

**Prepared by  
Geosyntec Consultants of Puerto Rico, P.C  
IEMES**



**2023 Puerto Rico Waste Characterization Study**



**Presented by  
Jill Gaffigan, Hanna Rodriguez, Aurimar Rodriguez  
Giorgio Castro, Bishow Shaha**

# 1. Introduction

## Purpose

The goal of the Study is to provide reliable and up-to-date data on solid waste quantities and characteristics currently being disposed of across municipalities in Puerto Rico. This data will be used to inform DNER's planning effort for developing Puerto Rico's 2024 Integrated Solid Waste Management Plan.

## Gate Surveys

Conducted at 23 operating landfills and 3 transfer stations to understand the origin of solid waste by municipality and to estimate by weight and/or volume the solid waste disposed of by each municipality and generator Sector

## Manual Sorting and Visual Surveys

Conducted at Humacao, Ponce, Mayagüez and Fajardo landfills to assess the nature of solid wastes disposed of by generator Sector.



## Solid Waste and Transfer Station Facilities

- |                |                     |
|----------------|---------------------|
| 1. Culebra     | 14. Peñuelas Valley |
| 2. Vieques     | 15. Juana Díaz      |
| 3. Fajardo     | 16. Ponce           |
| 4. Carolina    | 17. Salinas         |
| 5. San Juan TS | 18. Arroyo          |
| 6. Guaynabo TS | 19. Guayama         |
| 7. Toa Baja    | 20. Cayey           |
| 8. Vega Baja   | 21. Barranquitas    |
| 9. Arecibo     | 22. Hormigueros     |
| 10. Añasco     | 23. Jayuya          |
| 11. Mayagüez   | 24. Caguas TS       |
| 12. Lajas      | 25. Juncos          |
| 13. Yauco      | 26. Humacao         |

## Project Team

### DNER

Evelisse Colón Carrero  
Pedro Guevara  
Antonio Ríos Díaz  
María Victoria Rodríguez Muñoz

### Project Manager

Jillian-Marie Gaffigan

### Geosyntec Consultants

Youngmin Cho	Jeremy Morris	Majdi Othman
Sarah Gustitus-Graham	Sean O'Donnell	Giorgio Castro
Bill Gaffigan	Ivonne Badillo	Amy Padovani
Jaime Feliciano	Ryan Duckett	Berkley Myers
Rich Murray	Danny Espinoza	Marc Rogoff
Bishow Shaha		

### Special Thanks

Municipalities and Mayors Offices of Host Facilities  
Conwaste, EC Waste and Eco Park  
Kevin Kijanka, EPA  
Timothy Townsend, Subject Matter Expert  
Jaime J. Jaén, Project Manager for the 2003 Waste Characterization Study

### IEMES

Aurimar Rodríguez Morales  
Hanna K. Rodríguez Morales  
Fernando L. Rodríguez Ocasio  
Carmen M. Figueroa Santiago

### MSW Consultants

John Culbertson  
Alex Dávila  
Natalee Mannion  
Carl Muth

### Right Way Environmental

Alejandro Rodríguez  
Pedro Tejada  
Luis Ríos  
Pedro E. Tejada  
Francisco Centeno



Comunidad Mariposa  
Fecha: 20/03/2020  
Difundido por: 452333  
Almacén de basura: 452333  
Muestra: 577  
Grupos: 452333  
Mesa: 452333

**Humacao Landfill**

# 2. Work Plan and Schedule

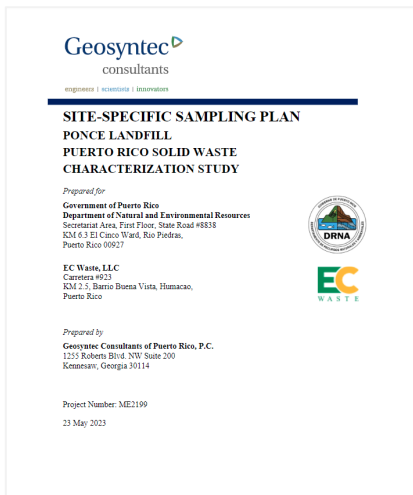
## Planning Documents

- Quality Assurance Project Plan (QAPP)
- 26 Site-Specific Health and Safety Plans (HASPS)
- Material Categories Memo
- 38 Certificates of Insurance (COI)
- 26 Site-Specific Sampling Plans

## Schedule

The field events took place between March 19 and June 21 of 2023:

- Four days of training events
- 30 weeks of Gate Surveys
- Four weeks of Waste Characterization
- Over 6,000 people hours of field work



Gate survey, manual sorting, and visual survey methodologies and procedures are detailed in site-specific sampling plans for each facility

Event Start Date	3/19/2023 (Monday)	Geosyntec Consultants	Display Week	1		
TASK	LEAD	MUNICIPALITY	ACTIVITY	START	END	DAYS
<b>Facility</b>						
Agua Dulce	EMES	Consuecos	Gate survey where scales are available	Mon 3/19/23	Sun 3/19/23	7
Agua Dulce	EMES	EC Waste	Gate survey where scales are available	Mon 3/19/23	Sun 3/19/23	7
Agua Dulce	EMES	Consuecos	Gate survey where scales are available	Mon 7/10/23	Sun 7/16/23	7
Agua Dulce	EMES	Consuecos	Gate survey where scales are available	Mon 4/03/23	Sun 4/09/23	7
Agua Dulce	EMES	Consuecos	Gate survey where scales are available	Mon 4/03/23	Sun 4/09/23	7
Agua Dulce	EMES	EC Waste	Gate survey where scales are available	Mon 4/24/23	Sun 4/30/23	7
Agua Dulce	EMES	EC Waste	Gate survey where scales are available	Mon 4/24/23	Sun 4/30/23	7
<b>San Juan</b>						
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 3/19/23	Sun 3/19/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 3/26/23	Sun 3/26/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 3/27/23	Sun 4/02/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 3/27/23	Sun 4/02/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/03/23	Sun 4/09/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/03/23	Sun 4/09/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/03/23	Sun 4/16/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/24/23	Sun 4/30/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/24/23	Sun 4/30/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 4/24/23	Sun 4/30/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 5/01/23	Sun 5/07/23	7
Arroyo	Right Way	Municipality	Gate survey with portable scales	Mon 5/01/23	Sun 5/07/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/01/23	Sun 5/07/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/08/23	Sun 5/14/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/08/23	Sun 5/14/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/08/23	Sun 5/14/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/15/23	Sun 5/21/23	7
Arroyo	Right Way	Municipality	Gate survey where scales are available	Mon 5/15/23	Sun 5/21/23	7
Arroyo	Right Way	EC Waste	Gate survey where scales are available	Mon 5/15/23	Sun 5/21/23	7
Arroyo	Right Way	EC Waste	Gate survey where scales are available	Mon 5/15/23	Sun 5/21/23	7
Arroyo	Right Way	EC Waste	Training Week for Manual Sorts	Mon 5/29/23	Sun 6/04/23	7
Arroyo	Right Way	EC Waste	Manual Sort and Gate Survey	Mon 6/05/23	Sun 6/11/23	7
Arroyo	Right Way	Consuecos	Manual Sort and Gate Survey	Mon 7/10/23	Sun 7/16/23	7
Arroyo	Right Way	Consuecos	Manual Sort and Gate Survey	Mon 7/10/23	Sun 7/16/23	7
Arroyo	Right Way	Consuecos	Gate survey	Mon 6/26/23	Sun 7/02/23	7

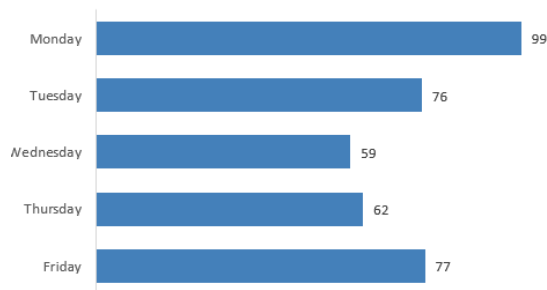
A scheduling plan was developed for approval by DNER and governed formal outreach to facility operators to obtain permission and support for conducting field events

# How field activities were scheduled

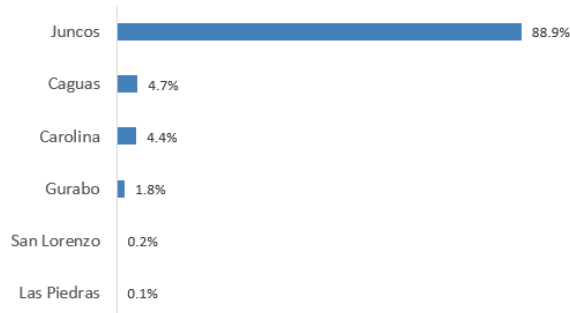
Gate surveys were scheduled first to understand tonnages and origin of waste at each landfill. Based on this information, DNER approved sites for manual sorting and visual surveys in order to maximize results and satisfy the requirements of the study.

## Juncos Landfill

Daily Waste Received (tons)



Origin (by % of waste)



## Procedure

1. Initial outreach to each landfill to establish points of contact and communication lines
2. Schedule and dates confirmed
3. Letters sent to Mayors and facility operators which included site-specific work plans, site-specific HASPS, and COI's.
4. 34 Field meetings conducted to agree on work areas, understand specific facility procedures, confirm operating hours and on-site contacts.

**Over 200 days of fieldwork were coordinated along with 15 days of field visits from DNER and EPA**

## Calendar of Field Events

Week	March
1st	Portable Scales and Tablet Training
13 <sup>th</sup>	Guaynabo TS, Barranquitas (Gate)
20 <sup>th</sup>	Caguas TS, Cayey (Gate)
27 <sup>th</sup>	Vieques, Culebra (Gate)

Week	April
3 <sup>rd</sup>	Fajardo, Mayagüez, Vieques, Culebra (Holy Week Gate)
10 <sup>th</sup>	Penuelas Valley, Guayama, Arroyo (Gate)
17 <sup>th</sup>	Hormigueros (Gate)
24 <sup>th</sup>	San Juan TS, Lajas (Gate)

Week	May
1 <sup>st</sup>	Jayuya, Fajardo (Gate)
8 <sup>th</sup>	Juncos, Vega Baja, Arecibo (Gate)
15 <sup>th</sup>	Yauco, Juana Díaz, Salinas (Gate)
22 <sup>nd</sup>	Añasco (Gate)
29 <sup>th</sup>	Humacao (Training week)

Week	June
5 <sup>th</sup>	Humacao (Manual, Visual, Gate)
12 <sup>th</sup>	Ponce (Manual, Visual, Gate)
26 <sup>th</sup>	Toa Baja (Gate)

Week	July
10 <sup>th</sup>	Carolina (Gate) Mayagüez (Manual, Visual, Gate)
17 <sup>th</sup>	Fajardo (Manual, Visual)



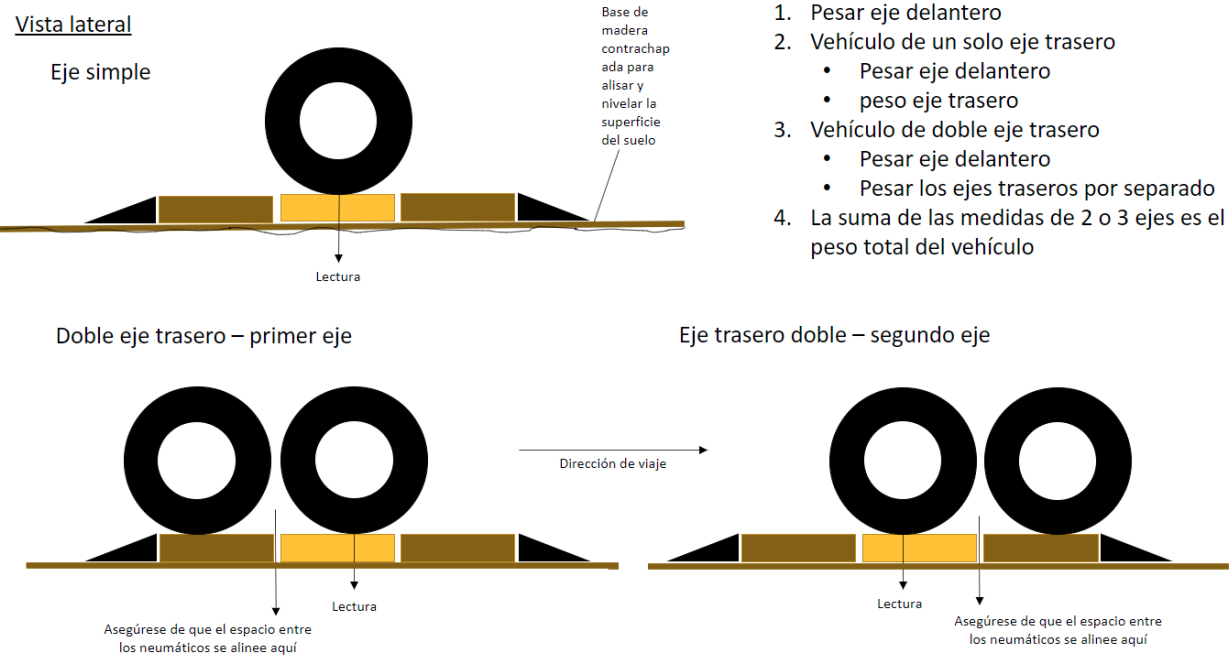


**Mayagüez Landfill**

# Portable Scales

Not all landfills in Puerto Rico have fixed scales to weigh vehicles. For these facilities portable scales were deployed. Geosyntec designed and engineered two sets of platforms to protect the scale pads from damage while also accommodating multi-axel vehicles, dually trucks and varying wheelbase distances. The portable scales were constructed and tested in Maryland and then shipped to Puerto Rico for certification and use in the field. **Over 2,200 vehicles were weighed with portable scales.**

FIGURA 9: PROCEDIMIENTO DE PESAJE



VEHICULO OFICIAL



Jayuya Landfill



**Vieques Landfill**

# Data Collection in the Field

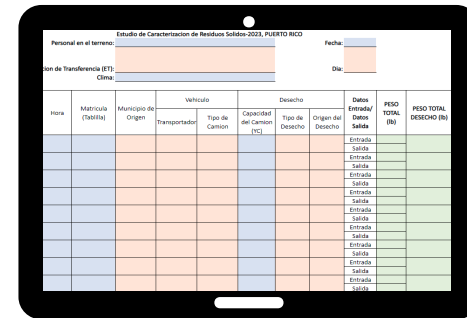
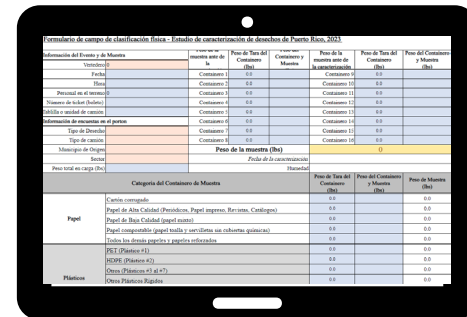
The Geosyntec field team collected data using cloud-linked forms on rugged tablet computers with shockproof and waterproof casings. The data was synced via cellular service with an enterprise data base which compiled and stored data, photos and notes.

## Field Forms

The forms contain built-in logic and error checking to prevent erroneous entries. Direct data entry avoids transcribing errors and makes tabulations in real time.

## Rugged Tablets

Rugged tablets were used to protect against weather, impact, and dusty conditions. The tablet allowed for data to be accessed and checked by project QA/QC staff while activities were ongoing.



Field forms were created in Spanish and English

# Training

Three separate training events took place. DNER hosted gate survey, tablet and portable scales classroom training and field training at their offices in San Juan on February 28, 2023. Right Way hosted classroom training for manual sorting and visual surveys at their office in Barranquitas on May 31, 2023. EC Waste hosted field training for manual and visual sorting at Humacao Landfill on June 1 and 2, 2023.

## Gate Survey, Tablet and Portable Scales Training

**Geosyntec**  
consultants

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**Puerto Rico 2023 Waste Characterization Study**  
**Training Log – Completing Gate Surveys and Operating Portable Scales**  
**DATE: March 1, 2023**


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**Training Description:** Overview of Gate Survey protocol, including driver interviews, data recording, truck identification, and waste identification. Overview of portable scale operation, including a field exercise in setting up and using portable scales.

**Attendees:**

Attendee Name	Title	Company Name
Fernando L. Rodriguez	Project Manager	IEMES
Hanna Rodriguez Morales	Project Supervisor	IEMES
Aurimar Rodriguez Morales	Technical Specialist	IEMES
Carmen M. Figueroa Santiago	Chemical Engineer	IEMES
Stephanie Hall Laureano	Chemical Engineer	IEMES
Kariannys Rodriguez	Engineer In Training	IEMES

I attest that the attendees listed above received the training described and are employees under my supervision.

  
Signature

March 1<sup>st</sup>, 2023  
Date

Fernando L. Rodriguez  
Name

Vice-President, IEMES, PSC  
Title, Company

## Manual Sorting and Visual Survey Training

### CARTÓN CORRUGADO (CORRUGATED CARDBOARD)



# Safety

Site specific HASPS were developed for each facility. Each field event featured a safety kick off meeting and daily safety briefings.

Over 175 safety briefings took place.



engineers | scientists | innovators

## HEALTH AND SAFETY PLAN

### - Lajas Landfill

FOR

### PUERTO RICO SOLID WASTE CHARACTERIZATION STUDY

Prepared for

Government of Puerto Rico  
Department of Natural and Environmental Resources  
Secretariat Area, First Floor, State Road #8838  
KM 6.3 El Cinco Ward, Rio Piedras,  
Puerto Rico 00927



Prepared by

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1255 Roberts Blvd. NW Suite 200  
Kennesaw, Georgia 30114

Project Number: ME2199

12 July 2022

## Background



The most common ways to get killed on a landfill

1. Run over or hit by a truck
2. Run over or hit by heavy equipment
3. Fatal fall
4. Asphyxiation
5. Explosion
6. Fire
7. Heat stroke
8. Boredom

Often a contributing factor

## Heat Related Illnesses



### Heat Cramps

- Primarily caused by loss of electrolytes
- Cramping may occur in arms, hands, legs or feet
- Stop all activity; sit in a cool shady place, drink water & avoid strenuous work for a while
- May be a symptom of heat exhaustion or heat stroke



### Heat Exhaustion- First Aid

- Profuse sweating, cool, pale, clammy skin, dizziness, rapid pulse
- Discontinue work; facilitate recovery
- Lie down in cool, dry place, with feet slightly elevate
- Apply cool, wet cloths or take cold shower/bath



### Heat Stroke

- No sweating, rapid, strong pulse, shallow breathing, fever >104F, unconsciousness, headache
- Heat stroke is life threatening with a high death rate- CALL 911 ASAP
- Pour water on affected person until help arrives & apply cold packs & remove unnecessary garments
- Move victim to air-conditioned environment



LOS  
FAVORES  
EMPIEZAN  
EN  
\$ 50

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**Vega Baja Landfill**



## 3. Gate Surveys

### Methodology

- Truck type,
- Body size or roll-off size on vehicle,
- What municipality the load originated from,
- Type of waste in load,
- Any unusual items in the load,
- Type of hauler,
- Truck number and/or ticket number,
- Generator sector,
- Note if it is a transfer trailer and, if so, the originating transfer station,
- Photo of vehicle,
- Gross weight of vehicle, and
- Empty weight of vehicle



**180**

Field Days



**26**

Facilities  
Surveyed



**11,300**

Drivers  
Interviewed

## 4. Manual Sorting

### Methodology

- Truck ID number,
- Generator Sector,
- Municipality of origin,
- Total load weight,
- Separate out 200-300 lb sample
- Sort into 28 categories
- Weigh out  $\pm 5$  lbs of original



**46,800** Pounds of waste sorted



**28** Material categories



**215** Loads sampled



**35** Municipalities of origin represented

## 5. Results Visual Surveys

### Methodology

- Truck ID number,
- Type of waste,
- Type of truck,
- Municipality of origin,
- Generator sector
- Total load weight,
- Volume of truck,
- Percent material by volume, and
- Volume to weight conversion



**788**

Tons of waste surveyed



**32**

Material categories



**263**

Loads sampled



**31**

Municipalities of origin represented



**Humacao Landfill**

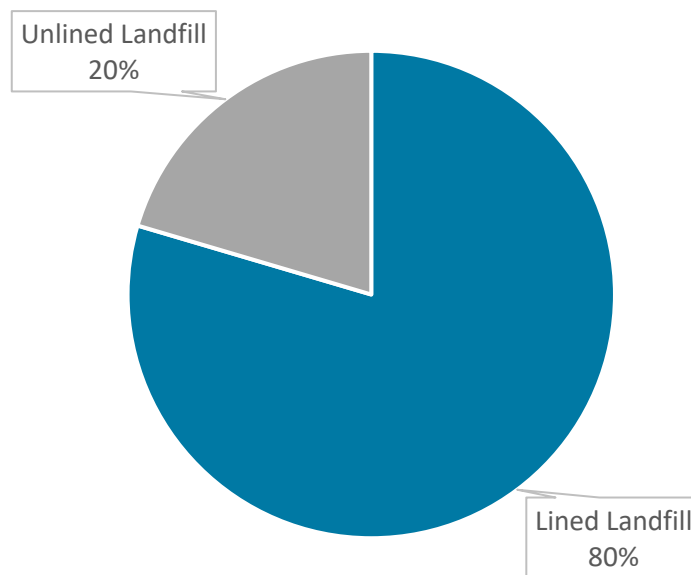
## 6. Summary Discussion

### 2003/2023 Comparison



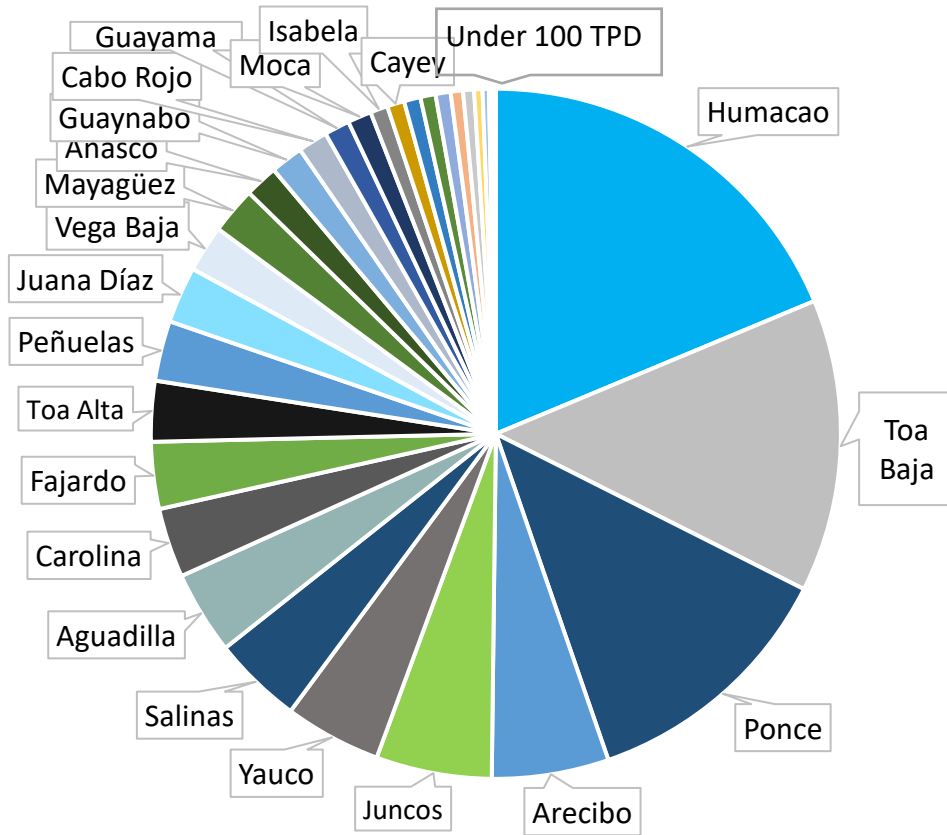
**Geosyntec estimates that waste going into lined landfills increased by 58% since 2003**

% of Waste going to Lined versus Unlined Landfill in 2023

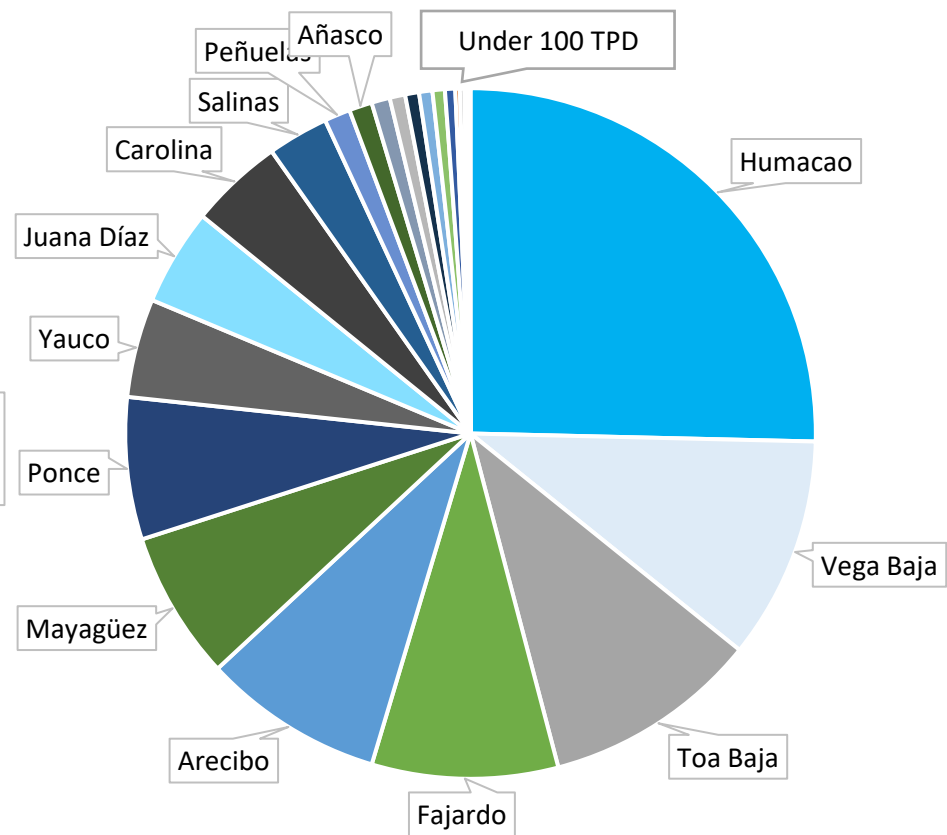


## 2003/2023 Landfill Tons Per Day

### 2003 Disposal (TPD)



### 2023 Disposal (TPD)



## 2003/2023 Comparison

90% of all tonnage is disposed of at landfills managed by ConWaste, EC Waste and Eco Park

Results		
	2003	2023
<b>Total Weekly Disposal (tons)</b>	69,211	55,064
<b>Estimated Annual Disposal (tons)</b>	3,598,972	2,863,331
<b>Estimated Daily Disposal (tons)</b>	9,860	7,845
<b>Estimated Daily Disposal (lbs)</b>	19,720,000	15,689,484
<b>Puerto Rico Population (2003 and 2022 Census)</b>	3,826,095	3,221,789
<b>Average Daily Discard Rate per Person (lbs)</b>	5.15	4.87



**Fajardo Landfill**



## Key Material Tonnages

The following tonnages of key materials are disposed of **weekly**:



**5,800** Tons of food waste



**1,600** Tons of PET and HDPE



**5,600** Tons of yard waste



**1,400** Tons of ferrous metals



**3,600** Tons of OCC



**550** Tons of aluminum

# GUAYNABO MRF



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