

Updated: 6 December 2019

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CEE 370 Environmental Engineering Principles

Lecture #34

Solid Waste II: Landfills

[Reading: Mihelcic & Zimmerman, Chapt 10](#)

[Reading: Davis & Cornwall, Chapt 9-4 to 9-6](#)

[Reading: Davis & Masten, Chapter 13-7](#)

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Landfilling

- The legal and controlled placement of wastes in the ground
- **Dumping** is illegal or uncontrolled
- Material undergoes chemical and biological changes
- Water is present which promotes biodegradation and carries away dissolved substances: **Leachate**
- Leachate collection and recirculation

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Leachate Characteristics

Complex Organics

↓


Simple Organics

↓

Acetic Acid

↓

CO₂ and CH₄

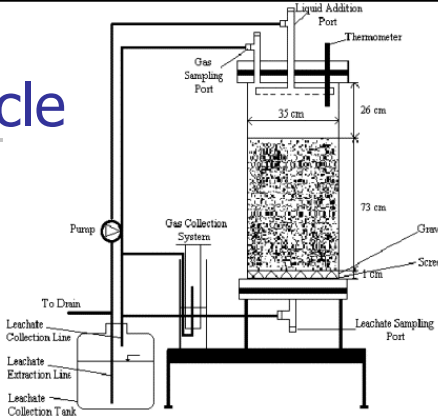


Constituent	Conc. Range, mg/L
BOD ₅	9-55,000
COD	0-90,000
Total solids	6-45,000
TDS	0-42,000
TSS	6-2,700
Chloride	34-2,800
TKN	0-1,400
Sulfate	1-1,800
Phosphate	0-154
Lead	0-5
Copper	0-10
pH	3.7-8.5

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Leachate Recycle

- leachate recirculation in municipal solid waste landfills as an effective way to enhance microbial decomposition of biodegradable solid waste.
- With leachate recirculation, a landfill can
 - be used as a relatively controlled anaerobic filter to treat leachate
 - provide accelerated waste stabilization, and
 - reduce the volume of leachate by maximizing evaporative losses during recirculation
- In order to maximize waste stabilization, leachate recirculation frequency must be carefully selected.
 - If too much leachate is recirculated, problems such as saturation, ponding, and acidic conditions may occur.



- Leachate should be introduced slowly, since high flow rates may deplete buffering capacity and remove methanogens, increasing the flow rates and frequency of recirculation as gas production is established. Waste decomposition can be improved by an increase in the moisture flow, as a result of increased flushing and dilution of the inhibitory products.

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Leachate Treatment

- A typical leachate treatment plant uses equalization, oxidation/reduction, precipitation/flocculation/sedimentation, neutralization, granular media filtration

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Siting Restrictions

The landfill disposal regulations provide the following restrictions on landfill location:

- Prohibit the placement of a landfill facility near an **airport** because of dangers from scavenging birds.
- Require the landfill to be located outside the 100 year **floodplain** or the landfill design must prevent the washout of solid waste during a 100 year flood.
- Prohibit the placement of a new landfill or expansion of an existing landfill into or on a **wetland**.
- Prohibit the placement of a landfill within 200 feet of an **earthquake** fault.
- Prohibit the placement of a landfill in an area with a high probability of a strong **earthquake**.
- Prohibit the placement of a landfill in an area with **unstable soil**.
- Require existing landfills which cannot meet the airport, floodplain, or unstable area requirements above, to close within five years. The state may grant a maximum of a two year extension.


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Operational Requirements

- Exclusion of hazardous waste from the landfill.
- Provide at least six inches of daily soil cover over new solid waste placed in the landfill.
- Control disease vectors such as rodents and insects.
- Monitor methane concentrations in the landfill and buildings. (Methane is explosive when combined with the oxygen in air.)
- Elimination of most open burning.
- Control public access.
- Construct run-on and run-off controls for water.
- Meet water quality discharge requirements (NPDES) to surface water.
- Prohibit all liquid wastes except small quantities of household liquid wastes.
- Maintain records indicating compliance.

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Design Requirements

- Synthetic membrane liner at least 30 mils thick
 - 1 mil is 0.001 inches
- Soil liner at least 2 ft. thick
- Hydraulic conductivity no more than 10^{-7} cm/s
- Other state-approved designs possible

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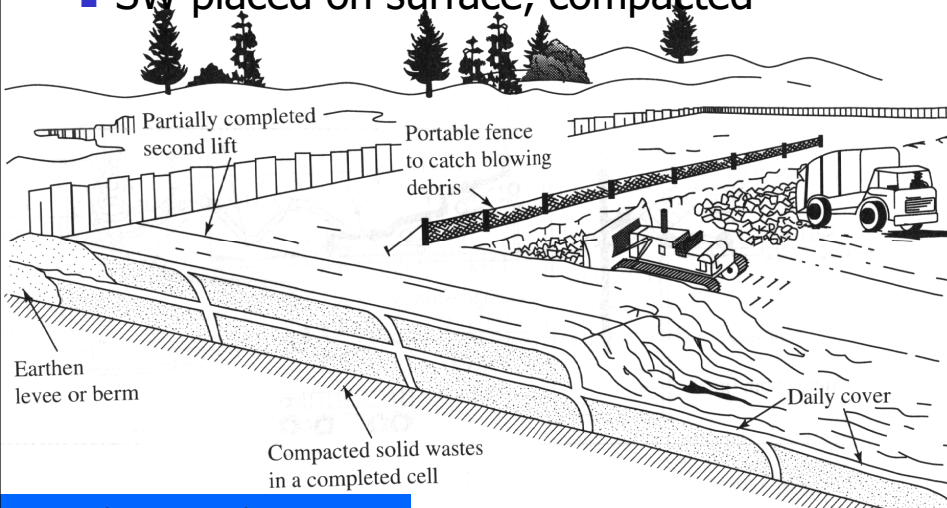
Solid Waste Disposal

- Sources
- Disposal Regulations
- Recycling
- Composting
- Collection
- Processing
- Landfilling
- Incineration

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Landfilling: Area Method

- SW placed on surface, compacted



The diagram illustrates the Area Method for landfiling. It shows a cross-section of a landfill cell. A truck is dumping solid waste (SW) onto a surface. The waste is then compacted by a roller. A portable fence is used to catch blowing debris. A partially completed second lift is shown. An earthen levee or berm is visible. A daily cover is applied to the waste. The compacted solid wastes are shown in a completed cell.

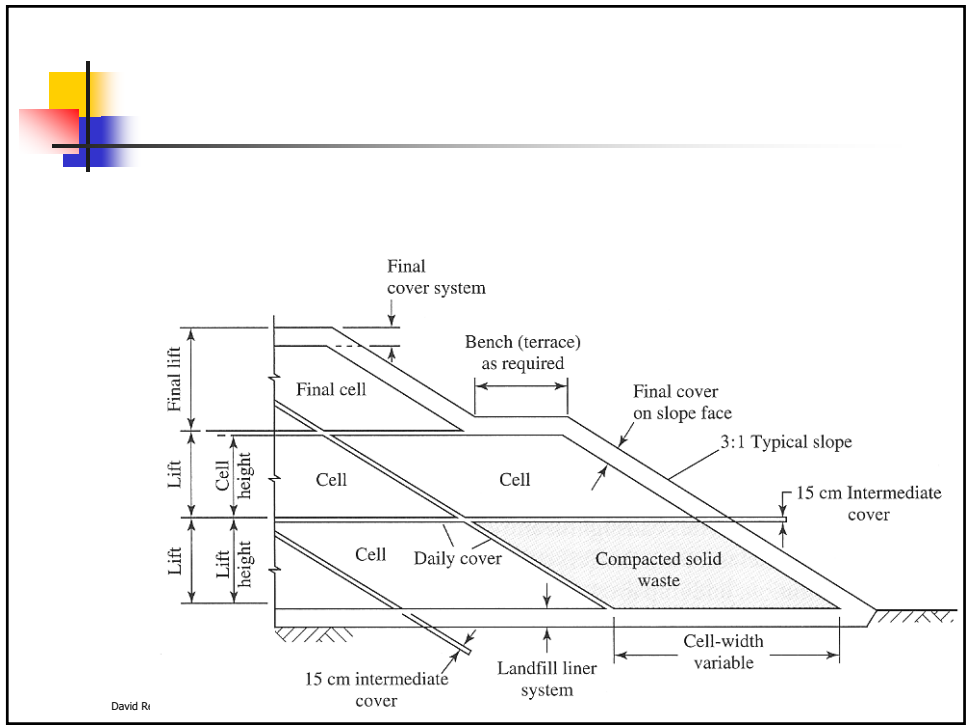
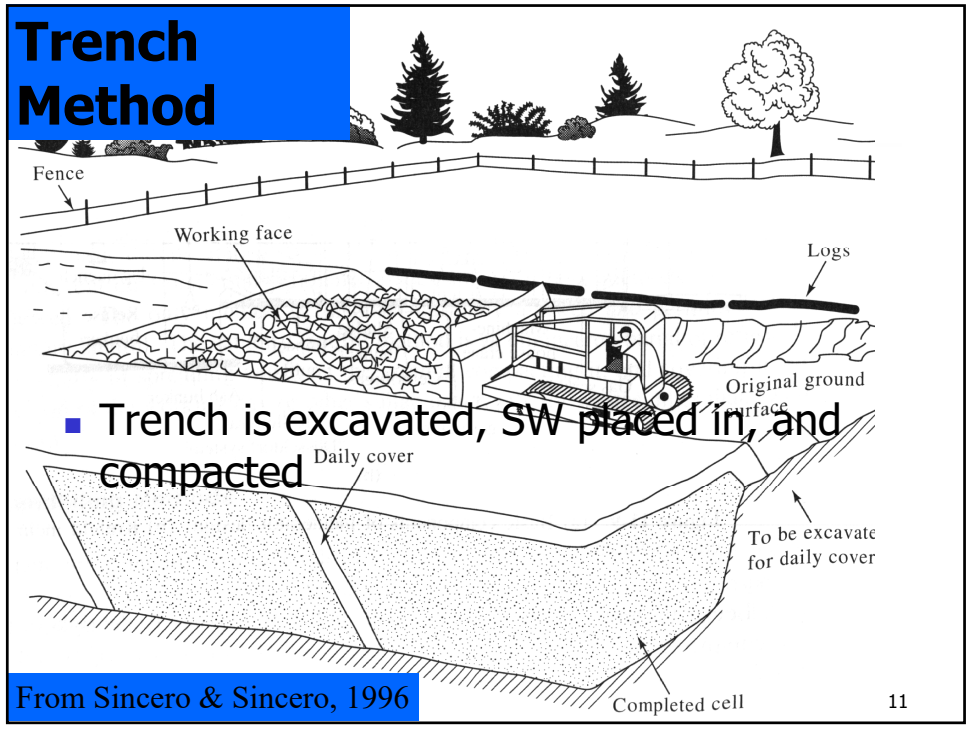
Partially completed second lift


Portable fence to catch blowing debris

Earthen levee or berm

Compacted solid wastes in a completed cell

Daily cover






Leachate Composition

TABLE 12-4 Typical Data of the Composition of Leachate from New and Mature Landfills

Constituent	Value (mg · L ⁻¹)		
	New Landfill (< 2 years)		Mature Landfill (> 10 years)
	Range	Typical	
BOD ₅ (5-day biochemical oxygen demand)	2000–30,000	10,000	100–200
TOC (total organic carbon)	1500–20,000	6000	80–160
COD (chemical oxygen demand)	3000–60,000	18,000	100–500
Total suspended solids	200–2000	500	100–400
Organic nitrogen	10–800	200	80–120
Ammonia nitrogen	10–800	200	20–40
Nitrate	5–40	25	5–10
Total phosphorus	5–100	30	5–10
Ortho phosphorus	4–80	20	4–8
Alkalinity as CaCO ₃	1000–10,000	3000	200–1000
pH (no units)	4.5–7.5	6	6.6–7.5
Total hardness as CaCO ₃	300–10,000	3500	200–500
Calcium	200–3000	1000	100–400
Magnesium	50–1500	250	50–200
Potassium	200–1000	300	50–400
Sodium	200–2500	500	100–200
Chloride	200–3000	500	100–400
Sulfate	50–1000	300	20–50
Total iron	50–1200	60	20–200

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Landfill Gas

- Not pure methane

TABLE 12-5 Typical Constituents Found in MSW Landfill Gas

Component	Percent (dry volume basis)	Characteristic	Value
Methane	45–60	Temperature (°C)	35–50
Carbon dioxide	40–60	Specific gravity	1.02–1.05
Nitrogen	2–5	Moisture content	Saturated
Oxygen	0.1–1.0	High heating value (in kJ · m ⁻³)	16,000–20,000
Sulfides, disulfides, mercaptans, etc.	0–1.0		
Ammonia	0.1–1.0		
Hydrogen	0–0.2		
Carbon monoxide	0–0.2		
Trace constituents	0.01–0.06		

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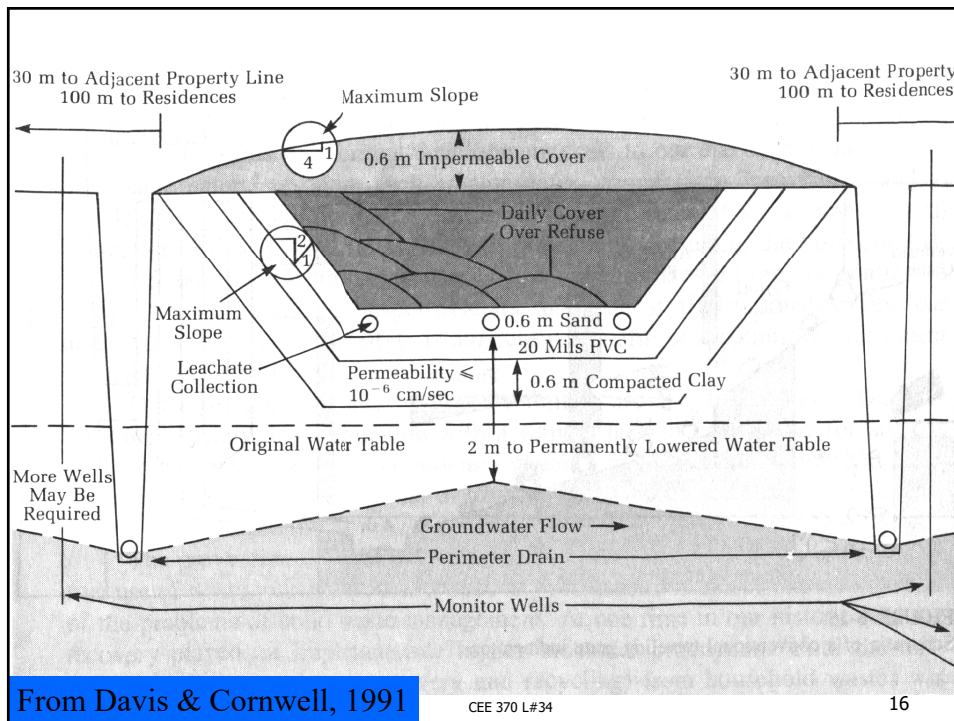


TABLE 12-6 Concentrations of Specified Air Contaminants Measured in Landfill Gasses (in ppb)

Compound	Landfill Site						
	Yolo Co.	City of Sacramento	Yuba Co.	El Dorado Co.	L.A.-Pacific (Ukiah)	City of Clovis	City of Willits
Vinyl chloride	6900	1850	4690	2200	<2	66,000	75
Benzene	1860	289	963	328	<2	895	<18
Ethylene dibromide	1270	<10	<50	<1	<1	<1	<0.5
Ethylene dichloride	nr	nr	nr	<20	0.2	<20	4
Methylene chloride	1400	54	4500	12,900	<1	41,000	<1
Perchloroethylene	5150	92	140	233	<0.2	2850	8.1
Carbon tetrachloride	13	<5	<7	<5	<0.2	<5	<0.2
1,1,1-TCA ^a	1180	6.8	<60	3270	0.52	113	0.8
TCE ^b	1200	470	65	900	<0.6	895	8
Chloroform	350	<10	<5	120	<0.8	1200	<0.8
Methane	nr	nr	nr	nr	0.11%	17%	0.14%
Carbon dioxide	nr	nr	nr	nr	0.12%	24%	<0.1%
Oxygen	nr	nr	nr	nr	nr	10%	21%



Landfill siting

Northampton Sanitary Landfill, Google Maps

Northampton Sanitary Landfill
Garbage dump

Directions Save Nearby Send to your phone Share

170 Glendale Rd, Florence, MA 01062
77RP+RJ Northampton, Massachusetts
northamptonma.gov
Closed today
Claim this business

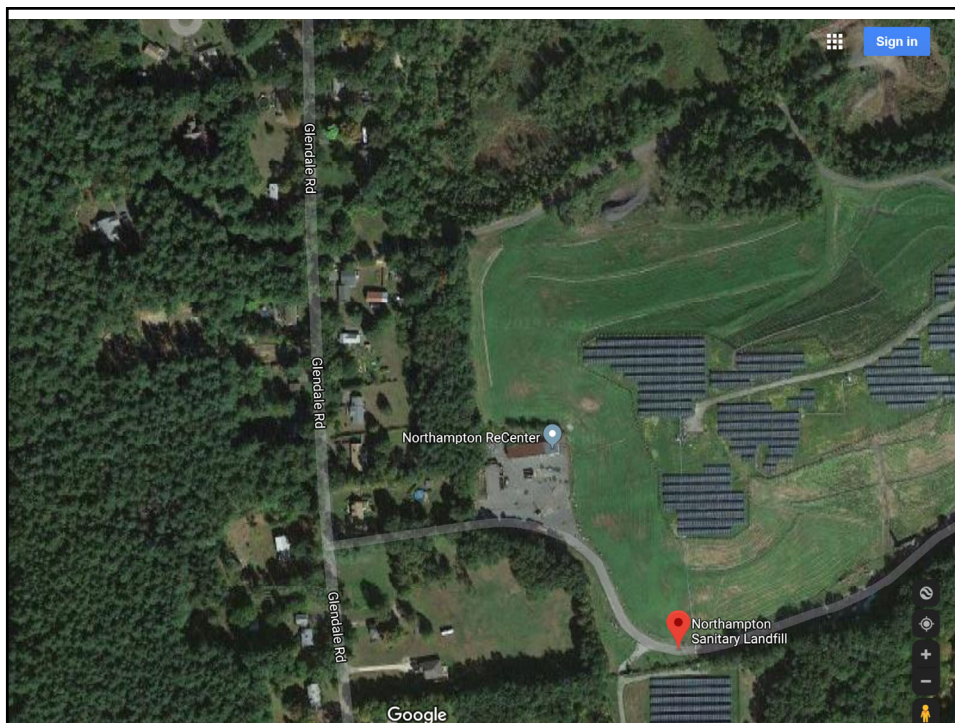
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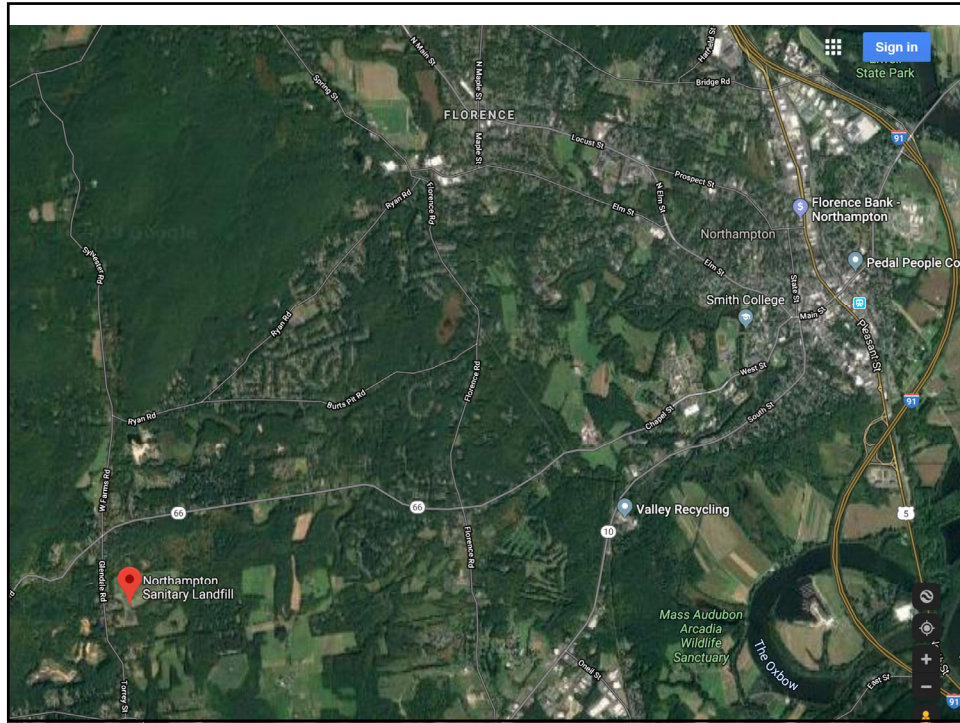
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