

**University of British Columbia, Vancouver**  
Department of Computer Science

# **CPSC 304 Project Cover Page**

Milestone #: 4

Date: November 28, 2025

Group Number: 68

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By typing our names and student numbers in the above table, we certify that the work in the attached assignment was performed solely by those whose names and student IDs are included above. (In the case of Project Milestone 0, the main purpose of this page is for you to let us know your e-mail address, and then let us assign you to a TA for your project supervisor.)

In addition, we indicate that we are fully aware of the rules and consequences of plagiarism, as set forth by the Department of Computer Science and the University of British Columbia

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Repository Link : [https://github.students.cs.ubc.ca/CPSC304-2025W-T1/team\\_68.git](https://github.students.cs.ubc.ca/CPSC304-2025W-T1/team_68.git)

SQL Initialization Script:

[https://github.students.cs.ubc.ca/CPSC304-2025W-T1/team\\_68/blob/main/database\\_initialization.sql](https://github.students.cs.ubc.ca/CPSC304-2025W-T1/team_68/blob/main/database_initialization.sql) (database\_initialization.sql in root of team\_68 folder)

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### **10 Queries:**

#### **1. Insert - appService.js (line 127)**

```
INSERT INTO GARDEN (garden_id, name, postal_code, street_name, house_number, owner_id)
VALUES (:garden_id, :name, :postal_code, :street_name, :house_number, :owner_id)
```

This query inserts a set of attributes into the Garden table. It ensures that the owner\_id and postal\_code already exist (references the Person table and Postal Code table respectively). If the attributes referencing the Location table (postal\_code, street\_name, house\_number) do not exist, these attributes are also inserted together into the Location table before the Garden insert.

#### **2. Update - appService.js (line 232)**

```
UPDATE PLANT SET is_ready = :0, section_id = :1 WHERE plant_id = :2
[ 1, 3, '3' ]
```

\*Note query above contains example input from the user

This query allows the user to update any of the non-primary key attributes in the Plant table.

#### **3. Delete - appService.js (line 504)**

```
DELETE FROM TOOLTYPE WHERE name = :toolTypeName
(toolTypeName is set via dropdown menu)
```

This query allows the user to select a tool type and delete it from the database (removes from relations Tool type and Tool).

#### **4. Selection - appService.js (line 200)**

```
SELECT * FROM PLANT WHERE plant_id = :0 AND LOWER(type_name) = :1 OR is_ready = :2
[ '2', 'tomato', '0' ]
```

\*Note query above contains example input from the user

This query allows the user to specify any number of attributes and logic (AND/OR) to retrieve from the Plant table. It returns a copy of the Plant table with the chosen characteristics. Conditions are based on equality.

#### **5. Projection - appService.js (line 329)**

```
SELECT ${columnList} FROM GARDEN ORDER BY garden_id
```

\*Note the columnList is selected by the user

This query allows the user to choose any number of attributes to view from the Garden table relation.

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### **6. Join - appService.js (line 465)**

```
SELECT p.plant_id, p.latitude, p.longitude, p.radius, p.is_ready, p.section_id, pt.name as type_name, pt.requirements, pt.description
FROM Plant p
JOIN PlantType pt ON p.type_name = pt.name
WHERE pt.name = :plantTypeName
ORDER BY p.plant_id`
```

This query allows the user to join relations PlantType and Plant on a plant type selected by the user.

### **7. Aggregation with GROUP BY - appService.js (line 354)**

```
SELECT type_name, count(*) as plant_count
FROM PLANT
GROUP BY type_name
ORDER BY type_name
```

This query groups all plants from all gardens by their plant type and counts how many plants belong to each type. It returns one row per plant type, in alphabetical order.

### **8. Aggregation with HAVING - appService.js (line 438)**

```
SELECT s.section_id, s.garden_id, g.name as garden_name, SUM(w.volume_litres) as total_water
FROM Section s
JOIN Garden g ON s.garden_id = g.garden_id
JOIN Water w ON s.section_id = w.section_id
GROUP BY s.section_id, s.garden_id, g.name
HAVING SUM(w.volume_litres) > 50
ORDER BY total_water DESC`
```

This query joins the Section, Garden, and Water tables to calculate the total amount of water used each by each section. It returns the sections whose total usage of water is greater than 50 litres, sorted from highest to lowest water consumption.

### **9. Nested Aggregation with GROUP BY - appService.js (line 404)**

```
SELECT s.section_id, s.garden_id, g.name as garden_name, COUNT(DISTINCT p.type_name) as diversity
FROM Section s
JOIN Garden g ON s.garden_id = g.garden_id
JOIN Plant p ON s.section_id = p.section_id
GROUP BY s.section_id, s.garden_id, g.name
HAVING COUNT(DISTINCT p.type_name) > (SELECT AVG(diversity_count)
```

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```
FROM (SELECT COUNT(DISTINCT p2.type_name) as diversity_count
      FROM Plant p2
     GROUP BY p2.section_id)
)
ORDER BY diversity DESC, s.section_id
```

This query finds all sections whose plant-type diversity is higher than average across all sections. It counts the distinct plant types per section and returns only sections (and their garden name and id) whose diversity is above the average.

### **10. Division - appService.js (line 372)**

```
SELECT s.section_id, s.garden_id, g.name as garden_name
  FROM Section s
 JOIN Garden g ON s.garden_id = g.garden_id
 WHERE NOT EXISTS (SELECT pt.name
                      FROM PlantType pt
                     WHERE NOT EXISTS (SELECT p.plant_id
                                         FROM Plant p
                                         WHERE p.section_id = s.section_id
                                           AND p.type_name = pt.name)
                    )
 ORDER BY s.section_id
```

This query finds all sections which contain every plant type in the database. It returns the section along with its garden name and id only if there is no plant type missing from the section.

#### **Description and Schema:**

Our project is a smart-garden monitoring system that allows for a garden to be broken up into sections, each of which may be allocated resources, plants, and tools as required. Each section has a monitoring system which tracks various environmental endpoints and resource usage, as well as maintains a maintenance log. Every garden has an owner and others may be granted access to it.

This is represented in a web application built on top of an Oracle database schema that allows users to interact with several connected tables that represent real smart-gardening information. Users can view all the tables and run meaningful queries that show details like gardens with high water consumption, find gardens with higher plant-type diversity, and more. Users can also interact with the database interface to insert into the garden table, update the plant table, and delete from the tools table.

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**Summary of Changes from Previous Schema:**

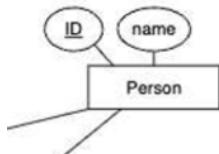
- 1) Our original location table (country, city, postal\_code, street\_address) was broken into 2 separate tables: Location which contains postal\_code, house\_number, street\_name and PostalCode which contains postal\_code, province, and city. This change was made to ensure our relations were all in BCNF.
- 2) Our original sections table(id, latitude, longitude, length, width) was broken into 2 separate tables: SectionDimensions (length, width, area) and Sections (section\_id, garden\_id, latitude, longitude, length, width). This change was made to ensure our relations were all in BCNF.
- 3) Garden table: The Garden table now contains a location foreign key (postal\_code, house\_number, street\_name) (it also includes a mandatory owner\_id foreign key to Person). This ensures that every garden has both a valid location and an owner, preventing any orphaned gardens from existing in our database.
- 4) Tool table: The Tool table now includes type\_name as a foreign key to our separate ToolType table (which stores name and function), instead of having tool type information directly as attributes. This was a normalization done in a previous milestone so that we don't duplicate tool information in our database.
- 5) Section table: The Section table now stores length and width as attributes, but these are also foreign keys to the SectionDimensions (see number 2 on this list for that change) table (which stores the area for each length and width combination). This ensures our dimensions are valid and our relations are all in BCNF.
- 6) Plant table: a column for plant\_type has been added to be a foreign constraint to the plant\_type table. This ensures every plant has a type with their description stored in the planttype table. This reduces any duplication of information in our database.
- 7) Maintenance Log table: this was previously a weak entity with only timestamp and entry as attributes. In our implementation, it is not a weak entity, (maintenance\_log\_id as primary key) making it a strong entity instead, containing section\_id as a foreign key to connect each log to a garden section.

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A copy of the original schema and screenshots that show what data is present in each relation after the SQL initialization script is run:

### 1. Person: Person(ID, name)

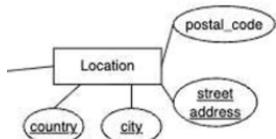


**Person**

| Person ID | Name             |
|-----------|------------------|
| 1         | Sarah Johnson    |
| 2         | Michael Chen     |
| 3         | Emily Rodriguez  |
| 4         | David Thompson   |
| 5         | Jessica Williams |
| 6         | Robert Martinez  |
| 7         | Amanda Lee       |

### 2. PostalCode: PostalCode(postal\_code, province, city)

Note the table was modified from the original schema (see above for explanation - change 1).



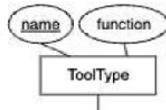
**PostalCode**

| Postal Code | Province         | City            |
|-------------|------------------|-----------------|
| V6T1Z4      | British Columbia | Vancouver       |
| V5K0A1      | British Columbia | Vancouver       |
| V7M2E3      | British Columbia | North Vancouver |
| V3H4K6      | British Columbia | Burnaby         |
| V6B1A1      | British Columbia | Vancouver       |
| V4N3M2      | British Columbia | Richmond        |

### 3. ToolType: ToolType(name, function)

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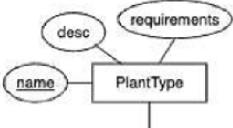
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**ToolType**

| Name           | Function                          |
|----------------|-----------------------------------|
| Shovel         | Digging into soil                 |
| Rake           | Gathering leaves or leveling soil |
| Pruning Shears | Trimming and shaping plants       |
| Watering Can   | Manual watering of plants         |
| Hoe            | Breaking up soil                  |
| Trowel         | Small-scale digging and planting  |
| Garden Fork    | Turning and aerating compost      |

### 4. PlantType: PlantType(name, requirements, description)

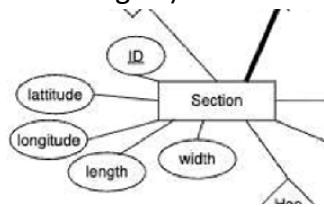


**PlantType**

| Name        | Requirements                                   | Descriptions   |
|-------------|--|--|
| Tomato      | Full sun, regular watering, pH 6.0-6.8         | make into sauces for pasta                                     |
| Lettuce     | Partial shade, consistent moisture, pH 6.0-7.0 | used for salads  |
| Carrot      | Full sun, loose soil, pH 6.0-6.8               | root vegetable good for soups                                  |
| Basil       | Full sun, warm temperatures, pH 6.0-7.0        | herb plant   |
| Cucumber    | Full sun, consistent watering, pH 6.0-7.0      | great veggie to dip in hummus                                  |
| Bell Pepper | Full sun, warm soil, pH 6.0-6.8                | not very spicy pepper, comes in red, green, orange, and yellow |
| Strawberry  | Full sun, well-drained soil, pH 5.5-6.5        | yummy berry good in cakes                                      |

### 5. SectionDimensions: SectionDimensions(length, width, area)

Note the table was modified from the original schema (see above for explanation - change 2).



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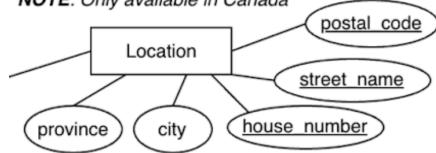
### SectionDimensions

| Length | Width  | Area    |
|--------|--------|---------|
| 10.500 | 9.300  | 97.650  |
| 5.500  | 12.920 | 71.060  |
| 7.300  | 8.120  | 59.276  |
| 10.900 | 11.400 | 124.260 |
| 12.500 | 11.700 | 146.250 |

### 6. Location: Location (postal\_code, house\_number, street\_name)

Note the table was modified from the original schema (see above for explanation - change 1).

**NOTE:** Only available in Canada

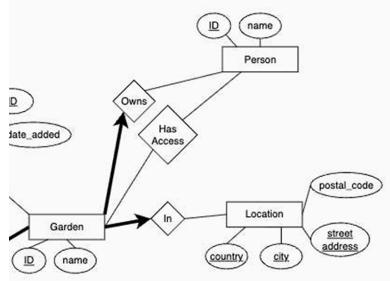


### Location

| Postal Code | House Number | Street Name      |
|-------------|--------------|------------------|
| V3H4K6      | 8900         | Eastlake Drive   |
| V4N3M2      | 7890         | Garden City Road |
| V5K0A1      | 1234         | Commercial Drive |
| V6B1A1      | 456          | Granville Street |
| V6T1Z4      | 2329         | West Mall        |
| V7M2E3      | 567          | Lonsdale Avenue  |

### 7. Garden: Garden(garden\_id, name, postal\_code, street\_name, house\_number, owner\_id)

Note the table was modified from the original schema (see above for explanation - change 3).



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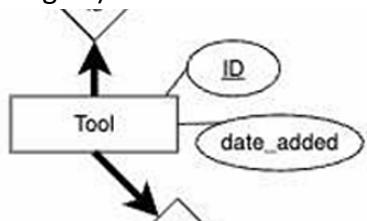
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### Garden

| Garden ID | Name                     | Postal Code | Street Name      | House Number | Owner ID |
|-----------|--------------------------|-------------|------------------|--------------|----------|
| 1         | UBC Community Garden     | V6T1Z4      | West Mall        | 2329         | 1        |
| 2         | Sunrise Urban Farm       | V5K0A1      | Commercial Drive | 1234         | 2        |
| 3         | North Shore Garden Haven | V7M2E3      | Lonsdale Avenue  | 567          | 3        |
| 4         | Burnaby Heights Garden   | V3H4K6      | Eastlake Drive   | 8900         | 4        |
| 5         | Downtown Rooftop Garden  | V6B1A1      | Granville Street | 456          | 5        |
| 6         | Richmond Family Garden   | V4N3M2      | Garden City Road | 7890         | 6        |

### 8. Tool: Tool(tool\_id, date\_added, garden\_id, type\_name)

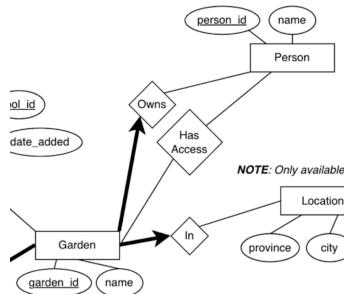
Note the table was modified from the original schema (see above for explanation - change 4).



### Tool

| Tool ID | Date Added               | Garden ID | Type Name      |
|---------|--------------------------|-----------|----------------|
| 1       | 2024-03-15T07:00:00.000Z | 1         | Shovel         |
| 2       | 2024-03-15T07:00:00.000Z | 1         | Rake           |
| 3       | 2024-04-01T07:00:00.000Z | 1         | Watering Can   |
| 4       | 2024-02-10T08:00:00.000Z | 2         | Pruning Shears |
| 5       | 2024-03-20T07:00:00.000Z | 2         | Hoe            |
| 6       | 2024-01-05T08:00:00.000Z | 3         | Trowel         |
| 7       | 2024-03-10T08:00:00.000Z | 3         | Garden Fork    |
| 8       | 2024-04-15T07:00:00.000Z | 4         | Shovel         |
| 9       | 2024-05-01T07:00:00.000Z | 5         | Watering Can   |

### 9. HasAccess: HasAccess(garden\_id, person\_id)



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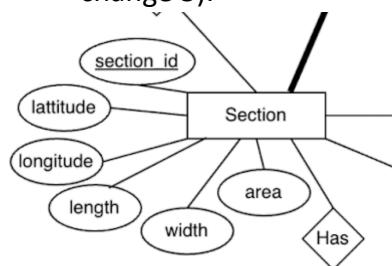
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### HasAccess

| Garden ID | Person ID |
|-----------|-----------|
| 1         | 1         |
| 1         | 2         |
| 1         | 7         |
| 2         | 2         |
| 2         | 3         |
| 3         | 3         |
| 3         | 4         |
| 4         | 4         |
| 5         | 5         |
| 6         | 6         |

### 10. Section: Section(section\_id, garden\_id, latitude, longitude, length, width)

Note the table was modified from the original schema (see above for explanation - change 5).



### Section

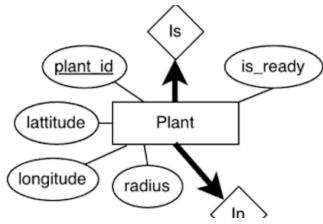
| Section ID | Garden ID | Latitude | Longitude | Length | Width  |
|------------|-----------|----------|-----------|--------|--------|
| 1          | 1         | 49.261   | -123.246  | 10.500 | 9.300  |
| 2          | 1         | 49.261   | -123.246  | 5.500  | 12.920 |
| 3          | 2         | 49.270   | -123.069  | 7.300  | 8.120  |
| 4          | 2         | 49.270   | -123.070  | 10.900 | 11.400 |
| 5          | 3         | 49.316   | -123.076  | 12.500 | 11.700 |
| 6          | 4         | 49.249   | -122.981  | 5.500  | 12.920 |
| 7          | 5         | 49.283   | -123.121  | 7.300  | 8.120  |

### 11. Plant: Plant(plant\_id, latitude, longitude, radius, is\_ready, type, section\_id)

Note the table was modified from the original schema (see above for explanation - change 6).

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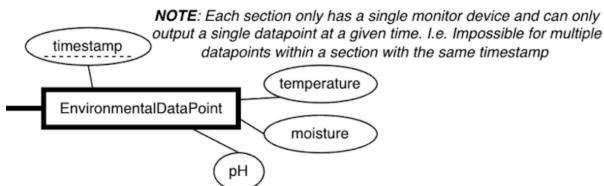
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**Plant**

| Plant ID | Latitude | Longitude | Radius | Status (1=Ready, 0=Not Ready) | Type        | Section ID |
|----------|----------|-----------|--------|-------------------------------|-------------|------------|
| 1        | 49.261   | -123.246  | 0.300  | 1                             | Tomato      | 1          |
| 2        | 49.261   | -123.246  | 0.250  | 1                             | Tomato      | 1          |
| 3        | 49.261   | -123.246  | 0.200  | 0                             | Basil       | 1          |
| 4        | 49.261   | -123.246  | 0.150  | 1                             | Lettuce     | 2          |
| 5        | 49.261   | -123.246  | 0.150  | 1                             | Lettuce     | 2          |
| 6        | 49.270   | -123.069  | 0.250  | 0                             | Carrot      | 3          |
| 7        | 49.270   | -123.069  | 0.300  | 1                             | Cucumber    | 3          |
| 8        | 49.270   | -123.070  | 0.250  | 0                             | Bell Pepper | 4          |
| 9        | 49.316   | -123.076  | 0.200  | 1                             | Strawberry  | 5          |
| 10       | 49.249   | -122.981  | 0.300  | 1                             | Tomato      | 6          |
| 11       | 49.261   | -123.246  | 0.180  | 1                             | Lettuce     | 1          |
| 12       | 49.261   | -123.246  | 0.220  | 0                             | Carrot      | 1          |
| 13       | 49.261   | -123.246  | 0.280  | 1                             | Cucumber    | 1          |
| 14       | 49.261   | -123.246  | 0.240  | 1                             | Bell Pepper | 1          |
| 15       | 49.261   | -123.246  | 0.190  | 0                             | Strawberry  | 1          |
| 16       | 49.261   | -123.246  | 0.270  | 1                             | Tomato      | 2          |
| 17       | 49.261   | -123.246  | 0.160  | 1                             | Basil       | 2          |
| 18       | 49.261   | -123.246  | 0.210  | 0                             | Carrot      | 2          |
| 19       | 49.261   | -123.246  | 0.290  | 1                             | Cucumber    | 2          |
| 20       | 49.261   | -123.246  | 0.230  | 0                             | Bell Pepper | 2          |

### 12. EnvironmentalDataPoint: EnvironmentalDataPoint(timestamp, section\_id, temperature, moisture, ph)



**EnvironmentalDataPoint**

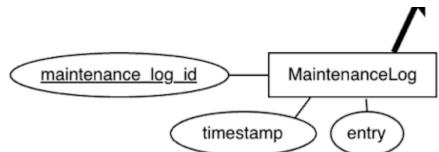
| Timestamp                | Section ID | Temperature | Moisture | pH    |
|--------------------------|------------|-------------|----------|-------|
| 2024-10-01T15:00:00.000Z | 1          | 22.500      | 65       | 6.500 |
| 2024-10-01T21:00:00.000Z | 1          | 25.800      | 58       | 6.400 |
| 2024-10-02T15:00:00.000Z | 1          | 21.300      | 70       | 6.600 |
| 2024-10-01T15:00:00.000Z | 2          | 23.100      | 62       | 6.800 |
| 2024-10-01T15:00:00.000Z | 3          | 24          | 55       | 6.200 |
| 2024-10-01T15:00:00.000Z | 4          | 22.800      | 60       | 6.700 |
| 2024-10-01T15:00:00.000Z | 5          | 20.500      | 68       | 5.800 |

### 13. MaintenanceLog: MaintenanceLog(maintenance\_log\_id, timestamp, entry, section\_id)

The table was modified from the original schema (see above for explanation - change 7).

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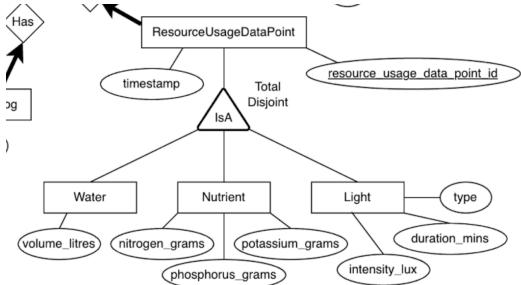
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**MaintenanceLog**

| Maintenance Log ID | Timestamp                | Entry  | Section ID |
|--------------------|--------------------------|--|------------|
| 1                  | 2024-09-15T17:30:00.000Z | weeded entire section and added nutrients to tomato plants | 1          |
| 2                  | 2024-09-20T21:15:00.000Z | pruned tomato plants and removed diseased leaves           | 1          |
| 3                  | 2024-09-22T21:15:00.000Z | harvested lettuce heads, replanted new seedlings           | 2          |
| 4                  | 2024-09-25T18:45:00.000Z | applied organic fertilizer to cucumber vines               | 3          |
| 5                  | 2024-09-28T23:20:00.000Z | installed trellis system for cucumber plants               | 3          |
| 6                  | 2024-10-01T15:30:00.000Z | treated bell peppers for aphid infestation using neem oil  | 4          |
| 7                  | 2024-10-03T15:30:00.000Z | removed strawberry runners and composted old leaves        | 5          |

**14. Water:** Water(volume\_litres, timestamp, resource\_usage\_data\_point\_id, section\_id)



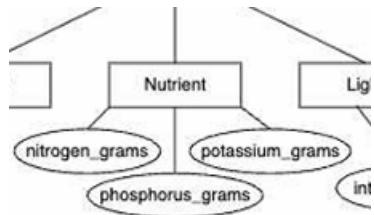
**Water**

| Resource Usage ID | Timestamp                | Volume (l) | Section ID |
|-------------------|--------------------------|------------|------------|
| 1                 | 2024-10-01T14:00:00.000Z | 45.500     | 1          |
| 2                 | 2024-10-02T02:00:00.000Z | 38.200     | 1          |
| 3                 | 2024-10-02T14:00:00.000Z | 42         | 1          |
| 4                 | 2024-10-01T14:00:00.000Z | 25.500     | 2          |
| 5                 | 2024-10-01T14:00:00.000Z | 65         | 3          |
| 6                 | 2024-10-01T14:00:00.000Z | 80.500     | 4          |
| 7                 | 2024-10-01T14:00:00.000Z | 15         | 5          |

**15. Nutrient:** Nutrient(resource\_usage\_data\_point\_id, timestamp, nitrogen\_grams, potassium\_grams, phosphorus\_grams, section\_id)

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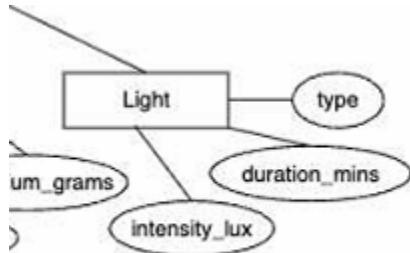
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### Nutrient

| Resource Usage ID | Timestamp                | Nitrogen (g) | Potassium (g) | Phosphorus (g) | Section ID |
|-------------------|--------------------------|--------------|---------------|----------------|------------|
| 1                 | 2024-09-15T17:00:00.000Z | 150          |               |                | 1          |
| 2                 | 2024-09-22T17:00:00.000Z | 120          |               | 70             | 2          |
| 3                 | 2024-09-25T18:00:00.000Z |              | 120           | 95             | 3          |
| 4                 | 2024-09-28T17:00:00.000Z | 200          | 140           | 110            | 4          |
| 5                 | 2024-09-30T16:00:00.000Z |              |               | 50             | 5          |
| 6                 | 2024-10-02T17:00:00.000Z | 160          | 110           |                | 6          |

**16. Light:** Light(resource\_usage\_data\_point\_id, timestamp, intensity\_lux, duration\_mins, type, section\_id)



### Light

| Resource Usage ID | Timestamp                | Intensity (lux) | Duration (min) | Type             | Section ID |
|-------------------|--------------------------|-----------------|----------------|------------------|------------|
| 1                 | 2024-10-01T19:00:00.000Z | 85000           | 480            | Natural Sunlight | 1          |
| 2                 | 2024-10-01T19:00:00.000Z | 78000           | 420            | Natural Sunlight | 2          |
| 3                 | 2024-10-01T19:00:00.000Z | 92000           | 510            | Natural Sunlight | 3          |
| 4                 | 2024-10-02T03:00:00.000Z | 15000           | 240            | LED Grow Light   | 5          |
| 5                 | 2024-10-01T19:00:00.000Z | 88000           | 465            | Natural Sunlight | 6          |
| 6                 | 2024-10-02T01:00:00.000Z | 25000           | 360            | LED Grow Light   | 7          |