Developing a willow SRC system to phytoextract heavy metals from biosolid stockpiles at Melbourne Water's Western Treatment Plant.

W.S. Laidlaw[1], A.J.M. Baker[1] and D. Gregory[2]

[1] Applied Ecology Research Group, School of Botany, University of Melbourne, Parkville, Victoria 3010, AUSTRALIA
[2] Research and Technology, Melbourne Water, 100 Wellington Parade, East Melbourne, Victoria 3002, AUSTRALIA

Melbourne Water is responsible for the supply of water and treatment of sewage for the city of Melbourne. The Western Treatment Plant covers 11000 hectares and processes 52% of Melbourne's sewage, or about 485 ML a day. This serves about 1.6 m people in the central, northern and western suburbs of Melbourne. About 30% of the raw sewage is derived from industrial sources and past activities resulted in a significant metal loading at the treatment plant. Annually, the treatment plant produces and stockpiles about 17,000 t of biosolids. The majority of the existing biosolid stockpiles exceed EPA (Victoria) metal contaminant limits for biosolid reuse by land application. Our research has been investigating the use of plants to extract the heavy metal contaminants in the biosolids. Extraction will reduce the level of contamination and allow reuse of the biosolid stockpile in agriculture or land rehabilitation programs. Average total concentrations (mg kg^{-1}) of heavy metals and arsenic in biosolids are As 29, Cd 34, Cr 1160, Cu 960, Ni 304, Zn 2800.

A pilot trial has included willows and, to a lesser extent poplars, to phytoextract cadmium, zinc, nickel and other metals. Willows and poplars were planted in a 30-60 cm layer of ploughed biosolid and watered daily. Leaves had greater concentrations of heavy metals than the stems but made up only 32% of the total above ground plant mass (oven dry weight). Plants were harvested in early autumn before the onset of leaf fall to maximize metal removal. The best performing species, *Salix matsudana* and *S. reichardtii,* produced 8.8 and 6.4 t ha^{-1} yr^{-1} respectively in the first year increasing to 56 and 72 t ha^{-1} yr^{-1} respectively in the following season. Estimated metal extraction values in the first year were As 3, Cd 89, Cu 95, Ni 168 and Zn 7420 (g ha^{-1}) for *S. matsudana* and As 14, Cd 104, Cu 67, Ni 448 and Zn 11360 for *S. reichardtii*. Plant tissue metal concentrations reduced in the second year. However the increased biomass production resulted in an overall increase in metal extraction (*S. matsudana* As <1, Cd 649, Cu 636, Ni 2430, Zn 61110 (g ha^{-1} yr^{-1}); *S. reichardtii* As <1, Cd 667, Cu 776, Ni 3280, Zn 57420 (g ha^{-1} yr^{-1})).

Outcomes from this project so far indicate that irrigation is essential to maximize survival and biomass production. The willow and poplar species trialed to date varied considerably in biomass production. There was variation in plant tissue metal concentrations between species and these concentrations were linked to the bioavailability of the metals in the biosolids. Cadmium, nickel and zinc were the most readily extracted heavy metals.

Future trials will determine the sustainability of metal extraction from biosolids by willows and poplars and the suitability of treatment plant wastewater for irrigation. We envisage scaling up our trials to a SRC system that will efficiently phytoextract heavy metals from the biosolid stockpiles annually.