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Knott Landfill LFG Projection

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Energyneering Solutions (ESI) has prepared a landfill gas (LFG) projection for the approximate lifespan of Knott Landfill. In previous projections, the waste composition was unknown, and therefore the model was generalized to treat all waste as MSW with the same methane generation rate and potential. With more comprehensive data collected in recent years, the model has changed dramatically, accounting for waste type, decomposition rate, leachate recirculation, and collection efficiency. The steps taken to refine the models are outlined below.

First, the waste was separated into three main groups based on each group's distinct waste composition and corresponding methane generation potential:

1. **Wood Waste (daily cover)**
2. **MSW in Areas 1 and 2**
3. **MSW in Cells 2-9**

MSW includes generic MSW, industrial waste, asbestos, and PCS, each of which have a different LFG generation potential. Industrial waste has approximately 50% the LFG generation potential of MSW; asbestos and PCS have no LFG potential. To account for these variances, the accepted MSW tonnages were modified to "Equivalent MSW Tonnages," approximately ~94% of the actual quantity of waste placed each year.

- **Equivalent MSW tonnage ≈ 94% Accepted MSW tonnage**

To further refine the model, each waste group was assigned its own methane generation rate (k) and methane generation potential (L_0). These are the main user inputs to the LandGEM LFG projection model utilized. The k-value (-/year) is based on the waste composition as well as the environmental conditions (moisture content, climate, etc). The L_0-value ($m^3/Mg\ CH_4$) is depend purely on the waste composition (i.e. liquid recirculation will not alter this value). The values utilized in this projection are EPA recommended numbers based on the known factors.

Case 1: In the first case, ESI focused on treating each waste group as its own bioreactor (three bioreactors). Meaning each waste group generates LFG without any influence from the other groups, and has its own unique k and L_0-values.

Waste Group	k- value (-/year)	L_0-value ($m^3/Mg\ CH_4$)	Assumptions
1. Wood Waste (Bioreactor 1)	**0.02**	**200**	Wood waste has a high methane generation potential (L_0) but a very low methane generation rate in the regionally dry climate
2. MSW in A1 and A2 (Bioreactor 2)	**0.02**	**80**	The waste composition in A1 and A2 is unknown and assumed to have less organic material, resulting in a lower L_0 than that of group 3. As leachate was not recirculated in these areas the k-value is low to match the dry climate.
3. MSW in Cells 2-9 (Bioreactor 3)	**0.09**	**100**	The waste composition is well known and with leachate recirculation, the methane generation potential and rate are as expected for MSW.

Case 2: In the second case, ESI assumed that the Wood Waste and MSW in Cells 2-9 were intermixed as one bioreactor with the same methane generation rate, k-value. As the waste composition of each group did not change, the L_0-values stayed the same.

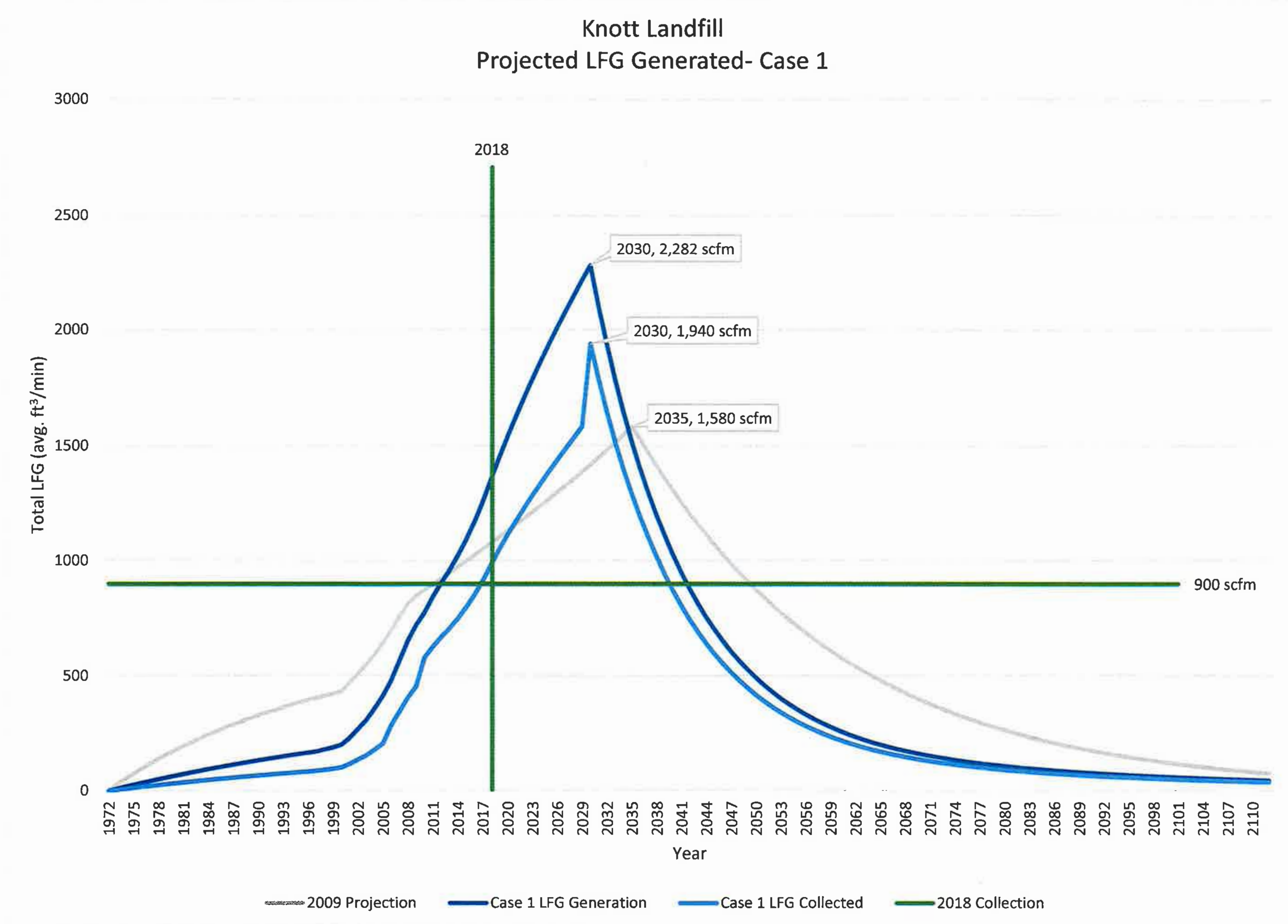
Waste Group	k- value (-/year)	L_0-value (m^3/Mg CH_4)	Assumptions
1. Wood Waste (Bioreactor 1)	**0.07**	**200**	Wood waste has a high methane generation potential (L_0) but is in the same bioreactor as the MSW with leachate recirculation so has a higher methane generation rate.
2. MSW in A1 and A2 (Bioreactor 2)	**0.02**	**80**	The waste composition in A1 and A2 is unknown and assumed to have less organic material, resulting in a lower L_0 than that of group 3. As leachate was not recirculated in these areas the k-value is low to match the dry climate.
3. MSW in Cells 2-9 (Bioreactor 1)	**0.07**	**100**	The waste composition is well known and the methane generation potential is as expected for MSW. The methane generation rate was slightly reduced to account for mixing with the wood waste and possible uneven leachate distribution.

To further refine the LFG generation projections, collection efficiencies were applied to each waste group, dependent upon the year and the LFG collection system in place at that time. (I.e. there was minimal to no LFG collection system in place before 2006, so collection efficiency was estimated at 50% for Group 2. Once a gas collection system was installed in 2006, collection efficiency was increased to 70%. After final closure in 2029, the collection efficiency was increased to 85%.)

The graphs produced show that Case 1 projects higher LFG generation than Case 2; at their peaks in 2030, Case 1 projects an LFG generation 200 scfm higher than Case 2. This is to be expected as the generation rate for MSW in Cells 2-9 is reduced in Case 2 and MSW makes up the majority of the landfill's waste stream. The graphs also show that the current, 2018, LFG collection runs in-between the projected collection curves for Cases 1 and 2. Assuming the collection efficiencies are accurate, this could indicate that Case 1 slightly overestimates the actual LFG generation, while Case 2 underestimates the actual LFG generation. Additional data will be required to confirm this conclusion.

Additional assumptions:

1. Waste acceptance tonnages before 2000 (47,500 tons accepted annually ≈ 44,650 equivalent tonnage)
2. 2% increase in annual waste acceptance tonnage from 2018-closure.
3. Wood waste tonnage assumed steady at 3500 ton/yr for 2018-closure.
4. Quantity of waste split between Areas 1/2 and the other cells (decreasing percentage from 1997-2010 at closure of Areas 1 and 2).
5. Final Closure year of 2029.
   a. Site Waste Capacity of 6,827,843 tons. Model reaches final closure before estimated waste capacity at 6,110,027 tons.
6. 2018 Average Flow of 900 scfm taken from site data.
7. LFG is 50% methane.


Knott Landfill
Projected LFG Generated- Case 1
Total LFG (avg. ft³/min)
3000
2500
2000
1500
1000
500
0
2018
2030, 2,282 scfm
2030, 1,940 scfm
2035, 1,580 scfm
900 scfm
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
2035
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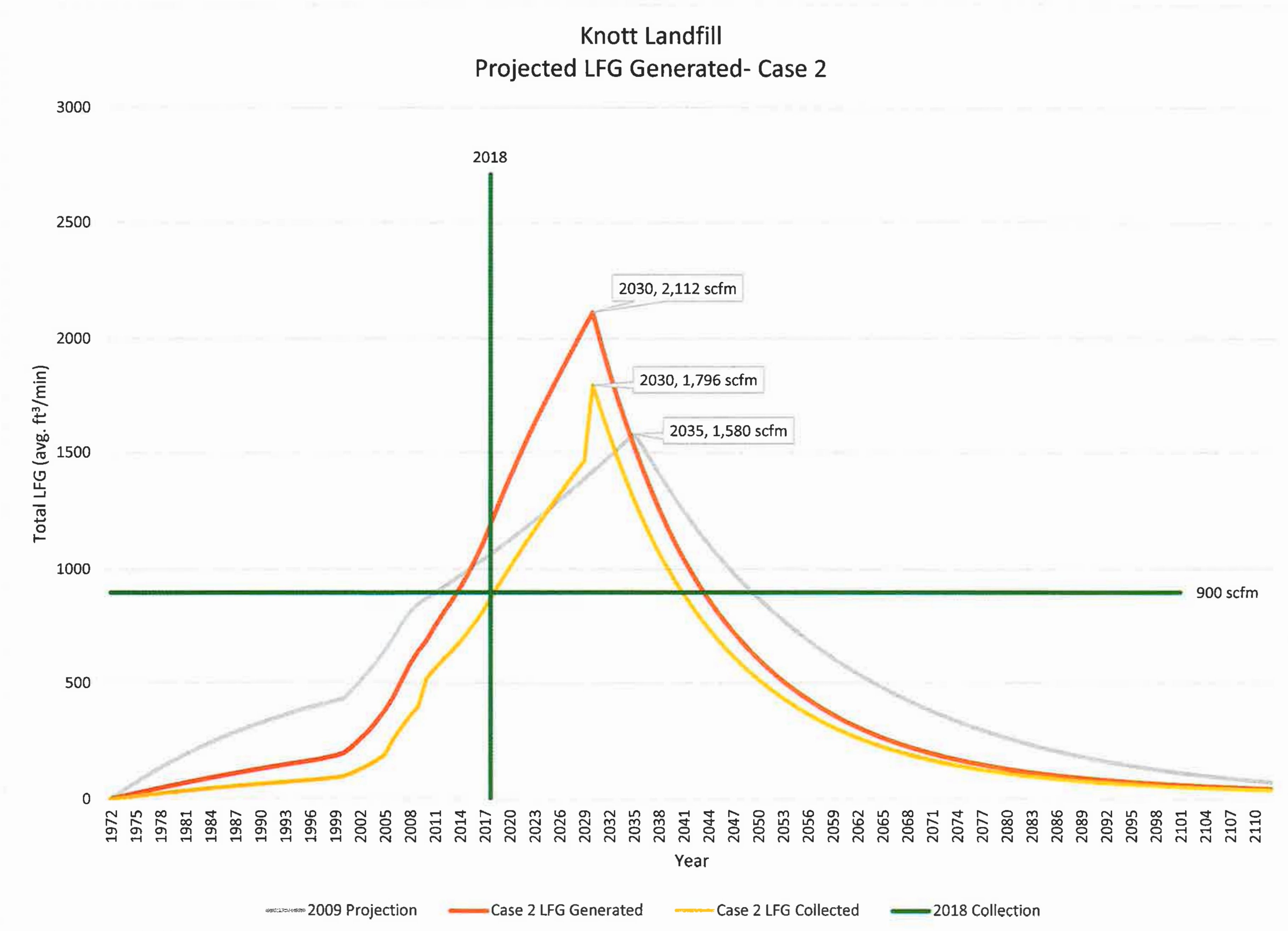
2065
2068
2071
2074
2077
2080
2083
2086
2089
2092
2095
2098
2101
2104
2107
2110
Year
2009 Projection
Case 1 LFG Generation
Case 1 LFG Collected
2018 Collection


Knott Landfill
Projected LFG Generated- Case 2
Total LFG (avg. ft³/min)
3000
2500
2000
1500
1000
500
0
2018
2030, 2,112 scfm
2030, 1,796 scfm
2035, 1,580 scfm
900 scfm
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
2032
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2071
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2080
2083
2086
2089
2092
2095
2098
2101
2104
2107
2110
Year
2009 Projection
Case 2 LFG Generated
Case 2 LFG Collected
2018 Collection