

“A Review of Landfill Gas Utilization Options at the City of Regina Landfill”

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Acknowledgments

- Conestoga-Rovers & Associates
- Landfill Operations Staff

Purpose

1. Corporate Goal
2. Opportunities and Challenges
3. Landfill Gas (LFG) Collection System
4. North American Experience
5. Utilization Options
6. Preferred Option(s) & Path Forward

Opportunities

- Enhance corporate image
- Generate revenue
- Carbon offsets
- Reducing the potential for adverse health impacts
- Reduce potential for safety hazards
- Improved air quality
- Effective use of energy

Challenges

1. System reliability - Uptime
2. Low pH Condensate – pump failure
3. High N₂
4. Seasonal variations in gas flow and quality
5. Funding

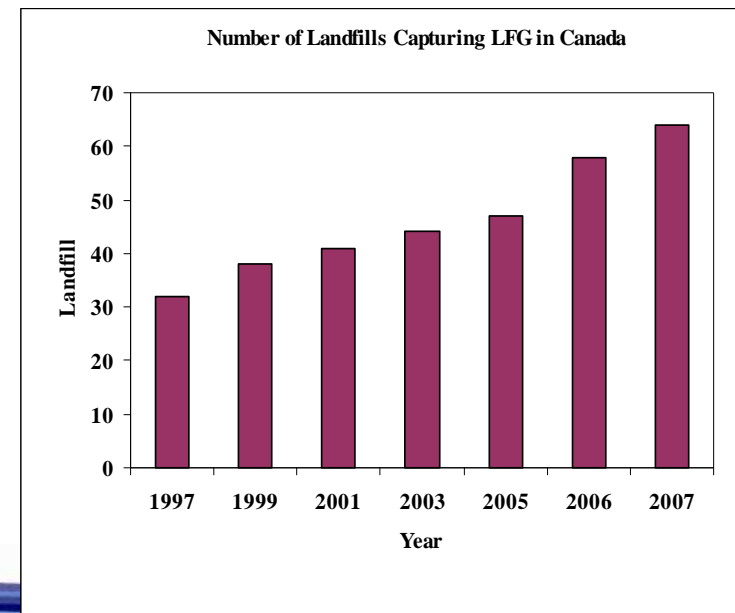
LFG Utilization – Canada (Source: Environment Canada)

Year	Utilization (U)	Flaring (F)	U & F
2006	26	44	12
2007	29	50	15

Year	Power (P)	Heating (H)	CPH
2006	17	9	0
2007	17	10	2

US EXPERIENCE

- 481 projects for electricity production
- 138 projects for heating purposes
- 3 projects for vehicle fuel use



Experience of Selected Landfills Western Canada

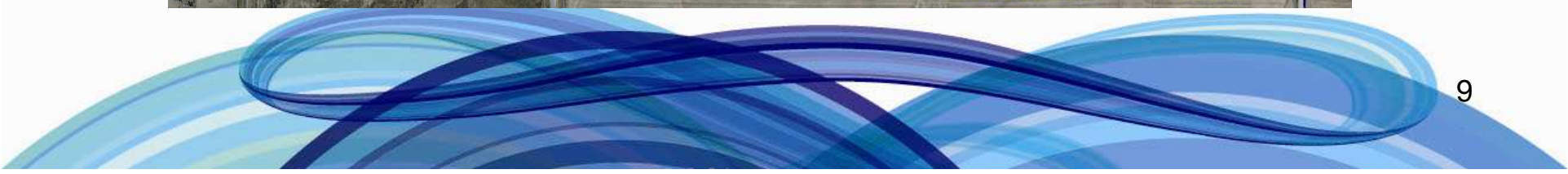
Vancouver	Cogeneration (Electricity + Waste heat). 4 x 1.7 MW Cat Engines. Waste heat for greenhouse heating
Prince George	Gas recovery system. No power or heat recovery
Kelowna (Glenmore)	Generate electricity (kW TBC) + Waste heat utilization. Micro-turbines. Export power
Victoria	1.6 MW Cat engine
Edmonton (Clover Bar)	3 x 1.6 MW Cat engines
Calgary (Shepard)	Gas recovery/clean up - 400 kW engine
Calgary East	70 kW micro-turbine. Expand to install 1 -2 MW engines
Brandon, MB	Open flare. MB to buy LFG credits. Discussing “design – build – operate – finance” scheme for LFG energy use with IGR

Typical Avg. Gas Quantity & Quality

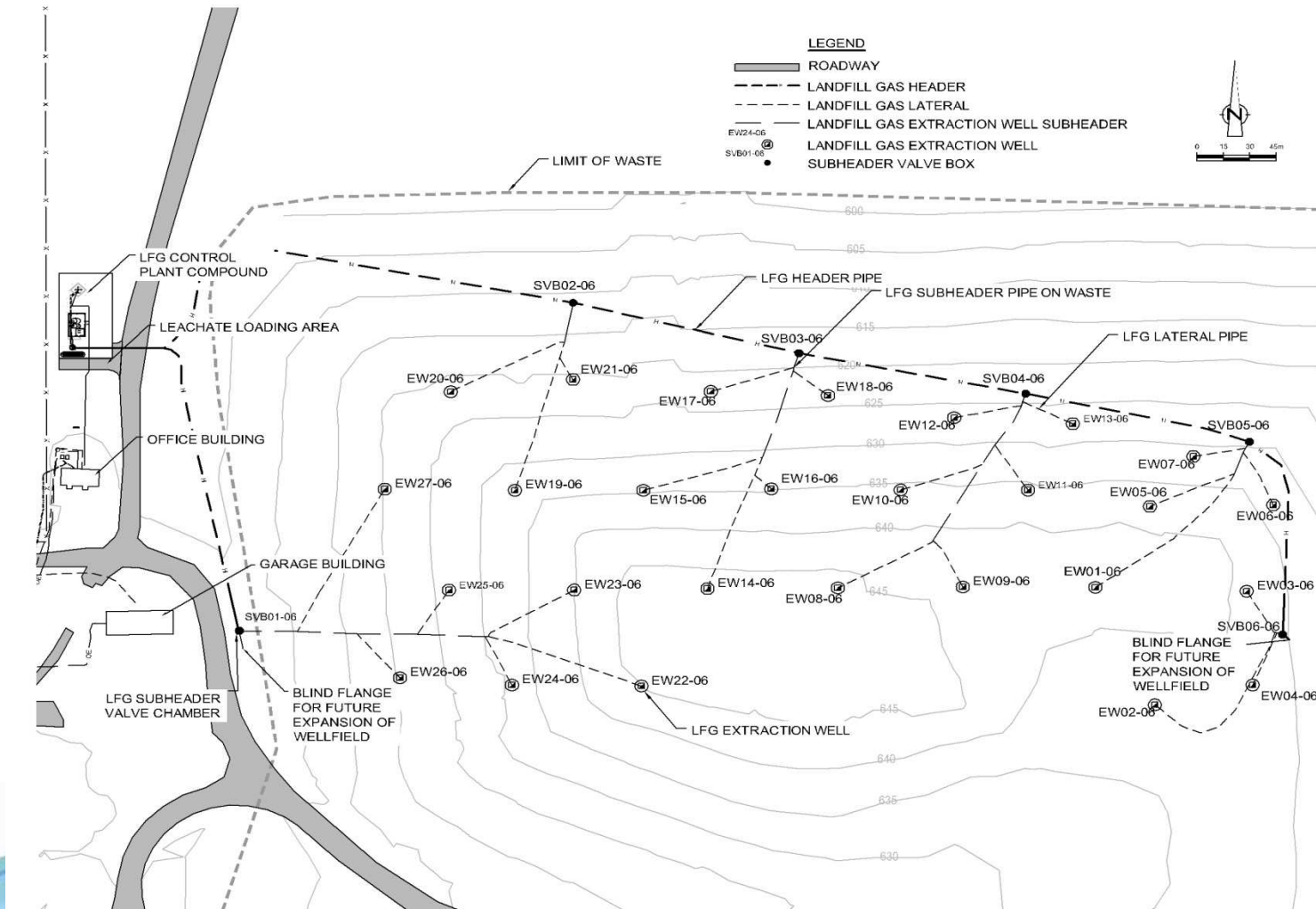
- 250 – 350 acfm
- HHV 16 – 18 MJ/m³
- Up to 1 MW electricity
- Additional analyses for siloxanes, VOCs and H₂S to be completed

Compound	Mol %
CH ₄	50
CO ₂	40
N ₂	9
O ₂	0.5
H ₂ O	Trace
H ₂ S	Trace
Siloxanes	Trace

Fleet Street Landfill



Gas Wells and Collection System (2007 Data)



Flare & Blower Building



Option: Fuel in City Asphalt Plant

- Heat demand 32 GJ
- Seasonal (summer/fall) and batch-wise operation (~ 10 hrs/day)
- On an annual basis, only 32% LFG can be used. Rest would be flared
- Supply >> Demand
- Heater modifications, piping and compression – cost prohibitive at current NG price



Option: Fuel Boilers at Provincial Correctional Centre

- Correction Center located immediately east of landfill
- Several boilers on NG
- Declines use of LFG



Utilization in Boilers at Provincial Correction Center not Practical

- Inmate sensitivity?
- Gas quality
- Need steady supply
- Seasonal variations

Option: Fuel Furnaces at Evraz

- Evraz has shown interest in using LFG in furnace(s)
- Steel plant ~ 10 km NW of landfill
- LFG needs to be blended with NG
- Approximately 10% heat load on furnace (s) can be reduced



Utilization in Furnaces at Evraz

- Compressor, piping and burner modifications required
- LFG may need to be blended with NG
- Gas quality (mainly moisture removal)
- Detailed cost and engineering review required



Option: LFG for Vehicle Fleet Use

- ~ 106 City buses, 1,000 fleet equipment and 50 fire units use 5.6 MM L diesel and 1.5 MM L gasoline annually
- Equipment had been tested on NG. O/M acceptance low
- Converting LFG to NG – cost prohibitive at current NG price (\$4/GJ)
- Gas clean up and engine conversions required
- Bio-diesel tried – seems promising



Transgas NG Specs

Compound/Characteristic		Metric			Imperial		
		Min	Max	Units	Min	Max	Units
1	Heating Value	35		(MJ/m³)	939.4		BTU/ft³
2	Hydrocarbon Dewpoint		-10	(°C@5500kPa a)		14	°F@797.7 psia
3	Water Content		65	(mg/m ³)		4.06	LB.MMcft
4	Hydrogen Sulphide		6	(mg/m ³)		0.261	gr/100 ft ³
5	Mercaptan Sulphur		6	(mg/m ³)		~1/4	gr/100 ft ³
6	Total Sulphur		23	(mg/m ³)		~1	gr/100 ft ³
7	Nitric Oxide		15	(ml/m ³)		15	ppm by volume
8	Total Oxides of Nitrogen		15	(ml/m ³)		15	ppm by volume
9	Carbon Dioxide		2	(% by volume)		2	(% by volume)
10	Oxygen		0.4	(% by volume)		0.4	(% by volume)
11	Temperature		50	(°C)		122	(°F)
12	Other Substances - Should be commercially free from sand, dust, gums, oils, impurities, and other objectionable substances.						

Notes:

All m³ @ 101.325 kPa, 15°C

ft³ @ 14.73 psia, 60°F

6 mg/m³ H₂S equates to 4 ppm or more specifically, 4.140 ppm

Option: Clean LFG and Tie into Trans-gas Pipeline

City of Regina



- Moisture removal (silica gel or molecular sieve)
- H₂S removal (Sulfa-treat, amine or iron sponge)
- CO₂ removal (pressure swing absorption)
- N₂ removal (molecular gate)
- Blowers, compressors, heat exchangers, metering system, new pipeline

Option: Reciprocating Engines

- 2 x 500 kW reciprocating engine-generator sets (containerized units)
- Pre-treatment of LFG (Removal of H₂O, H₂S, Particles and Siloxanes) in a separate containerized unit
- Low voltage and high voltage switchgear, and transformer
- Radiators and exhaust systems
- Blower(s), chiller, and heat exchange equipment
- Electrical and mechanical equipment, instrumentation, and controls, including LFG analyzer and flow meter
- Electrical grid interconnection controls and equipment
- Waste heat utilization options being reviewed
- Phase 2 (~ 2017) (new wells on south slope) – Additional 1MW power anticipated (TBC)

Typical View of Engines



Typical PFD Engine Option

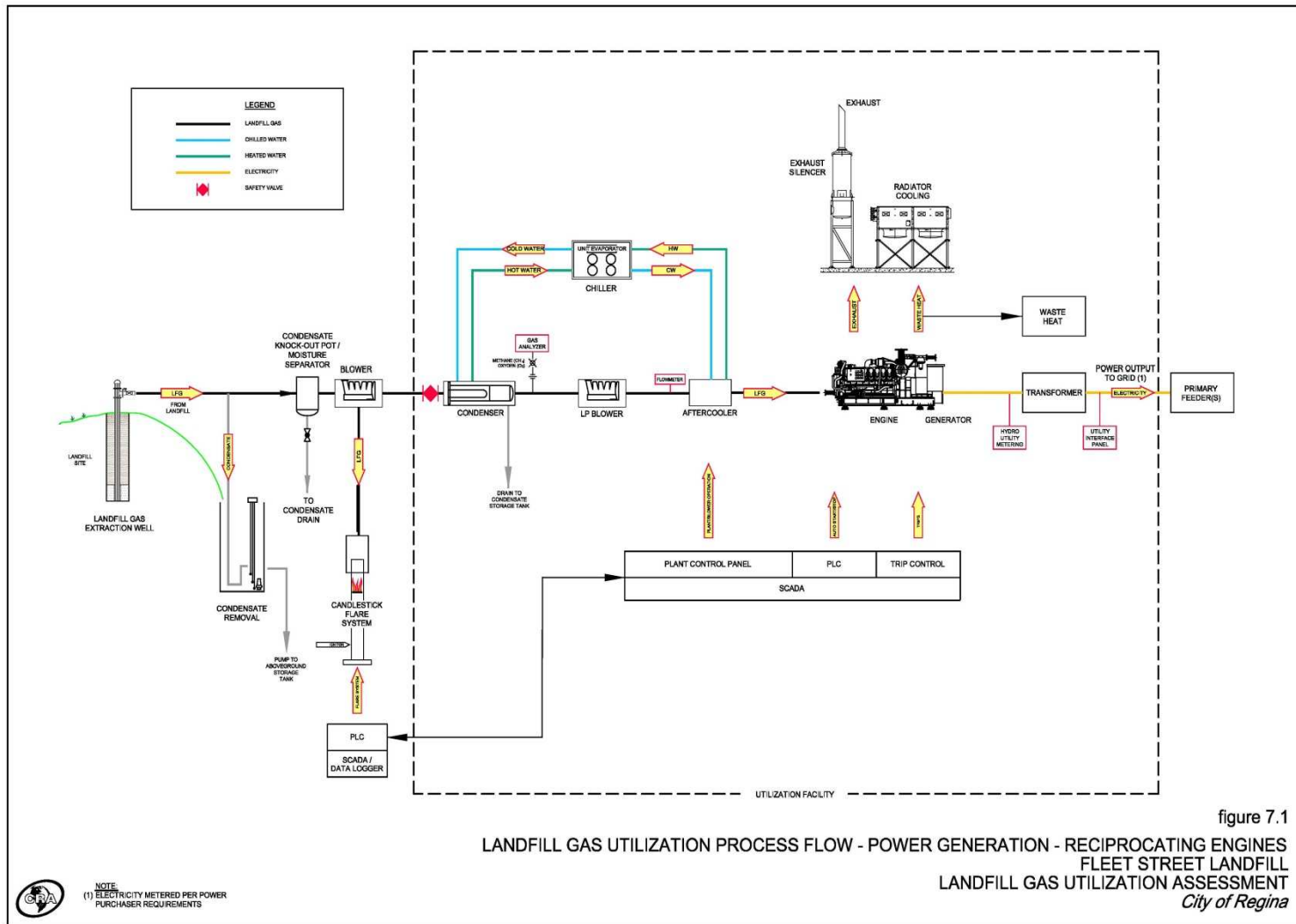


figure 7.1

LANDFILL GAS UTILIZATION PROCESS FLOW - POWER GENERATION - RECIPROCATING ENGINES
FLEET STREET LANDFILL
LANDFILL GAS UTILIZATION ASSESSMENT
City of Regina

Evaluation of Options

(CRA January, 2011 Study)

LFG Utilization Technology	Capital (MM\$)	Technical Capability (efficiency of Energy Utilization)	Proven Experience	Operations and Maintenance Aspects	Life Cycle Cost (Economics)
Reciprocating Engine Electrical Generation	3.9	B	A	B	A
Micro-turbine Electrical Generation	4.4	C	C	C	B
Pipeline Supply	7.6	B	C	C	C

Notes:

Rankings based on a comparative evaluation of available landfill gas utilization technologies

A = Above average, or 'good'

B = Average

C = Below average, or 'poor'

MOVING FORWARD

- Application to SP on Green Options Partners Program (GOPP) submitted for 2 x 500 kW reciprocating engines on biomass (landfill gas)
- Solicit proposals from proponents to design, build and operate the technology
- City is receptive to joint partnership project
- New gas wells to be added to south face around 2015. Will add 1 MW power generation by 2017

City of Regina first in SK to:

- Proactively install gas collection and flare system
- Validate and verify GHG offsets from flaring