Identification of Methane Hazards Near Municipal Landfills

Two Australian Case Studies

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INTRODUCTION

- Sydney, NSW (within Australia's most populated state) there is increasing pressure for urban land
- Land that was once on the fringes of urban areas is now sought after as prime residential land
- In some cases residents of new developments are now neighbours with old municipal landfills
- Identifying methane hazards is important in the landfill rehabilitation and land redevelopment process

METHANE

- Colourless, odourless, tasteless gas
- Sources include swamps, coal/oil mining, fermentation and landfills
- Methane (CH_4) is flammable and has a Lower explosive limit of 5% (v/v)
- Methane can cause oxygen deficient environments (asphyxiation) and explosion risks
- Methane produced in landfills can present a hazard to neighbouring areas

CASE STUDIES - OUTLINE

- Two Australian landfill sites north of Sydney where methane investigations were carried out as part of rehabilitation planning
- Both sites were adjacent to new residential subdivisions
- Results of the studies are presented including investigation techniques used to identify the presence of methane, potential sources, pathways and remedial management options

STUDY LOCATION

Study Locations

CASE STUDY 1

- Methane Investigation requested as part of landfill rehabilitation planning process
- Explosive concentrations of methane identified near adjacent residential subdivision
- Objectives
  - Assess nature and extent of methane
  - Identify the sources of methane and migration pathways
  - Provide advice on short term remediation
  - Monitoring
  - Risk Analysis

AERIAL PHOTOGRAPH OF SITE

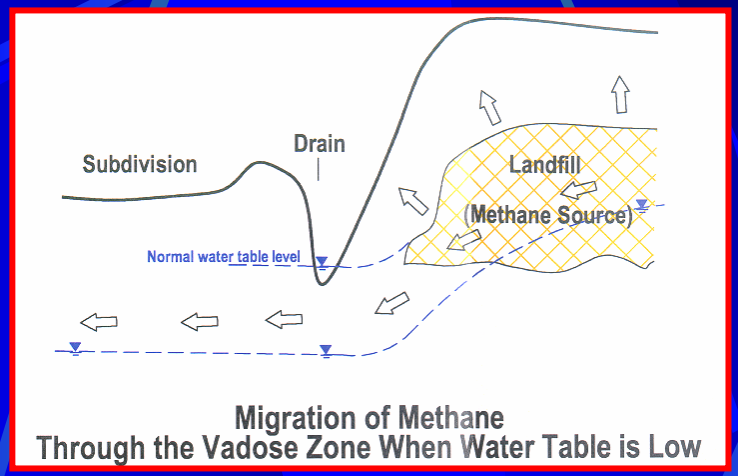

Residential Subdivision
Former Landfill (North)
Oval & Car Park (former sanitary depot)
Coffey
SITE LAYOUT
Former Landfill (South)
Wetland
300m
180m
Main Drainage Lines
Sewers


Subdivision
Landfill
Coffey

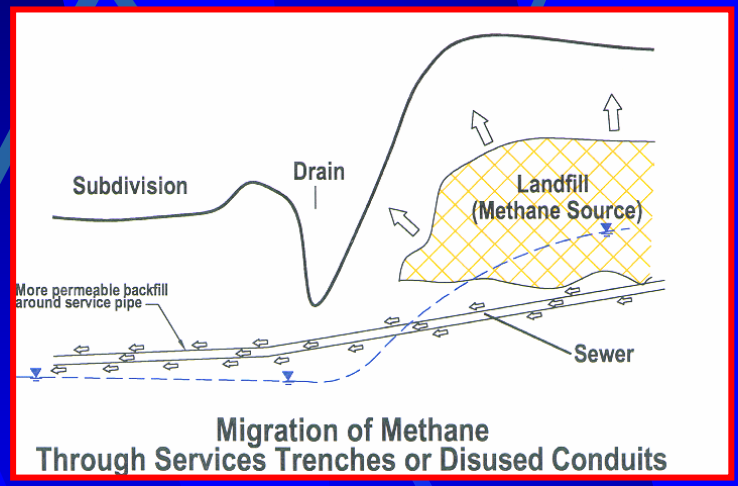
POTENTIAL METHANE SOURCES

- "LANDFILL"
- Fill Soils
  - Sanitary waste depot
  - Subdivision fill
  - Backfill around sewers and underground service trenches
- Natural organic soils
- Leaks in natural gas pipelines
- Deep coal seams

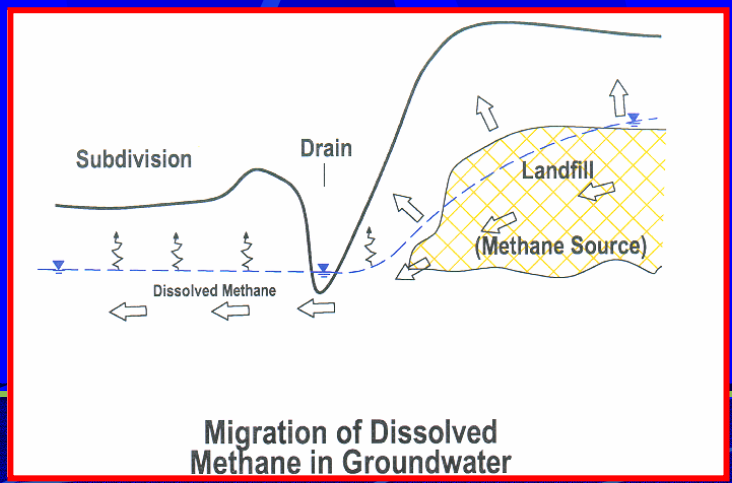
POTENTIAL METHANE MIGRATION PATHWAYS?



Migration of Methane
Through the Vadose Zone When Water Table is Low



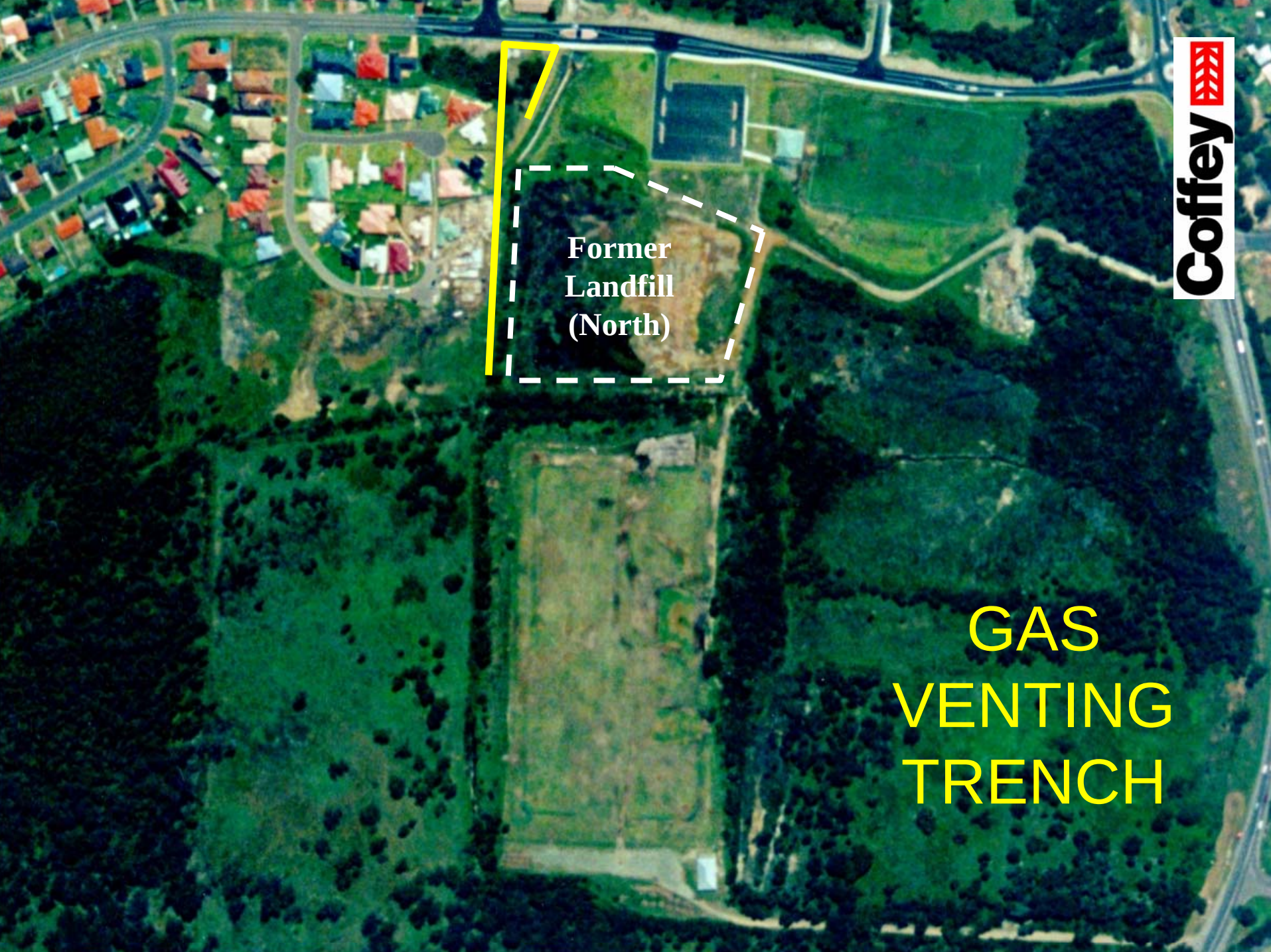
Migration of Methane
Through Services Trenches or Disused Conduits



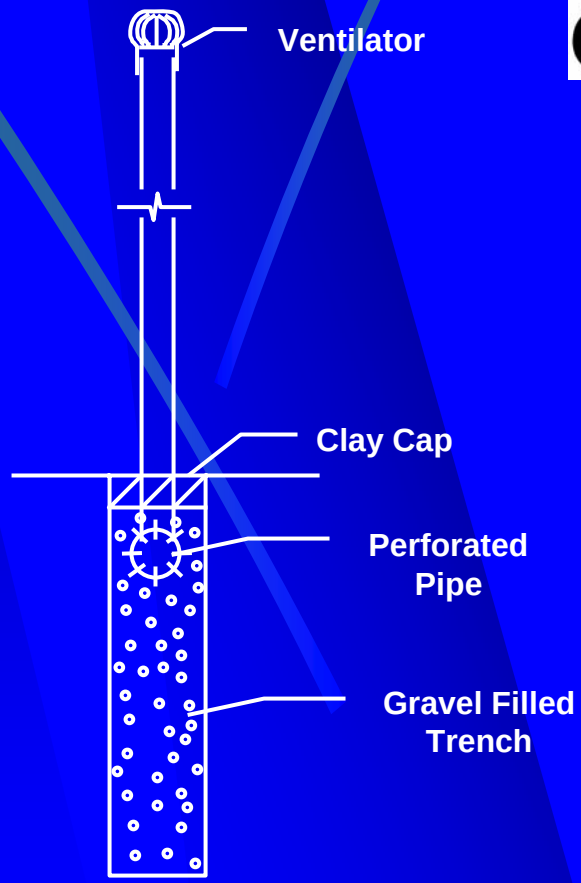
Migration of Dissolved
Methane in Groundwater

INVESTIGATIONS, SHORT TERM REMEDIATION AND MONITORING

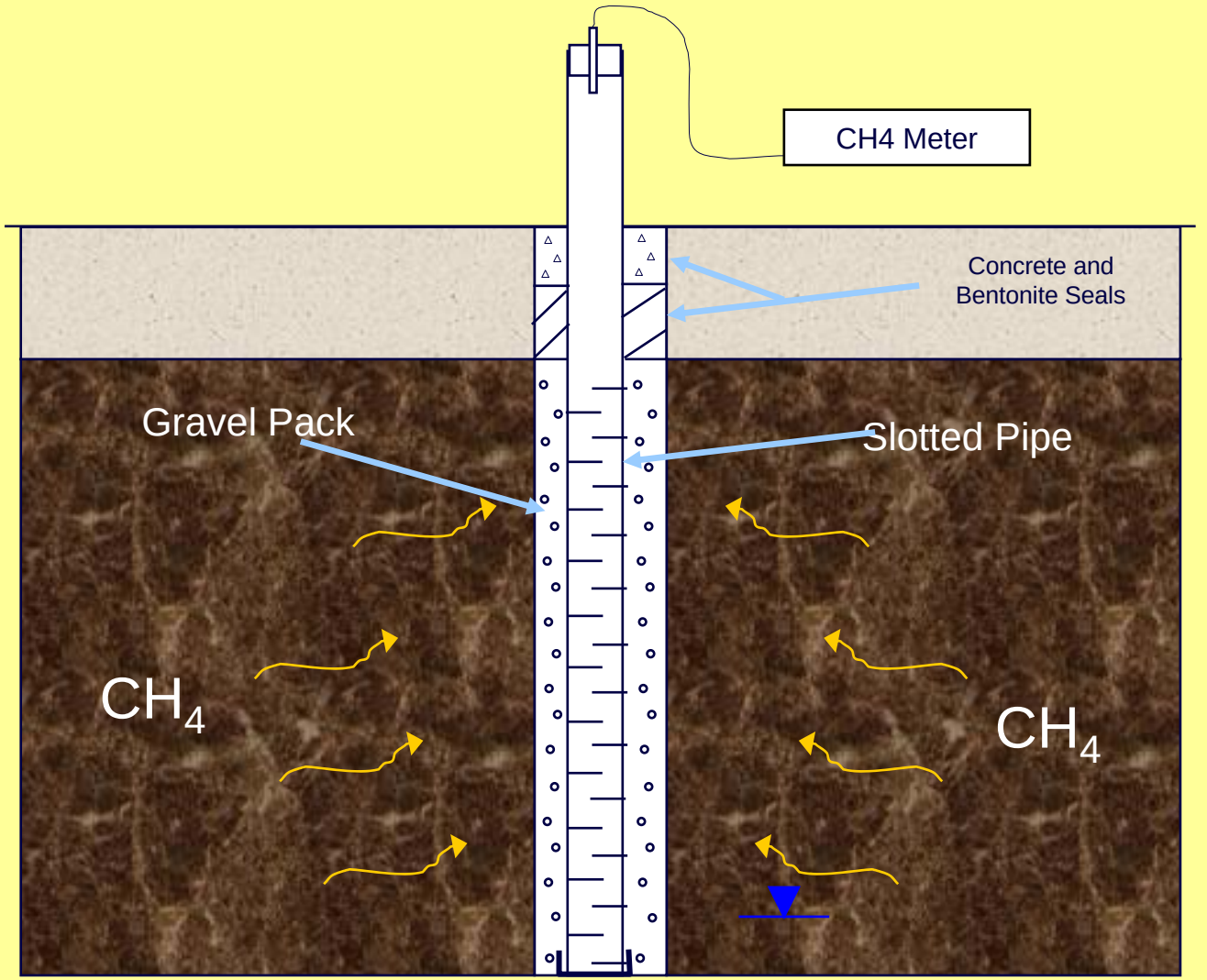
- Construction of gas venting trench
- Monitoring inside residential houses
- Site history study and literature review
- Geophysical surveys
- Insitu soil gas testing (724 locations)
- Logging of Test Pits and Boreholes (44 locations)
- Installation and sampling of gas and groundwater wells (66 locations)
- Gas analysis (fingerprinting)
- Groundwater Analysis (dissolved methane)
- Soil Analysis (total organic carbon)
- Gas pressure testing


Former
Landfill
(North)
GAS
VENTING
TRENCH
Coffey

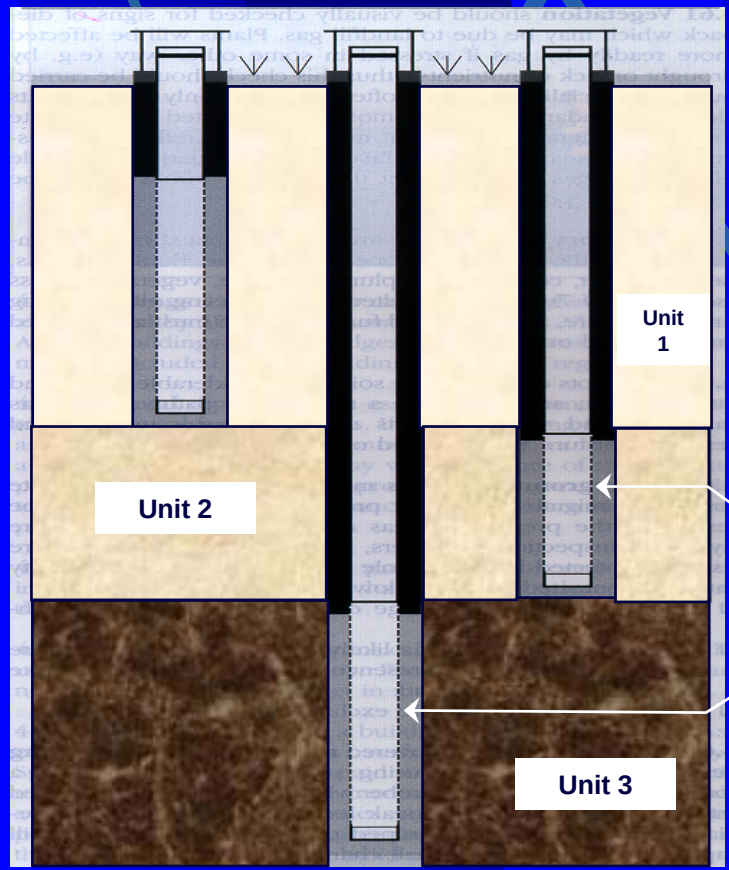
INSTALLATION OF GAS VENTING TRENCH



TYPICAL GAS WELL



STAGED GAS MONITORING WELLS

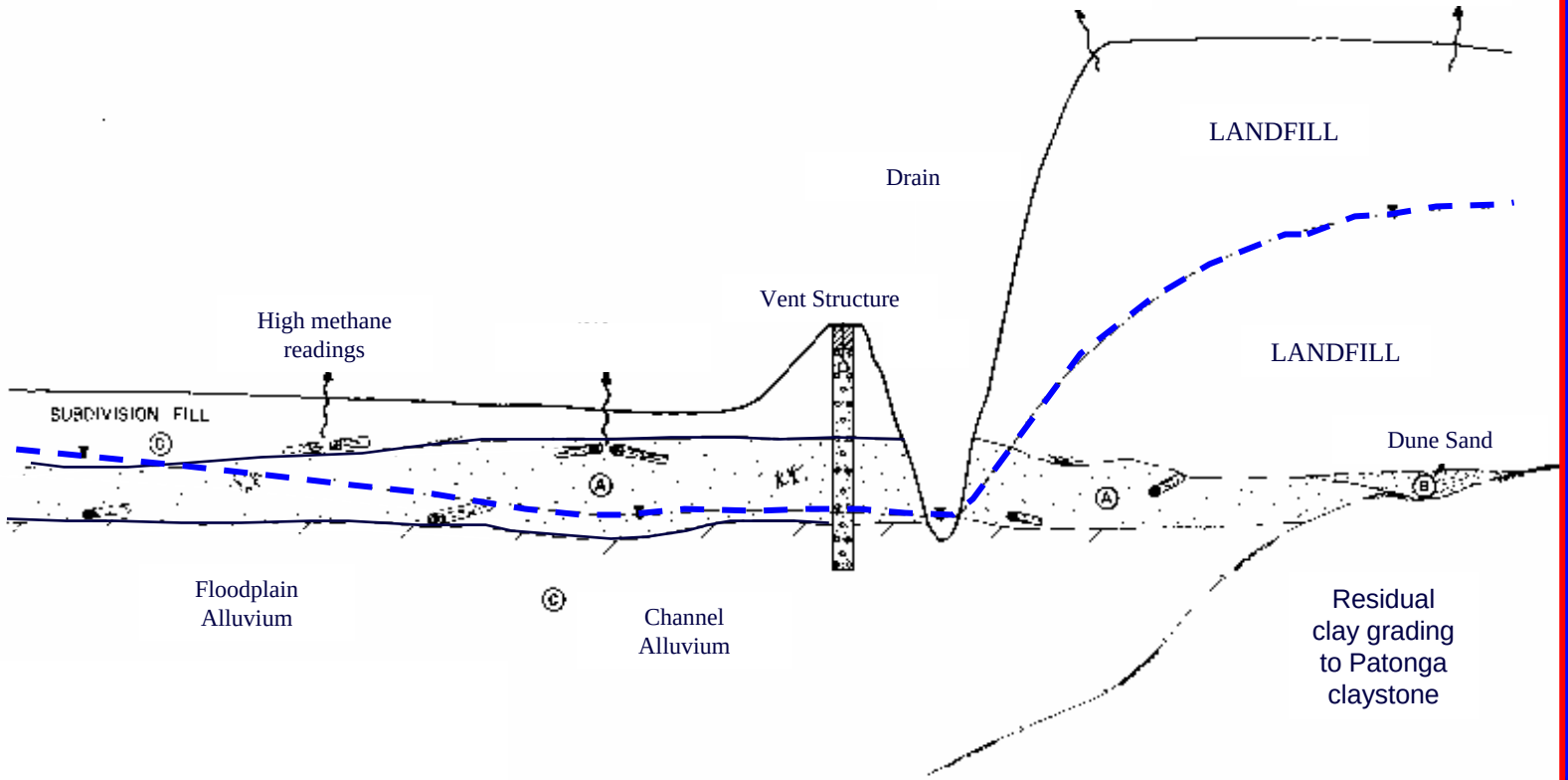


Monitoring wells screened to target different soil units


MONITORING FROM GAS WELL
Coffey


Coffey
INVESTIGATION
LOCATIONS

GEOLOGICAL MODEL

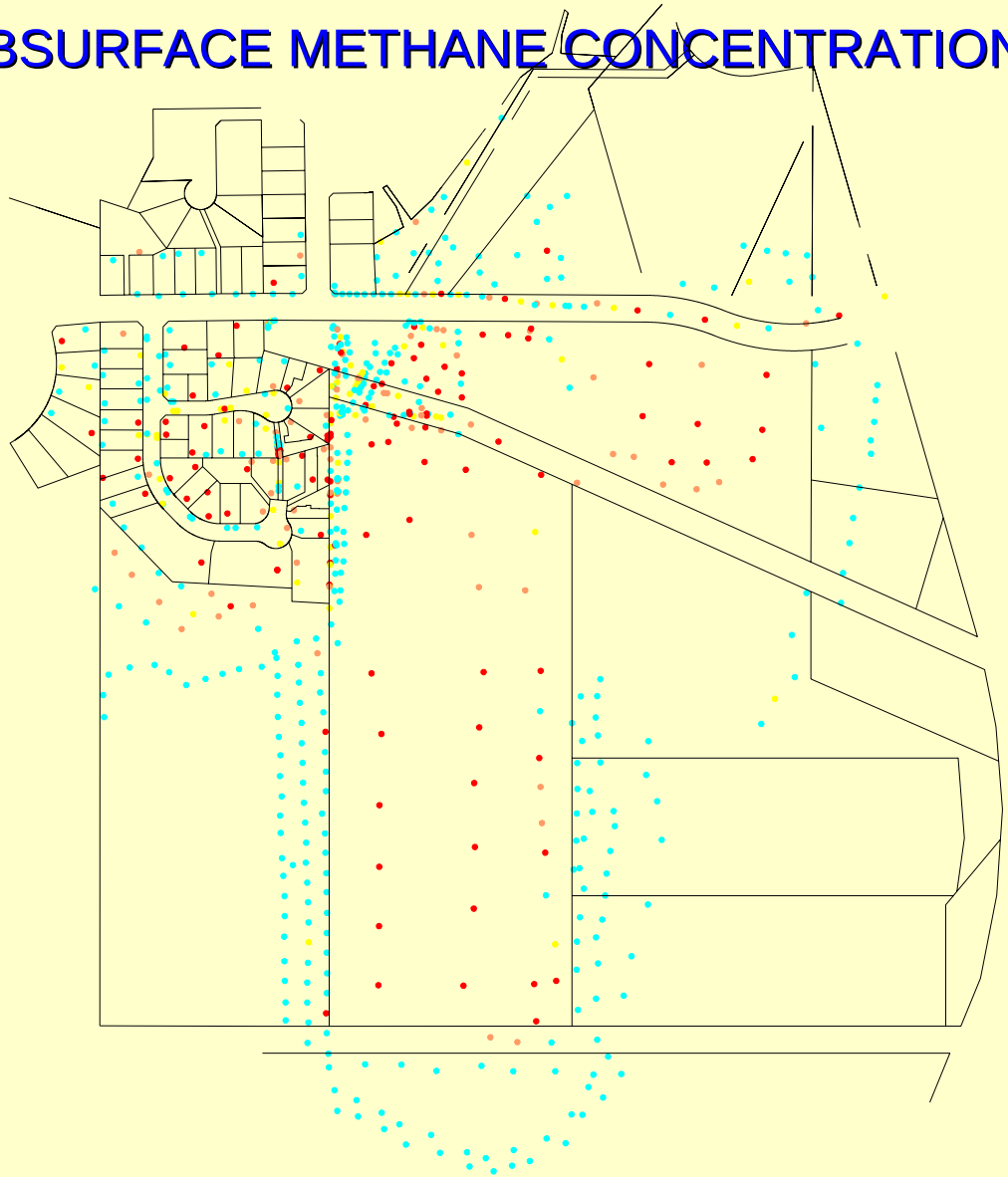


RESULTS

SUBSURFACE METHANE CONCENTRATIONS

Methane levels up to 60% in landfill and subdivision

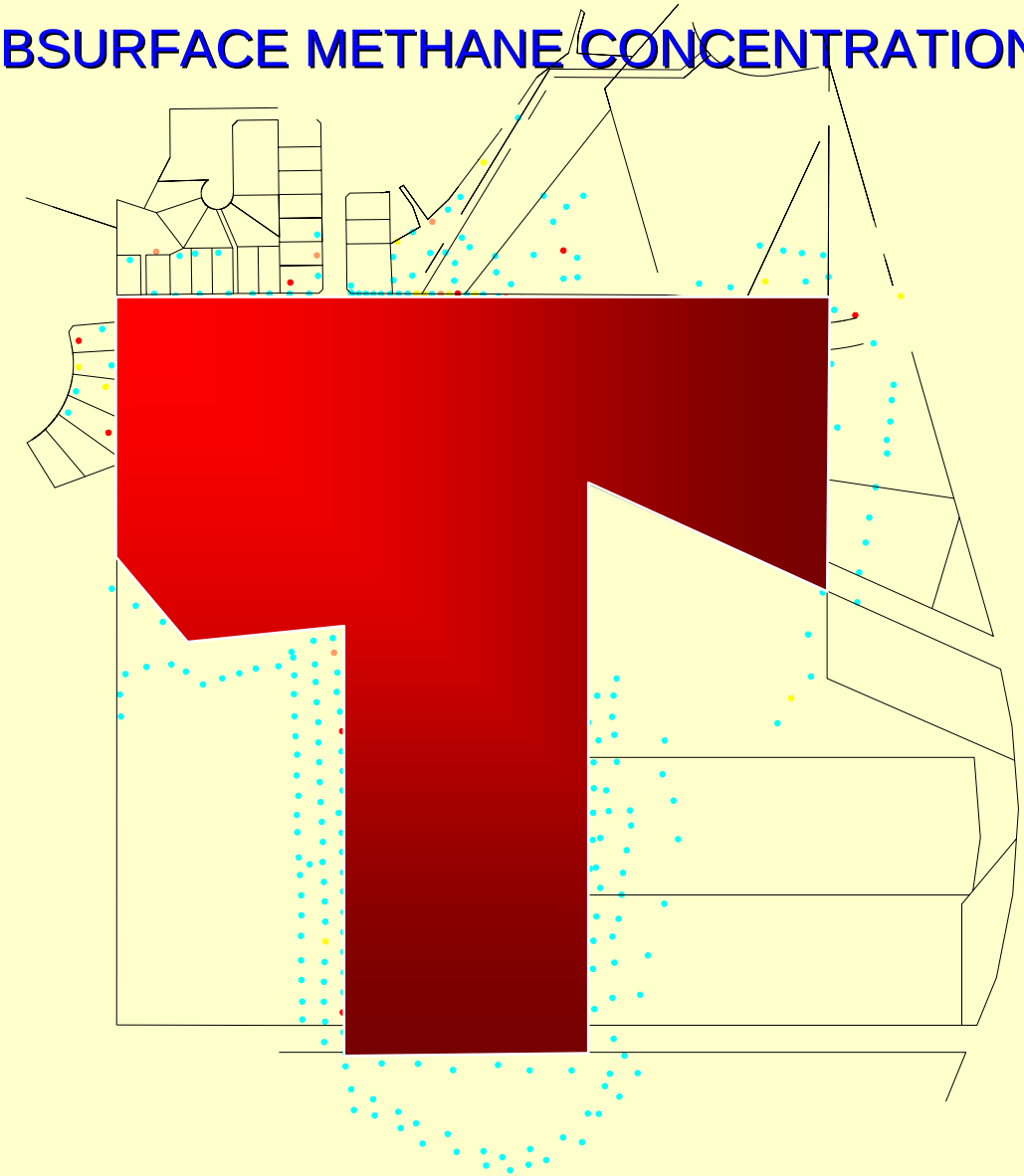
One property recorded 30% methane in a void beneath the concrete slab



RESULTS

SUBSURFACE METHANE CONCENTRATIONS

Typically, areas that did not have fill recorded low methane concentrations



IS THE LANDFILL THE SOURCE OF METHANE FOUND IN THE SUBDIVISION?

- Migration through vadose zone (unlikely)
  - discontinuities in high methane concentrations
  - the north-south drain
  - relatively high water table
  - Fingerprinting - no correlation between gas in landfill and gas in subdivision
- Migration Through Service Trenches (unlikely)
  - similar issues
- Migration Through Groundwater (unlikely)
  - Low solubility
  - Concentrations encountered too high for dissolved methane
  - Low pressures
- Landfill encroaching into subdivision (unlikely)
  - Site history and aerial photographs do not show landfill encroaching into the subdivision

IS METHANE IN THE SUBDIVISION DERIVED FROM FILL OR NATURAL ORGANIC SOILS?

- Anecdotal information suggests burial of vegetation and organic soils in the subdivision
- Vegetation observed in test pits and Total organic carbon results indicated that the fill and floodplain alluvium have organics (2%-4%)
- Conditions beneath the subdivision may be suitable for production of methane
- Soccer Oval (Control site) 1.5km away from the landfill in a similar environment shows similar trend with CH_4 levels up to 20%.


CONTROL SITE
Soccer Oval
(Control Site)
Landfill
~1.5km
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WHAT TO BE AWARE OF ?

- No guidance in Australia on naturally produced methane
- Soils which could naturally generate methane
- Low lying or filled areas
- Similar site settings

HOW CAN THIS PROBLEM BE MANAGED?

- Through the planning process
- Guidance by regulatory agencies
- Being aware of the problem
- Preliminary testing for methane on sites at risk
- Methane generating capacity testing
- Risks Assessment
- In this case the site was managed through regulatory control, notation on the land planning certificate and notification to land owners

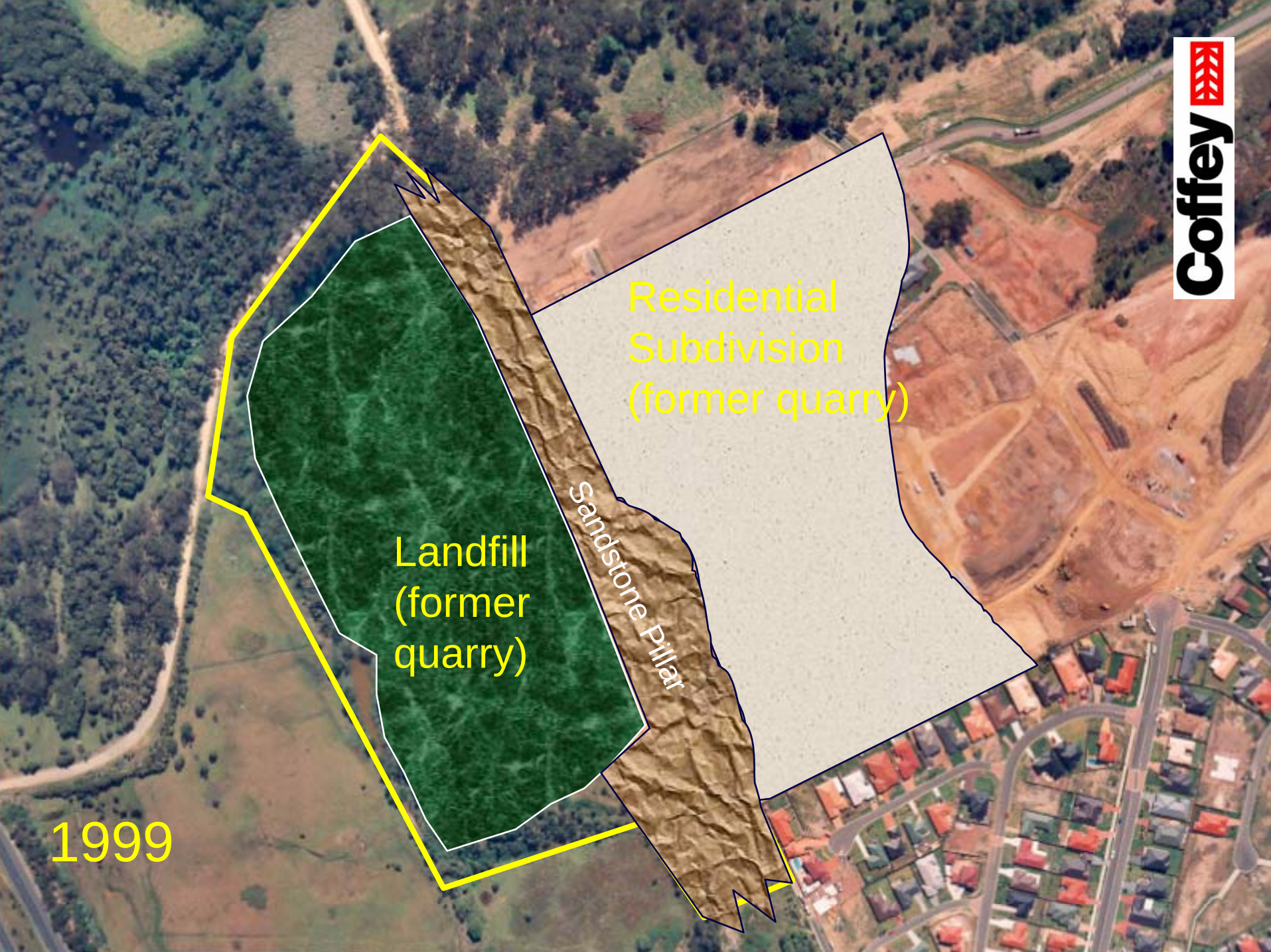
CASE STUDY 2

- Methane Investigation requested as part of landfill rehabilitation planning process
- Relatively new residential subdivision (1999) located near landfill
- Investigations concentrated along boundary of landfill adjacent to the subdivision
- Study objective were to assess the potential for methane migration from the landfill towards the subdivision

INVESTIGATION TECHNIQUES

- Site history Study
  - Aerial photographs
  - Interviews
  - Old site plans
  - Council records
- Geophysical (electromagnetic survey)
- Installation and monitoring from gas wells


Residential
Subdivision
(former quarry)
Landfill
(former
quarry)
1999
Coffey

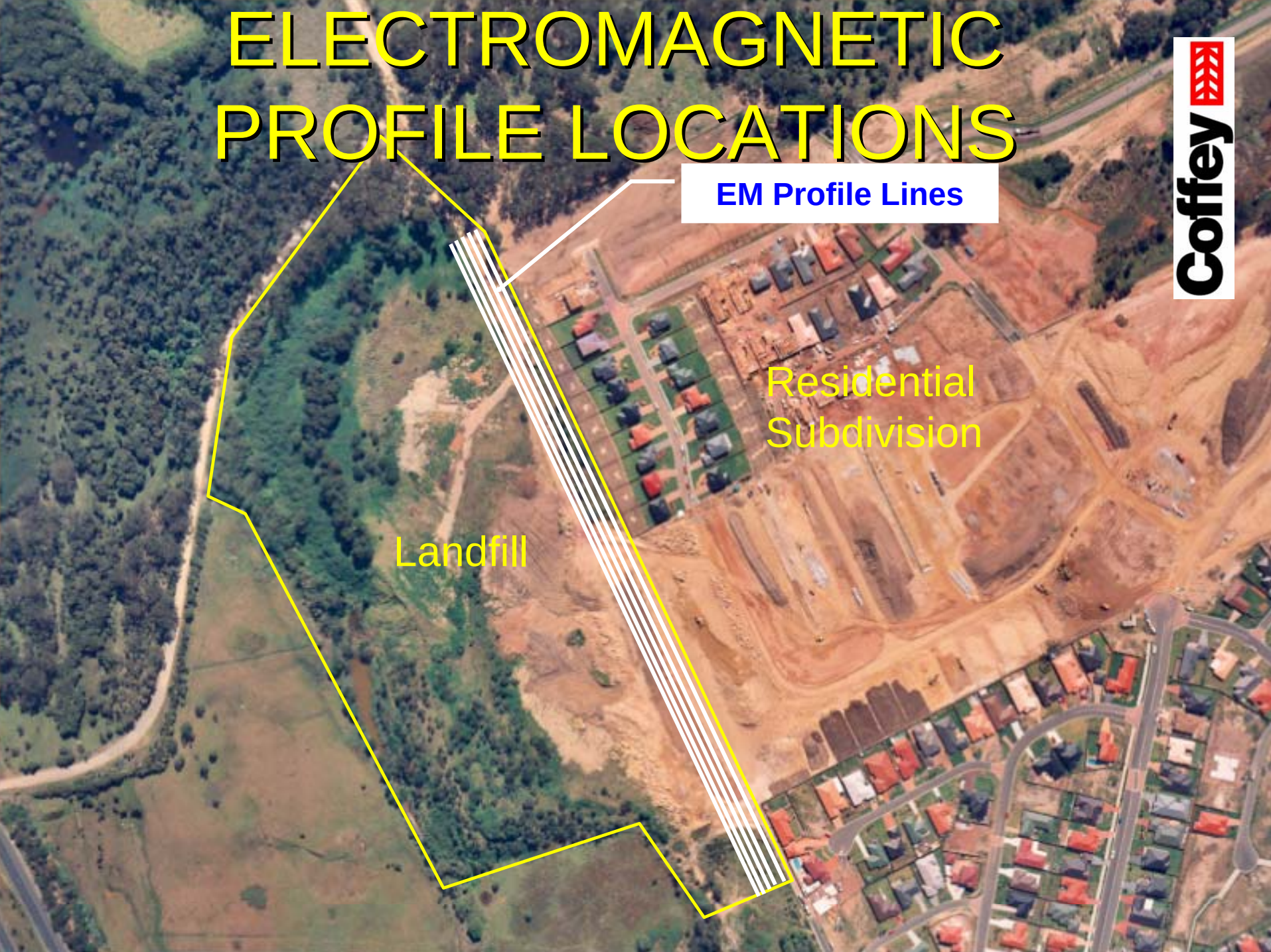

Residential
Subdivision
(former quarry)
Landfill
(former
quarry)
Sandstone Pillar
1999
Coffey

CROSS SECTION

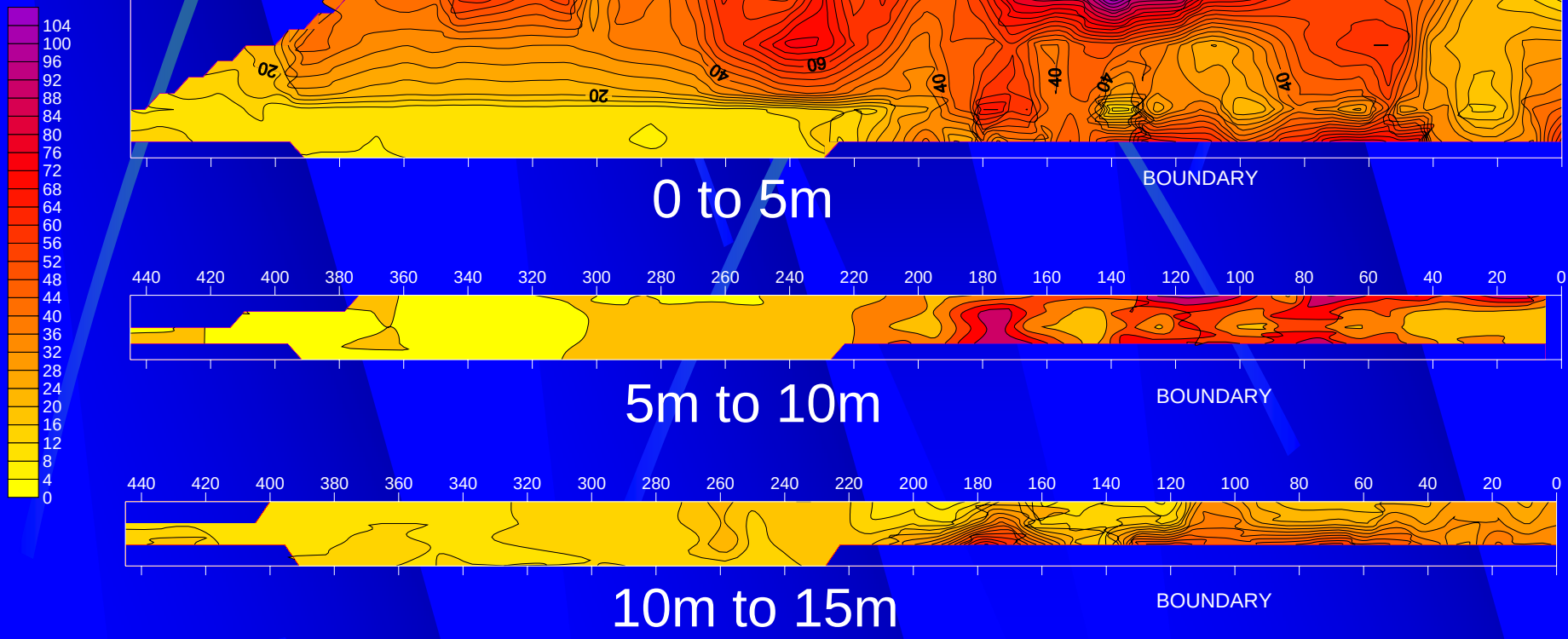

Landfill
Subdivision
Coffey


Potential Area
of Concern
1984
Coffey

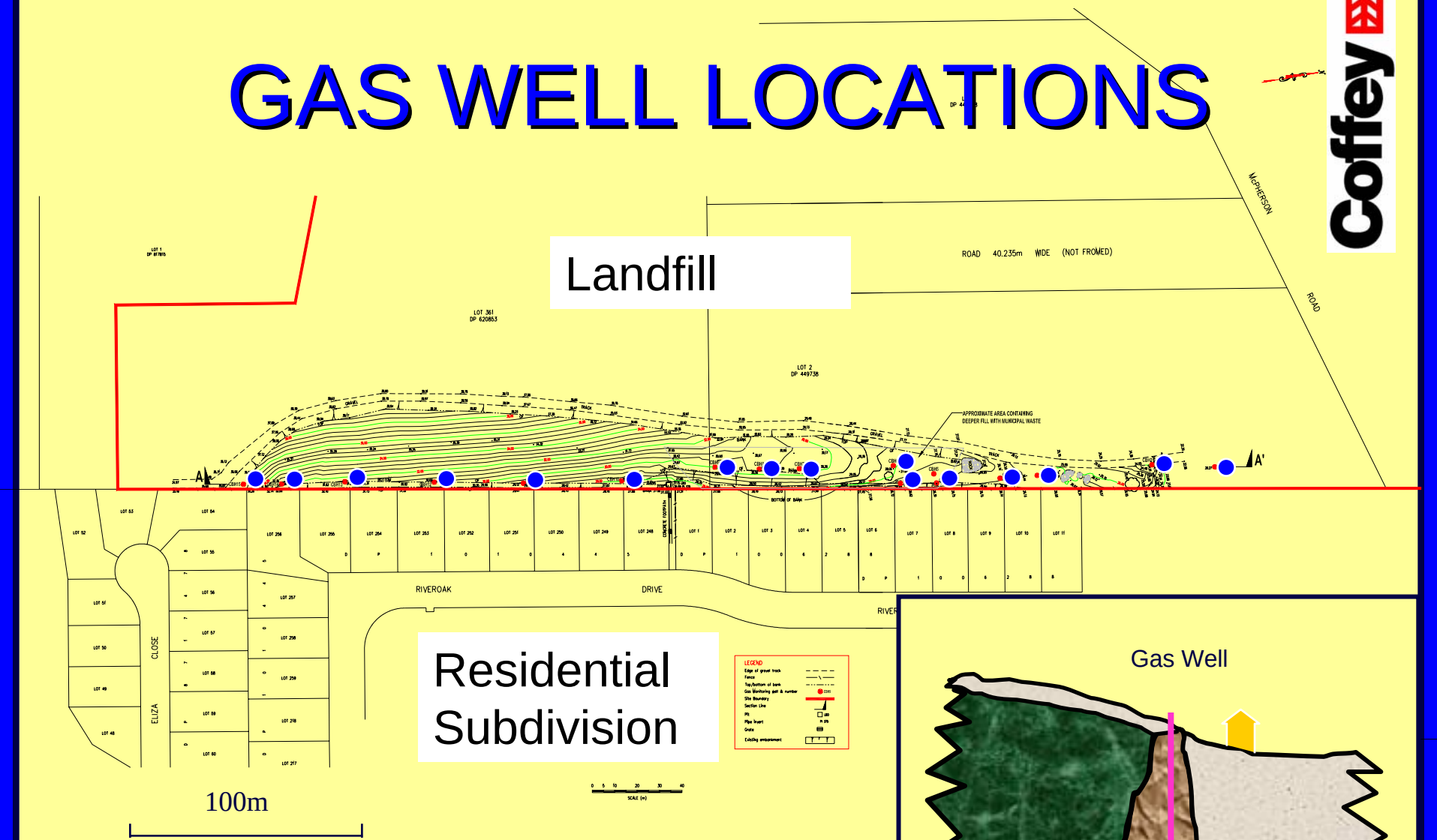
ELECTROMAGNETIC PROFILE LOCATIONS

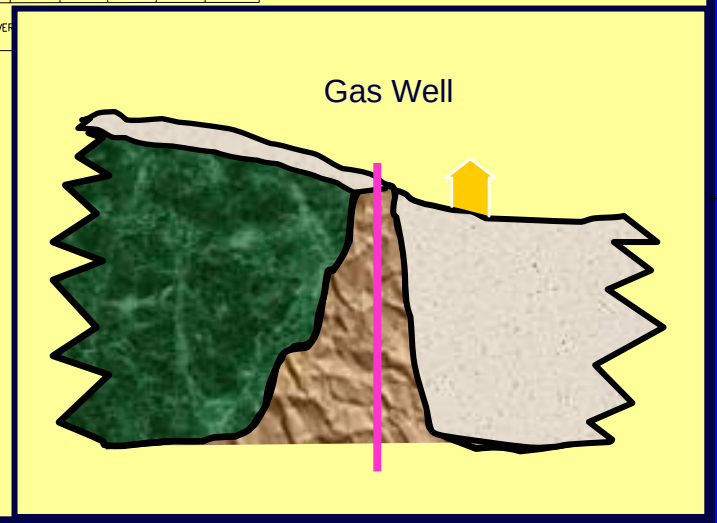


ELECTROMAGNETIC PROFILE RESULTS



GAS WELL LOCATIONS



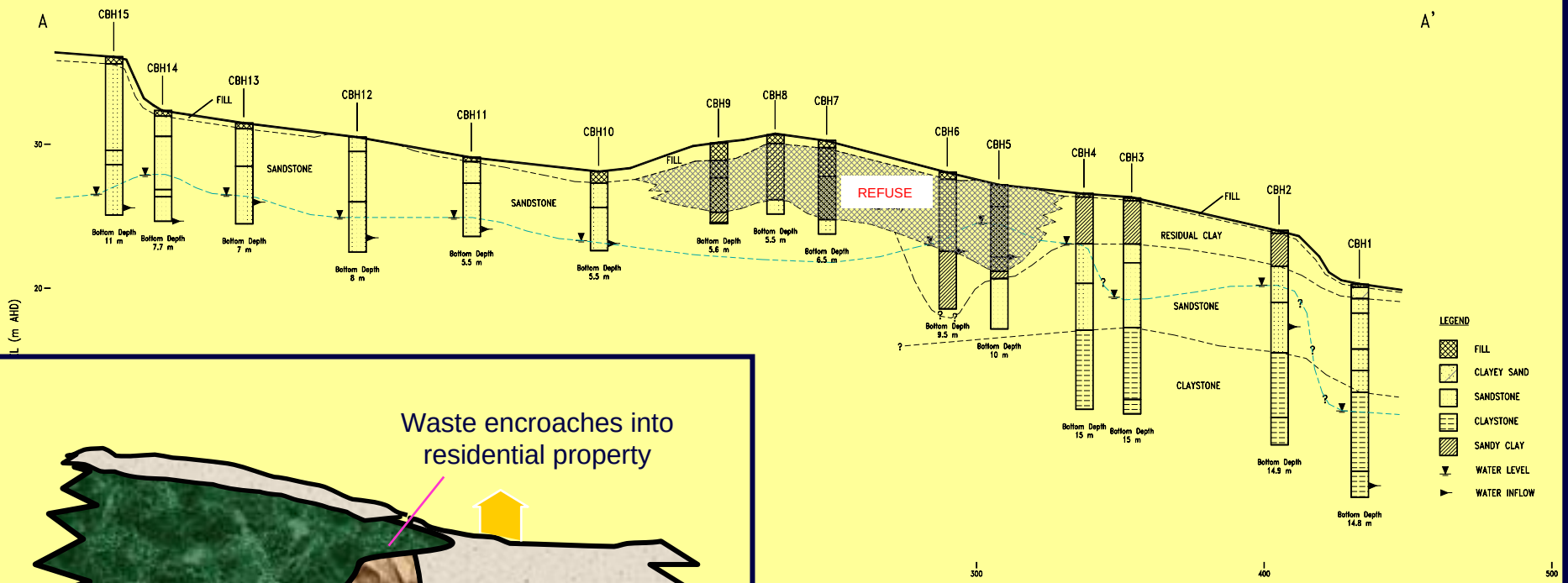


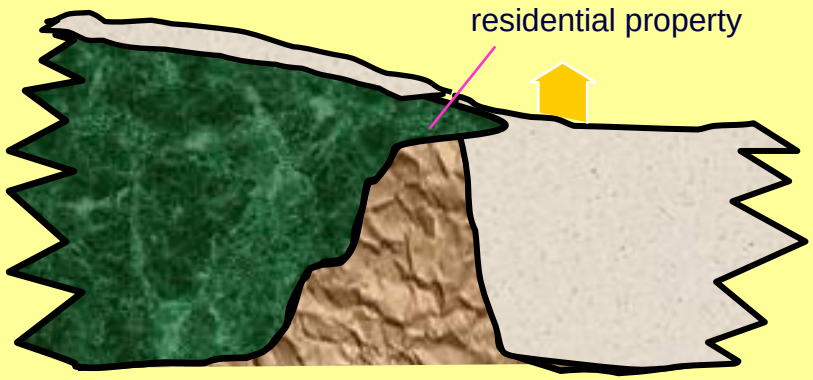
RESULTS

CH_4 < 0% (v/v)

CH_4 up to 44% (v/v)

CH_4 < 0% (v/v)





REMEDIATION

- Short Term
  - Removal of wastes from rear of residential premises
  - Construction of low permeability barrier
  - Ongoing Monitoring
- Long Term
  - Rehabilitation of landfill
  - Gas collection, venting, flaring

Landfill wastes being excavated from rear of residential properties

Proximity of properties to landfill wastes

CONCLUSIONS

- Important to establish adequate planning processes to identify and manage environmental hazards from landfills such as methane prior to redevelopment
- Use the right investigation techniques to identify hazards
- Be aware of sites that could potentially produce methane through changes to the environment during redevelopment
- Methane hazards adjacent to landfills can be managed (barriers, venting, flaring, collection)