Title

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Engineered Logjam Technology: A Self-Mitigating Means for Protecting Transportation Infrastructure and Enhancing Riverine Habitat

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Abstract

Transportation projects set within river valleys are susceptible to incurring economic and environmental costs when they fail to recognize and accommodate geomorphic processes. For example, overlooking natural processes such as channel migration can lead to costly protection measures that adversely impact aquatic habitat and further exasperate problems elsewhere. In situations where proposed protection measures may adversely impact endangered species, the resulting regulatory constraints can result in major delays and cost overruns. River-reach assessments and new engineering technologies can provide transportation managers with valuable tools to find sustainable solutions to develop and maintain transportation infrastructure in sensitive environments. Reach assessments provide valuable scientific information on how a river has changed through time and how it is likely to change with or without the implementation of a particular project. New "biomimicry" technologies such as engineered logjams, which emulate natural conditions, offer a self-mitigating approach that successfully achieves project goals and regulatory requirements. Since transportation corridors occupy significant portions of stream and river valleys, the cumulative affect of implementing this type of approach presents a cost-effective opportunity for sustaining and restoring ecological integrity throughout the world.

Scientific advancements in the understanding the role of woody debris in river ecology has led to increased efforts and regulations to restore natural wood function to rivers. There are numerous benefits and advantages of strategic, well-designed wood placement in rivers, such as: food-web support, increased hyporheic connectivity and exchange, creation of salmonid spawning and refuge-habitat rehabilitation, bank protection, grade control, and debris retention. Wood is often a required element in bank-protection design for obtaining environmental permits in the PNW. However, there are currently no industry standards and protocols for the re-introduction and management of wood in rivers. Wood placement for habitat enhancement has largely been done without adequate scientific and engineering design and little or no consideration of consequences such as future debris accumulation, channel change, flood inundation, and safety hazards. The lack of engineering standards and information on the structural performance and longevity of wood-debris habitat structures has hindered the development and application of wood-based structures to treat traditional river-engineering problems.

The long-term success of river restoration efforts will depend on well-designed projects and how human encroachment into fluvial domains is managed to tolerate natural processes such as channel migration and wood loading. Functional wood loading can have significant effects such as channel avulsions and increased flood frequency. While these processes have important ecologic benefits, they can adversely impact human development that is not prepared to deal with the consequences. Efforts to expand protection of riparian forests, delineate channel migration zones, and in-stream habitat restoration will all lead to more wood in rivers. Thus the hydrologic and geomorphic consequences will increase in the coming decades. We present a design protocol that includes geomorphic analysis of channel dynamics and riparian conditions, force balance (stability), hydraulics, scour, constructability, material specifications, cost projections, risk assessment, and liability. Engineered logjam technology presents a rigorous alternative for reintroducing woody debris and natural complexity to rivers, while also treating traditional problems such as bank erosion. Engineered log jam projects constructed over the last 10 years demonstrate that this technology is capable of providing sound solutions that protect highways and restore aquatic and riparian habitat.

Biographical Sketches: Timothy B. Abbe, Ph.D., L.E.G., L.H.G., director of river science and geomorphology, Herrera Environmental Consultants. Tim Abbe has 17 years of experience in geology, geomorphology, environmental restoration, applying engineering principles in environmental project design, and solving problems in urban fluvial and coastal environments. He has pioneered the development of engineered logjams, which are artificial structures that emulate naturally occurring stream structures to achieve particular purposes (e.g., bank protection, grade control, and sediment trapping). His work on engineered logjams has offered new technology to professionals who must comply with environmental regulations while solving traditional problems such as runoff and bank erosion.

Jennifer Black Goldsmith is a senior scientist with Herrera Environmental Consultants in Seattle. Ms. Goldsmith has 14 years of experience conducting natural-resource assessments throughout the Pacific Northwest. Her professional expertise includes water resources, water quality, geomorphology, and forestry. Ms. Goldsmith has extensive experience preparing water-resource analysis documentation for a variety of environmental impact statements, reach analysis, environmental assessments, and permit applications for a variety of projects.