PENGURUSAN SISA (LANDFILL)

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Pengurusan sisa pepejal

Interaksi sistematik antara pelbagai aktiviti pengeluaran sisa, penyimpanan, pengumpulan, pemindahan (*transfer*), dan pengangkutan, perawatan sementara dan pelupusan akhir (Landfill)

Most favoured option

Reduce lowering the amount of waste produced

Reuse using materials repeatedly

Recycle using materials to make new products

Recovery recovering energy from waste

Landfill safe disposal of waste to landfill

Least favoured option

Pengurusan sisa pepejal (solid waste management, SWM)

- **United Kingdom**
  - **Landfill design, construction, and operational practice. Waste Management Paper 2B, Department of Environment (1995).**

- **Malaysia**
  - **The technical guideline for sanitary landfill, design, and operation. Department of Local Environment, Ministry of Housing anf Local Environment (2006).**

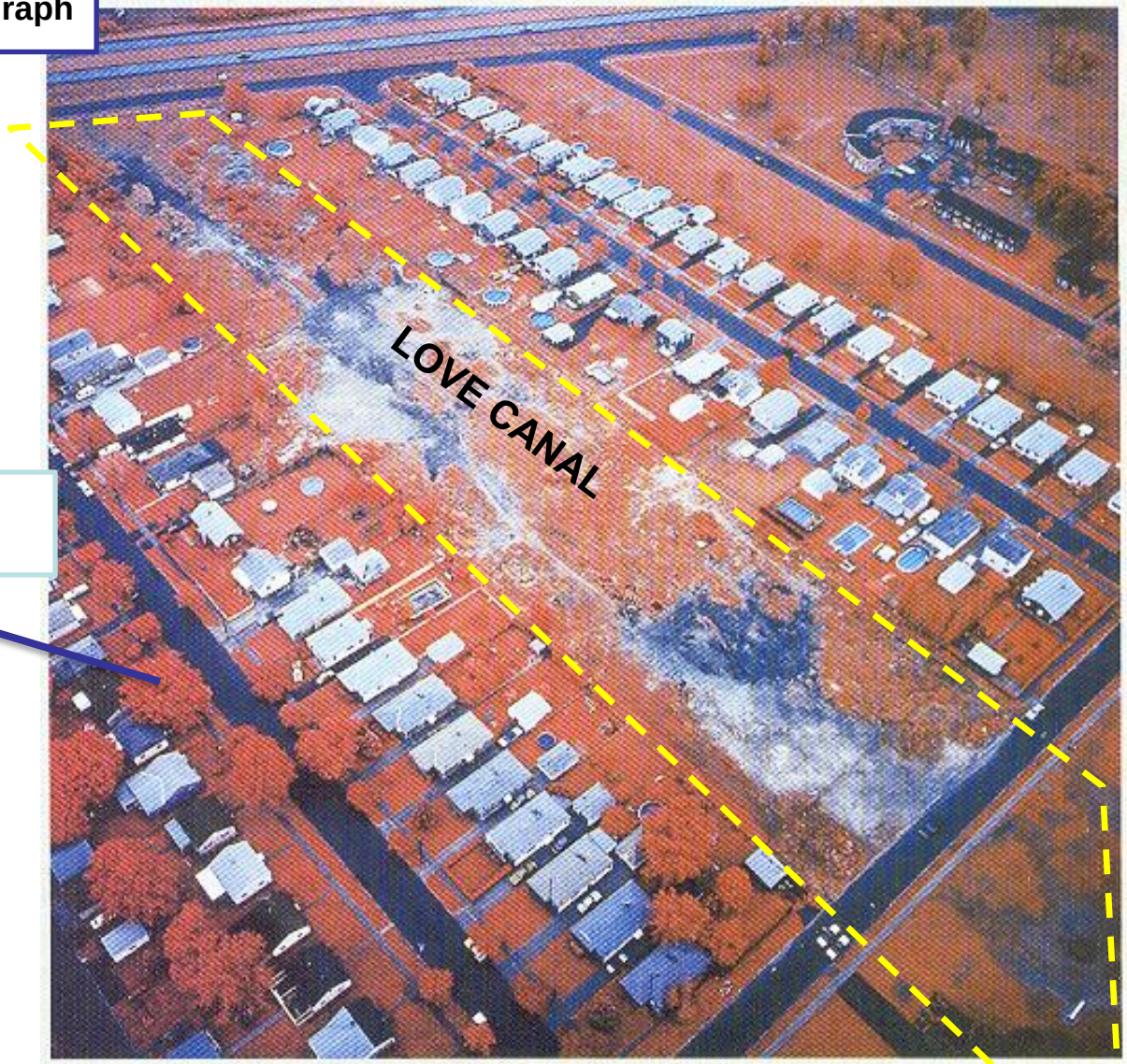
CASE STUDY: Love Canal (1)

- **1892 - William T. Love began construction of a canal**
- **1920 - the Hooker Chemical Company : bought the canal & used as a chemical dump site (21,800 tons of chemicals); Eg. benzene that causes leukemia, dioxin, & 200 tons of trichlorophenol**
- **1953 - Hooker covered the site with dirt and sold the land to the Niagra Falls Board of Education for "$1.00"**
- **1955 - School opened and homes were built on the 16-acre rectangular site**
- **1976 - found chemicals leaking at Love Canal**
- **1978 - the story of Love Canal became a national issue**

CASE STUDY: Love Canal (2)

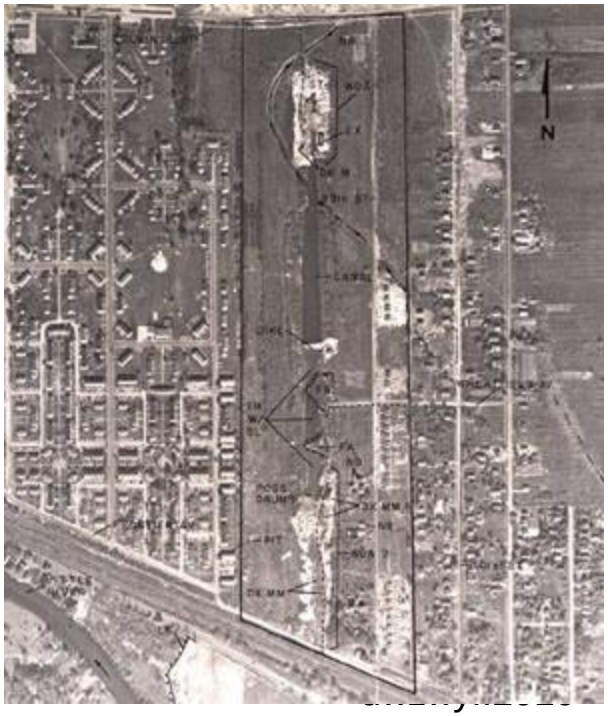
- **1980 - Federal government acted**
- **1981 - by Feb. 400 families had been moved**
- **1988 - 239 homes closest to the canal were demolished,**
- **1994 - Occident Petroleum Co. paid $98 million to New York to pay for the clean-up and relocation**
- **1995 paid $129 million to the federal government**
- **1997 paid $20 million to 1,300 people**
- **1998 - of the 900 families at Love Canal, 67 decided to stay and 733 were relocated**

Aerial infrared photograph



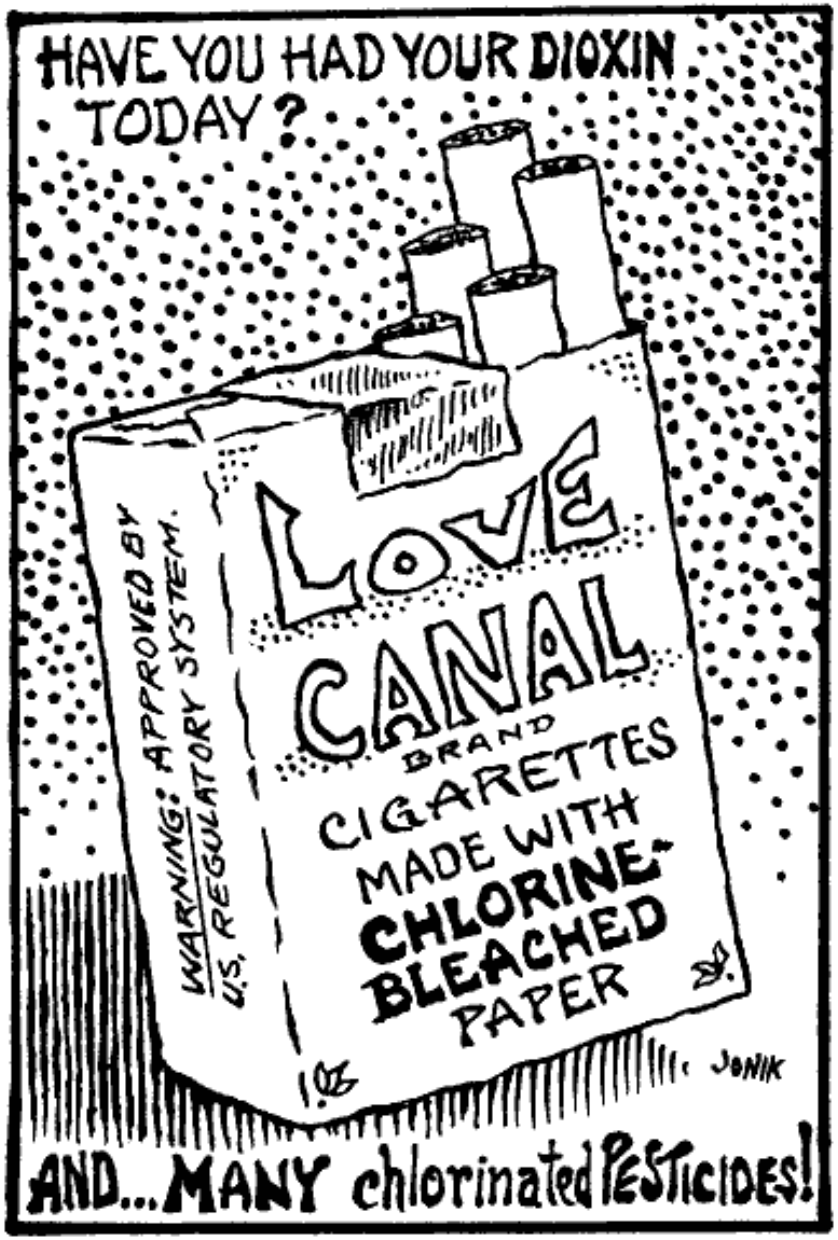
Healthy vegetation (bright red)

▲ **FIGURE 12.B** This is an aerial infrared photograph of the Love Canal area in New York. Healthy vegetation is bright red. This portion of Love Canal runs from the upper left corner to the lower right. It appears as a scar on the landscape. Buried chemical waste seeped to the surface to cause numerous environmental problems and concern here. The site became a household name for toxic waste. (*New York State Department of Environmental Conservation*)



Love Canal in 1951

Love Canal in 1980


HAVE YOU HAD YOUR DIOXIN TODAY?
LOVE CANAL BRAND CIGARETTES
MADE WITH CHLORINE-BLEACHED PAPER
WARNING: APPROVED BY U.S. REGULATORY SYSTEM.
JONIK
AND... MANY chlorinated PESTICIDES!

Method of disposal

1. Onsite disposal
2. Composting
3. Open dumps
4. Sanitary landfills
5. Incineration

1. On-site disposal

- **Mechanical grinding of kitchen food waste – “Flintstone”**

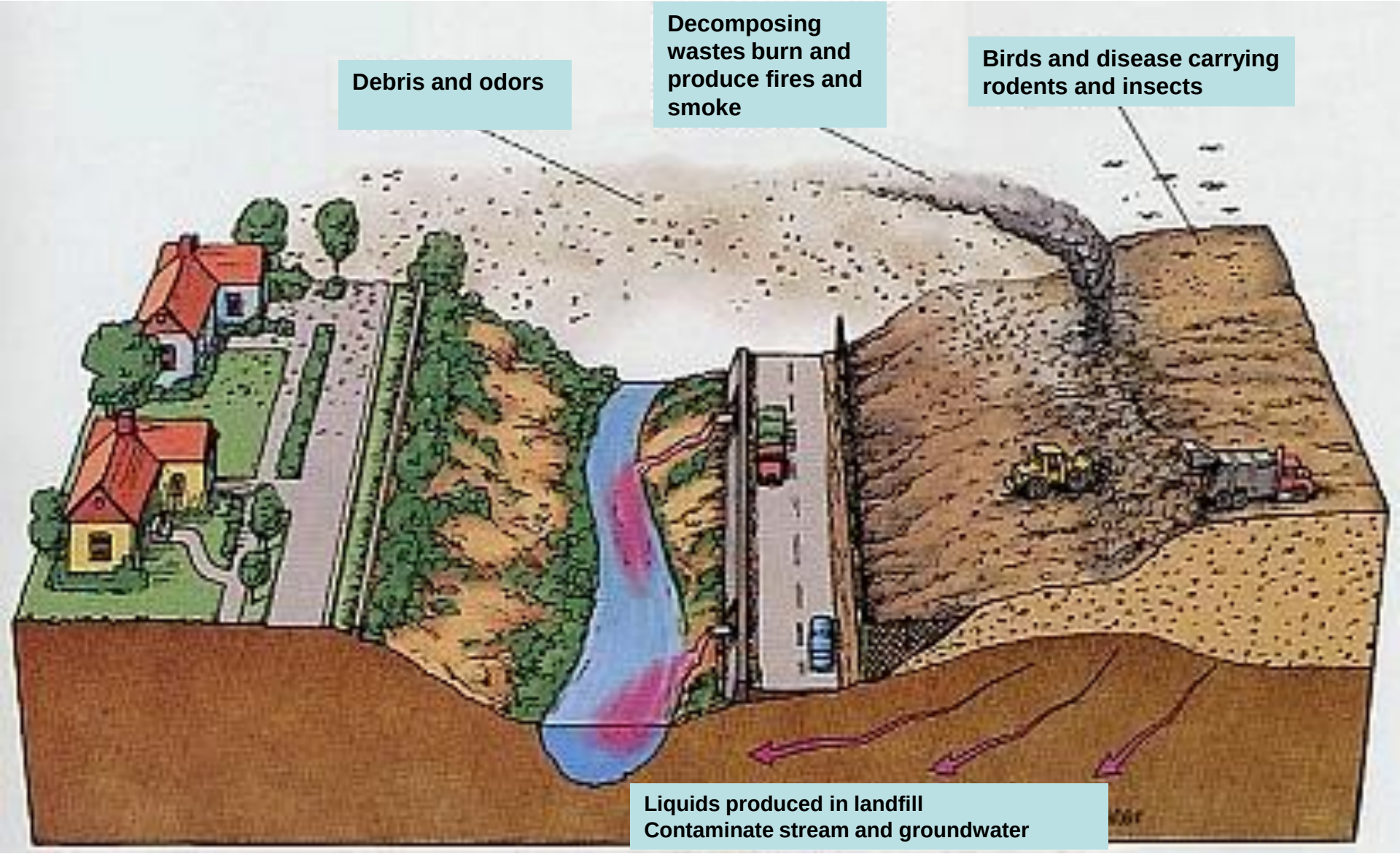
- **The garbage is ground and flushed into a kitchen sink**

2. Composting

3. Open dumps

Rodent – rats, mouse, squirrel

OPEN DUMPS



4. Landfill

- Sistem pelupusan sisa kambus bersih
- Tanah ditanam dengan ciri kejuruteraan yang baik untuk mengelak berlakunya pencemaran leachate dan gas methana

5. Incinerator

- Pembakaran suhu tinggi
- Terkawal dan tertutup
- Gas terkawal - dibersihkan

Landfill

Table 4 Existing Landfill Sites in Malaysia

No	States	Number of landfill	Average area (ha)	Waste received (ton/day)	Landfill level				
					Level 0	Level 1	Level 2	Level 3	Level 4
1	Johor	18	5.6	1,082	10	6	2	1	0
2	Melaka	4	18.5	1,065	2	0	1	1	0
3	N. Sembilan	11	10.9	727	7	3	1	0	0
4	Selangor	14	10.6	2,285	0	7	1	1	5
5	Pahang	14	8.7	895	5	3	2	3	1
6	Terengganu	8	5.6	707	2	4	1	0	1
7	Kelantan	12	5.6	424	10	1	1	0	0
8	Perak	19	10.3	1,450	9	6	3	1	0
9	Kedah	10	7.7	893	3	2	4	0	1
10	P. Pinang	2	22.3	1,400	0	0	1	1	0
11	Perlis	1	4.0	100	0	0	0	0	1
12	Sarawak	36	2.9	1,000	20	14	2	0	0
13	Sabah	20	21.7	851	15	4	1	0	0
14	KL	1	12.0	600	0	0	1	0	0
15	Labuan	1	12.1	12	0	1	0	0	0
Total		171	9.1	13,491	83 48%	51 30%	21 12%	8 5%	9 5%

Notes: Level 0: Open dumping
Level 1: Controlled tipping
Level 2: Controlled landfill with bund and daily cover soil
Level 3: Sanitary landfill with leachate recirculation system
Level 4: Sanitary landfill with leachate treatment system

Source: MHLG, 2001

Ministry of Housing and Local Government (2001)

BILANGAN TAPAK PELUPUSAN SISA PEPEJAL YANG BEROPERASI DAN YANG TELAH DITAMATKAN OPERASI MENGIKUT NEGERI SEHINGGA 30 SEPTEMBER 2009

NEGERI	BILANGAN TAPAK PELUPUSAN SISA PEPEJAL YANG BEROPERASI	BILANGAN TAPAK PELUPUSAN SISA PEPEJAL YANG TELAH DITAMATKAN OPERASI
Johor	13	21
Kedah	10	5
Kelantan	13	4
Melaka	2	5
Negeri Sembilan	8	10
Pahang	19	13
Perak	20	9
Perlis	1	1
Pulau Pinang	1	2
Sabah	21	1
Sarawak	51	12
Selangor	6	12
Terengganu	9	12
Wilayah Persekutuan KL	1	7
Wilayah Persekutuan Labuan	1	0
Jumlah	176	114
Jumlah Keseluruhan	**290**	

Jenis sisa di Malaysia

- **Sisa pepejal (*solid waste*)**
- **Sisa Berjadual (*scheduled waste*)**
- **E-Waste (*electronic waste*)– barang eletrik**

Komposisi Bagi Sisa Pepejal di Malaysia 2005 (RMK9)

Komponen	Peratus
Sisa makanan	45
Plastik	24
Kertas	7
Besi	6
Kaca	3
Lain-lain	15
Jumlah	**10**

- Household waste
- Commercial waste
- Institutional waste
- Industrial waste
- Construction waste.

Sanitary landfill
(kaedah kambus bersih)

(***<u>Definition by</u> American Society of Civil Engineering, ASCE***)

Sanitary Landfill

Advantages	Disadvantages
1. Most Economic method 2. Low initial investment 3. Operation in a short time period 4. All types of waste – all in one 5. Completed sites – other purposes	1. Not suitable in densely populated area 2. Require daily maintenance 3. Methane and other gases 4. Leachate – problem for years

Landfill - Kesesuaian tapak

- **Stability Underlying geology**
- **Nearby earthquake faults**
- **Water table**
- **Location of nearby rivers, streams, and flood plains**

Classification of sanitary levels

- : Controlled tipping
- : sanitary landfill with a bund and daily cover soil
- : sanitary landfill with leachate recirculation system
- : sanitary landfill with leachate treatment facilities

Level of sanitary landfill system

Level	Description
Level O	Open dumpsite
Level I	Controlled tipping
Level II	Sanitary landfill with bund and daily cover
Level IIII	Sanitary landfill with leachate recirculation system
Level IV	Sanitary landfill with leachate treatment facilities and MORE

- Monitoring
- Water quality
- Liner facility

Statistics of landfills in Selangor

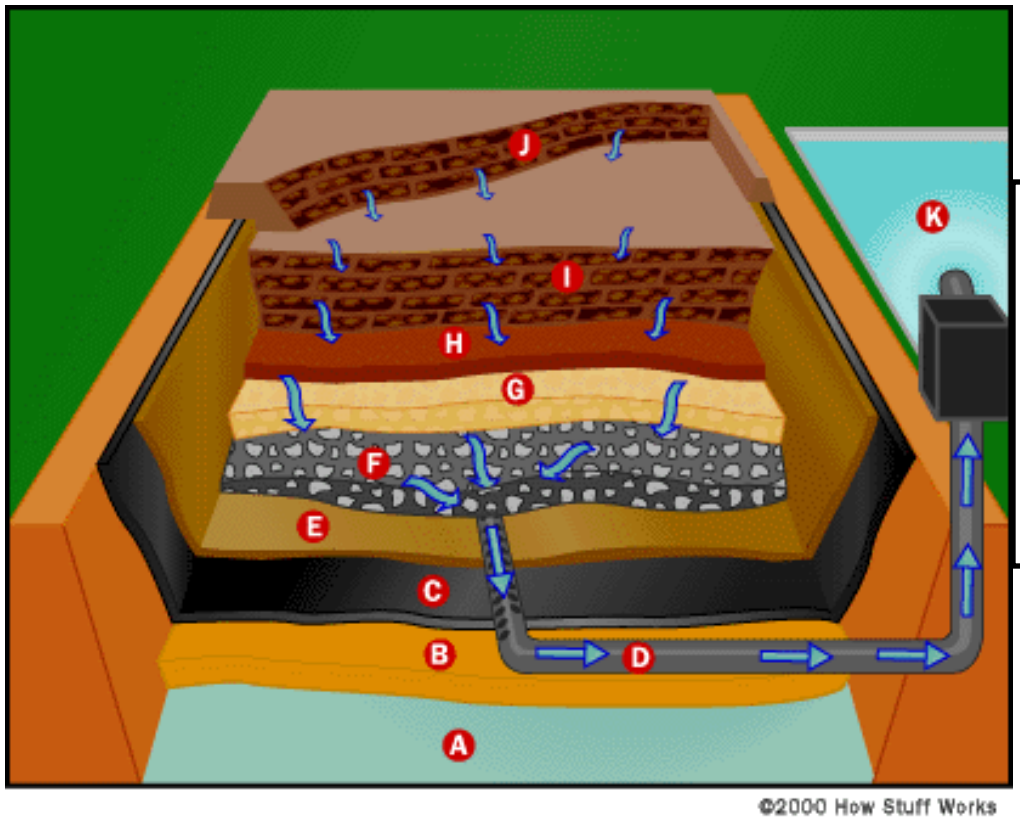
Statistics	Number of landfill	%
Current status		
Operating	7	37
Closed	12	63
Groundwater protection (liner)		
Yes	3	16
No	16	84
Groundwater monitoring well		
Yes	4	21
No	15	79
EIA Study		
Yes	4	21
No	15	79
Sanitary Landfill (Level 4)		
Level 4	3	18
unsanitary	16	82

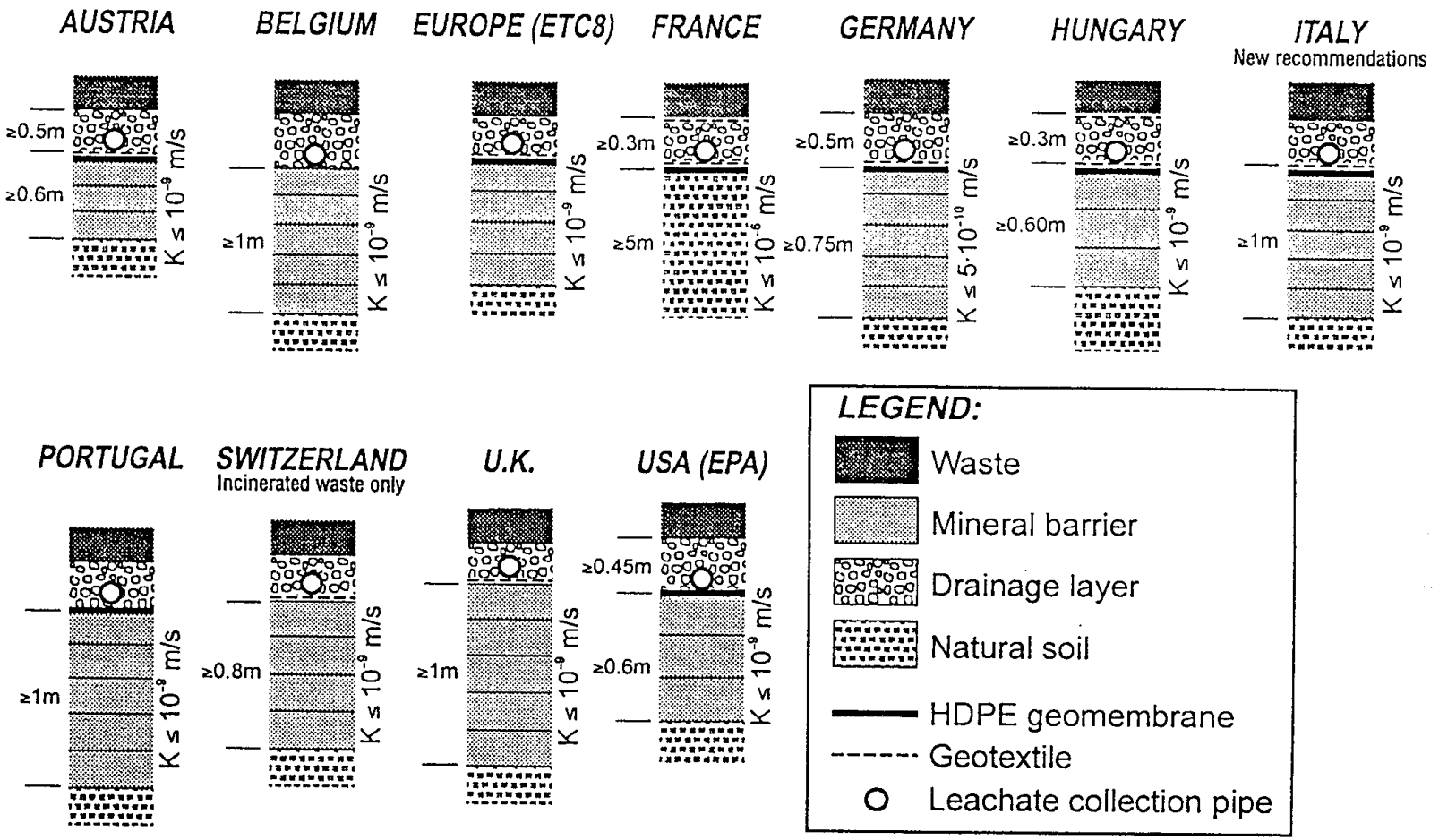
Statistics	Number of landfill	%
Landfill Operators (active)		
Worldwide Landfills	1	14
KUB Berjaya	1	14
Alam Flora	3	43
Local Authorities	2	29
Distance to major river		
<100m	12	71
>100m	5	29
Distance to housing area		
<500m	6	35
>500m	11	65

The basic parts of a landfill

- **Bottom liner system**
  - **separates trash and leachate from groundwater**
- **Cells (old and new)**
  - **The trash is stored within the landfill**
- **Storm water drainage system**
  - **collects rain water that falls on the landfill**
- **Leachate collection system**
  - **collects water that has percolated through the landfill itself and contains leachate**
- **Methane collection system**
  - **collects methane gas that is formed during the breakdown of trash**
- **Covering or cap**
  - **seals off the top of the landfill**

The cross-section of a municipal solid waste landfill




AUSTRIA
≥0.5m
≥0.6m
K ≤ 10⁻⁹ m/s
BELGIUM
≥1m
K ≤ 10⁻⁹ m/s
EUROPE (ETC8)
K ≤ 10⁻⁹ m/s
FRANCE
≥0.3m
≥5m
K ≤ 10⁻⁶ m/s
GERMANY
≥0.5m
≥0.75m
K ≤ 5·10⁻¹⁰ m/s
HUNGARY
≥0.3m
≥0.60m
K ≤ 10⁻⁹ m/s
ITALY
New recommendations
≥1m
K ≤ 10⁻⁹ m/s
PORTUGAL
≥1m
K ≤ 10⁻⁹ m/s
SWITZERLAND
Incinerated waste only
≥0.8m
K ≤ 10⁻⁹ m/s
U.K.
≥1m
K ≤ 10⁻⁹ m/s
USA (EPA)
≥0.45m
≥0.6m
K ≤ 10⁻⁹ m/s
LEGEND:
Waste
Mineral barrier
Drainage layer
Natural soil
HDPE geomembrane
Geotextile
Leachate collection pipe

Compacted clay and geomembrane


Compacted clay soil
Geomembrane (HDPE)

Masalah dengan landfill

- **Cecair larut lesap (leachate)**

- **Gas metana (i.e. biogas)**

LEACHATE (1)

- **A liquid: result of water seeping into and through the wastes – waste juice!!**
- **The water dissolves part of the organic and inorganic matter.**
- **Exit the bottom of the landfill -- contaminants to the groundwater and/or surface water.**

LEACHATE (2)

- **Strength and nature depend on:--**
  - **(1) the composition of waste**
  - **(2) length of time – contact with waste**
  - **(3) amount of water in waste**

Landfill gas (1)

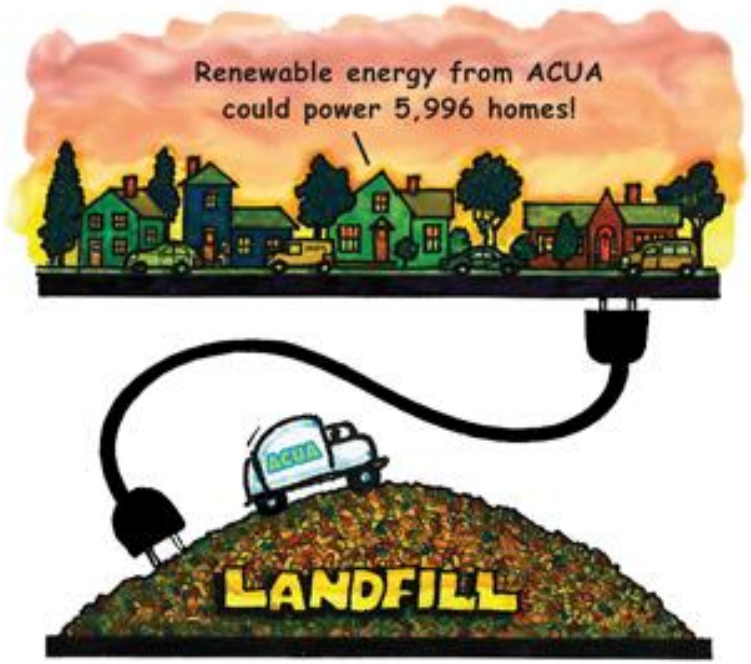
-  **methane (Colorless; odorless, explosive)**
-  **carbon dioxide.**
- **Small amounts of nitrogen, oxygen, ammonia, sulfides, hydrogen, carbon monoxide**
- **Nonmethane organic compounds (NMOCs) such as trichloroethylene, benzene, and vinyl chloride**

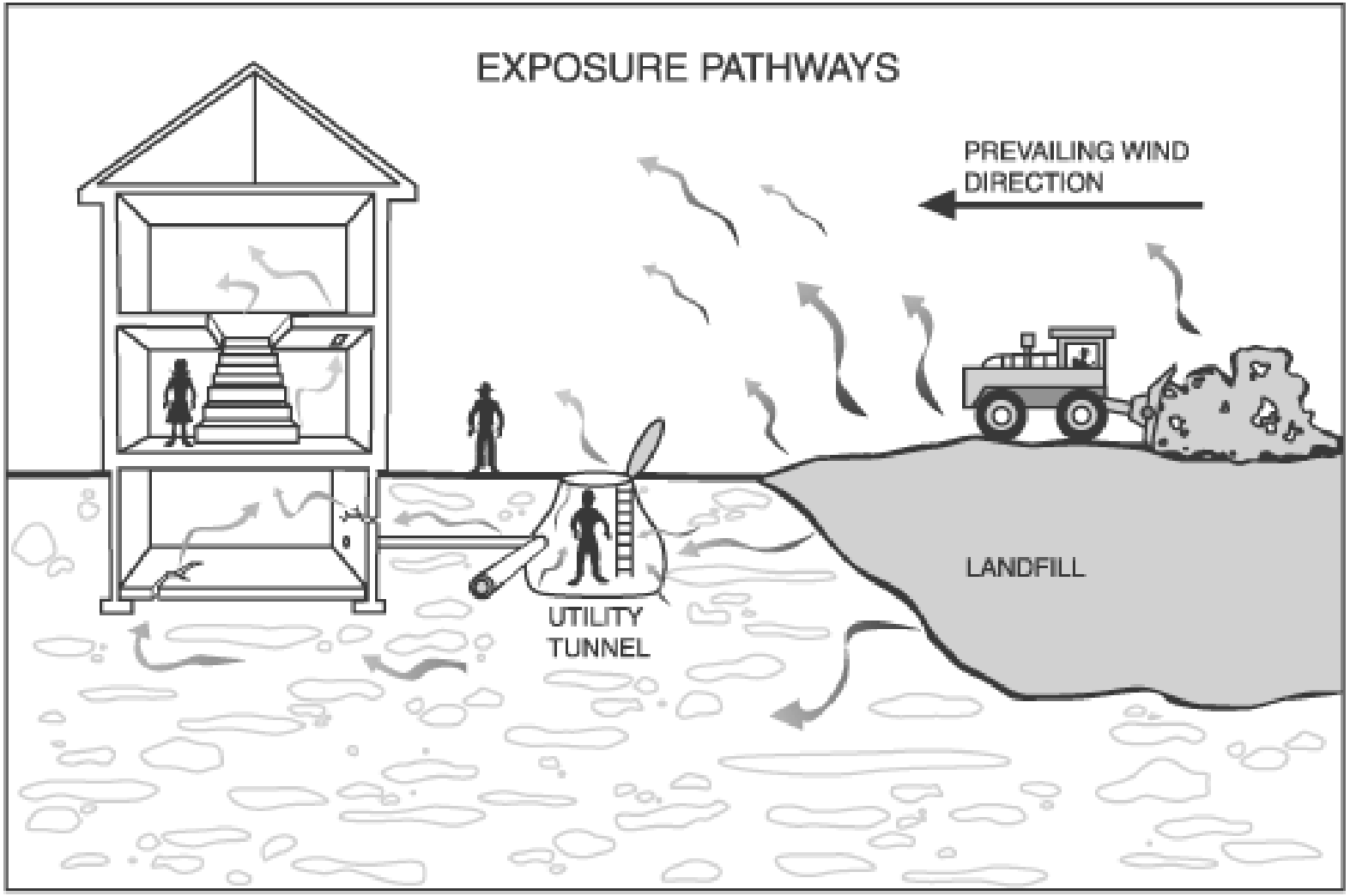
Landfill gas (2)

- **Methane is highly explosive when mixed with air at a volume between its [redacted] and its UEL [redacted]**
- **At concentrations [redacted] and above [redacted] methane is not explosive.**

LEL – Lower explosion limit

UEL – Upper explosion limit

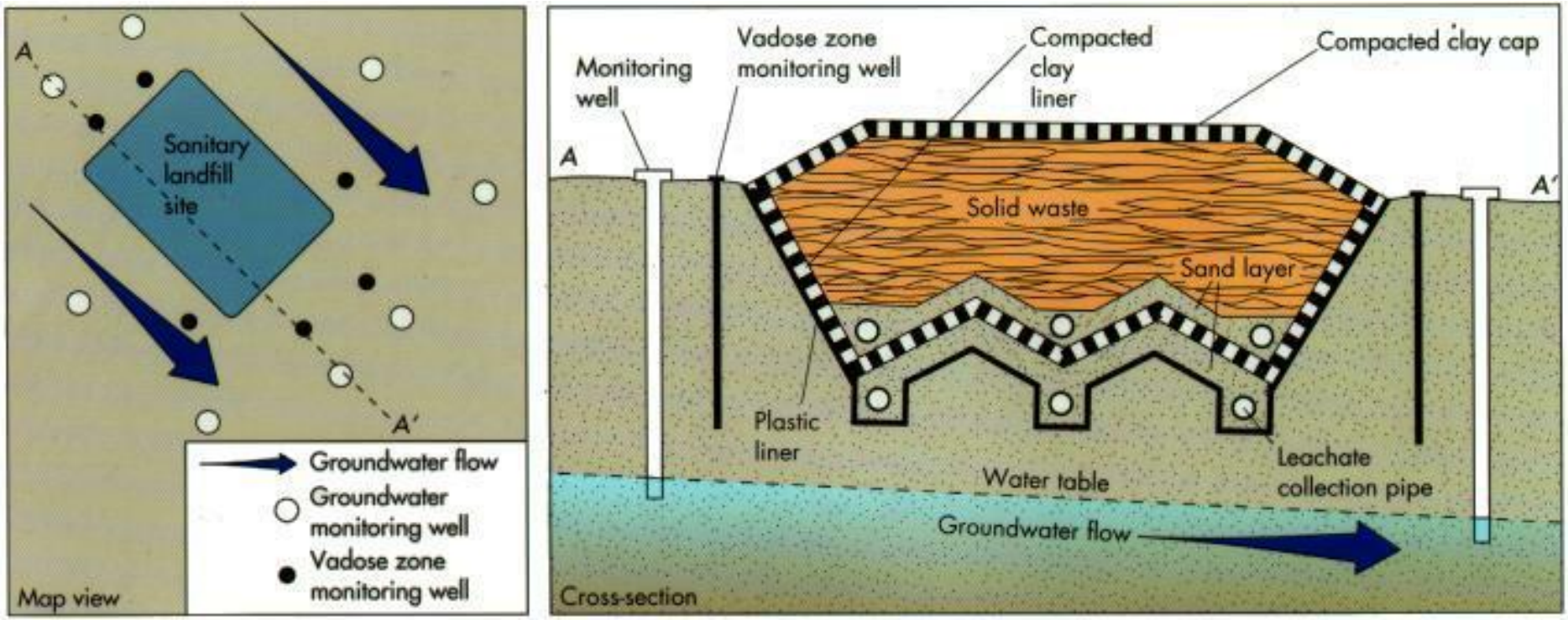

Renewable energy from ACUA
could power 5,996 homes!
ACUA
LANDFILL


EXPOSURE PATHWAYS
PREVAILING WIND DIRECTION
LANDFILL
UTILITY TUNNEL

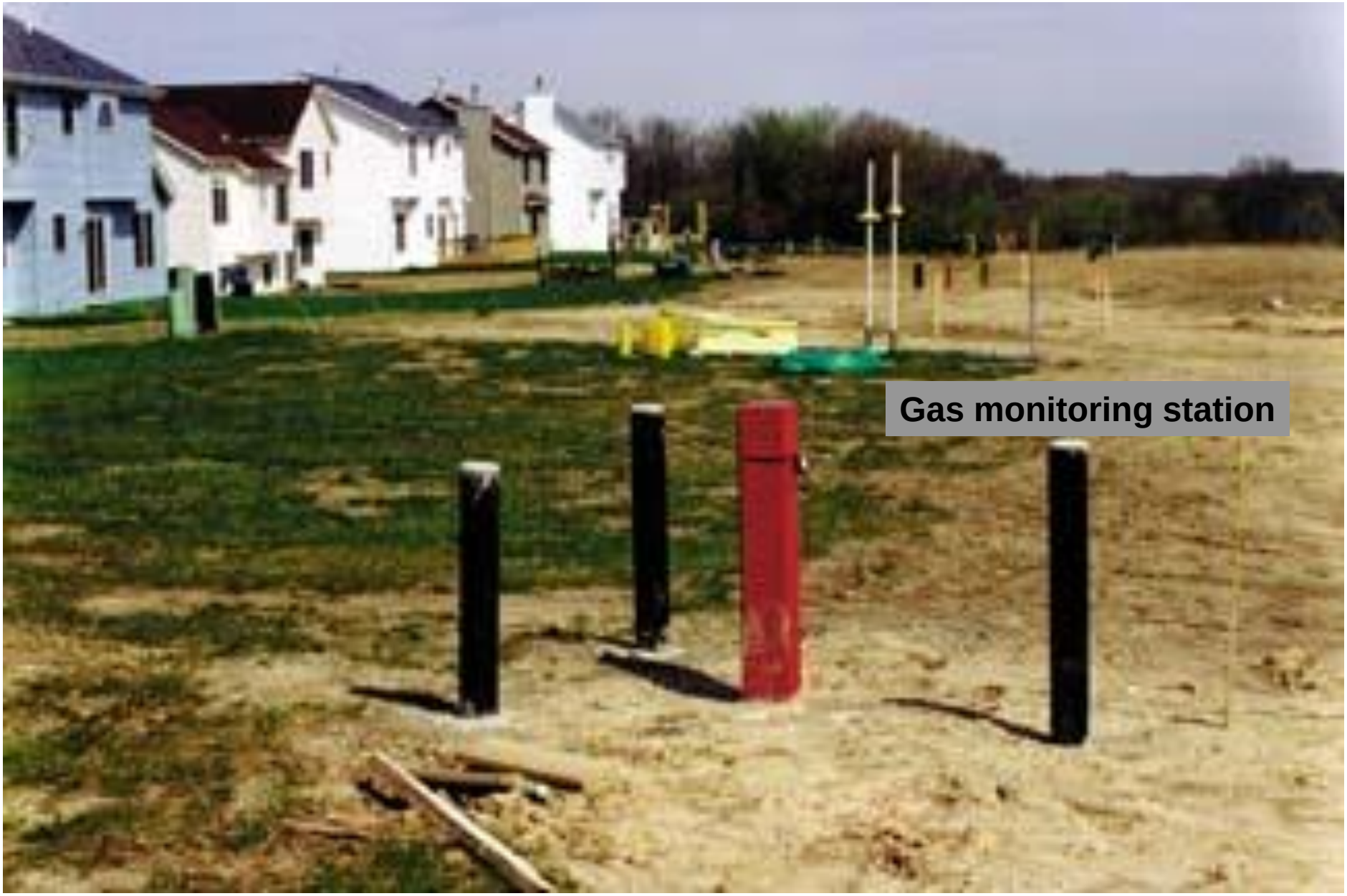
Landfill monitoring

- **Monitoring the landfill waste**
- **Monitoring the leachate and discharged water**
- **Monitoring of gas generation**
- **Monitoring of bad adours**
- **Monitoring the surrounding environment**
- **Monitoring of Groundwater**
  - **Position and number of boreholes**
  - **Parameters to be monitored and frequency**

Groundwater monitoring



Idealised diagrams showing map view (a) and cross section (b) of a landfill with a double liner of clay and plastic and a leachate collection system.


Gas monitoring station

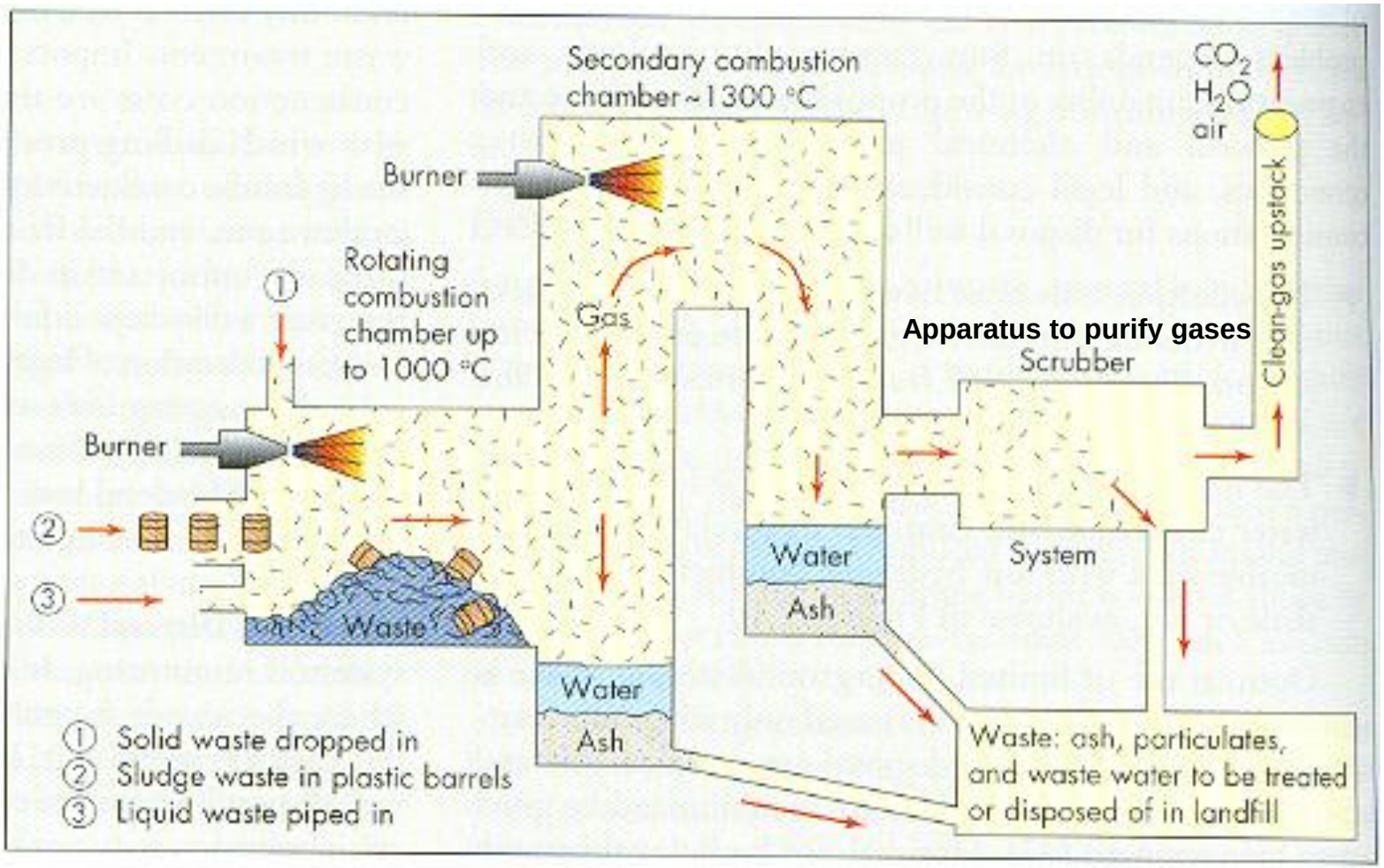
Incinerator

INCINERATOR (1)

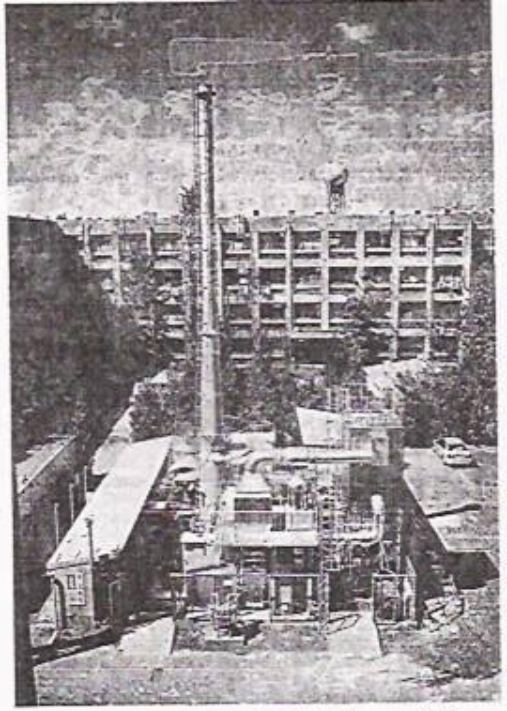
- **Burning waste in large furnaces**
- **Segregated and burnt →**
- **Ash floats in hot air -- FLY ash.**
- **Ash that is left in the furnace after burning – BOTTOM ash**
- **Fly and bottom ash --- high concentrations of dangerous toxins such as <u>metals.</u>**
- **Disposing of this ash is a problem.**
- **The ash that is buried at the landfills leaches the area and cause severe contamination.**

INCINERATOR (2)

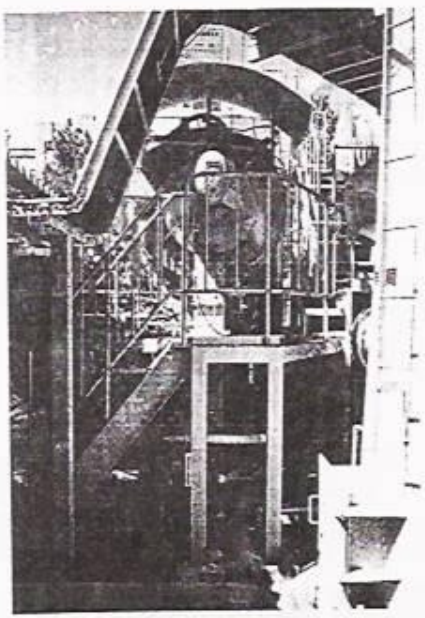
- **Reduce volume of waste ---**
- **2 advantages**
  - **(1) Reduce the volume of waste**
  - **(2) Generating electrical power**
- **Consider as treatment; not disposal**


Secondary combustion chamber ~1300 °C
CO_2
H_2O
air
Clean-gas upstack
Burner
Rotating combustion chamber up to 1000 °C
①
Gas
Apparatus to purify gases
Scrubber
Burner
②
③
Waste
Water
Ash
System
Water
Ash
① Solid waste dropped in
② Sludge waste in plastic barrels
③ Liquid waste piped in
Waste: ash, particulates, and waste water to be treated or disposed of in landfill

Incinerator
(Kyoto Uni, Japan)



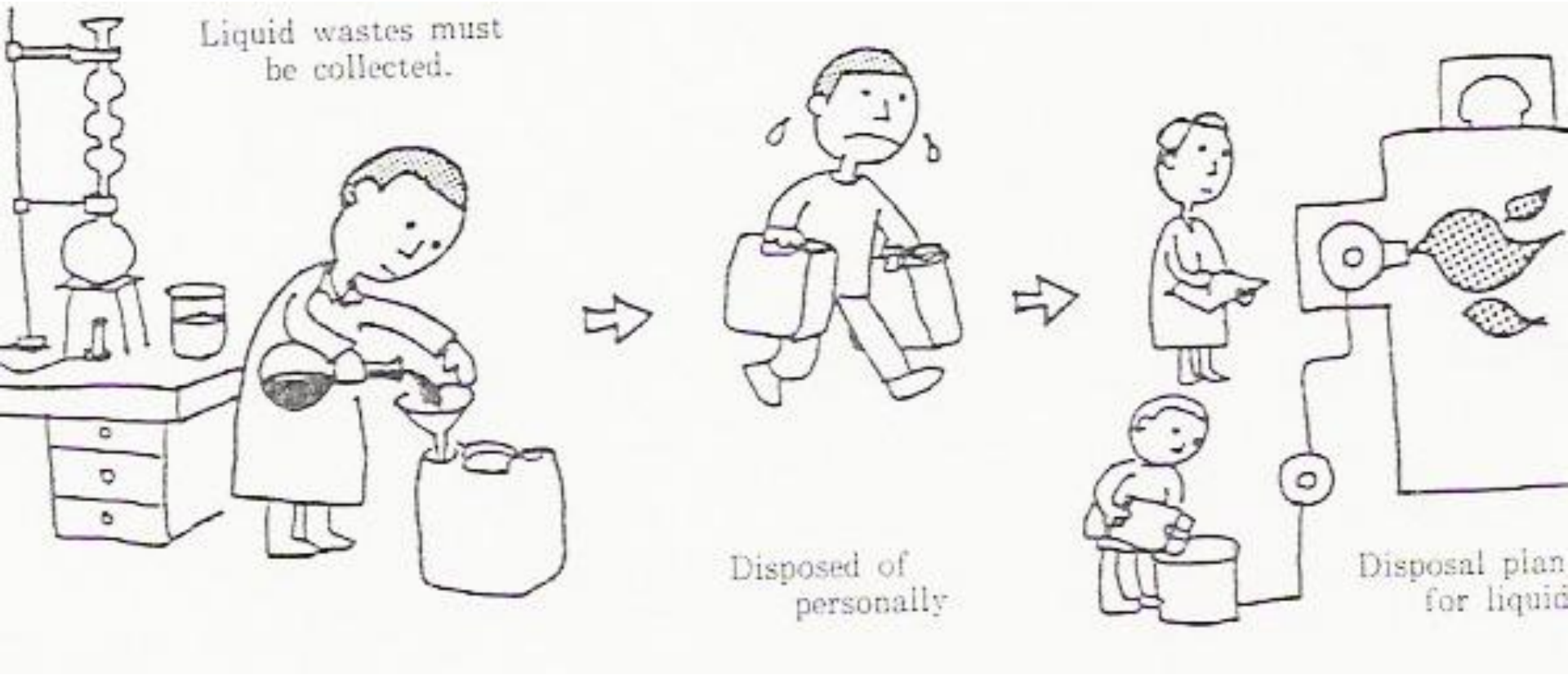
Disposal Plant for Organic Liquid Wastes (KYS)



Incinerator

Computer

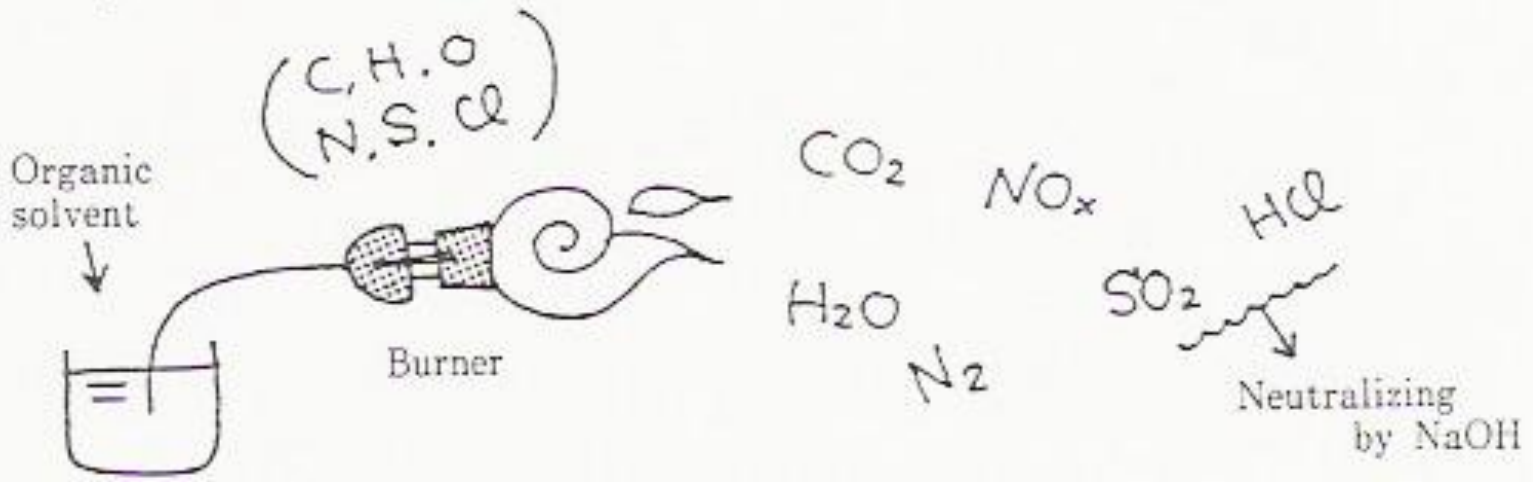
Super power incinerator (Kyoto)


Liquid wastes must
be collected.
Disposed of
personally
Disposal plan
for liquid

ory of disposal of organic liquid waste

Disposal of organic liquid waste

Disposal by rotary burner



THE END