Hydrologic Implications of Mountain Pine Beetle:

Learning from Experience

October 10, 2007

Ramada Hotel
Edmonton, Alberta

Alberta Sustainable Resource Development

SUSTAINABLE FOREST MANAGEMENT NETWORK
RÉSEAU DE GESTION DURABLE DES FORÊTS

College of Alberta Professional Foresters

foothills MODEL FOREST
research growing into practice.

College of Alberta PROFESSIONAL FOREST TECHNOLOGISTS

Welcome!

Thank you for joining us today to participate in our workshop "*Hydrologic Implications of Mountain Pine Beetle: Learning from Experience*".

Alberta's quality of life depends on having a healthy and sustainable water resource for the environment, for our communities and for our economic well-being. Alberta Sustainable Resource Development is committed to the wise management of Alberta's water quantity and quality for the benefit of Albertans now and in the future.

Left unchecked, mountain pine beetle threatens to impact not just Alberta's forests but the entire range of values represented by our forests – including watersheds, fish and wildlife habitat, recreation opportunities and the sustainability of communities. Accordingly, mountain pine beetle management plans must meet the criteria set out in the Forest Management Planning Standard to take into account other forest values including watersheds.

I would like to express my gratitude to the many speakers, many from far away, who have taken time away from their busy lives to share with us today their experiences with mountain pine beetle and the water resource. I would also like to thank the many volunteers who have made today a reality. These include Cynthia Kaufmann, Jane Stewart, Uldis Silins, Axel Anderson, John Diiwu and Barry White. Finally, I would like to acknowledge the kind support of our co-sponsors including the Sustainable Forest Management Network, Foothills Model Forest, College of Alberta Professional Foresters and the College of Alberta Professional Forest Technologists.

I encourage each of you to take this opportunity to engage the many speakers and each other to better prepare ourselves for the many challenges that lay ahead. Your attendance today is appreciated.

D. (Doug) Sklar
Executive Director, Alberta Sustainable Resource Development

Program Overview

7:30 – 8:10 am	**Registration and Continental Breakfast**
8:10 – 8:20 am	**Welcome and Opening Comments** Brad Pickering, Deputy Minister, Alberta Sustainable Resource Development **Moderator:** Axel Anderson, Alberta Sustainable Resource Development
8:20 – 8:50 am	**Current Status of MPB in Alberta and the Policies and Strategies to Manage the Insect** Dan Lux, Mountain Pine Beetle Management Coordinator, Alberta Sustainable Resource Development
8:50 – 9:20 am	**Climate Warming, Beetle Outbreaks, Forest Fires and Freshwater in Alberta** Dave Schindler, Professor, University of Alberta
9:20 – 9:50 am	**Managing the Land Base for Competing Needs** Rick Blackwood, Southern Rockies Area Manager, Alberta Sustainable Resource Development
9:50 – 10:05 am	**Break**
10:05 -10:35 am	**Stand Water Balance of Lodgepole Pine Forests in the Absence of MPB: Synthesis of Studies** Uldis Silins, Associate Professor, University of Alberta
10:35 – 11:05 am	**Influence of MPB on Site Water Balance** Dave Spittlehouse, Forest Climatologist, BC Ministry of Forests & Range
11:05 – 11:35am	**Effects of MPB on Channel and Riparian Response** Tim Giles, Research Geomorphologist, BC Ministry of Forests & Range
11:35 – 12:05 pm	**Hydrologic Effects of Front-end Control and Salvage Logging** John Stednick, Professor, Colorado State University
12:05 – 1:00 pm	**Lunch** Hosted by the Sustainable Forest Management Network
1:00 – 1:25 pm	**Overview of Tools and Procedures Used in Alberta to Estimate Increases in Water Yield** Rich Rothwell, Watertight Solutions
1:25 – 1:50 pm	**Overview of Tools and Assessment Procedures Used in BC** Cam Brown, Forsite Consulting
1:50 – 2:15 pm	**Case Study: BC Regulatory Approaches** Dave Maloney, Technical Advisor, Watershed Science, BC Ministry of Forests & Range

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2:15 – 2:30 pm	**Break**
2:30 – 2:55 pm	**Case Study: Operational Challenges for Forest Managers in BC** Shawn Meisner, Forester, Tolko Industries, Cariboo Woodlands Division
2:55 – 3:20 pm	**Case Study: Challenges in Developing a Pro-Active MPB Timber Harvest** Peter Denney, Harvest Planning Manager, Sundre Forest Products
3:20 – 4:20 pm	**Panel Discussion** Rick Blackwood, Alberta Sustainable Resource Development John Diiwu, Alberta Sustainable Resource Development Uldis Silins, University of Alberta Dave Maloney, BC Ministry of Forests and Range Peter Denney, Sundre Forest Products
4:20 – 4:30 pm	**Closing Statements and Wrap Up**

Speaker Abstracts

Current Status of Mountain Pine Beetle in Alberta and the Policies and Strategies to Manage the Insect

Dan Lux, Alberta Sustainable Resource Development

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (MPB) is the most significant insect agent attacking the mature pine forests of western North America. It is presently at epidemic levels in British Columbia, where it is predicted to kill up to 80 per cent of merchantable pine forests by 2013.

Alberta Sustainable Resource Development (ASRD) has monitored the presence of MPB in Alberta since 1977, as a consequence of recurring eastward short- and long-range beetle immigrations from British Columbia, as well as survival and expansions of local infestations primarily in the southwestern part of this province. Since the late 1990s, however, MPB infestations have spread and occurred in new areas in west-central and northwestern portions of the province, coincident with expansions in central and northeastern British Columbia. Changes in climate, including more moderate winter temperatures, have allowed MPB to survive farther north and at higher elevations. This has increased the risk of population expansion and spread into Alberta's lodgepole pine, limber pine and whitebark pine forest ecosystems and has raised new threats of invasion and spread into the boreal jack pine forests.

Should the outbreak reach its full potential, many forest resources and socio-economic values could be at stake, including watersheds, forest ecosystems, high-value and sensitive sites (e.g., genetic plantations, wildlife habitats, permanent inventory sample plots and conservation areas) and stable long-term fibre supply for communities dependent upon these resources. In addition, the increased fuel load of pine-killed stands creates the potential for more forest fires that are larger, more intense and less predictable.

The potential consequences of MPB invasion and spread into Alberta's pine forests make development and implementation of comprehensive mitigation measures urgent and complex. ASRD is incorporating recent science-based information and beetle infestation and spread models. It defines two prime provincial objectives:

- Contain infestations and minimize spread of MPB north and south along the eastern slopes of Alberta; and
- Prevent the spread of MPB eastward into the boreal forest of lodgepole-jack pine hybrid and jack pine.

ASRD bases its management of MPB in Alberta on three principles: assessing the current status and risk of MPB spread; determining immigration of beetle populations; and pursuing achievable objectives. These principles determine beetle management priority zones at the provincial level. Three MPB management priority zones encompass all intensity levels of MPB infestation and determine levels of management and control strategies. The three zones are the Leading-edge Zone, the Holding Zone and the Salvage Zone.

Dan Lux *has been working on mountain pine beetle management since obtaining a Masters Degree from Simon Fraser University in 1995 and has been with the Alberta Government since 1999. Dan led an interagency team of Parks Canada, Municipalities, private land developers, forest industry, and Alberta Parks to begin to manage beetles at a landscape coordinated scale when beetles first arrived in the Canmore area in 2002. Dan has taken this coordinated approach at a Provincial level when he moved from Rocky Mountain House to Edmonton just over a year ago to work as the Alberta Mountain Pine Beetle Coordinator. Dan works with a team of Forest Health Officers to strategize, plan, detect, survey, control, and communicate Alberta's operational MPB program.*

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Climate Warming, Beetle Outbreaks, Forest Fires and Freshwater in Alberta

David Schindler, University of Alberta

Western Alberta watersheds has already undergone a >2 º C increase in mean annual temperature, with greater temperature increases in winter and early spring. It is believed that warmer temperatures have caused the outbreak of mountain pine beetle in adjacent British Columbia, and will exacerbate the beetle's spread into Alberta. Studies and models in BC and the western USA suggest that greater flood flows will result from the death of trees, and that salvage logging increases runoff even more. This increased hydrologic energy is expected to increase erosion, causing higher turbidity in streams and rivers. This may make filtration for drinking water more difficult for downstream water treatment plants.

Beetle-killed forests also represent an increased fuel load. Coupled with warmer temperatures, this should cause increased forest fire. Studies in Alberta and Ontario show that this will compromise water quality by causing runoff of nutrients, mercury and other elements from forested watersheds. In a recently-completed study, increased nutrients and mercury caused considerable increases in mercury in fish. The cumulative effects of climate warming, beetle outbreaks, fires, logging and human withdrawals thus pose an important threat to scarce freshwaters in southern and western Alberta.

David Schindler *holds the Killam Memorial Chair and is Professor of Ecology in the Department of Biological Sciences at the University of Alberta. His work on lakes has been widely used in formulating policy internationally. He received his doctorate from Oxford University, where he studied as a Rhodes Scholar. He has served as President of the American Society of Limnology and Oceanography, and as Canadian National Representative to the International Limnological Society. He is the author of over 275 scientific publications.*

Dr. Schindler's international awards include the G.E. Hutchinson Medal of the American Society of Limnology and Oceanography, the Naumann-Thienemann Medal of the International Limnological Society, the first Stockholm Water Prize, the Volvo Environment Prize (1998), and the Tyler Prize for Environmental Achievement (2006). In 2001 he was awarded the National Science and Engineering Research Council's Gerhard Herzberg Gold Medal for Science and Engineering, Canada's highest scientific honour. He is a Fellow of the Royal Society of Canada, the Royal Society of London, the Royal Swedish Academy of Engineering Sciences, and a member of the U. S. National Academy of Sciences. He has received ten honorary doctorates from Canadian and US universities. He is an Officer in the Order of Canada.

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Managing the Land Base for Competing Needs

Rick Blackwood, Alberta Sustainable Resource Development

Alberta has a rich and diverse natural landscape that provides a wealth of natural resources that continue to be the cornerstone of Alberta's economy. Forestry, oil and gas, domestic cattle grazing, mining, and commercial recreation and tourism are but a few of the many industrial activities that take place in Alberta's forested landscape. Albertan's and visitors from around the world also have staked claim to this diverse landscape for a wide variety of personal recreational and tourism opportunities including fishing, hunting, camping, trail riding, hiking, off-highway vehicle use, and mountain biking to name but a few. Sustainable Resource Development has routinely considered the impacts of many of these activities on our water resources and has developed various operating ground rules and conditions for users to guide their activities and minimize impacts of land use on both water quality and quantity. Tremendous population growth in all of Alberta, but particularly Calgary and surrounding area, has accentuated the need to consider land use impacts on water resources to ensure a safe and dependable supply of water to feed a City of now over one million people. The ongoing and slowly expanding infestation of mountain pine beetle in Alberta and particularly in the eastern slopes, which supply a large percentage of the water for the prairie provinces, has now created a new and very challenging task for natural resource managers.

Alberta's forest management strategies need to ensure that we now manage the risk of large scale impacts on forested watersheds by mountain pine beetle in a manner that gives us the best options for not only maintaining the wide variety of commercial and individual uses and activities that have been traditionally found there but for long-term water supply to meet both local and downstream needs.

***Rick Blackwood**, RPF #372, received his Bachelor of Science, Forestry from the University of Alberta in 1983. He has worked as a park warden for Parks Canada Jasper National Park, as a forester with the Alberta Forest Service and as the operations forester and general manager for the Foothills Model Forest. He currently works with Sustainable Resource Development, as the Area Manager, Southern Rockies Area, where he is responsible for all aspects of government service delivery in the area relating to forest and public land management, fish and wildlife, and enforcement including the integration of all program areas within Sustainable Resource Development.*

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Stand Water Balance of Lodgepole Pine Forests in the Absence of Mountain Pine Beetle: Synthesis of studies on transpiration and rainfall interception

Uldis Silins, University of Alberta

Mountain Pine Beetle (MPB) is currently driving change in hydrology of Western Canadian forested landscapes by affecting canopy regulation of forest water balance (transpiration and interception losses). Predicting MPB effects on landscape hydrology relies on understanding how MBP uniquely affects these processes to drive changes in water balance away from baseline or "reference" conditions in lodgepole pine dominated forests. This presentation synthesizes several studies on individual components of water balance related to canopy evaporative losses in lodgepole pine that were not affected by MPB; these components help outline "reference" water balance relationships in lodgepole pine under climatic conditions characteristic of north & west-central Alberta.

Canopy leaf area dynamics and rainfall interception

- Stand leaf area (LAI) peaks early in the developmental sequence of lodgepole pine (roughly around the timing of peak crown closure; ~25 yr. old on productive sites). Volume increment can be used a proxy predict recovery of leaf area in regenerating stands.
- The rainfall interception-storage capacity of canopies varied from 1-4 mm. Because of the dominance of smaller rainfall event sizes within the summer season, interception losses represented 23-37% of growing season precipitation.

Canopy transpiration

- Total daily canopy transpiration averaged 1.5-2 mm/day. Stand thinning reduced canopy transpiration, but after 5 years, crown growth & physiological adjustment resulted in 53% recovery of transpiration initially lost after partial canopy removal.

Total water balance of younger lodgepole pine

- Evaporative losses by the canopy consumed ¾ of total annual precipitation (north-central AB).

Projected (modelled) water balance components - rainfall dominated portion of season ***(Apr 15 - Oct 14)***

		Projected water balance components					Percentage of total annual precipitation (%)				
	Total Annual Precipitation (mm)	Transpiration (mm)	Canopy interception (mm)	Litter interception (mm) *	Total atmospheric losses (mm)	Percolation below litter (mm)	Transpiration (mm)	Canopy interception (mm)	Litter interception (mm) *	Total atmospheric losses (mm)	Percolation below litter (mm)
1985	631	188	122	185	496	202	30%	19%	29%	79%	32%
1986	579	159	102	153	414	182	28%	18%	26%	72%	31%
1987	487	183	87	138	407	161	38%	18%	28%	84%	33%
1988	709	180	100	160	439	255	25%	14%	22%	62%	36%
1989	567	167	114	142	423	159	30%	20%	25%	75%	28%
1990	538	175	99	131	404	116	32%	18%	24%	75%	22%
1991	574	178	109	132	418	122	31%	19%	23%	73%	21%
1992	537	170	111	157	437	115	32%	21%	29%	81%	21%
1993	615	167	111	150	428	183	27%	18%	24%	70%	30%
1994	749	173	96	175	444	248	23%	13%	23%	59%	33%
Average	598	174	105	152	431	174	30%	18%	26%	73%	29%

Dry year
Wet year

* Litter interception storage (5 mm) estimated from Stanton & Golding (1972), and Putuhena & Cordery (1996)

Management Implications

- Presence of healthy forest canopies can exert a very large influence on total water cycling in under Alberta's climate, thus MPB has significant potential to affect this cycling.
- Predicting how potential MPB scenarios & management interventions are likely to impact watershed-scale hydrology (water production, peakflows, etc.) will require key information on how MPB drives changes in stand-scale water balance.

Project members: Uldis Silins, Victor Lieffers, Doug Reid, Brendan Brabender, Kevin Bladon, Pablo Piña and Ellen Macdonald

Uldis Silins *(Ph.D., RPF) is an associate professor of forest hydrology in the Dept. of Renewable Resources at the University of Alberta. His research focuses on how disturbance & vegetation/hydrologic recovery after disturbance affect watershed hydrology. Uldis currently leads the Southern Rockies Watershed Project focused on hydrology of upper foothills / Rocky Mtn. watersheds & how natural disturbance by severe wildfire affects hydrology of high water yielding east slopes watersheds in addition to numerous other smaller research projects dealing with forest hydrology. Uldis works with both the provincial government and industrial forestry sector on approaches to integrated forest watershed management University of Alberta*

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Influence of Mountain Pine Beetle on Site Water Balance

Dave Spittlehouse, BC Ministry of Forests and Range

Objective: Assess the forest water balance changes when the trees are killed by the mountain pine beetle.

Forest cover influences snow interception, snow melt, rainfall interception and evaporation. These, in turn, influence the root zone soil water content and drainage. The magnitude of the effect on the stand water balance of killing the trees was evaluated with a process-based water balance model that is based on work at the Upper Penticton Creek Watershed Experiment, BC. The forest is composed of 100+ years-old lodgepole pine, 20 to 22 m tall at a stand density of 2800 live stems per hectare and 50% canopy cover. The terrain is flat to gently rolling and the soil is 0.6 m deep, loamy sand with 20% coarse fragment content. The red attacked condition was simulated by assuming all the trees in the forest died at once and the needles retained. In the grey attack condition all the needles were assumed to be lost. Simulations were also done for various percentages of killed trees in the stand and for a recent clearcut.

Results:

- The red attack stand still had needles that maintain the precipitation and radiation interception characteristics of a forest; but there is no tree transpiration. The loss of needles in the grey attacked stand reduced precipitation interception, there is no tree transpiration and there is increased light available to the understory.
- The forest had the highest total evaporation (transpiration plus intercepted rain and soil surface evaporation).
- The soil in the red and grey attack stands remained moist during the summer because there was no tree transpiration and only a small amount of evaporation from the shaded understory. Soil moisture conditions are similar to those in a clearcut.
- The forests and red attack stands had similar peak snowmelt rates that are about two thirds of those for a clearcut under the same weather conditions. The rate for the grey attack stand was slightly greater than that for the forest.
- The lower interception capacity of the grey attack stand meant it had more drainage than the forest and red attack stands, but less than from the clearcut. Conditions in the fall influence the difference in timing and amount of drainage from red and grey attack stands and the clearcut as compared to the forest.
- The red and grey attacked stands were intermediate between the forest and clearcut situations for annual drainage.
- A red attacked stand with greater than 60% live trees interspersed with dead trees had similar drainage loss to that of the forest. Summer root zone soil water content was similar to that of the forest.

Management implications: The percentage of dead trees in the stand will influence any changes in the water balance. Red attack stands are somewhat similar to the forests in regards to snowmelt and drainage. Grey attack stands are intermediate between the forest and clearcut. Summer soil moisture may influence the harvesting operational capabilities in red and grey attack stands because the soils do not dry out. The significance of this will depend on soil texture, restrictions to drainage, slope position, the summer precipitation regime and percentage of the stand killed.

Dave Spittlehouse *is a Senior Research Climatologist with the Research Branch, BC Ministry of Forests and Range, Victoria, BC. He has over 25 years experience in forest climatology, ecophysiology, hydrology and climate change. He is a member of the research teams the Upper Penticton Creek Watershed Experiment and Mayson Lake Project determining effects of forest management and forest disturbance on forest hydrology. He is also works on climate change impacts and adaptation assessments in forestry and on the influence of forest management on BC's forest carbon balance. He has represented the Ministry of Forests and Range at the provincial and national level on climate change, greenhouse gas management and forest carbon balance issues.*

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Effects of Mountain Pine Beetle on Channel and Riparian Response

Tim Giles, BC Ministry of Forests and Range

The Mountain Pine Beetle (MPB) is having a significant effect on hydrologic regimes in BC watersheds. Loss of forest cover may result in earlier onset of spring snowmelt, increased spring and total annual streamflow volumes, changes to summer and fall flows, increased water on hillslopes, and more rapid stormflow response. The magnitude of these effects will depend on the extent and distribution of the MPB infestation, the characteristics of the watersheds, and the climate. Hydrologic changes may be gradual if the infestation passes slowly across the watershed, or if the watershed has mixed stand types. Alternately, change can be immediate if, as a result of the MPB, the dead stands burn or there is extensive salvage logging. Salvage logging can promote change in a watershed by disturbing or removing the understory, exposing loose soil, altering the wood budget or by conversion of subsurface flow to surface runoff on roads or trails.

With increased water yields expected as a result of a combination of standing dead, salvage logging and wildfire, the hydrograph within watersheds is expected to change. Peak flows are likely to be earlier in the season and have higher volumes, higher elevation flows may become synchronized with lower elevation flows, and summer and fall low flows may become shorter and less critical. Groundwater levels are expected to rise, and may lead to changing of harvest timing, logging equipment or silvicultural site preparation. With elevated groundwater levels and porewater pressures, there is also the increased risk of soil erosion and landslides. The existing capacity of forest road drainage structures and crossings may be compromised. All of the processes in the watershed eventually lead into the riparian zone and especially into the stream channels.

Stream channels within riparian zones act as the conduit for water, sediment and organic debris out of a watershed. A stream channel is in a state of dynamic equilibrium as hydrology and sediment supply vary and framework elements develop, erode, and migrate downstream. Forest development in a watershed, especially when there is connectivity between the logging or road building and the channel, increases the amount of sediment entering the stream. The results of this will be reflected in adjustments in the channel, increased stream bank erosion, aggraded and widened channels, log jams and degradation of the relatively stable stream framework and function. Observation of an impact to a stream channel often occurs after the forest has been developed and the channel may continue to degrade for many more years.

Tim Giles, *M.Sc., P.Geo., is a Professional Geoscientist with Southern Interior Forest Region in Kamloops, B.C. He is currently studying the relationship between stream channels and hillslope processes throughout the various biogeoclimatic and physiographic regions of south central BC. Twenty-one permanent reach sites have been established, surveyed and photographed with detailed, low-level techniques to form a visual compendium of stream types and conditions. Study watersheds are located on the lee side of the Coast Mountains, in the hot and dry valleys, on the plateau, and in the interior rainforests of the Monashee Range. As part of the long-term Upper Penticton Creek Watershed Experiment, Tim is investigating the effects of forest development on water quality, sediment production and transfer processes. One control and two test watersheds have been studied for 25 years to evaluate the effects of forest harvesting on water in snowmelt-dominated watersheds. In 2003, BC experienced numerous wildfires which burnt extensive areas of productive forest lands. The McLure Fire, located less than an hour north of Kamloops, burnt most of the 135 km^2 Fishtrap Creek watershed, including a Water Survey of Canada gauging weir. Tim and several other researchers saw the opportunity to study the disturbance and subsequent recovery of the stream in a floodplain reach of Fishtrap Creek following the fire. Channel morphology is strongly influenced by the riparian vegetation on the floodplain, the hydrologic processes acting in the watershed to determine peak flows, and by the sediment supply from the hillslopes and upstream channel network.*

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Hydrologic Effects of Front-end Control Compared to Salvage Logging

John D. Stednick, Colorado State University

The mountain pine beetle is killing millions of lodgepole pine trees in Colorado, and has dramatically increased over the past 5 years, especially in North-Central Colorado. Though the beetles are part of forest succession, the natural cycles of the forest have been disrupted over the past century. As a result, the impact of the beetle epidemic is greater than ever before. As the mature lodgepole forests succumb to the beetles, the hydrological processes change, decreasing interception and evapotranspiration, thus potentially increasing soil moisture and streamflow. Research in 1955 on the White River Plateau in Colorado documented an increase in streamflow following a beetle epidemic. This was the first study investigating the effects of beetle-killed trees on water. Given the current beetle outbreak, water yields may increase, but other water resources effects need to be evaluated, especially given the extent of the beetle-killed area.

The USDA Forest Service and the Colorado State Forest Service have developed a timber management plan that includes timber salvage sales, hazardous fuel reduction, forest health chemical spraying, and hazard tree reduction. Some of the practices are used as front-end control and some are salvage. What are the effects of these practices on water resources? These practices vary in the extent of application by ownership, topography, infrastructure, and populated areas to name but some of the operational constraints. This presentation will compare and contrast the effects of different management prescriptions for front-end control as compared to timber salvaging on Colorado water resources. Water quantity and water quality changes may be expected from several of these practices, but Best Management Practices (BMPs) will minimize non-point source pollution and protect water resources.

John Stednick *is a professor in the Department of Forest, Range and Watershed Stewardship in Colorado State University. He teaches courses in watershed science, land use, water quality, and environmental impact assessment, among others. His research interests are in water quality and quantity as affected by land use activities. General areas include forest hydrology, montane water quality and hydrology, best management practices, cumulative effects, water chemistry, hydrometry, risk assessment, standard development, and environmental impact assessment.*

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Overview of Tools and Procedures Used in Alberta to Estimate Increases in Water Yield

R.L. Rothwell, Watertight Solutions Ltd.

The objectives of this presentation are to present an overview of two models used in Alberta to assess the hydrologic effects of forest harvesting, and simulation results of two harvesting scenarios on water yield and peak flows.

WRENSS and ECA-Alberta are used in Alberta to assess the effects of forest harvesting or forest cover removal on water yield and peak flows. The models were developed from the "WRENSS Handbook" developed by the USFS and EPA designed to assess the hydrologic effects of forest management. Both are lumped models that provide estimates of change in annual water yield, peak flows (WRENSS only), and equivalent clearcut area (ECA) from which hydrologic recovery can be inferred.

WRENSS was modified and adapted for Alberta conditions by R. H. Swanson in the 1980's. ECA-Alberta is a simplified version of WRENSS prepared by U. Silins (2003) from the University of Alberta. The data requirements for both models are modest, which make them easy to apply as planning tools for forest managers. Primary data include long term annual precipitation, water yield, watershed aspect (WRENSS only), harvest block area, year of harvest, species for regeneration, site quality and stand growth characteristics.

The hydrologic effects of two harvesting scenarios were evaluated using WRENSS. Scenario 1 was an accelerated harvest where 75% of mature pine was harvested in 20 years. Scenario 2 was a mountain pine beetle infestation, where trees were salvaged as the infestation developed for the first 10 years followed by complete mortality of all trees by the end of a second ten years. In the second period only a portion of the beetle killed trees were salvaged.

The same watersheds were used in both scenarios, and ranged in size from 5-248 km^2. Watershed areas harvested in Scenario 1 ranged from 10-62% compared to 25-89% in Scenario 2. Water yield increases in Scenario 1 ranged from 4-30% compared to 11-96% in Scenario 2. The larger increases in Scenario 2 are driven largely by the greater extent of tree mortality. Changes in annual maximum daily flows followed a similar pattern. Increases in the 2-5 year events for the accelerated harvest were 2-52% and 2-38% respectively. Increases for the beetle infestation scenario for 2 and 5-yr events were greater ranging from 13-92% and 7-50% respectively.

Assessment of the significance of increases in water yield and peak flow is difficult. No established criteria have yet been established to define acceptable and unacceptable changes in water flows. One possible approach is to use the upper 95% confidence limit of the mean annual water yield used as a base to calculate percent changes. Another approach is to use the upper limit of the "natural variability" of flows in a region, defined at the mean flow ± 2 standard deviations as starting point to set limits on 2-5 years events where the effects of land use are considered to have the most effect on water flows.

R.L. Rothwell *(PhD) started his career in Forestry with the Canadian Forestry Service in Calgary 1966, where he worked in the East Slopes Watershed Research program, a multi-agency program, evaluating the hydrologic effects of forest harvesting on water flows and water quality. His work focus was on development of watershed management guidelines for forestry harvesting and the effects of road-stream crossings on water quality. He completed a PhD while with the Canadian Forestry Service on the dynamics of sapwood water content of lodgepole pine. In 1976 he joined the forestry program at the University of Alberta, where he taught and researched in the areas of forest hydrology, peatland hydrology, and mechanical site preparation. After 21 years with the University he retired in 1997 and started a forestry consulting business (Watertight Solutions Ltd) providing hydrologic advice and input for forest planning, hydro-metric monitoring, training programs for the forest industry community.*

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Overview of Tools and Assessment Procedures Used in British Columbia

Cam Brown, Forsite Consulting

The mountain pine beetle (MPB) epidemic is having a profound effect on BC's forest ecosystems, and in an effort to further understand the potential MPB risk before and after an expected infestation across the Kamloops TSA, a multidisciplinary team has developed a GIS-based watershed risk assessment procedure. This assessment was applied to 371 drainage units in the Kamloops TSA. Relative rankings were used to help identify watersheds that require a more detailed assessment and where an investment of management resources could yield the greatest risk reduction. The project utilized three overlapping spatial scales (watersheds, basins, subbasins) so that it could capture cumulative watershed effects occurring in large drainages while also focusing on smaller basin/subbasin units within these larger units. Separate risk rankings for social values and environmental values were completed for both current and post mountain pine beetle (MPB) scenarios.

Cam Brown *is a Strategic Planning Forester with Forsite Consulting in Salmon Arm, British Columbia. Cam holds a BSF from the University of British Columbia and a Masters of Forestry from Oregon State University. He is a Registered Professional Forester in BC and has worked in consulting for the past 11 years - first in forest operations and then in strategic planning and analysis. Cam's recent work experience has included timber supply analysis to set annual allowable harvest rates, strategic silviculture analysis, policy change impact analysis, GIS based watershed risk assessments, analysis to support establishment of new tenures, and numerous landscape level planning projects.*

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British Columbia Regulatory Approaches

Dave Maloney, BC Ministry of Forests and Range

The presentation will outline the British Columbia Ministry of Forests and Range response to the mountain pine beetle infestation as it relates to forest hydrology. The presentation will identify three components. The first component identifies the regulatory regime within which forest licensees have to operate, their forest management responsibilities and the scale of the mountain pine beetle issue. In 2006 forest legislation moved from being plan and process based code to a results based code. In the new results based framework, industry was given an increased level of accountability for the results and outcomes of their practices.

The second component identifies the Ministry of Forests and Range response to the mountain pine beetle epidemic as it relates to forest hydrology. Topics addressed include the distribution and responsibilities of hydrologist in B.C., their response to the beetle infestation, and the projects they initiated to resolve critical data gaps.

The third component is a view backward to identify what could have been done differently. This component is designed as a "heads up" for hydrologists who will have to deal with the mountain pine beetle in the near future. This component identifies the need to co-ordinate a response, set priorities, have access to current inventories, promote landscape planning early on and to have a single point of contact to disseminate research results and initiate regulatory changes as required.

Dave Maloney *(M.Sc., P. Ag.) joined the BC Ministry of Forests and Range in 1994 as an assistant research hydrologist in the former Prince Rupert Forest Region. In 2000 he moved to Prince George to become a regional research hydrologist for the Northern Interior Forest Region. While a research hydrologist his research work included forest canopy interception, soil moisture and harvesting impacts on riparian habitat. In 2005 Dave began working for BC Ministry of Forests and Range, Forest Practices Branch to become the provincial technical advisor, watershed science. Current duties include managing the development of a water quality effectiveness evaluation procedure to assess forestry impacts on water quality, assessing mountain pine beetle impacts on forest hydrology and runoff, fish/forestry interaction issues, and riparian management.*

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Operational Challenges for Forest Managers in British Columbia

Shawn Meisner, Tolko Industries

The Cariboo region of British Columbia has a long experience with mountain pine beetle epidemics. The most recent epidemic arose in the mid 1990's and has progressed to a level where the harvest of the vast mountain pine beetle infested forest of the Cariboo has switched from control to salvage and the economic stability of many communities has been placed at risk. As viewed from an operational timber planning perspective the presentation offers a history of this epidemic, the approach that was used in attempting to control the epidemic, the hurdles that were faced, some current issues around hydrological management and closes with some questions for Alberta to consider as it now faces its own mountain pine beetle epidemic.

Shawn Meisner: *Graduating UNB and moving west in 1992, Shawn worked within the consulting industry for three years before joining Lignum, now Tolko. As a member of Tolko, Shawn has seen the rise of the mountain pine beetle epidemic from its early stages to its current state of salvage. Through this time Shawn has been involved in all aspects of beetle management from probing, to pre-harvest layout and supervision of single-tree salvage, to the harvest of large expanses of beetle infested timber. Shawn now primarily deals with regulation, due diligence, land use planning and certification; but still keeps his feet on the ground through supervising pine beetle salvage and Douglas-fir bark beetle control for various Tolko partners. Shawn is a registered professional forester based in Williams Lake, British Columbia.*

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Challenges in Developing a Pro-Active Mountain Pine Beetle Timber Harvest

Peter Denney, Sundre Forest Products

Implementing a Mountain Pine Beetle Response Plan prior to a beetle epidemic in the watersheds and playground for Calgary and Red Deer presents numerous challenges.

Sundre Forest Products operates a Forest Management Area of 500,000 hectares north- west of Calgary and west of Red Deer. The terrain is rugged, beautiful and relatively un-roaded. The forest is old and dominated by lodgepole pine. The watersheds include many of the tributaries to the Red Deer and North Saskatchewan Rivers.

Pro-actively addressing a Mountain Pine Beetle epidemic means accelerating the harvest of susceptible stands which in turn requires abandoning developed harvest plans, re-sequencing and accelerating the planning process, all, in an environment of uncertainty.

Sundre Forest Products is grappling with the uncertainties of when and where the beetle attack will occur, the reliability of the MPB Susceptibility Model's ability to predict beetle survival and what control strategies can be initiated on the non FMA lands.

Clearly, responding quickly, and addressing peak water flows are two priority challenges. Sundre Forest Products has developed a road design tool utilizing LiDar that improves response time. We have also developed tools and a process to address the impacts of harvesting on the watersheds within the FMA. These processes will be discussed.

Peter Denney *graduated from the forestry program at the Northern Alberta Institute of Technology in 1967, took Business Administration at the University of Alberta in 1972-74 and is a long standing Registered Professional Forester. The first half of his career was spent providing consulting and silviculture services to Alberta's forest industry. In 1991 he joined Sunpine, now Sundre Forest Products, where he has been involved with the development of two forest management plans and is responsible for harvest Planning.*

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Speakers' gifts are generously donated by the
Foothills Model Forest.

The Sustainable Forest Management Network is pleased to provide
planning and financial contributions.

The assistance of the College of Alberta Professional Foresters and the College
of Alberta Professional Forest Technologists is gratefully acknowledged.

Presentations from this workshop will be available from the SFM Network website, www.sfmnetwork.ca, under the "Events / Previous Workshops" section.

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