U.S. Greenhouse Gas Inventory: Update on Methodology Improvements for MSW Landfills

December 13, 2017

Rachel Schmeltz
Agenda

• Where we are in the Inventory development process
• Update on improvements to the 1990-2016 Inventory
  – Data on landfills that do not report to the EPA’s GHGRP
  – Scale-up factor
  – Oxidation factor
• Expert review comments received on the 1990-2016 Inventory
• Q&A and discussion
• Schedule and next steps for the 1990-2016 Inventory
1990-2016 Inventory Schedule

Expert Review
• Oct. 16 – Nov. 14

Incorporate Expert Review Comments/Compile Full Inventory Report

Public Review
• Feb. 7 – Mar. 7

Incorporate Public Review Comments and QA/QC Review

Submit to UNFCCC
• Apr. 12
Potential Improvements to the 1990-2016 Inventory
1990-2015 Inventory

• For the first time, we used CH4 emissions as directly reported to the GHGRP
  – Facility-specific CH4 recovery (where applicable)
  – Variety of oxidation factors (0, 0.10, 0.25, 0.35)
  – GHGRP DOC (0.20 for MSW, 0.31 for bulk MSW)
  – Facility-reported annual waste disposal quantities 50 years prior to first acceptance

• Gap = emissions from facilities that do not report to the GHGRP
Scale-Up Factor

- Completes the Inventory
- Proxy for emissions from landfills that do not report to the GHGRP
- Roughly estimated at 12.5% with the goal of revising for the 1990-2016 Inventory
Efforts to Revise the Scale-up Factor

1. Create a master list of MSW landfills (open and closed) that have never reported to the GHGRP
2. Develop the scale-up factor based on total waste-in-place (WIP) from the non-reporting landfills

Scale-up factor =

\[
\text{Non-reporting landfill WIP} / \text{Total WIP}
\]

where

\[
\text{Total WIP} = \text{GHGRP WIP} + \text{Non-reporting landfill WIP}
\]
## Background on Datasets

### Landfill Methane Outreach Program (LMOP) database 2017
- Voluntary program
- Dataset used in this analysis contains all landfills in the 2017 database, regardless of LMOP project status (i.e. Active, Planned, Shutdown, etc.)

- Directory is comprised of data gathered from telephone surveys of owners and operators
- Directory includes other waste processing and disposal operations – not limited to landfills

### EPA/OAQPS Landfill dataset
- Developed for the NSPS and EG for MSW landfills
- Contains a combination of GHGRP and LMOP landfills, as well as NSPS/EG model landfills and newer, smaller landfills identified by OAQPS
## Number of Facilities in each Dataset

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Number of Landfills</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHGRP</td>
<td>1,292</td>
<td>Landfills reporting to the GHGRP in any reporting year</td>
</tr>
<tr>
<td>LMOP 2017</td>
<td>2,405</td>
<td>Unique landfills in the LMOP database</td>
</tr>
<tr>
<td>WBJ Directory 2016</td>
<td>1,578</td>
<td>Landfills that accept MSW (could not confirm all were MSW landfills vs. C&amp;D, transfer station, etc.); likely does not include all closed landfills</td>
</tr>
<tr>
<td>OAQPS (for NSPS/EG for MSW landfills)</td>
<td>1,812</td>
<td>Omitting 5 EG model landfills; 22 separate facilities matched a WBJ facility not designated as a landfill and were omitted</td>
</tr>
</tbody>
</table>
Data Gaps Across the Datasets

- 60% of the list had all data needed to estimate WIP
- 40% of landfills were missing 1 or 2 data elements to estimate WIP
  - Used forced assumptions for landfills with 1 missing data element

<table>
<thead>
<tr>
<th>Missing Data Needed to Estimate WIP</th>
<th>Number of Landfills</th>
<th>Percentage of 1,773 Landfills</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (all data available)</td>
<td>1,069</td>
<td>60%</td>
</tr>
<tr>
<td>1 (1 missing data element, made assumptions to estimate WIP)</td>
<td>437</td>
<td>25%</td>
</tr>
<tr>
<td>2 (2 or more missing data elements, could not estimate WIP)</td>
<td>267</td>
<td>15%</td>
</tr>
<tr>
<td>Total</td>
<td>1,773</td>
<td>100%</td>
</tr>
</tbody>
</table>
Expert Review Charge Questions

- Best approaches to estimate a scale-up factor to account for landfills that do not report to the GHGRP.
- Additional datasets that we can use to generate a list non-reporting landfills with waste-in-place data, and start/closure years to develop a scale-up factor for landfills that do not report to the GHGRP.
- How to consider landfills that off-ramp from the GHGRP going forward with respect to the scale-up factor?
- Best approach for applying a scale-up factor
  - Apply the same scale-up factor for 2005 and later years
  - Apply a variable scale-up factor in blocks of time (e.g., 5 years), annually, when GHGRP facilities off-ramp, etc.
Methods to Improve Completeness

• Shared our list of facilities with informed stakeholders with the goal of
  – Verifying landfill (e.g., WIP) data
  – Confirming matches to GHGRP facilities
  – Filling data gaps

• Reviewers looked at our list in different ways
  – Highest WIP
  – By states with large numbers of landfills
  – By facilities with no information on WIP or years of operation
## Reviewer Input Provided

<table>
<thead>
<tr>
<th>Number</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Number</strong></td>
<td>1,773</td>
</tr>
</tbody>
</table>

| Reviewed | 1,207 | 279 of the total landfills were reviewed by more than one reviewer |
| Matches to GHGRP facilities | 165 | Matched by landfill name aliases, geographical plotting |
| Non-MSW landfills | 57 | Mostly transfer stations, limited information found online |
| Duplicates | 7 | Similar names between LMOP and WBJ databases |

| Total removed | 229 |
| **Not reviewed** | 566 | 37% of 1,544 |

| New Total Number | 1,544 |

| New information provided for | 829* | *Less than half of the input was related to WIP (n=403) and 33% of that data was for 1 year only |
| Unmatched GHGRP facilities | 29 | Indicates that our main list does not provide complete coverage |
New Information to Estimate WIP

• Identified WIP data for 403 landfills
  – Confirmed or revised WIP data from LMOP and WBJ
  – New WIP data for 54 landfills (6.5% of the 403)

• Data for 134 landfills are for 1 year only
  – Requires us to make broad assumptions to estimate WIP if we use the reviewer-provided values

• Still a high amount of uncertainty in this analysis
Revised List of Non-Reporting Landfills

- Similar results when compared to the initial list and a lot more conflicting data at the landfill-level
- High degree of uncertainty in how we use this data

<table>
<thead>
<tr>
<th>Missing Data Needed to Estimate WIP</th>
<th>Number of Landfills</th>
<th>% of 1,544 LFs</th>
<th>% of Initial List (1,773 LFs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>969</td>
<td>63%*</td>
<td>60%</td>
</tr>
<tr>
<td>(all data available)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>341</td>
<td>22%</td>
<td>25%</td>
</tr>
<tr>
<td>(1 missing data element, made assumptions to estimate WIP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>234</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>(2 or more missing data elements, could not estimate WIP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,544</td>
<td>100%</td>
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* Most of this information is coming from LMOP or WBJ versus reviewer feedback.
Impact on WIP from Data Gaps for Non-Reporting Landfills

- Reviewer input contributed approximately 50% of the estimated WIP data that was not forced
- Remainder of unforced data are from LMOP or WBJ

<table>
<thead>
<tr>
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<th>Total Estimated WIP (MT)</th>
<th>Amount of Total Estimated WIP Contributed by Reviewers Input (MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without forcing data</td>
<td>509,943,345</td>
<td>257,108,109 (50%)</td>
</tr>
<tr>
<td>With forcing data</td>
<td>412,031,366</td>
<td>28,810,664 (7%)</td>
</tr>
<tr>
<td>Total</td>
<td>921,974,711</td>
<td>285,918,774 (31%)</td>
</tr>
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</table>
Handling Data Gaps for Non-Reporting Landfills

- Forced data assumptions:
  - If closure year, but no start year: forced start year back 30 years
  - If start year, but no closure year: forced 2016 for facilities with waste acceptance data
  - If only 1 year of waste disposed was provided, we assumed the same quantity disposed for all estimated years of operation

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Steps Taken to Calculate the Scale-up Factor Options

• Estimated scale-up factor = 9%

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<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-reporting facilities (2016)</td>
<td>921,974,711</td>
<td>9%</td>
</tr>
<tr>
<td>GHGRP (RY2016)</td>
<td>9,082,365,791</td>
<td>91%</td>
</tr>
<tr>
<td>Total</td>
<td>10,004,340,503</td>
<td>100%</td>
</tr>
</tbody>
</table>

• Previous webinar cited an incorrect total for WIP that has been revised from 12,936 MMT to 9,082 MMT
  – Decrease by 3,854 MMT
Scale-up Factor Impact on the 1990-2016 Inventory

Methane Emissions (kt)

- with 12.5%
- with 9%
Scale-up Factor Impact 2000-2016
Other Comments on Scale-up Factor

• There are no other datasets to use.
• 12.5% is too high
  – Should be no greater than 5% based on removed WIP from matches to the GHGRP facilities
• Use WIP, not FOD estimated emissions.
• Not necessary to make special account of off-ramped facilities.
• Do not overcomplicate by applying different scale-up factors for different years or blocks of years in time series.
Next Steps for the Scale-up Factor

- Will use 9% in the Public Review draft
- If no additional comments or data are received, we will use the 9% going forward
- Drafting a technical memorandum on how the scale-up factor was developed for technical records and Inventory references.
  - Will be ready when Public Review draft is available
Methodological Improvements for the 1990-2016 and Future Inventories

Oxidation factor
Oxidation Factor (OX) Review

• IPCC 2006 Guidelines recommends a 10% OX
• The literature provides evidence for higher oxidation rates
• Inventory currently uses:
  – 10% for 1990-2004
  – Average of 19.5% for 2005-2015 (because we incorporated the GHGRP data)
    • Allowable GHGRP OX factors: 0, 0.10, 0.25, 0.35
Activities to Assess OX for 1990-2004

1. Reviewed the literature for data specifically for older, or smaller landfills

2. Reviewed the GHGRP data to determine the extent to which older, smaller GHGRP-reporting facilities use an OX based on their calculated methane flux
Findings from the Literature

- Literature tends to focus on landfills that would report to the GHGRP
  - Measurements of oxidation for location-specific facilities and/or gas management and cover systems
- Recent studies (e.g., Chanton and Abichou, 2011; Bogner et al., 2014; SWICS, 2012) provide evidence for higher OX rates at specific facilities
  - Results vary, but range up to 35% or more
  - Some support for 10% OX when accounting for a wide range of facilities, such as those that make up a nationwide Inventory
Findings from the GHGRP

OX averages from RY2015:
- 19.5% for all facilities (for equation used in facility total)
- 18.2% for older, smaller facilities (across equations)
- 15.3% for facilities with GCCS (Equation HH-5)
- 20-25% for the 13 facilities that have off-ramped
OX Charge Questions

• What should OX be for landfills for 1990-2004 with and without GCCS? Are there data sources on trends?

• What should OX be if we use one value for all of 1990-2004?

• Comment on methane leakage (e.g., from cracks and fissures in the cover) with respect to OX. If we apply a higher oxidation factor, should we also apply a leakage factor to waste disposed at landfills with gas collection and control, or all landfills in general?
OX Comments

• If using one value for OX for all U.S. landfills for 1990-2004, 10% is biased low, but no clear alternative value to use

• Suggestions to calculate OX were to
  – Assign different value to landfills with gas collection (although this ignores all other variables that impact OX)
  – Calculate the methane flux by landfill and bin appropriately, similar to GHGRP

• Do not apply a leakage factor to an OX factor
  – Too much uncertainty and more uncertainty will not improve emissions estimates
Decision Moving Forward

- We will continue to use the 10% OX for 1990-2004 to be consistent with IPCC 2006 Guidelines.
- We will continue to effectively use an average of 20% OX for 2005 to date in the Inventory by incorporating the GHGRP data.
- IPCC is currently refining the Guidelines and may recommend an alternative default.
Impact on Time Series of Changing OX to 20% and Scale-up Factor to 9%
Additional Expert Review Comments on the 1990-2016 Inventory
Additional Comments
Received for MSW Landfills

• Degradable organic carbon (DOC) value
• Decay (k) value
DOC Value Comments

- Comments
  - Inventory DOC of 0.20 is too high
  - GHGRP values of 0.20 and 0.31 are too high
  - Using a single value of DOC for all U.S. landfills assumes that waste composition does not change over time; DOC should vary annually or in 5-year increments

- Cite evidence from an EREF assessment of recent state-level waste characterization studies
  - Average DOC for MSW only waste = 0.184 with values ranging from 0.142 to 0.209
DOC Value Comments

• The Inventory uses
  – a DOC value of 0.20 for 1990-2004, and
  – A mix of values that the facilities reporting to the GHGRP use in their emissions equation (most use 0.20, followed by 0.31)

• We are still investigating revisions to a DOC value for the earlier years in the Inventory (1990-2004) based on state-level waste characterization studies

• Unsure of the impact on time series consistency if we make changes to other variables (e.g., k value)
k Value Comments

- Inventory and GHGRP use k-values based on climate:

<table>
<thead>
<tr>
<th>Precipitation range (inches/year)</th>
<th>Inventory k (yr⁻¹)</th>
<th>Climate Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>0.020</td>
<td>Dry</td>
</tr>
<tr>
<td>20-40</td>
<td>0.038</td>
<td>Moderate</td>
</tr>
<tr>
<td>&gt;40</td>
<td>0.057</td>
<td>Wet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precipitation range (inches/year)</th>
<th>GHGRP k (yr⁻¹)</th>
<th>Waste Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>0.020</td>
<td>Bulk waste</td>
</tr>
<tr>
<td>20-40</td>
<td>0.038</td>
<td></td>
</tr>
<tr>
<td>&gt;40</td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td>Selected k value depends on average annual precipitation</td>
<td>0.02 to 0.057</td>
<td>Bulk MSW excluding inerts and C&amp;D waste</td>
</tr>
</tbody>
</table>

- EPA Draft AP-42 (EPA 2008) notes significant uncertainty in k values
- Commenters recommend that EPA review and resolve the significant problems with the k value data set
Q&A; Discussion
Schedule and Next Steps

- Review cycle for the 1990-2016 Inventory:
  - Address Expert Review comments and update for Public Review draft
    - Anticipated Public Review draft in early February 2018 with comments due early March
    - Public Review will be the full Inventory report
  - Address Public Review comments and update for Final Inventory Report
    - Due to UNFCCC on April 15, 2018; we plan to submit April 12.
For More Information and to Send Feedback

Rachel Schmeltz
Schmeltz.Rachel@epa.gov

Kate Bronstein
kbronstein@rti.org