Culvert Inlet Sizing Alert – Mountain Pine Beetle Epidemic

As of 2004 the mountain pine beetle (dendroctonus ponderosa) had attacked and seriously affected over seven million hectares of BC forests. The infestation continues to spread and has cost over $2.1 million in relief from the Federal and British Columbia governments to help deal with the problem. The beetle, which infects only mature lodge pole pine is devastating the lumber industry. The communities that are supported by the industry, depend on the sustained management of this valuable resource.

AERIAL VIEWS OF BEETLE KILLED (RED & BLACK) LODGE POLE PINE

BC forests are full of 80 year old, mature trees. Through forest fire control and intensive management practices there is estimated to be three times more mature trees than existed in the forests of 90 years ago. The beetle is indigenous and is killed by natural fire events and extreme cold. Recent hot dry summers, attributed to climate change, leave the trees distressed and more prone to infestation and to wild fire. Mild winters in recent years have allowed the beetle population to run rampant.

In an attempt to salvage the economic value of the trees, lumber companies are racing to harvest the dead timber before it rots. The loss of trees and vegetative cover, resulting from mountain pine beetle kill, is causing major changes to the way water falls to the ground, is stored and runs off of the land. The hydrology of British Columbia is rapidly being altered. We are seeing dramatic changes in runoff volumes, erosion, sedimentation and floating debris. These changes will necessitate major changes to the design of new culverts, bridges and highways. In many cases existing structures will require upgrading to accommodate the change in runoff volume and debris from the dead timber.

Each mature pine tree absorbs and transpires back into the atmosphere about 200 litres of water per day. In a healthy forest only about 2% of precipitation actually runs off of the land. About 30% of precipitation is caught in the

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forest canopy as rain and snow. From here it evaporates or sublimates back into the atmosphere. Without a canopy the snow falls directly to the ground increasing the snow pack and ultimately increasing spring runoff. Runoff volume is generally expressed as a percentage ratio. It doesn't take that much more water to increase runoff volume by 20% and turn what was traditionally a ten-year storm into a one hundred-year storm event. There is considerable work being done at the BC Ministry of Forests (BCMOF) and at the University of British Columbia to better understand the consequences of deforestation of this magnitude. The challenge is significant, as most research to date has been done on smaller plots using the "paired watershed approach". It is difficult to extrapolate the data to a problem of this scale.

Much can be learned from the Rocky Mountain Research Station, United States Department of Agriculture (USDA). They have spent several years studying the effects of forest fires and have developed several approaches to post-fire rehabilitation. (Evaluating the Effectiveness of Post-fire Rehabilitation Treatments, Robichaud, Beyers and Neary Sept. 2000, see CSPI Tech Bulletins). A fire, whether in a healthy forest or a beetle killed forest increases the magnitude of the problems as not only are the mature trees and canopy lost but the moisture absorbing organic soils may also be destroyed. Although dependent on many variables it is not uncommon to see a one hundred times times increase in runoff and a one thousand times increase in erosion and sedimentation after a wild fire.

Understanding the consequences of increased runoff due to land use changes upstream is not a new science. It is the basis of modern storm water management and most often is applied in urban development design as farmland and forests are paved over. A typical example of the consequence of deforestation occurred in the fall of 2004 near Thunder Bay Ontario, when a major storm event

RACING TO HARVEST DEAD TREES

EARLY STAGE OF INFESTATION

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picked up a heavy debris load and washed out several bridges and a 1.2 metre span timber box culvert that had performed adequately for fifty years. The Trans Canada Highway was closed for a few days while a much larger 3000mm diameter CSP was fabricated in extra long lengths, delivered to site under police escort and installed. Selecting Larger Culverts is part of the solution as they are less likely to become blocked with sediment and debris and will carry the higher volumes due to increased peak flows. A designer must anticipate changes to runoff patterns and volumes in the future.

The capacity of most road culverts is governed by inlet control. It is possible to modify with Improved Inlets, both existing and newly installed culverts to significantly increase capacity and performance while optimizing conduit size and costs.

Trash, debris and sediment buildup is a consequence of deforestation. Trash and uprooted trees can block the inlet of a culvert causing water to build up and ultimately flow over the road. In many cases wash outs of the installation will occur. Several designs are available to intercept debris to protect the culvert entrance. In some cases two stage inlet chambers can accommodate both normal flow and fish passage while providing an emergency overflow inlet. Regular inspection and removal of debris from culverts and upstream channels, particularly after storm events, will help to reduce losses.

Overflow Structures can be a cost effective way to accommodate the increased flows, which in many cases are significant. In high fill situations, large diameter CSP overflow pipes can be economically installed higher in the fill to provide extra capacity. In cases where water over the road is not an issue an armoured ford crossing is an economical compromise.

BEETLE ENTRY POINTS

BEETLE ENTRY POINTS INFECTED AREA UNDER BARK

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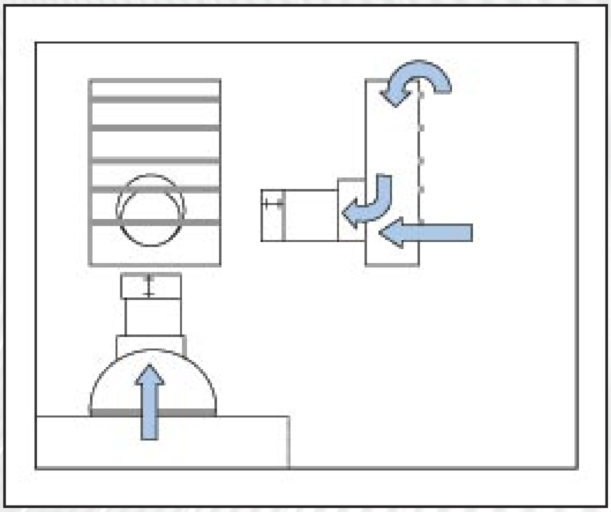
These crossings should be installed away from the main crossing, with lower pavement elevations than the main crossing, to minimize damage in the event of road topping.

Check Dams and Designing Road Embankments as Dams is an effective way to reduce damage downstream and to slow the erosion process. By restricting the main pipe size and constructing drop inlets or elevated overflow pipes, peak flows can be delayed. If a road is to act as a dam it must be constructed as a dam with measures taken to prevent saturation of the fill, erosion or scour (particularly near flow structures). Piping along the outside of the conduit can be controlled with cut off walls and anti seepage collars.

Slope Stabilization and natural vegetation replacement are key elements to the long term management and rehabilitation. In forest fire areas logs are dug into side hills along the contour to effectively slow down runoff and catch sediments and moisture. Seeding with various grasses and other plants will help to stabilize the slope until reforestation can catch up.

Taking initiative with the Inlet Design of Corrugated Steel Pipe will reduce the likelihood of failure due to excessive water volumes and debris. CSP is available in a wide range of shapes and sizes to accommodate many drainage challenges. Special designs are easily fabricated in steel to manage unique situations. Environmental changes will significantly alter flow patterns creating new challenges for drainage engineers and the structures they design. Designers will be required to specify larger pipes and structures, with protected inlets to manage the floodwaters of the future.

EMERGENCY REPLACEMENT FLOODED BOX CULVERT WITH CSP



TRASH INLET GUARD