 https://doi.org/10.1051/e3sconf/202456906004

Sustainability aspects of geosynthetic landfill final cover systems

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Abstract. Progressively, geosynthetics have been used in combination with and in lieu of natural materials to solve complex geotechnical problems while offering a drastic reduction in carbon emissions and minimizing environmental impacts. Commonly used final cover systems for landfills and containment areas include soil-only, soil-geosynthetic, engineered turf cover (ETC), and evapotranspiration (ET) cover system. This presentation provides a detailed review of various sustainability aspects of a geosynthetic ETC including comparisons with traditional covers. Sustainability aspects considered include carbon emissions; deforestation, land use change and borrow areas; land, soil and water conservation; run-off water quality and downstream impacts; reduction in fugitive landfill gas emissions; and beneficial reuse opportunities.

Greenhouse gas (GHG) emissions from landfills are a major contributor to global warming. Emissions from waste activities in the U.S. summed to 169.2 million metric tons of carbon dioxide equivalent (MMT CO_2 e) in 2021. Most of these emissions, 122.6 MMT CO_2 e, were from landfills representing the third largest anthropogenic source of methane emissions. Organizations all over the world are actively seeking opportunities to reduce their GHG emissions and meet their sustainability goals.

Final closures at containment facilities are required to comply with certain federal and state regulations and have traditionally included use of soil-only and soil-geosynthetic composite covers. This presentation provides a detailed review of the sustainability aspects of a geosynthetic engineered turf cover (ETC) that comprises a structured geomembrane, an engineered turf, and a specified infill. An ETC offers a myriad of sustainability benefits, when compared with traditional cover systems as included below.

A drastic reduction in requirement of soil materials (typically, at least 0.6 meters) is realized. This reduces use of natural materials and land resources. Typically, adequate type of soil such as sand for drainage and clays meeting specific hydraulic conductivity requirements are necessitated for traditional soil cover construction. These natural materials are typically obtained by developing borrow areas. Development of borrow areas have multiple detrimental environmental impacts including land use change, potential deforestation, and biodiversity impacts. When using an ETC geosynthetic cover, these environmental impacts are avoided.

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Significant carbon emissions associated with transportation (Fig. 1) and construction of materials are avoided when using ETCs. Fig. 2 shows cradle to end-of-construction emissions for multiple final cover systems. Further, a drastic reduction in fugitive landfill gas emissions can be achieved from frequent smaller incremental closures rather than infrequent large closures due to speed of construction and simplicity of installation. Quantifications for reduction and avoidances in carbon emissions will be presented.

Water resources are conserved as moisture conditioning of cover soils and irrigation of vegetative layer are not necessary. Further, improvement in stormwater runoff quality is observed (Fig. 3) thereby preserving downstream ecology.

Fig. 1. Transportation Emissions of Soil Cover v. ETC.

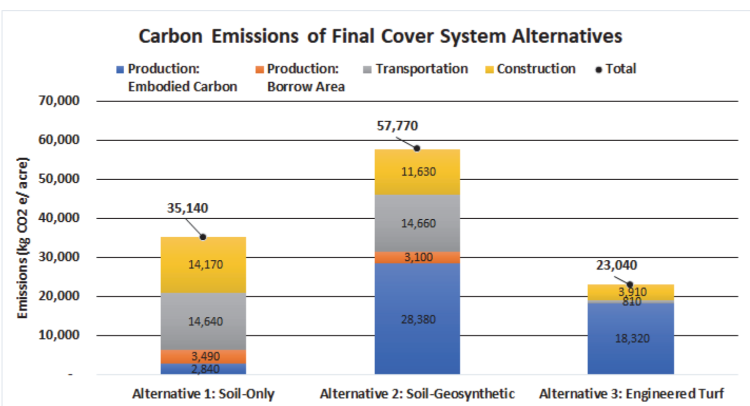

Fig. 2. Carbon Emissions of Final Cover System Alternatives.

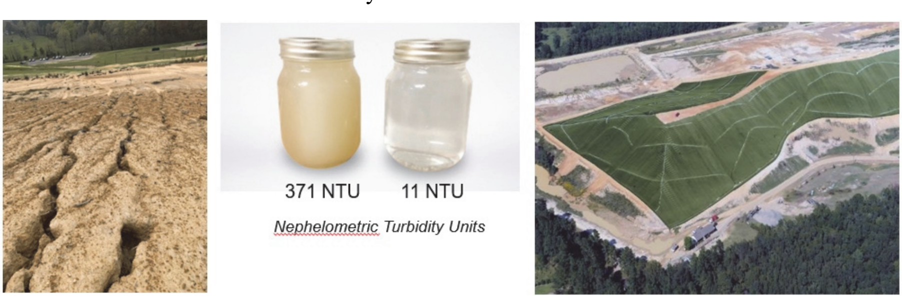

Fig. 3. Stormwater Runoff Quality of Soil Cover and ETC Areas.