Landfill Gas to Energy:

Turning Waste Into a Resource

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MSW Permits Section

Before

☹

After

☺

Outline: Landfill Gas to Energy

Overview

Benefits

TCEQ Requirements

Application Excerpts

Part I: Overview

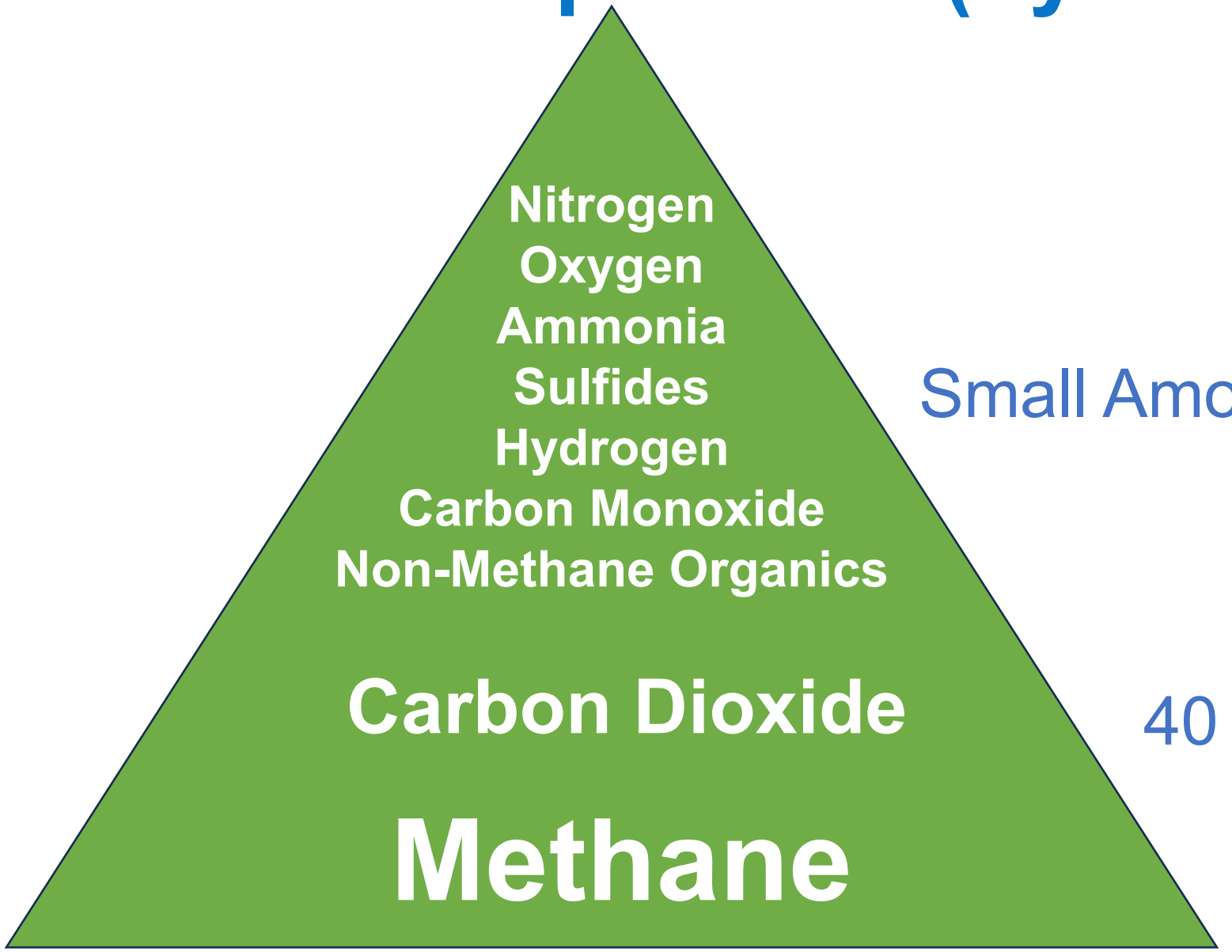
What is Landfill Gas?

Gas generated from the decomposition of organic material contained in landfills.

Formation depends on waste:

- type and age.
- organics – type and amount.
- moisture content.
- temperature.

Landfill Gas Composition (by volume)



Small Amounts

40 – 60 %

45 – 60 %

What's the Problem?

Odor – due to the presence of hydrogen sulfide, dimethyl sulfide, mercaptans, and/or ammonia.

Migration – may migrate underground and enter buildings or utility corridors on or near the landfill.

Explosive Potential – when combined with air in a confined space.

Landfill Gas Emissions

Methane (CH_4) is a greenhouse gas.

Methane is 28 times more effective than carbon dioxide at trapping heat.

Landfills are the 3rd largest human-related contributor of methane emissions.

Source: https://www.epa.gov/lmop/basic-information-about-landfill-gas

Traditional Management of Landfill Gas

Flaring

Prior to development of other options, landfill gas was routinely vented to the atmosphere or to a flare.

Still a common control method for safety and/or odor.

Back-up control method for gas-to-energy projects.

Flaring Drawbacks

Flares emit oxides of nitrogen (NOx), hazardous air pollutants (HAPs), formaldehyde (HCHO), and other organic compounds.

NOx and organic compounds are ozone (O_3) precursors.

Uncombusted emissions are still released.

Flares may be a visual issue for the community.

An Alternative is Born

Image Credit: Waste Management Review

The Early Days

The 1973 oil crisis helped inspire the quest for other energy sources.

Landfill gas to energy concepts began to emerge in the late 1970s.

The first landfill gas to energy project began operating in Wilmington and Sun Valley, California in 1979.

The Wonder Years

The 1980s saw continued initiative in renewable energy.

The Puente Hills Landfill Gas to Energy Facility began producing electricity in January 1987 (Los Angeles County).

The 1990s saw a steep rise in development.

In 1994 EPA launched the Landfill Methane Outreach Program (LMOP) – a voluntary program that works to reduce methane emissions.

Enter Federal Standards (1996)

In 1996, EPA promulgated the Landfill New Source Performance Standards (NSPS) and Emission Guidelines.

The NSPS required MSW landfills to reduce non-methane organic compound emissions. (40 CFR Part 60 Subpart WWW)

The Emission Guidelines required emission reductions at existing landfills.

Federal Standards (1996)

1996 NSPS/Emission Guidelines trigger for capacities ≥ 2.5 million megagrams (Mg) or 2.5 million cubic meters of waste:

≥ 50 Mg non-methane organic compounds (NMOC) per year.

Sites above the threshold were required to install controls.

Controls: A properly designed/operated collection system PLUS a control system capable of reducing NMOC by 98 weight percent.

Federal Standards (1997 - Present)

1997 amendment to NSPS WWW clarified “modification” to mean an increase in permitted volume by horizontal or vertical expansion.

2016 NSPS XXX specified a control threshold of **≥ 34 Mg** NMOC per year for landfills constructed or modified after July 17, 2014.

Control options were also clarified: combustion in an enclosed device (boiler, engine, or turbine), treating the gas for beneficial use, or flaring the gas.

Where We Stand Today

How Many Landfill Gas to Energy Facilities Are There?

EPA reports that as of September 2024:

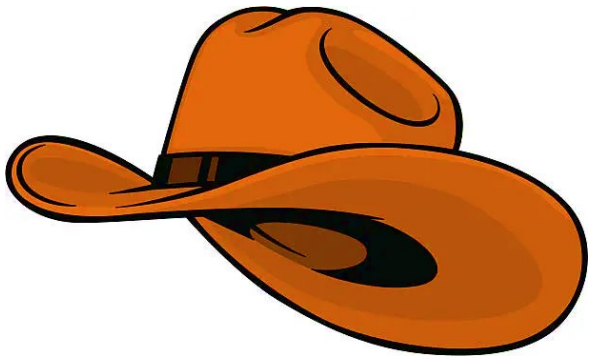
- 542 facilities in the United States.
  - 444 additional sites are good candidates.
- 29 facilities in Texas.
  - 44 additional sites are good candidates.

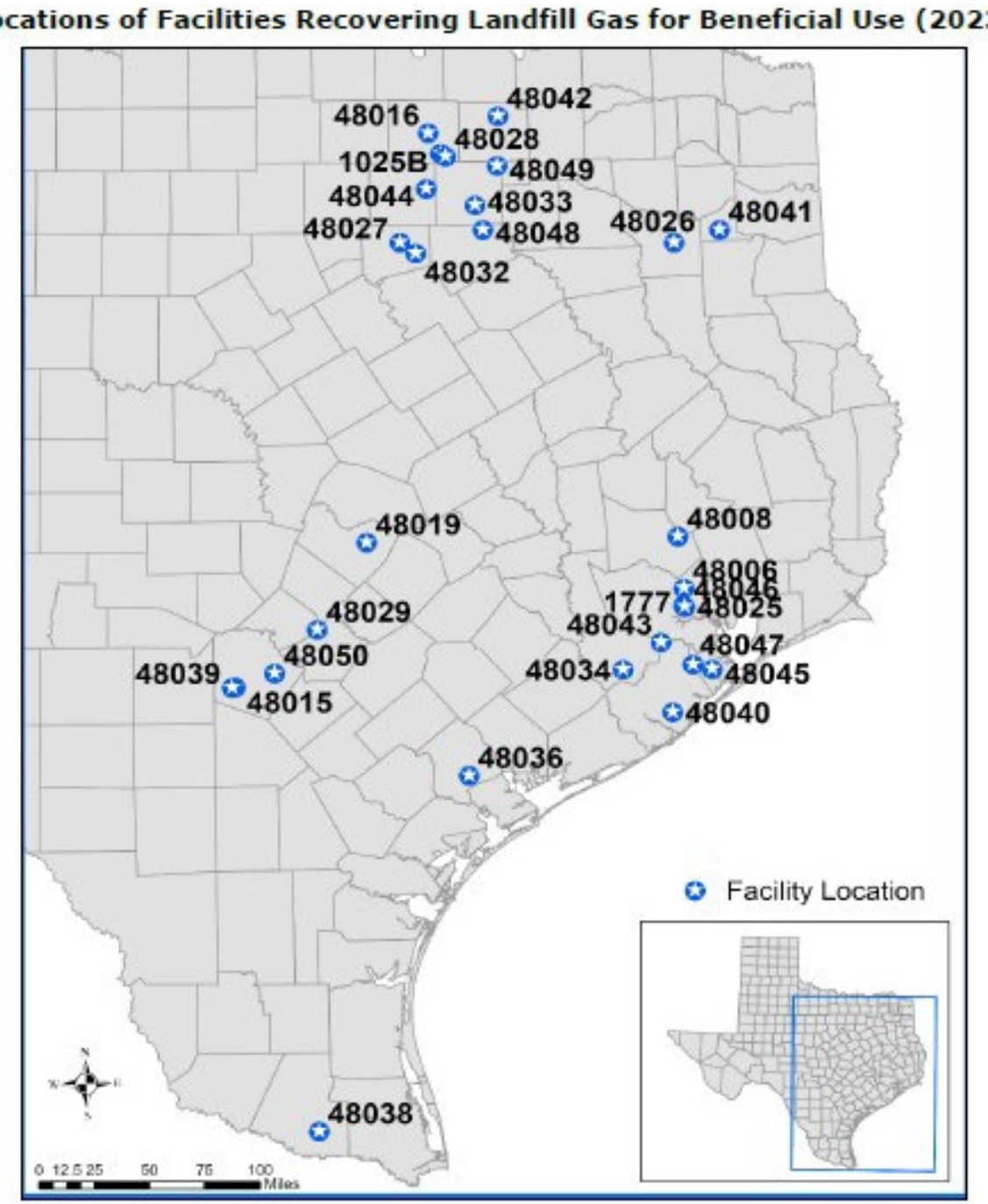
Source: https://www.epa.gov/lmop/project-and-landfill-data-state

What Makes a *Good Candidate*?

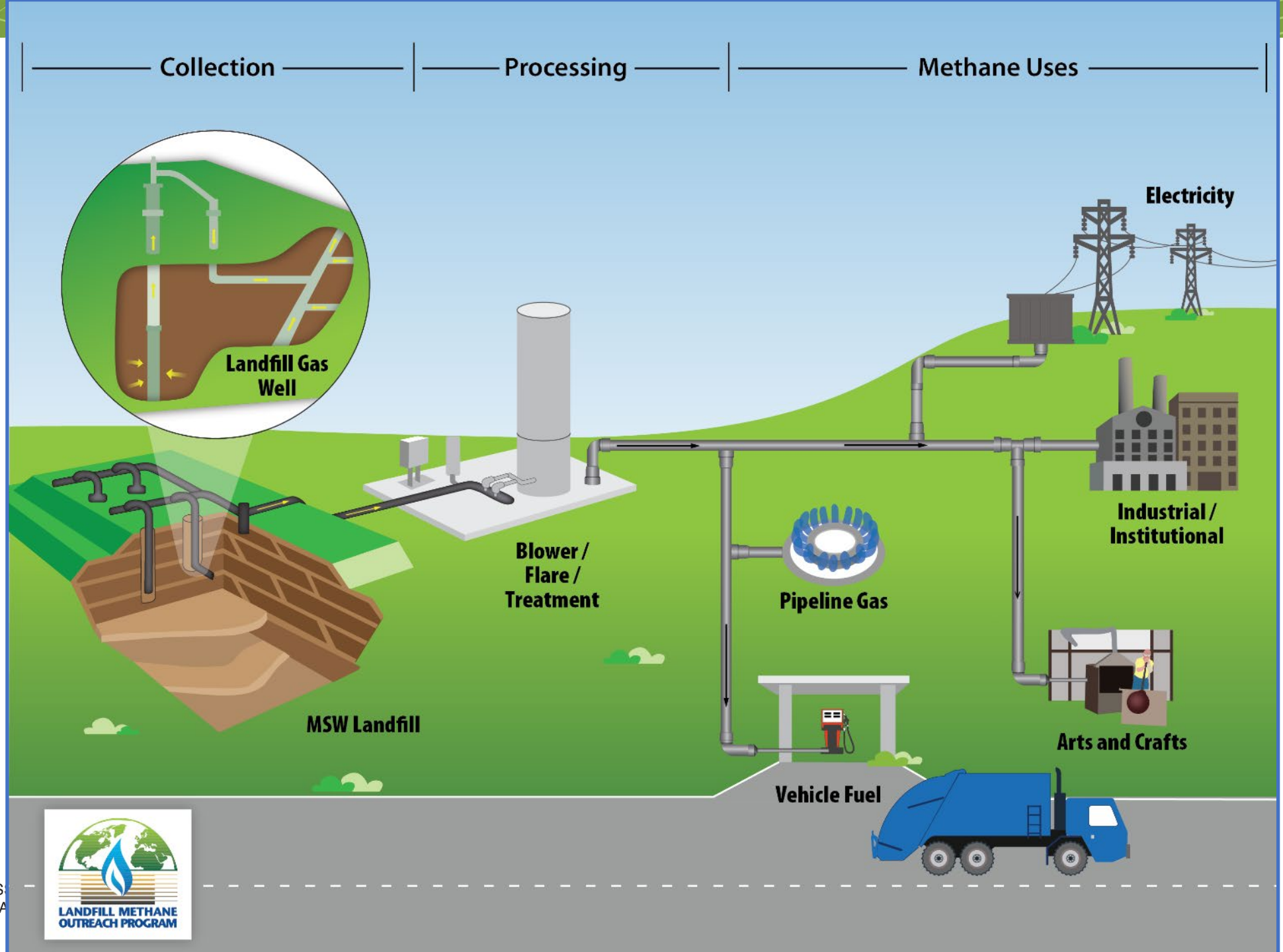
- At least 1 million tons of waste.
- A depth of at least 50 feet.
- Open or recently closed.
- 25 inches or more of precipitation per year.
- Enough organic content to generate sufficient landfill gas.

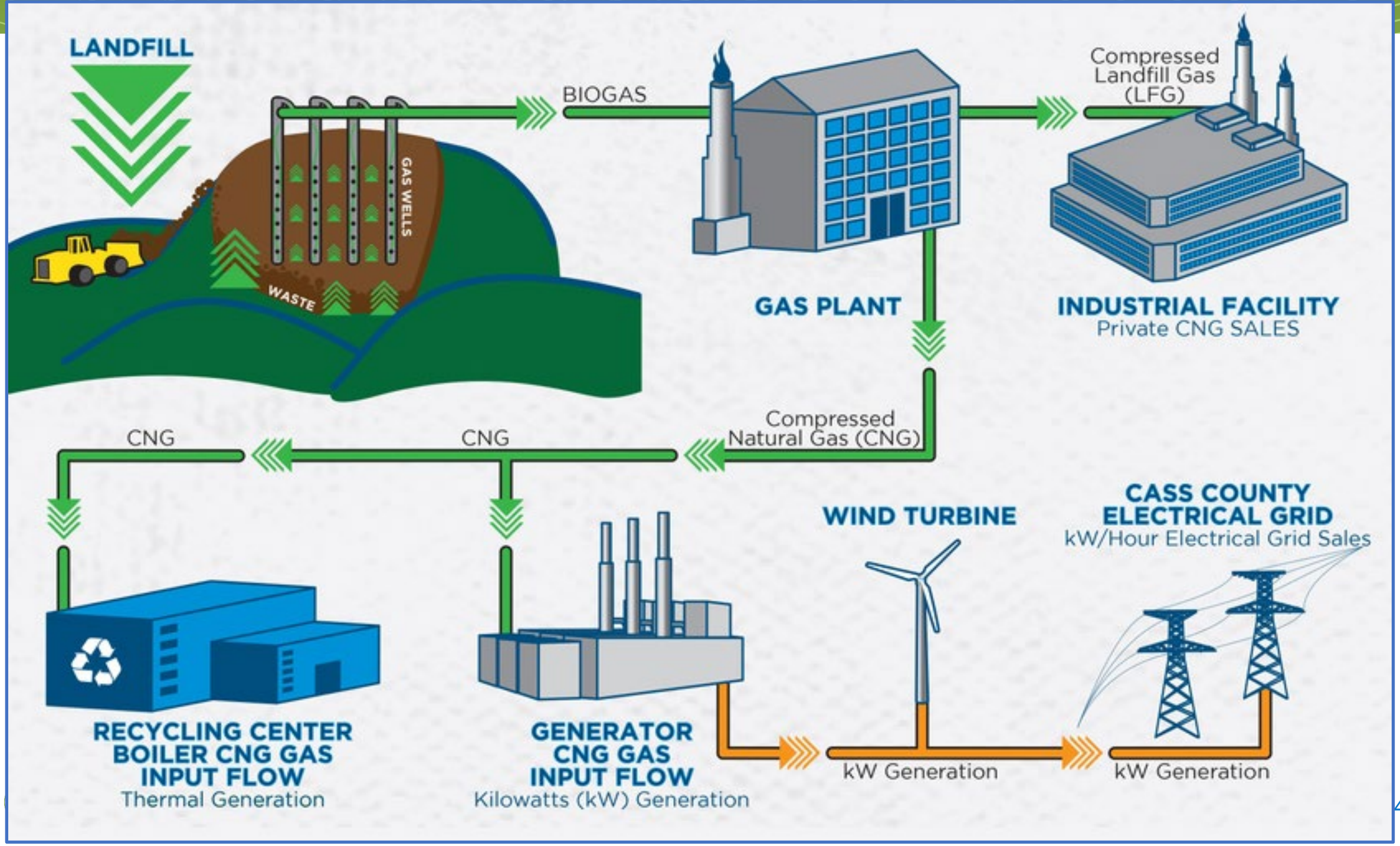
Locations of Texas Facilities (2023)

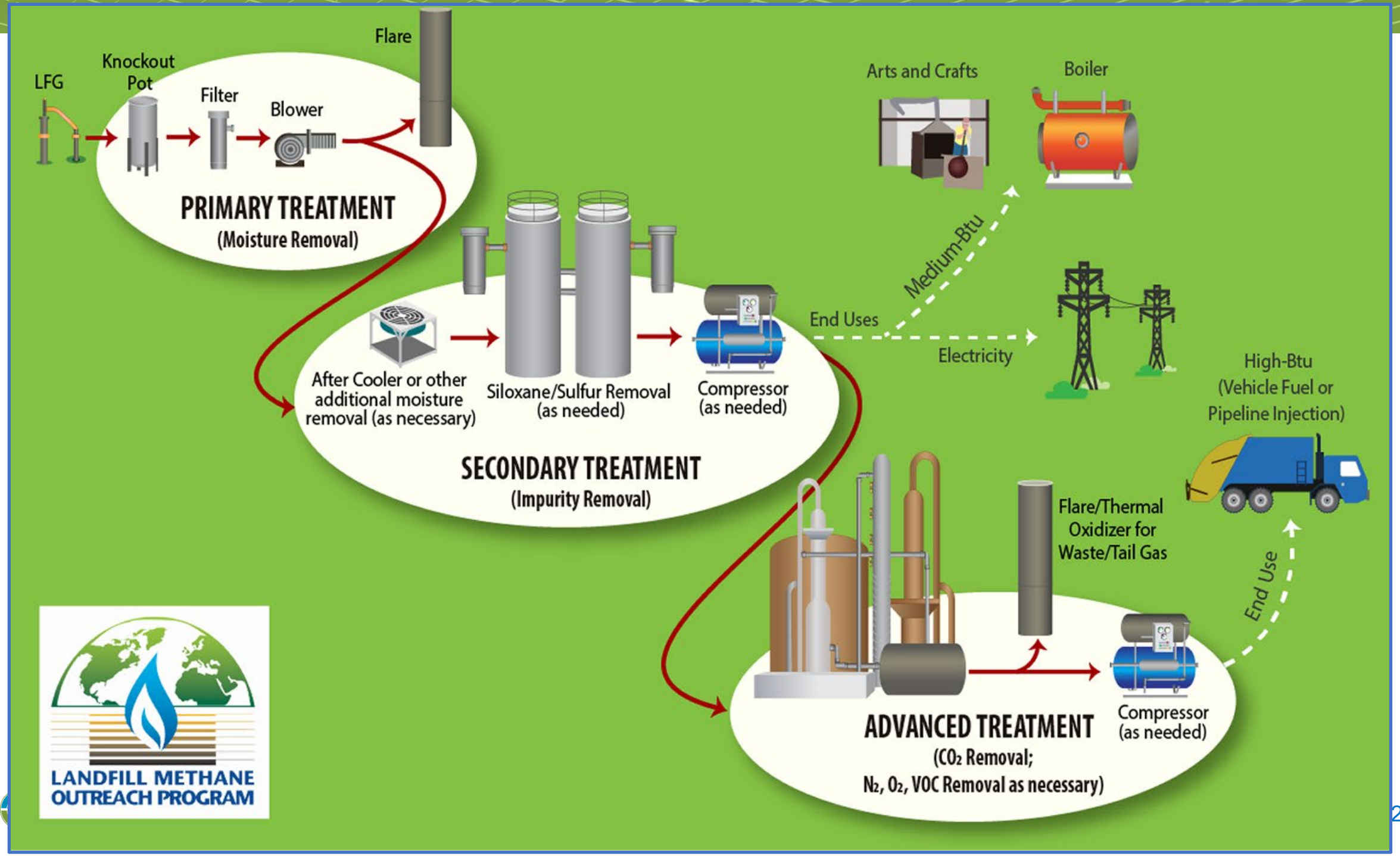




The Process


Collection
Processing
Methane Uses
Landfill Gas Well
Blower / Flare / Treatment
MSW Landfill
Electricity
Industrial / Institutional
Pipeline Gas
Arts and Crafts
Vehicle Fuel
LANDFILL METHANE OUTREACH PROGRAM


LANDFILL
BIOGAS
GAS WELLS
WASTE
GAS PLANT
Compressed
Landfill Gas
(LFG)
INDUSTRIAL FACILITY
Private CNG SALES
Compressed
Natural Gas (CNG)
CNG
CNG
WIND TURBINE
CASS COUNTY
ELECTRICAL GRID
kW/Hour Electrical Grid Sales
RECYCLING CENTER
BOILER CNG GAS
INPUT FLOW
Thermal Generation
GENERATOR
CNG GAS
INPUT FLOW
Kilowatts (kW) Generation
kW Generation
kW Generation


LFG
Knockout Pot
Filter
Blower
Flare
PRIMARY TREATMENT
(Moisture Removal)
After Cooler or other additional moisture removal (as necessary)
Siloxane/Sulfur Removal (as needed)
Compressor (as needed)
SECONDARY TREATMENT
(Impurity Removal)
Arts and Crafts
Boiler
End Uses
Medium-Btu
Electricity
High-Btu (Vehicle Fuel or Pipeline Injection)
Flare/Thermal Oxidizer for Waste/Tail Gas
End Use
Compressor (as needed)
ADVANCED TREATMENT
(CO_2 Removal;
N_2, O_2, VOC Removal as necessary)
LANDFILL METHANE OUTREACH PROGRAM

Optimization

Position wells in organic-rich disposal areas.

Tighter well spacing helps avoid over-pull (and excess oxygen/nitrogen).

Adjust valve settings to optimize flow and prevent overdrawing from areas susceptible to air intrusion.

Minimize fugitive leaks. Maximize collection efficiency.

Potential Challenges

- High initial capital cost. $$$$$
- Estimating an accurate landfill gas volume.
- Maintaining sufficient gas flow to minimize downtime.
- Gas composition variability.
- Maintaining a high collection efficiency.

Part II: The Benefits

Environmental Benefits

Reduce greenhouse gas emissions from landfills.

Help reduce fugitive emissions due to a more efficient collection system and financial incentive.

Offset emissions of other pollutants associated with non-renewable fuels (e.g., coal, oil, diesel, natural gas).

Help destroy VOC and hazardous air pollutants when treated landfill gas is combusted in electric generating units.

Community Benefits

Help improve safety by reducing explosion hazards from landfill gas accumulation.

Help reduce odor due to an optimized gas collection system.

Provide renewable energy generation capacity to supply local power needs.

Provide employment opportunity in the design, construction, and operation phases.

Economic Benefits

- Revenue generated from treated gas sales.
- Jobs provided for those who design, construct, and operate the facilities.
- Construction- and operation-related jobs indirectly help local businesses that employees (and their families) support.
- Industrial/commercial users of treated gas can see lower fuel costs.

Part III: TCEQ Requirements

Texas Rule 30 TAC §330.5(a)(7)

- Classifies the landfill gas to energy project as a Type IX Facility – a facility that recovers energy for beneficial use.
- Located within or adjacent to a closed disposal facility, an inactive portion of a disposal facility, or an active disposal facility.
- Specifies that registration by rule requirements are prescribed by §330.9(j).

30 TAC §330.5(a)(7) – Rule References

Incorporates by reference:

- Operational Standards for MSW Solid Waste Storage and Processing Units (Chapter 330 Subchapter E).
- Closure Requirements for Municipal Solid Waste Storage and Processing Units (§330.459).

30 TAC §330.5(a)(7) – More References

Also incorporates by reference:

- Certification of Final Facility Closure (§330.461).
- Closure Cost Estimates for Storage and Processing Units (§330.505).
- Financial Assurance for MSW Facilities (Chapter 37, Subchapter R).

30 TAC §330.5(a)(7) – Air Quality

- Air quality review must be completed and approved prior to the effective date of the Type IX registration.
- TCEQ Air Permits Division Home Page: https://www.tceq.texas.gov/permitting/air/air_permits.html
- Email: airperm@tceq.texas.gov Phone: 512-239-1250

Texas Rule 30 TAC §330.9(j)

Contains the basic checklist for what goes into the application:

- ✓ Plan drawing showing all boundaries and equipment.
- ✓ Fire and explosion mitigation elements.
- ✓ Condensate disposal methods.

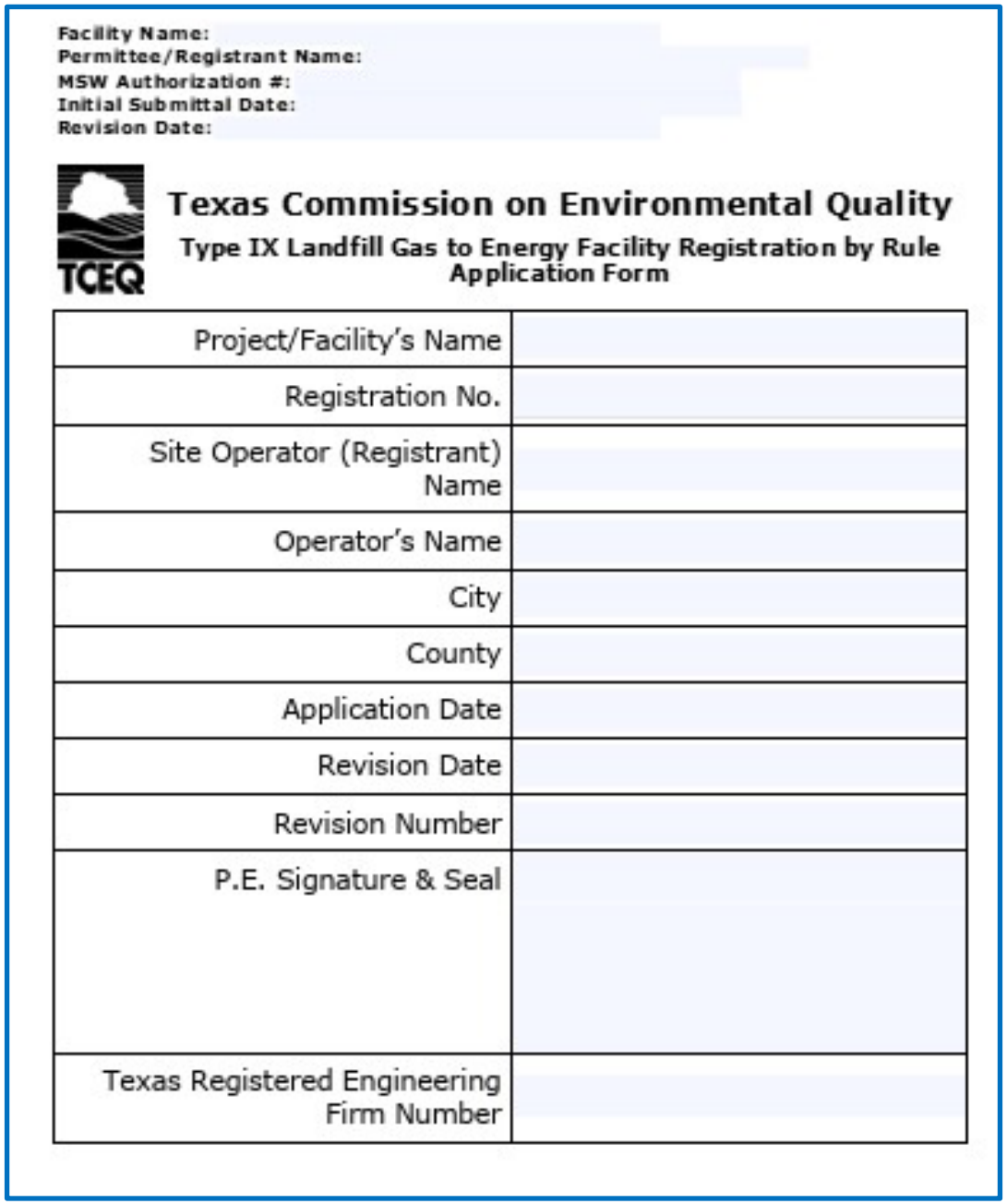
30 TAC §330.9(j) – The List Goes On

- ✓Average daily gas production rate.
- ✓ Design daily gas production rate.
- ✓ Process unit descriptions.
- ✓ Closure cost estimate.
- ✓ Financial assurance mechanism.

30 TAC §330.9(j) – Rule References

- ✓ Required air authorizations.
- ✓ Operational standards (Chapter 330 Subchapter E).
- ✓ Closure requirements (§330.459).
- ✓ Certification of final closure (§330.461).
- ✓ Closure cost estimate (§330.505).

TCEQ Application Form – TCEQ 20651



Facility Name:
Permittee/Registrant Name:
MSW Authorization #:
Initial Submittal Date:
Revision Date:

Texas Commission on Environmental Quality

Type IX Landfill Gas to Energy Facility Registration by Rule Application Form

Project/Facility's Name	
Registration No.	
Site Operator (Registrant) Name	
Operator's Name	
City	
County	
Application Date	
Revision Date	
Revision Number	
P.E. Signature & Seal	
Texas Registered Engineering Firm Number	

TCEQ Form 20651

https://www.tceq.texas.gov/downloads/permitting/waste-permits/msw/forms/20651.pdf

Please read the instructions section within the PDF very carefully. If you have questions, contact TCEQ MSW staff!

mswper@tceq.texas.gov or 512-239-2335

Attachments are important!

- Facility Legal Description
- Property Owner Affidavit
- Verification of Legal Status
- Evidence of Competency
- General Location Map
- Site Layout Plan
- Closure Cost Estimate
- Financial Assurance
- Fire/Explosion Control
- Process Unit Description

Description of Attachments: See Pages 5 - 9 of the Form.

Application Tips

Include the engineer's seal/signature and the firm registration number on the title page, plans, and drawings. [22 TAC §137.33]

Ensure the large-scale plan drawing shows both the proposed facility and the associated landfill unit boundaries. [§330.9(j)(1)(A)(i)]

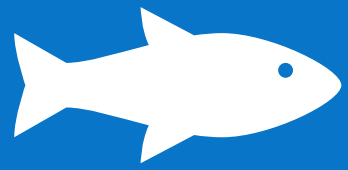
Clarify whether the existing gas collection system will route to the new Type IX facility, and if an existing flare will be used. [§330.9(j)(1)(A)(ii)]

Application Tips 2

For enclosed structures, remember to address fire control, methane monitoring, and explosion-proof fixtures. [§330.9(j)(1)(B)]

Specify how any waste generated by the facility will be managed (ex: spent carbon, wastewater, etc.). [§330.205, §330.207]

Address contaminated water management practices and compliance with state and federal water quality rules. [§330.207]



Application Tips 3

Address plans for spill control and clean-up.
[§330.227]

Include a detailed closure cost estimate with a line-item breakdown and unit costs.
[§330.9(j)(1)(G) and §330.505]

Address financial assurance.
[30 TAC Chapter 37, Subchapter R]
Contact: revenue@tceq.texas.gov or 512-239-1738.

Application Tips 4

Address access control, including appropriate fencing, lockable gates, and an attendant during operating hours.

[30 TAC §330.223]

The site must have at least one supervisor or manager with a Class A or Class B MSW Facility Supervisor License.
[30 TAC §30.213(a)]

Application Tips 5

Address ventilation and air pollution control, employee health and safety, and sanitation facilities. [§330.245, §330.247, §330.249]

For more on air authorizations, the TCEQ Air Permits Division may be reached at 512-239-1250. [30 TAC §330.9(j)(2)]

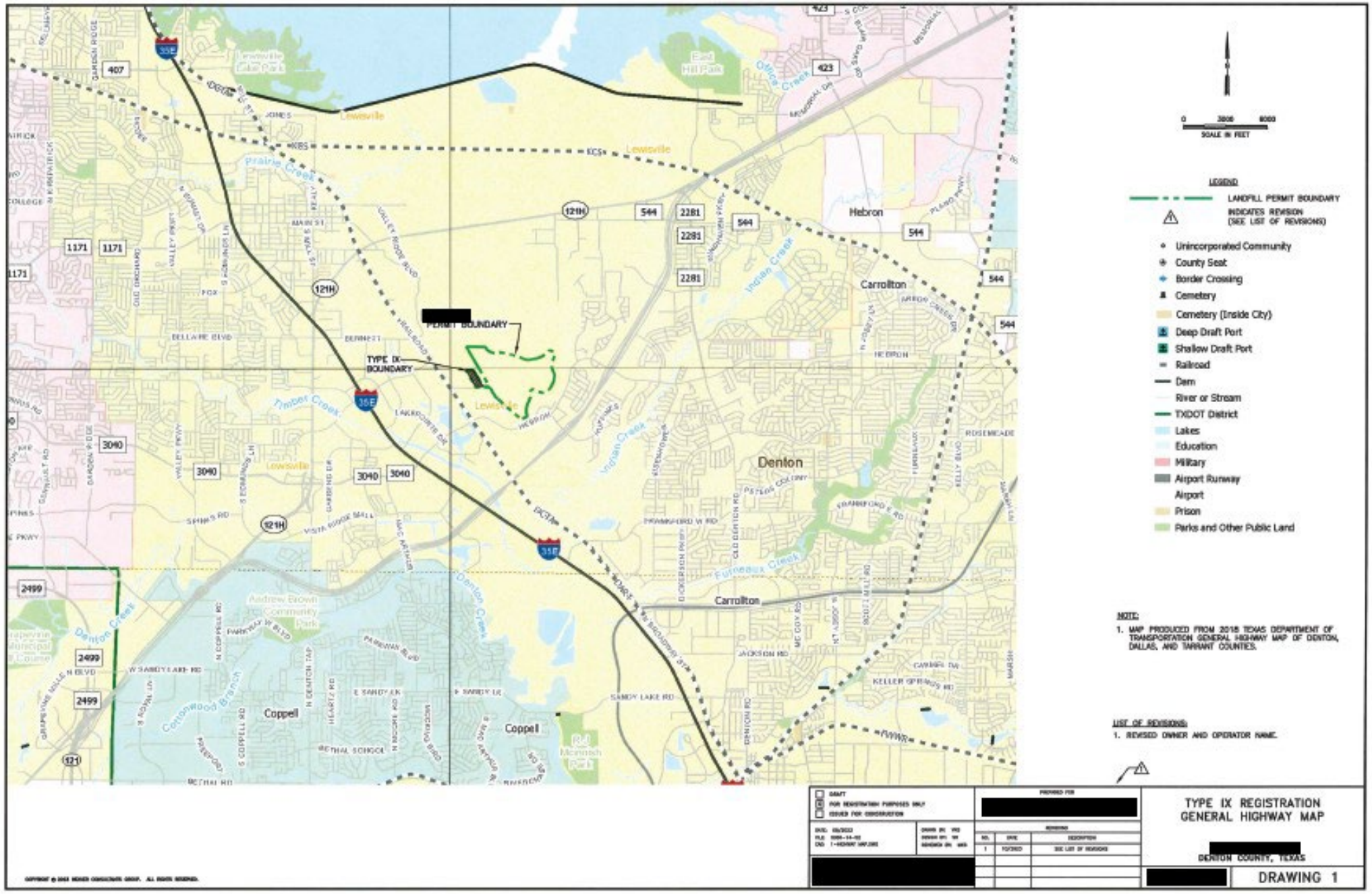
Application Tips 6

A landfill permit modification is required for updates to the Site Layout Plan and the landfill gas collection system. [§305.70(j)(7)]

Active landfill permit?
Comply with permit and rules for closure and post-closure. [TCEQ Permit and 30 TAC Chapter 330, Subchapter K]

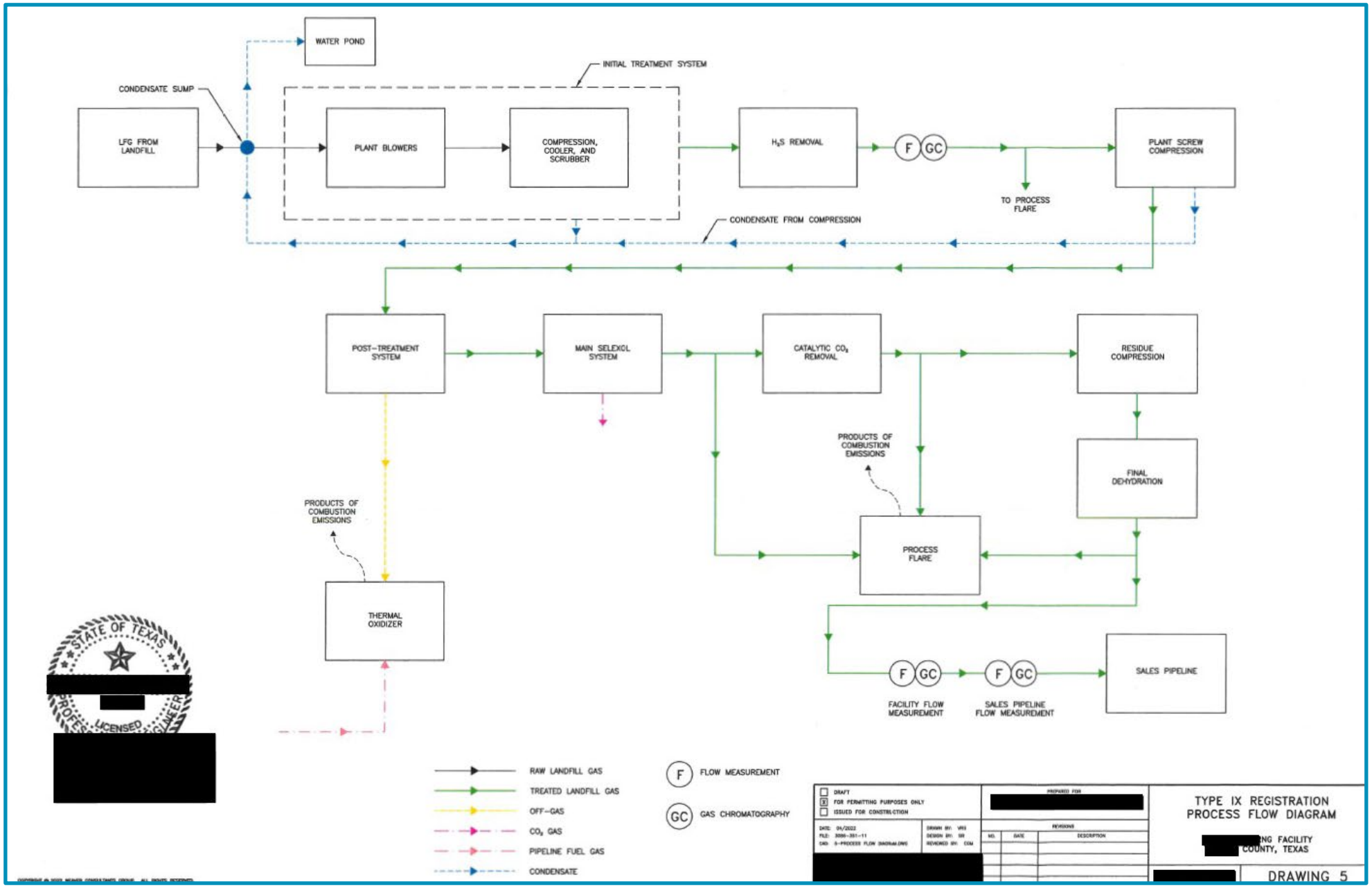
Revoked landfill permit?
Comply with rules to maintain integrity of the final cover. [30 TAC Subchapter T]

Part IV: Examples

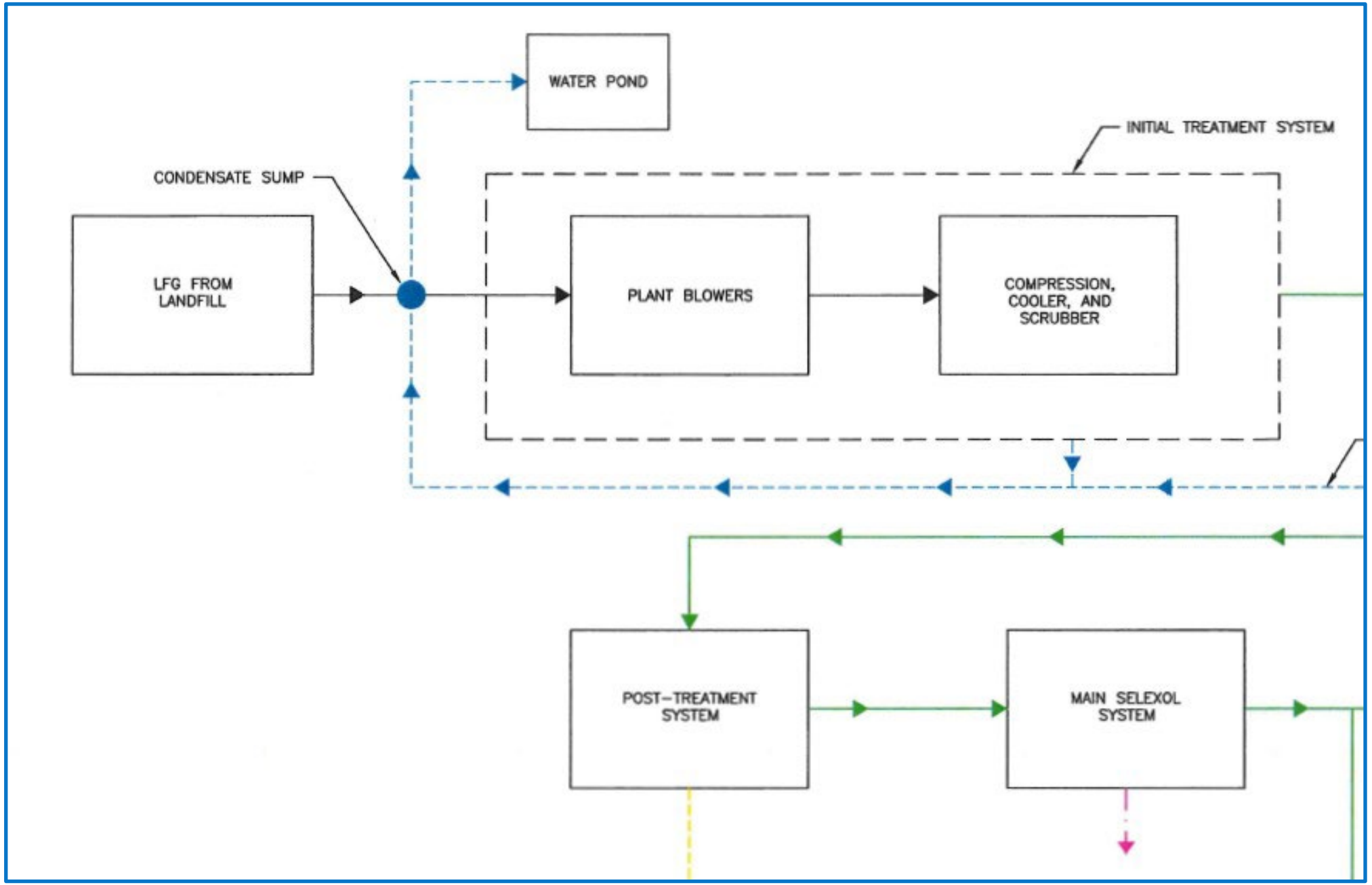


Example: General Location Map

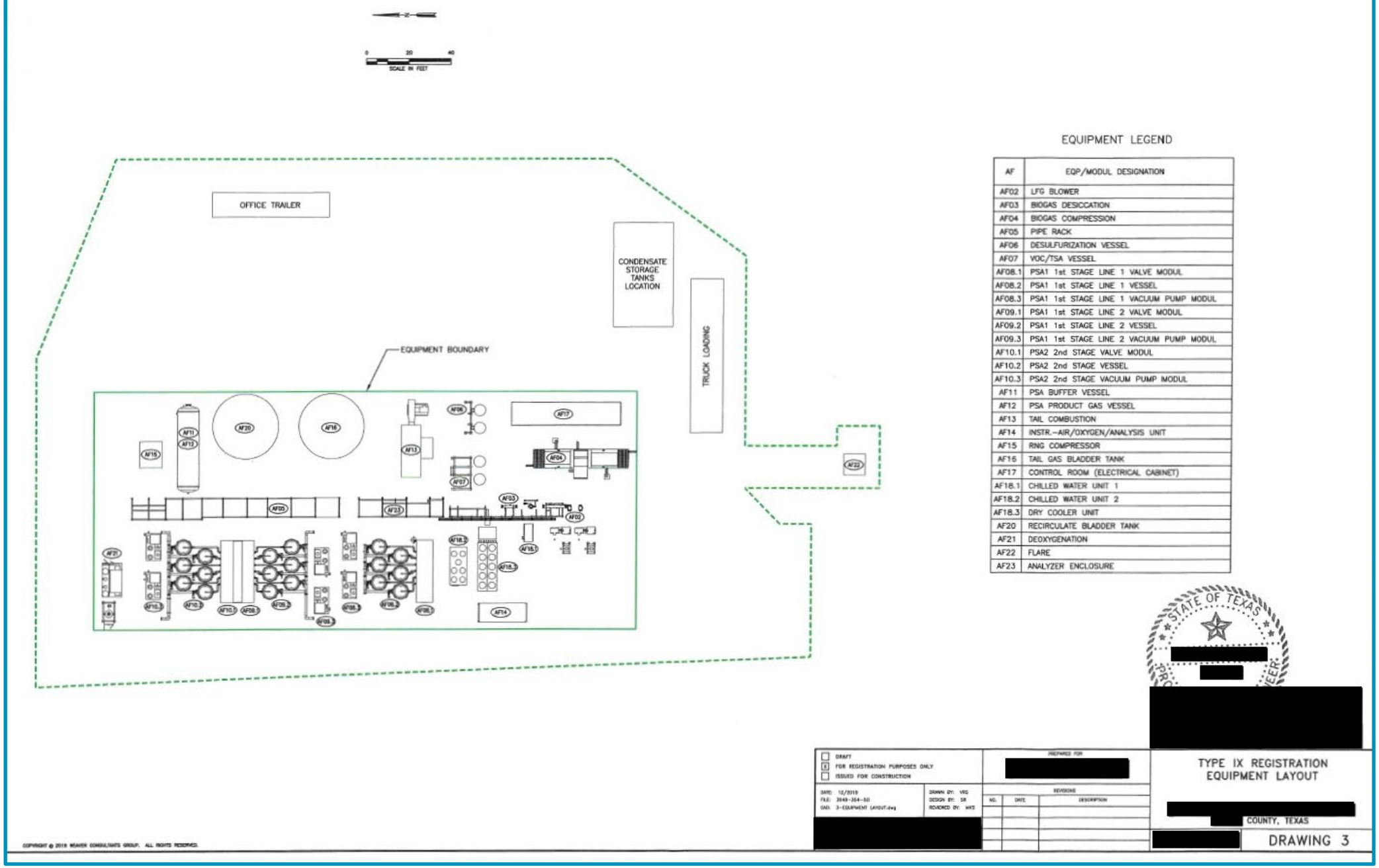
Example: General Location Map – Zoomed In



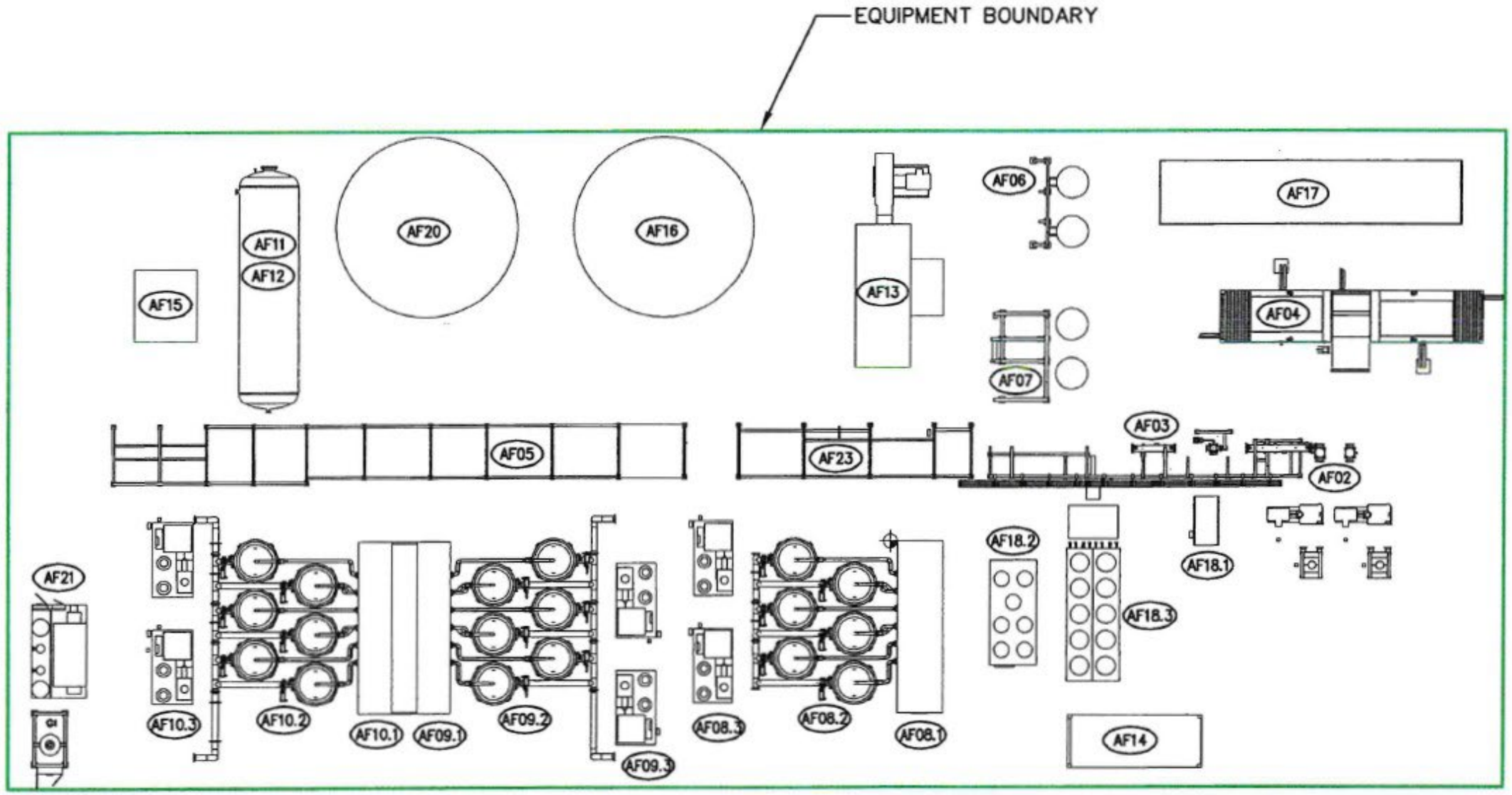
Example: Block Flow Drawing



Example: Block Flow Drawing (Partial Zoom)



Example: Equipment Layout Drawing



Example: Excerpt of Equipment Layout Drawing

The facility will maintain a copy of its current closure cost estimate in its operating record. The following table presents a summary of the facility closure cost estimate (in 2024 dollars).

Task	Units	Quantity	Unit Cost	Total
LFG Redirection[1]	LS	1	$15,000	$15,000
Decommissioning Pipeline Interconnection[1]	LS	1	$10,000	$10,000
LFG Treatment and Processing Equipment Demobilization	ton	500	$100/ton	$50,000
Equipment Removal	ton	500	$200/ton	$100,000
Equipment Disposal	ton	500	$100/ton	$50,000
Support Structure Demobilization	LS	1	$80,000	$80,000
Surface Restoration	LS	1	$10,000	$10,000
TCEQ Administration	LS	1	$10,000	$10,000
			Subtotal	$325,000
			10% Contingency	$32,500
			Total Closure Cost Estimate	$357,500

[1] Line item includes decommissioning in place of subsurface piping and associated equipment.

Example: Closure Cost Summary Table

3.2.1 §330.9(j)(2)(A) – Subchapter E (Operational Standards for MSW Storage and Processing Units)

[redacted] agrees to comply with all of the applicable requirements of Subchapter E during the operation of the proposed RNG facility, as further discussed below.

§330.203: Waste Acceptance and Analysis. The RNG facility will recover and beneficially use LFG generated by the on-site landfill. As such, waste acceptance and analysis is not applicable for the RNG facility.

§330.205: Facility-Generated Wastes. The waste generated by the RNG facility during operation will include used containers of oil, coolant, and incidental cleaning materials. All containers will be shipped to a nearby approved disposal facility.

§330.207: Contaminated Water Management. Any contaminated water generated by the RNG facility will be collected and disposed as described in Section 3.1.3. Liquids resulting from the operation of this facility will be disposed of in a manner that will not cause surface water or groundwater pollution. The owner/operator will not discharge contaminated water without specific written authorization.

§330.209: Storage Requirements. Operation of the RNG facility will not involve handling and storage of solid waste.

Example: Excerpt from Narrative Report

Part V: Closing

Recap

TCEQ encourages the conversion of waste into a resource.

Landfill gas to energy projects can benefit the environment, the community, and the economy.

Texas Rules: 30 TAC §330.5(a)(7) and §330.9(j).

Application Form: TCEQ-20651.

Resources are available and TCEQ staff are here to help!

Resources

EPA Landfill Methane Outreach Program (LMOP)

https://www.epa.gov/lmop

TCEQ – Landfill Gas Recovery Facilities Webpage

https://www.tceq.texas.gov/permitting/waste_permits/msw_permits/lfg-recovery

Global Methane Initiative (GMI)

https://www.globalmethane.org/biogas/msw.aspx

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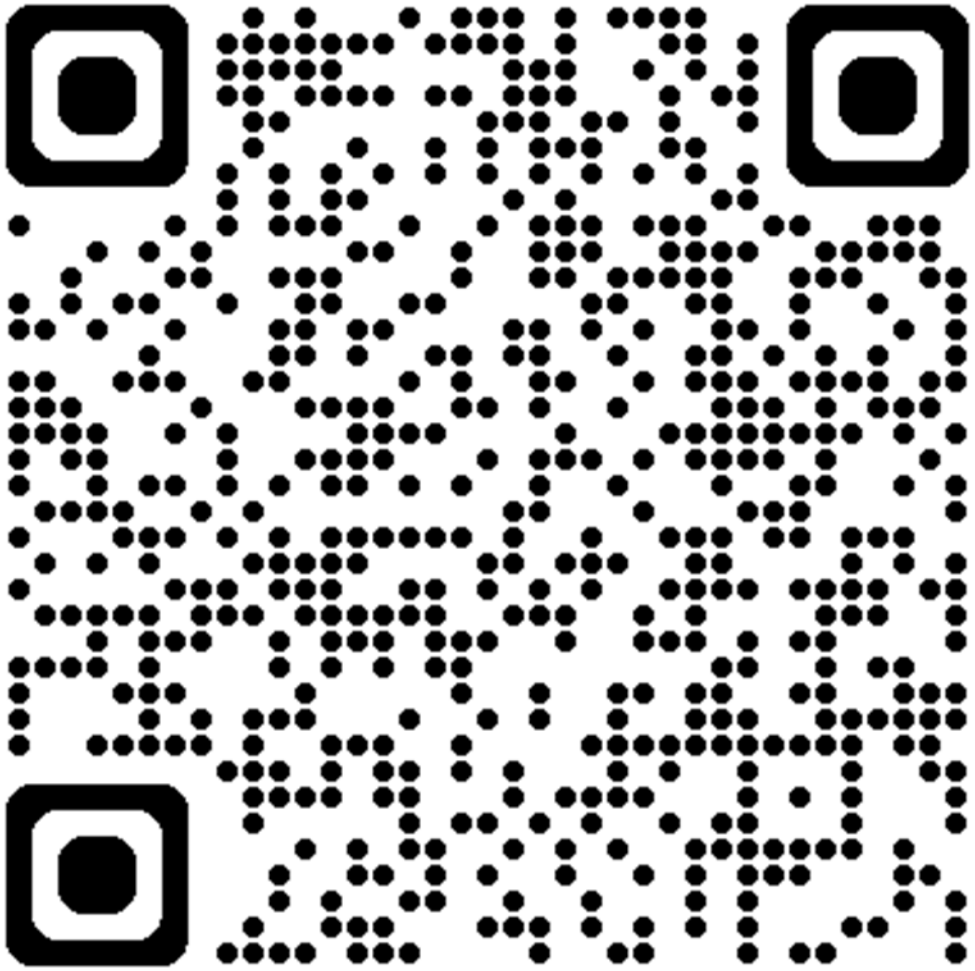
Scan here!



TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

https://public.govdelivery.com/accounts/TXTCEQ/subscriber/new

Contacts

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