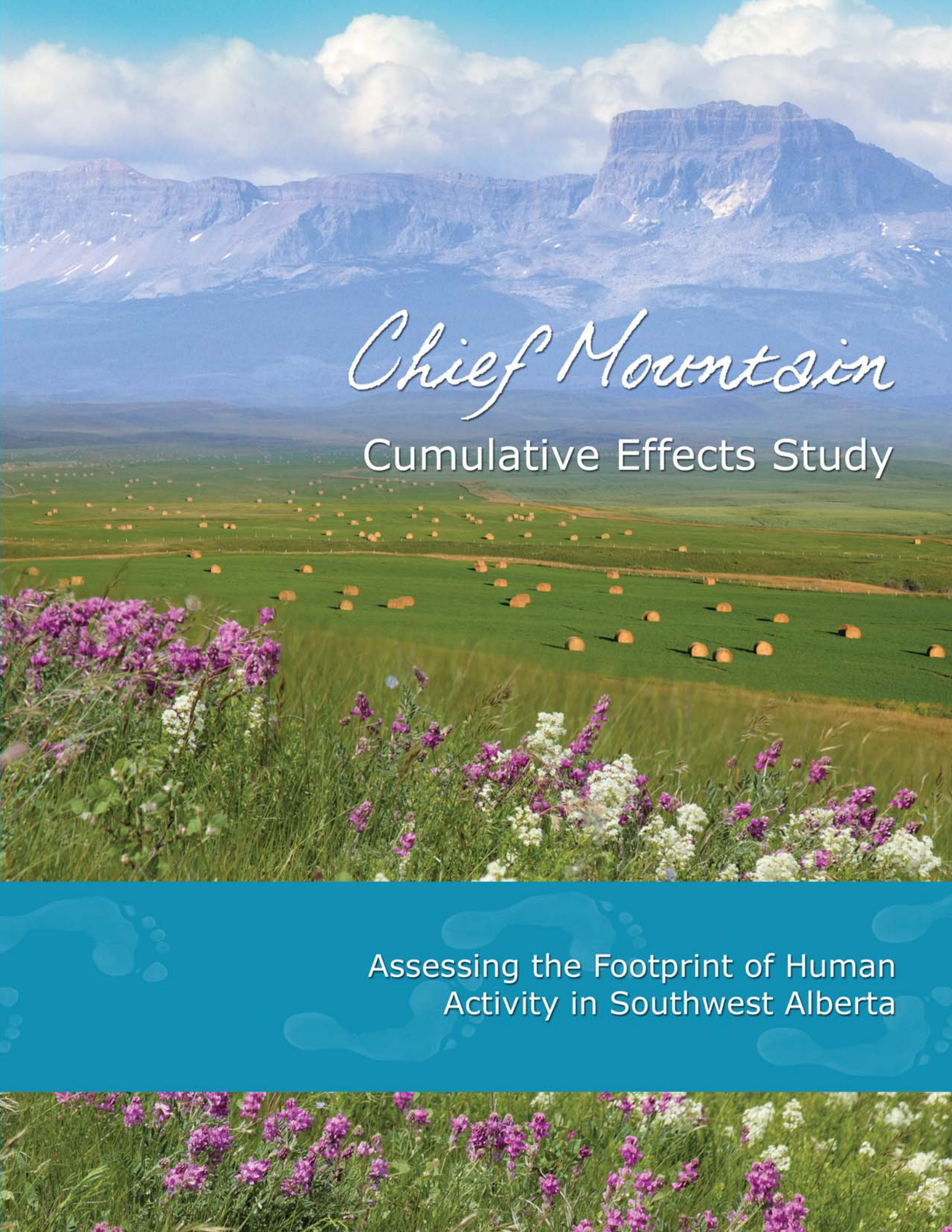


Chief Mountain

Cumulative Effects Study

Assessing the Footprint of Human Activity in Southwest Alberta

Acknowledgments

The Chief Mountain Cumulative Effects Study (CMS) was conducted by Barry Wilson and Mark Hudson, Silvatech Consulting Ltd.

Many individuals and organizations contributed to the publication and success of this study, particularly Dr. Brad Stelfox (Forem Technologies; an associate of Silvatech Consulting Ltd.), and Jeff Bectell (CMS project chair). Dr. Stelfox provided the Southern Foothills Study model template and enhancements, technical advice, and assistance with land base information acquisition. The steering committee, comprised of Jeff Bectell (chairman), Tim Romanow, Cyndi Smith, and Larry Frith, provided countless hours of volunteer time helping with data acquisition, project administration, and promoting awareness of the final results by giving public presentations.

Data used in the model was obtained from the Southern Alberta Sustainability Strategy (Government of Alberta), the Southern Foothills Study, Apache Canada Ltd., Shell Canada, Statistics Canada, Canadian Wind Energy Association, Hydrogeological Consultants Ltd., Forem Technologies, Silvatech Consulting Ltd. and the CMS stakeholder group.

The CMS Stakeholder Group included representatives from Apache Canada Ltd., the Blood Tribe, the Canadian Wind Energy Association, Cardston County, the Chief Mountain Landowners Information Network, the Chinook Area Land Users' Association, the Government of Alberta, I.D. #4 Waterton Park, the Nature Conservancy of Canada, the Oldman Watershed Council, the Municipal District of Pincher Creek, the Southwest Alberta Sustainable Community Initiative (SASCI), Shell Canada, the Town of Cardston, the Town of Pincher Creek, the Waterton Biosphere Reserve Association, and Waterton Lakes National Park. They provided valuable input to the study.

Funding for the publication and printing of this booklet came from the Waterton Biosphere Reserve Association, the Shell Environmental Fund and the Oldman Watershed Council (Watershed Legacy Program). Barbara Grinder edited the text for this booklet; Elizabeth Saunders designed the final publication.

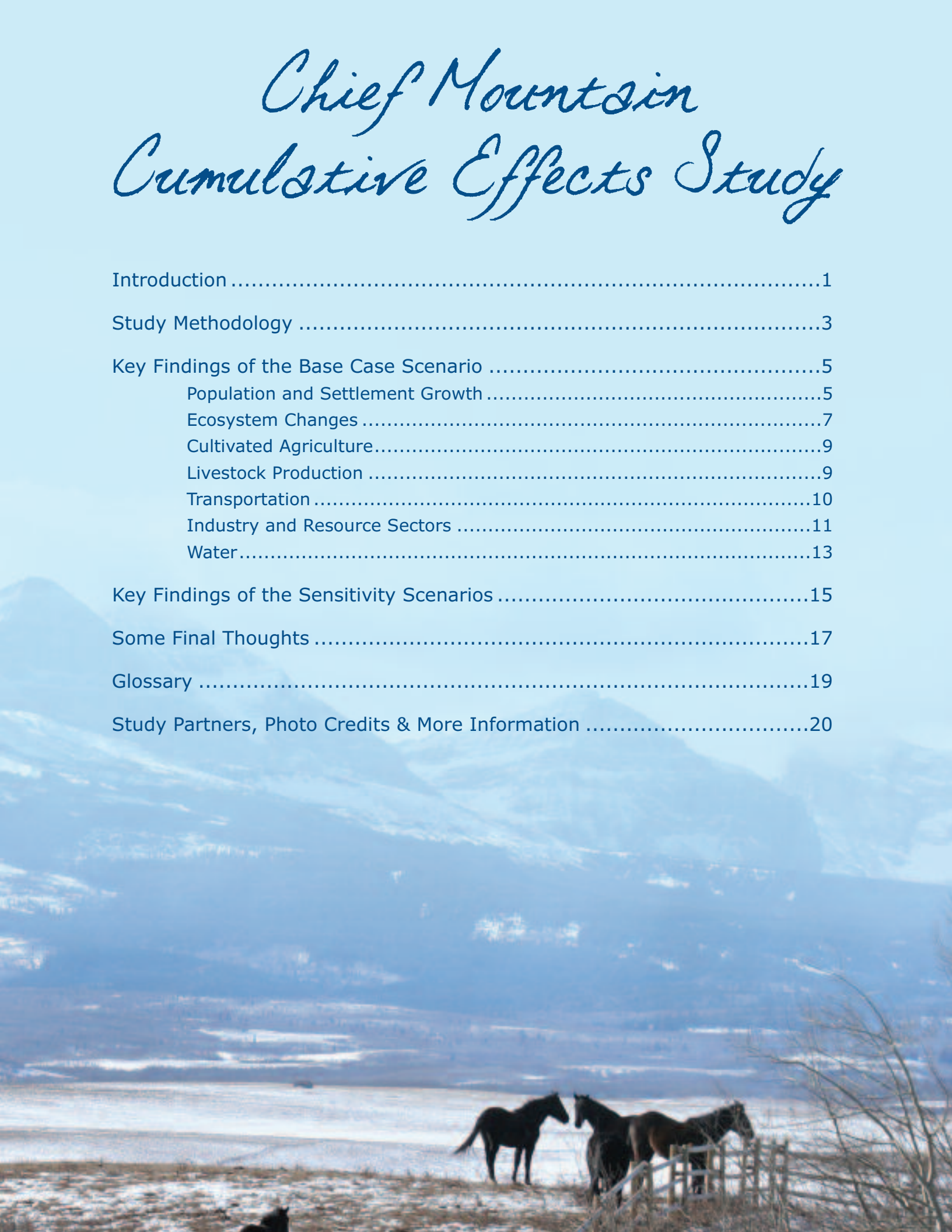
For more information on the study methodology or details of the findings, phone:

Cardston County - 403-653-4977

or

Chief Mountain Landowners Information Network - 403-653-2219 - chiefmountainlandowners@gmail.com

Chief Mountain Cumulative Effects Study



Introduction

Background

The Chief Mountain Cumulative Effects Study (CMS) was grassroots driven and directed by a multi-stakeholder, consensus-based working group that included representation from Parks Canada, other government agencies, non-government organizations, industry, First Nations, and area landowners. The project arose from local concern about land-use trends and their associated long-term impacts on groundwater and surface water reserves, water quality, wildlife populations and habitats, land fragmentation, native grassland integrity, and agricultural lands in general.

The study originated in the fall of 2006, when results of a similar project were presented for the Southern Foothills, the area between Pincher Creek and High River. That study was well received and stakeholders in the Chief Mountain area felt it would be useful to have a similar report, to provide a picture of possible future scenarios for their region.

The Chief Mountain Study attempts to balance the perspectives of different stakeholders in the area and is based on the premise that all land uses examined provide economic benefits, but these benefits may have associated environmental liabilities, such as impacts on surface and groundwater or the loss of natural biodiversity. It also recognizes some liabilities may be minor by themselves, but have more serious cumulative effects. The study attempts to identify potentially conflicting land use trends and to show that even the decisions of individuals can have beneficial or negative consequences.

Cumulative effects are changes to environmental, social and economic values caused by a human activity in combination with other past, present, and reasonably foreseeable future activities. The need for cumulative effects assessment is critical to understanding and planning for water use, growth of population and urban settlements, the transportation infrastructure, energy sector development, and climate change.

Southwest Alberta is at a crossroads of economic growth. Rural residential and recreational development is increasing; there is renewed interest in resource activity, especially the oil and gas sector. The agricultural community that has characterized settlement till now is experiencing low commodity prices, high input costs and many more challenges. As markets and profits decrease, some landowners are forced to sell or subdivide land to support their families and way of life. These decisions create new developments that increase the population of nearby communities, create more fragmentation and challenge traditional stewardship of the land.

The purpose of the CMS is not to set policy, but to provide information on the potential outcomes of changes in land use and development in the area if current trends continue. This information could be used as a tool for long range planning and meaningful discussion about the environmental, economic and social future of the region. Such a look into the future will provide a picture of what the landscape may be like by the year 2057 and a better understanding of the potential impacts of changing land uses and how these impacts might affect the lives of current and future residents. While some of the study findings may be areas for concern, they also show there is still time to make a difference.

The study is based on conservative growth rates and optimistic estimates for reclamation. Most of the data was collected and analysed in 2007. No attempt to update the information is made in this summary report.

The study area is located in the southwest corner of Alberta, in the Oldman River watershed and to a more limited extent in the Milk River Basin. It includes Cardston County, the Municipal District of Pincher Creek, the Kainai (Blood) and Piikani (Peigan) First Nations' Reserves, and Waterton Lakes National Park. Approximately 23,000 people are permanent residents of the study area. Another 5,000 to 8,000 live in the area on a seasonal basis and also have an impact on land use.

The area occupies roughly 925,000 hectares (2.28 million acres) and is comprised of five major natural ecoregions - alpine, sub-alpine, foothills parkland, foothills fescue, and mixed grass. Land cover is predominantly irrigated and non-irrigated cultivated agriculture (43% of study area), native grasslands (30%), forests (18%) and developed lands such as towns and roads.

Land Use or Cover	% of CMS Area
Cultivated Agriculture	42.70
Native Grassland	29.80
Forest	17.50
Surface Water	3.10
Non-vegetated[1]	2.50
Shrubland[2]	2.20
Transportation Network	1.40
Residential Development	0.47
Energy	0.14
Mining	0.02
Other	0.20

1. Mostly bare rock and bare soil.
2. Includes early stage regrowth following forest fires, boggy areas dominated by willows, shrubby coulee areas, etc.

Study Methodology

The ALCES® computer simulation model was chosen to assist with projection, analysis and reporting of the changes brought about by natural ecological processes and human land use.

Like all simulation models, ALCES® is based on assumptions about the future; such model projections are never made with total certainty. The variables used in the study, such as rates of population and livestock growth, are constantly changing and will continue to change during the forecast period. Agricultural markets are often cyclical and technology changes and causes many other variables to change.

The ALCES® projections are not meant to be a crystal ball. Rather, they are an attempt to provide land managers with the opportunity to explore and understand different land use trajectories and the strategies or activities that could maximize desirable outcomes and minimize unfavourable consequences. They also help stakeholders understand the cumulative environmental, social and economic effects of changes in human activities, in combination with other past, present, and future activities.

Sensitivity analysis is a technique for assessing how changes in the assumptions of a model affect the model's output. The CMS assessed a base case and three sensitivity scenarios. Two of the study's three sensitivity analyses were based on changing rates of land use development; a third was based specifically on assessing risk associated with the range of estimates from the best available data about current groundwater aquifer volumes.

ALCES® was developed in 2000 by Forem Technologies as a strategic level simulation or modelling tool, intended for use by resource managers, the scientific community, industry, and the general public. It has been used for the Crown of the Continent Ecosystem Regional analyses, by Alberta Energy and the Canadian Association of Petroleum Producers, the Alberta Forest Products Association, the Kenai (Alaska) National Wildlife Refuge, and was adopted as the central software for conducting land use simulations by the Integrated Resource Management Branch of the Alberta Research Council. Its primary purpose is to facilitate integrated landscape and resource management.

The base case scenario assumed things would continue to occur during the next 50 years in much the same way they do in the present. It is intended to be a benchmark for comparing outcomes tested in other scenarios or sensitivities.

The first sensitivity scenario assumed oil and gas production rates would double. The second sensitivity scenario was based on doubling of the human population growth rate in the area. A third sensitivity scenario was based on an estimate of the groundwater reserve 73% lower than used in the base case.

Assumptions of the Model

Due to the lack of data available for the precise study area, certain assumptions were made in the base case and sensitivity scenarios.

The exact amount of water in the aquifer is unknown and estimates are highly uncertain. For this study, groundwater data from a study of Cardston County was extrapolated and assumed to apply to the entire study region. The base case scenario uses a midpoint of the estimated range for the region. Only shallow aquifers were included as they provide almost all the groundwater used in the study area. The only consumptive use of the groundwater resource was assumed to be by humans and livestock.

The model does not take into account changes in market behaviour, prices or major technological or socio-cultural changes.

Land Use Sectors Modelled

The CMS modelled human-based activity, including energy production, mining, forestry, agriculture, transportation, settlements, general industry, and recreation. The study also modelled natural processes, including fire and major insect disturbances.

Key Findings of the Base Case Scenario

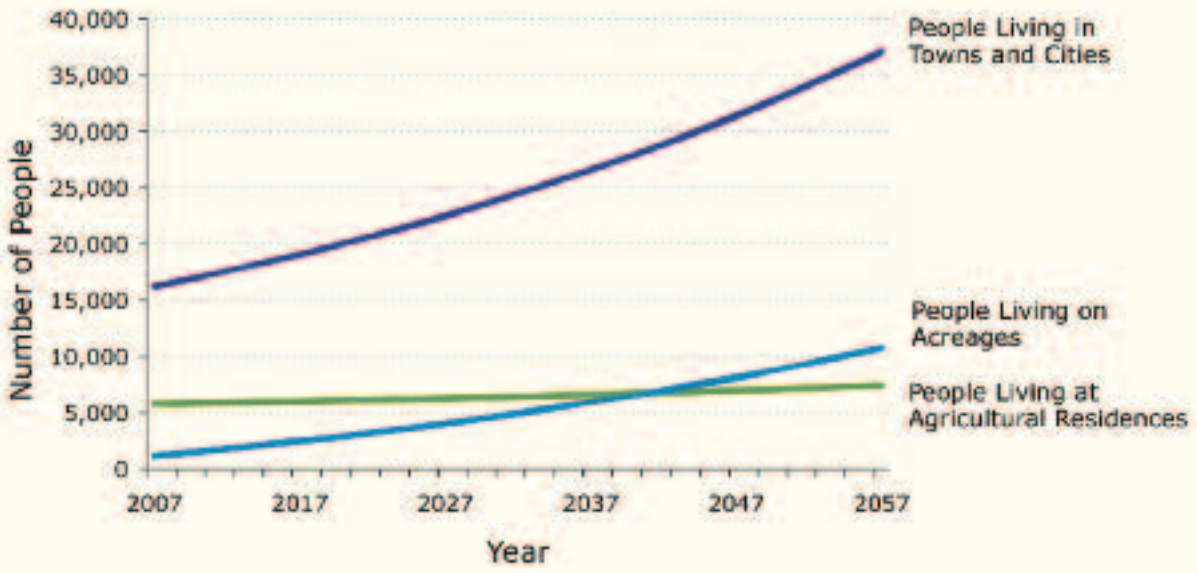
The Base Case Scenario assumes things will continue to occur during the next 50 years in much the same way and at the same rate as they do now.

Population & Settlement Growth

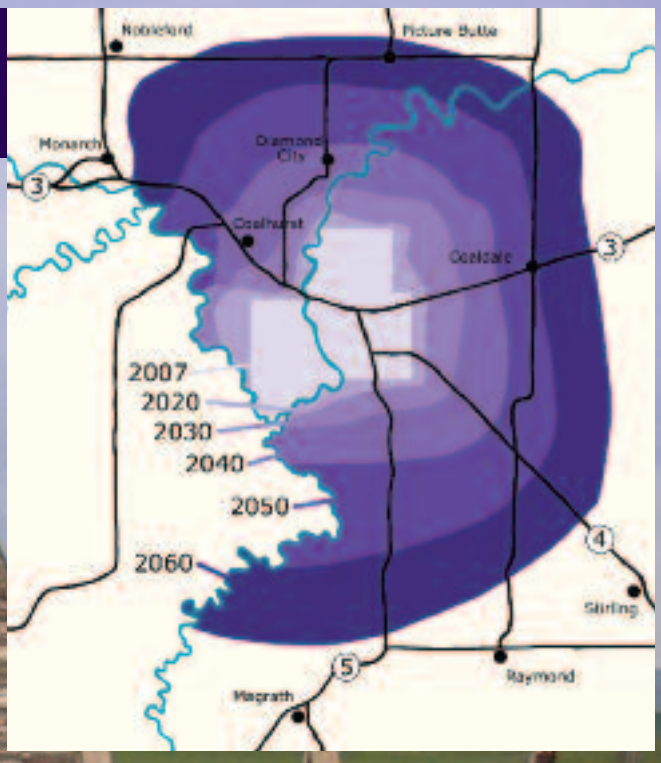
The population in the study area is expected to more than double in the next 50 years, to 55,000.

- The area occupied by urban conglomerations (hamlets, villages, cities) is projected to be twice that of acreages and agricultural residences combined. This represents a significant threat to the integrity of native grassland and other ecosystems.
- By 2040, the number of people living on small non-farm acreages is projected to surpass those in agricultural residences.
- If current trends continue, by 2057 the number of people living in rural non-farm residences in the study area is projected to increase by 828% and those living in towns and villages by 128%. This represents a major shift from a predominately agricultural community to one based on non-farm rural residential development.
- The increase in population will continue to put pressure on other land uses and will require additional housing, transportation and communication networks and increased use of water and other resources. It will also bring increased demand for recreational activities and for services such as fire and police protection, utilities, schools, and medical care.
- 86% of new footprint growth is projected to be concentrated in the transportation, residential development and recreation sectors.
- The greatest increase in land disturbance (35% of all new growth) will be associated with residential development.
- Large urban centres (especially Lethbridge and Calgary) will continue to impact the study area through their population's desire for rural homes and recreational areas.

Predicted Human Population Growth in the Study Area



Lethbridge Projected Population Growth (~3.78%)

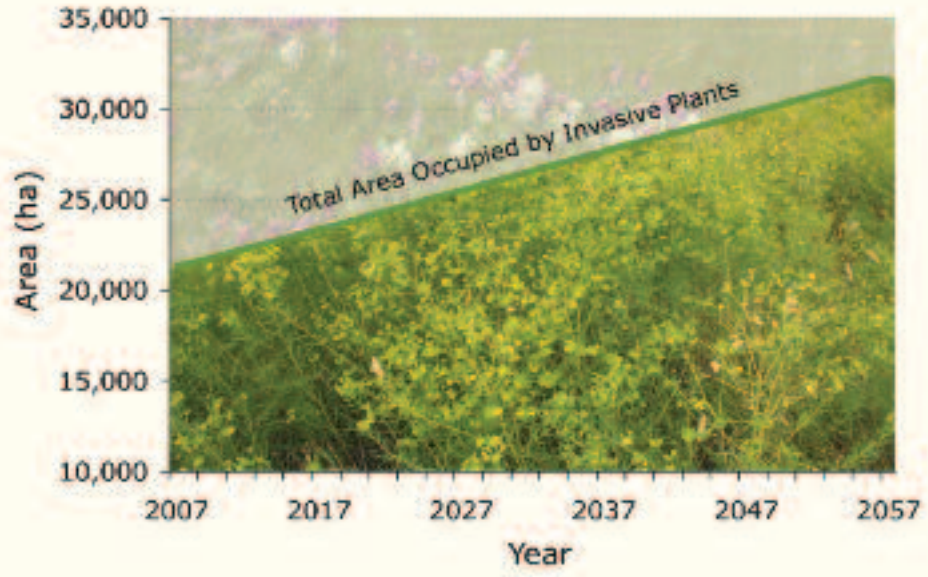


Ecosystem Changes

The area in native grassland is projected to decrease by 3% (8,000 ha, 20,000 ac) during the next 50 years.

- 80% of this loss will be due to invasion by non-native plants, introduced through human activities such as reclamation, recreation and the conversion of native prairie to tame pasture through encroachment by tame grasses and weeds. The other 20% of the loss will be due to direct destruction of prairie grasslands by the placement of infrastructure such as roads and houses.

Area Occupied by Invasive Plants



- The total area occupied by invasive plants is forecast to increase by 48% (from 22,500 ha to 32,000 ha or 55,575 ac to 79,040 ac). The rate of increase will be greatest during the next 15 years, due to activity in the hydrocarbon sector.
- The projected doubling of the population will result in loss of native prairie at a rate ten times higher than from hydrocarbon sector development. However, the edge effect of energy sector activity is greater than that created by residential development.
- Forest fragmentation is expected to increase due to construction of roads associated with forestry activities and seismic lines. The average patch size is expected to be 16% smaller than it is currently. Such fragmentation can lead to increases in invasive species and higher likelihood of wildlife conflicts and loss of habitat.

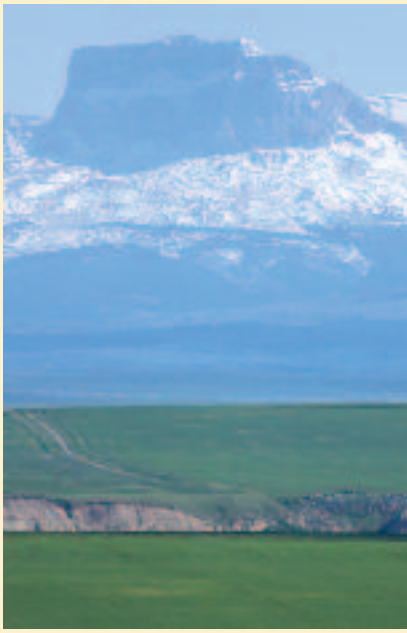
Edge effects are the ecological changes that occur at habitat boundaries, including changes in species composition, amounts of moisture and sunlight received, and soil and air temperatures. Shape has a considerable influence on edge effects. Long narrow land fragments may be completely dominated by such ecological changes.

Native biodiversity is projected to decrease in the study area during the next 50 years.

- The risk of exposure of grizzly bears to humans and human activity is expected to increase 13% by 2057. Grizzly bears were used as an index for all wildlife biodiversity in this study. They are typically considered an umbrella species, because protecting them indirectly protects the many other species that make up their ecological community.
- The higher probability of grizzly-human encounters is due to increased human presence in bear habitat.
- The loss of native grassland and other native plant communities and the possible loss of associated wildlife will also affect the area's biodiversity.

Cultivated Agriculture

Agriculture was one of the first land uses in the area and is still a dominant activity. However, productive farmland will continue to be converted into rural residential and recreational property.



- The acreage in cereal crops is projected to decline by 2% in the next 50 years, primarily due to conversion of cropland to residential use.
- Land under irrigation (9% of the cultivated acreage) will remain about the same.
- The area of tame pasture will increase by 15% (6,400 ha or 17,280 ac) due to the unintentional degradation of native grassland by invasive plant species and direct conversion of native grasslands.
- The ALCES® model does not deal with changing agricultural prices or markets or the consequences these changes may have.

Livestock Production

Livestock populations are projected to grow.

- Cattle currently account for 84% of the livestock raised in the study area. In the next 50 years, there could be 94,000 (28%) more cattle, 31,000 (55%) more swine and 21,000 (235%) more horses in the study area.
- Some of the increase in livestock numbers will be from animals moved into the area to finish in feedlots, as little growth is possible on existing acres without supplemented feeding.
- The model does not deal with changing livestock markets and prices, nor does it take into consideration limitations on water allocations and possible future restrictions on development or growth of feedlots in the study area.

Livestock Composition and Potential Increase

	Cattle	Swine	Horses
Current numbers	341,384	56,252	9,101
Potential by 2057	435,894	87,258	30,518
% Increase	28	55	235
Annual growth rate	0.45	0.9	2.5

Transportation

The total transportation network, including provincial highways, municipal roads, resource access roads, private roads leading to sub-divisions, and rural driveways, is projected to increase by 26% during the next 50 years.

- By 2057, the area occupied by smaller access roads, private roads and driveways (65%) is projected to be greater than all other transportation facilities combined. These minor roads and trails contribute heavily to loss of native grassland integrity. Roads to rural residences often occupy more land than the buildings themselves.

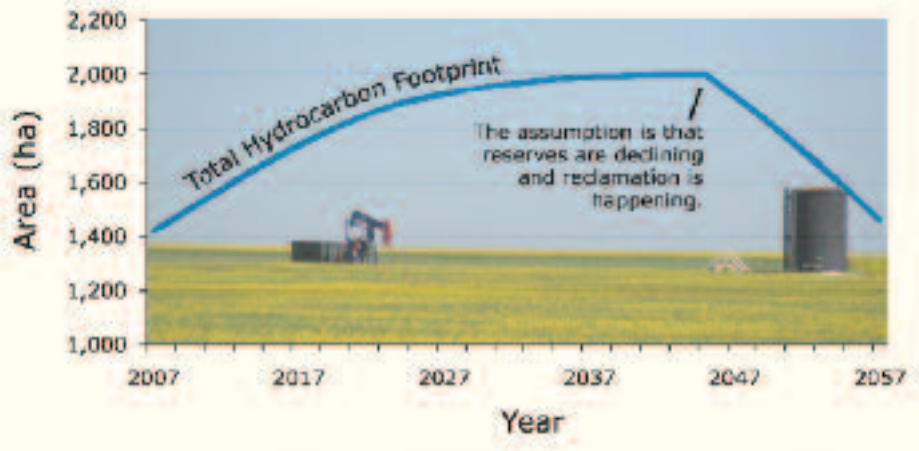
- Linear features, such as roads, pipelines, power lines, and seismic lines, and their associated "edges" have a major impact in terms of fragmentation of ecosystems and in the spread of invasive species. By 2045, edge density is projected to rise from about 1.5 km per km^2 to approximately 2.25 km per km^2. After 2045, edge density is expected to stabilize due to new road development being offset by hydrocarbon sector reclamation and decline.

Industry & Resource Sectors

Growth of the hydrocarbon energy sector (conventional oil, natural gas and coalbed methane) is projected to be low compared to other land uses. Production in the study area is expected to peak in 20 years and then decline, due to depletion of known resource reserves.

- Hydrocarbon energy production is projected to peak at 239,000 barrels of oil, 13 billion ft^3 of natural gas, and 815 million ft^3 of coalbed methane each year.
- The relatively low footprint associated with the petroleum energy sector is based on the assumption that exploration roads and pipeline areas will be largely reclaimed.

Hydrocarbon Area Footprint



Wind energy production has been a growth industry in the study area. The number of turbines is expected to increase from 251 in 2007 to 1001 by 2057. However, the actual area of land used for this projected growth is only 85 hectares (210 ac).

- In the future, it is estimated that, 85% of wind turbines will be located on cultivated land; 15% will be placed on grasslands.
- Loss of native prairie due to construction of service roads to wind farms and the spread of invasive plants are the primary environmental effects of this land use.
- The visual impact of the turbines was not examined.

In the mining sector, the CMS looked at the removal and processing of gravel or road aggregate only. The growth of this industry is directly linked to the growth of housing and transportation networks. The land use impact of the gravel pits themselves is small, compared to the potential for damage from access road construction.

Forestry is a minor land use in the study area. Forests occur mainly at the area's southwest edge, near Waterton Lakes National Park and the Castle Special Management Area. Timber harvesting in the area is expected to remain constant during the next 50 years.

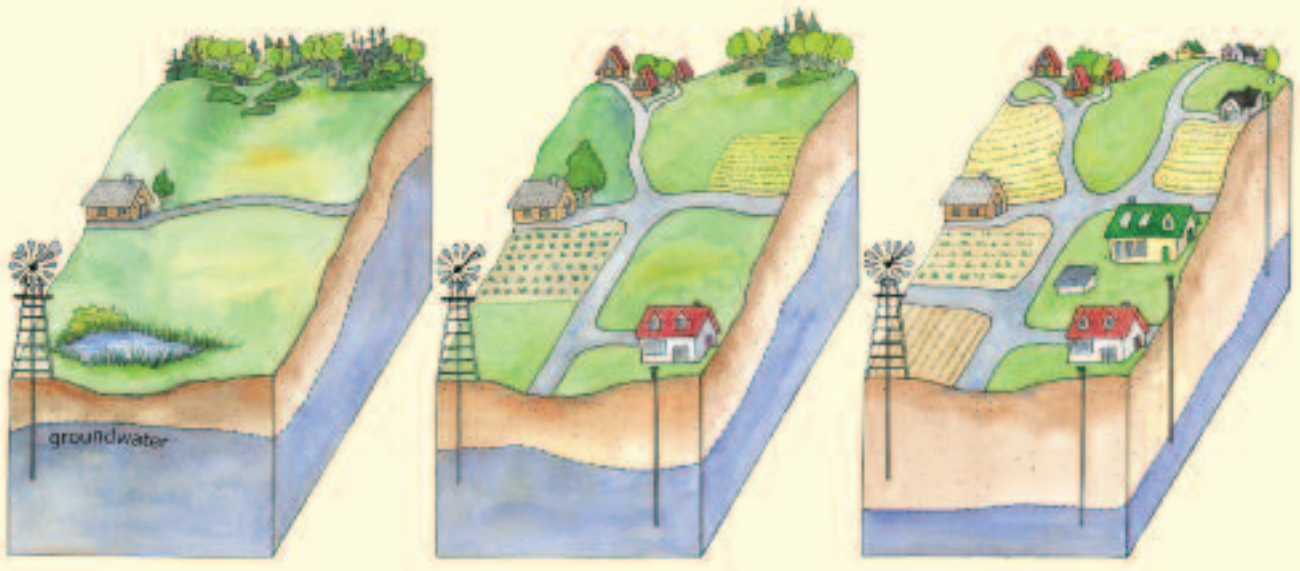
- If the timber harvest remains constant at 89,000 m^3 of softwood and 36,000 m^3 of hardwood a year, there will be a land base disturbance of 542 hectares (1,339 ac) each year.
- The median age of forest trees is expected to shift from 60-120 years to younger stands (0-60 years) and older stands (120-200 years).
- Older stands are important habitat for many species of wildlife.
- Younger stands are less susceptible to insect infestation, so salvage logging is expected to decrease. Softwood and hardwood harvest is expected to increase slightly.

Water

Shallow wells provide 97% of the total groundwater used in the study area. The amount of groundwater in shallow aquifers is projected to decline 18% by 2057, due to consumption from groundwater wells and recharge deficits created by cultivation and other human disturbances. Per capita consumption of groundwater is projected to double by 2057.

- The only consumptive use of groundwater in the study area is for human and livestock use.
- Thirteen percent of the projected decline is the result of the imbalance between input and output; that is, the rate of recharge from precipitation is slower than the rate of discharge.
- The imbalance is also, in part, a result of human use of the land. Cultivation, logging, road building, and the increasing fragmentation of forests will increase runoff and reduce the amount of water going into aquifers.
- An additional 5% decline will come from increased rates of groundwater use from wells.
- Declining groundwater reserves may result in the scarcity of water in wells and springs.

As the number of roads and residences increase, evaporation and surface runoff increase. Combined with the greater use of groundwater, this results in lowering of groundwater levels.



Surface water (from rivers and other streams) accounts for 97% of all water used in the study area. Irrigation currently uses more water than all other uses combined.

- Surface water in the study area is scarce. Streams, lakes and reservoirs comprise only 3.1% of the study area.
- On a provincial basis, 80% of surface water is in the northern half of Alberta and 80% of the demand is in the south.
- Watersheds in the mountain portion of the study area are critically important for the water supply to the entire Canadian prairie.

Nutrient loading of nitrogen and phosphorus in area surface waters is likely to increase by roughly 25% in the next 50 years, due to increases in the number of people and livestock. Sedimentation levels are expected to remain largely unchanged.

- At the beginning of the study period, nitrogen and phosphorus levels in surface waters in the study area were five times higher than in pre-settlement years; sedimentation was ten times greater.

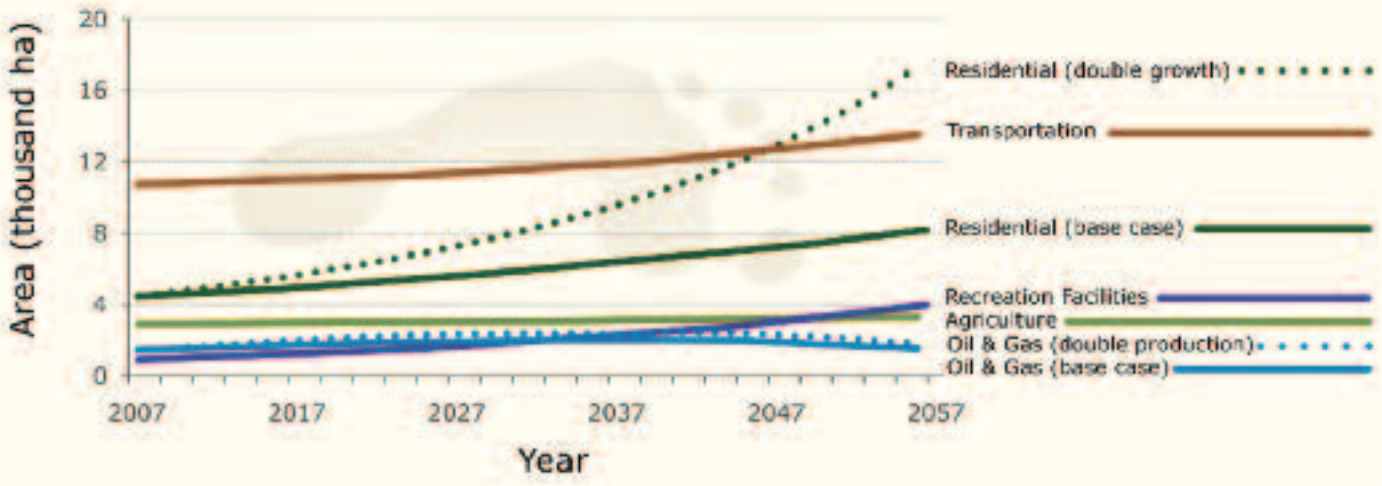
Key Findings of the Sensitivity Scenarios

The first sensitivity scenario assumed oil and gas production rates would double. This would increase the hydrocarbon footprint 20% by 2040, a land area increase of 1.6% (395 ha or 976 ac).

Doubling the human population growth rate would cause the footprint of residential land use to replace transportation as the dominant footprint by 2045.

- The footprint of small acreages will surpass that of agricultural residences by 2042.
- The footprint of urban residences will be four times the current level by 2057.
- Native prairie losses would be 10 times greater than those expected from doubling of the hydrocarbon sector.
- The grizzly bear exposure index is 2% higher, compared to the base case scenario.
- There would be a further 3% drop in groundwater volume relative to the base case.

Total Footprint



Assuming a 73% lower estimate for the existing groundwater resource would leave the total volume used unchanged, but would increase the relative decline of the aquifer volume to 62%.

- Estimates of groundwater reserves are difficult to make and subject to interpretation. Sub-soil structure, geologic formation, and location play a crucial role in determining the potential for water storage in groundwater reservoirs. Many experts believe current estimates are considerably higher than actual reserves. Figures used in the Base Case Scenario reflect the average volume of groundwater that experts estimate. The 73% figure reflects the worst-case scenario, that is, the lowest estimated volume of groundwater reserves.
- Though groundwater use accounts for only 3% of total water use in the study area by volume, it is a crucial source of domestic water for rural residences and their livestock.

Some Final Thoughts. . .

So what now?

The CMS suggests the human footprint within the study area is growing. This is probably no surprise to anyone. However, it is worth noting again that the model has been built on the conservative side; therefore it is reasonable to assume growth of most land use sectors will not be less than suggested, unless current trends change unexpectedly.

As has been stated, all the modeled land uses have benefits and liabilities associated with them. Some of the liabilities have been described and quantified by the study; the benefits of the land uses were not within the scope of the study, but they are significant and proponents can argue their merit. Each individual will likely have land uses they favour and those they do not; some practices they'dlike to see remain in place and some they wouldn't.

Is it all doom and gloom?

On the optimistic side, there are a lot of good things that have already happened and are continuing to happen within the study area. Land trusts are working with agricultural producers to keep working landscapes intact and the ranching heritage of our area alive. More than 60,000 acres of conservation easements and purchases have been arranged.

Municipalities and landowners are working cooperatively to manage invasive species and to keep new invaders from getting a foothold in the area. Community-driven watershed stewardship groups continue to be established for many creeks and rivers. These groups understand that watershed health does not stop at a property line and are working together to improve conditions by better managing riparian areas and our impact on them.

Community land use groups, such as the Chief Mountain Landowners Information Network and Chinook Area Land Users Association, are working to ensure issues such as these are on the minds of both the community and its elected officials. These groups are influencing municipal policy on oil and gas activity protocols, as well as ensuring companies are held to high reclamation policies and standards.

We still have large tracts of undisturbed native landscapes within the study area. And we still have time to make decisions that will sustain our communities and our landscape in the future.

So what are we prepared to lose?

Are there any limitations that should be imposed to maintain a healthy environment, our agricultural heritage, wildlife, native grasslands, and viewscapes? The choice is not entirely between using the land and leaving it alone, but decisions need to be made about what, where, and how much.

Other jurisdictions have arrived at a point where they looked back and wished they had done something differently, before natural assets were lost. The real point of this study is to allow us to plan ahead so that we can avoid the same fate. The land as it is provides benefits that should be just as highly valued as the benefits development provides.

Consider the cumulative effects the study suggests we're going to see in the next 50 years and decide if they are desirable; then let policy makers know your opinion. Municipal and tribal governments establish bylaws to govern land use. This study should be used to set these bylaws.

The province of Alberta is currently constructing its Land Use Framework, so talk to your neighbours, councillors and MLAs about this study. Look at your own impact on the land.

This area is our home.
Careful planning can help future
generations enjoy the benefits
it provides us now.

Glossary

Biodiversity (biological diversity) is the variation of life forms within a given ecosystem or for the entire Earth. It is often used as a measure of the health of the biological systems within it.

Consumptive Use - Water used in such a way as to make it unavailable for other uses because it has evaporated, transpired, been incorporated into products and crops, or been consumed by animals, including humans.

Ecosystem (ecological system) refers to the combined physical and biological components of an environment. An ecosystem is generally an area within the natural environment or the same habitat in which physical factors, such as rocks and soil, function together with interdependent biological organisms, such as plants and animals. An **ecoregion** is a geographical area containing one or more ecosystems.

Edge effects are the ecological changes that occur at habitat edges or boundaries, including changes in species composition, amounts of moisture and sunlight received, and soil and air temperatures. Shape has a considerable influence on edge effects. Long narrow land fragments may be completely dominated by such ecological changes. **Edge density** is calculated as the total length of habitat edge, divided by the overall land area of the area being considered.

Fragmentation is a process of environmental change that causes discontinuities in an organism's preferred environment or habitat. It can be caused by human activities that alter the environment, such as logging, residential development or road building.

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures in and between rock formations. Such spaces are called **aquifers** when they can provide a usable quantity of water.

Habitat is the environment in which an animal or ecological community normally lives or can more readily survive as a single organism and as a species.

Invasive Species are non-indigenous or introduced plants (or animals) likely to cause economic or environmental harm, especially as they restrict or limit the growth of native species. However, not all introduced species are considered invasive.

Native Grassland refers to any ecosystem dominated by but not restricted to indigenous, non-introduced grasses (gramineae) or in which grasses are the dominant taxonomic group of plants from the standpoint of biomass, productivity, cover, density, or overall impact on the biotic community.

Nutrient Loading is the introduction of excessive amounts of nitrogen, phosphorus and other fertilizer components into streams or soils.

Simulation Modelling uses computer-driven representations of the essential characteristics of a real-world system or situation to predict future changes. The representations are based on a set of **scenarios** or descriptions of specific assumptions.

Sedimentation is the process of solid particles of material, usually from the weathering of soil and rock, settling to the bottom of a stream through gravity. Though sedimentation is a natural process of stream erosion, the sediment load may be increased by human practices such as logging, overgrazing and road construction.

Streams are flowing bodies of water, confined within a bed and banks. Rivers, brooks and creeks are examples of names given to specific streams, often based on the size of their flow.

Surface Water is water (essentially from precipitation) that collects on rather than under the ground surface. Surface water includes streams, lakes and wetlands.

Tame Pasture is a field with a semi-permanent or annual growth of naturalized or introduced grasses, legumes and herbaceous plants used for grazing livestock.

Study Partners

Thank-you to everyone who contributed towards the Chief Mountain Study:

Apache Canada Ltd.
Blood Tribe
Canadian Wind Energy Association
Cardston County
Chief Mountain Landowners Information Network
Chinook Area Land Users' Association
Corb Lund and Family
Government of Alberta
I.D. #4 Waterton Park
Municipal District (MD) of Pincher Creek
Nature Conservancy of Canada
Oldman Watershed Council
Shell Canada
Southwest Alberta Sustainable Community Initiative (SASCI)
Town of Cardston
Town of Pincher Creek
Waterton Biosphere Reserve Association
Waterton Lakes National Park

This publication was funded by the Shell Environment Fund, Waterton Biosphere Reserve Association, and the Oldman Watershed Council (Watershed Legacy Program).

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Inside front cover: Elizabeth Saunders; p1/2 - Andy Hurly & Shane Hansen; p3/4 - Elizabeth Saunders & Kristie Romanow; p5/6 - Tim Romanow; p7/8 - Elizabeth Saunders, Andy Hurly & Stephen Harrington; p9/10 - Andy Hurly, Elizabeth Saunders, Lorne Fitch & Kristie Romanow; p11/12 - Andy Hurly; p13/14 - Tim Romanow, Elizabeth Saunders; p15/16 - Andy Hurly, Lorne Fitch & Elizabeth Saunders; p19/20 - Andy Hurly, Kristie Romanow & Shane Hansen.

For More Information

For further information, please contact: chiefmountainlandowners@gmail.com

Copies of this booklet are available from: Cardston County Office

This booklet and further study information are both available at www.watertonbiosphere.com

Printed in Canada
1,500 copies
June 2011