2.0 Methods

2.1 Indicators of Ecological Integrity

Indicators are measures of environmental quality that are used to assess the status and trends of the physical condition of a watershed. Their purpose is to show how well a system is functioning. If there is a concern, an indicator can help determine what direction to take to address the issue. To be effective, an indicator must be:

- relevant - able to educate the public about the ecosystem;
- straightforward;
- easy to understand;
- reliable - the information the indicator provides is trustworthy; and
- timely - the information is available while there is still time to act.

On March 05, 2008, an Indicator Workshop was held in Red Deer, AB, to identify to indicators to be used in this report. Attendees included representatives from the RDRWA, Alberta Environment, Ducks Unlimited Canada, Alberta Sustainable Resource Development, Alberta Health Services, Alberta Agriculture and Rural Development, Prairie Farm Rehabilitation Administration, the City of Red Deer, Sundre Forest Products and the University of Lethbridge. Presentations on the following topics were made to help the RDRWA and its stakeholders to understand and select the indicators that are important to their watershed:

- water quality;
- wetlands;
- riparian areas and fish; and
- natural flow of the Red Deer River.

After group consideration and a ranking exercise by workshop attendees, a list of indicators was chosen and ranked on priority. There were a total of 20 indicators that fell within four major indicator groups: land use, water quality, water quantity and bioindicators. These are addressed in depth in Appendix A.

On November 20, 2008, a subset of these indicators was chosen by the Technical Advisory Committee to indicate the condition of, or risk to, each of the 15 subwatersheds of the Red Deer River watershed, i.e., “condition indicators” and “risk indicators”. A similar approach is being used by the United States Environmental Protection Agency (2002) to assess watershed condition and vulnerability to stressors. Nine condition indicators and three risk indicators were chosen for this report. The remaining eight indicators serve as background information only.

2.2 Assessing Watershed Condition

The condition of a watershed can be described by its ecological functions, including the hydrologic cycle, water quality, water quantity, the nutrient cycles and biological diversity; however, the condition of a watershed will ultimately be determined by the users of its resources. While assessing the condition of (or risk to) a watershed is challenging, it is possible to choose indicators of watershed condition, such as water quality as measures of nutrient concentrations. Here, water quality is an indicator of watershed condition, and nutrient concentration is a specific measurement, or “metric”, of the water quality

indicator. Similarly, an indicator of risk indicates a potential threat to a component of the ecological integrity of a subwatershed, such as density of roads.

A good environmental indicator can simplify large amounts of complex information into a concise, easily understood format, such as the Alberta Surface Water Quality Index (Alberta Environmental Protection, 1996). To report on subwatershed condition or the risk to a subwatershed, it was important to examine each of the chosen indicators individually. For each subwatershed, condition indicators were ranked "good", "fair" or "poor" based on data from the scientific literature, while risk indicators were ranked "low", "medium" or "high" relative to the other subwatersheds.

Condition indicators

Wetland loss – The gain, improvement or maintenance of any wetlands was deemed "good", the maintenance but impairment of existing wetlands was deemed "fair" and any loss of wetlands was deemed "poor".

Riparian health – Riparian health assessments have been done by various agencies and are generally based on those done by Cows and Fish, i.e., based on their inventory and assessments protocols. The ratings provided in this report follow those of the agencies that have performed the riparian assessments, e.g., Cows and Fish, ACA, ASRD.

Linear developments – Linear development totals < 2% was considered "good", from 2-3% was deemed "fair" and > 3% was deemed "poor". These percentages represent proportions of the total subwatershed area affected by linear developments. Right-of-ways for linear developments followed NSWA (2005) definitions: roads – 16 m width; pipelines – 15 m width; powerlines – 30 m width; cutlines/trails – 6 m width; railways (active and inactive) – 15 m width. The width for roads used in this report represents an average of different types of roads (1-lane gravel roads – 8 m; 2-lane gravel roads – 16 m; 2-lane paved undivided highway – 16 m; 4-lane paved undivided highway – 32 m; paved divided highway – 40 m; unimproved road – 8 m).

Total phosphorus and total nitrogen – Total phosphorus concentration < 0.05 mg/L was deemed "good", from 0.05-0.10 mg/L was deemed "fair" and > 0.10 mg/L was deemed "poor". Total nitrogen concentration < 1.0 mg/L was deemed "good", from 1.0-1.5 mg/L was deemed "fair" and > 1.5 mg/L was deemed "poor". The "good" rating for both variables follows CCME Protection of Aquatic Life (PAL) guidelines (0.05 mg/L for total phosphorus and 1.0 mg/L for total nitrogen) (CCME, 1999, 2001).

Bacteria – E. coli counts from 0-100 CFU/100 mL were deemed "good" and counts > 100 CFU/100 mL were deemed "poor". The "good-poor" rating follows CCME Agriculture/Irrigation guidelines (*E. coli* concentration of 100 CFU/100 mL) (CCME, 1999).

Parasites –If any parasite concentrations exceeded Health Canada drinking water guidelines, a rating of "poor" was given.

Pesticides – If any pesticide concentrations exceeded CCME PAL guidelines (CCME, 1999), a rating of "poor" was given, otherwise, a rating of "good" was given.

Land cover – Combined land cover values for wetlands, grasslands and all forested areas > 50% was deemed "good", 25-50% was deemed "fair" and < 25% was deemed "poor".

Minimum flow – No reduction in water flow is deemed "good", a reduction in water flow up to 15% was deemed "fair" (resulting in intermediate chronic impacts on fish populations due to a reduction in habitat availability for intermediate periods) and a reduction in flow > 15% was deemed "poor" (resulting in high chronic or instantaneous impacts on fish populations due to a reduction in habitat availability for prolonged periods) (Clipperton et al., 2003).

Risk indicators

Manure production – Manure production data is expressed on an aerial basis as tonnes manure/ha. The risk was deemed "high" if manure production in a subwatershed was in the upper third of manure production relative to the other subwatersheds (> 10 tonnes manure/ha). The risk was deemed "medium" if it was in the middle third (5.1-10 tonnes manure/ha) and "low" if it was in the lower third of manure production relative to the other subwatersheds (< 5.1 tonnes manure/ha).

Urban, rural, agricultural and recreational developments – Disturbances from urban, rural, agricultural and recreational developments < 50% of the landbase were deemed "good", from 50-89% was deemed "fair" and > 90% was deemed "poor".

Oil and gas activity – The risk was deemed "high" if the number of total oil/gas wells (active and abandoned) in a subwatershed was in the upper third of total wells relative to the other subwatersheds. The risk was deemed "medium" if it was in the middle third and "low" if it was in the lower third of total wells relative to the other subwatersheds.

In addition to these condition and risk indicators, this report also addresses water quality, quantity and biological variables that may influence various components of the ecological integrity of the subwatersheds. These variables include pipeline crossings and other structures crossing waterbodies, pollution from point sources into the air and aquatic environments, water discharge rates of rivers and creeks, the area of a subwatershed contributing to the drainage of the subwatershed, surface and ground water allocations for various purposes, groundwater recharge and discharge areas, wildlife diversity, fish populations and organisms listed under the federal government's *Species at Risk Act*.

It should be noted that individual subwatershed condition and risk evaluations are generally based on limited data, and a rating of "poor" or "good" for any condition or risk indicator cannot be assumed to be representative of the entire subwatershed. For example, a condition assessment of "poor" for riparian health may be based on three riparian health assessments within a subwatershed; however, this rating cannot be extrapolated to *all* riparian areas within that subwatershed.

2.3 Data Collection

Data were assembled from a variety of freely-available sources, such as government agency internet websites, and, where possible, through data sharing agreements with RDRWA partners. The focus for data collections was the initial indicators selected by the Technical Advisory Committee that represented water quality, water quantity, land use and biological indicators. Data-sharing agreements were established with Alberta Sustainable Resource Development (ASRD), Agriculture and Agri-Food Canada-Prairie Farm Rehabilitation Administration (AAFC-PFRA) and Ducks Unlimited Canada (DUC). Other sources of data are referred to throughout this report and consist of reports from federal and provincial governments, non-governmental agencies, municipalities, industry and scientific literature. The most recent and freely-available data were used to generate all maps in this report.

Maps were generated by AAFC-PFRA and are referenced as "AAFC-PFRA, 2008" throughout this report. Table 2 indicates data sources for the maps in this report.

Table 2. Data sources for maps generated by the Prairie Farm Rehabilitation Administration (Agriculture and Agri-Food Canada).

Map	Data sources	Year	Precision
Active/abandoned wells	Alberta Environment	2008	400 m
Agricultural intensity	Ag-Census	2006	200-400 m
Feedlots	Alberta Natural Resources Conservation Board	2007	400 m
Groundwater licenses	Alberta Environment	2008	based on centre of ¼-section
Land cover	AAFC-PFRA satellite imagery	2000	30 m
Linear developments	Alberta Environment	---	---
Cattle density	Ag-Census	2006	200-400 m
Manure production	Ag-Census	2001	200-400 m
Natural Subregions	ASRD, Alberta Environment, Tourism, Parks, Recreation and Culture and Agri-Food Canada	2005	200-400 m
Non-contributing drainage area	AAFC	2007	200-400 m
Pipeline crossings	Developed from Canvec 1:50,000 hydrology and Alberta Environment linear developments	---	---
Subwatersheds	AAFC-PFRA watershed dataset	2007	200-400 m
Surface water licenses	Alberta Environment	2008	based on centre of ¼-section
Topography	Canvec 1:50,000	2001	5-10 m
Waterbody crossings	Developed from Canvec 1:50,000 hydrology and Alberta Environment linear developments	---	---
Waterbodies	Canvec 1:50,000 hydrology	2001	---

