.009 mg/L TDP • TARGET: Eliminate levels that cause nuisance aquatic plant growth.	Open Water Weaselhead 93-06 monthly 0.002 (0.009)[90]	• Based on 90th percentile (1993-2006) for all available data from Mar. to Nov. at the Elbow River at Weaselhead.	27, 28
Total Organic Carbon	Elbow River Central	• WQO: Should not exceed 5.0 mg/L (instantaneous). • TARGET: Should not exceed 3.0 mg/L (instantaneous).	Open Water[86] Weaselhead 93-06 monthly 1.41 (3.97)[90]	• Values exclude periods of snowmelt runoff, mountain runoff, and significant precipitation events.	9
Total Phosphorus	Elbow River Central	WQO: 0.05 mg/L TARGET: Eliminate levels that cause nuisance aquatic plant growth.		• Total Phosphorus objectives were not originally provided in Phase One. Where this occurred, the agreement was to use Alberta Surface Water Quality Guidelines.	27, 28
Total Phosphorus	Elbow River Central	• WQO: No recommendation for TP. TDP is believed to be the better WQO for this reach. • TARGET: Eliminate levels that cause nuisance aquatic plant growth.	Open Water Weaselhead 93-06 monthly 0.011 (0.089)[90]	• Total phosphorus in this reach is predominantly particulate phosphorus which can increase above this level without concurrent algae production. For this reason, total dissolved phosphorus is the better indicator for this reach.	
Total Suspended Solids	Elbow River Central	• WQO: If the background[87] concentration is: – < 25 mg/L conditions must not exceed an SEV value of 6 – > 25 mg/L conditions must not exceed an SEV value of 7- (CCME 2002, Caux et al 1997) – > 250 mg/L (CCME 2002) applies (conditions should not increase more than 10% above background levels when background is >250 mg/L) • Calculation of the SEV value must be taken from fully mixed zone. • WARNING LEVEL: Visible plume entering river during base river flow. • TARGET: CCME (CCME 1999), increase compliance frequency with objectives	Open water[88] Weaselhead 98-06 monthly 8.1 (62.0)[90]	• Trend analysis has indicated that levels of suspended solids are increasing. • There are different objectives to consider natural and anthropogenic TSS variation along the river. • When the background is less than < 250 mg/L, the objectives are based on SEV values derived from Newcombe and Jensen 1996. The approach relates the biological fish response to duration of exposure and suspended sediment concentration. The SEV values selected ensures that only a moderate level of physiological stress is endured by fish in this reach during 1 and 7 day exposure periods. • SEV objectives are based on ASRD and DFOs' mandates which strive to ensure that fish and their habitats support success in all life stages. SEV exposure periods for 1 and 7 days were used to protect fish during storm events. • It is recognized that the objectives may be temporarily exceeded during spring freshet and storm events.	27, 28, 31, 33, 50, 53

[86] Include some Mar. and Nov. data

[87] Two general approaches are considered acceptable to define background concentrations of water quality variables which involve (CCME 2002 pg20, Site-specific guidance):
i) Utilization of historically-collected water quality data for site (i.e., prior to the commencement of activities that could have substantially altered water quality conditions); or
ii) Monitoring contemporary water quality conditions at one or more stations located upstream of contaminant sources.

[88] Available data is mostly from Apr.-Sep., although some years include Mar., Oct. and Nov. dates

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Water Temperature	Elbow River Central	WQO: Should not exceed 18°C at any time or a 7-day mean of 18°C.	Open Water Weaselhead 98-06 monthly 9.9 (14.5) ^{90} (17.2) ^{max}	• 18°C is above the recorded maximum • To protect most sensitive native fish, namely white fish. • Chronic maximum based on Taylor & Barton 1992.	2, 27
Riparian Condition	Elbow River Central	TARGET: maintaining a "healthy" rating using Cows and Fish rating system.		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy" → "healthy with problems" → "healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy".	45, 47, 49, 56, 57, 59
Soil Erosion	Elbow River Central	TARGET: An erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has a direct connection to a water body (no buffer, no interception). This applies to all construction sites and endures for the life of project (during and post construction phases).		• An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	27, 28, 29, 45, 48, 50, 51
Attached Algae (Periphyton) Biomass - defined as chlor a	Elbow River Upper	• WQO: 150 mg/m^2 maximum value during open water season • TARGET: 47 mg/m^2 maximum	Open Water Downstream Bragg Creek 88-89 monthly 14.8 (21.5) ^{75} (61.1) ^{max}	• Target is an experimentally derived value based on 10 years of monitoring data for the Bow River near the Town of Banff. It is the value that represents the transition from good to fair rankings. In the absence of reach specific data for the Elbow, the upper Bow objective was considered a reasonable target. • A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998). • Not currently monitored and no historic data in this reach, very sparse.	14
Dissolved Oxygen	Elbow River Upper	WQO: CCME (CCME 1999) with protection of spawning and incubation. • 9.5 mg/L for spawning and incubation • 6.5 mg/L for acute daily minimum.	Open Water Above Bragg Creek 00-06 monthly 10.6 (9.4) ^{10} (8.1) ^{min}	• CCME provides a high-level of protection for saturated conditions.	2
Nitrate (nitrate + nitrite (as N))	Elbow River Upper	WQO: 0.13 mg/L during the open water season	Open Water Above Bragg Creek 99-06 monthly 0.083 (0.118) ^{90}	• Trying to maintain this reach at its current trophic state. • 90th percentile for Elbow River above Bragg Creek = 0.125 mg/L (1999 - 2006).	27, 35

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Pathogens as indicated by E. coli	Elbow River Upper	WQO: Meet recreational guideline – no single value to exceed 400 E. coli per 100 mL or < 200 E. coli per 100 mL (geometric mean 5 samples /30 d).	Year Round [89] Above Bragg Creek 98-06 monthly 4 per 100 mL (22) [90]	• 400 E. coli per 100 mL is the CCME re-sampling guideline (CCME 1999).	28
Pathogens as indicated by Total Coliforms	Elbow River Upper	WQO: Should not exceed 20,000 total coliforms per 100 mL at intake for drinking water treatment plant.	Year Round [90a] Above Bragg Creek 98-06 monthly 68 per 100 mL (249) [90]	• The instantaneous objective of <20,000 counts per 100 mL is based on conventional water treatment plant's ability to remove contaminants if pre-disinfection is present (US EPA 1991). • Protects human health by ensuring that municipal water treatment plants can remove pathogens (e.g., bacteria, protozoa, and viruses) from raw water.	28, 34
Pathogens – Giardia	Elbow River Upper	WQO: Not set for this reach. However, Giardia is an important issue, and agencies should continue to monitor for Giardia and attempt to identify and reduce sources.	Insufficient data	• Insufficient data to make recommendation. We need to first determine Giardia counts in surface water reaches that can be effectively treated by different methods. • Wildlife are the prime vectors of Giardia transmission in this reach.	3
Pesticides and Degradation Products	Elbow River Upper	WQO: Should not exceed the lower of: • < 1/10 of federal drinking water guidelines or • < CCME guidelines for aquatic life in the river (CCME 1999). (provisional objective)	Insufficient data	• Provisional objective as there is currently no ongoing monitoring available at this time to set an objective. • <1/10 of federal drinking water guidelines used to provide a safety margin to protect against compounds for which there is no treatment. • Protects drinking water and aquatic ecosystems.	37, 38, 39, 41, 42
Total Ammonia	Elbow River Upper	WQO: Should not exceed CCME guideline for protection of aquatic life (CCME 1999). To apply outside mixing zone (AENV 1995).	Open Water Above Bragg Creek 00-06 monthly 0.010 (0.020) [90]	• Designed to protect aquatic life and takes into account the influence of both temperature and pH on the toxicity of ammonia. • Historical total ammonia values have not exceeded 0.02 mg/L in 7 years of data.	27, 28
Total Dissolved Phosphorus	Elbow River Upper	WQO:0.006 mg/L TDP	Open Water Above Bragg Creek 00-06 monthly 0.001 (0.006) [90]	• Based on year-round historical data at Elbow River above Bragg Creek using 90th percentile (2000-2006).	28
Total Organic Carbon	Elbow River Upper	• WQO: Should not exceed 5.0 mg/L (instantaneous). • TARGET: Should not exceed 3.0 mg/L (instantaneous).	Open Water [91] Above Bragg Creek 00-06 monthly 0.960 (3.76) [90]	• Values exclude periods of snowmelt runoff, mountain runoff, and significant precipitation events.	28

[89] Not entirely year round historical data, year round data for 2004-2006
[90a] Not entirely year round for all years in the period of record (2004-2006)
[m] Healthy riparian condition filters nutrients and minimizes the runoff of sediments into receiving water bodies.
[91] Include some March and November data

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Phosphorus	Elbow River Upper	WQO: 0.019 mg/L TP	Open Water Above Bragg Creek 99-06 monthly 0.003 (0.019) ^{90}	• Based on historical data at Elbow River above Bragg Creek using 90th percentile.	28
Total Suspended Solids	Elbow River Upper	WQO: CCME (CCME 1999).	Year Round [92] Above Bragg Creek 01-06 monthly 1.0 (16.7) ^{90}	• To maintain existing water quality for the protection of aquatic life.	27, 50, 52, 54
Water Temperature	Elbow River Upper	WQO: Should not exceed 18°C at any time or a 7-day mean of 15°C.	Open Water Above Bragg Creek 98-06 monthly 8.8 (11.3) ^{90} (14.0) ^{max}	• 14°C is the recorded maximum in the Elbow River above Bragg Creek. • To protect most sensitive native fish, namely bull trout • Chronic maximum based on Taylor & Barton 1992.	2, 27
Riparian Condition	Elbow River Upper	TARGET: maintaining a "healthy" rating using Cows and Fish rating system.		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy" ➔ "healthy with problems"➔"healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy".	45, 47, 49, 57, 59
Soil Erosion	Elbow River Upper	TARGET: An erosion and sediment control (ESC) plan should be designed with a T-value or maximum soil erosion rate target of 2t/ha/yr where disturbed land has direct connection to a water body (no buffer, no interception). Applies to all construction sites and endures for the life of the project (during and post construction phases).		• For new developments that are permitted within the defined boundaries, Operating Ground Rules are in place to minimize erosion and sedimentation (ASRD). • An erosion and sediment control plan (ESC) must be developed, implemented and monitored for construction sites with any direct connection to surface water. • An ESC plan should be prepared by a qualified professional (a professional certification that includes erosion and sediment control as a field of expertise). • Based on methods described in Wall et al 2002.	45, 50, 51, 52, 54
Attached Algae (Periphyton) Biomass - defined as chlor a	Nose Creek	• WQO: No periphytic algal biomass that adversely affects users. • Target: 150 mg/m^2 maximum value during open water season	Open Water Downstream Airdrie 99-01 monthly 48 (136) ^{90} (257.2) ^{max}	• Creeks may be light-limited so the amount of periphyton is highly variable depending on location. • A literature review over many regions determined that periphyton concentrations above 150 mg/m^2 are associated with adverse impacts on users (Welch et al 1998). • Not currently monitored.	19

[92] Data record is not entirely year round for all years in the period of record (2004-2006.)

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Dissolved Oxygen	Nose Creek	• WQO: Not recommended at this time. • TARGET: 5.0 mg/L (acute daily minimum), 6.5 chronic (7-day running average).	Open Water At Mouth 95-06 7.1 (4.8) ^{10} (2.3) ^{min} Open Water At Mouth 2004 6.6 (4.52) ^{10} (2.21) ^{min}	• Action and more research is required before setting a WQO. • DO is currently going well below 5.0, at both the mouth and the City of Calgary limit (can go as low as 3.0 mg/L).	2, 11, 27, 28
Nitrate (nitrate + nitrite (as N)	Nose Creek	• WQO: 1.5 mg/L • TARGET: Eliminate levels that cause nuisance aquatic plant growth. • WARNING LEVEL: Need to better understand the limiting factor for macrophytes and periphyton growth before assigning a warning level. • All apply during the growing season.	Open water At the Mouth 95-06 monthly 0.500 as nitrate (1.408) ^{90} as nitrate	• Although exceeded at times, the WQO is reasonable and will be a catalyst for action. • WQO of 1.5 mg/L nitrate was the concentration in the City of Calgary Total Loading Management that corresponded to 5 mg/L DO for the period April to Sept 30 (Golder 2007). • Although the City of Calgary model was not designed for Nose Creek, the model's predicted limit is appropriate and has been applied to this reach as well.	27, 28
Pathogens as indicated by E. coli	Nose Creek	Provisional WQO: Meet recreational guideline – no single value to exceed 400 E. coli per 100 mL or < 200 E. coli per 100 mL (geometric mean 5 samples /30 d).		• E. coli objectives were not originally provided in some cases in Phase One. Where this occurred, the agreement was to use CCME Guidelines. A provisional WQO indicates that further research is required.	
Pathogens as indicated by fecal coliforms	Nose Creek	TARGET: Meet 100 fecal coliforms per100 mL (no single value to exceed objective) at the point of withdrawal	Year Round At the Mouth 95-06 monthly 350 per 100 mL (2540) ^{90}	• Irrigation guidelines set by CCME (CCME 1999). • The WQO values can be briefly exceeded for short periods of time during storm events. • The challenge for Nose Creek is to determine what pathogen levels will be indicative of negative impacts to human health, stock health and pet health.	28
Pesticides and Degradation Products	Nose Creek	• WQO: Not recommended at this time. • TARGET: Should not exceed CCME guidelines for aquatic life in the river (CCME 1999).	1999-2001 (Cross 2002): samples exceeding CCME irrigation MCPA: 35% Dicamba: 59% (sensitive crops)	• Guidelines are currently being exceeded.	37, 38, 39, 41, 42, 44
Total Ammonia	Nose Creek	• WQO: US EPA during the growing season for growth of aquatic vegetation. To apply outside mixing zone (AENV 1995). • TARGET: CCME (CCME 1999)	Open Water At the Mouth 95-06 monthly 0.250 (0.500) ^{90}	• Currently both the WQO and target are exceeded at times. • Ammonia can be toxic to fish and other aquatic species.	27, 28
Total Dissolved Oxygen	Nose Creek	Provisional WQO 5.0 mg/L (acute daily minimum), 6.5 chronic (7 day running average)		• Dissolved Oxygen objectives were not originally provided in Phase One for Nose Creek. Where this occurred, the agreement was to use CCME Guidelines. A provisional WQO indicates that further research is required.	
Total Dissolved Phosphorus	Nose Creek	Provisional WQO: 0.02 mg/L TARGET: Eliminate levels that cause nuisance aquatic plant growth.	Open Water At the Mouth 99-06 (as DRP) monthly 0.020 (0.070)90	• Values fluctuate widely throughout the basin. • Sources likely urban storm water and agricultural runoff adjacent to stream. • Total Dissolved Phosphorus objectives were not originally provided in Phase One for Nose Creek. The TDP objective for Nose Creek was calculated based on the average/median TDP/TP values calculated for Nose Creek at the Mouth (average=0.35, median=0.35, N=135), and then applied the ratio to the provisional TP WQO of 0.05 mg/L, i.e., WQO = (0.05 mg/L * 0.35) = 0.02 mg/L. A provisional WQO indicates that further research is required.	27, 28, 36

PROPOSED INDICATOR OR TOPIC AREA	REACH OR RIVER	WQOS, WARNING LEVELS AND TARGETS (INDICATORS WITH ONLY TARGETS ARE GREYED)	BASELINE WATER QUALITY (MEDIAN, PERCENTILES), MG/L UNLESS OTHERWISE NOTED	RATIONALE	RELATED RECOMMENDATION NUMBER IN TABLE 2, BBWMP
Total Phosphorus	Nose Creek	• Provisional WQO: 0.05 mg/L TARGET: Eliminate levels that cause nuisance aquatic plant growth. • TARGET: Reduction in number of exceedences of the SWQG.	Open water At the Mouth 95-06 monthly 0.170 $(0.500)^{90}$	• The provincial guideline is frequently exceeded, with values fluctuating widely throughout the basin. • West Nose is in better condition but is still two times higher than the SWQG. • Sources are urban storm water and agricultural runoff adjacent to stream. • Total Phosphorus objectives were not originally provided in Phase One. Where this occurred, the agreement was to use Alberta Surface Water Quality Guidelines. A provisional WQO indicates further research is required.	27, 28, 36
Total Suspended Solids	Nose Creek	• WQO: Provisional WQO: If the background concentration is: – < 25 mg/L conditions must not exceed severity of ill-effect (SEV) value of 6 – > 25 mg/L conditions must not exceed an SEV value of 7- (CCME 2002, Caux et al 1997) – > 250 mg/L (CCME 2002) applies (conditions should not increase more than 10% above background levels when background is > 250 mg/L) • Calculation of the SEV value must be taken from fully mixed zone. WARNING LEVEL: Visible plume entering river during base river flow. TARGET: CCME (CCME 1999), increase compliance frequency with objectives • TARGET: Maintain and then reduce TSS loadings from current levels.	Year Round At the Mouth 95-06 monthly 19.0 $(62.1)^{90}$	• Highest levels are at the mouth and downstream of Airdrie probably resulting from urban runoff and urban flow alteration (higher flows). • Nose Creek is a very turbid system with a mixture of natural sediments and those that result from human activities. • Total Suspended Solids objectives were not originally provided in Phase One for Nose Creek. Where this occurred, the agreement was to use CCME Guidelines. A provisional WQO indicates that further research is required.	10, 27, 50, 55
Water Temperature	Nose Creek	WQO: Should not exceed 29°C at any time or a 7-day mean of 24°C.	Open Water At Mouth 95-06 Monthly 13.10 $(18.91)^{90}$ $(20.50)^{max}$ At Mouth 2004 hourly 16.57 $(20.94)^{90}$ $(26.2)^{max}$	• Objective is derived from Taylor and Barton 1992.	2, 11, 27
Riparian Condition	Nose Creek	• TARGET FOR WEST NOSE CREEK: a "healthy" rating using the Cows and Fish rating system. • TARGET FOR NOSE CREEK: a "healthy with problems" rating using the Cows and Fish rating system.		• Based on the best available data, targets were set at one level higher than initial conditions measured using the Cows and Fish Riparian Health Inventory rating system (Fitch and Ambrose 2003) (e.g., "unhealthy"➔"healthy with problems"➔"healthy"). If the river and/or reach previously rated as "healthy", the target remained as "healthy". In all cases, the long-term goal is "healthy". • Also to follow riparian protection recommendations outlined in the Nose Creek Watershed Management Plan (NCWP 2006). The Nose Creek Watershed Partnership website is located at www.nosecreekpartnership.com.	45, 47, 49, 57, 59
Runoff, soil erosion and impervious areas	Nose Creek	TARGET: Impervious and runoff recommendations as detailed in the Nose Creek Watershed Water Management Plan.		• To preserve the natural hydrological runoff volume to pre-development conditions (i.e., natural conditions). • Based on the overall goal of trying to achieve pre-development rates and volumes entering the streams or rivers. • Erosion and sediment control plan required (encourage retrofitting where possible). • Erosion control plan applies to any new development or construction site during and post construction.	10, 26, 40, 45, 48, 50, 51, 55

APPENDIX C

PHASE ONE RECOMMENDATIONS

#	THEME	ACTIVITY	PROPOSED INDICATOR OR TOPIC AREA	RIVER OR REACH	RECOMMENDATIONS	DECISION-MAKERS	IMPLEMENTATION TIMELINES
The recommendation numbers in the leftmost column are referenced in Appendix A for each water quality objective. *Asterisked Recommendations: Projects that are either in progress or are planned subject to budgetary approval. Blue Recommendations: Identified by the Technical Committee as being the highest priority based on science for short-term implementation.							
1.1	1a water quality performance indicators	Monitoring and evaluation	Coordinated Monitoring	Overall Bow Basin	Coordinate a workshop to develop strategies for enhanced coordination of monitoring programs within the Bow Basin.	BRBC	Short-Term (2008-2010)
1.2	1a water quality performance indicators	Reporting	Real-Time Monitoring	Overall Bow Basin	Expand real-time monitoring for both flow and water quality and make data “publicly accessible”.	Calgary*, AENV, EC, BRBC	Medium-Term (2011-2012)
1.3	1a water quality performance indicators	Research	Giardia	Overall Bow Basin	Further research and monitoring to develop a long-term target for Giardia, and to determine natural and anthropogenic sources.	Research communities	Long-Term (2012-2013)
1.4	1a water quality performance indicators	Indicator development	Cryptosporidium	Overall Bow Basin	Develop a report to review Cryptosporidium data and monitoring methodologies.	Research communities, Calgary, U of C, CHR, AENV and EC	Medium-Term (2011-2012)
1.5	1a water quality performance indicators	Monitoring and target development	Pathogens E.coli	Bow above park boundary	Include E. coli in surface water quality monitoring to determine an appropriate target.	PC and EC	Medium-Term (2011-2012)
1.6	1a water quality performance indicators	Monitoring and evaluation	Spawning and Dissolved Oxygen Levels	Bow River Central	Evaluate wastewater treatment methods and/or other options to improve river DO levels particularly during trout spawning and incubation.	Calgary	Medium-Term (2011-2012)
1.7	1a water quality performance indicators	Research and monitoring	Research and Monitoring on Dissolved Oxygen	Bow River Central	Further research on dissolved oxygen to determine the following: • cause of low nocturnal dissolved oxygen levels in the Bow River downstream from Calgary in the spring and summer; • whether N and/or P is the limiting nutrient for aquatic plant growth which contributes to low dissolved oxygen levels; • additional monitoring, model refinement and research to ensure that 0.015 mg/L TDP is sufficient to prevent DO from falling below 5 mg/L • spawning success in relation to interstitial oxygen levels.	Research communities, Calgary, AENV, ASRD	Short-Term (2008-2010)
1.8	1a water quality performance indicators	Education	Pathogens (E. coli) and Education	Bow River Central	Increase education programs about the risks associated with body contact recreation.	Calgary*, CHR, Bow River Central Municipalities, AENV	Short-Term (2008-2010)
1.9	1a water quality performance indicators	Research	Total Organic Carbon Thresholds and Exceedences Options	Bow River Central and Elbow River Central	Further research to better define thresholds for total organic carbon to set treatment and source control options if necessary.	Calgary, U of C, AENV and EC	Medium-Term (2011-2012)
1.10	1a water quality performance indicators	Indicator development and research	Total Suspended Solids WQO and Research	Nose Creek	Develop a total suspended solids WQO and conduct research to identify the anthropogenic causes of total suspended solids relative to natural sources.	NCWP	Long-term (2012-2013)

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1.11	1a water quality performance indicators	Monitoring and evaluation	Dissolved Oxygen Monitoring	Nose Creek	Enhance monitoring of DO to better characterize and understand low nocturnal DO concentrations.	AENV, Calgary, NCWP	Short-Term (2008-2010)
1.12	1b. Aquatic ecosystem performance indicators	Indicator development	Benthic Invertebrate Research and Index of Biotic Integrity	Overall Bow Basin	Complete benthic invertebrate study for sites upstream and downstream of Calgary. Develop an index to assess benthic invertebrate response to water quality and assess overall aquatic ecosystem health.	Calgary*, EC, AENV, ASRD, ACA, PC, Research communities	Medium – Term (2011- 2012)
1.13	1b. Aquatic ecosystem performance indicators	Indicator development	Fish community Index	Overall Bow Basin	Fisheries Management will continue to refine the fish IBI (Index of biotic integrity) for use as an index to assess fish community response to water quality.	ASRD*	Medium-Term (2011-2012)
1.14	1b. Aquatic ecosystem performance indicators	Research	Macrophyte, Periphyton and Fish Research	Overall Bow Basin	Further research is required to link adverse human use impacts to macrophyte growth. Research is needed to determine acceptable periphyton levels with respect to water quality and still provide benefits for fish growth.	Research communities	Medium-Term (2011-2012)
1.15	1b. Aquatic ecosystem performance indicators	Research	Didymosphenia Research	Bow River Above Park Boundary, Bow River Below Park Boundary	Research is required to determine how Didymosphenia geminata is proliferating and what can be done to contain its growth.	Research communities, EC	Short-Term (2008-2010)
1.16	1b. Aquatic ecosystem performance indicators	Research	Water Temperature & Cutthroat Trout	Bow River Below Park Boundary	Research to help determine if water temperatures are sufficiently warm for cutthroat trout spawning in the spring.	PC, ASRD, Trout Unlimited	Short-Term (2008-2010)
1.17	1b. Aquatic ecosystem performance indicators	Monitoring and evaluation	Water Temperature and Dissolved Oxygen &	Bow River Central	Establish thresholds for acute and chronic temperature and dissolved oxygen effects on mountain whitefish.	Research communities, ASRD	Short-Term (2008-2010)
1.18	1b. Aquatic ecosystem performance indicators	Research	Mountain Whitefish	Bow River Central	Further research on the effects of smaller particle sizes (e.g., in storm water) on fish health and spawning.	Research communities, other academic agencies	Long-Term (2013-2014)
1.19	1b. Aquatic ecosystem performance indicators	Monitoring and evaluation	Total Suspended Solids – Particle Size & Fish	Nose Creek	Future water quality monitoring should include the collection of periphyton biomass (as chlorophyll a).	AENV	Short-Term (2008-2010)
1.20	2a. Water quantity management in relation to water quality	Modelling and research	Periphyton Biomass Water Balance Schematics	Overall Bow Basin	Develop water balance schematics, including groundwater, for the basin and all key reaches defined in this document.	AENV, ASRD	Medium-Term (2011-2012)

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1.21	2a. Water quantity management in relation to water quality	Indicator development	Flow Deviations	Overall Bow Basin	Further work is needed to develop an appropriate method to evaluate the deviation of recorded flows from naturalized flow regimes and three flow regime benchmarks[93] (AENV 2006a, Clipperton et al 2003) that have been set in the Bow Basin to meet the needs of the aquatic environment and consumptive water users.	AENV, ASRD, EC*	Short-term (2008-2010)
1.22	2a. Water quantity management in relation to water quality	Indicator development	Water Conservation	Overall Bow Basin	Develop water conservation, efficiency, productivity targets and programs to meet targets for all municipalities and irrigation districts within the Bow Basin.	Bow Municipalities	Short-Term (2008-2010)
1.23	2a. Water quantity management in relation to water quality	Reporting	Water Use Data	Overall Bow Basin	Provide readily, accessible water use data for all major licensed water users in the Bow Basin (i.e. IDs, municipalities, and industry) and strive for enhanced recording of use for all other licence users.	AENV	Medium-Term (2011-2012)
1.24	2a. Water quantity management in relation to water quality	Modelling	Coupled-water quantity and quality modelling	Bow River Central, Bow River Lower	Modelling work is required to understand the effects of flow alterations (i.e. upstream hydroelectric dams and irrigation diversions) on the assimilation capacity of the river to wastewater loadings and on ambient water quality.	Research communities, hydroelectric and irrigation groups	Medium-Term (2011-2012)
1.25	2a. Water quantity management in relation to water quality	Modelling	Headwater runoff modelling	Bow River Upper, Bow River Below Park Boundary, Elbow River Upper	Evaluate the potential landcover scenarios in the headwaters of the Bow Basin using existing runoff models in response to different levels of forest disturbance (e.g. forestry, fire and mountain pine beetle). Investigate the relative risks using more extreme flow events, changes in annual water supplies, and changes to erosion and sediment loading.	ASRD, U of A	Medium-Term (2011-2012)
1.26	2a. Water quantity management in relation to water quality	Research	Peak and Base Flows	Nose Creek	Further research is needed to compare the frequency and magnitude of base and peak flows. Storm events should remain within the range of pre-developments conditions (pre-1970).	NCWP	Short-Term (2008-2010)
1.27	2b. Storm water and wastewater management	Modelling	Water Quality Modelling	Overall Bow Basin	Expanded water quality modelling for both NPS and PS pollution entering the Bow River and key tributaries.	Calgary, Research communities , AA&RD, & AENV*	Medium-Term (2011-2012)
1.28	2b. Storm water and wastewater management	Monitoring and reporting	Wastewater Monitoring and Reporting	Overall Bow Basin	Wastewater loadings from all licensed municipal and industrial sources throughout the Bow Basin should be monitored and reported for the various sub-basins.	AENV, Bow Municipalities and industries with discharges to the river	Medium-Term (2011-2012)

[93] The three flow benchmarks that have been set for the Bow Basin are: i) the Instream Flow Need values determined using the Instream Flow Incremental Methodology, ii) the Water Conservation Objectives established under the approved Water Management Plan for the South Saskatchewan River, and (iii) the Instream Objectives established under the Water Act and used as regulatory restrictions on existing water licences for dams and diversions.

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1.29	2b. Storm water and wastewater management	BMP implementation	Wastewater and Stormwater Treatment	Overall Bow Basin	Municipalities must evaluate and implement the best treatment wastewater and stormwater options or technologies to protect the river water quality.	Bow Municipalities, AENV (lead), AT	Medium- Term (2011-2012)
1.30	2b. Storm water and wastewater management	BMP implementation	Total Suspended Solids and Source Control Practices	Bow River Central	Develop design guidelines for source control practices (i.e., BMPs).	Calgary*	Medium-Term (2011-2012)
1.31	2b. Storm water and wastewater management	Monitoring and modelling	Storm water Monitoring	Bow River Central, Elbow River Central	Continue to conduct the water quality monitoring program for the representative storm water outfalls in Calgary in support of the Total Loading Management Plan (CoC 2005). Work on verifying and improving the storm water total suspended solid loading estimates. Expand the model to estimate loadings from the pertinent storm outfalls in the Elbow Central reach (both Elbow and Glenmore outfalls).	Calgary*	Short-Term (2008-2010)
1.32	2b. Storm water and wastewater management	Objective development	Pathogen (E. coli) Source Tracking	Bow River Central, Elbow River Central	Further source tracking within the City of Calgary (including evaluation of risks) is required prior to setting WQOs and warning levels.	Calgary, U of C, CHR, AENV and EC	Medium Term (2011-2012)
1.33	2b. Storm water and wastewater management	BMP implementation	Stormwater Improvements	Bow River Central, Elbow River Central	Implement significant stormwater quality upgrades / improvements within Calgary.	City of Calgary*	Short to Long-Term (2008–2014)
1.34	2b. Storm water and wastewater management	Research	Pathogenic Speciation and WQOs (Total Coliforms)	Elbow River Central	Need to determine the species composition of pathogens and other organisms when counts exceed 20,000 coliforms/100 mL at the intake for Glenmore Water Treatment Plant. Once the pathogenic speciation work has been completed, further work will be required to refine the WQO.	Calgary, BRBC, CHR, AENV, EC and U of C	Medium-Term (2011-2012)
1.35	2b. Storm water and wastewater management	Research	Nitrate Research	Elbow River Central, Elbow River Upper, Bow River Above Park Boundary	Further research to determine if increased nitrate in the headwaters and foothills is from natural sources, local anthropogenic changes or long-range transport.	Research communities, other academic agencies	Medium-Term (2011-2012)
1.36	2b. Storm water and wastewater management	Research	Total Phosphorus Reductions	Nose Creek	Conduct research into the primary productivity of Nose Creek with the intent to reduce total phosphorus and total dissolved phosphorus.	NCWP (lead), Research communities	Medium-Term (2011-2012)
1.37	2c. Pesticide management	Education	Pesticide Use and Education	Overall Bow Basin	Develop education programs to encourage a reduction in urban pesticide applications.	Bow Municipalities	Medium-Term (2011-2012)
1.38	2c. Pesticide management	Indicator development	Pesticide Index	Overall Bow Basin	Once completed, the new 1) Alberta pesticide index (based on thresholds of observable effects limits developed by A-M. Anderson, AENV) and the new 2) European Union Water Framework Directive pesticide index be reviewed as alternatives to the existing recommended WQO.	BRBC's Knowledge Data and Research team	Short-Term (2008-2010)

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1.39	2c. Pesticide management	Monitoring and evaluation	Pesticide Monitoring	Overall Bow Basin	Agencies monitor pesticide concentrations in long-term monitoring programs. Parks Canada will consider adding pesticide monitoring to their existing agreement with Environment Canada. The monitoring programs should be coordinated and consistent with the sampling methodologies utilized by AENV (e.g., frequency, variables tested, etc.)	AENV*, Calgary, EC, PC	Long-Term (2013-2014)
1.40	2c. Pesticide management	BMP implementation	Topsoil Thickness in New Developments	Overall Bow Basin	Require developers to provide thicker topsoil layers for all landscaped areas within new developments, to minimize the use and resulting impacts of urban pesticide applications and will increase water retention.	Bow Municipalities	Medium-Term (2011-2012)
1.41	2c. Pesticide management	BMP implementation	Pesticide Use	Overall Bow Basin	Municipalities to uphold the principle of minimizing the quantity and/or toxicity of active ingredients when applying pesticides on the land they manage. It is recognized that the management of invasive species may require aggressive control measures.	Bow Municipalities, landowners	Short-Term (2008-2010)
1.42	2c. Pesticide management	Reporting and evaluation	Pesticide Surveys for Bow Basin	Overall Bow Basin	Continue to survey pesticide sales every five years and break information down by major river basins including the Bow Basin. Data on pesticide sales can contribute important information for a variety of monitoring and research needs, such as the relationship between pesticide use and their persistence in the environment.	AENV*	Short-Term (2008-2010)
1.43	2c. Pesticide management	Education	Pesticide Applications and Buffer Areas	Bow River Central & Elbow River Central	Continue to support pesticide use education programs and BMP extension materials. Producers and commercial applicators must continue to follow product label application specifications if spraying on cultivated land. If no specifications are provided on the label, the provisions contained in the fact sheet "Pesticide Use In or Near Water" should be followed. http://environment.gov.ab.ca/info/library/7459.pdf	AA&RD, BRBC Legislation & Policy Committee, Bow Municipalities	Short-Term (2008-2010)
1.44	2c. Pesticide management	Reporting	Pesticide Use and Sales in Calgary	Bow River Central & Elbow River Central, Nose Creek	Continue to prepare annual surveys of urban domestic pesticide sales and actual use by golf course and landscape companies beyond 2008.	Calgary*	Short-Term (2008-2010)
1.45	2d. Land use management in relation to water quality	Education	Low Impact Development Education	Overall Bow Basin	Take a lead role in helping to educate municipalities and developers on the basic principles of low impact development and encourage developers to utilize these practices in the overall design.	ALIDP, Bow Municipalities	Short-Term (2008-2010)
1.46	2d. Land use management in relation to water quality	Education	Manure Application & Setbacks	Overall Bow Basin	Continue to educate producers on manure application and setback distances with respect to water bodies as outlined by the Agriculture Operations Practices Act. Research the effectiveness of different application techniques to reduce runoff of manure into receiving water bodies.	AA&RD*, NRCB* Bow Municipalities	Short-Term (2008-2010)
1.47	2d. Land use management in relation to water quality	BMP implementation	Cattle Grazing in Riparian Areas	Overall Bow Basin	Encourage landowners to implement grazing strategies to reduce the degree and impact of cattle grazing on riparian habitat along rivers and creeks (for grasslands, forested areas and protected areas).	Cows & Fish*, ASRD, Alberta Environmental Farm Plan Company, AA&RD, Bow Municipalities	Short-Term (2008-2010)

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1.48	2d. Land use management in relation to water quality	BMP implementation	Low Impact Development and Municipal Approvals	Overall Bow Basin	Incorporate elements of low impact development Best Management Practices and performance monitoring into the overall development design of new residential and commercial developments.	Bow Municipalities, landowners	Short-Term (2008-2010)
1.49	2d. Land use management in relation to water quality	BMP implementation	Riparian Buffer Zone Protection	Overall Bow Basin	Adopt riparian setbacks (e.g. City of Calgary setback policy (COC 2007); Nose Creek Watershed Management Plan (NCWP 2006) in all new developments.	Bow Municipalities	Short-Term (2008-2010)
1.50	2d. Land use management in relation to water quality	BMP implementation	Soil Erosion	Overall Bow Basin	Include erosion and sediment control measures for construction sites in all development plans submitted to municipalities or management agencies (e.g. Alberta Transportation) e.g. The City of Calgary's erosion and sediment control manuals. A requirement for an inspection of the development site by a professional should be included.	Bow Municipalities	Short-Term (2008-2010)
1.51	2d. Land use management in relation to water quality	Target development	Runoff, Erosion and Effective Impervious Areas	Overall Bow Basin	Review the 1) effective impervious area targets, 2) reach-specific runoff volume targets, and 3) erosion control targets for all new developments; to meet water quality objectives.	Bow Municipalities, AENV	Medium-Term (2011-2012)
1.52	2d. Land use management in relation to water quality	Target development	Runoff and Soil Erosion	Bow River Upper, Bow River Below Park Boundary and Elbow River Upper	Review the effectiveness of existing forestry guidelines (e.g., stream crossings, riparian protection, road maintenance) on water quality. Erosion control targets should be developed and implemented for reaches without a target.	ASRD	Short-Term (2008-2010)
1.53	2d. Land use management in relation to water quality	Indicator development	Effective Impervious Areas	Bow River Central & Elbow River Central	Develop effective impervious area targets for all new developments based on the overall goal of trying to achieve pre-development rates & volumes entering the streams or rivers.	Calgary, M.D. of Rocky View, Airdrie, Strathmore, AENV, other municipalities in the reaches	Short-Term (2008-2010)
1.54	2d. Land use management in relation to water quality	BMP implementation	Soil Erosion	Elbow River Upper, Bow River Upper	Continue efforts to reduce erosion from trails, recreation sites or other activities. Erosion and sediment control plans must be developed and implemented for construction sites with any connection to surface water. A requirement for environmental inspection of the development site during (and following) construction (by a qualified professional) should be included.	ASRD*; Alberta Tourism, Parks & Recreation*	Short-Term (2008-2010)
1.55	2d. Land use management in relation to water quality	Target development	Runoff and Effective Impervious Areas	Nose Creek	Enhanced stream and storm water flow monitoring at various points throughout the system is needed to assist in the identification of the impervious and runoff targets.	Calgary, NCWP, AENV	Short-Term (2008-2010)
1.56	2e. Source water protection	Planning	Alluvial Aquifer	Elbow River Central	Land use on alluvial aquifer lands overlying groundwater under the direct influence of surface water (GUDI) has the potential to affect both groundwater and surface water quality. Carefully consider land use in the context of downstream river water uses with appropriate groundwater assessments done prior to development, if any. Groundwater assessments may lead to some additional monitoring.	MD of Rocky View, Tsuu T'ina , City of Calgary	Short-Term (2008-2010)

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1.57	2f. Wetland and riparian characterization and protection	Objective and indicator development	Wetland and Riparian Health Inventory and Classification	Overall Bow Basin	A comprehensive wetland and riparian inventory which includes drained and altered wetland and developed and degraded riparian areas is critical for source water protection. The inventories to classify wetland and riparian areas at appropriate resolution/scale and according to their existing vegetation, the vegetation potential and the type and intensity of land use occurring within them. Priorization by geographic area (e.g., White/Settled area vs. Green/Forested area, heavily populated versus lightly populated areas). Reassess objectives and indicators of wetland and riparian health that relate to water quality when this is complete.	AENV, DUC, ASRD Cows and Fish*	Short-Term (2008-2010)
1.58	2f. Wetland and riparian characterization and protection	Objective and Indicator development	Wetland Coverage	Overall Bow Basin	The comprehensive wetland inventory capturing historic wetland loss and alteration should be used as an indicator for future state of watershed reporting and planning and the setting of wetland conservation and restoration goals.	BRBC	Short-Term (2008-2010)
1.59	2f. Wetland and riparian characterization and protection	Planning	Wetland and Riparian Restoration and Planning	Overall Bow Basin	Develop a wetland management plan and riparian management plan, based on comprehensive wetland and riparian inventories.	AENV, DUC	Medium-Term (2011-2012)
1.60	2f. Wetland and riparian characterization and protection	Research	Wetlands and Storm water	Overall Bow Basin	Further research to determine the practicality of using existing undisturbed wetlands for storm water treatment purposes.	DUC, AENV, Bow Municipalities, BRBC, ASRD U of C*	Long-Term (2013-2014)
1.61	2f. Wetland and riparian characterization and protection	Research	Wetlands and Water Quality	Overall Bow Basin	Further research into wetland function and which include investigating groundwater recharge and surface water quantity relationships in wetland function.	DUC*, AENV	Medium-Term (2011-2012)

APPENDIX D

BBWMP PHASE TWO ENGAGEMENT SUMMARY

PROCESS OR EVENT, LEAD INDIVIDUAL AND DATE	DETAILS	ESTIMATED NUMBER OF CONTACTS	INVOLVING BROADER PUBLIC [94]
Concept Presentation to BRBC Board of Directors (Rob Wolfe – May 20, 2010.)	Presentation to BRBC BOD.	12	
Presentation to BRBC Legislation and Policy (Rob Wolfe – May 28, 2010.)	Presentation to BRBC L&P.	12	
Inaugural BBWMP Phase Two Steering Committee Meeting (Rob Wolfe – June 29, 2010.)	Inaugural Steering Committee meeting.	10	
Meeting with Bryce Starlight and Tony Starlight (Gloria Wilkinson, July 7, 2010.)	Declined involvement with the BBWMP at this point. Will work with the Elbow River Watershed Partnership to see how best to involve First Nation's perspectives with WPACs and WSGs.	2	Yes
Presentation to BRBC Quarterly Education and Networking Forum (Rob Wolfe, September 9, 2010.)	Presentation at BRBC forum.	60	
Presentation to Keepers of the Athabasca Upper McLeod River Information Session (Rob Wolfe, September 25.)	Presentation at conference.	9	Yes
Presentation to the Calgary Real Estate Board at the Cochrane Ranche House (Mark Bennett, September 30, 2010.)	Presentation to a breakfast meeting attended mainly by agents and appraisers (Local decision makers also present i.e. the Mayor).	25	Yes
Presentation to the Calgary Real Estate Board at the D'arcy Ranch Golf course (Mark Bennett, October 6, 2010.)	Presentation to a breakfast meeting attended mainly by agents and appraisers (Local decision makers also present i.e. the members of Okotoks Council).	40	Yes
Encana's Charity Fair (Mark Bennett, October 26, 2010.)	Questions and discussion on the BBWMP.	6	Yes
Infrastructure and Operations Committee, Rocky View County (Mark Bennett, November 9, 2010.)	Presentation on BBWMP Phase Two and Terms of Reference.	30	Yes
Cochrane Eagle Article on BBWMP Phase Two (Based on Presentation to Rocky View County.)	Newspaper article.	5000?	Yes
Agri-Environmental Partnership of Alberta (Mark Bennett, November 24, 2010.)	Presentation to members of a conference call.	12	Yes
City of Brooks (Mark Bennett, December 6, 2010.)	Presentation to City of Brooks Council.		Yes
BRBC L&P and BBWMP Phase Two Workshop (Rob Wolfe, November 26, 2010.)	Full-day workshop including keynote speakers, panel discussion and break-out sessions to brainstorm draft recommendations.	75	Yes
BRBC Forum (Steve Meadows, December 8, 2010.)	Presentation to BBWMP membership at Forum.	70	Yes
Town of Banff (Mark Bennett, December 29. 2010.)	Presentation to Town of Banff Council, media and members of the public.	20	Yes
BRBC Preserving Our Lifeline Newsletter (March 1, 2011.)	Cover article in BRBC newsletter.	200	
BRBC Forum (Gloria Wilkinson, March 9, 2011.)	Presentation to BBWMP membership at Forum.	70	Yes
Calgary Regional Partnership Regional Servicing and Staff Policy Governance Working Group (Mark Bennett, April 7, 2011.)	Presentation to CRP Working Group.	30	Yes
Calgary Regional Partnership Regional Services Committee (Gloria Wilkinson, April 27, 2011.)	Presentation to CRP Regional Services Committee.	50	Yes
Canadian Water Resources Association Provincial Conference (Gloria Wilkinson, April 12, 2011.)	Presentation on the BBWMP and lessons learned to date.	70	Yes

[94] Broader public involvement refers to individuals outside of the 189 members of the BRBC.

PROCESS OR EVENT, LEAD INDIVIDUAL AND DATE	DETAILS	ESTIMATED NUMBER OF CONTACTS	INVOLVING BROADER PUBLIC [94]
MD of Bighorn (Mark Bennett, March 15, 2011)	Presentation to MD of Bighorn including members of Town Council.	15	Yes
Battle River Watershed Alliance (Mark Bennett, March 24, 2011)	Presentation to Steering Committee.	10	Yes
BRBC L&P and BBWMP Phase Two Workshop (Rob Wolfe, March 25, 2011)	Full-day workshop including keynote speakers, panel discussion and break-out sessions to review draft indicators, thresholds and recommendations.	75	Yes
Town of Okotoks Council (Mark Bennett, March 28, 2011)	Presentation to City of Okotoks Council, media and public.	50	Yes
Newspaper Article in Cochrane Eagle	Newspaper article on the BBWMP and workshop.	5,000?	Yes
Expert Input & Review Conference Calls (Headwaters and Land Use) (Rob Wolfe – February 23, 2011)	Conference calls to allow expert review on the BBWMP.	10	Yes
Expert Input and Review Conference Calls (Wetlands and Riparian Lands) (Rob Wolfe – February 23, 2011)	Conference calls to allow expert review on the BBWMP.	10	Yes
CRP Steering Committee Meeting (High River), Gloria Wilkinson, April 27, 2011	Calgary Regional Partnership Regional Water & Waste Water SC comprised of staff from member municipalities.	40	Yes
BBWMP Presentation to BRBC Board of Directors (Rob Wolfe – April 28, 2011)	Presentation to BRBC BOD.	12	Yes
Presentation to BRBC Legislation and Policy (Rob Wolfe – April 29, 2011)	Presentation to BRBC L&P.	12	Yes
CWWA National Conference, Mark Bennett, Toronto, May 19, 2011	Conference of water and wastewater professionals from across Canada.	100	Yes
BRBC Forum (Gloria Wilkinson, June 8, 2011)	Presentation to BBWMP membership at Forum.	70	Yes
CRP Executive Meeting (Strathmore, AB), Gloria Wilkinson, April 27, 2011	Calgary Regional Partnership Executive Committee comprised of Elected Officials from member municipalities.	50	Yes
Mount Royal University, Current Thinking Conference, Mark Bennett, June 20, 2011	Conference attended by Environmental Science Professors from Post Secondary Institutions from across Canada.	50	Yes
MD of Bighorn (Gloria Wilkinson, July 12, 2011)	Presentation to MD of Bighorn Council. Some staff were present.	10	Yes
Brooks Local Decision-Maker Workshop (September 20, 2011)	Presentation and discussion with local decision-makers from the Brooks area.	12	No
Brooks General Public Open House (September 20, 2011)	Presentation and discussion with the general public from the Brooks area.	11	Yes
WPAC Summit 2011 – Slave Lake, AB (October 13, 2011)	Presentation to a Province-Wide audience.	100	Yes
Calgary Local Decision-Maker Workshop (October 20, 2011)	Presentation and discussion with local decision-makers from the Calgary area.	6	No
Calgary General Public Open House (October 20, 2011)	Presentation and discussion with the general public from the Calgary area.	8	Yes
MD of Foothills Council (Mark Bennett, October 27, 2011)	Presentation to MD of Foothills Council. Some staff were present along with public in the gallery.	25	Yes
Rocky View County, Operations and Infrastructure Committee Meeting	Presentation to the Committee as a follow-up and update from earlier Briefings.	25	Yes
Canmore Local Decision–Maker Workshop (December 8, 2011)	Presentation and discussion with the Bow Corridor Ecosystem Advisory Group.	12	No
Canmore General Public Open House (December 8, 2011)	Presentation and discussion with the general public from the Canmore area.	3	Yes
BBWMP Survey	Using XX software, this survey was distributed to the entire BRBC membership with a request that it be given the widest distribution possible. Note actual number of responses.	22	Yes
Battle River Watershed Alliance, Camrose (January 23, 2012)	Briefed BRWA Steering Committee on BBWMP Progress to date.	15	Yes

APPENDIX E

LEGISLATION AND POLICY INVOLVING WATER AND WATERSHED MANAGEMENT

LEGISLATION AND POLICY	INTENT
Federal Fisheries Act – Department of Fisheries and Oceans Canada	Regulates and enforces on harmful alteration, disruption and destruction of fish habitat in section 35.
Provincial Water Act – Alberta Environment (AENV)	Governs the diversion, allocation and use of water. Regulates and enforces actions that affect water and water use management, the aquatic environment, fish habitat protection practices, in stream construction practices, storm water manage.
Provincial Environmental Protection and Enhancement Act (EPEA) – AENV	Provides management of contaminated sites, storage tanks, landfill management practices and enforcement.
Provincial Agricultural Operations Practices Act (AOPA) – Natural Resources Conservation Board (NRCB)	Outlines manure management standards for all farming and ranching operations in Alberta. It also provides producers and other stakeholders with a process for siting new and expanding confined feeding operations (CFOs).
Provincial Municipal Government Act (MGA) – Municipal Affairs and Appended Regulations	Provides municipalities with authorities to regulate water on municipal lands, management of private land to control non–point sources, and authority to ensure that land use practices are compatible with the protection of aquatic environment.
Provincial Public Lands Act – Sustainable Resource Development (ASRD)	Regulates and enforces activities that affect Crown–owned uplands that may affect nearby water bodies.
Provincial Safety Codes Act – Municipal Affairs	Regulates and enforces septic system management practices, including installation of septic field and other subsurface disposal systems.
Regional Health Authorities Act – Alberta Health	RHA have the mandate to promote and protect the health of the population in the region and may respond to concerns that may adversely affect surface and groundwater.
Provincial Wildlife Act – ASRD	Regulates and enforces on protection of wetland–dependent and wetland associated wildlife and endangered species (including plants).
Provincial Parks Act and Wilderness Areas, Ecological Reserve, Heritage Rangelands and Natural Areas Act – ATPR	This Act is used to minimizes the harmful effects of land use activities on water quality and aquatic resources in parks and other protected areas.
Land Use Bylaws (Municipal)	The bylaw that divides the municipality into land use districts and establishes procedures for processing and deciding upon development applications. It sets out rules that affect how each parcel of land can be used and developed and includes a zoning map.
Area Structure Plans (Municipal)	Adopted by Council as a bylaw pursuant to the Municipal Government Act that provides a framework for future subdivisions, development, and other land use practices of an area, usually surrounding a lake.
Municipal Development Plans	The plan adopted by Council as a municipal development plan pursuant to the Municipal Government Act.
Grazing Lease Stewardship Code of Practice	Describes key rangeland management principles and practices that grazing leaseholders on Alberta public lands must apply to meet defined rangeland health targets, including both upland and riparian communities.

APPENDIX F

BRBC MEMBERSHIP (APRIL 1, 2011)

COMMERCIAL INDUSTRIAL (45)

Agrium
Alberta Erosion Control Ltd.
Alberta Golf Course
AMEC Earth & Env.
Applied Aquatic Research Ltd
Aquality Env'l Consulting Ltd.
Baseline Water Resource
Bordeaux Developments
Brilliant Green Solutions
Brown & Associates
Calgary C of Commerce
CH2MHill
Clear Flow Group
Encana
Enmax
EPCOR
Fossil Water
Full Circle Adventures
Glencoe Golf & C. C.
Golder Associates Ltd.
Hopewell Residential Com.
Huntington Hills Mobile Health U
IHS Energy
Imbrium Systems Inc.
Jacques Whitford Env. Ltd.
Matrix Solutions
Maureen Lynch Consulting
Newalta Corporation
Penn West Energy
Prairie Waves
Riparia
Tera Env'l Consultants
Tesera Systems Inc.
Spray Lake Sawmills Ltd.
Summit Env'l Consultants
Umbel Communications
Urban Systems Ltd.
Watercat Consulting LLC
Water Rights
Westhoff Engineering
Worley Parsons Komex
WPC Solutions
WQ Consulting
Zanshin Environmental
Zurich Industry Ltd.

INDIVIDUAL PUBLIC MEMBERS (77)

The BRBC currently has 77 such members including:
Consultants / Engineers
Lawyer/Doctor
Ranchers
Scientists/Prof's/Students
University professors
1 MLA

NON-PROFIT INTEREST GROUPS & ACADEMIA (43)

Alberta Fish & Game Assoc.
Alberta lake Mgmt. Society
ALIDP
Alberta Stewardship Network
Alberta WaterSMART
AWA
Bow Waters Canoe Club
Bragg Creek Environmental Coalition
Calgary Regional Partnership
Calgary River Forum
Canada West Foundation
Canadian Parks & Wilderness Society
Cochrane Env'l Action Com.
Cows & Fish
Ducks Unlimited Canada
Elbow River Watershed Partnership
Friends of Fish Creek
Ghost Watershed Alliance
Inglewood Bird Sanctuary
Inside Education
Kananaskis Field Station
Mount Royal University
Nature Calgary
North Saskatchewan Watershed Alliance
Nose Creek Partnership
Oldman Watershed Council
Partners FOR The Sask. River Basin
River Watch Science Prog.
Rocky Mountain Dirt Riders
Rosebud R. Watershed Partners
Sarcee Fish & Game
St. Thomas United Church
Sustainability Resources
Trees Alive Alberta
Trout Unlimited Canada
UN Water for Life Decade
University of Calgary
Urban Development Institute Calgary
Water Matters
Waters of Wheatland
Weaselhead Preservation Society
Western Sky Land Trust
Wildsight
Young Env'l Professionals

MUNICIPAL GOVERNMENT (18)

City of Airdrie
City of Brooks
City of Calgary
County of Newell
Kananaskis Improvement District
M.D. of Bighorn No. 8
M.D. of Foothills No. 31
Rocky View County
Town of Banff
Town of Black Diamond
Town of Canmore
Town of Chestermere
Town of Cochrane
Town of Crossfield
Town of High River
Town of Okotoks
Town of Strathmore
Town of Turner Valley
Wheatland County

REGULATORY, ADMINISTRATIVE & FIRST NATIONS (14)

Alberta Agriculture & Food
Alberta Community Development
Alberta Environment
Alberta Sustainable Resource Development
Alberta Tourism, Parks and Recreation
Banff National Park
Alberta Health Services
Environment Canada
Fisheries & Oceans Can.
First Nations TSAG
Prairie Farm Rehabilitation Administration
Siksika Nation
Stoney Nation
Tsuu T'ina Nation
Licensee (5)
Bow River Irrigation District
Eastern Irrigation District
La Farge Stormceptor
TransAlta Utilities
Western Irrigation District

APPENDIX G

SWAT EXECUTIVE SUMMARY

The Strategic Watershed Assessment Team (SWAT) is a BRBC project team that was formed in late 2007 to provide long-term planning direction and advice to the BRBC Board of Directors (BOD). Using the Bow River Basin Council's 1) Decision Support Matrix and 2) Risk Analysis combined with Alberta Environment's 3) Watershed Sensitivity Analysis, the following planning priorities were identified for the years 2010 – 2016.

NOTE: These are the original dates from the SWAT report. A updated version is shown in Section 4.2 of the BBWMP incorporating updated timelines.

PHASE	PRIMARY FOCUS	DETAILS	INCLUDES	START	FINISH
One	Surface Water Quality	Water quality objectives and recommendations were developed for key rivers and/or reaches.	Completed. Released in September 2008.	September 2006	August 2009
On-Line State of Watershed	On-Line State of Watershed Report and Summary Booklet	As part of an adaptive management cycle, indicators and thresholds will be used to monitor the state of the watershed.	Completed. Released in November 2010.	May 2009	August 2010
Two	Land Use within the Entire Bow Basin, Headwaters, Wetlands and Riparian Areas	Key areas for consideration include irreversible changes to land use and loss of sensitive and/or important areas.	• Includes updated information to all previous versions of the BBWMP • The first year is set aside for developing the plan with the following year set aside for implementation.	September 2010	August 2012
Three	Surface and Groundwater Quantity	Key areas for consideration include unacceptable water deficits, potential impacts from climate change, and low and high flow events.	• Includes updated information to all previous versions of the BBWMP • The first year is set aside for developing the plan with the following year set aside for implementation.	September 2012	August 2014
Four	Surface Water Quality Revisited and Groundwater Quality	Will expand on the water quality objectives and recommendations developed in Phase One, and will also include groundwater quality.	• Includes updated information to all previous versions of the BBWMP • The first year is set aside for developing the plan with the following year set aside for implementation.	September 2014	August 2016

LEVEL OF EFFORT	PRE OR POST PROJECT PHASE OR CONTINUOUS EFFORT (20% EFFORT)	PROJECT PHASE (80% EFFORT)	IMPLEMENTATION PHASE (40% EFFORT)

PRIMARY FOCUS	2009 [95]	2010	2011	2012	2013	2014	2015
On-Line State of Watershed Report and Summary Booklet COMPLETED!							
Phase Two: Land Use within the Entire Bow Basin, Headwaters, Wetlands & Riparian Areas							
Phase Three: Surface and Groundwater Quantity							
Phase Four: Surface Water Quality Revisited and Groundwater Quality							

[95] All years shown are for the period from September 1 of the noted year to August 31 of the following year.

APPENDIX H

REFERENCES AND SELECTED BIBLIOGRAPHY

NOTE TO USER: Additional hyperlinks can also be found in the footnotes section in Appendix A.

Agriculture and Agri-Food Canada and Alberta Agriculture, Food and Rural Development. 2006. Beneficial Management Practices: Environmental Manual for Alberta Farmsteads. AGDEX 090-1 http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex11162

Agriculture and Rural Development. 2008. Understanding Groundwater. Government of Alberta. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wwg406

Alberta Beef Producers and Alberta Agriculture, Food and Rural Development. 2004. Beneficial management practices: Environmental manual for Alberta Cow/Calf Producers. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw8724

Alberta Land Stewardship Act, Statutes of Alberta, 2009. http://www.qp.alberta.ca/documents/Acts/A26P8.pdf

Alberta Low Impact Development Partnership. http://alidp.org/

Alberta Sustainable Resource Development. 2007. Grazing Lease Stewardship Code of Practice. http://www.srd.alberta.ca/LandsForests/GrazingRangeManagement/documents/GrazingLeaseStewardshipCodeofPractice_signed_Dec2014-07.pdf

Bailey, A.W., D. Mccartney and M.P. Schellenberg. 2010. Management of Canadian Prairie Rangeland. Agriculture and Agri-Food Canada No. 10144. http://www.cattle.ca/media/file/original/991_2010_02_TB_RangeMgmnt_E_WEB_2_.pdf

Bow River Basin State of Watershed Summary. 2010. http://wsow.brbc.ab.ca/reports/BRBCWSOWBookletV2-Dec28.pdf

Bow Basin Watershed: Water Quality Objectives & Indicators. Prepared by the Bow Basin Watershed Management Plan Technical Committee for the Steering Committee. (Contact BRBC for Copy)

Bow Basin Watershed Management Plan: Phase One – Water Quality. Prepared by the Bow Basin Watershed Management Plan Steering Committee. September 2008. http://www.brbc.ab.ca/index.php?option=com_content&view=article&id=96&Itemid=210

Bow Basin Watershed Management Plan: Phase Two – Terms of Reference. September 2010. http://brbc.ab.ca/index.php?option=com_docman&task=doc_view&gid=13&Itemid=

Bow River Project Final Report. Prepared for the Bow River Project Research Consortium, December 2010. http://www.albertawater.com/index.php?option=com_content&view=article&id=476&Itemid=95

Calgary Regional Partnership. http://www.calgaryregion.ca/crp/

City of Calgary Environmental Reserve Policy. http://www.calgary.ca/_layouts/cocis/DirectDownload.aspx?target=http%3A%2F%2Fwww.calgary.ca%2FCSPS%2FParks%2FDocuments%2FPlanning-and-Operations%2FNatural-Areas-and-Wetlands%2Fenvironmental_reserve_setback_policy.pdf&noredirect=1&sf=1

City of Calgary Wetland Conservation Plan. http://www.calgary.ca/CSPS/Parks/Pages/Planning-and-Operations/Protecting-Calgarys-wetlands.aspx

City of Calgary, 2001 Guidelines for Erosion and Sediment and City of Calgary Environmental Regulatory Review and Responsibilities: Calgary Construction Sites 2009. 3) http://www.calgary.ca/_layouts/cocis/DirectDownload.aspx?target=http%3A%2F%2Fwww.calgary.ca%2FUEP%2FWater%2FDocuments%2FWater-Documents%2Fescguidelines2001-02-12.pdf&noredirect=1&sf=1

Costanza, R., d' Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., et al. (1997). The value of the world's ecosystem services and natural capital. Nature, 387, 253-260. http://www.uvm.edu/giee/publications/Nature_Paper.pdf

Cows and Fish Riparian Health Assessment. http://www.cowsandfish.org/riparian/health.html

Describing the Integrated Land Management Approach, Government of Alberta. http://www.srd.alberta.ca/LandsForests/IntegratedLandManagement/default.aspx

Ecosystem Goods and Services Assessment – Southern Alberta, Phase 1 Alberta Environment, 2007. http://www.environment.gov.ab.ca/info/library/7793.pdf

Ecosystem Goods and Services Assessment – Southern Alberta, Phase 2 Version 2, Alberta Environment, 2007 http://www.environment.gov.ab.ca/info/library/7794.pdf

Ecosystem Goods and Services: Southern Alberta. A Framework for Assessing Natural Asset Condition 2009. http://environment.gov.ab.ca/info/library/8374.pdf

Elbow River Basin Water Management Plan. http://www.erwp.org/index.php/water-management-plan/plan

Environmental Management Frameworks and the Lower Athabasca Regional Plan, Facts at Your Fingertips, Government of Alberta, 2011. http://environment.alberta.ca/documents/LARP_Management_Frameworks_-_Overview_FS_2011-08-26.pdf

Future Planning Priorities for the Bow River Basin, Prepared by the Bow River Basin Council Strategic Watershed Assessment Team, May 6, 2009. http://www.brbc.ab.ca/pdfs/SWATMaterials/SWAT_May_6_2009_Final_Report.pdf

Glossary of Reclamation and Remediation Terms Used in Alberta – 7th Edition, 2002, Alberta Environment. http://environment.gov.ab.ca/info/library/6843.pdf

Glossary of Terms Related to Water and Watershed Management in Alberta, Alberta Environment, 2008. http://environment.gov.ab.ca/info/library/8043.pdf

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

Land-use Framework, Government of Alberta, 2008. https://www.landuse.alberta.ca/Pages/LUF_Publications.aspx

Memorandum of Understanding Between the Energy Resources Conservation Board, Alberta Environment, Alberta Sustainable Resource Development, and the Special Areas Board on the Identification and Delineation of Water Bodies, ERCB, 2010. http://www.ercb.ca/docs/documents/directives/MOU_Waterbodies_Appendix.pdf

Nose Creek Watershed Water Management Plan. http://nosecreekpartnership.com/our-plan/nose-creek-watershed-water-management-plan.

Recommendations for a New Wetland Policy, Alberta Water Council, 2008. http://www.albertawatercouncil.ca/Portals/0/pdfs/WPPT%20Policy%20web.pdf

Riparian Land Conservation and Management Project: Phase 1 Final Report. Prepared for: Riparian Land Conservation and Management Project Members, February 2007. http://www.brbc.ab.ca/pdfs/SWATMaterials/Riparian.pdf

Rocky View County Riparian Policy. http://www.rockyview.ca/LinkClick.aspx?fileticket=gzYikAZER3M%3D&tabid=401

Rocky View County Wetland Policy. http://www.rockyview.ca/LinkClick.aspx?fileticket=HT1Lz5XkYag%3D&tabid=401

Rocky View County Servicing Standards. http://www.rockyview.ca/Default.aspx?tabid=686

Source of Opportunity: A Blueprint for Securing Source Water in Southern Alberta, Water Matters. http://www.water-matters.org/pub/source-of-opportunity

South Saskatchewan Regional Advisory Council Advice to the Government of Alberta for the South Saskatchewan Region Plan, Government of Alberta 2010. https://www.landuse.alberta.ca/Documents/SSRP%20RAC%20Advice%20to%20the%20Government%20of%20Alberta%20for%20the%20South%20Saskatchewan%20Regional%20Plan%20Report-P2-2011-03.pdf

South Saskatchewan River Basin Water Management Plan, Government of Alberta. 2006. http://environment.alberta.ca/01233.html

Stewart, A., S. Reedyk, B. Franz, K. Fomradas, C. Hilliard and S. Hall. 2010. Field Manual on Buffer Design for the Canadian Prairies. Agri-Environment Services Branch, Agriculture and Agri-Food Canada. 55p. http://publications.gc.ca/site/eng/387723/publication.html

Stewart, R.E. and H.A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C., USA. Resource Publication 92. 57 pp. http://www.npwrc.usgs.gov/resource/wetlands/pondlake/index.htm

Township of Langley, British Columbia.EROSION AND SEDIMENT CONTROL BYLAW 2006 NO. 4381 AMENDMENT BYLAW 2009 NO. 4754. https://langley.civicweb.net/Documents/DocumentList.aspx?ID=9416

Upper Bow River Basin Cumulative Effects Study. http://www.alces.ca/home/Projects/Case_Studies/Upper_Bow_River_Basin_Cumulative_Effects_Study

Wall, G.J., D.R. Coote, E.A., Pringle and I.J. Shelton (editors). 2002. RUSLEFAC – Revised Universal Soil Loss Equation for Application in Canada. A Handbook for Estimating Soil Loss from Water Erosion in Canada. Research Branch, Agriculture and Agri-Food Canada. Ottawa. Contribution No. AAFC/AAC2244E. 117 pp. http://res.agr.ca/cansis/publications/manuals/2002-92/intro.html

Water for Life. http://www.waterforlife.alberta.ca/

Wilson, S., Griffiths, M., Anielski, M. The Alberta GPI Accounts: Wetlands and Peatlands. Report #23. Pembina Institute for Appropriate Management. 2001. http://dspace.cigilibrary.org/jspui/bitstream/123456789/21346/1/The%20Alberta%20GPI%20Accounts%20Wetlands%20and%20Peatlands.pdf?1

B.R. Taylor and B.A. Barton, 1992. Temperature and Dissolved Oxygen Criteria for Alberta Fishes in Flowing Waters. Alberta Fish and Wildlife Division, Edmonton Alberta. 72pp.