Geochemical Aspects to Reusing Dredged Canal Sediment

9 July 2020 | Member's Blog

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Figure 1. Forth and Clyde Canal at Dalmuir, Clydebank – 1970s. Source Scottish Canals.

Geochemical Considerations on the Beneficial Reuse of Dredged Canal Sediments

Britain's canal network was instrumental in the rapid explosion of the industrial revolution in the late 18thcentury, allowing efficient transportation of coal and iron to industrial centres and of products to market. The canal network began to diminish in importance with the advent of rail transportation in the mid-1800s, but still served commerce until the 1960s; the larger ship canals are still used. By the late 20th century many canals were abandoned, derelict (Figure 1), impacted by pollution, and were

thirty canal obstructions via new road bridges, locks, and the iconic Falkirk Wheel canal lift (Figure 2).

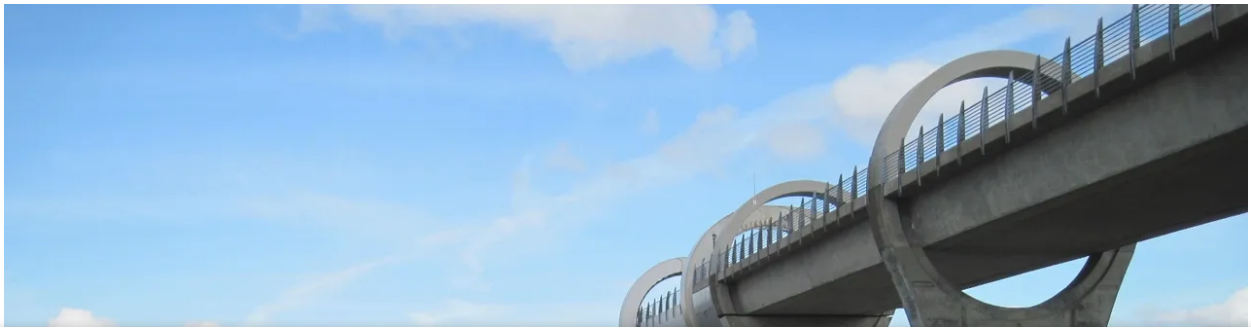

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Figure 2. The Falkirk Wheel which links the Union Canal to the Forth and Clyde Canal.

Like all water bodies, canals receive input of sediment from runoff, pollution, and natural sediment in streams that feed the canals. Sediments are generally organic-rich silt and fine sands in texture, with the obligatory complement of urban waste, such as shopping carts and old bicycles. Frequent dredging is therefore required to maintain navigation (Figure 3).

Under the 2008 EU Waste Framework Directive (European Union 2008), all dredged sediment is classified as waste and must be disposed of in accordance with the waste regulations within each country. In Scotland (Scottish Government 2011), there are exemptions that allow dredged sediment to be spread on land for agricultural improvement or the reclamation/improvement of land, subject to meeting certain criteria. For other beneficial uses, the geotechnical properties of the sediment need to be improved through treatment to render it suitable for other uses, such as a construction material. As handling, transportation, storage, and treatment of dredged

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Figure 3. Dredging operations on the Forth and Clyde Canal at Auchenstarry Basin.

It is estimated that only 1% of the 200 million cubic metres of sediments[1] that are dredged from Europe's ports and waterways are reclaimed, with the remainder disposed of at sea or in landfills. As periodic dredging is necessary to maintain navigation in ports, canals and rivers, reduction of this sizable waste stream is focused on finding beneficial uses for dredged sediments, including through their incorporation in erosion and flood control projects. The European Union (EU)-funded SURICATES[2] Project is a collaboration between port authorities, research institutes, SMEs, and universities to demonstrate dredged sediment reuse for key infrastructure projects in Northwest Europe. Through pilot trials it seeks to address the physical, environmental, and economic barriers to effective sediment reuse and to implement tools for sediment managers to quantify the impacts and benefits of different reuse options.

In urban areas reuse is often complicated by the presence of potentially toxic metals (Lassière et al. 2009) and contaminants in the sediments, which can originate from multiple sources, as shown in Table 1. Urban soils within the Clyde Basin are elevated in Cu, Mo, Ni, Pb, Sb and Zn ((Fordyce et al. 2017) so sediments within the canal should mirror those exceedances. Of special note are organotin compounds, including tributyl tin (TBT) which was widely used as anti-fouling paints. These compounds enter the sediments, along with lead-based paints, during hull stripping and painting

potential contaminants related to those uses. Representative sediment samples should be collected in-situ and analysed for suites of likely contaminants, to determine whether sediment meets any of the criteria for hazardous waste.

	Contaminants	Notes
Canal operations	Tributyl tin PAHs, Pb, CCA	Anti-fouling paint from maintenance and stripping of vessels. CCA treatment of lock gates and
Historical pollution	Pb, Cd, As, Hg, Cr,	Direct discharges of waste to

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fulminate (Hg(CNO)2) in the manufacture of detonator. Releases from the site methylated to organic mercury compounds upon entering the canal which are detectable in sediment (Cavoura et al. 2017). Hexavalent chromium, as chromium ore processing waste, was generated at the Glasgow Shawfield factory of J & J White Chemicals. As this waste material was widely used as inexpensive fill throughout the city it is often encountered on brownfield sites in Glasgow (Graham et al. 2006), many of which are near to the Forth and Clyde Canal. Local knowledge is therefore invaluable in determining potential risks and formulating a robust screening strategy.

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partners, focussed on the beneficial reuse of sediment dredged from Scotland's canal network. The University of Strathclyde has specific expertise in waste soil management in the Circular Economy, unsaturated soil characterisation and an active Sustainability and Environmental Studies MSc program. Scottish Canals are responsible for operating and maintaining Scotland's canal network with a strong commitment to sustainable sediment management (Lassière et al. 2009), in line with the Scottish Government's Zero Waste Plan[3]. Adjacent to the Union Canal in Falkirk a pilot study (Figure 4) has been underway to recover dredged sediment removed from the canal to condition it for enhanced beneficial use. Other pilot studies at other canal sites are scheduled to begin later in 2020.

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[1] 2016 SedNet European network assessment, WP2

[2] SURICATES -Sediment Uses as Resources In Circular And Territorial EconomieS http://www.nweurope.eu/projects/project-search/suricates-sediment-uses-as-resources-in-circular-and-territorial-economies/

[3] https://www.gov.scot/publications/policy-statement-zero-waste-regulations/pages/2/

09 July 2020

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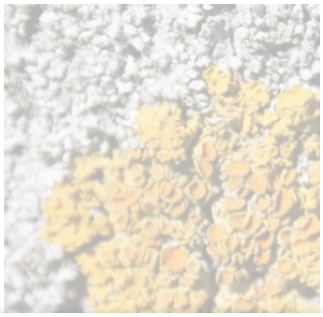

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