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BIOENGINEERING TO RESTORE ECOLOGICAL LOSS AFTER WILDFIRES

LOCATION: FORT MCMURRAY AND SURROUNDING AREA
CLIENT/OWNER: REGIONAL MUNICIPALITY OF WOOD BUFFALO
CONSULTANT: ASSOCIATED ENGINEERING
SUBCONSULTANTS: POLSTER ENVIRONMENTAL SERVICES & THURBER ENGINEERING

Associated Engineering

REBUILDING ECOLOGICAL RESILIENCY

IN MAY 2016, THE HORSE RIVER WILDFIRE IMPACTED OVER 500,000 HECTARES OF LAND IN FORT MCMURRAY AND ITS SURROUNDING AREA. THE WILDFIRE SIGNIFICANTLY IMPACTED THE HYDROLOGIC FUNCTIONS OF THE SURROUNDING WATERSHEDS. RECOGNIZING THE RISKS OF EROSION TO LOCAL COMMUNITIES, BIOENGINEERING WAS SELECTED AS THE PRIMARY EROSION REPAIR STRATEGY. ALREADY THE LOCAL COMMUNITIES ARE SEEING THE BENEFITS OF REMEDIATION WORKS. THE FOREST HAS BEGUN TO REVEGETATE.

BIOENGINEERING TO RESTORE ECOLOGICAL LOSS AFTER WILDFIRES

EXECUTIVE SUMMARY

In May 2016, the Horse River Wildfire devastated the community of Fort McMurray and its surrounding areas within the Regional Municipality of Wood Buffalo (RMWB) in Northern Alberta. Affected areas lost significant vegetation and soil function, resulting in increased runoff and erosion. Additionally, the equipment used by fire control crews to create firebreaks altered natural drainage patterns, compacted existing soils, and reduced the ability for these areas to absorb water.

The RMWB retained Associated Engineering to assess and prioritize wildfire-related erosion sites and to develop and implement design solutions to address erosion and drainage issues and remediate select fire-damaged areas.

Recognizing that traditional solutions requiring heavy construction equipment would further damage the environment, the Associated team recommended bioengineering as the primary erosion repair strategy, augmented by conventional engineering solutions.

Bioengineering involves soil treatments and revegetation with live tree staking to increase soil strength, and reduce stormwater runoff and erosion.

A team of multi-discipline engineers and environmental scientists collaborated to evaluate 300 sites, develop criteria for prioritizing sites for restoration, and design integrated bioengineering and engineering solutions for 14 prioritized sites.

Almost 7 hectares of land were restored—one of the largest bioengineering projects in the Regional Municipality of Wood Buffalo. This project demonstrates the success of combining natural and engineered solutions to address erosion, drainage and slope stability issues, and supports the economic viability of bioengineering for broad-based erosion control.

Already, restored areas have started to build ecological resiliency, reviving watersheds and wildlife habitat.

BACKGROUND

The 2016 Horse River Wildfire devastated Fort McMurray and surrounding areas in the Regional Municipality of Wood Buffalo (RMWB) in Northern Alberta. Homes and businesses were destroyed, and the natural environment was charred. Over 500,000 hectares of land were incinerated. Burned areas lost vegetation and soil function, increasing stormwater runoff and erosion.

As part of the immediate emergency response, firefighters created firebreaks by clear cutting trees and shrubs. Firebreaks prevented fire from spreading to private and public properties, but the equipment used to create the firebreaks altered natural drainage patterns, compacted existing soils, and reduced the ability for these areas to absorb water, instead causing drainage to flow to erosion-prone areas.

Conn Creek Ravine Firebreak

Erosion in fire-ravaged area

Recognizing the potential for flooding and landslides from these areas to damage public and private property and the natural environment, the RMWB retained Associated Engineering to prioritize wildfire-damaged erosion sites and develop restoration solutions.

INNOVATION

The integrated team of engineers and environmental scientists conducted a preliminary assessment which identified more than 300 sites. To short-list and prioritize sites for remediation, the team developed evaluation criteria and a rating system to help with prioritization. Fourteen sites, predominantly ravines and steep slopes, were prioritized as having the most potential risk to property and the environment.

The team recognized that traditional engineering solutions that required heavy equipment for construction would further damage the sensitive environment. Thus, the project team recommended bioengineering as the primary erosion repair strategy, augmented by conventional engineering solutions. Bioengineering involves soil treatments and revegetation with live tree staking. While bioengineering had not previously been used on such a large scale, with one of the 14 areas (Conn Creek Ravine) being 4 hectares, the team saw the benefits of bioengineering.

BIOENGINEERING HAD NOT PREVIOUSLY BEEN USED ON SUCH A LARGE SCALE, WITH ONE OF THE AREAS BEING 4 HECTARES.

Live stakes are planted by hand and thus would not cause major disturbance to environmentally sensitive areas; no heavy equipment is required in waterways. Bioengineering restores eroded areas and effectively manages stormwater. Solutions are self-sustaining and mitigate climate change by sequestering carbon.

Due to the diversity of terrain, damage, hazard, and risk to property and the environment, the team had to evaluate and develop unique solutions for each site, combining various bioengineering and engineering techniques.

Almost 7 hectares of land were restored—one of the largest bioengineering projects in the Regional Municipality of Wood Buffalo. This project demonstrates the success of combining natural and engineered solutions to address erosion, drainage and slope stability issues. Already, revegetated areas have started to build ecological resiliency and restore watersheds and wildlife habitat.

Surface roughening soil treatment at Conn Creek Ravine site

COMPLEXITY

The team developed a list of factors, including drainage, runoff area, erosion, and soil compaction, and related risk to infrastructure, private property or environmentally sensitive habitats to prioritize sites for remediation. They then evaluated and categorized factors at each site on a predetermined rating system. Field data was processed and included with LiDAR and infrastructure datasets to develop a matrix for site prioritization.

Fourteen sites were prioritized, typically ravines or steep slope, where access for construction equipment would be challenging and could result in further disturbance. The team employed a combination of bioengineering and traditional engineering techniques for rehabilitation.

Bioengineering techniques included surface roughening, dense live toe staking along creeks, live silt fencing, live popular staking, wattle fences (short retaining walls built of live cuttings on steep slopes) and live pole drains (bundled cuttings in shallow trenches to direct drainage). Bioengineering techniques were integrated with engineering solutions, such as culverts and riprap, to prevent erosion.

Adding to the complexity, live cuttings had to be collected while plants were dormant from September to May. Cuttings were planted using hand tools, avoiding the need to isolate creeks and salvage fish. Construction took place during periods of low flow so that crews could perform live staking along the toe zone of creeks without working in water.

INTEGRATING BIOENGINEERING AND TRADITIONAL ENGINEERING SOLUTIONS BENEFITED REMEDIATION.

Because local contractors did not have bioengineering experience, Associated's team took the unique and unprecedented approach of training all contractors bidding on the project on bioengineering installation methods to allow for competitive bidding.

Conn Creek after bioengineering treatment

SOCIAL AND/OR ECONOMIC BENEFITS

Bioengineering construction was a new approach for land restoration for local contractors. Project staff conducted a bioengineering workshop, comprising both classroom and hands-on field work, for all contractors bidding on the project.

The workshop gave local contractors the opportunity to familiarize themselves with the scope of work, the various bioengineering techniques that would be employed, and considerations for stake harvesting, storage, planting, and maintenance. This approach ensured competitive bids and mitigated the risk of scope changes during construction.

This project restored almost 7 hectares of the 500,000 hectares of land impacted by the 2016 Horse River Wildfire, successfully demonstrating the application of bioengineering for ecological restoration of landscapes. The project sets the stage for future restoration work in the RMWB area and builds capacity for the local construction industry to undertake this work in Wood Buffalo, as well as other bioengineering projects.

Many of the restored sites are in public areas, providing the opportunity for public education and social learning through public exposure to the ecological recovery strategies. At the Conn Creek Ravine site near the popular Birchwood Trail system, interpretive signage provides educational opportunities for trail users.

THIS PROJECT DEMONSTRATES THE ECONOMIC VIABILITY OF BIOENGINEERING FOR EROSION PROTECTION.

The 4-hectare Conn Creek Ravine site, the largest of the 14 sites restored on this project, had a cost of $1.36 million. By comparison, covering the equivalent restoration area with riprap, a traditional engineered erosion protection approach, was estimated at approximately $4 million. This project demonstrates that bioengineering is an economical and viable solution for erosion protection.

Conn Creek Ravine after bioengineering treatment

ENVIRONMENTAL BENEFITS

Bioengineering techniques for landscape and watershed restoration mimics natural processes, conditioning soil and establishing live plants which accelerate and promote natural revegetation of damaged areas. Live stakes use poplar and willow species, both approved FireSmart trees which have enhanced resilience to fires.

Bioengineering reduces soil erosion throughout the sites impacted by wildfire, and, as a result, sedimentation in waterbodies will be reduced. Soil loss assessment for pre- and post-treatment conditions at the sites shows the effectiveness of soil bioengineering treatments. Slope lengths are shortened by the surface roughening soil treatment and established vegetation increases infiltration.

Bioengineering accelerates revegetation and restoration of the natural hydrologic functions within watersheds. The restored landscape will be more resilient to climate change and will likely respond or recover faster from climate change events, like flooding. Bioengineering enhances the ability to build resilience within watersheds. Watershed health is inextricably linked to erosion and flooding issues due to issues related to peak runoff during major storm events.

Bioengineering also supports climate change mitigation, through carbon sequestration, with increasing rates of carbon capture as tree matures.

BIOENGINEERING REDUCES GREENHOUSE GAS EMISSIONS.

Employing bioengineering minimized construction impacts for sensitive sites on the project, such as Conn Creek. With hand planting, no heavy equipment was required in creeks or on steep slopes, such as Conn Creek Ravine, for construction which avoided additional disturbance to soil, habitat, watersheds, waterways, and aquatic life. The result is sustainable restoration and improvements to ecosystem functions, watershed resiliency, water quality, nutrient cycling, carbon sequestration, habitat, and biodiversity. Vegetation is resilient requiring little-to-no long-term maintenance, such as watering or grass cutting. Already trees and plants have grown restoring treated areas.

Balsam poplar stakes

MEETING CLIENT'S NEEDS

The 2016 wildfire in Fort McMurray destroyed homes, businesses and infrastructure, and severely impacted the natural environment, wiping out forests, destabilizing slopes, and damaging watersheds.

Recognizing the flood and landslide risks to private property, public infrastructure, and environmentally sensitive areas, the Regional Municipality of Wood Buffalo retained Associated Engineering to develop solutions for erosion protection and slope stabilization.

Associated Engineering's team recommended bioengineering, augmented by traditional engineering, to restore the devastated landscape. The team evaluated 300 sites, prioritizing 14 locations for rehabilitation based on detailed hazard and risk assessments.

The team recommended a combination of traditional engineering and bioengineering techniques at each site, based on the type of rehabilitation required. The team trained local contractors on bioengineering installation and developed a construction plan to manage a variety of ecological timing windows and constraints to optimize the construction schedule, and ensure quality and cost effectiveness.

After one growing season, the community is already seeing the benefits of restoration works. The restored sites no longer experience erosion and runoff. Plantings have taken root, filling in the firebreaks and bare erosion sites with new foliage; in essence, the forest is regrowing. As an added benefit, the plantings are self-sustaining and require little-to-no maintenance. As the plantings continue to establish, they will create conditions that promote later seral species to grow, further stabilizing the soil and increasing ecological functions.

This project demonstrates on a broad scale that bioengineering can be employed to prevent erosion, stabilize slopes, and restore watersheds and wildlife habitat.

BIOENGINEERING CAN BE EMPLOYED TO PREVENT EROSION, STABILIZE SLOPES, AND RESTORE WATERSHEDS AND WILDLIFE HABITAT.

CONCLUSION

In total, 300 sites damaged during the 2016 wildfire in the Regional Municipality of Wood Buffalo were evaluated for erosion and runoff control and restoration. Fourteen locations were prioritized for rehabilitation using a combination of bioengineering and traditional engineering techniques.

Bioengineering mimics natural processes for soil conditioning with live stake planting to accelerate and promote natural revegetation. This is done using poplar and willow species that are supported by FireSmart principles, for enhanced resiliency in the event of future wildfires. The principles of bioengineering also support climate change mitigation, through carbon capture and establishment of dense woody vegetation for the benefit of future generations.

After one season, the Regional Municipality of Wood Buffalo is already seeing the benefits of the works completed to date. Erosion and runoff from the critical sites has been mitigated. There is the added benefit for the community aesthetics as the live stakes have started to establish, filling in the fire breaks and bare erosion sites with new foliage. In essence, the forest is being revegetated through the efforts of bioengineering.

BIOENGINEERING IS AN ECONOMICAL AND ENVIRONMENTALLY SUSTAINABLE APPROACH TO PREVENT EROSION AND RUNOFF AND RESTORE FIRE-DAMAGED LAND.

One of the largest projects of its kind in the Regional Municipality of Wood Buffalo, the 2016 Wildfire Erosion and Drainage Control project demonstrates the broad-scale application of bioengineering for erosion protection.

Associated Engineering's integrated team employed bioengineering techniques to restore almost 7 hectares of land in Fort McMurray devastated by the wildfire. Already, trees have established, rebuilding ecological resiliency, reducing potential for landslides, mitigating the impacts of flooding, and restoring watersheds and wildlife habitat.