Field Measurement of Greenhouse Gas Emissions from Landfills in Tropical Developing Countries

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Emission of CH_4 from Landfills

- Sanitary landfills (containing biodegradable organic waste) account for about 10% (estimated) of the worldwide anthropogenic emissions of CH_4
- These emissions arise from landfills in both developed and developing countries

Global Landfill CH_4 Emission Estimates

- Global landfill CH_4 emission estimates are mostly based on assumptions of waste generation rates and biodegradation kinetics
- Some verification of these estimates have been done (primarily at North American and European landfills)
- Few emission surveys have been done in developing countries (especially in South America or Asia)

Our Collaborative Landfill Projects

We started our collaborative projects in 1998.

Currently, we have collaborative projects in several countries in South America and Asia.

Aims of Our Collaborative Projects

- Accurate estimation of waste generation rates and biodegradation kinetics (under local conditions)
- Develop and promote appropriate landfill design and operation practices
- Undertake gas emission surveys at different types of South American and Asian landfills; well-designed landfills, “open dumps”, shallow and deep landfills

Two of the Landfills Investigated:

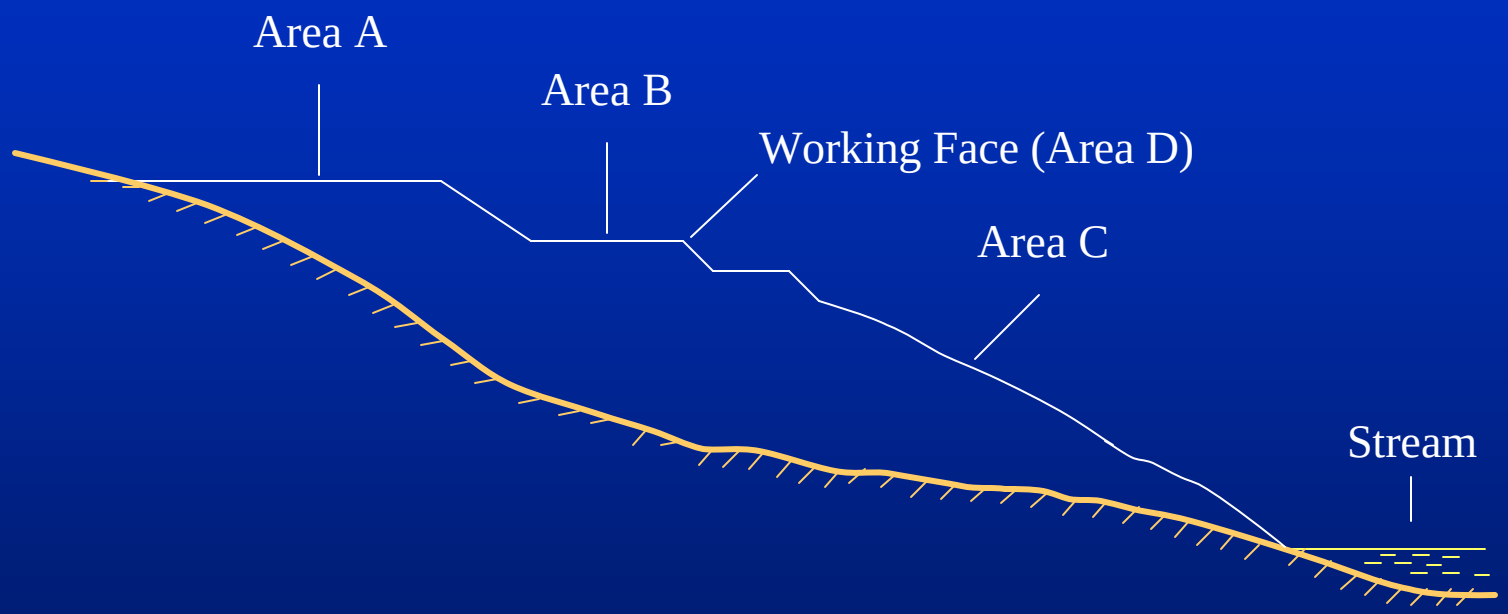
The Zambisa landfill in Quito, Ecuador
(a Canyon “landfill”, in operation for more than 20 years)

The Loma Los Colorados landfill, near Santiago, Chile
(a well designed Cell-type landfill, in operation for about 5 years)

Zambisa Landfill

- Accepts almost all of the waste collected within the city of Quito (about 1,100 tpd). Currently contains about 5-6 million tonnes of waste.
- At present, the landfill is operated as a “sanitary landfill” but in 80’s and early 90’s, it was a little more than an “open dump”.
- We undertook a surface emission survey (in 1998) using conventional flux chamber technique. We studied four sections (A, B, C and D)

Zambisa Landfill (contd…)



X-section along the length of the landfill

Zambisa Landfill (contd…)

Area A (with final cover)

Zambisa Landfill (contd…)

Area B (with intermediate cover)

Zambisa Landfill (Area C)

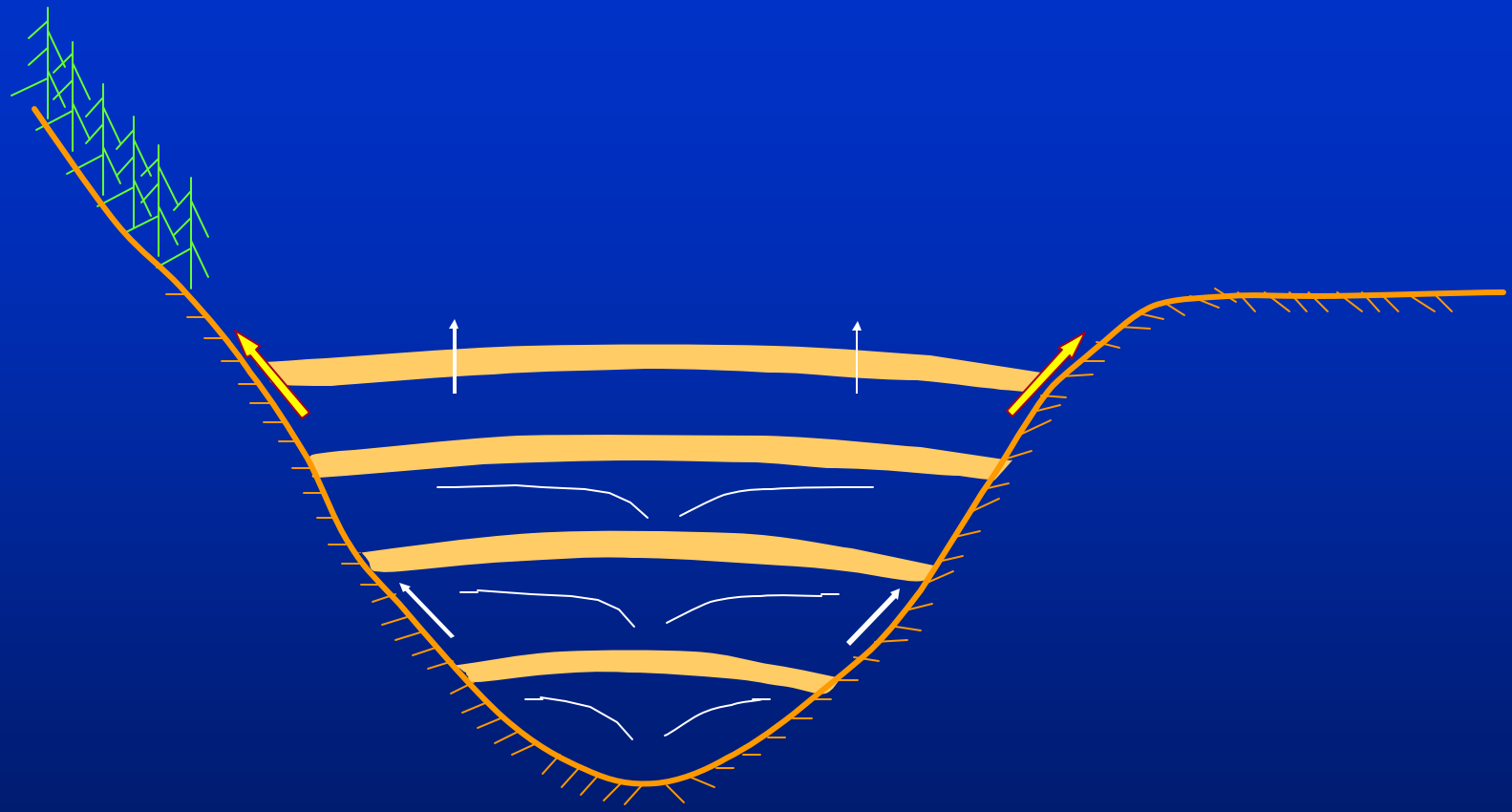
Zambisa Landfill (contd…)

Area D (Working Face)

Zambisa Landfill (contd…)

Area D (Flames from the Abyss)

Zambisa Landfill (contd…)

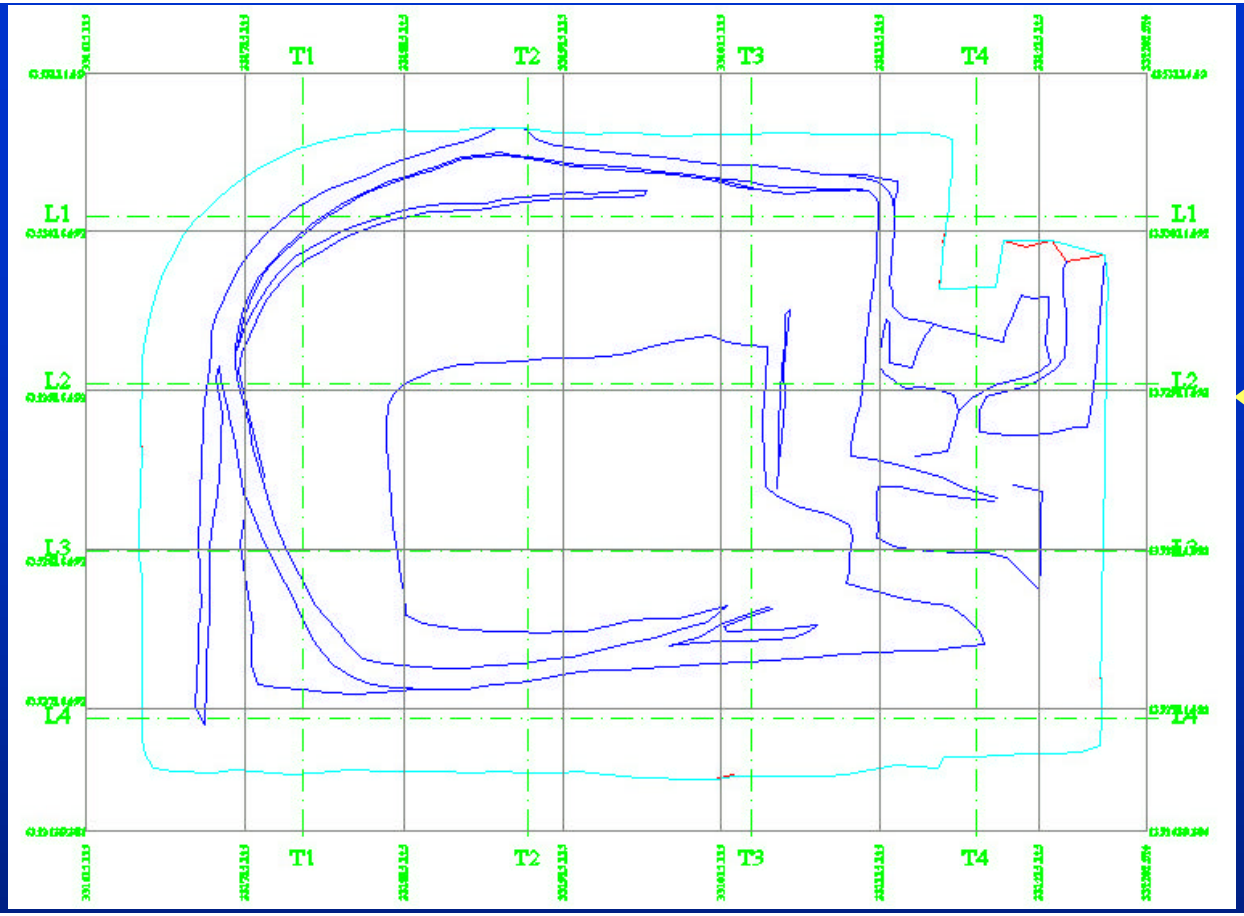


X-section along the transverse direction

Loma Los Colorados Landfill, Chile

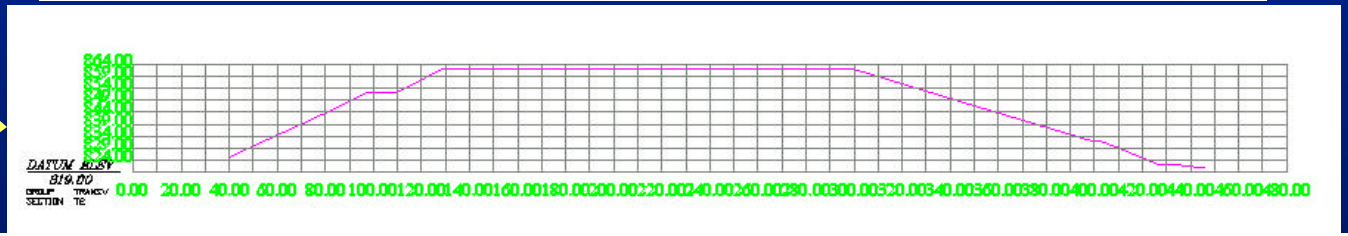
Loma Los Colorados Landfill

- Area or Cell-type landfill, with a design cell area of 210 ha. Plan area of Phase I = 24 ha.
- Started Phase I operations in March 1996; has received about 5 million tonnes of waste by Summer, 2000.
- Design height = 100 m,
  maximum depth in summer 2000 = 45m
- Lift thickness = 5m, intermediate cover = 0.4 m
- Nominal compaction density = 1000 kg/m^3
- leachate/gas collection systems, and leachate recirculation

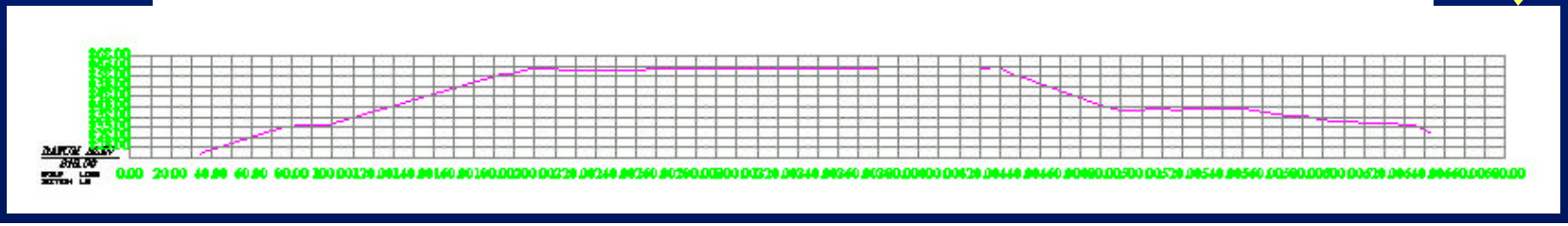


Plan

X-Section
T_2T_2



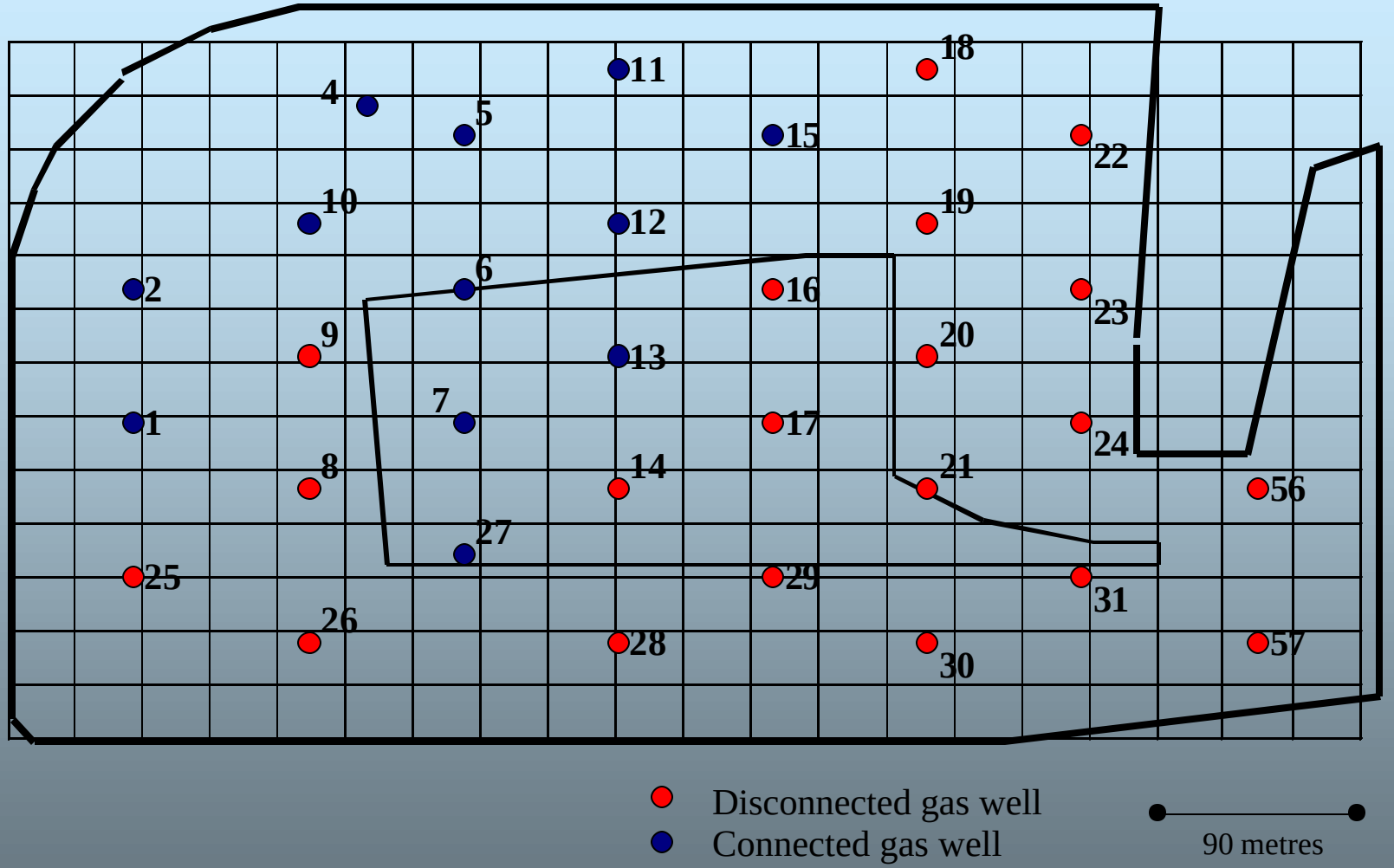
X-Section
L_2L_2



Sources of Gas Emissions/Extraction at Loma Los Colorados

- Gas collection system: 13 deep wells connected to a modern incinerator.
- Vent gas: 20 dis-connected wells
- Surface emissions: measured using flux chamber technique (232 measurements; 10 per ha)
- Other emissions: leachate pools, storage ??

Loma Los Colorados (contd…)



Gas Wells

Landfill Gas Incinerator

CH_4 burned= 1660 tonnes/year (or 6450 m^3/d)

Loma Los Colorados (Passive Venting)

Methane flow rate of passive vents: 1180 tonnes/year

Landfill Gas Vents

Loma Los Colorados (Surface Emissions)

Average Surface Emissions

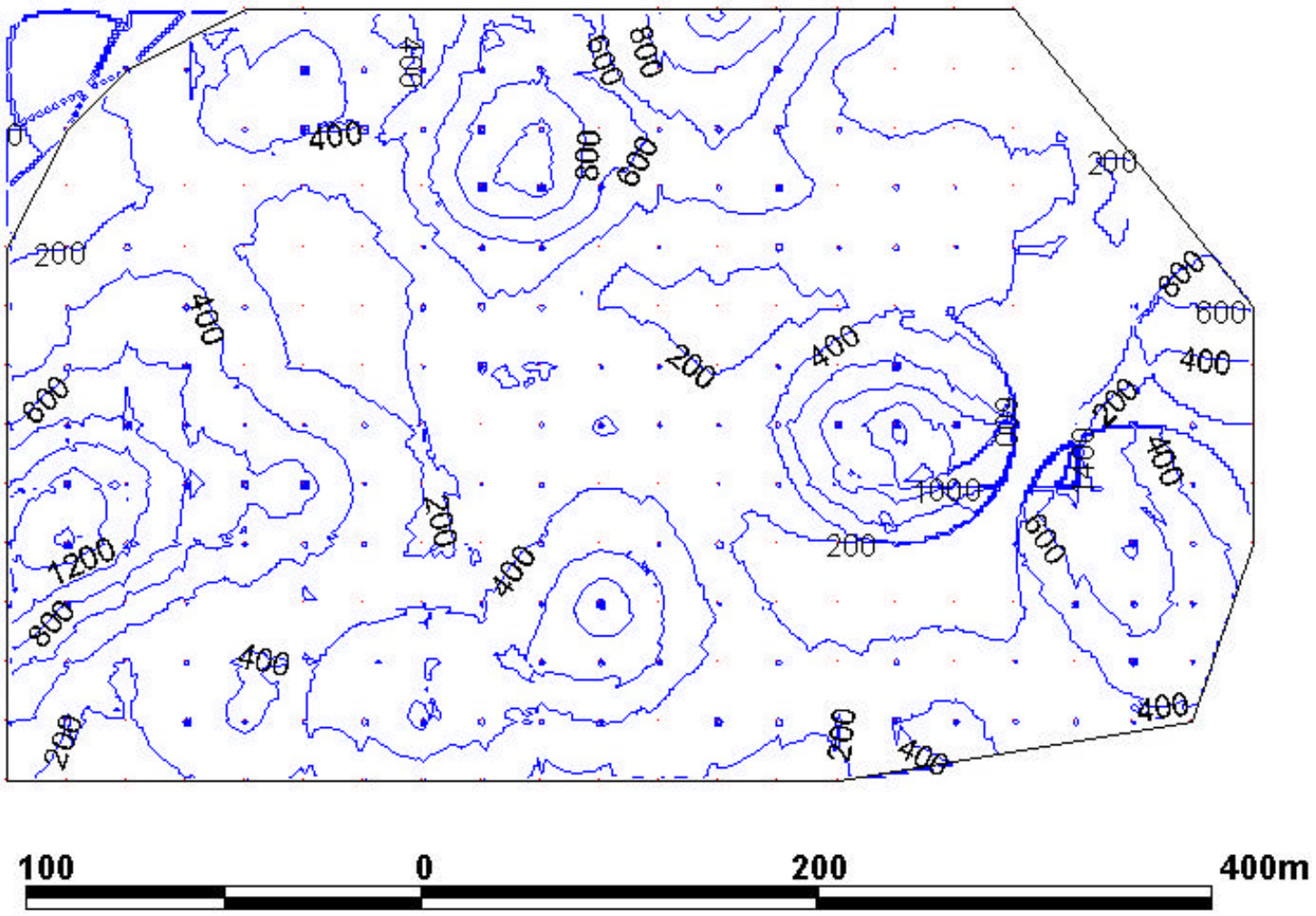
- CH_4 surface flux = 172 $g \times m^{-2} \times day^{-1}$
- CO_2 surface flux = 389 $g \times m^{-2} \times day^{-1}$

Total Surface Emissions

- CH_4 emitted/year = 13,320 tpy
- CO_2 emitted/year = 31,980 tpy

- CH_4 oxidation in cover soil = 880 tpy
  = 6.2% of total surface emission

CH_4 Emission Contour Plot



Loma Los Colorados (Emissions contd…)

Total CH_4 emitted/burned = 17,040 tonnes/year
(exclude “leachate pool” emissions)

More than 75% of the “produced methane gas” escapes across the cover soil.

Loma Los Colorados (contd…)

Theoretical Estimations

Scholl Canyon model predicts CH_4 production of 30,600 tonnes/year, when the following parameter values are used:

- a waste half-life of 5 years
- a L_o value of 105.6 m^3/tonne (based on waste composition data)

Loma Los Colorados (contd…)

Leachate Pools

Average CH_4 flux = 13,231 g × m^{-2} × day^{-1}

Average CO_2 flux = 23,393 g × m^{-2} × day^{-1}

Conclusions

- In developing countries, very high quantities of CH_4 are produced before closure of a landfill, during operation.
- At Zambisa, most of the CH_4 emissions come from a small percentage of the landfill area (no consideration given to gas issues when establishing intermediate covers).
- At Loma Los Colorados, large quantities of methane escape from the surface: require short term control (bio-cap??).
- Use of smaller sized cells will minimize uncontrolled methane escape during operation (cost??).
- Theoretical calculations may over-estimate methane emissions from developing country landfills.

Thank You!!!