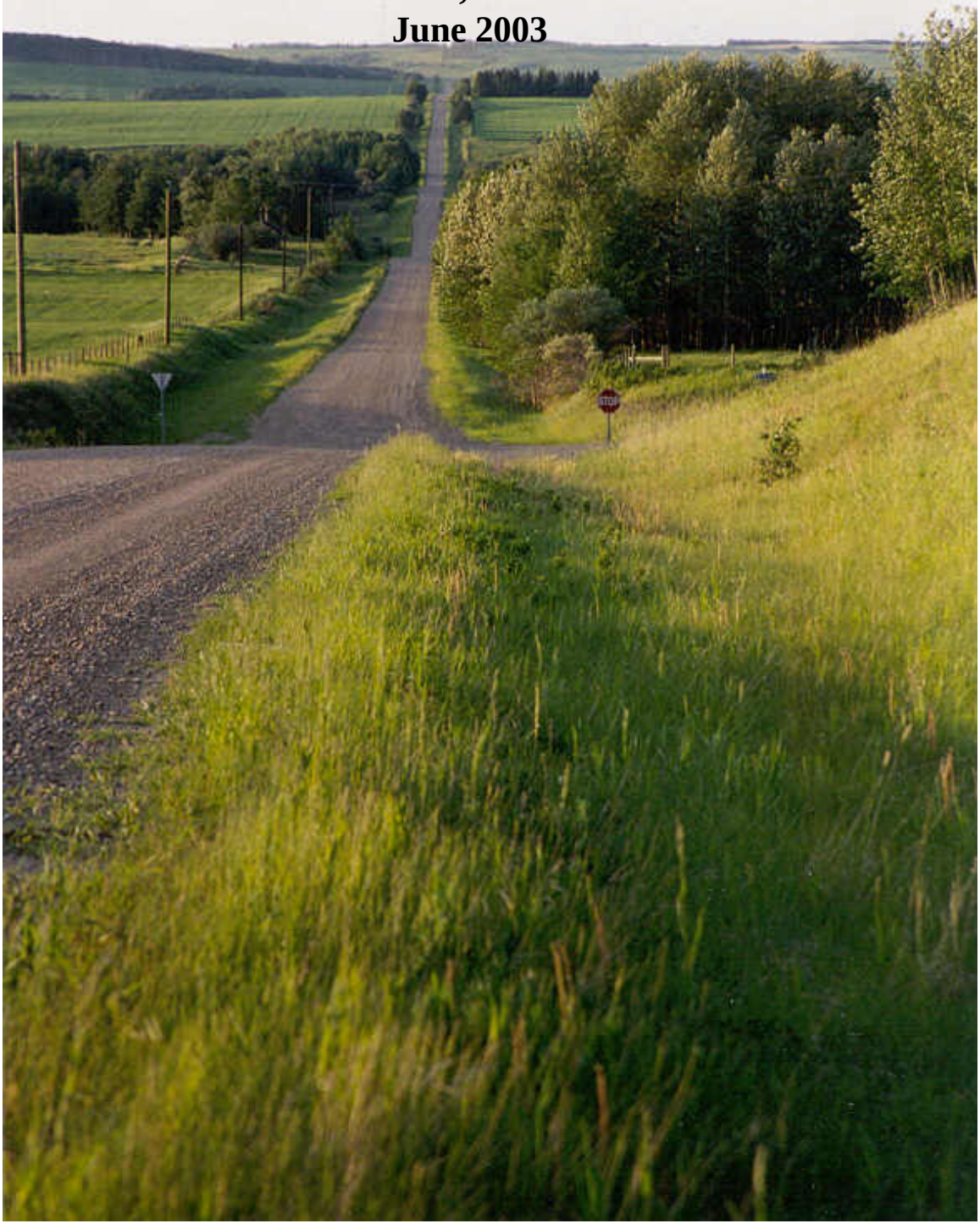
Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Project Report

Biophysical Attributes Rating in the M.D. of Rocky View No. 44

Alberta, Canada

June 2003



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Usage Guide for Biophysical Attributes Rating Data

How to Best Use this Data

The purpose of the project was to develop a planning tool that could be used by an M.D. to identify, at a regional scoping scale, natural resources and ecosystem components of environmental importance that may be sensitive to the potential impacts of proposed developments.

Data are presented in the reports' maps and figures at a coarse scale. ***This is intentional, as the information is suitable for general planning purposes and should not be used at a site-specific scale.*** Neither the individual data layers used to create this information nor the final product is intended or capable of indicating this site-specific level of detail. Detailed examination of site-specific conditions by experts in various fields, for example range specialists, biologists, hydrogeologists, etc., is necessary for any project.

Background and Limitations

Table I indicates the data and the rank assigned to the data used to create the biophysical attributes rating (BAR) information. No weighting, other than an initial ranking of the data, was used. In addition, only five layers of information were used to create the BAR's. This is not a complete list of relevant information; rather it is a list of information available across the entire area of study which was necessary to create a complete coverage across the M.D. of Rocky View. Where available, more detailed data and examinations of the area should be considered. ***As a result, BAR values assigned to areas may not indicate their actual importance or significance.***

Other considerations

- Estimates of *aquifer vulnerability* are based on the type of surficial geology and are intended for general planning purposes only. Areas shown as higher vulnerability require more investigative efforts and/or mitigative measures than areas shown with an estimated lower vulnerability rating. Site-specific assessment is required to confirm local geological conditions and aquifer vulnerability;
- The *roadless data* was ranked based on distance from a road. The farther the distance, the higher rank it received. As a result, important aquatic and/or terrestrial features that are located near a road may have their overall value lowered. Similarly, it is assumed that the further the distance from the road, the higher the potential for intact, healthy and important aquatic and/or terrestrial features. This may not always be the case.
- Existing *environmentally sensitive areas* delineated in other studies were not included in this analysis. These areas may be significant and should be considered in any management decision;
- The Biophysical Attribute Rating does a good job of identifying areas the cumulative importance of individual features (aquifer vulnerability, landcover,

Table I

Variable	Rank	Description
Aquifer Vulnerability	1	Low
	2	Medium
	3	High
	4	Very high
Landcover	1	Other land
	1	Cropland
	1	Forage
	4	Shrubs
	4	Grasslands
	4	Trees
Roadless Lands	1	0-300m from nearest road
	2	>300-700m
	3	>700-1000m
	4	>1000m
Parks and Protected Areas/Environmental Reserves	2	500m buffer
	4	Inside Administrative boundaries
Riparian Areas	2	Medium Risk (100 – 200 m from stream)
	3	High Risk (30 - 100 m from stream)
	4	Very High Risk (0 – 30 m from stream)

- roadless lands, parks and protected areas and riparian areas). It does not identify areas where an individual component, such as a riparian area, is important;
- When using this information talk to land owners in the area. They typically have an intimate knowledge of the area and can provide valuable information; and
- The ranks assigned to the data are based on literature and opinion of experts in the field. These ranks, however, may need to be adjusted to better reflect local site conditions and detailed expert knowledge.

Executive Summary

The purpose of the project was to develop a planning tool that could be used by an M.D. to identify, at a regional scale, natural resources and ecosystem components of environmental importance that may be sensitive to the potential impacts of proposed developments.

The relative sensitivity of any given land location within the M.D. of Rocky View is evaluated by ranking terrestrial and aquatic features (riparian areas, groundwater contamination potential, parks and protected areas and environmental reserves, landcover and roadless areas) using a simple numerical index. Individual features are then overlaid in a GIS. The relative sensitivity of a given area is established by calculating the sum of the values of the overlapping features of that area. The result has been coined ' Biophysical Attribute Ratings" (BAR).

The sensitivity values for each variable occupying any given cell were summed to yield a total score. The possible score for any given cell ranges from 0 (sites with no data) to 20 (sites where the value for every variable is 4; the highest value). The data were classified into 4 classes using the Natural Breaks classification method which finds groupings and patterns inherent in the data.

The classification can be used to confirm the value of previously designated ESAs and to help refine the boundaries and restrictions associated with each. The information identifies zones potentially important as core wildlife habitats and areas that may be suitable as wildlife corridors. As such the information can be used to identify priority sites for new ESAs or other protected areas, community greenspace, or priority sites for special consideration (mitigative measures, development constraints, etc). The evaluation also contributes to the identification of development opportunities and restrictions in a M.D. As such it can be used as a useful tool for regional scale land use planning, zoning, and by-law initiatives.

The biophysical attributes rating analysis is also a useful tool for finer scale environmental analysis down to the section level. At this level the analysis may be used as an input into design and development plans e.g., identification of environmental reserves, community greenspace, lot size and design, location of roads. Some caution, however, must be exercised against using the analysis for project specific approvals. All geographic data has inherent limitations in terms of accuracy and scale and the information used for this project is no exception.

The strength of the biophysical attributes rating at this scale is that it identifies environment issues that should be addressed in site-specific development plans and environmental assessments. BAR's also provides a way to evaluate the relative magnitude of environmental issues related to a proposed development and may be used to define the appropriate level of effort to be applied toward further environmental analysis and study.

This study does not address cumulative and competing land uses, an important consideration in land use planning and an important impact on areas rated high in this Biophysical Attribute Ratings study. Therefore, study is suggested to address the cumulative and competing land uses such as oil and gas, rural residential, agriculture, industry and recreational uses. The M.D. of Rocky View could use a landscape simulator, such as used in the Southern Alberta Sustainability Strategy (SASS), to provide decision makers with information that examines cumulative and competing land uses in the M.D.

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1.0 Project Background

In 1998 the Municipal District (M.D.) of Foothills No. 31's Council appointed an Environment Committee composed of citizens residing in and representing various areas of the M.D. The Environment Committee was charged with making recommendations to the M.D. Council regarding the locations of environmentally-important areas in the M.D., a first for a municipality in Alberta.

Despite the completion of a number of past studies to identify environmentally significant areas (ESAs) in the M.D., the Environment Committee felt that the biophysical and climatic variation, as well as human uses and values related to ecosystem resources, were not fully represented in these studies. For example, ESAs designated by past work did not take into consideration the establishment of connected networks of wildlife habitat, habitat protection for endangered and threatened wildlife species, the protection of watersheds or even complete stream networks. While ESA studies had identified some of the most unique and pristine natural environments in the M.D. at a Provincial, National and International scale, the committee felt that the scope of past ESA work was not suited to the day-to-day decision-making and planning work of the M.D.

To address these concerns the Environment Committee initiated a geographic information systems (GIS) mapping project in partnership with Agriculture and Agri-Food Canada - Prairie Farm Rehabilitation Administration (AAFC/PFRA). The project was intended to provide information on sensitive ecosystem resources that would help the Environment Committee identify environmentally important areas in the M.D. at a scale suited to the day-to-day operations of the M.D.

The M.D.s of Rocky View and Foothills share their south and north boundary, respectively. They also share many of the same development pressures. For example, the M.D. of Rocky View had an increase of 32% in population from 1996 to 2001, annexation by the Cities of Airdrie and Calgary and agriculture intensification. As a result, the M.D. of Rocky View is taking a proactive approach to land use pressures through the use of innovative tools. These include an Agricultural profile and Municipal Growth Strategy. It is anticipated that mapping sensitive ecosystem components, such as completed in the M.D. of Foothills, will provide useful information for land use decision makers.

1.1 Purpose

The purpose of the project is to 1. develop a terrestrial and aquatic based planning tool that can be used by the M.D. of Rocky View to identify ecosystem components of environmental, economic and social importance which may be sensitive to the potential impacts of human use.; 2. to provide detailed information that forms the basis of the planning tool that is scientific, quantitative and as a result, defensible; and 3. to supply the terrestrial and aquatic information to the M.D. of Rocky View in a GIS compatible format.

1.2 Study Area

The M.D. of Rocky View located in southern Alberta (Figure 1). It surrounds Calgary, a city of nearly 880,000 (Statistics Canada, 2003), on three sides. The terrestrial environment of the M.D. of Rocky View can be divided into four ecoregions (Figure 2): Western Alberta Uplands, Northern Continental Divide, Aspen Parkland and Fescue Grassland.

The M.D. has a wide variety of topographic features, generally increasing in elevation from east to west and, as a result, has significant climatological and biological diversity. The area transitions from mixed grass ecoregion found in the extreme southeast of the municipality, to fescue grasslands and aspen parkland, which occupy the majority of the M.D., to the mountainous regions found in the Alberta Upland on the western boundary.

The pattern of human use and development in the M.D. is a reflection of the natural diversity found across the M.D. landscape. Agriculture dominates land use patterns in the M.D. (Figure 3). Cultivated croplands dominate the eastern portion of the M.D. while lands used predominantly for grazing and forage occupy the western half. Much of the native cover of the M.D. has been converted to croplands, forage or tame pasture. This land use pattern is rapidly changing. The proximity to Calgary has brought increased pressures for country residential development and recreation property in the M.D.

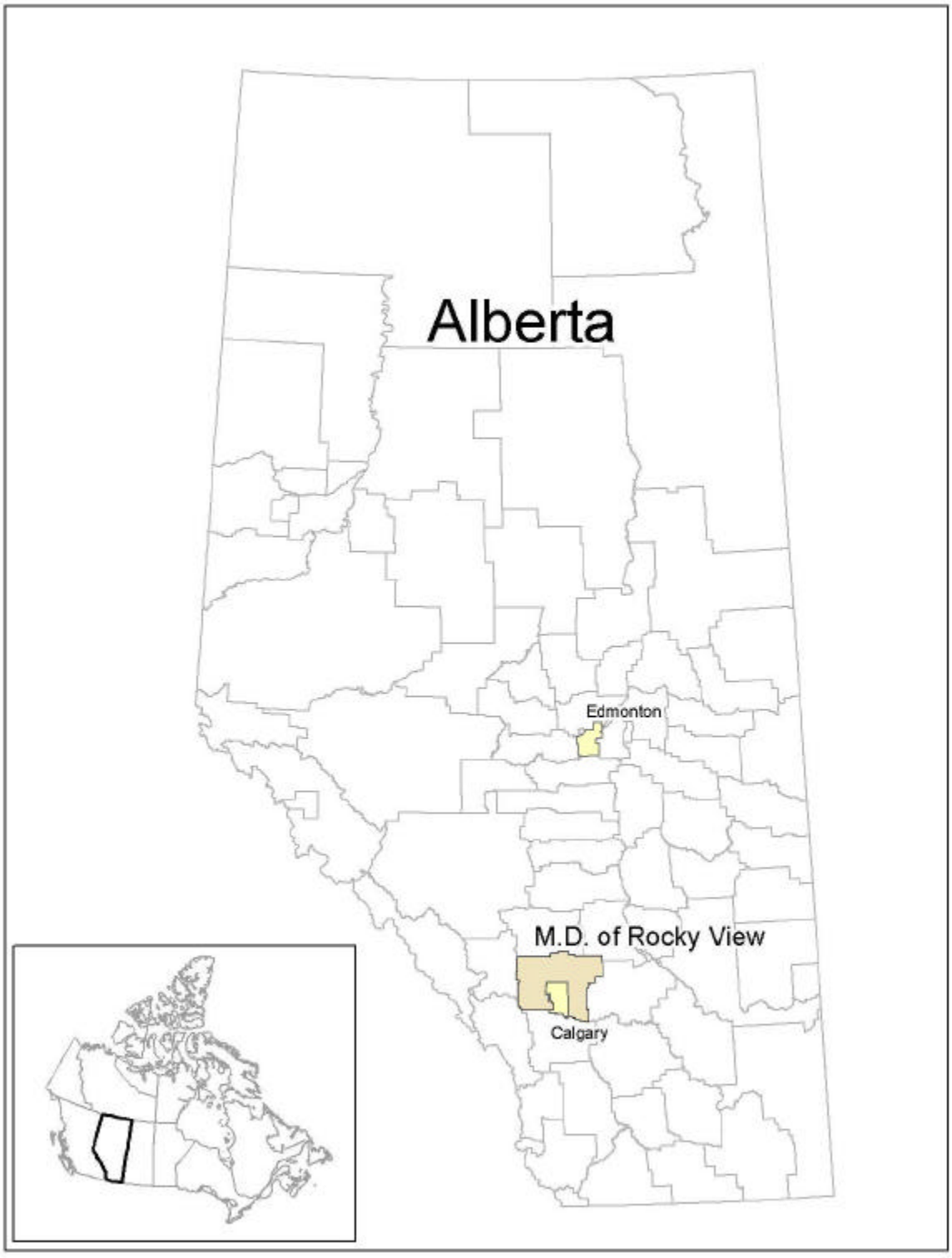


Figure 1: M.D. of Rocky View

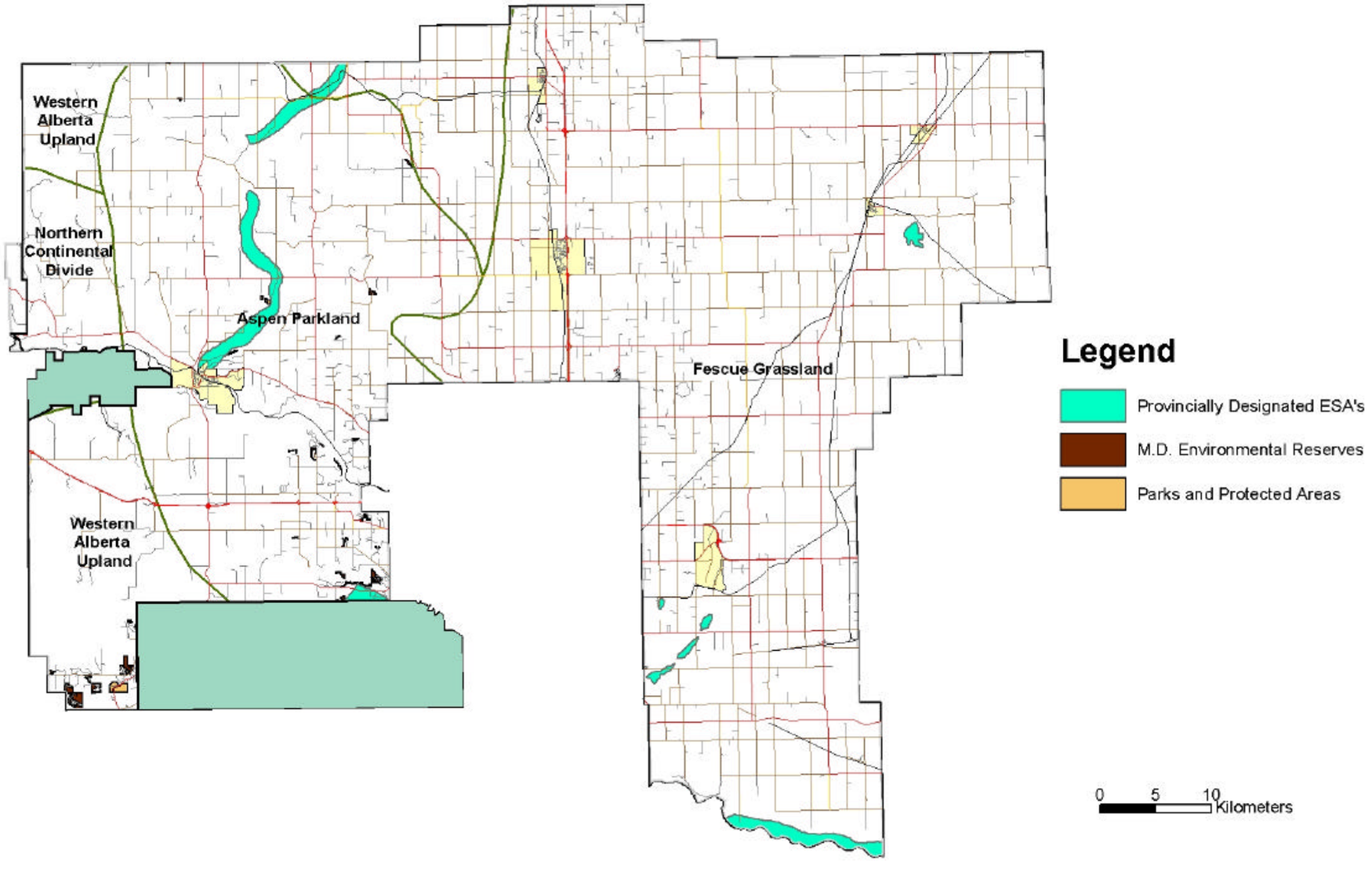


Figure 2: Ecoregions and Existing Environmentally Significant Areas in the M.D. of Rocky View

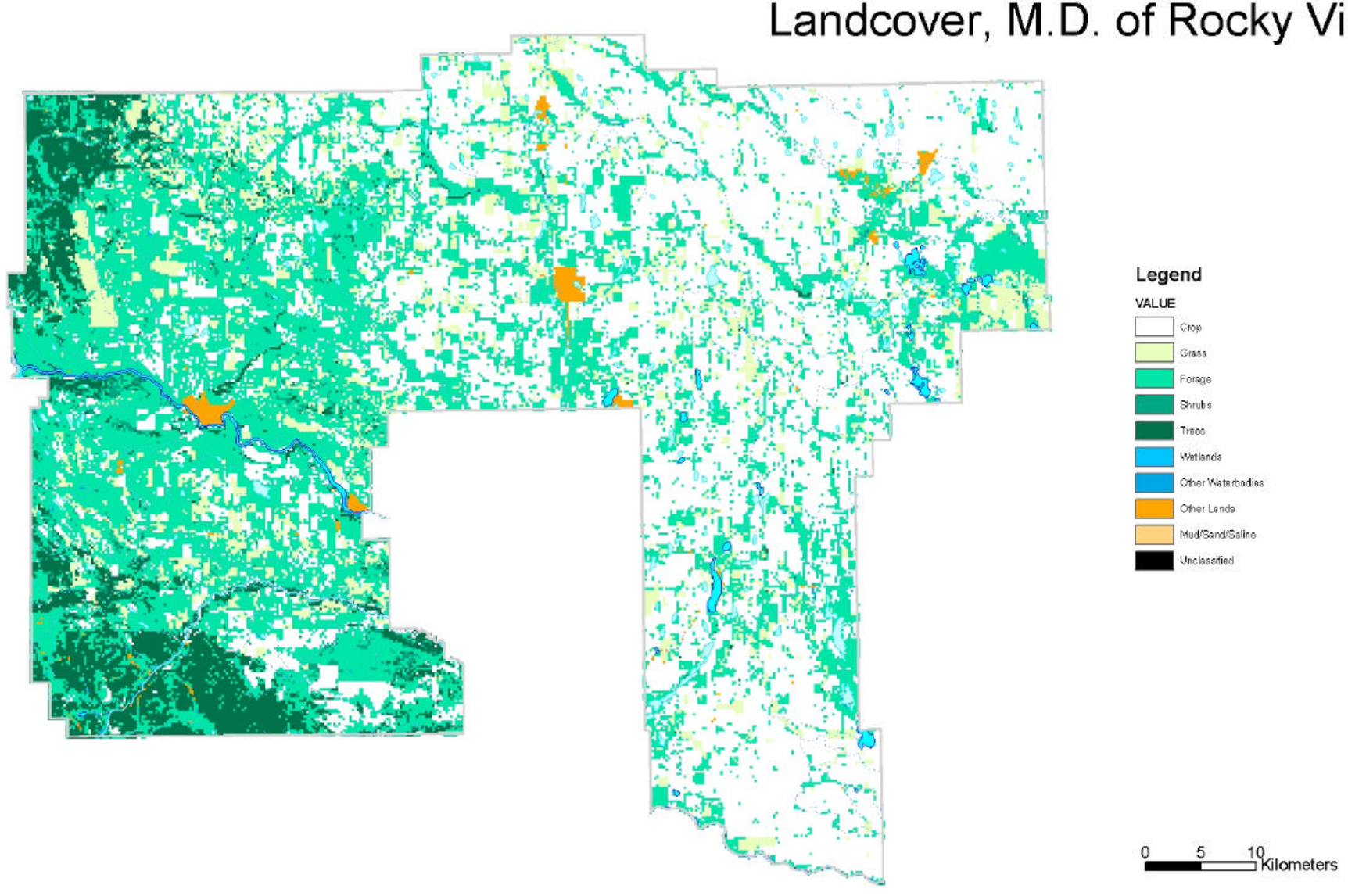


Figure 3: Landcover in the M.D. of Rocky View

2.0 Discussion of Terms

2.1 Environmentally-Significant Areas

Environmentally-significant areas have been defined as "landscape elements or places which are vital to the long-term maintenance of biological diversity, soil, water, or other natural processes, both on-site and in a regional context" (Jennings and Reganold 1991). Alberta environmentally significant areas identification and evaluation however, has been based on four factors: representativeness, diversity, naturalness, and ecological integrity. Environmentally-significant areas have been further evaluated and ranked in terms of international, national or provincial significance.

Application of the above criteria has effectively narrowed the scope of ESA designation to areas that feature rare, endangered, unique, pristine or unmodified ecosystem components significant at a regional scale or greater. The result is that ESA designation as practiced in Alberta is primarily suited to protecting important core elements of biodiversity, wildlife habitat, and landforms. While this study acknowledges that ESAs as designated through past work are very important, as a system or network they fail to address the full range of expectations implicit in the broad definition of ESAs.

2.2 Biophysical Attributes Rating

Designation of ESA's at a provincial scale is of limited use for management and protection of natural resources and ecosystem processes at the scale of a M.D. This project refines the ESA evaluation process to identify regions at the scale of the M.D. This evaluation results in the designation of a 'biophysical attribute rating" (BAR) based on the concentration of potentially sensitive physical ecosystem components.

For the purposes of this study, biophysical attributes rating include key physical ecosystem components and complexes that are vulnerable to the potential impacts of a broad range of land use, development and management activities, particularly, the alteration, disruption or destruction of fish and wildlife habitat, permanent or temporary soil disturbance, the removal or modification of native vegetation cover, or the release of biological or chemical contaminants. BAR's also include ecosystem or landscape elements where the impacts of land use, development or management activities as described above may directly or indirectly affect ecosystem areas or features.

BAR's may be distinguished from environmentally significant areas these categories are not, and need not, be mutually exclusive of each other. The BAR's are perhaps most effectively seen not as another environmental category, as much as an information tool that may be used as input into decision making and planning processes related to significant areas. For instance, BAR's analysis may contribute to the evaluation, designation and management of environmentally-significant areas by identifying candidate lands and features for inclusion in these categories, by providing guidance in relation to appropriate land use, or by identifying other areas suited to special management considerations or requiring ecological restoration.

Despite a number of individual studies to identify candidate ESAs, the biophysical and climatic variation found within the M.D. remains under-represented by the current ESA models. Currently, the M.D. of Rocky View Environmental Reserves total 493 hectares, approximately 0.12% of the M.D.; Provincially designated parks and protected areas cover 191 hectares or 0.05% of the M.D.; finally, provincially designated ESAs cover 5,972 hectares or 1.4% of the M.D.

Human resource uses and values have not been expressed within any of the proposed ESA models. The consideration of BARs in an agricultural landscape, such as the M.D. of Rocky View, extends beyond the identification of pristine natural environments and native plants and wildlife to include ecosystem resources and services that have considerable economic and social value as well. The quality and quantity of both surface and ground water resources, for instance, have implications for the integrity of fish and wildlife populations as well as for the sustainability and viability of human enterprises including agricultural, industrial and residential water uses.

3.0 Methods

This project identifies Biophysical Attributes Ratings based on an evaluation of groundwater, surface water and terrestrial ecosystem components. Natural resource and cultural data were collected to provide the baseline information for evaluation. BARs are based on professional judgment and reviews of related literature and existing information. The relative sensitivity of any given land location was evaluated by ranking each feature and zone using a simple numerical index. Features were then overlaid with each other using a GIS. Ratings were established by simply calculating the sum of the values of the overlapping sensitive features occupying any given area.

3.1 Groundwater Sensitivity Analysis

The groundwater sensitivity analysis for this project does not deal with the issues of groundwater sourcing, groundwater allocation, or aquifer depletion. While these are important and legitimate issues with respect to development plans and approvals, for the purpose of a BAR evaluation they are excluded. Groundwater withdrawal is controlled and licensed by the Government of Alberta, and as such decisions with regard to allocation are beyond the direct control of the M.D. For the purpose of identifying biophysical attributes rating, this evaluation considers groundwater sensitivity from only the perspective of potential vulnerability to contamination as a result of land development or land use activities.

For this study, the approximate regional vulnerability (Figure 4) to contamination has been estimated using the surficial geology (Dash and Rodvang, 2002). Materials of coarser texture such as river-lain sands or gravels are more permeable and allow more rapid infiltration of contaminants to shallow groundwater. These areas have a relatively higher contamination risk. Conversely, thick lacustrine clays are relatively impermeable and pose a very low contamination risk to shallow groundwater. Fractured glacial tills pose a moderate to low risk.

Surficial materials were ranked into one of four risk categories (Low, Medium, High or Very High) based on the assumed vertical permeability of the geological material. Each groundwater sensitivity category was quantified and assigned a sensitivity value ranging from 1(Low) to 4 (Very High). Areas at Very High or High vulnerability to shallow groundwater contamination may be considered to be of considerable sensitivity due to potential effects on groundwater and surface water resources.

This regional-scale vulnerability information is used most appropriately to gauge the *relative* vulnerability of an area. This evaluation should not be considered a definitive or quantitative evaluation of the actual risk of groundwater contamination for any given area. However, an area may be judged to be more sensitive to contamination than another area under the same development conditions. Actual risk for individual projects can only be determined by a site-specific investigation under the direction of a groundwater professional. More detailed information is available in the report M.D. of Rocky View No. 44 Regional Groundwater Assessment (Hydrogeological Consultants Ltd., 2002).

3.2 Surface Water Analysis

The M.D. of Rocky View is divided into two major watershed, the Bow and Red Deer Basins (Figure 5). The evaluation of surface water resources for this project does not address surface water diversion, allocation, or in-stream flows required for fish and wildlife habitat. Although these are critical environmental issues, surface water allocation and management is the jurisdiction of the Government of Alberta while fish and fish habitat is a Federal responsibility.

Water quantity and quality issues are only dealt with indirectly by addressing land use, management and planning issues that may affect natural surface water flow regimes and the ecological capacity of a watershed to filter sediments, chemicals and biological contaminants from water. This evaluation also focuses on the nature and importance of water bodies with respect to fish and wildlife habitat, and on the characteristics and extent of the area surrounding a water body affecting the ecological function of the riparian zone.

3.2.1 Riparian Zones

The riparian zone, the area where vegetation type and abundance is influenced by the elevated water table and deep soils adjacent to a water body, is often identified as an environmentally sensitive zone. Healthy riparian zones provide a number of critical ecological services, and their importance to both aquatic and terrestrial ecosystem function is critical despite the relatively small geographic area they occupy within a watershed (Figure 6).

Riparian area functions include maintenance of surface water and groundwater quality through:

- Interception and filtration of sediments and debris from surface runoff,
- Interception, filtration, storage, and transformation of chemical and biological contaminants, and

Attenuation of Runoff Rates Which:

- Protects against property damage by reducing peak discharges (flooding and erosion), and
- allows surface water to infiltrate into the ground, thereby recharging groundwater and enhancing base flow in surface watercourses.

Provision of terrestrial wildlife habitat by:

- Providing part of, or all of the critical life cycle requirements for over 80% of Alberta wildlife species through wildlife travel corridors, migratory, nesting and staging areas, and
- Providing the only habitat for many rare or threatened plant and animal species.

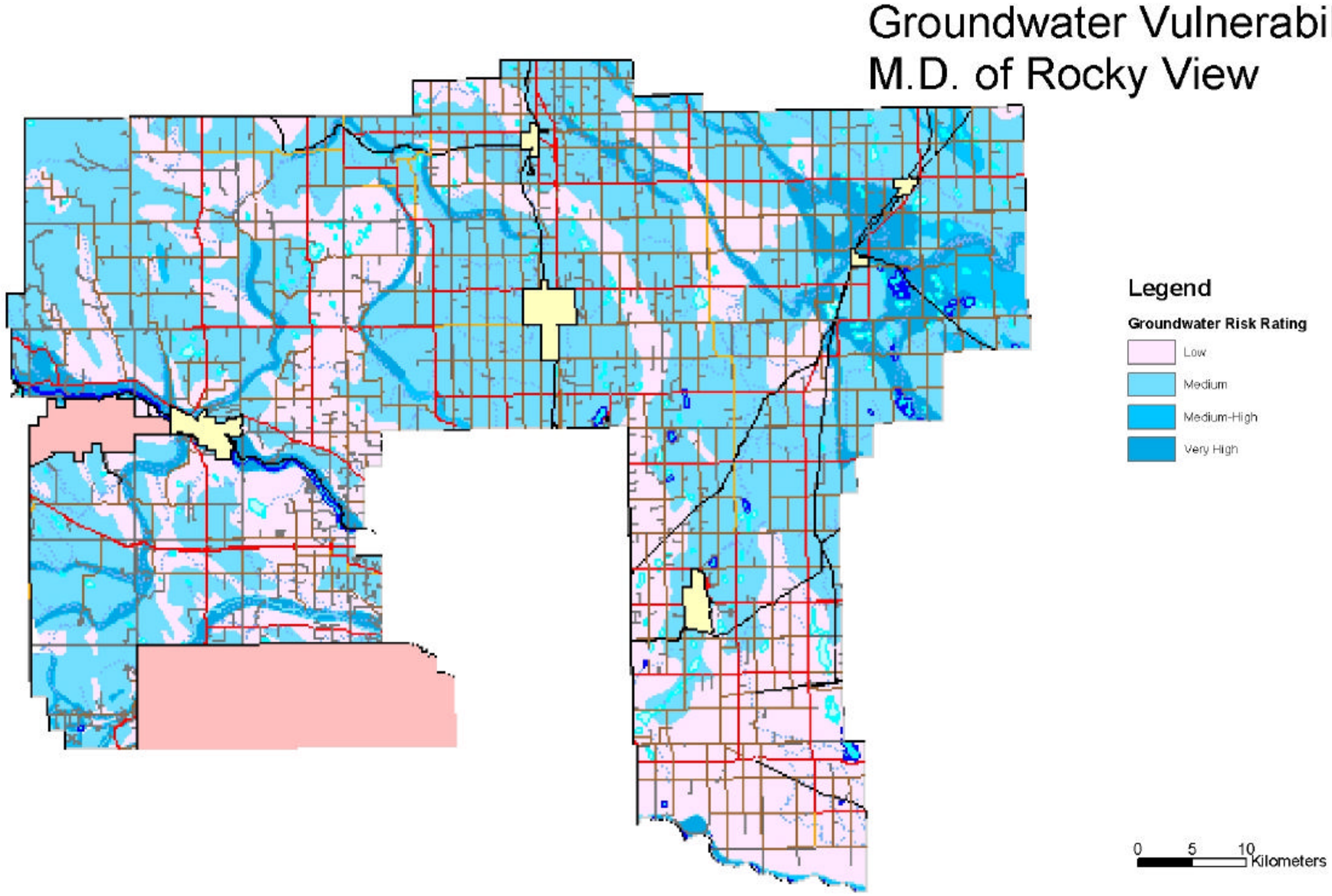


Figure 4: Groundwater Vulnerability in the M.D. of Rocky View

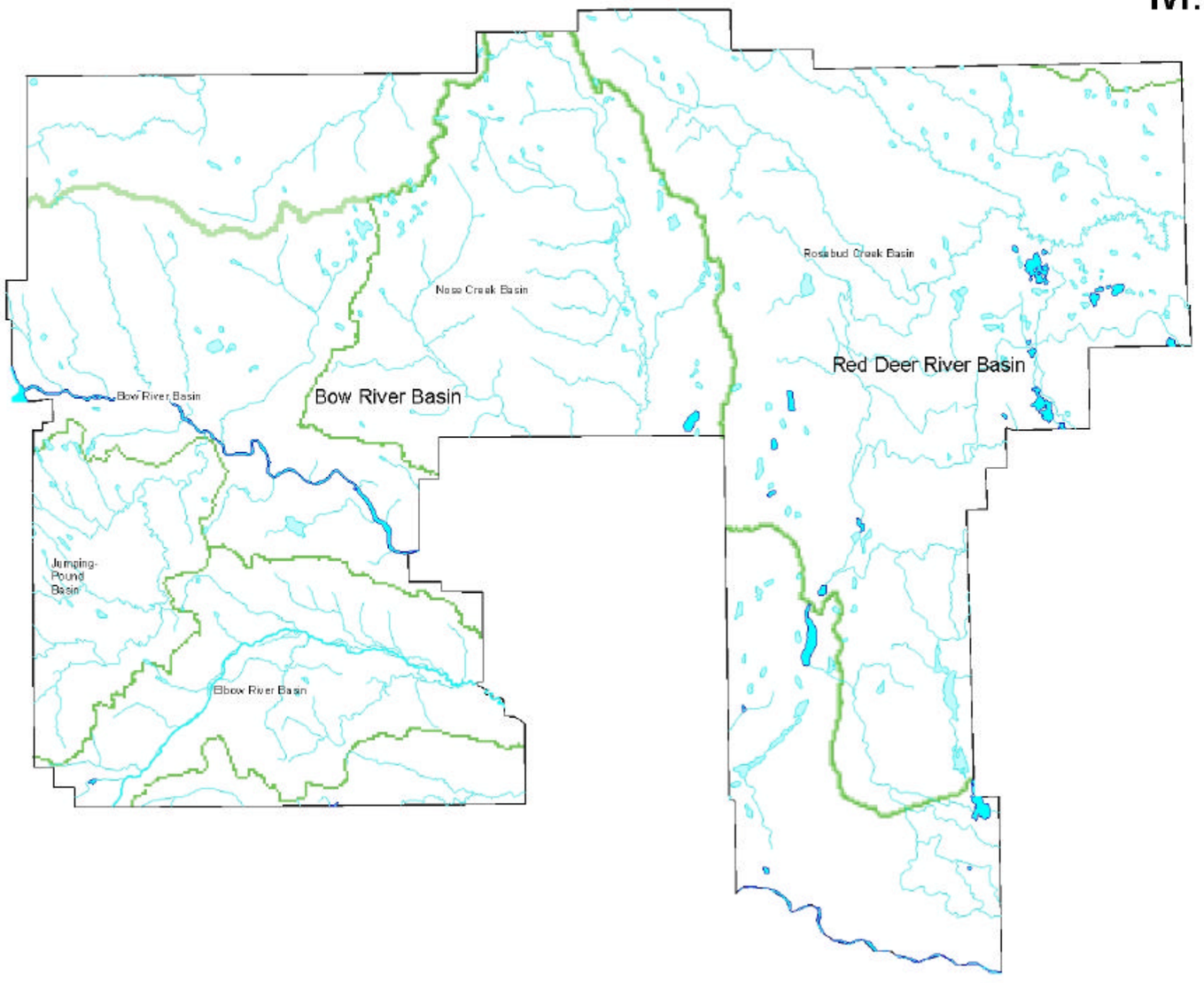


Figure 5: Major Watersheds in the M.D. of Rocky View

Provision of fish and aquatic wildlife habitat:

- Stabilization of river banks and bed,
- Control of stream water temperatures, sedimentation and turbidity,
- Provide cover, habitat structure (e.g. pools), and nutrients to aquatic ecosystems, and
- Maintenance of consistent water quantity and quality.

Agricultural productivity, economic and social values and services:

- High productivity of forage and timber resources,
- Recreation and tourism opportunities,
- Hunting and fishing resources,
- Aesthetic qualities - visual and noise,
- Improve air quality/carbon sequestration, and
- Increased land values.

While human activities and developments in the riparian zone have direct impacts on water, wildlife and economic resources, such activities in upland ecosystems outside the riparian area may also affect riparian resources either directly or indirectly, by impacting the environmental inputs (e.g., sediments, contaminants, nutrients, surface water, invasive plant and animal species) to the riparian zone. Many aquatic species, both vertebrate and invertebrate, as well as aquatic and riparian vegetation communities, are highly sensitive to relatively small changes in local environmental parameters such as water levels, temperature, sedimentation, turbidity and vegetation type and structure. Even very small and localized impacts may have cumulative effects downstream throughout the aquatic and riparian ecosystem, resulting in significant ecological changes not easily predicted by individual environmental effects. Compounding the complexity of upland/riparian/aquatic ecosystem relationships is that downstream effects may also affect the upstream flow of energy and nutrients throughout the watershed (e.g., movement of fish and wildlife) (Figure 6).

3.2.2 Review of Methodologies for Analysis of the Sensitivity of Surface Water to Land Use

A variety of literature was reviewed to identify methods or procedures for mapping BARs surrounding surface water features (lakes, ponds, wetlands, and streams). The review was concentrated primarily on Provincial and Federal Government Guidelines, Codes of Practice, and Standards related to petroleum, forestry, and livestock operations as well as subdivision developments. A limited review of related scientific literature was also conducted. Ecological and distance criteria for the designation of riparian buffer zones were identified as the primary result of the review.

Mapping options were derived from the literature, from consultation with Provincial Department of Fish and Wildlife Biologists, and through consultation with water and land management specialists from AAFC-PFRA. The results of the literature review are summarized in Appendix A. Recommendations from the literature can be classified into two primary categories - those approaches that rely on a specified fixed, multi-width setback distance and those that rely on the evaluation of site-specific ecological criteria.

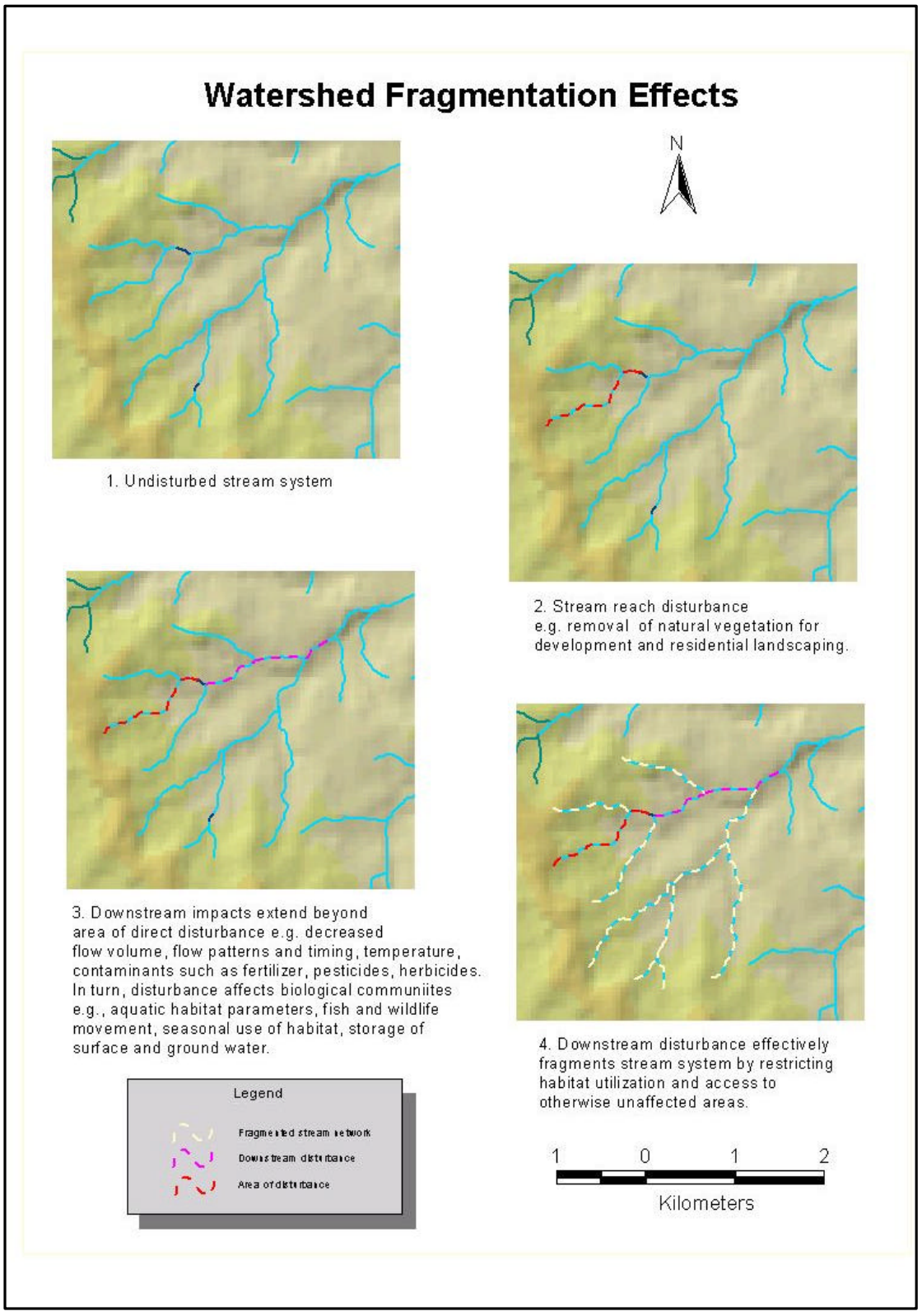


Figure 6: Downstream Impacts on Riparian and Aquatic Resources

Fixed and Multi-Width Buffers

Specifying a predetermined, fixed-width buffer around surface water features has the advantage of being easy to apply, measure and map, is easy to understand and provides a consistent guideline for planners. The primary disadvantages are that: the predetermined distance may not include all of the important ecological components affecting the riparian area; or extends beyond the area that can be classified as a riparian area. A small buffer distance appropriate for an ephemeral stream is not likely to encompass the riparian zone or provide protection for a large river. Conversely, a large buffer suitable to a large river or lake will likely encompass an area greater than is required to provide protection for a small pond or stream.

Fixed buffer distances also do not account for variability in human activities. The ideal buffer distances for cattle grazing, intensive livestock operations, forestry, road building, pipeline activities and subdivision development are all potentially different depending on site-specific environmental conditions and the nature of each operation. Recommended buffer distances identified in the literature review range from 1.5m to 200m. In an attempt to narrow this range a small survey of stream crossings in the M.D. of Foothills was conducted (Figure 7 and Appendix B). Crossings were selected to represent different watersheds, streams, and watercourses throughout the M.D., based on a pre-determined circular route. The buffer zone width at each crossing was estimated based on vegetative characteristics and/or topographic considerations i.e. a clearly defined valley or coulee.

On most small stream or intermittent watercourse crossings the entire width of riparian vegetation was found to be less than 60m. On these small streams a pre-determined buffer distance of 30m on either side of the stream would encompass the sensitive riparian vegetation zone, and in several cases, would take in related topographic features. On larger watercourses that were surveyed the riparian zone was better defined by topographic features e.g., steep or incised valleys or coulees. Change in riparian vegetation species from upland vegetation often occurred at obvious breaks in slope rather than being necessarily associated with the valley bottom or high water table conditions. The results of this survey suggest that a fixed-width approach to the delineation of protective riparian buffers will provide inadequate protection in some cases and excessive protection in others. It also suggests that a buffer distance of less than 30m is insufficient in terms of addressing or managing direct impacts to riparian vegetation or topography.

The fixed-width buffer concept can be modified to prescribe different widths based on the intended resource use, e.g. human activity, fish production, wildlife habitat etc. Another potential modification of the fixed-width approach is to divide a wide buffer into discreet zones: usually a narrow, no-permanent-development zone immediately adjacent to the banks of the water body, a central restricted-use zone where only certain activities or intensity of use is permitted, and an outer zone where a wider range of activities is allowed (Figure 8). Modified fixed-width buffers are referred to herein as “multi-width” buffers.

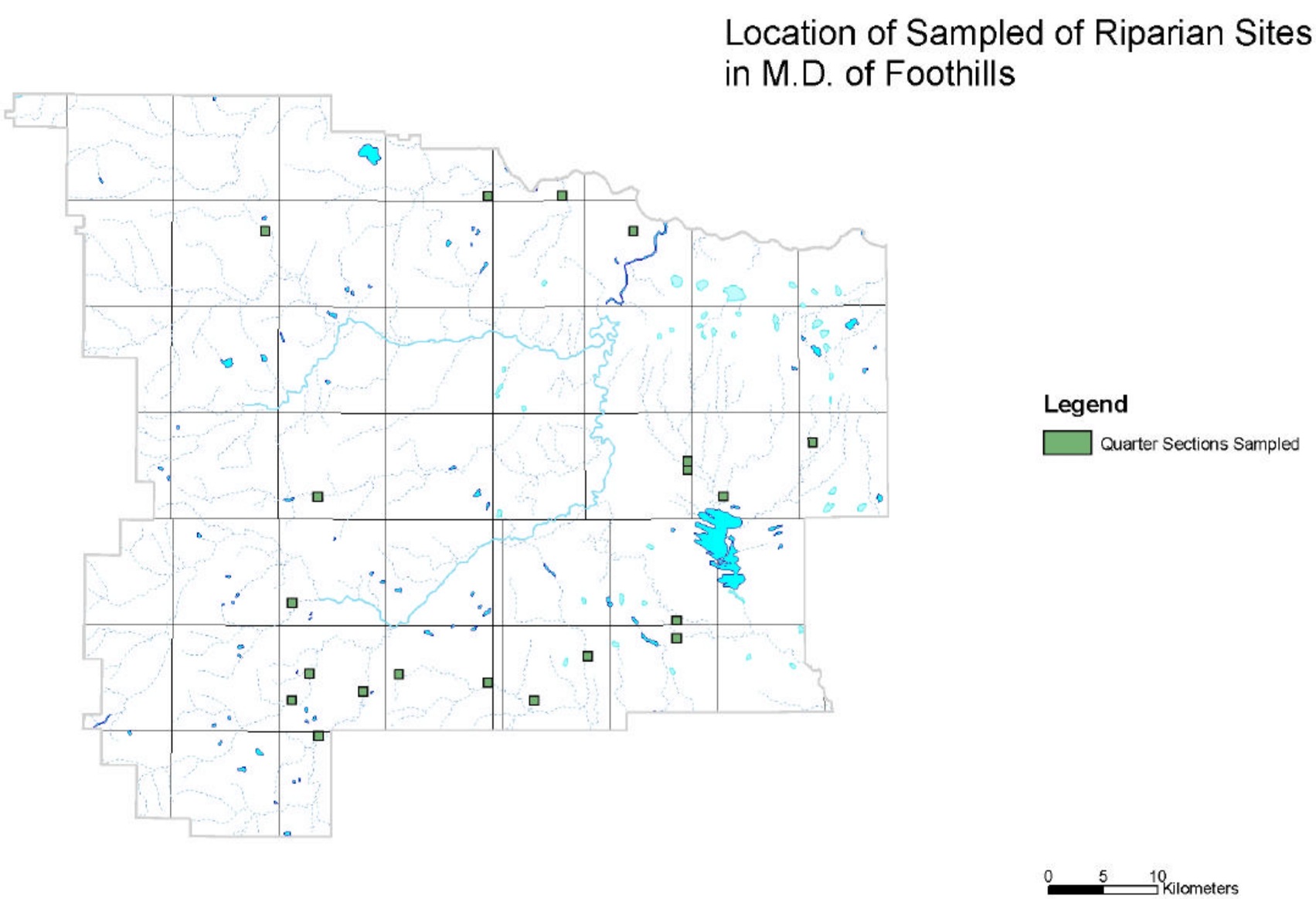


Figure 7: Location of Stream Crossing Survey in M.D. of Foothills

Site-Specific Ecological Criteria

Accurate mapping of the riparian zone for a large watershed would involve considerable fieldwork and costs. Further, delineation of the riparian zone itself does not necessarily account for all environmental variables that may be affected by development activities and which may, in turn, affect surface water features or the functioning of the riparian zone itself. For regional planning purposes, designation of the actual riparian area is somewhat subjective given the complexity of the task and the limitations of the sciences involved, expensive, time consuming and limited in the scope of land use issues that can be addressed.

Height, type and density of surrounding vegetation are variables identified as affecting the health of surface water features, especially as related to fisheries and aquatic habitat, and the filtration of sediments, biological contaminants, and pesticides. Delineating a sensitive zone

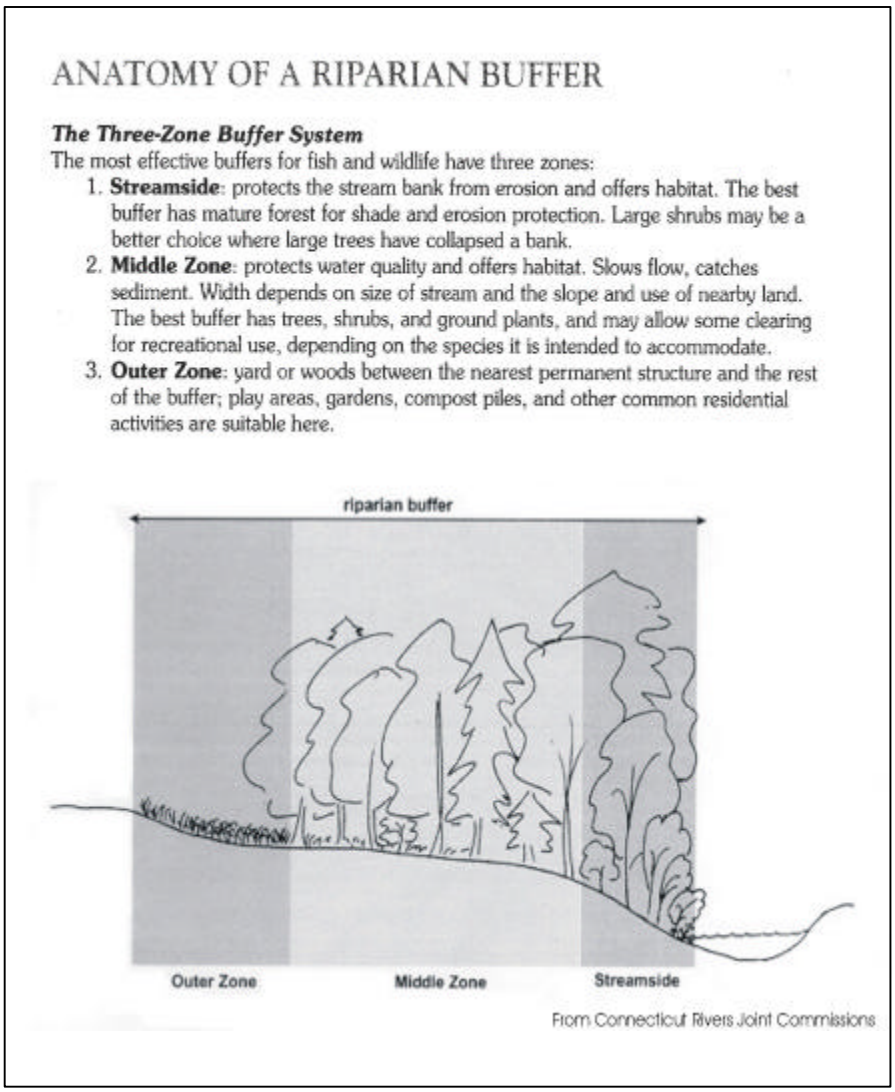


Figure 8: Multi-Width Buffer Concept from Connecticut Rivers Joint Commissions

by doubling the average height of mature trees has been suggested for fisheries streams in the Pacific Northwest. While this type of model is relevant to forested sites, it does not suggest a solution for grassland or parkland sites where forest cover may be patchy or non-existent. Other forestry buffer models are based on the evaluation of multiple ecological variables affecting water temperature, surface run-off, sediment capture and viable recruitment of large organic debris. Each of the models has advantages or disadvantages for specific environments and activities.

Most academic research and management literature reviewed suggests using multiple ecological criteria including vegetation, soils, slope, topography, surficial geology, groundwater, and surface hydrology to delineate the sensitive zones around surface water features. Multiple criteria models provide the most all-encompassing analysis of sensitive environmental features. The drawback to a multi-parameter approach is that the analysis is heavily dependent on the availability and accuracy of data, and existing map data sets are usually not available at the fine scale needed to conduct such an evaluation for small streams, ponds, wetlands, and watercourses. To acquire detailed data at a fine scale could require intensive fieldwork and additional associated costs.

A maximum-protection approach is to evaluate several ecological criteria and then adopt the greatest width so as to encompass all criteria. This type of method is most easily facilitated by the use of GIS mapping technologies. Use of GIS makes it feasible to map and overlay a number of sensitive environmental features. In addition to identifying the geographic extent of a suite of sensitive features or ecological criteria, overlay analyses make it possible to evaluate the relative environmental value and the protection and development status of any given area within and adjacent to the riparian area.

3.2.3 Methodology for Analysis of the Sensitivity of Surface Water to Land Use

Based on the discussion in the previous sections, a multi-width, ecological based approach for the delineation of sensitive zones around surface water features in the M.D. of Rocky View seems appropriate. The purpose of specific recommendations is to delineate an area of concern around surface water features so that the potential for conflicts with proposed land use or development can be identified, examined carefully and resolved by the M.D., perhaps through the implementation of development or land use restrictions, or by employing other mitigation measures. This approach should not be seen as a definitive environmental analysis appropriate for project-specific approvals, but rather as a planning tool suited to providing guidance for further analysis and decision making.

The following information should not be viewed as an alternative to, or substitute for, established Provincial Legislation, Codes of Practice, or Guidelines related to land use and development affecting water courses or water bodies.

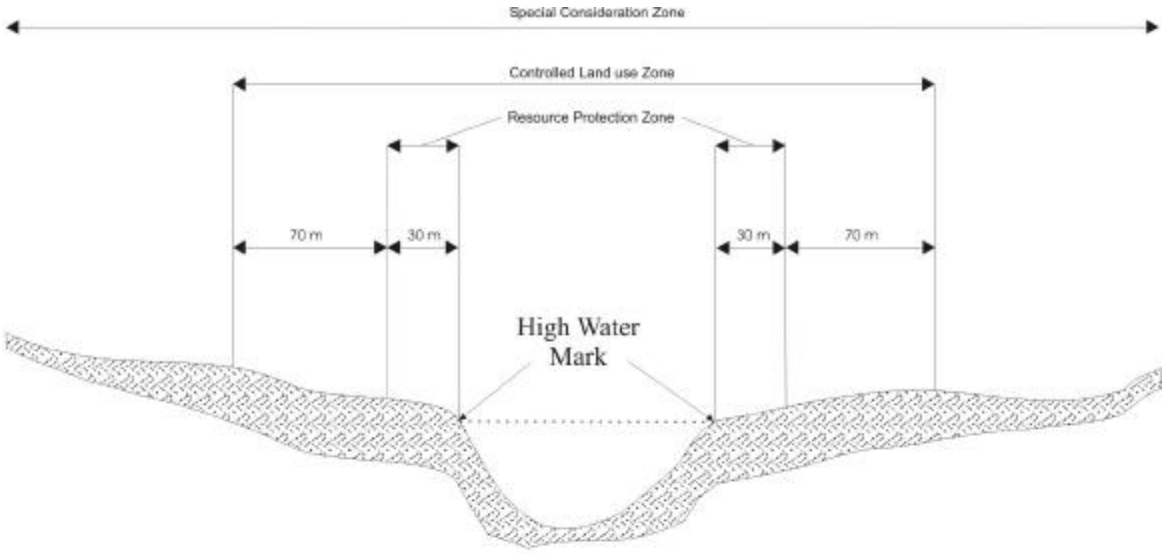
Minor Watercourses and Waterbodies

The term Riparian Sensitive Zones (RSZs) will be used to refer to designated areas of concern over the potential impact that land use activities might have on the quality and quantity of surface waters. Due to the relatively low risk of direct impacts to water quality or fish and wildlife habitat, the lack of physiographic data to conduct site-specific evaluations at this scale, and the prohibitive cost of acquiring such data for the entire M.D., the use of a multi-width buffer is suggested for designating RSZ's around "minor" (small streams and intermittent watercourses, sloughs, and wetlands) watercourses and water bodies. The components comprising the RSZ would consist of: an interior "Resource Protection" component (usually 30 m), an additional "Controlled Land Use" component (usually 70 m beyond the latter component), and a "Special Consideration" component, which would overlap, and usually extend beyond, the first two components (Figure 9). As described in the flowing paragraphs, the first two components vary in width depending on the nature of the water body (but usually total 100 m), while the last component is defined by physiographic and ecological characteristics. The 100 m width defined by the first two components may, in some cases, be reduced based on a review of the nature of the third component.

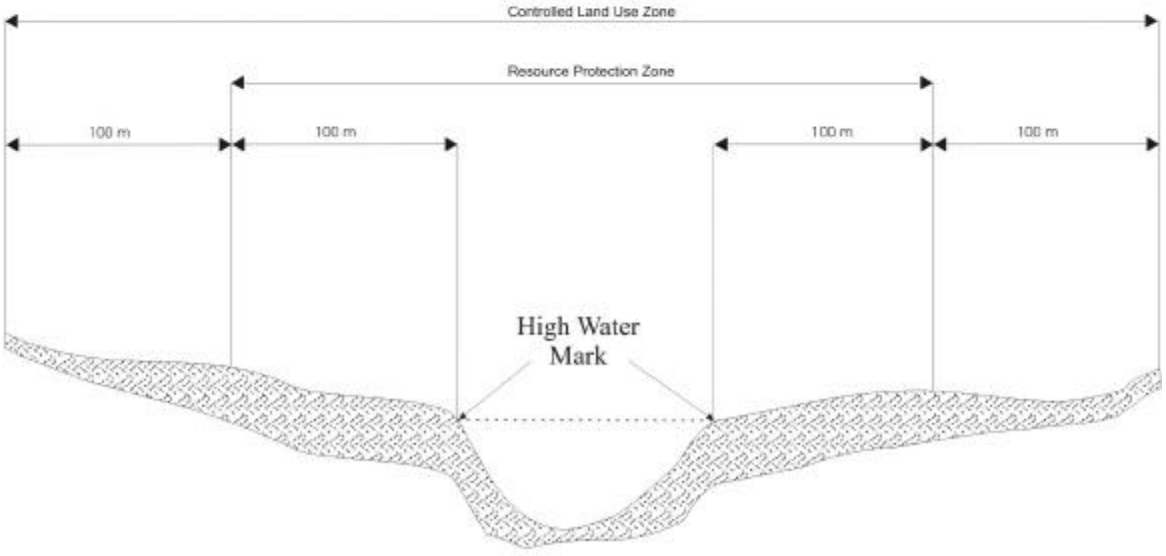
For small streams and intermittent watercourses a zone extending 30m back from the normal high water mark can be used to identify an interior, 'Resource Protection' RSZ. The intent of the Resource Protection designation would be to prevent direct impacts to riparian and aquatic ecosystems. Low impact land uses in this zone might include rotational grazing, or non-motorized recreation. Land use activities with high potential to impact on riparian or aquatic ecosystems would include any excavation or soil disturbance, in-water works, removal or long-term changes to natural vegetation, or the development of permanent structures such as fences, roads, or buildings.

An additional 70m 'Controlled Land Use' RSZ would extend back from the 30m zone creating a multi-width buffer 100m in total width (Figure 8). 'Controlled land use' in this case would refer to low-impact activities that have minimal effects on soils, natural or tame vegetation, or surface runoff; activities with low potential for release of contaminants; or developments with low potential for direct sensory disturbance or disruption of wildlife and wildlife habitat in the inner 30m zone. Low impact land uses in this zone might include activities such as forage production, zero-till agriculture, rotational grazing, low-density residential development, or non-motorized recreation. Land uses with high potential to impact on sensitive aquatic or riparian ecosystems in this zone might include activities such as intensive cultivation or livestock operations, high-density residential development, or commercial and industrial developments.

Impacts to small lakes, ponds, sloughs and wetlands are potentially longer lasting and more concentrated due to the potential containment and accumulation of contaminants and ecological effects such as temperature changes. AAFC-PFRA suggests that the 'Resource Protection' designation for lakes, ponds, wetlands, and sloughs, including all intermittent water bodies should be extended to the entire 100m RSZ with no long-term land development or sustained land use activities taking place.



Minor Watercourse Riparian Buffers



Primary Watercourse Riparian Buffers

Figure 9: Cross Section of Riparian Buffer Zones

The suggested RSZ distances are consistent with Department of Fisheries and Oceans Land Development Guidelines for the protection of salmonid habitat; are appropriate for flagging areas of concern related to flooding, erosion, and reduction of native vegetation cover as outlined in the Environmental Reference Manual for the Review of Subdivisions in Alberta (Alberta Environment 1996); and address potential impacts to sensitive wildlife species as outlined in the Recommended Land Use Guidelines For Protection of Selected Wildlife Species and Habitat Within Grassland and Parkland Natural Regions of Alberta (Alberta Sustainable Resource Development 2001).

Minor Watercourses and Waterbodies: Special Consideration Zones
Hydrologic features, topography defining the extent of river valleys, coulees and steep slopes, groundwater vulnerability, vegetation, and wildlife habitat should be overlaid on the multi-width buffers to identify sensitive ecological features lying outside the extent of the multi-width buffer zones. These features would define the maximum geographic extent of the RSZ and be designated as 'Special Consideration' zones. The particular ecological characteristics (e.g., potential for groundwater contamination, sensitive wildlife habitat, steep slopes) falling within a Special Consideration zone would guide decision making on the appropriate types of land development and land use. In some cases the ecological characteristics may fall within the multi-width buffer zone prompting consideration for reducing the width of the overall RSZ.

Increasing the multi-width buffers to include the 'Special Consideration Zone' aligns the approach more closely to distances recommended for forestry, livestock operations, and sensitive wildlife species habitat and is appropriate given the environmental risks associated with these watercourses and water bodies. Adding site-specific ecological factors to the evaluation has the advantage of being the most comprehensive in terms of the environmental issues identified, is consistent with current academic and scientific management approaches, and allows for objective flexibility in land use decision making.

Primary Watercourses and Waterbodies
PFRA suggests that site-specific ecological information be used to more accurately delineate RSZs around the primary (permanent streams, larger lakes, e.g. Bow, Highwood and Sheep Rivers, and Frank Lake) water bodies and watercourses in the M.D. The risk of direct or indirect impacts to water quantity and quality, to fish and wildlife habitat, and to human use and consumption is significantly higher for primary water bodies than for minor water bodies in the M.D. The potential environmental risk of development and the relative low cost of this type of evaluation justify the increased effort required to identify and map site-specific ecological features. Much of the data required to conduct this type of evaluation is already held by the M.D.

Multi-width buffers around primary rivers and lakes would be designated as 100m Resource Protection zones and a further 100m as Controlled Land Use zones (200m total) (Figure 8). In situations where watercourses are defined by, or immediately bordered by steep topography it is suggested that the RSZs begin at the first significant and regular break in slope over 100m wide (e.g., the crest of steep river valleys or coulees).

3.2.4 Surface Water Sensitivity Summary

Designating Riparian Sensitive Zones through a combination of multi-width buffers refined by the use of ecological variables will offer an effective balance between environmental protection, time and cost effectiveness, while taking into consideration the relative level of risk associated with different classifications of surface water features.

It is expected that implementation of the RSZ system will result in the increased ability of land managers to make more informed and educated decisions, will provide support/defense for decisions made, and will provide objective guidance as to the need for further research, environmental assessment, outside or professional expertise, and the involvement of other jurisdictions.

It should be noted that for the purposes of this project all three buffer widths were mapped for all watercourses and waterbodies in the M.D. due to limitations to the accuracy of hydrologic data.

3.3 Terrestrial Environment Analysis

3.3.1 Landcover/Vegetation

Information on vegetation cover and land use in the M.D. is taken from AAFC-PFRA's Classified Landcover database interpreted from 1995 satellite imagery (Figure 3). The data has a 25m resolution and separates land cover into broad categories including grassland, shrubs, trees, forage and cultivated lands. No distinction is made between native grasslands and tame pastures or between different forest cover types. In addition to the above limitations, land uses are constantly changing; trees are cleared for pasture or development, aspen forests encroach on grasslands over time, native grasslands are replaced with tame grasses, crop types and forages are alternated or changed. All of these limit the accuracy of the data, particularly with regard to site-specific evaluation.

Generally, however, the Classified Landcover provides an accurate depiction of vegetation cover and land use patterns across the M.D. As such, it is useful for identifying broad areas that may be suitable as wildlife habitat. Areas of forest, shrub and grassland cover are generally considered to be less disturbed than areas of forage or cultivation and to support greater levels of native biodiversity. These areas can be considered the most sensitive in terms of potential impacts to wildlife and habitat. Native grasslands are among the most endangered ecosystems on the prairies and most wildlife species in the M.D. that are listed as "at risk" or "sensitive" by Alberta Sustainable Resource Development are strongly associated with native grasslands. A detailed survey of native grasslands in the M.D. would be a very valuable tool for identifying BARs.

This is not to suggest that lands in forage or in cultivation have no value for wildlife. Ungulates and waterfowl in particular use these areas for feeding and nesting habitat. However areas in forage or cultivation can be seen to be relatively less sensitive than lands that remain under native cover; few sensitive species or species at risk rely on cultivated or forage lands as habitat.

3.3.2 Environmental Reserves and Parks and Protected Areas

Land use and land development activities immediately adjacent to protected areas may have deleterious impacts that extend well into parks and protected areas making them effectively smaller as wildlife habitat. Impacts may include noise and visual disturbance, vandalism and accidental damage by humans, e.g. fire, predation from domestic animals, colonization of invasive species, chemical contamination from herbicides or pesticides, and removal of vegetation that may reduce protective cover and increase the intensity of edge effects. Variable width buffers utilizing zoning designations similar to those for riparian sensitive zones should be established on a case-by-case basis for all parks and protected areas in the M.D. For the purposes of this study, parks and protected areas were buffered at a distance of 500m

The M.D. of Rocky View has protected land called Environmental Reserves (ER). ER's are protected under the Municipal Government Act and

"Environmental reserves are protected under the Municipal Government Act and must be left in their natural state or used as a public park. Environmental reserves tend to be of a more sensitive nature, (i.e. there is a watercourse or a low-lying wetland habitat that needs to be protected)." From http://www.gov.mdrockyview.ab.ca/Admin/municipalreserves.asp
The M.D.'s definition of Environmental Reserve (ER):

a) a swamp, gully, ravine, coulee or natural drainage course,
b) land that is subject to flooding or is, in the opinion of the subdivision authority, unstable, or
c) a strip of land, not less than 6 metres in width, abutting the bed and shore of any lake, river, stream or other body of water for the purpose of
   (i) preventing pollution, or
   (ii) providing public access to and beside the bed and shore.

Parks and Protected Areas managed by Alberta Sustainable Resource Development, Alberta Community Development, Heritage Canada or non-government organizations were mapped as sensitive areas.

3.3.3 Roadless Lands

Roadless areas and other undeveloped landscapes can be expected to contain wildlife species sensitive to human activities and disturbance. Large species such as black bear and predators such as cougars are particularly sensitive to human disturbance and require large areas to accommodate their home ranges. Most species at risk are also sensitive to human caused disturbance or modification of natural habitats.

Considered in isolation, roadless or undeveloped lands do not necessarily indicate sensitive lands. However when considered in combination with other factors such as vegetation cover

and the presence of species at risk, roadless lands may indicate prime areas for the designation of protected areas or the implementation of environmental protection and conservation management measures. For this project roadless lands were calculated and mapped based on 1:20,000 transportation data (Figure 11)

3.3.4 Steep Slopes

The M.D. of Rocky View specifies slope limits for the development of roads and building sites. Roads are not to exceed a grade of greater than 7%. Building parcels are not approved on slopes exceeding a grade of greater than 15%. While these specifications are primarily intended for pragmatic operational, maintenance and safety purposes, steeper slopes may also be considered to have greater potential for erosion, and the transfer of sediment and contaminants downstream during runoff events is accomplished more quickly. Disruption of vegetation on steep slopes may exacerbate these potential issues. Steeper slopes are the least likely to have been broken for agriculture or heavily grazed and may be among the least disturbed native vegetation environments in the M.D. Slope maps can be used to help identify areas at risk of erosion or that may affect water quality by expediting the movement of contaminants downhill or downstream.

Slope maps were created for the M.D. using contour data derived from Provincial 1:20,000 digital elevation model. Although maps with any slope interval can be created with the DEM, for the purposes of this project it was decided to use the specifications that the M.D. planning staff already use for evaluation of development plans; 0-7%, >7-15%, >15% (Figure 12). This information is included with the data supplied but is not included in the BAR analysis.

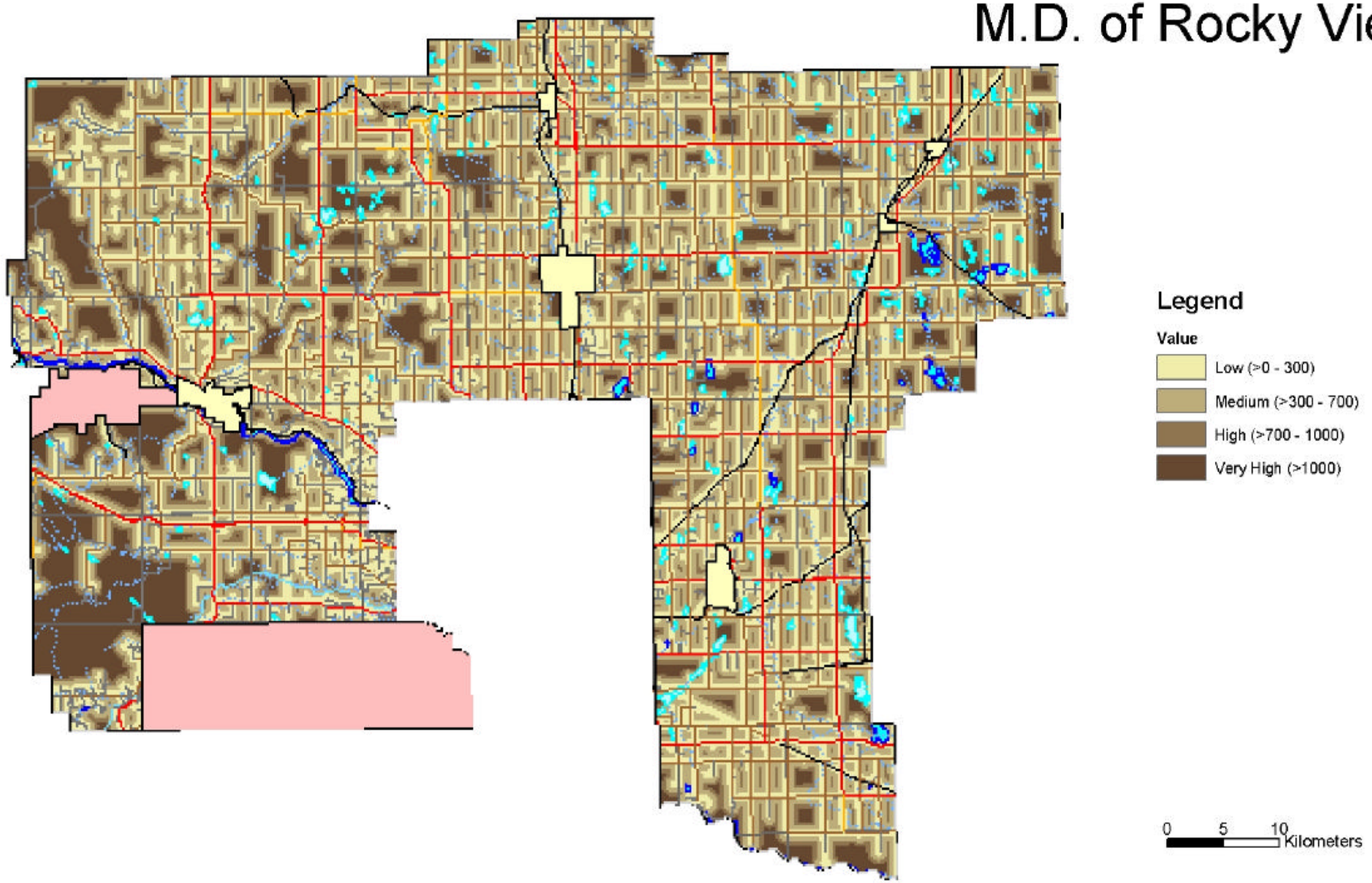


Figure 11: Roadless Areas in the M.D. of Rocky View

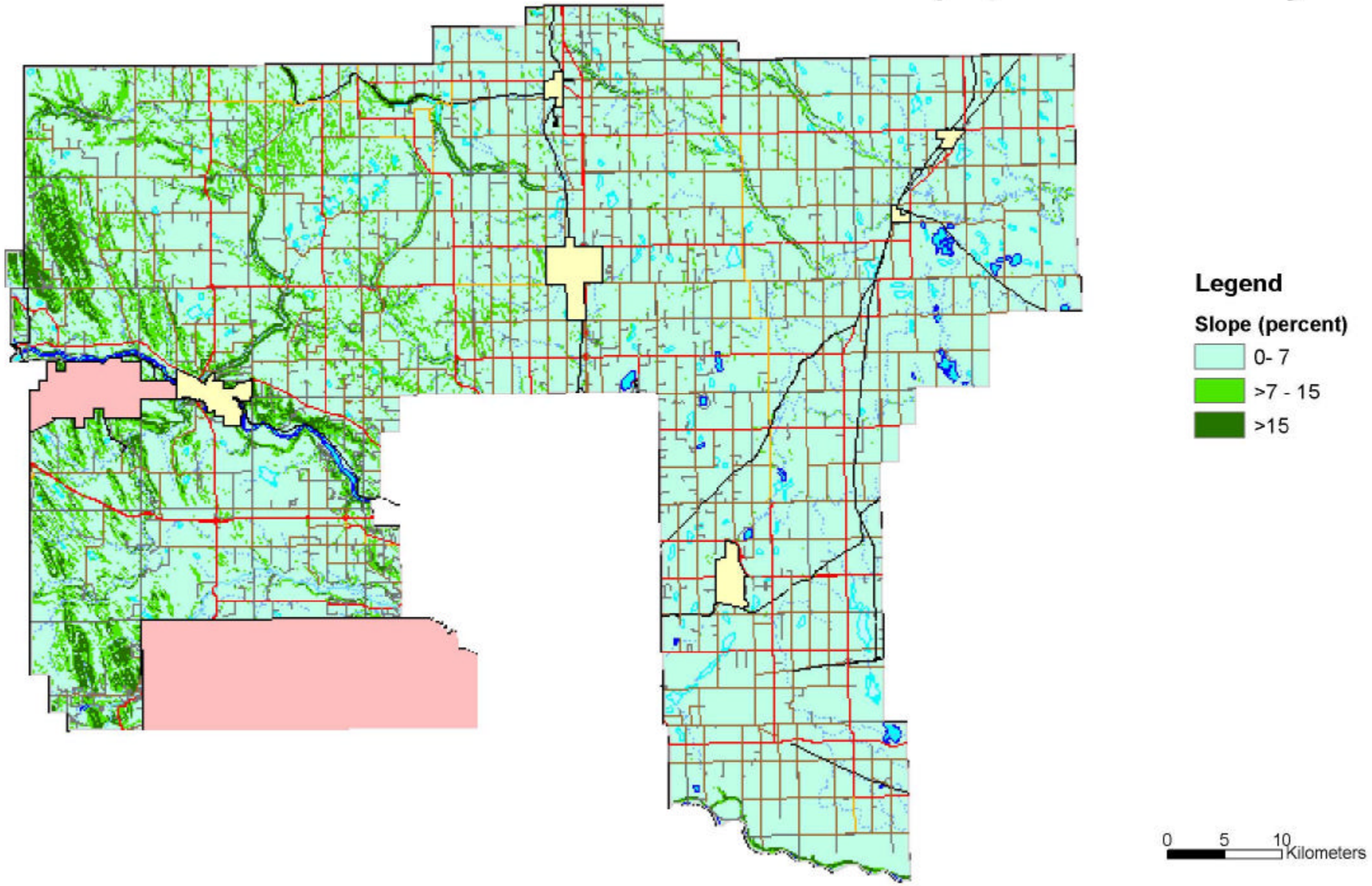


Figure 12: Slope Classification in the M.D. of Rocky View

4.0 Conclusion: Biophysical Attributes Rating Analysis

The purpose of the BAR is to provide planners with another piece of information to evaluate and compare the relative environmental importance of lands across a M.D. The analysis accomplishes this task by mapping and ranking concentrations of sensitive ecological variables from groundwater, surface water and terrestrial evaluations.

Ecological variables included in the analysis are:

- Aquifer vulnerability
- Riparian sensitive zones
- Landcover
- Roadless lands
- Parks and Protected Areas and Environmental Reserves

All map data were converted to a regularly spaced grid format. Each variable was assigned a sensitivity value from 1 (least sensitive) to 4 (most sensitive). Numerical scores were based on existing available rankings for aquifer vulnerability (Dash and Rodvang, 2002). The remaining variables were assigned scores on the basis of professional judgments about the relative sensitivity of each feature to potential development impacts. Sensitivity values for each variable are summarized in Table 1.

The sensitivity values for each variable occupying any given cell were summed to yield a total score. The possible score for any given cell ranges from 0 (sites with no data) to 20 (sites where the value for every variable = 4). The data were classified into 4 classes using the Natural Breaks default classification method in ArcGIS 8.2. This method identifies breakpoints between classes using a statistical formula (Jenk's optimization). The Natural Breaks method finds groupings and patterns inherent in the data. The resultant map provides a graphic representation of the location, pattern and concentration of sensitive ecological variables across the M.D. (Figure 12).

The classification can be used to confirm the value of previously designated ESAs and to help refine the boundaries and restrictions associated with each. The information identifies zones potentially important as core wildlife habitats and areas that may be suitable as wildlife corridors. As such the information can be used to identify priority sites for new ESAs or other protected areas, community greenspace, or priority sites for special consideration (mitigative measures, development constraints, etc). The evaluation also contributes to the identification of development opportunities and restrictions in a M.D. As such it can be used as a useful tool for regional scale land use planning, zoning, and by-law initiatives.

The biophysical attributes rating analysis is also a useful tool for finer scale environmental analysis down to the section level. At this level the analysis may be used as an input into design and development plans e.g., identification of environmental reserves, community greenspace, lot size and design, location of roads. Some caution, however, must be exercised against using the analysis for project specific approvals. All

geographic data has inherent limitations in terms of accuracy and scale and the information used for this project is no exception.

Table 1: Biophysical Attributes Rating Criteria

Variable	Rank	Description
Aquifer Vulnerability	1	Low
	2	Medium
	3	High
	4	Very high
Landcover	1	Other land
	1	Cropland
	1	Forage
	4	Shrubs
	4	Grasslands
	4	Trees
Roadless Lands	1	0-300m from nearest road
	2	>300-700m
	3	>700-1000m
	4	>1000m
Parks and Protected Areas/Environmental Reserves	2	500m buffer
	4	Inside Administrative boundaries
Riparian Areas	2	Medium Risk (100 – 200 m from stream)
	3	High Risk (30 - 100 m from stream)
	4	Very High Risk (0 – 30 m from stream)

Numerically higher values indicate a higher potential sensitivity.

The strength of the biophysical attributes rating at this scale is that it identifies environment issues that should be addressed in site-specific development plans and environmental assessments. The zones also provides a way to evaluate the relative magnitude of environmental issues related to a proposed development and may be used to define the appropriate level of effort to be applied toward further environmental analysis and study.

The M.D.'s Municipal Development Plan (MDP) plays an important role in setting the tone and direction of municipal land use activities and decision. The MDP has diverse goals, including; allowing settlement while preserving agricultural lands and promoting economic development (M.D. of Rocky View, 1998).

To address the goals outlined in the MDP, study is suggested to address the cumulative and competing land uses such as oil and gas, rural residential, agriculture, industry and recreational uses. Biophysical Attribute Ratings, while valuable, provide only a piece of the environmental information necessary to make planning decisions. The M.D. of Rocky View could use a landscape simulator such as used in the Southern Alberta Sustainability Strategy (SASS) to provide decision makers with information that examines cumulative and competing land uses in the M.D.

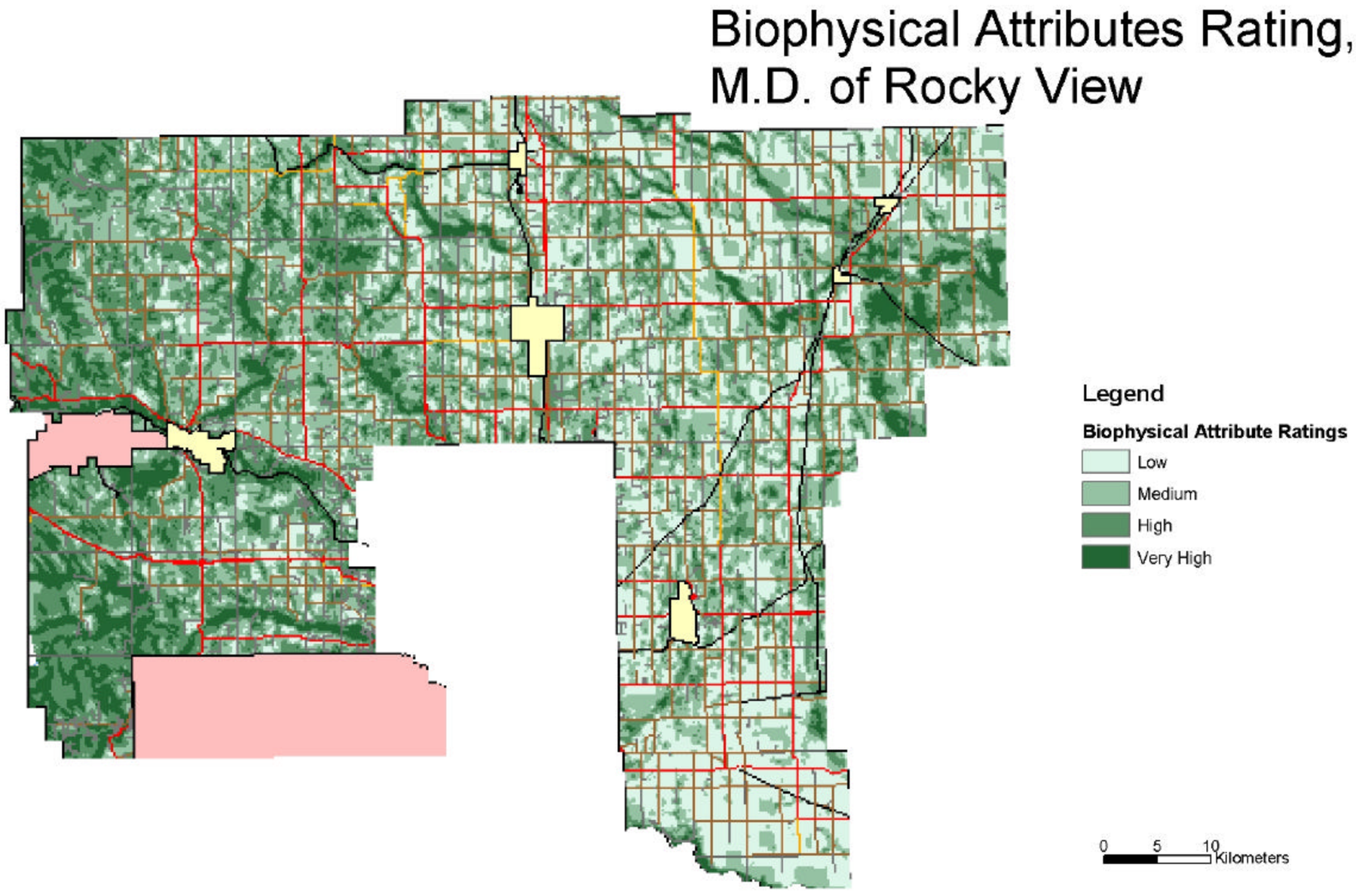


Figure 12: Biophysical Attribute Rating in the M.D. of Rocky View

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7.0 Appendices

Appendix A - Riparian Buffer Literature Summary

Buffer Width	Source	Target activities	Recommended scope
15m from HWM	DFO-HMD, B.C. Min of Env/Chilibeck et al	low density residential development	all watercourses flowing into or containing fish or fish habitat
15m from top of slope	DFO-HMD, B.C. Min of Env/Chilibeck et al	low density residential development	above watercourses with steep slope banks or ravines
30m from HWM	DFO-HMD, B.C. Min of Env/Chilibeck et al	high density residential and commercial development	all watercourses flowing into or containing fish or fish habitat
30m from top of slope	DFO-HMD, B.C. Min of Env/Chilibeck et al	high density residential and commercial development	above watercourses with steep slope banks or ravines
30-60m	AB Env	livestock operations	important wildlife areas for nesting waterfowl
30m from bank	AB Env	tree felling during timber operations	permanent watercourses
200m from bank	AB Env	tree felling during timber operations	lakes or waterbodies
30m	AB Env	road construction for timber operations	intermittent watercourses
50m	AB Env	road construction for timber operations	permanent watercourses
200m from bank	AB Env	road construction for timber operations	lakes or waterbodies
100m	AB Env	manure storage facilities	surface watercourses, springs, wells
100m or 1:100FP	AB Env	livestock operations approvals	open water bodies, springs, wells, irrigation works
1m above 1:50 FP	AB Env	manure storage facilities, feedlots,catch basins,feeding sites	floodplains
10-90m	AB Env	manure application	dependent on slope and incorporation time
2X avg ht mature trees	AB Env -Fitch pers com, 2001	forestry, agriculture, development	all watercourses (in AB = 20-100m buffer) Pacific NW model
>90m	CAESA	grazing	chernozemic soils
15m	Connecticut River Joint Commissions (CRJC)	bank stabilization, sediment and contaminant filter	any watercourse - Connecticut River Watershed
30m	CRJC	filter dissolved nutrients, pesticides	any watercourse - Connecticut River Watershed
30m	CRJC	fisheries and aquatic habitat quality	any watercourse - Connecticut River Watershed
90-100m	CRJC	protect wildlife habitat	any watercourse - Connecticut River Watershed
30-200m (3 zone)	CRJC	timber operations	increase in width from 1st order to 4th order streams
15-200m (3 zone)	CRJC	wildlife habitat protection	any watercourse - Connecticut River Watershed
15-30m (3 zone)	CRJC	agriculture	any watercourse - Connecticut River Watershed
25-50m or variable	CRJC	community development	any watercourse - Connecticut River Watershed
30-200m (3 zone)	Kalamazoo cons district	wildlife habitat protection	any watercourse - Michigan
7-10m	USDA Forest service	filter dissolved sediments, nutrients, pesticides	any watercourse
10-25m	USDA Forest service	wildlife habitat protection	any watercourse
15-30m	USDA Forest service	filter soluable nutrients and pesticides	any watercourse
18m	USDA Forest service	agricultural croplands	any watercourse
31m	Shultz et. al. 1994	cropland remediation	streams adjacent to cultivated lands
21m (3 zone)	Shultz et. al. 1994	great plains agroecosystems	streams adjacent to cultivated lands
10-60m	Castelle et.al.	sediment removal	streams adjacent to cultivated lands
5-90m	Castelle et.al.	nutrient removal	streams adjacent to cultivated lands
5-100m	Castelle et.al.	species diversity	streams adjacent to cultivated lands
15-30m	Castelle et.al.	water temperature moderation	streams adjacent to cultivated lands
1.5-25m	Idaho Stream Protection Zones/Cited in Belt, et al	forestry/fisheries	human water supply or fisheries/sig impacts downstream
1.5-30m	Washington Riparian Mgt Zones/Cited in Belt, et al	forestry/fisheries	human water supply or fisheries
15-61m	California Watercourse & Lake Protection Zones/Cited in Belt, et al	forestry/fisheries	human water supply or fisheries
8-30m	Oregon Riparian Mgt Areas/Cited in Belt, et al	forestry/fisheries	human water supply or fisheries
multiple variables	AB Env -Fitch pers com	any activity	vegetation, slope, groundwater, soils, surficial geology, hydrology
variable widths	Belt et.al.	forest practices, water quality, fish habitat	soils,slope, aspect, nature, size and volume of stream, vegetation type, intended land use
multiple variables	Kie et al.	rangeland management for wildlife	vegetation,soils, hydrology, wildlife
multiple variables	CRJC	community development/ forestry/wildlife/agriculture	soils,slope, aspect, nature, size and volume of stream, vegetation type, intended land use
multiple variables	Mannan et al. 1994	management of forestlands for wildlife	topography, geology, groundwater, plant communities

Appendix B - Riparian Zone Visual Observations - November 5, 1999

Location	Width of Riparian Vegetation	Topographic Width	Site Description
02-01-22-1 W5	20m	53m	grasslands
01-02-22-29 W4	200m	450m	grasslands - wooded valley
08-28-21-28 W4	200m	200m	incised coulee near Highwood R
02-30-19-26 W4	43m	indefinite	cultivated
01-08-19-27 W4	50m	indefinite	pasture
09-13-19-28 W4	46m	indefinite	pasture
08-24-19-28 W4	30m	indefinite	cultivated
08-03-18-28 W4	60m	600m	Little Bow Valley - pasture
08-34-17-28 W4	50m	300m	pasture
02-26-17-29 W4	35m	600m	grasslands - exposed bedrock formations
15-08-17-29 W4	14m	45m	cultivated
16-13-17-01 W5	indefinite	400m	pasture
01-19-17-01 W5	150m	200m	pasture/forage
02-14-17-02 W5	indefinite	300m	Stimson creek/pasture
09-07-17-02 W5	300m	300m	Pekisko Creek/pasture
12-33-16-02 W5	indefinite	300m	Stimson creek/pasture
07-20-17-02 W5	indefinite	400m	Pekisko Creek/pasture
08-07-18-02 W5	350m	350m	incised coulee near Highwood R
05-9-19-02 W5	indefinite	600m	Tongue Creek/pasture
05-25-21-03 W5	600m	600m	Pothole creek/pasture