

# Waste Management Industry

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# Project Description

## Waste Management Database System(WMDS)

As the world becomes more data-driven so does the waste management industry. Efficient and accurate data handling is more necessary than ever to ensure optimal operations, environmental compliance, and sustainable growth. Currently, in the market, businesses are struggling with the challenges of disparate data sources, lack of real-time tracking, and inability to view data. This industry remains mostly in the dark in the US. Most Americans do not know what happens to our food waste, or plastic after it the garbage gets collected. With our Waste Management Database System(WMDS), we aim to address each of these issues for both businesses and individual households. WMDS wants users to have access to different waste data such as food, plastic, wrapping, boxes, and other common waste. The data will be collected using multiple different sources to get the most accurate results and have everything in one spot. There is a lot of data so the data will be narrowed down to the user's location and purpose. WMDS will also be integrated into Discord for a familiar and user-friendly interface. With the familiarity of the interface, users will have a quick and easy way of accessing the data wherever there is a connection to a network.

The database will efficiently collect, organize, store, and analyze the data from various waste management activities to provide users with the most accurate and up-to-date data possible at all times. WMDS wants users to have access to good information that could be used to enrich their lives at the tip of their fingers. The system will allow users to gain insightful knowledge and find patterns in the individual's and the communities' waste-handling processes. WMDS believes

that knowledge is crucial for any decision-making process and hopes to enhance the user's operational efficiency. We want to transform the way businesses and individuals handle waste but also give them insight that could enhance their operations.

Two software tools that could benefit from this database are Waste Logics and DesertMicro. Waste Logics is a waste management software that shoots to automate and optimize administrative processes in the waste management business. Waste Logic could use WMDS to enhance its data-handling capabilities and give personalized data to different entities. Not only that, Waste Logic will have waste information from multiple different sources all gathered in one spot for quick and easy access. DesertMicro or otherwise known as AMCS now since its acquisition in 2018. AMCS aims for sustainability in resource-intensive industries that would one day be economically viable in a net-zero carbon future. AMCS could utilize this database to gain information on different areas and pinpoint where the waste is coming from then find alternatives that can cut waste and potentially cut costs.

## Use Cases

### 1. **Use Case:** Food Waste - Spoiled food

**Actor:** Tom Chen, Restaurant Owner

**Description:** Tom is a small restaurant owner who prepares a variety of fresh food daily.

As his consumer fluctuates month-to-month, he faces challenges with food wastage due to items spoiling before having a chance at being sold. This loss significantly impacts his restaurant profits and contributes to unnecessary waste. With the Waste Management Database system, Tom can now keep better track of his waste and predict what to buy in the following months. WMDS provides Tom with detailed analytics based on past food waste data using previous data. This allows Tom to make more informed purchases for the restaurant. He can adjust his order based on the system's predictions. Reducing the likelihood of food spoilage. This in turn will help the restaurant with sustainability and business output.

### 2. **Use Case:** Waste Management - Packaging Materials

**Actor:** John Adams, Online E-commerce Business Owner

**Description:** John operates a global online E-commerce business, packing, and shipping products out to customers. Due to the variety of carriers that John uses and the need for his product safety during transit, he uses substantial amount of packing material. This creates significant waste output and cost. He will be able to use WMDS to find different information on the types of packaging he is using whether it be plastic or paper. John can use this information to find opportunities to cut down on packaging and any associated costs.

3. **Use Case:** Consumer Waste Management - Waste Reduction

**Actor:** Robert Smith, Father in a Family of 5

**Description:** Robert, a father in a family of 5, is struggling with the cost and environmental impact of the household's high waste output. The family produces high amounts of waste from food and packaging materials due to work, school, and recreational schedules. This in turn increases the monthly costs of garbage disposal for Robert. By using this database, Robert can find ways to mitigate the cost and environmental impact by their waste. He can log details of his family's waste including type, quantity, and disposal method into the system. The system will then provide analysis and patterns to help better manage their waste.

4. **Use Case:** Waste Management - Construction Waste Reduction

**Actor:** Lisa Green, Construction Site Manager

**Description:** Lisa wants to decrease the amount of waste generated at her construction sites to cut disposal costs and meet environmental regulations. The excess waste that her project produces not only has regulations but also generates inflated costs in disposal and material. She uses WMDS to track waste sources and find patterns to figure out different waste reduction strategies. She could also pull data from different construction sites to assist provide more information on construction waste and see how other sites are being managed. Additionally to the data access, she would be provided with analytic data to help plan and implement waste reduction strategies proactively. This would decrease waste as well as increase profits due to material costs.

5. **Use Case:** Waste Management - Event Waste Reduction

**Actor:** Amanda Hawkins, Event Planner

**Description:** Amanda hosts and plans many different events ranging from small office parties to large-scale weddings. While her business is very well received, she is concerned about the significant amount of waste produced by these events and wants to maximize profits. She wants to reduce waste and find areas where she can recycle material to create a more sustainable and eco-friendly experience. By utilizing WMDS, she can track waste generated by past events from food waste to packing and goods waste. She then can use this data to review her waste. She can find different areas where she can implement waste reduction strategies and where she can't.

## Functional Requirements

### 1. User

- 1.1. A user shall create only one account.
- 1.2. A user shall be able to access multiple devices.
- 1.3 A user shall be able to look up information on different wastes.
- 1.4 A user can access information from past waste data.
- 1.5 A user can access information across different industries' waste.
- 1.6 A user shall have default information based on location unless specified.
- 1.7 A user shall be able to generate and download reports based on available data.
- 1.8 A user shall be able to request patterns and program analysis.
- 1.9 User privacy settings shall allow users the option to have control over their data visibility and sharing.
- 1.10 A user search history shall be able to save specific searches for future reference.
- 1.13 User reports shall include all the data and dataset that have been accessed in that run.
- 1.14 A user activity log shall have data of all function calls and dataset access.

### 2. Account

- 2.1 Each user shall have only one account.
- 2.2 Each account will have access to the database.
- 2.3 Account creation shall require mandatory fields for user information.
- 2.4 Account profiles shall allow users to manage personal information.



### 3. Waste Transporter

3.1 The system should be able to uniquely identify each waste transporter with a unique ID.

3.2 The system should support the addition, viewing and updating of detailed information about each transporter.

3.3 The system should allow the association of waste transporters with specific waste collection.

3.4 The system should allow users to search for waste transporters based on various attributes.

### 4. Regulator Body

4.1 The system should uniquely identify each regulatory body with a unique ID

4.2 The system should support recording and updating detailed information about each regulatory body.

4.3 The system should support the creation, modification, and deletion of waste management regulations associated with each body.

4.4 The system should support the creation of reports based on the tracked regulatory and compliance data.

### 5. Waste Category

5.1 The system shall uniquely identify each waste category with a unique ID or code.

5.2 The system should allow the assignment of a clear and descriptive name for each category.

5.3 The system should allow the support of additional detailed descriptions for each category.

5.4 The system should support the categorization of waste into various levels.

5.5 The system should allow users to update the details of a category.

5.6 The system should allow users to delete a category given that it would not affect anything else.

5.7 The system should support the ability to search for a waste category.

5.8 The system shall allow the assignment of a specific waste item to a category.

## 6. Waste Item

6.1 The system shall uniquely identify each waste item with a unique ID or code.

6.2 The system should allow the addition of a detailed description for each waste item.

6.3 The system should allow for each waste item to be assigned to a category.

6.4 The system should allow users to enter new waste items into the database.

6.5 The system should allow users to delete waste items from the database.

6.6 The system shall track the quantity of each item.

6.7 The system should provide a way to search for a waste item based on an attribute.

6.9 The system shall record the disposal method for each item.

## 7. Waste Disposal Site

7.1 The system shall uniquely identify each waste disposal site with a unique ID or code.

7.2 The system should support the addition of detailed descriptions for each waste disposal site, including physical location, size, and any specific disposal capabilities or restrictions.

7.3 The system should monitor the capacity of each site, tracking the volume or weight of waste already present.

7.4 The system should allow for the association of waste items or categories with a specific waste disposal site.

7.5 The system should track the current status of each site, such as active, inactive, full, or closed.

7.6 The system should support searching for waste disposal sites based on various attributes.

## 8. Waste Generator

8.1 The system shall uniquely identify each waste generator with a unique ID or code.

8.2 The system should support recording and updating the public information for each waste generator, such as name, location, and contact details.

8.3 The system should allow for the association of waste items or categories generated by a specific waste generator.

8.4 The system should be capable of classifying waste generators based on certain criteria, such as industrial, commercial, residential, medical, etc.

8.5 The system should monitor and record the volume or weight of waste generated by each waste generator over specific periods.

8.6 The system should allow for the search of waste generators based on various attributes.

## 9. Waste Collection Schedule

9.1 The system should allow authorized users to create a new collection schedule, specifying the date and time of collection based on service providers.

- 9.2 The system should allow authorized users to modify an existing collection schedule.
- 9.3 The system should allow authorized users to delete a collection schedule.
- 9.4 The system should associate each collection schedule with a specific waste generator, and a specific waste type or category.
- 9.5 The system should provide a way for users to view the collection schedule.
- 9.6 The system should support notifications related to the collection schedule.
- 9.7 The system should allow users to search the collection schedules based on various attributes

## 10. Waste Management Service Providers

- 10.1 The system shall uniquely identify each waste management service provider with a unique ID or code.
- 10.2 The system should allow the recording, viewing, and updating of detailed information about each service provider.
- 10.3 The system should allow the listing and categorization of services provided by each waste management service provider.
- 10.4 The system should be capable of linking waste generators with service providers based on service needs and provider capabilities.
- 10.5 The system should allow for users to view the rating of service providers.
- 10.6 The system should allow users to search for service providers based on user's criteria.
- 10.7 The system should record details of contracts between waste generators and service providers.

## 11. Waste Recycling Centers

11.1 The system shall uniquely identify each waste recycling center with a unique ID or code.

11.2 The system should support the addition, viewing, and updating of detailed information about each recycling center.

11.3 The system should allow the listing and updating of the types of waste materials accepted at each recycling center.

11.4 The system should track the processing capacity of each recycling center.

11.5 The system should allow for the association of waste items or categories with specific recycling centers based on the types of materials they accept.

11.6 The system should allow users to search for recycling centers based on various attributes.

## 12. Waste Treatment Facility

12.1 The system should uniquely identify each waste treatment facility with a unique ID or code.

12.2 The system should support recording and updating detailed information for each waste treatment facility.

12.3 The system should allow the listing and updating of the types of waste that each facility is equipped to treat.

12.4 The system should allow for the association of specific waste items or categories with a treatment facility based on the types of waste it can treat.

12.5 The system should allow users to search for treatment facilities based on various attributes.

## 13. Waste Regulations

13.1 The system should uniquely identify each waste regulation with a unique ID or code.

13.2 The system should support the recording and updating of detailed information about each waste regulation.

13.3 The system should allow the association of specific waste categories or items with particular regulations.

13.4 The system should support tracking compliance with each regulation.

13.5 The system should allow users to search for regulations based on various attributes.

13.6 The system should support updating regulation information as changes are made, and notifying relevant parties of these changes.

#### 14. Waste Management Reports

14.1 The system should allow authorized users to create a new report, selecting the desired data fields, time period, and format.

14.2 The system should integrate data from various parts of the waste management system.

14.3 The system should provide standard templates for commonly used reports.

14.5 The system should allow users to view reports.

14.6 The system should allow users to export reports in various formats.

#### 15. Waste Tracking

15.1 The system should be able to uniquely identify each piece or batch of waste or item.

15.2 The system should allow users to record key characteristics and quantity of each piece or batch of waste.

15.3 The system should maintain a history of each piece or batch of waste.

15.4 The system should support the creation of reports based on the tracked waste data.

## 16. Waste Log

16.1 The system should allow authorized users to view and save logs.

16.2 The system should automatically incorporate data from various parts of the waste management system.

16.3 The report should include detailed information about each disposal event, such as date, and waste type.

16.4 The system should allow users to export the report in various formats.

## 17. Environmental Impact Data

18.1 The system shall uniquely identify each environmental impact with a unique ID or code.

18.2 The system should allow the assignment of a clear and descriptive name for each category.

18.3 The system should allow the support of additional detailed descriptions for each impact.

18.5 The system should allow users to update the details of an impact.

18.6 The system should allow users to delete an impact given that it would not affect anything else.

## 18. Records

19.1 The system should record data between the service provider and waste generators.

19.2 The system shall uniquely identify each relationship between providers and generators with a unique ID or code.

## 19. Treatment Technology

20.1 Treatment Technology should be uniquely identifiable via a unique ID or code.

20.2 The system should allow the recording, updating, and viewing of detailed information about each Treatment Technology.

20.3 The system should allow the linking of specific Treatment Technology to the relevant waste items or categories they can treat.

22.4 The system should allow users to search for treatment technology based on various attributes.

## 20. Treatment Process

21.1 Treatment Process should be uniquely identifiable via a unique ID or code.

21.2 Treatment Process should be uniquely identifiable via a unique ID or code.

The system should allow the recording, updating, and viewing of detailed information about each Treatment Process.

21.3 The system should allow the linking of specific Treatment Processes to the relevant waste items or categories they can treat, and the Treatment Technology used.

## 21. Sustainability Initiatives

22.1 The system should be able to uniquely identify each sustainability initiative with a unique ID or code.

22.2 The system should support the addition, viewing, and updating of detailed information about each sustainability initiative.

22.3 The system should record the specific goals or targets of each initiative.



22.4 The system should allow users to search for sustainability initiatives based on various attributes.

## 22. Educational Programs

23.1 The system should be able to uniquely identify each educational program with a unique ID or code.

23.2 The system should support the addition, viewing, and updating of detailed information about each educational program.

23.3 The system should record the specific goals or targets of each program.

23.4 The system should allow users to search for programs based on various attributes.

## 23. Inventory

24.1 The system shall allow users to see the inventory of waste generators and service providers.

24.2 The items in the inventory should allow users to track through waste track.

## 24. Vehicle Fleet

25.1 The system should be able to uniquely identify each type of vehicle with a unique ID or code.

25.2 The system should support the addition, viewing, and updating of detailed information about each vehicle.

25.3 The system should record the specific goals or targets of each vehicle.

25.4 The system should allow users to search for vehicle based on various attributes.

## 25. Health and Safety Records

26.1 The system should be able to uniquely identify each record with a unique ID or code.

26.2 The system should support the addition, viewing, and updating of detailed information about each record.

26.3 The system should record the specific goals or targets of each record.

26.4 The system should allow users to search for records based on various attributes.

## 26. Read Access

27.1 The system shall only allow users to read the data.

27.2 The system should prevent users from modifying the existing data.

## 27. Full Access

28.1 The system shall allow users full access to the data including reading and modifying.

28.2 The system shall return the modified data to the user who initiated the modifications.

## Non-functional

### 1. Performance

1.1 The database system shall provide high availability, minimizing downtime and ensuring accessibility to users.

1.2 The database system shall support a high volume of concurrent transactions or requests.

1.3 The database system shall provide fast response times for user interactions.

### 2. Storage

2.1 The database system shall support a large storage capacity.

2.2 The database system shall ensure data durability and persistence.

2.3 The database system shall provide mechanisms for data archiving.

2.4 The database system should support data partitioning strategies.

### 3. Security

3.1 The database system shall enforce an access control mechanism.

3.2 The database system shall support data encryption.

3.3 The database system shall implement measures to maintain data integrity.

### 4. Recovery/Backup

4.1 The database system should support mechanisms for data backup and recovery to prevent data loss in case of system failures.

### 5. Scalability

5.1 The database system should support horizontal scaling to handle increased data volume and user load.

5.2 The database system shall provide mechanisms for adding additional servers.

## 6. Reliability

6.1 The database system shall have a high availability architecture to minimize downtime and ensure continuous access to data.

6.2 The database system should support data replication.

6.3 The data collected from users shall be verified before updating to main dataset.

## 7. Data Integrity

7.1 The database system shall enforce referential integrity constraints to maintain data consistency and accuracy.

## 8. Accessibility

8.1 The database system should provide remote access capabilities, allowing users to access and interact with the database from different locations.

8.2 The database system shall support multi-user access, enabling concurrent access to the database by multiple users or applications.

## 9. Usability

9.1 The database system should have a user-friendly interface and intuitive query language to facilitate ease of use and efficient data retrieval.

9.2 The database system shall provide comprehensive documentation and user guides to assist users in understanding its functionalities and capabilities.

## 10. Maintainability

10.1 The database system should support database schema changes and version upgrades without disrupting data availability.

10.2 The database system shall provide tools and utilities for database administration, monitoring, and performance tuning.

## 11. Data Synchronization

11.1 Data synchronization should be enabled among all datasets to ensure consistency.

11.2 Data synchronization shall support both real-time and scheduled synchronization.

11.3 Data synchronization shall support incremental updates.

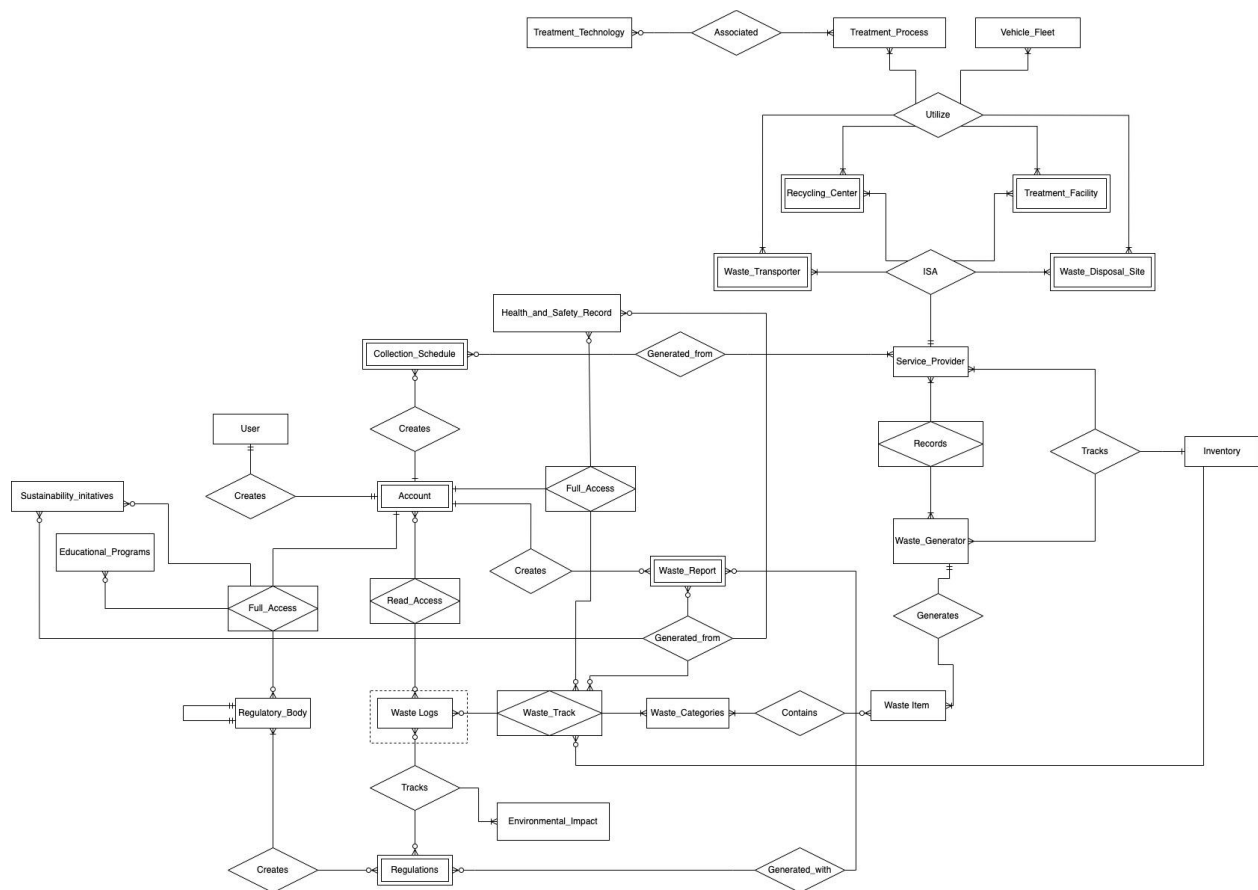
## 12. Data Cleaning

12.1 The system shall offer features to clean and improve data quality.

12.2 Data cleaning shall be a feature to allow users to clean data manually.

12.3 Data cleaning shall provide a log, data quality report and monitoring.

Entity Relationship Diagram(ERD)



## Entity Description

### 1. User (Strong)

- email: multivalued, alphanumeric
- location: multivalued, alphanumeric
- name: composite, alphabetic
- User\_id: key, alphanumeric

### 2. Account (Weak)

- account\_id: key, alphanumeric
- user\_id: key, alphanumeric
- user\_name: key, alphabetic

### 3. Collection Schedule (Weak)

- schedule\_id: key, numeric
- account\_id: key, alphanumeric
- title: composite, alphanumeric
- description: alphanumeric

### 4. Service Provider (Strong)

- service\_id: key, numeric
- service\_type: key, alphabetic
- description: alphanumeric

5. Recycling Center (Weak)

- center\_id: key, numeric
- name: key, alphanumeric
- center\_information: alphanumeric
- location: alphanumeric

6. Waste\_Transporter (Weak)

- transporter\_id: key, numeric
- name: key, alphanumeric
- transporter\_information: alphanumeric

7. Treatment Facility (Weak)

- facility\_id: key, numeric
- facility\_name: key, alphanumeric
- facility\_information: alphanumeric

8. Waste Disposal Site (Weak)

- site\_id: key, numeric
- site\_name: key, alphanumeric
- site\_information: alphanumeric
- capacity: alphanumeric

9. Waste Generator (Strong)

- generator\_id: key, numeric
- generator\_type: alphabetic
- location: alphanumeric

10. Waste Item (Strong)



- item\_id: key, numeric
- name: alphabetic
- item\_description: alphabetic
- item\_quantity: numeric

#### 11. Waste Category (Strong)

- category\_id: key, numeric
- category\_name: multivalue, alphabetic
- category\_description: alphabetic
- item\_name: composite, alphanumeric

#### 12. Waste Report (Weak)

- report\_id: key, numeric
- title: composite, alphanumeric
- description: alphanumeric
- user\_id: key, numeric user\_ID

#### 13. Waste Track (Weak)

- item\_name: alphabetic
- generator\_id: key, numeric
- Track\_id: key
- Log\_id: key, numeric

#### 14. Waste Logs (Strong)

- log\_id: key, alphanumeric
- description: alphanumeric
- timestamp: numeric

#### 15. Regulations (Weak)

- regulation\_id: key, numeric
- title: alphanumeric
- description: alphanumeric

#### 16. Regulatory Body (Strong)

- body\_id: key, numeric
- name: alphanumeric
- website: alphanumeric
- parent\_body\_id: foreign key(reference body\_id), numeric

#### 17. Treatment Technology (Strong)

- tech\_id: key, numeric
- name: alphanumeric
- manufacturer: alphanumeric

#### 18. Treatment Process (Strong)

- process\_id: key, numeric
- name: alphanumeric
- description: alphanumeric

#### 19. Vehicle Fleet (Strong)

- vehicle\_id: key, numeric
- vehicle\_type: alphanumeric
- capacity: numeric

#### 20. Inventory (Strong)

- inventory\_id: key, numeric
- inventory\_use\_type: alphabetic
- quantity: numeric

#### 21. Sustainability Initiatives (Strong)

- initiative\_id: key, numeric
- initiative\_Name: alphanumeric
- initiative\_description: alphanumeric

#### 22. Educational Programs (Strong)

- program\_id: key, numeric
- program\_Name: alphanumeric
- program\_Description: alphanumeric

#### 23. Full Access (Weak)

- user\_id: key, numeric
- access\_granted\_date: date
- accessed\_entity: alphanumeric
- access\_ID: key, numeric

#### 24. Read Access (Weak)

- user\_id: key, numeric
- access\_granted\_Date: Date
- read\_id: key, numeric

#### 25. Healthy and Safety Record (Strong)

- HSrecord\_id: key, numeric

- violation\_type: alphanumeric
- resolution\_status: alphanumeric

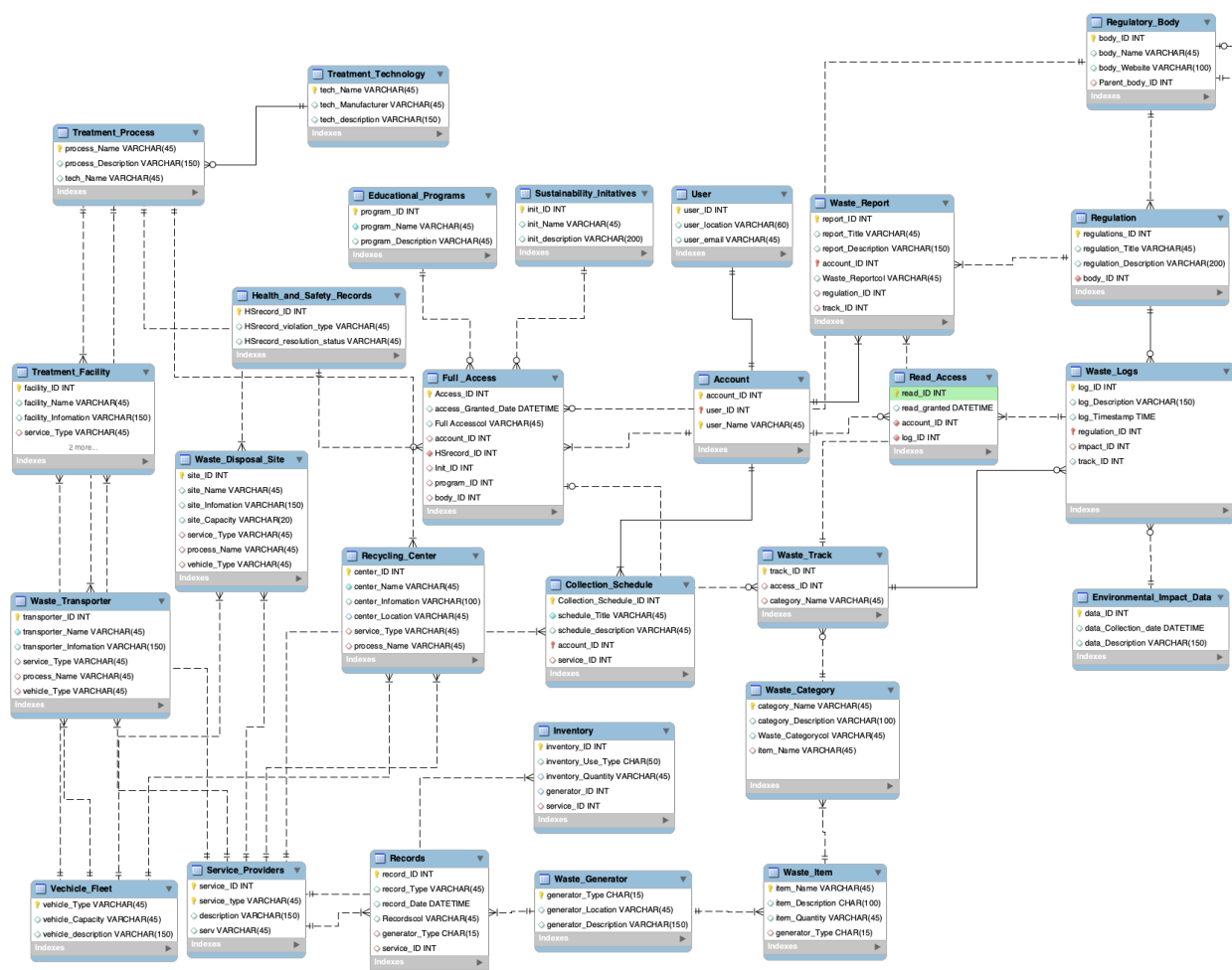
#### 26. Environmental Impact Data (Strong)

- data\_id: key, numeric
- data\_collection\_date: date
- data\_description: alphanumeric

#### 27. Records (Weak)

- record\_id: key, numeric
- record\_type: alphanumeric
- record\_date: date

### Enhanced Entity Relationship



### Constraints Description

Table	FK	On Delete	On Update	Comment
Account	user_ID	ON CASCADE	ON CASCADE	If a user ID changes, it will change within the account as well.
Collection Schedule	account_ID service_ID	ON CASCADE	ON CASCADE	If the account or service associated with the schedule is updated then the schedule will also be updated.
Full Access	account_ID HS_record_ID init_ID program_ID body_ID	ON CASCADE	ON CASCADE	If any of the IDs associated with the permission entity Full Access is deleted, then the user shall lose access to that resource.
Inventory	service_ID	NO ACTION	NO ACTION	If the service provider's ID gets updated then the data shall update within inventory as well.
Read Access	account_ID log_ID	ON CASCADE	ON CASCADE	The permission entity read access shall update on the deletion of the account_ID or log_ID.
Records	service_ID generator_ID	NO ACTION	NO ACTION	Records between service providers and waste generators shall remain regardless of their update.
Recycling Center	service_Type process_Name vehicle_Type	ON CASCADE	ON CASCADE	Recycling centers' information shall be updated upon the changes of any service, process, or vehicle.
Regulations	body_ID	NO ACTION	NO ACTION	The information of the regulation is set once it is made and no changes can happen.
Regulatory Body	Parent_body_ID	NO ACTION	NO ACTION	If the parent regulatory body were to get deleted, it would not change within regulatory body.

Treatment Facility	service_Type process_Name vehicle_Type	ON CASCADE	ON CASCADE	If any service, process or vehicle gets updated then it will update treatment facility information.
Treatment Process	tech_Name	ON CASCADE	ON CASCADE	If the technology used within the process gets changed, treatment process will update to the new technology or nothing at all.
Waste Category	item_Name	ON CASCADE	ON CASCADE	If the item were to change then the change will be replicated in waste category.
Waste Disposal Site	service_Type process_Name Vehicle_Type	ON CASCADE	ON CASCADE	If there is any change in service, process or vehicle then the change will be replicated in waste disposal site data.
Waste Item	Generator_Type	NO ACTION	ON CASCADE	Regardless of deletion in generator, the waste has already been set but will update upon new data.
Waste Log	regulation_Id impact_ID track_ID	ON CASCADE	ON CASCADE	The waste log keeps track of all current data within waste track, impact, and regulation and will update accordingly.
Waste Report	account_ID regulation_ID track_ID	ON CASCADE	ON CASCADE	Upon any changes within regulation, account and waste track, waste report will update accordingly.
Waste Track	access_ID Category_Name	ON CASCADE	ON CASCADE	If access or category were to be changed the update would follow through to waste track.