Landfill Leachate Mitigation with Aspen

A Case Study

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Case Study

A landfill site in the West of Scotland ceased operations within the last 10 years and subsequently capped and restored. The landscape is characterised by a dome which encapsulates the waste mass. This has been capped with a lower geotextile layer and overlying impermeable plastic geomembrane layer, with up to 2m of soil above (1m of subsoil/1m of topsoil).

The surface vegetation is characterised by mixed grassland. The site remains a under a Waste Management Licence due to the ongoing treatment of problematic leachates. Consequently, there is no permitted public access to the site.

The Leachate Management System includes a series of settling ponds, a drainage and pumping system, mechanical aeration and a reed bed filtration system. Clean water is ultimately discharged into a neighbouring river.

One problem identified at the site is the excess of water, with the surface water drainage system being unable to cope with rainfall amounts and therefore clean surface water requiring to be pumped into the leachate management system loading its capacity and potentially extending the clean-up time to at least a further 10 years. The ongoing treatment of leachate at the site is therefore a significant cost burden to the site operator.

Planting Trees on Landfill Sites

The main concern often expressed when considering establishing woodland on capped landfill sites is the integrity of the cap and the potential for damage from root penetration. There has been some research into the depth of root growth and the impacts on clay caps. The conclusions from such studies is that where soils are at least 1.2m thick, few if any roots reach the underlying cap after 16 years of growth. The recommendations are therefore that 1.5m of soil cover is provided to allow healthy tree establishment and sufficient root growth without penetrating the cap.

In the case study, there is generally about 2m of soil cover which is underlain by an impermeable plastic geomembrane. This membrane layer will present a complete barrier to root growth. The nature of the cap together with the thickness of soil cover suggests that tree establishment will be technically feasible without compromising the integrity of the landfill including the cap.

There are two ways in which trees reduce groundwater yield. Trees use and lose water in two ways. Firstly their canopies, branches and trunks intercept rainfall which is subsequently evaporated. Secondly, tree roots take up water from the soil and then transpire this through the leaves. Together the total loss of water from trees is termed Evapotranspiration.

The total amount of evapotranspiration can be calculated based on the average annual rainfall and the species of tree.

In the West of Scotland for example the average annual rainfall will be around 1400mm. Typically for this level of rainfall, the proportion of rainfall intercepted will be around 19% which equates to around 270mm/yr.

Annual transpiration rates are less influenced by climate with annual rates of between 300mm/yr and 350mm/yr. However it is here that aspen has a particular advantage over other tree species as transpiration rates can be in excess of 500mm/yr for this species.

Taken together therefore, the total annual evapotranspiration resulting from a mature aspen woodland (100% ground cover) will be around 770mm/yr which equates to 55% of the annual rainfall.

Of course when assessing the net reduction in groundwater yield from woodland, one has to take into consideration the current evapotranspiration losses from the existing vegetation cover. In the case study, the grass cover will typically lose water to between 400mm/yr and 600mm/yr. It is therefore considered that the likely existing losses from evapotranspiration will be approximately 450mm.

On this basis, a woodland cover will have an evapotranspiration rate 70% higher than the existing vegetation cover.

Canopy closure in newly established woodland usually takes place between 10 and 20 years depending on the species and planting density. In the case study, it is assumed that canopy closure and therefore maximum interception will take place at around 15 years. However as soon as trees are established and the surface vegetation recovers from any disturbance, evapotranspiration rates will increase, with immediate effect.

It is perhaps more difficult to quantify the impact a woodland cover will have on the timeframe for site clean-up, however inevitably, the significant increase in water losses will have a positive effect.

It is likely that the reduced surface water infiltration and run-off from the dome will reduce or possibly eliminate the need to pump clean surface water into the leachate management system. This will reduce the load on the system, thereby reducing operating and management costs (pumping, settling pond maintenance etc).

In addition by reducing the dilution effects of adding clean water to the leachate, as is currently practiced, potentially the rate at which leachate levels are reduced could be increased. Assuming the reed bed system is scaled appropriately then the treatment system will become more efficient leading to a reduction in treatment time with significant cost savings.

It should also be noted that trees can have additional benefits to landfill sites, including prevention of surface soil erosion.

Other Benefits of Woodland

Following site clean-up, and the permitting of public access to former landfill sites, a woodland cover can offer a wide range of other benefits in the long term including:

Economic

- ✓ Costs saving to operator;
- ✓ Potential external funding for woodland creation;
- ✓ No further landscaping required following closure.

Landscape

- ✓ Creation of landscape feature.

Environment

- ✓ Create of woodland habitat;
- ✓ Creation of genebank for rare native aspen;

Community

- ✓ Creation of a future community woodland following site closure;
- ✓ Creation of a potential community woodfuel resource;
- ✓ Creation of an amenity site including footpaths, recreation, picnic etc.

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