Developer's Guide to the Riparian Setback Matrix Model For Use by Parkland County

April 14, 2015

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Executive Summary

The following is a companion document to the recently-developed *Riparian Setback Matrix Model: Formulation and Parameterization for Parkland County,* for use on all water bodies within the County. The current document has been prepared to give an overview of model application for those working in the development industry. The Riparian Setback Matrix Model is used to establish unique environmental reserve setbacks to lakes, streams, brooks, creeks, wetlands and intermittent water drainage courses during the development process under authority of Part 17 of the *Municipal Government Act* to sustain watershed and/or watercourses in balance with developmental pressure.

For more details, you can request a copy of the *Riparian Setback Matrix Model* from Parkland County, Land Use Planning Department office by contacting:

Parkland County

Planning and Development Services

53109A Hwy 779

Parkland County, Alberta

T7Z 1R1

Phone: 780-968-8888

Or Toll Free at 1-888-880-0858

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1 Introduction and Background on Environmental Reserves

Facing increasing development pressure, the need to protect and restore riparian areas within Parkland County has become a requirement. Riparian areas are the areas of water-loving vegetation beside a stream, river, lake or pond. Riparian areas are critical to plant and animal communities and to reduce the negative effects of various land-uses on adjacent waters. The Riparian Setback Matrix Model (RSMM) was created to help prevent development impacts on surface water bodies. The model is an effective tool to establish adequate riparian buffer setbacks to aid in the protection of shorelines, water quality and riparian lands[1], while allowing for development to occur in a sustainable manner.

The purpose of this guide is to help those in the development industry to apply the Parkland County RSMM in a stepwise manner and to identify those qualified professionals required to apply the model. This guide also reinforces the need for Environmental Reserve (ER) protection to maintain healthy and functional riparian areas for the purpose of preventing aquatic pollution[2], while providing public access that will not impede natural functions. The RSMM will be used by Parkland County administration to determine and enforce appropriate Environmental Reserve setback dedications located adjacent to bodies of water, including lakes, streams, brooks, creeks and intermittent water inflows during the development process.

1.1 What is the Riparian Setback Matrix Model?

The RSMM is a scientifically-based, legally defensible model that allows municipalities to take adequate precautions to prevent the most common forms of pollution, instead of establishing arbitrary setbacks (Aquality 2015). This policy and procedure is applied under direction from the *Municipal Government Act* (Sections 663 and 664). To obtain the required information (vegetation, slope, groundwater risk/susceptibility, and adjacent land use data) for the RSMM, applicants will need to retain the services of a qualified professional, registered in the province of Alberta with an organization that is part of the Joint Environmental Professional Practice Board[3] to undertake a geophysical assessment of the proposed development. Please see the section entitled "Professional Requirements for Site Assessments" for a

[1] "Riparian land" means the lands adjacent to a watercourse where the vegetation and soils show evidence of being influenced by the presence of water. Riparian areas are the green zone around a watercourse. They are the vital transitional zone between surface water and the drier uplands and play a vital role in the healthy functioning of both. For the purposes of this model, riparian lands are taken to start at the bank or ordinary high water mark of a body of water.

[2] "Pollution" means any non-point source impacts on the environment from substances such as sediments, nutrients, pesticides, bacteria, parasites or toxic chemicals that reach a watercourse by surface or subsurface flow though adjacent land, and the unauthorized release of any "deleterious substance" as defined in the *Fisheries Act* (Canada), or the unauthorized release of any substance whether non-point or otherwise that may cause an adverse effect under provisions of the *Environmental Protection and Enhancement Act.*

[3] Includes Alberta Institute of Agrologists (AIA), Alberta Society of Professional Biologists (ASPB), Association of the Chemical Profession of Alberta (ACPA), Association of Professional Engineers and Geoscientists of Alberta (APEGA), Association of Science and Engineering Technology Professionals of Alberta (ASET), College of Alberta Professional Foresters (CAPF), and College of Alberta Professional Forest Technologists (CAPFT)

guide to the types of professional affiliation that are required for different site conditions based on a cursory initial assessment.

1.2 What is an Environmental Reserve?

An Environmental Reserve (ER) is a buffer of natural land that lies between developed/developable land and environmentally sensitive areas such as lakes, rivers, streams, creeks, and wetlands (Figure 1). During subdivision of a parcel of land, under conditions prescribed in the *Municipal Government Act*, a municipality can acquire "reserve lands". Environmental Reserve is "undevelopable" land that must be left in its natural state, or used as a public park or for public access to the area (Sec 671 MGA). The strip of land determined by the model will be dedicated to Parkland County as Environmental Reserve (where the County takes ownership), or, placed under an Environmental Reserve Easement, at the discretion of the County. Under this latter form of protection, the County may specify additional conditions on the land, in addition to restricting development. The use of environmental reserve parcels for exclusive, private purposes is not permitted. As the owner of environmental reserve, the County has the responsibility to control access and use to ensure that these sensitive landscapes are sustained for current and future generations.

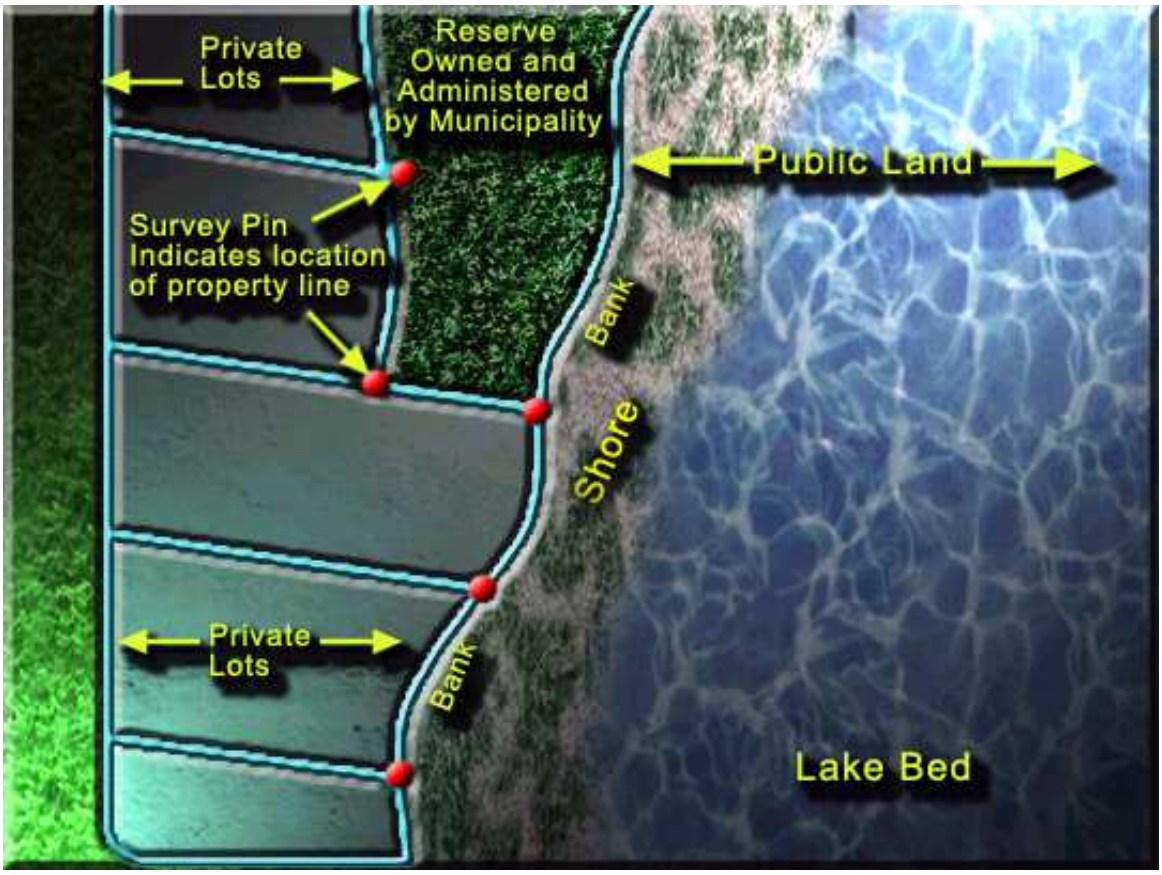


Figure 1. Illustration of lake bed and bank which is public land and owned by the Province and the Environmental Reserve land that is owned by the Municipality.

1.3 When do I need to dedicate reserve lands?

As stated in the *MGA*, a municipality can require the dedication of ER if the lands proposed for subdivision abut the bed and shore of any lake, river, stream or other body of water[4] (Figure 1). When such reserves are taken for the purposes of **preventing pollution** or **providing public access to or beside the bed and shore**, the reserve taken must be **not be less than 6 metres in width**, allowing that these objectives may require greater ER widths (Stewart, 2006). In addition, environmental reserves may also be taken on land that **consists of a swamp, gully, ravine, coulee or natural drainage course**, or **that is subject to flooding or is, in the opinion of the subdivision authority, unstable**. In the latter two cases, the reserves will comprise the entirety of these lands, and may be wider than the minimum 6 meters required for pollution prevention or access.

By preventing nutrients from entering a fresh water body, algal and aquatic vegetation growth is minimized. Other benefits of ER dedication include public access to the water body, wildlife habitat as well preservation, and shoreline erosion prevention. When the RSMM is applied through zoning bylaws, there is no transfer of ownership, though development within the setback area can still be prevented through landowner education and the enforcement of the bylaw by the County.

The trend of residing in an urban subdivision in a rural setting is increasing nationally. As the population shifts to these desirable rural subdivisions, more pressure is placed on the environment. The Riparian Setback Matrix Model gives the community the ability to benefit from the environmental social and economic services of the land.

1.4 What is the purpose of an Environmental Reserve?

The strip of land abutting a lake or other watercourses are taken as ER for two purposes: to prevent pollution, or to provide public access to and beside the bed and shore. Environmental Reserve is dedicated to protect provincially owned beds and shores and the aquatic environment[5] from "pollution". Therefore, the definition of pollution that a municipality adopts constitutes pollution in their community. Nutrients are defined by the County as pollutants (as are other compounds such as suspended sediments, hydrocarbons, salts, and metals), and steps will be taken to protect aquatic systems from additional nutrients from making their way into watercourses via point and non-point source discharges. One of the most effective ways to protect aquatic ecosystems and prevent pollution is to ensure that riparian areas are intact, healthy and functional.

Sometimes, residents think that their property rights allow them to use adjacent ER parcels for exclusive, private purposes. They landscape, cut down trees, mow vegetation along streams, and plant gardens outside their lot lines with invasive species of flowers, shrubberies and trees. ER shore lands are often

[4]"water body" means any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood, and includes but is not limited to wetlands and aquifers … *Water Act*, S1, RSA 2000

[5](h) "aquatic environment" means the components of the earth related to, living in or located in or on water or the beds or shores of a water body, including but not limited to (i) all organic and inorganic matter, and (ii) living organisms and their habitat, including fish habitat, and their interacting natural systems.*Water Act*, S1 RSA2000

fenced or barricaded or restricted against the natural flow of people and floodwaters even when ER strips lie between their property and the bed and shore of a river or lake.

People compete with wildlife for ER adjacent to rivers and lakes which act as wildlife corridors or migratory bird habitat, and provide shade, shelter, food and water for flora and fauna. Some citizens consider ER private playgrounds to walk dogs, cycle, and ride all-terrain vehicles. These activities create *ad hoc* pathway systems, adversely affecting the natural ground cover and vegetation, pollution, erosion of escarpments and ravines, and sedimentation of adjacent watercourses and bodies of water.

Riparian zones act as buffers and protect water quality. Contaminants are absorbed onto sediments, taken up by vegetation and transformed by soil microbes into less harmful forms. Defining a riparian area (riparian buffer strip) that is large enough to effectively protect the water and the aquatic ecosystem is necessary. Each water body requires uniquely set riparian buffer widths and development setbacks. It is essential that municipalities determine appropriate land uses adjacent to bodies of water, including wetlands, to avoid or minimize development impacts of our valuable water resources, as stated in the provincial and municipal *Land Use Bylaws*. The importance of identifying and protecting a properly-sized buffer strip is critical for source water protection.

1.5 How much land will be taken as an Environmental Reserve?

The RSMM seeks to balance the protection of the natural environment and the needs of developers, taking only the minimum setback or Environmental Reserve required to adequately protect aquatic environments from pollution. The Environmental Reserve created through this process will also provide other significant functions such as public access, but the determination of ER width under the RSMM is based only on requirements for pollution protection. Pollution can be defined as substances such as sediments, nutrients, pesticides, bacteria, parasites or toxic chemicals that reach a watercourse by surface or subsurface flow. Riparian areas reduce the amount of pollution reaching a watercourse. The reduction in pollution reaching the watercourse is highly correlated with the characteristics of the adjacent riparian lands, depending on the site characteristics such as slope, vegetation cover, soil, and bank height.

The amount of land the County will require to be dedicated as Environmental Reserve will range from 10 - 50 meters. The amount of land required will vary with the changing vegetation cover, slope, groundwater risk/susceptibility, and adjacent land use present on the land. Setbacks are reduced in areas where conditions provide good protection for the aquatic environment and increased in areas where conditions provide poor protection for the aquatic environment.

Conditions	Protection of aquatic environment	Setback Width
Low slopes, high cover of robust vegetation, low groundwater risk, low intensity land use	Good	Narrow
High slopes, little vegetation cover, high groundwater risk, high intensity land use	Poor	Wide

1.6 Development Setbacks for Buildings

A municipality is responsible for the planning and development of private lands within its geographical boundaries. The *Municipal Government Act* requires municipalities to enact a Land use Bylaw[6], the provisions of which can be used to control the development of "buildings" **on land subject to flooding or subsidence or that is low lying, marshy or unstable**; or, **land adjacent to or within a specific distance of the bed and shore of any lake, river, stream or other body of water**. What constitutes a "building" is defined in the *MGA* to include all structures except highways and bridges. Controlling development of buildings within prescribed development setback areas can be done through policy statements and land use bylaw provisions. The opportunity to create appropriate development setbacks and land uses in riparian areas is underutilized by municipal governments. The RSMM presented here will assist the County to create a defensible "natural environmental reserve" land use designation with associated permitted and discretionary land uses. The natural riparian function of each landscape that a municipality wishes to preserve will determine the extent of the development setback required.

[6]MGA 640(1)

2 Environmental Constraints Included in the Implementation of the RSMM

The current version of the Riparian Setback Matrix Model includes four environmental constraints that contribute strongly to the ability of riparian areas to protect aquatic ecosystems: vegetation cover, bank slope, groundwater risk/susceptibility, and adjacent land use. The parameterization of the model for each of these factors is summarized below.

2.1 Vegetation Cover

Vegetation cover in riparian buffers provides both physical and biochemical mechanisms for the protection of associated aquatic environments. The physical structure of vegetation and the terrain roughness that plants provide resistance to surface water flows, slowing rates of runoff and allowing particulate matter to settle out of the water column more effectively.

The weights for the vegetation types included in the model are presented in Table 1.

Table 1. Vegetation cover setback coefficients and conditions.

Vegetation Cover Type (% cover)	Coefficient (m/% cover)	Special Conditions
Trees	0.1	
Shrubs	0.2	
Grass / Forbs	0.3	
Bare Ground	0.5	If bare ground includes impermeable surfaces, the width of the buffer must be increased by the width of the impermeable surface

2.2 Slope

Slope is an important factor in determining an appropriate riparian setback width. Steeper slopes are more susceptible to erosion and can increase the velocity of overland flow (runoff) and reduce the amount of time that surface runoff spends in contact with the riparian buffer, which is a key component to pollutant removal effectiveness.

The minimum setback for slope was established at 10 m, with a linear increase in the setback distance of 1.0 m for every degree in slope. For slopes exceeding 20 %, a geotechnical assessment of stability is required. Additionally, any areas where slopes exceed this cutoff value do not contribute to the width of the riparian buffer, and the total length where the slope exceeds 20 % must be added to the width of the buffer.

Table 2. Slope setback coefficients and conditions

Slope Range (% slope)	Coefficient (m / % slope)
0 – 20	1.0
>20	Geotechnical assessment of stability required Areas with slopes >20% do not contribute to buffer width

2.3 Groundwater Susceptibility

In areas around rivers, streams, lakes, and other water bodies, there are generally strong interactions between surface water and ground water sources. Groundwater and shallow subsurface flows can contribute nutrients and pollutants to surface waters, and groundwater itself can become compromised when polluted runoff infiltrates through the soil. Protecting shallow groundwater sources from nutrients and other pollution, therefore, is an important part of protecting surface water bodies.

Due to the coarse scale of other groundwater risk/susceptibility data sources for the County, the Riparian Setback Matrix Model will utilize a Groundwater Susceptibility Map prepared by the County from data referenced in the 2014 Parkland County Environmental Conservation Master Plan. Approximately a half dozen data layers were used in the Environmental Conservation Master Plan and in creating the Susceptibility Map, with these layers including, but not limited to, groundwater contamination risk, groundwater recharge, locations of buried aquifers, and groundwater volume for the County.

Table 3. Groundwater susceptibility coefficients. Values taken from groundwater susceptibility mapping presented in the Groundwater Susceptibility Map (Appendix A: Parkland County Groundwater Susceptibility Map).

Groundwater Susceptibility Category	Setback (m)
Extremely Low	10
Very Low	15
Low	20
Medium Low	30
Medium	40
High	50

2.4 Adjacent Land Use

This version of the RSMM takes into consideration land uses on the adjacent property, as there can exist large variations in water quality from surface runoff from different land uses. To apply the model to new developments or subdivisions, broad categories of land use were selected, to correspond roughly with land uses encountered during rezoning

Table 4. Adjacent land use multiplier coefficients.

Dominant Adjacent Land Use	Setback Multiplier
Natural cover (forest, shrubland, grassland, wetland)	1.0
Agriculture – non-intensive (rangeland, pasture, grazing)	1.2
Agriculture – intensive (cultivated crops, livestock farms)	1.6
Agriculture – confined feeding operations	2.0
Residential –any residential developments	1.4
Commercial	1.2
Industrial	2.0

3 Riparian Setback Matrix Model

The amount of ER taken by the County will be determined by using the Riparian Setback Matrix Model (Aquality 2015). Environmental Reserve will be determined at several sites starting at the transition to upland vegetation (i.e. upper edge of the riparian area). The area dedicated as Environmental Reserve will vary throughout the site as it follows this edge. Some areas will require wider Environmental Reserve and others will require much less, all based on site conditions. The Environmental Reserve will vary throughout the parcel of land depending on existing features: vegetation cover, slope of the land, groundwater influence and adjacent land use.

The model may be applied to either determine the width of Environmental Reserve that will be taken during the subdivision process, or to determine the setbacks required for the development of lands and the construction of new buildings.

Under the RSMM for Parkland County, the baseline setbacks (determined from vegetation cover, slope and groundwater risk/susceptibility) fall within the range of 10 – 50 m. Depending on the type of adjacent land use, these setbacks are subject to a multiplicative factor to increase protection to the aquatic environment. Under "worst case" conditions for the protection of the aquatic environment from pollution, the maximum setback is increased to 100 m (50 m baseline setback × 2.0 adjacent land use multiplier).

3.1 How to use the Riparian Setback Matrix Model

Because environmental conditions can vary significantly within a property's boundaries, measurement of conditions on the ground at several points within a property is required to determine appropriate setbacks. The total length of the property bordering the water's edge will affect the number of sampling points and how riparian setbacks are determined. One setback determination locations are established, measurements of environmental conditions at each point are made. Setbacks for each point are determined, and then these setback endpoints are joined with straight lines to produce the final riparian setback distance for the property (Figure 2).

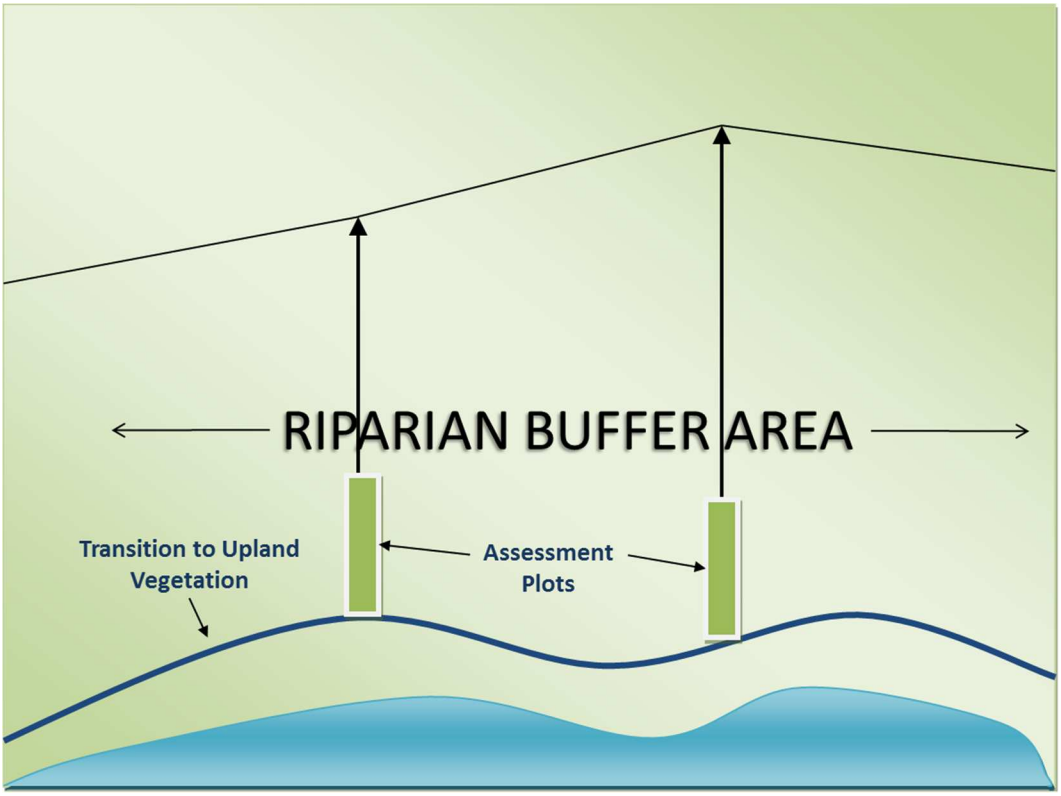
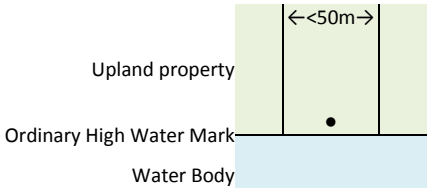


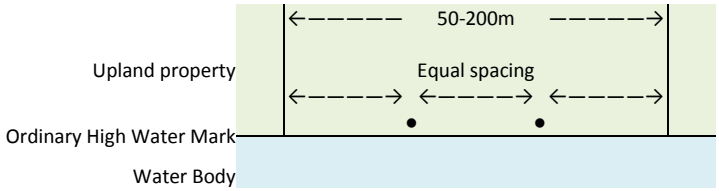
Figure 2. Schematic of application of Riparian Setback Matrix Model to a property bordering a body of water.

3.2 Selection of Sampling Locations

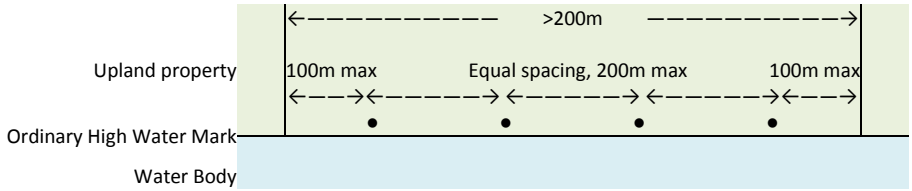
1. **Establish the number of setback points required**.
   1.1. Whereas the length of land bordering the water body, stream or wetland is:
      1.1.1. **Less than 50 meters –** One (1) setback point will be required at the midpoint of the property boundary along the body of water.



      1.1.2. **200 meters to 50 meters –** Two (2) setback points will be required equal distance apart and equal distance from each end of the property, along the boundary between the property and the water body.



      1.1.3. **Greater than 200 meters –** The outside setback points will be no more than 100 meters from each end of the property, along the boundary between the property and the water body. If the distance between these setback points is more than 200 meters, additional setback points will be required. These must be equally spaced from each other and the two outside setback points, and no more than 200 meters apart along the boundary between the property and water body.



2. **Establish the location setback points**
   2.1. Whereas the location of the point will be:
      2.1.1. At the boundary of the bed and shore between the private and crown-owned property (ordinary high water mark), as delineated by a legal land surveyor; or,
      2.1.2. If the property has not been delineated by a legal land surveyor, the point where evidence of surface water influence on the soil ends and where vegetation (living or dead) characteristic of an aquatic environment (including but not limited to sedges, cattails, and bulrushes) end changes to that of upland vegetation; or,
      2.1.3. If no vegetation exists, the point at the current edge of water.

3.3 Determining Setbacks Based on Environmental Conditions at Each Sampling Location

1. **Vegetation Cover** is determined for each measurement location in a 1 x 10 m plot extending directly upslope from the margin of the body of water towards the upland area.
   - 1.1. From each setback point, determine the vegetation type perpendicular to the water body, stream or wetland, by creating a 1 m x 10 m plot.
   - 1.2. Determine the percent of the plot that is herbaceous/graminoid, shrub, forested, impermeable and bare ground. Total cover must add up to 100 %; if vegetation forms a multi-story canopy, then the tallest statured vegetation (tree > shrub > herbaceous) is used for the overlapping area.
   - 1.3. Multiply the percentage of each vegetation cover class by the respective distance adjustment for each type.
   - 1.4. Put the required adjusted distance beside the respective vegetation cover.
   - 1.5. Add up the setback requirements from all vegetation cover types to obtain the total vegetation cover setback.
2. **Slope** must be determined by a geotechnical engineer or legal land surveyor at each of the setback points. From each setback point, determine the slope of the land directly upslope of the water body, stream or wetland. The base setback distance for slope is calculated as follows:
   - 2.1. The minimum setback distance based on slope is 10 m.
   - 2.2. For slopes in the range of **0 to 20 %,** the setback distance will be 10 m + 1.0 m for every 1 % slope.
   - 2.3. If the slope is **>20 %,** then a geotechnical study is required for the site to determine the stability of the bank. The total setback required for this site will be determined by a registered professional, and be subject to the approval of the subdivision authority. The determined setback must:
     - 2.3.1. take into account the slope, height of bank, groundwater influence, soil type and vegetative cover;
     - 2.3.2. be no less than the setback calculated based on the other parameters in the RSMM
     - 2.3.3. exclude lands with slopes greater than 20% from the riparian buffer.
   - 2.4. Record the measured slope in Step 2.
   - 2.5. If the slope is ≤20%, enter the calculated setback distance in the TOTAL box in Step 2.
3. **Groundwater Risk/Susceptibility** is determined from the Parkland County Groundwater Susceptibility Map (see Appendix A) for the subject property.
   - 3.1. Find the subject property within the Parkland County Groundwater Susceptibility Map.
   - 3.2. Record the groundwater susceptibility class in Step 3 and enter the corresponding setback distance in the TOTAL box in Step 3.
4. **Adjacent Land Use** is determined on a line extending from the assessment plot directly upslope to the outer property boundary.

4.1. Determine the land use with the highest multiplier coefficient present directly upslope along the line. This excludes land uses falling behind a berm, grade, or other rise that prevents surface runoff from these areas from directly reaching the associated water body by direct flow downslope through the property.

4.2. Place a check next to the associated class in Step 5, and enter the corresponding multiplier

5. The **Overall Setback** is determined by calculating the baseline setback, and multiplying by the adjacent land use multipliers:

5.1. Determine the maximum setback calculated from Steps 1 – 3 and enter it as the baseline setback in 6(a).

5.2. Enter the adjacent land use setback in the appropriate spaces in 5(b).

5.3. Multiply the baseline setback by the adjacent land use setback to determine the final overall setback. This is the buffer width requirement for that setback determination location

6. Riparian buffer boundaries are determined by joining adjacent setback points/distances. Setback points located closest to the property boundaries are extended parallel with the high water mark to the boundary with the adjacent property.

RSMM Field Sheet

Water Body Name: _____

Location (1/4 – Sec – Rge – Twp – Mer): _____

Setback point location (UTM Coordinates): _____

Land Owner: _____

Field Personnel: _____

Date and Time:

1. VEGETATION			
Cover Type (% cover)	**Coefficients**	**Vegetation cover (%)**	**Baseline Setback (calculate)**
Forest	0.10		
Shrub	0.20		
Herb/graminoid	0.30		
Bare ground	0.50		
TOTAL			
2. SLOPE SETBACK			
Slope Category (%)	**Coefficients**	**Measured slope (%):**	**Baseline Setback (calculate)**
0 - 20%	10 m + 1.0 m / %		
>20%	Geotechnical study*		
TOTAL			
3. GROUNDWATER SUSCEPTIBILITY			
Groundwater susceptibility	**Coefficients (m)**	**Check one:**	**Baseline Setback**
Extremely Low	10	◯	
Very Low	15	◯	
Low	20	◯	
Medium Low	30	◯	
Medium	40	◯	
High	50	◯	
TOTAL			
4. Highest Intensity Adjacent Land Use	**Coefficients**	**Check one:**	**ESA Coefficient**
Natural cover	1.0	◯	
Agriculture	1.2	◯	
Agriculture – intensive	1.6	◯	
Agriculture – confined feeding operations	2.0	◯	
Residential	1.4	◯	
Commercial	1.2	◯	
Industrial	2.0	◯	
TOTAL			
5. OVERALL SETBACK			**Overall Setback (calculate)**
Baseline Setback	Largest from #1-3:	a)	
Adjacent land use coefficient	Value from #4:	b)	
Total Overall Setback		**Multiply a and b:**	

*A geotechnical study must be conducted for the site to determine appropriate setbacks, which must be no less than the value calculated by the RSMM. Areas with slopes greater than 20% do not contribute to further riparian buffer width in this case.

3.4 Professional Requirements

Although every effort has been made to make the RSMM accessible to as wide an audience as possible, the determination of setbacks should not be undertaken without enlisting the assistance of a professional(s) with qualifications appropriate for the conditions and complexity of the site (Table 5).

Table 5. Professional requirements for site assessments

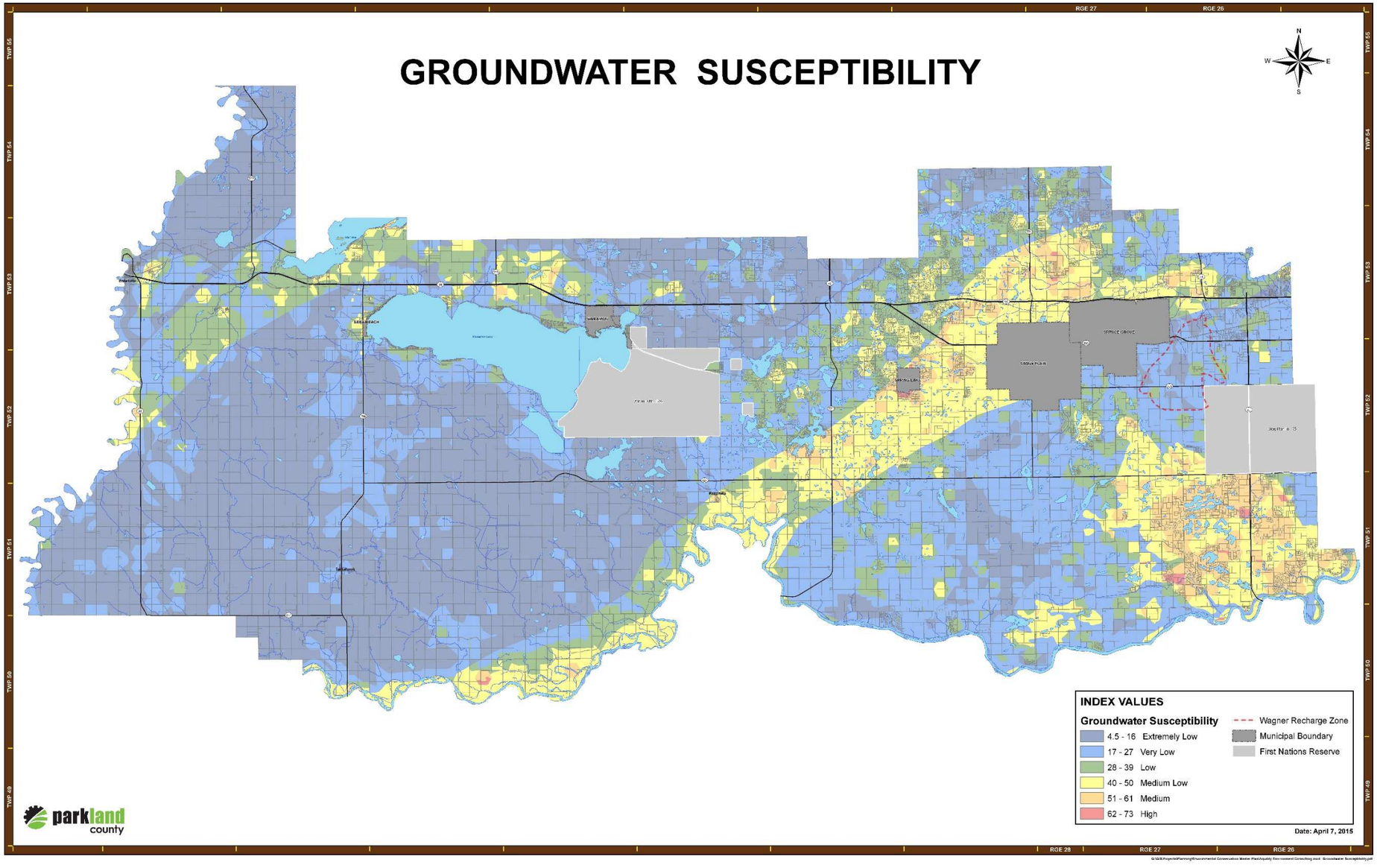
Condition	Professional Requirements for setback determination
Low slope, obvious transition from aquatic to upland vegetation, groundwater table known from nearby wells	Professional biologist
Complex vegetation communities with no obvious transition from aquatic to upland vegetation	Qualified Aquatic Environmental Specialist (QAES) or Qualified Wetland Aquatic Environment Specialist (QWAES)
Moderate slopes (0-20 %)	Professional biologist
Steep slopes (>20 %)	Professional biologist + Geotechnical engineer
Extensive river meander* or presence of flood plain	QAES/QWAES + Geotechnical professional

* - The turns in a river associated with meander result in large, potentially overlapping riparian setback areas. Meander often indicates bank instability, channels that vary in position from year to year, and generally results in a larger area than would otherwise be expected being incorporated into riparian areas. The model as currently formulated is not designed to handle this case, and requires a geotechnical assessment of bank/channel stability, and a QAES/QWAES assessment to determine the long-term/historical high water marks and extent of riparian vegetation.

4 Vegetation Definitions

Term	Definition
Aquatic Vegetation	Plants that grow in water or in saturated soils (i.e. bulrushes, sedges, cattails, rushes, willows).
Bare Ground / Cleared	An area where the soil is exposed. There may be sporadically occurring plants present, especially weedy or colonizing species.
Forest	An area with a canopy created by one or more woody-stemmed trees with an average height of at least 2 m and an associated understory
Herbaceous	An area with cover provided by plant species without woody above-ground structures. Includes both graminoids (such as grasses, sedges, and rushes) and forbs (leafy plants).
Impermeable	An area devoid of vegetation with the ground surface covered with a substance that prevents the infiltration of water, such as concrete or asphalt
Shrub	An area with a canopy of woody or semi-woody plants with low stature (<2m), often though not always producing several basal shoots instead of a single trunk. Tree seedlings (saplings) <2m will also be considered as shrubs for the purposes of the model.

5 Appendix A: Parkland County Groundwater Susceptibility Map



6 References

Aquality Environmental Consulting Ltd. 2015. The Riparian Setback Matrix Model: Formulation and Parameterization for Parkland County. Aquality Environmental Consulting Ltd., Edmonton, Alberta.

Parkland County. 2014. Parkland County Environmental Conservation Master Plan: Phase 1 Background Technical Report. Prepared for Parkland County by O2 Planning+Design Inc.