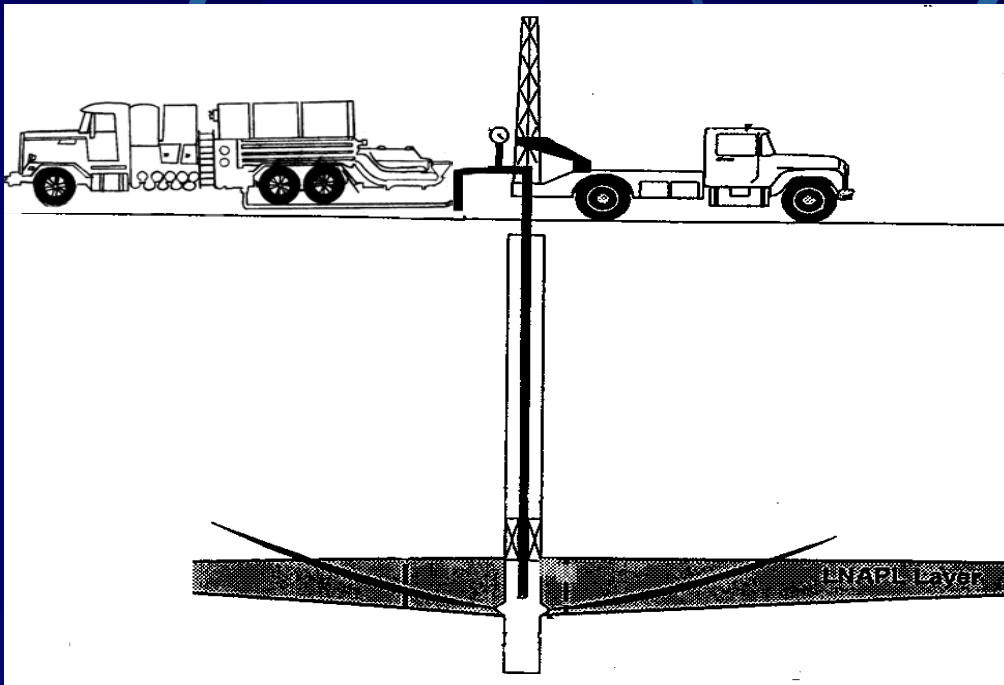


FRAC RITE™



SOIL FRACTURING
TECHNOLOGY FOR
ENHANCED IN SITU
SITE REMEDIATION

Landfill Fracturing for Enhanced Leachate Recovery



Waste Management
Landfill

Cloverbar Landfill



Edmonton Municipal Landfill

- Vertical expansion of landfill sought to increase capacity of municipal wastes
- Landfill operator required to reduce leachate levels as a condition for approval
- No existing leachate recovery system in place and conventional recovery wells yield low leachate flow rates (less than 0.5 gpm)
- Pilot fracturing program conducted to assess feasibility of enhancing leachate production

Objectives

- To investigate the feasibility of fracturing saturated municipal landfill wastes (ours was the first attempt to fracture municipal landfill wastes in the world)
- If fracturing is feasible, to assess the performance of fractured wells for enhancing the recovery of landfill leachate

Field Program

- Fracturing Pilot Program consisted of the placement of 8 sand-filled fractures in three fractured recovery wells (FW1, FW2, FW3)
- Fractures placed in saturated wastes at depths ranging from 7 metres to 14 metres
- Short term (24 hr) and long term (10 week) pump testing on conventional recovery wells and fractured recovery wells

Sand Slurry Formulation and Pumping

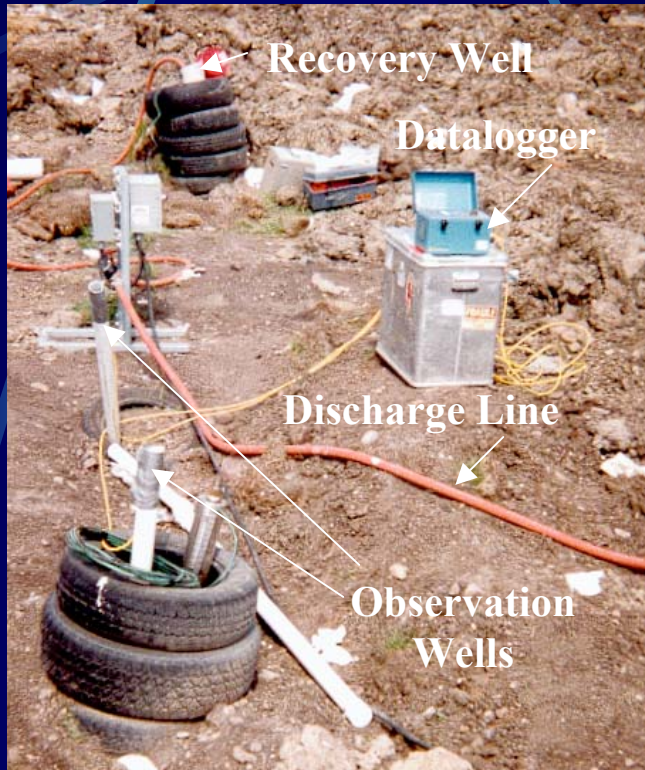
- Batch mixed a total of 17 m³ of sand slurry comprising 10 tonnes of sand
- Sand slurry injected into wastes at pressures ranging from 0.4 MPa to 2.3 Mpa
- Pumping rate ranged from 120 to 200 Litres per min.



Fracture Distribution

FRACTURE BOREHOLE	FRAC NO.	DEPTH (M)	VOLUME (M3)	SAND (KG)
FW1	1	11.5	1.8	900
FW1	2	12.5	1.8	855
FW1	3	13.5	1.5	600
FW2	1	9.7	2.0	980
FW2	2	10.7	2.0	920
FW2	3	11.7	2.0	950
FW3	1	7.0	2.9	2117
FW3	2	8.0	2.9	2117

Long Term Pump Testing



Leachate Recovery and Monitoring

Diesel Generator and Leachate Recovery Tank



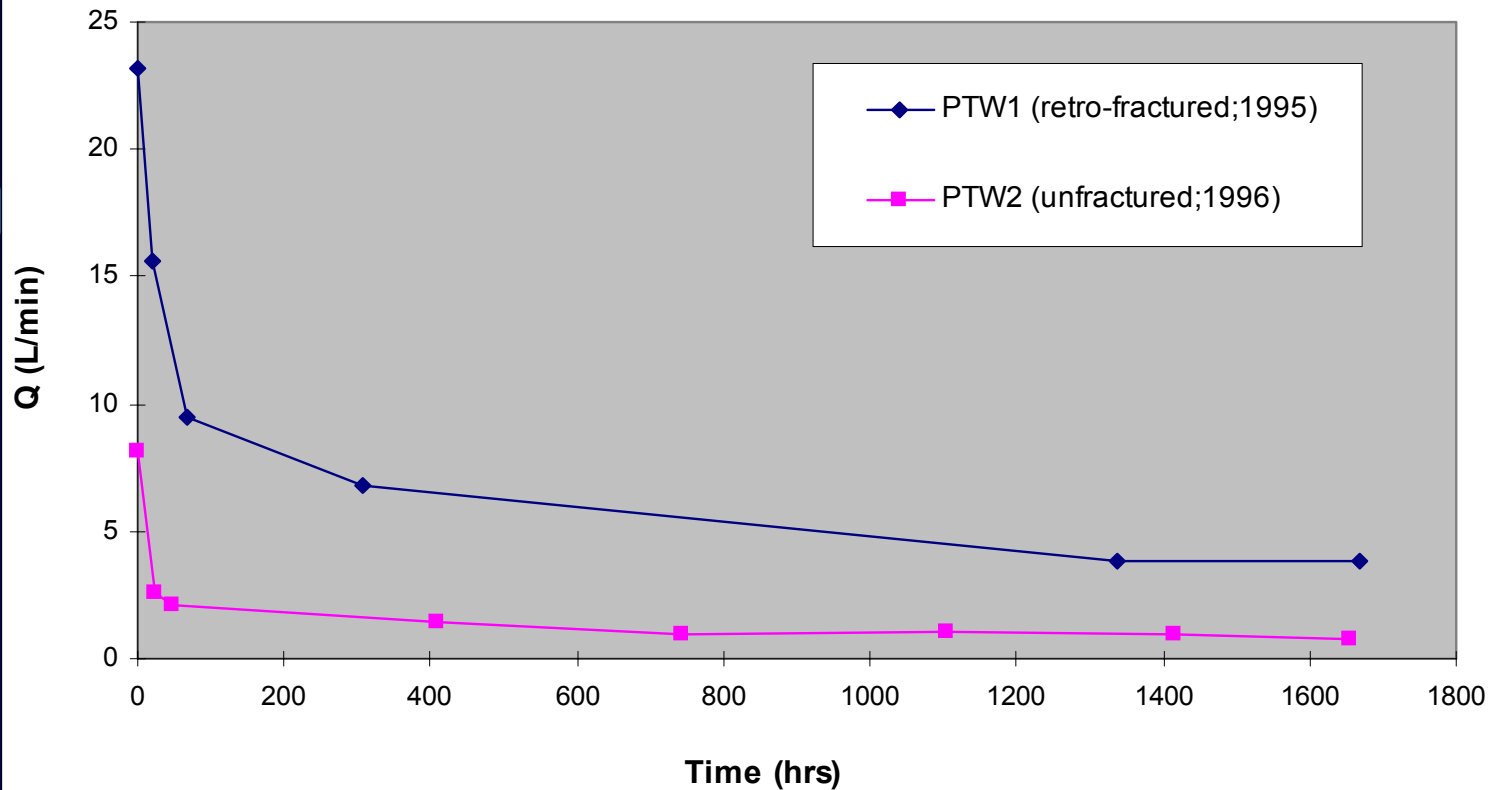
Borehole Video Camera

Leachate Recovery Well Performance

Parameter	Conventional	Retro-Fractured	Fractured
Hydraulic Conductivity (m/sec)	4×10^{-6}	2×10^{-5}	6×10^{-5}
Flow Rate (after 24 hrs) (L/min)	1.5	15	30
Radius of Influence (m)	19	25	47

Long Term Leachate Flow Rates

Leachate Flow Rate vs. Time
PTW1 and PTW2



Summary of Results

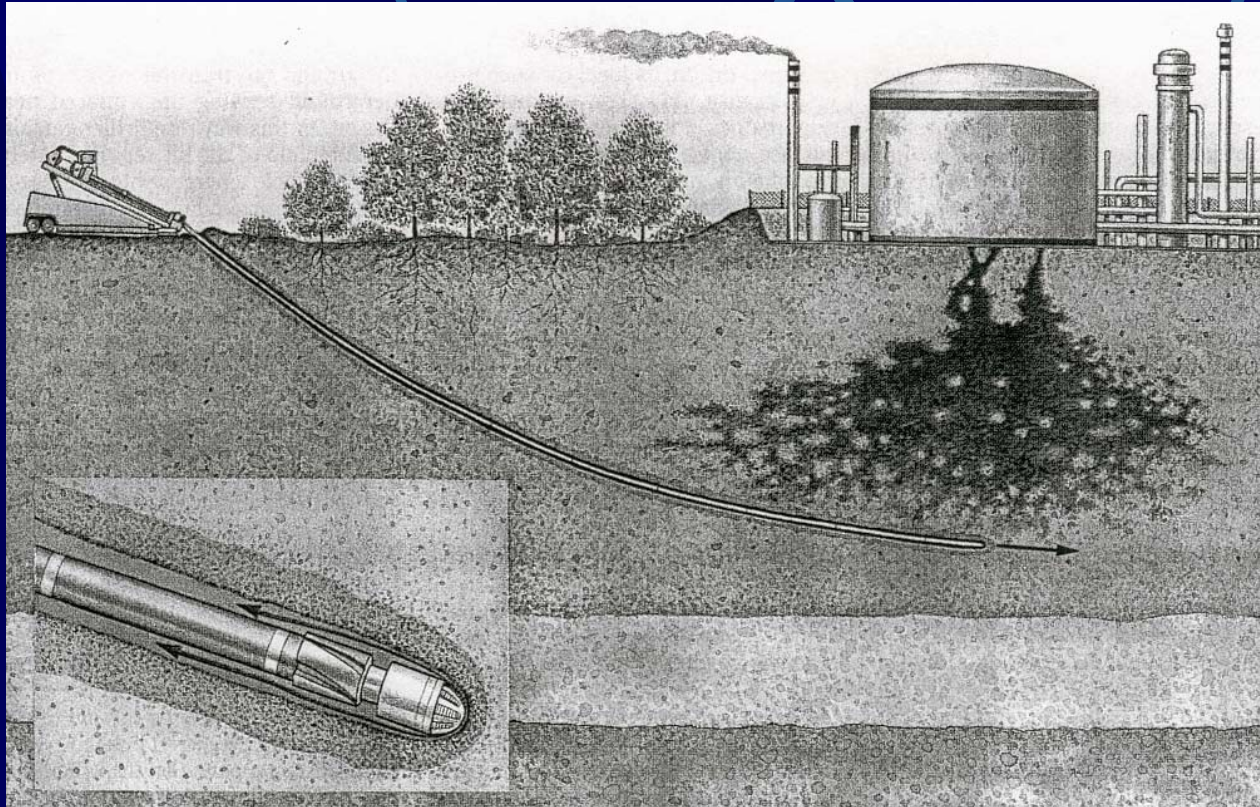
Fracturing Municipal Landfill Wastes was proven to be feasible and Fractured Leachate Recovery Wells exceeded the performance of conventional wells by:

- An order of magnitude in hydraulic conductivity
- 20 times the short term leachate flow rate
- 5 times the long term, steady-state flow rate
- Twice the radius of influence

Benefits to Landfill Operator

- A reduction in the number of wells required to collect leachate from 55 conventional wells to less than 30 fractured wells
- Reduction in landfill cell porewater pressure resulting in ability to vertically expand landfill and increase its waste capacity
- Cost savings of US \$330,000 for the installation of fewer recovery wells
- Additional cost savings due to fewer pumps and infrastructure required and significantly reduced Operation and Maintenance costs

Further Innovations : Horizontal Directional Drilling for Site Remediation



Horizontal Drilling at Cloverbar Landfill, Edmonton



Installation of Horizontal Well



- 300 metre long horizontal borehole drilled in old municipal landfill cell
- 150 mm diameter High Density Polyethylene slotted well casing installed in borehole
- Installation of single horizontal well was equivalent to installation of 20 vertical wells