Mass stabilization processing of impounded sediments in dam removals promoting ecological river restoration and upland beneficial use

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Introduction: From a global perspective**,** dam removals are increasingly urgent due to aging infrastructure, flood safety issues, fluvial recreational demands, and changing priorities in conservation management. Dam removals are frequently intrinsic to watershed restoration efforts designed to promote ecosystem recovery. Of interest to SedNet is the interconnection of the riverine to the sea system (Mountains to the Sea) which takes into account the soil-sediment-water interface. Sediment quantity and quality behind a dam plays a complex role in determining engineering and environmental considerations for dam removal and subsequent downstream recovery. In many cases, marked increases in sediment transport due to upstream development/deforestation have accelerated the buildup of sediment loads behinds dams raising reservoir pool elevations to the point of by-passing. Through the Mountains to the Sea journey, contaminated sediments originating in urban catchment areas are concentrated in the loadings settled behind the dam. Sediment storage capacity as well as sediment quality characteristics will determine the design and engineering viability of dam removal scenarios and ability to achieve subsequent downstream - River to the Sea- ecological recovery.

Challenge: Management alternatives to address removal actions of sediments impounded behind a dam need to take into account the working site access and consideration of sediment beneficial use options because of the large sediment volumes (and subsequent disposition) that usually need to be dredged. Sediment quality parameters that include contamination from watershed historical and point/non-point sources are critical in determining removal strategies. Failure to proactively identify and plan for contamination could result in a release of impaired sediments into the restored riverine system. Conventional removal strategies such as hydraulic or mechanical dredging, can pose significant challenges for both distance transport and final disposition (and beneficial use) of the sediments. The challenge is to balance an engineering cost effective solution that processes large volumes of contaminated sediments quickly in conjunction with the dam removal schedule. Passive dewatering, geotubes or mass stabilization with pozzolanic binders offers these options. Beneficially using the sediments upland adjacent to the dredging site to construct a community-supported recreation area is a vision that encompasses a sustainable circular economy approach by design and end use – sediment becomes a resource and not a waste.

Case Study: Gorge Dam located on the Cuyahoga River in Akron, Ohio USA was at the fulcrum of the US environmental movement. Historical pollution in the river have caused 14 major fires making the Cuyahoga a symbol of urban riverine degradation. Excessive nutrients, low dissolved oxygen, change in riverine flow alteration, loss of benthic habitat and contaminated sediments have resulted in the Cuyahoga River being designated as a Great Lakes Area of Concern by the International Joint Commission (US and Canada). To facilitate restoration of the Cuyahoga River, Gorge Dam sediments will be removed in 2022-2023 and the dam removed by the end of 2024. Behind the dam reservoir pool, 670,000 m^3 of contaminated sediments must be dredged, transported 3.2 km to an upland 35-acre former landfill adjacent to the river and used for a beneficial use application acceptable to all stakeholders. Based on removal efficiency, site limitations, scheduling of the dam removal and beneficial use considerations, mechanical dredging and mass stabilization has been selected as the appropriate removal methodology. In-line Pneumatic Flow Tube Mixing (PFTM) which has an output of an engineered structural fill (similar to flowable fill) will mix by turbulence the sediment with Portland cement and other binders such as Cement Kiln Dust. The PFTM is a self-enclosed barge mounted system that can be pumped up to 1 km and further with booster pumps. The amended sediment will be placed upland on the 35-acre former landfill. Native grasses and trees will be planted for reforestation.

Gorge Dam program design, geotechnical treatability tests, material handling and beneficial use restorations applications will be presented highlighting the PFTM stabilization sediment processing campaign. Dam history, sediment quality, volume removal considerations, engineering complexity, and beneficial use restoration are significant requiring innovative, public acceptability with sustainable outcomes.