Strategies for reusing canal sediments in the Scottish Circular Economy.

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Introduction: Scottish Canals (SC) is responsible for 220km (137 miles) of inland waterways including the Caledonian, Forth & Clyde, Union, Crinan and Monkland Canals. Formerly part of British Waterways, SC became a standalone public body in July 2012, as the Canal and River Trust in England and Wales separated from British Waterways. SC is legally responsible for ensuring that the canals in Scotland maintain a minimum navigable depth (typically 1.06m to 4.11m) to ensure the safe passage of recreational and commercial craft, meaning maintenance dredging must regularly take place across the network. Dredging on Scotland's canals faces a number of challenges – the linear nature and geographic range, the Scheduled Ancient Monument status of all canals, the isolated location of some sites, changing waste legislation, escalating costs of Landfill Tax, transportation and disposal costs, and historical contamination in the sediment from industrial activity along the canals. Mercury contamination in the Falkirk area was a major issue addressed during construction of the Millennium Link project, in which the Forth & Clyde and Union Canals were revitalised and reconnected by the Falkirk Wheel and reopened for public use following their fall into disrepair. Here heavily contaminated sediment was dewatered and lime-stabilised before being sent to a specially engineered landfill monocell [1]. Recent monitoring studies are evaluating the long-term environmental performance of this stretch of canal [2]. A variety of sediment management approaches have been considered [3]. In practice, however, most of the material was subsequently sent to landfill, or was placed along the canal bank.
Scotland's Zero Waste Plan [4] has set challenging targets of 70% recycling with a maximum 5% to landfill by 2025 for all Scotland's waste. In 2015-2016 the devolved Government of Scotland made a commitment to creating a more resource efficient and circular economy [5] as a key strategic approach within its economic and environmental policy, with Scotland the first nation to join the Ellen MacArthur Foundation Circular Economy 100 network.

Methods: In 2012 a Knowledge Transfer Partnership between Scottish Canals and the University of Strathclyde was established to investigate diverting dredged material from landfill by identifying cost-effective options to reduce, reuse or recycle the materials extracted. The partnership examined a range of industrial symbiosis options by running field trials alongside active dredging works.

Results: Options identified for the direct reuse of dredged material as soil included land-spreading for agricultural or ecological benefit and use for restoration of former landfills, mineral workings and brownfield sites for energy crop production. Bankside trials were used to compare the effectiveness of revegetation and soil stabilization using Reed Canarygrass (*Phalaris aruninacea*) to amenity wild flower seed mix. Co-composting with green waste was trialled as a means of combining restoration soil manufacture with dewatering. Trials used geotubes to de-water material for reuse while direct bank repairs using Nicospan geotextile containment systems were agreed with Scottish Natural Heritage. Laboratory trials demonstrated the suitability of using dredged sediment to partially replace aggregate in concrete for use in canal wall repairs or emergency flood measures, achieving strengths up to 20 MPa with a 20 % replacement by contaminated sediment, indicating geotechnical suitability for use behind sheet piling. Other options addressed complementary needs of SC, such as co-application with compost or anaerobic digestate from water-weed clearance, or surfacing of car parks or tow paths by mixing with hydraulic binders.

Discussion: The potential benefits of the circular economy approach to sediment management include waste diversion from landfill, renewable energy, reduction of primary aggregate resource use, reduced transport, carbon footprint and greenhouse gas emissions. Future large-scale projects are planned to use dredged sediments in sustainable flood prevention measures as a trigger for redevelopment.

References:

[1] Smith & Lassiére (2000) *in* Fleming G. (ed.), Thomas Telford, London, 117-124; [2] Cavoura (2014) Unpub. PhD thesis, University of Strathclyde; [3] Lassiére et al. (2009) *J ASTM Int* **6**:17pp; [4] Scotland's Zero Waste Plan (2010); [5] Making things Last – A Circular Economy Strategy for Scotland (2016), Scottish Government www.gov.scot