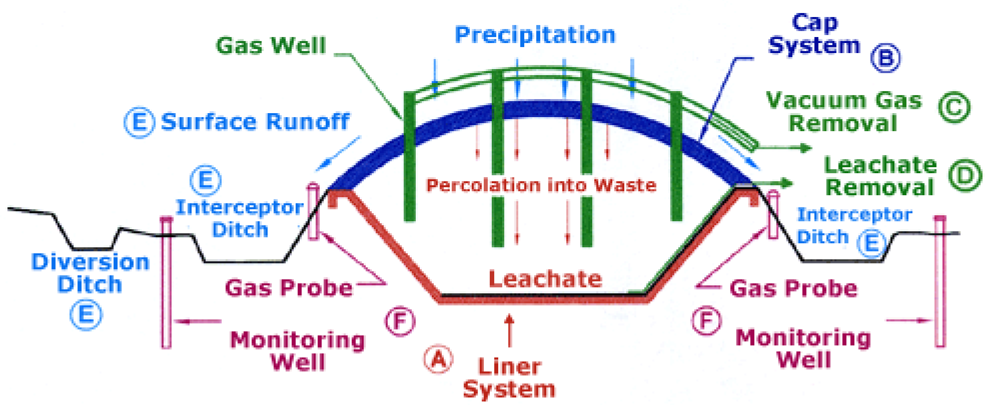
Waste Sector Technology factsheets

Sanitary landfill

Defining characteristics	Narrative
General	Historically, landfills have been the most common method of waste disposal and remain so in many places around the world today. In particular, sand and gravel pits and borrow areas are commonly used as primitive landfills. Sanitary landfills get their name from health-focused improvements in design and facility management compared to open dumps. Improved designs include the emplacement of materials and structures to contain the release of contaminants into the environment, and soil covering to address odour issues and curtail insect and vermin infestation of the site. In some cases, methane generation is encouraged, and the gas thereby generated collected and used as fuel. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste especially in countries that have adequate land resources to accommodate these sites.
Siting and land use	Landfill siting requires rigorous geotechnical, environmental and economic studies to ensure that the best available science is used and local environmental and safety concerns are taken into account. In this regard, a facility location decision must be informed by expertise in diverse areas and stakeholder/public consultations, and validated through a permitting process. Ultimately, land requirements for installation of a sanitary landfill depend on its design life span, topography and hydrogeology of the milieu.
Design (components) and Operation	After solid waste has been tipped by trucks into a landfill, bulldozers are used to spread and compact the waste in order to utilise available landfill capacity to the fullest. Daily waste deposits are then covered with soil to reduce odours and provide a firm base upon which vehicles may operate. The use of daily cover may preempt the occurrence of landfill fires, and limit adverse visual impact. Under anaerobic conditions prevalent in landfill sites, the biodegradable fraction of solid (and semi-liquid/liquefied) waste is broken down by micro-organisms into intermediate organic compounds and finally into landfill gas (LFG), principally made up of methane and (CH_4) and carbon dioxide (CO_2), and water (Barlaz et al. 1989). Seepage from landfills, commonly referred to as leachate, is controlled by the hydroclimatic conditions at the landfill site, hydraulic properties of the landfill and biological and chemical processes taking place within the landfill. In modern sanitary landfills, the waste is isolated from the ground water by a liner system, and from flooding by surface drainage structures. Key sanitary landfill components are as follows: 1) stormwater management system; 2) landfill liner; 3) leachate collection system; and 4) gas collection and recovery system. Stormwater control systems play a crucial role diverting surface runoff from the landfill and protecting it from flooding. Typical infrastructure includes detention basins, diversion berms and cutoff ditches. A landfill liner made of a low conductivity natural or synthetic material (compacted clay or geotextile) is laid out at the bottom of the landfill to prevent or delay the migration of leachate (loaded with micro-organisms, organic and inorganic contaminants) into underlying aquifers and nearby surface water bodies. A typical leachate collection system is made up of hydraulically connected drainage material, leachate collection pipes, riser pipes and submersible pump that collectively function to remove leachate impeded by the liner at the base of the landfill. Failure to control leachate build-up and its removal will most likely cause seepage from the sides and slope instability. A gas collection and recovery system makes it possible for gas generated from waste through biochemical reactions to be pumped out of the landfill to prevent spontaneous fires, gas migration onto adjacent properties, and for use as an energy resource if desirable. A typical set-up includes one or more vertical/horizontal

	wells strategically positioned within the landfill, a header system to connect gas collection wells to a gas pumphouse system. To purify landfill gas (LFG) for end users, carbon dioxide (CO_2) can be removed by dissolving in water or potassium hydroxide (KOH). In the event LFG is not needed, it can be oxidised using a flare system (Hirshfeld et al .1992, Humer and Lechner, 1999).
Costs	The construction and operating cost of sanitary landfills depends on a multitude of locational factors, design features, equipment deployed, volume and type of wastes disposed, maintenance costs, wage and salary costs of personnel, etc. Thus, a detailed engineering study and cost estimate is an absolute necessity for each individual landfill site. To this effect, To fix some ideas, Clayton and Huie (1900) provide annual solid waste disposal costs in excess of USD1.9/ton for facilities handling 100 tons of waste or less in a day. In the authors' worked example, costs decrease exponentially to around USD0.65/ton for facilities receiving 1,200 tons of waste or higher in a day.
Supporting infrastructure	Vehicle wheel cleaning facilities Leachate treatment and disposal plant/facility
Advantages	Sanitary landfills provide a means for significant reduction of adverse environmental impacts, nuisance factors and health risks associated with primitive dumpsites. Methane, a potent greenhouse gas, can be safely captured and oxidised or utilised as a primary source of energy.
Disadvantages /Challenges	Design challenges relate to maintaining the conveyance efficiency of the leachate collection system over landfill's active life (i.e. several decades/centuries) in the face of continual clogging by silt, mineral encrustation or micro-organism growth in the pipes. Additionally, infrastructure materials should be able to survive in hostile environments and able to withstand the crushing weight of overlying garbage. Precautionary measures include the use of steep pipe grades, high density polyethylene (HDPE) pipework, and condensation traps to overcome potential problems highlighted.
Abatement potential	LFG generation is not only highly dependent on design and operational factors, but also on waste composition. Notwithstanding the high variability of landfill LFG generation (Oonk and Boom, 1995; Lou and Nair, 2009), LFG capture and flaring (i.e., conversion of CH_4 to CO_2) reduces the global warming potential (GWP) of landfill emissions by 95%. Under field conditions, the scope of GHG emissions abatement is tributary to the efficiency of LFG recovery, reported to be between 50% and 100% (Pipatti and Wihersaari, 1998), whilst Lou and Nair (2009) found lower floor and ceiling efficiency figures of 24% and 60%, respectively.
Level of penetration	Sanitary landfills are a completely new technology



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Further Reading

Barlaz, M.A., Schaeffer, D.M. and Ham R.K., 1989. Bacterial population development and chemical characteristics of refuse decomposition in a simulated sanitary landfill. Applied and Environmental Microbiology, Jan. 1989, p. 55-65

Hirshfeld, S, Vesilind, P.A,, Pas. E.I., 1992. Assessing the true cost of landfills. Waste Management and Research, 10, 471-484.

Humer, M., Lechner, P., 1999. Methane oxidation in compost cover layers on landfills. Proceedings of the Seventh International Waste Management and Landfill Symposium 3, 403–410.

Lou, X.F. and Nair, J. The impact of landfilling and composting on greenhouse gas emissions – A review. Bioresource Technology 100, 3792–3798

Oonk, J., and Boom, A., 1995. Landfill gas formation, recovery and emissions. In: Pipatti, R., Wihersaari, M., 1998. Cost-effectiveness of alternative strategies in mitigating the greenhouse impact of waste management in three communities of different size. Mitigation and Adaptation Strategies for Global Change 2, 337–358.

Pipatti, R. and Wihersaari, M. 1998. Cost-effectiveness of alternative strategies in mitigating the greenhouse impact of waste management in three communities of different size. Mitigation and Adaptation Strategies for Global Change 2, 337–358.

Websites

https://en.wikipedia.org/wiki/Landfill