Permeable Layers to Improve Landfill Gas Recovery from Indian Landfills

March 3, 2010

Don Augenstein[1]
Ramin Yazdani[2]
Chetan Zaveri[3]
John Benemann[1]

[1] Institute for Environmental Management Inc., 4277 Pomona Avenue, Palo Alto, California, U.S.A.
[2] Yolo County Planning and Public Works Department, Division of Integrated Waste Management, Yolo County, California, U.S.A.
[3] IL&FS Ecosmart Ltd, Mumbai, India

Presentation

- Introduction
- Description of permeable layer approach and benefits
- Current Project objectives
- The site selection
- Future plans

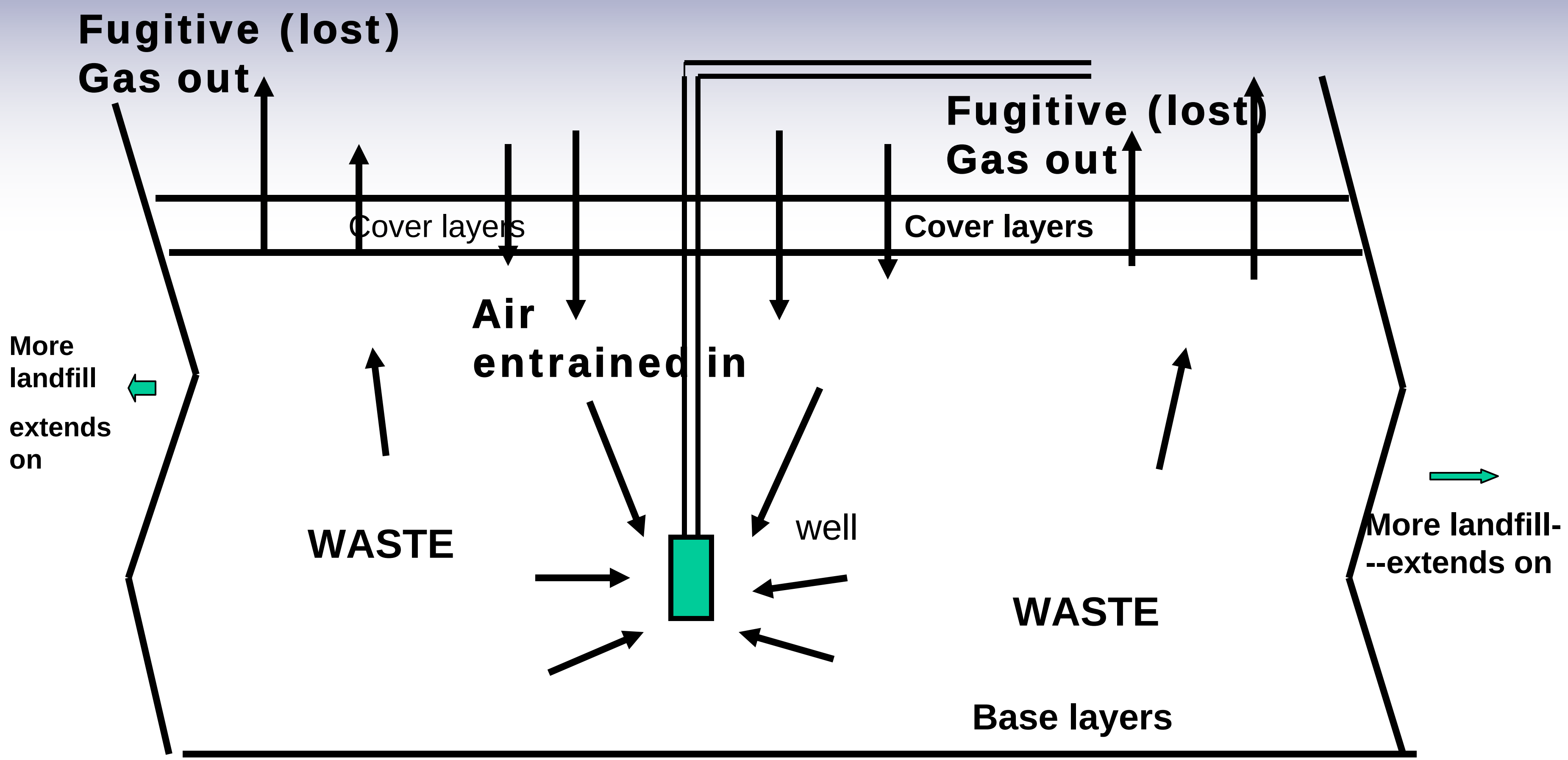
Typical Landfill and Gas Collection

- Current landfill gas collection technology
  - Fill waste and cover with soil
  - Drill vertical well
  - Install gas wells and collect gas
  - Adjust gas wells weekly to maximize methane content

Typical Landfill Gas Collection

- Limitation with current methods
  - No soil cover and waste placement is haphazard
  - Poor gas quality due to air entrainment
  - Staff needed for constant well adjustment
  - Vertical well could be waterlogged

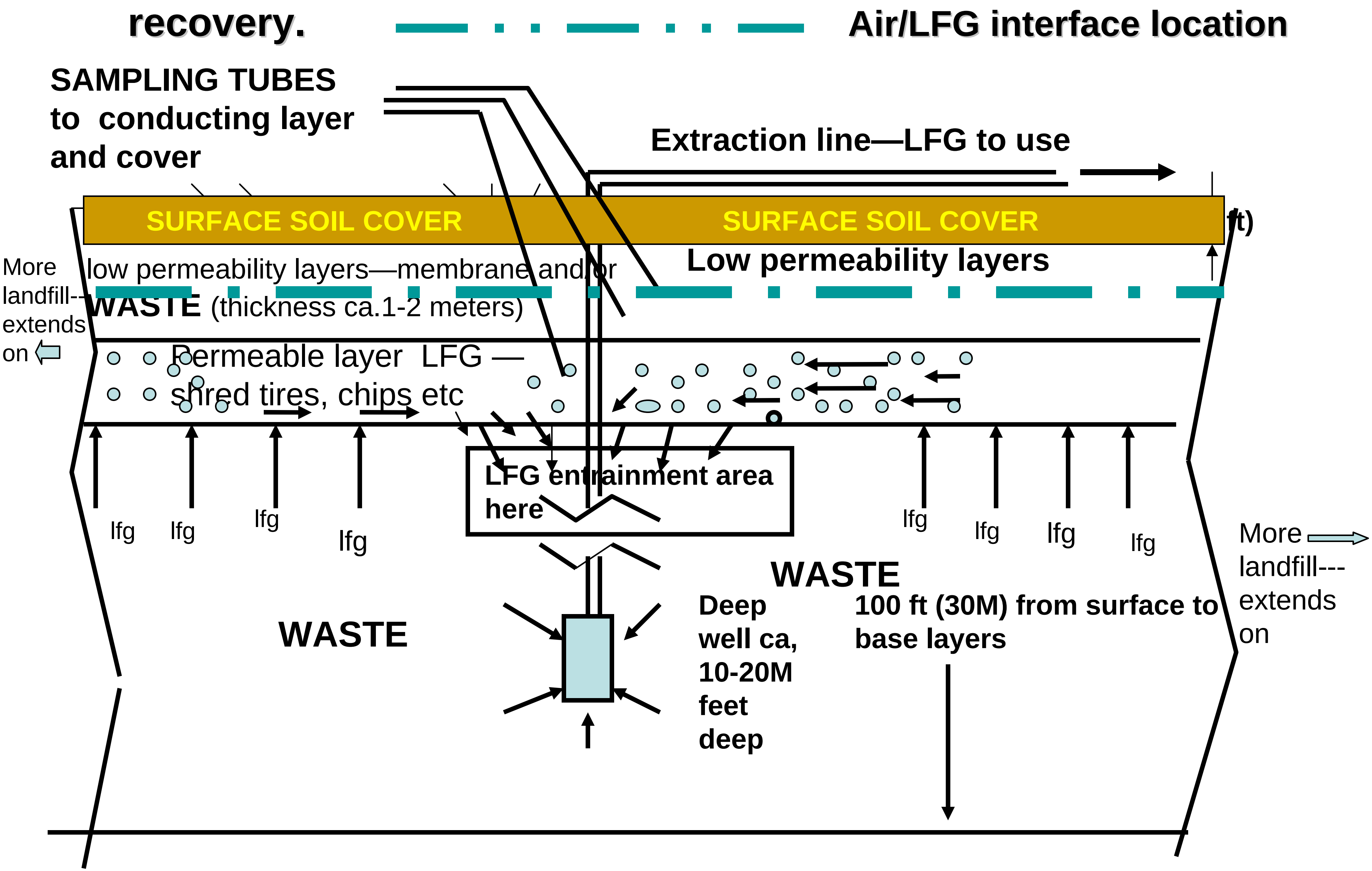
Simplified schematic of conventional LFG well and gas flow: Illustration of typical problem – irregular surface flux

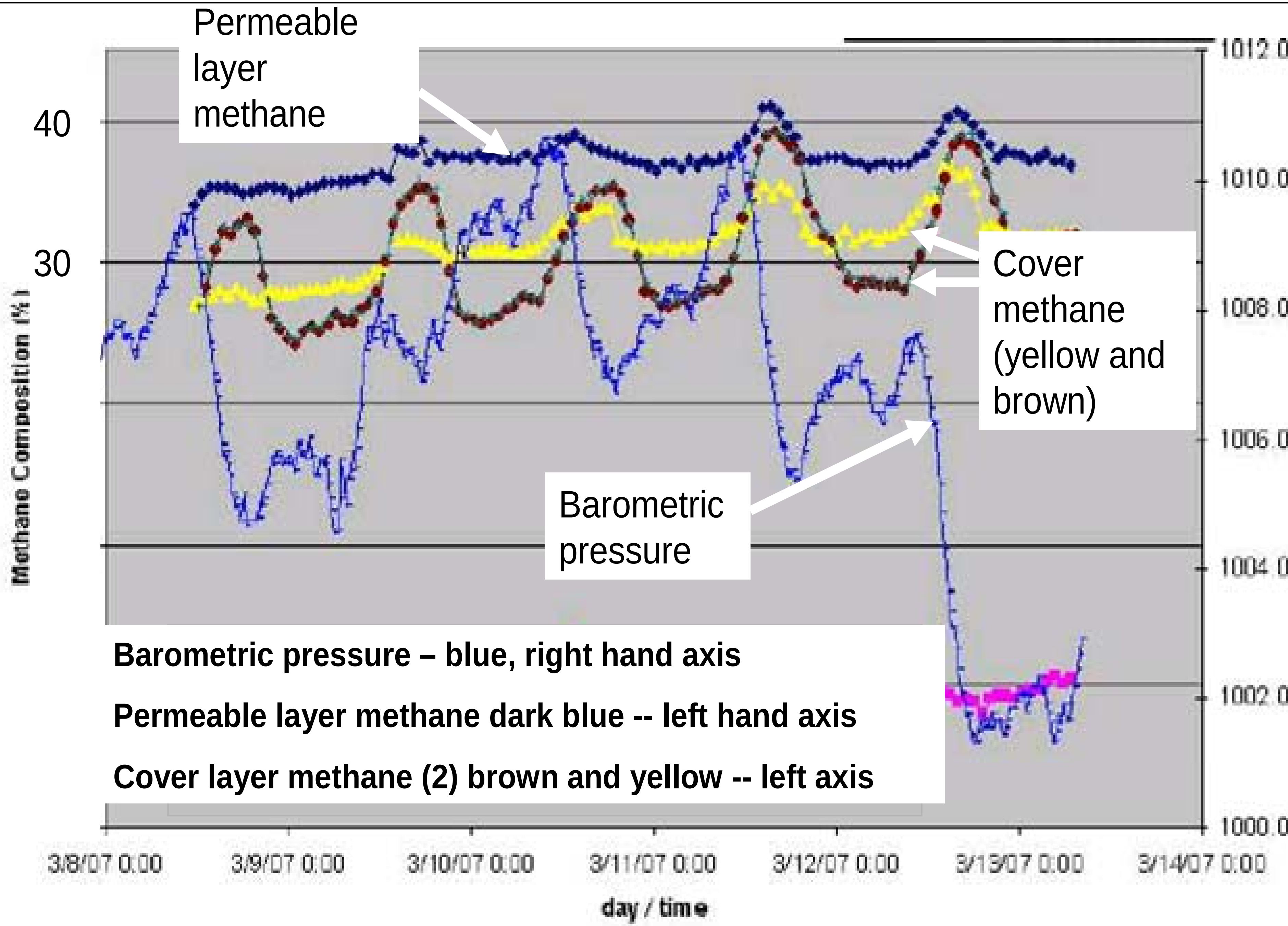


Arrows and lengths denote gas flows or fluxes.. Note variable surface fluxes and emissions distant from well, entrainment near well, inefficient collection. Fissures, irregularities in waste/ cover exacerbate problems

PERMEABLE LAYER TO IMPROVE LFG COLLECTION

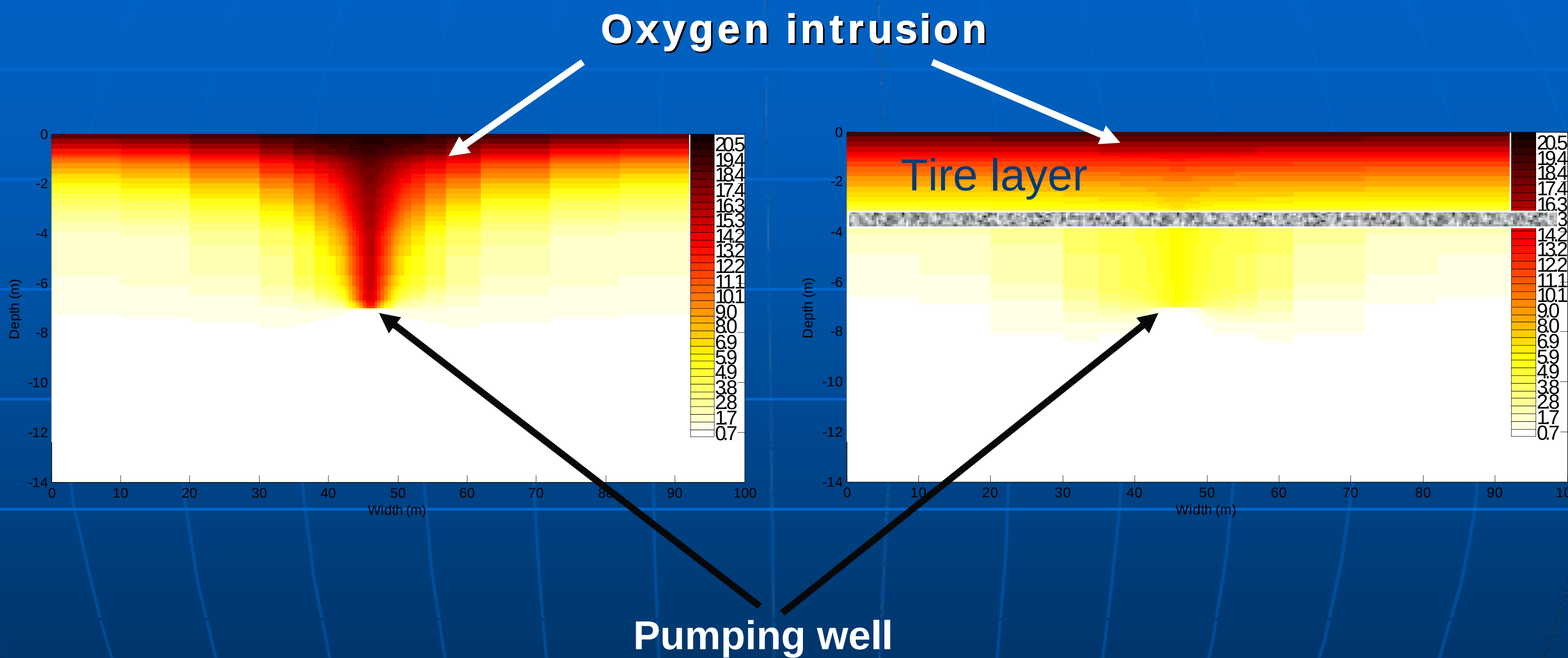
Simplified illustration: Subsurface probes to track and control LFG recovery.





Permeable layer methane
Cover methane (yellow and brown)
Barometric pressure
Barometric pressure – blue, right hand axis
Permeable layer methane dark blue -- left hand axis
Cover layer methane (2) brown and yellow -- left axis
Methane Composition (%)
40
30
1012.0
1010.0
1008.0
1006.0
1004.0
1002.0
1000.0
3/8/07 0:00
3/9/07 0:00
3/10/07 0:00
3/11/07 0:00
3/12/07 0:00
3/13/07 0:00
3/14/07 0:00
day / time

Permeable Layer Gas Well Benefit

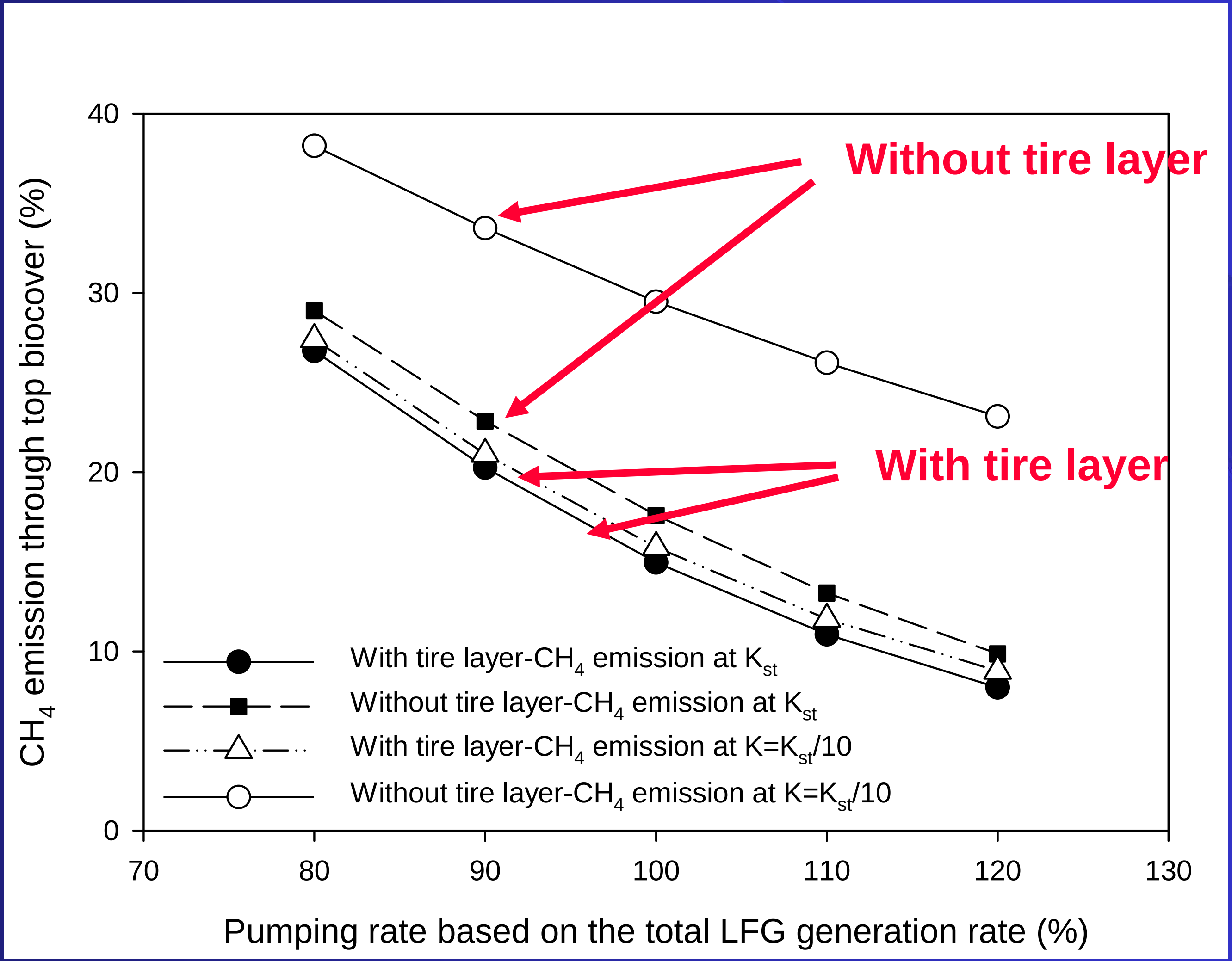


Without permeable layer

With permeable layer

Results of finite element analysis

- **Pumping rate**



Summary of Benefits

- Recover methane gas for power
- Reduce current fugitive methane emissions
- Revenue generated from power generation
- Revenue generated from carbon credits
- Reduce typical number of gas wells per acre
- Reduce labor cost for gas well monitoring

Application in USA: Placement of Permeable Layer Over Waste

VIEW OF ONE ACRE SHRED TIRE LAYER


SHRED TIRE PERMEABLE LAYER BEING PLACED
WASTE LAYERS
SEP 28 2005

USA: Waste Placement Over Permeable Layer

Soil Cover and Gas Collection Piping Installation

Gas Well Installation and Data Collection and Evaluation

Project Objectives in India

- Visit sites
- Select best site for a demonstration project
- Develop a preliminary design
- Perform feasibility study
- Report to EPA Methane to Markets

Site Visit and Selection Criteria

- Selection criteria for sites
  - Adequate organic waste flow (>1,000 tons per day)
  - Waste height (>15 meters)
  - Available permeable material for use
  - Available soil cover on site
  - Available equipment and personnel
  - Agency cooperation, assistant, and technical knowledge
  - Site security for future demonstration project
  - Power generation potential on-site

INDIA PROJECT TEAM

IL&FS ECOSMART LTD: EAST MUMBAI, INDIA

IL&FS Ecosmart, located in East Mumbai, India. Technical expertise and numerous contacts in India's municipal waste industry were of inestimable value in conducting the project

3 India Trips

November 2008 –Chennai
January 2009 – Multiple sites
January 2010 – Mumbai – 3 sites

SUMMARY OF SITES EVALUATED

Trip 1 November 2008 (Benemann)
Chennai -- Kodungaiyur

Trip 2 January 2009 (Yazdani, Zaveri)
New Delhi --Okhla
New Delh -- Balsawa
New Delhi —Gazipur
Agra – Shahdara
Perungudi – Chennai
Vellakal – Madurai TN
Betahalli Bangalore
Vidyaranyapuram Mysore
(City) Hubli Dharwad Karnataka
Hyderabad

Trip 3 January 2010 Mumbai (Augenstein, Yazdani, Zaveri, Augenstein)

Mulund
Kalyan Dombivali
Ulhasnagar

OFFICIALS MET: 3 MUMBAI SITES:

1. Mulund, Mumbai

Mr. R. A. Rajeev, IAS, Additional Municipal Commissioner
Mr. B.P. Patil, Chief engineer (SWM), In-charge (and Dy. Ch. Engineer (SWM) Projects) [He holds 2 positions]
Mr. P.S. Awate, Executive Engineer, SWM Project
Mr. Phalari, Executive Engineer, SWM Project
Mr. Machewad, Sub-Engineer, SWM Project
Mr. Desai, Asst. Engineer, SWM Project

2. Kalyan Dombivali, Mumbai

Mr. Pramod Narkhade, Sanitary Inspector
Mr. Sulakhe, APHO
Mr. Shiju Jacob, Antony Waste Handling Cell (P) Ltd.

3. Ulhasnagar, Mumbai

Mr. Mhatre
Mr. Shiju Jacob, Antony Waste Handling Cell (P) Ltd.

Mulund Site Findings

- Adequate waste and height
- Potential permeable layer and cover soil available!
- Needed equipment available
- Agency cooperation and interest
- Potential future power generation facility from methane
- Site can be secured to prevent damage to pipes and equipment

Mulund Site Findings--cont

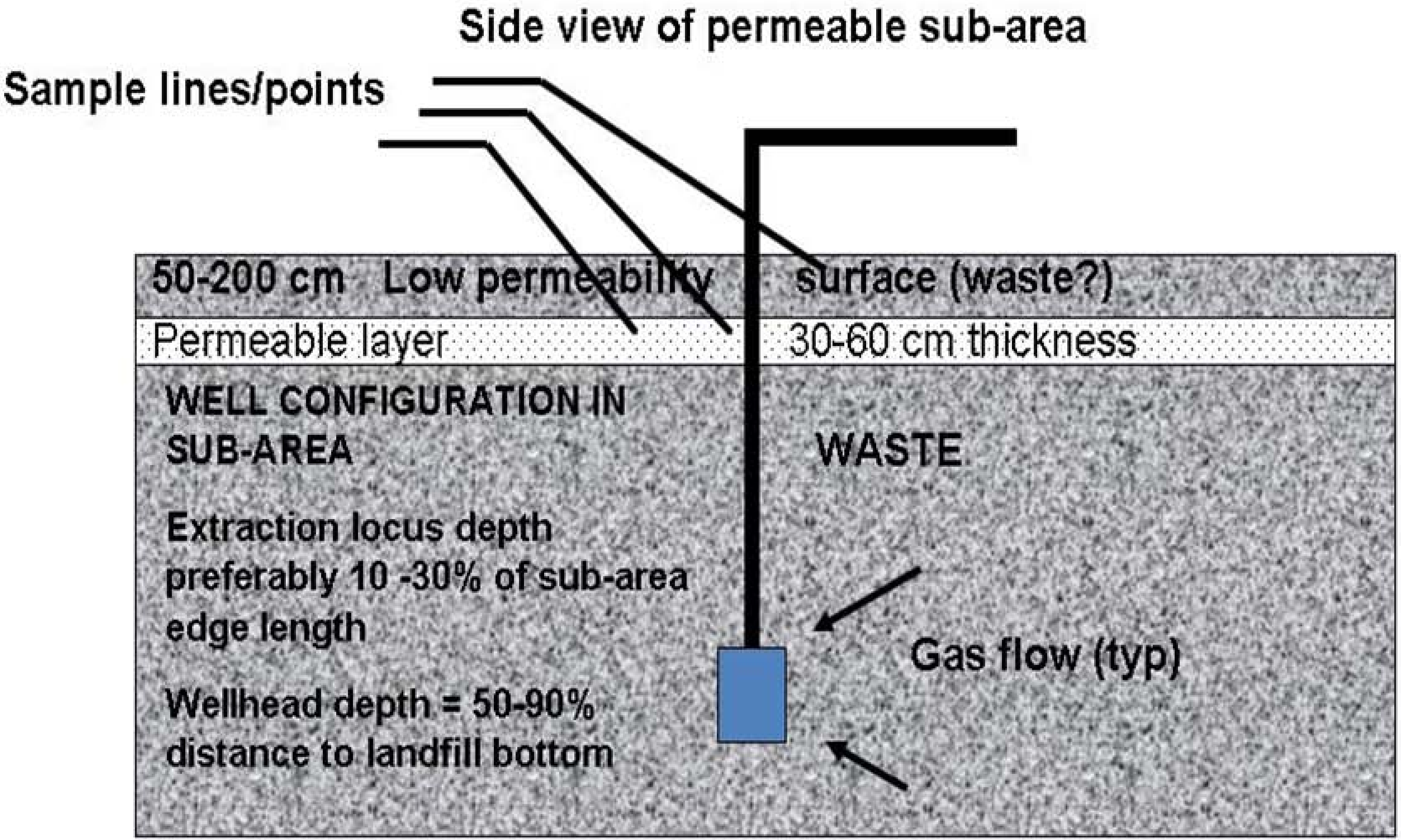
- Future capacity and operation assured.
- Footprint for testing can be available
- Onsite technical personnel for vessel methane digester can do gas sampling
- Needed equipment available
- Ability to collaborate with IL&FS Ecosmart

Example of Mulund Data: Waste Analysis (IL&FS Ecosmart, Mumbai, India)

Table 1: Average Characteristics of MSW Reaching the Mulund Disposal Site

Sr. No	Parameter	Avg. 7 Days (3 Shifts)
a	Vehicles Sampled	11
b	Weight of Sample collected for Physical Analysis (Kg)	100
A.	**Physical Characteristics (% of total weight)**	
1	**Wet organic Material (above 1 sq. inch mesh)**	
a	Kitchen waste	39.24
b	Fruit waste	8.33
c	Flower waste	0.14
d	Green grass	0.62
e	Animal Excreta	0.00
2	**Wet organic Material (below 1 sq. inch mesh)**	**3.79**
	Total Wet Organic Material	**52.12**
3	**Dry organic material**	
a	Dry grass	9.10
b	Dry tree remaining	0.48
c	Cotton waste	2.48
d	Wood Chips	0.33
e	Wooden furniture waste	0.62
	Total Dry Organic Material	**13.01**
4	**Recyclable Materials**	
a	Plastic	10.14
b	Paper	7.52
c	Cardboard	0.00
e	Thermocol	0.19
f	Glass	0.71
g	Rubber	0.52
h	Leather	0.67
i	Metals	0.19
	Total Recyclable Material	**19.94**
5	**Inert**	
a	Sand and Silt	11.64
b	Stone	0.81
c	Bricks	2.48

SIMPLE TEST AREA CONFIGURATION



Site Challenges

- Issues:
  - Waste fires frequent (but usually small)
  - Air intrusion could be an issue
  - Leachate seeps

Addressing Site Challenges

- Potential Solutions:
  - Add cover soil and compact to stop fire
  - Construct test cell away from the side slopes
  - Pump leachate from the perimeter ditches and inject near top and side slopes to stop fire and eliminate leachate runoff from site

Future Plans

- Explore support for construction and operation of a demonstration project
- Construct and monitor project
- Expand project to other sites (India and worldwide)

Questions and Answers?

Thank you for your attention