

# Spatial Analysis of Hospitals, Shelters, and Social Facilities in Ireland



**Maynooth  
University**  
National University  
of Ireland Maynooth

Presented by Subramanyam Palagiri  
Module: CS621 Spatial Databases

# Introduction :

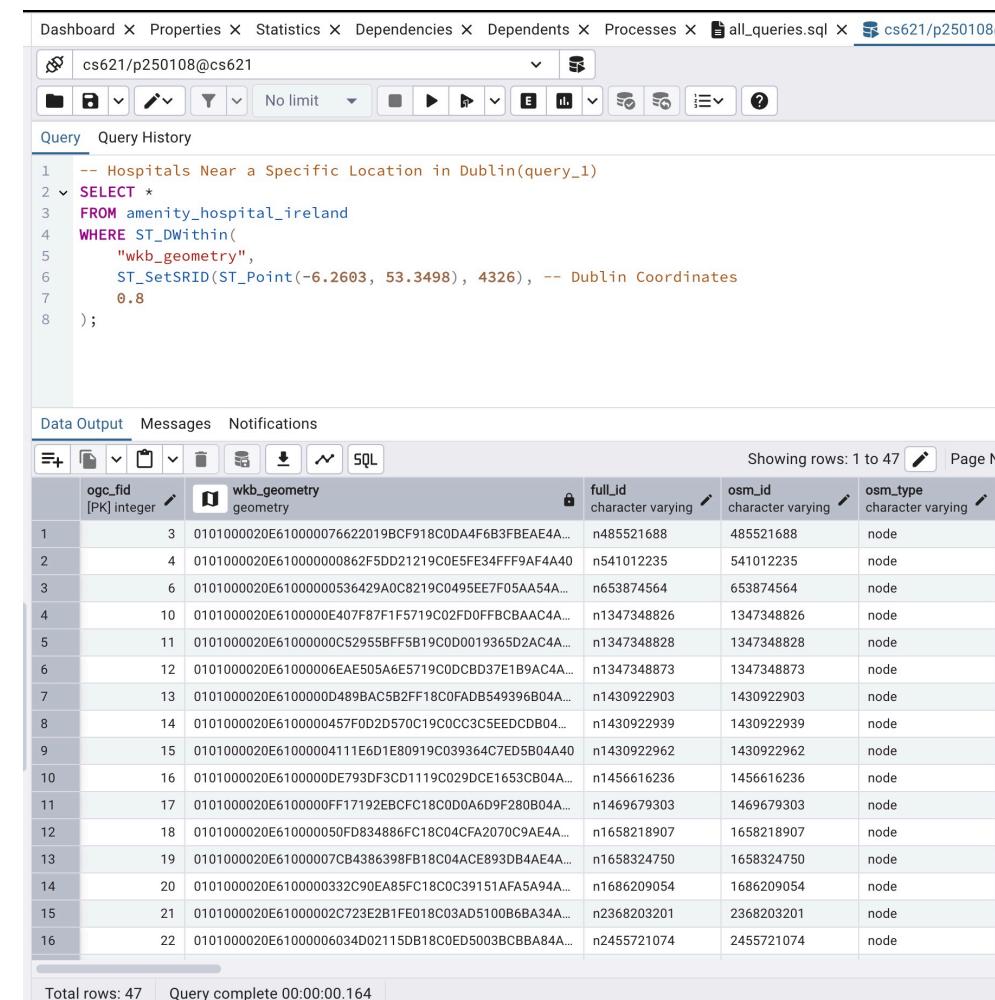
- **Spatial Analysis of Hospitals, Shelters, and Social Facilities in Ireland.**
- **Dataset Overview and Choice**

The datasets used include hospitals, shelters, social facilities, and bus stops across Ireland. These were selected to analyze critical services and their accessibility, focusing on healthcare, social welfare, and transportation. Ireland was chosen for its diverse geography, providing valuable insights into urban and rural infrastructure planning.

- **Tools :**
  - PostgreSQL with PostGIS:** For advanced spatial queries and geographic data manipulation.
  - QGIS:** For mapping, visualization, and further analysis of spatial data.
- **Datasets:**
  - **Hospitals:** Locations and attributes of medical facilities.
  - **Shelters:** Emergency and social shelters.
  - **Social Facilities:** Locations serving community needs.
- **Bus Stops:** Points for public transportation services.

# Query 1 - Hospitals Near a Specific Location

- This query is designed to identify hospitals that are located within a 8-kilometer radius of a specific point in Dublin, represented by the coordinates (-6.2603, 53.3498). By using the spatial function `ST_DWithin`, the query checks whether each hospital's location geometry falls within the defined distance from the given point.
- The results of this query reveal the distribution of hospitals near Dublin, providing insights into healthcare accessibility in the region. It highlights areas with hospital coverage and can help identify regions that may lack adequate healthcare facilities.



The screenshot shows a database query interface with the following details:

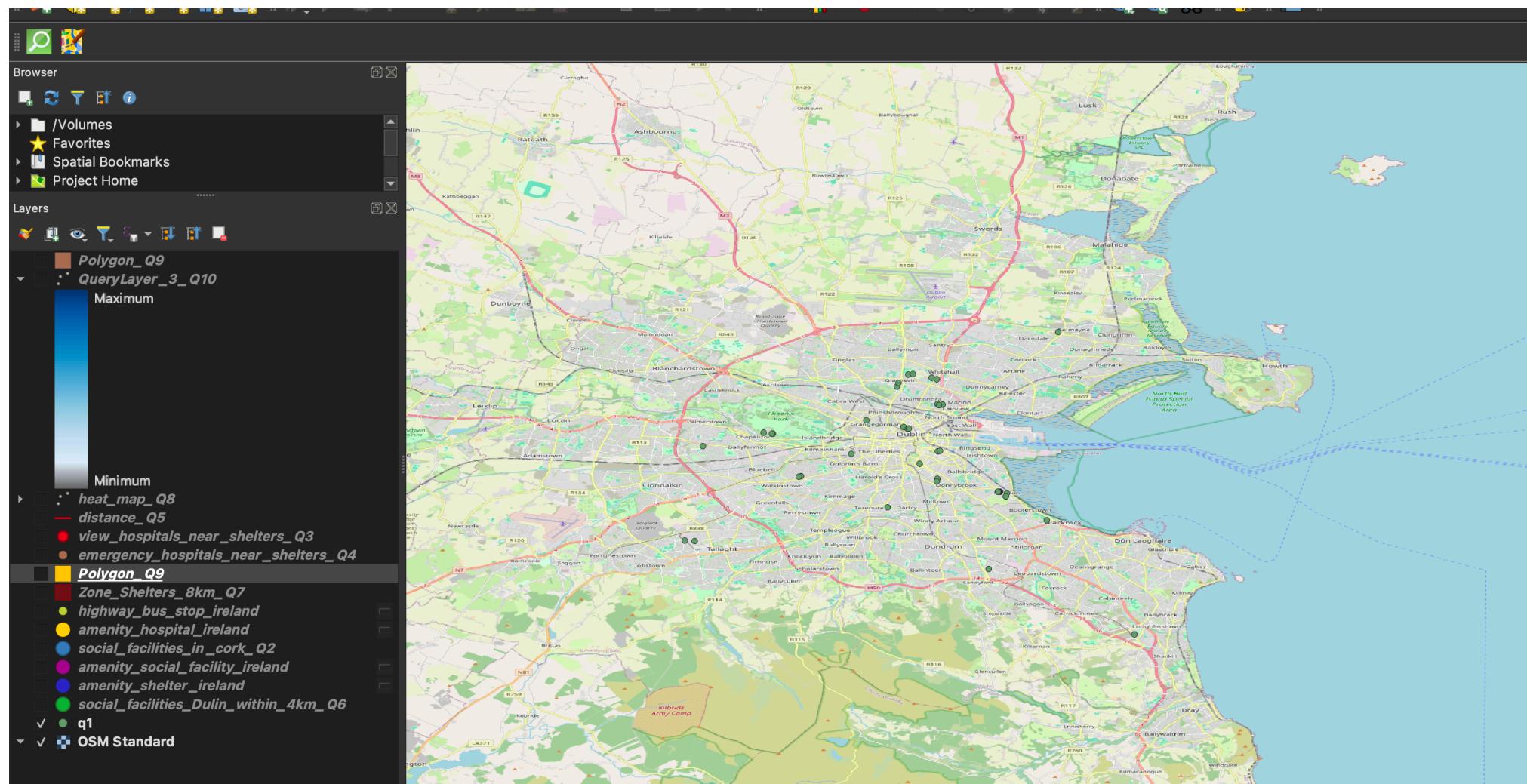
- Query History:** Shows the executed SQL query.
- SQL Editor:** Contains the following code:

```
-- Hospitals Near a Specific Location in Dublin(query_1)
SELECT *
FROM amenity_hospital_irland
WHERE ST_DWithin(
    "wkb_geometry",
    ST_SetSRID(ST_Point(-6.2603, 53.3498), 4326), -- Dublin Coordinates
    0.8
);
```
- Data Output:** A table showing the results of the query, including columns: `ogc_fid`, `wkb_geometry`, `full_id`, `osm_id`, and `osm_type`. The table has 47 rows.

	ogc_fid [PK] integer	wkb_geometry geometry	full_id character varying	osm_id character varying	osm_type character varying
1	3	010100020E610000076622019BCF918C0DA4F6B3FBEAE4A...	n485521688	485521688	node
2	4	010100020E61000000862F5DD21219C0E5FE34FFF9AF4A40	n541012235	541012235	node
3	6	010100020E6100000536429A0C8219C0495EE7F05AA54A...	n653874564	653874564	node
4	10	010100020E6100000E407F87F1F5719C02FD0FBCBAAC4A...	n1347348826	1347348826	node
5	11	010100020E61000000C52955BF5B19C0D0019365D2AC4A...	n1347348828	1347348828	node
6	12	010100020E61000006EAE505A6E5719C0DCBD37E1B9AC4A...	n1347348873	1347348873	node
7	13	010100020E6100000D489BAC5B2FF18C0FADB549396B04A...	n1430922903	1430922903	node
8	14	010100020E6100000457FD2D570C19C0CC3C5EDCDB04...	n1430922939	1430922939	node
9	15	010100020E61000004111E6D1E80919C039364C7ED5B04A40	n1430922962	1430922962	node
10	16	010100020E6100000DE793DF3C1119C029DCE1653CB04A...	n1456616236	1456616236	node
11	17	010100020E6100000F17192EBCFC18C0D0A6D9F280B04A...	n1469679303	1469679303	node
12	18	010100020E610000050FD834886FC18C04CFA2070C9AE4A...	n1658218907	1658218907	node
13	19	010100020E61000007CB4386398FB18C04ACE893DB4E4A...	n1658324750	1658324750	node
14	20	010100020E6100000332C90EA85FC18C0C39151AFA5A94A...	n1686209054	1686209054	node
15	21	010100020E61000002C723E2B1FE018C03AD5100B6BA34A...	n2368203201	2368203201	node
16	22	010100020E61000006034D0215DB18C0ED5003BCBBA84A...	n2455721074	2455721074	node

Total rows: 47 | Query complete 00:00:00.164

- When executed and visualized in QGIS, the query results are represented as point features on a map. Each point corresponds to a hospital that meets the criteria, plotted against the geographic backdrop of Dublin.



# Query 2 - Social Facilities in Cork

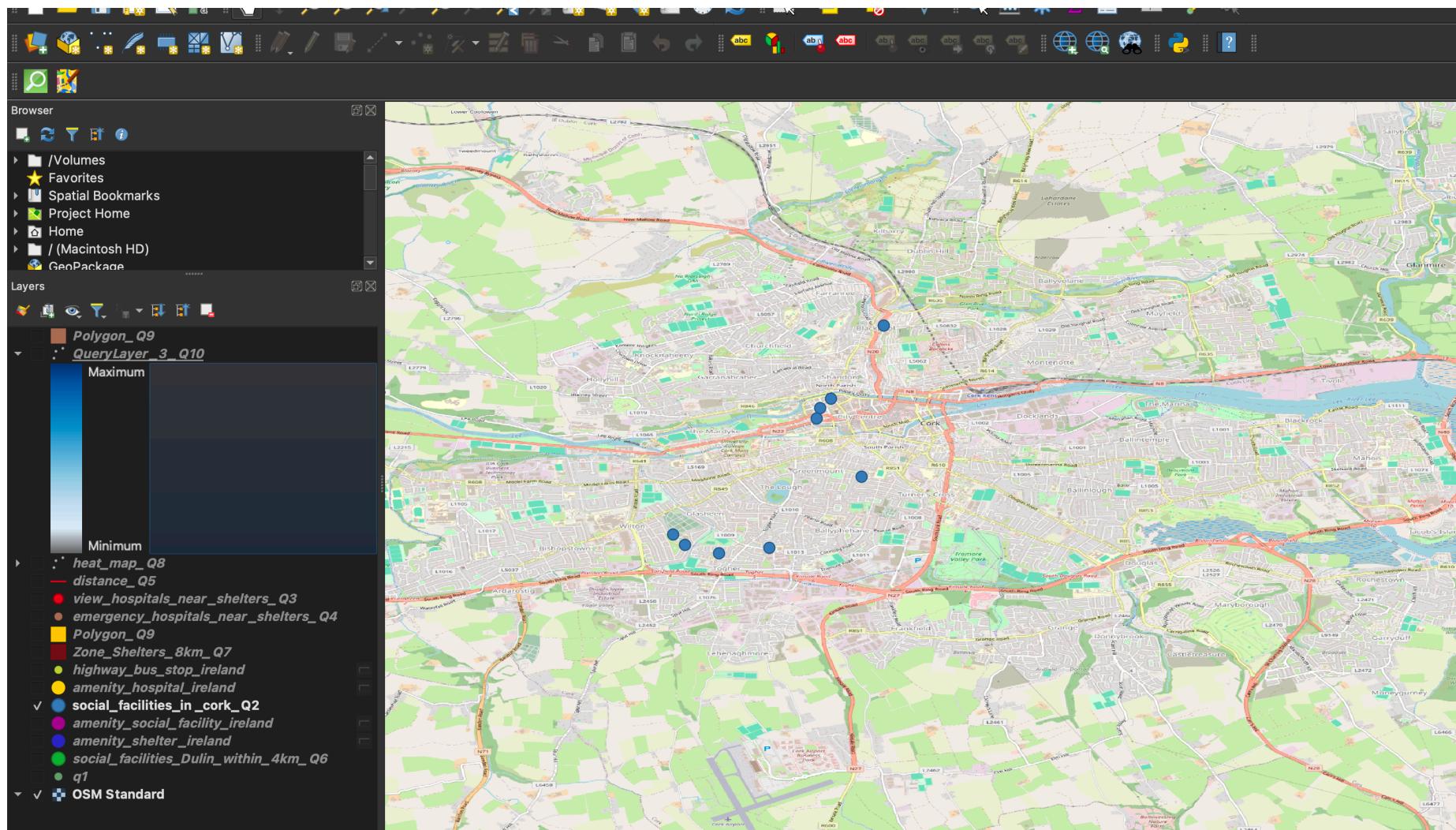
- This query is focused on identifying social facilities within a 3-kilometer radius of the city center of Cork, defined by the coordinates (-8.4863, 51.8985). By leveraging the spatial function `ST_DWithin`, it checks if the geometry of each social facility falls within the specified distance from the central point.
- The query returns a list of social facilities that are geographically close to Cork's city center. These facilities might include community centers, care homes, or other locations providing social services. The results help in analyzing the concentration and accessibility of such facilities within the urban area.

```
-- Social Facilities Within 3 km in Cork(query_2)
SELECT
    sf."full_id" AS social_facility_id,
    sf."wkb_geometry" AS geometry
FROM
    amenity_social_facility_irland_sf
WHERE
    ST_DWithin(
        sf."wkb_geometry",
        ST_SetSRID(ST_Point(-8.4863, 51.8985), 4326),
        0.03 -- 3 km radius
    );

```

	social_facility_id	geometry
1	n1221653980	0101000020E6100000213EB0E3BF0021C029EB371D3F04940
2	n1221655704	0101000020E61000004D2F3196E9FF20C0778AB03CA3F04940
3	n2177217021	0101000020E61000000E7FF21C36F620C05AB9179815F34940
4	n3090423785	0101000020E6100000A72A23E472F620C0B4ECA419E6F24940
5	n4311268034	0101000020E61000008B68E0EC7BFD20C0EA7019DC7BF049...
6	n4318616943	0101000020E610000056061F9441F320C030EB6A97DBF14940
7	n7114383461	0101000020E6100000C39151AFA5F120C07B713D6590F44940
8	n7228333651	0101000020E6100000C5854DAE73F520C0F0B03F3F42F34940
9	n11159715846	0101000020E610000094D27D4ADFF920C0A811442795F04940

In QGIS, the output of this query is visualized as a series of point features around Cork's central location. Each point represents a social facility, and the 3-kilometer radius can be visually depicted as a circle overlaying the map.



# Query 3 - Hospitals Near Shelters

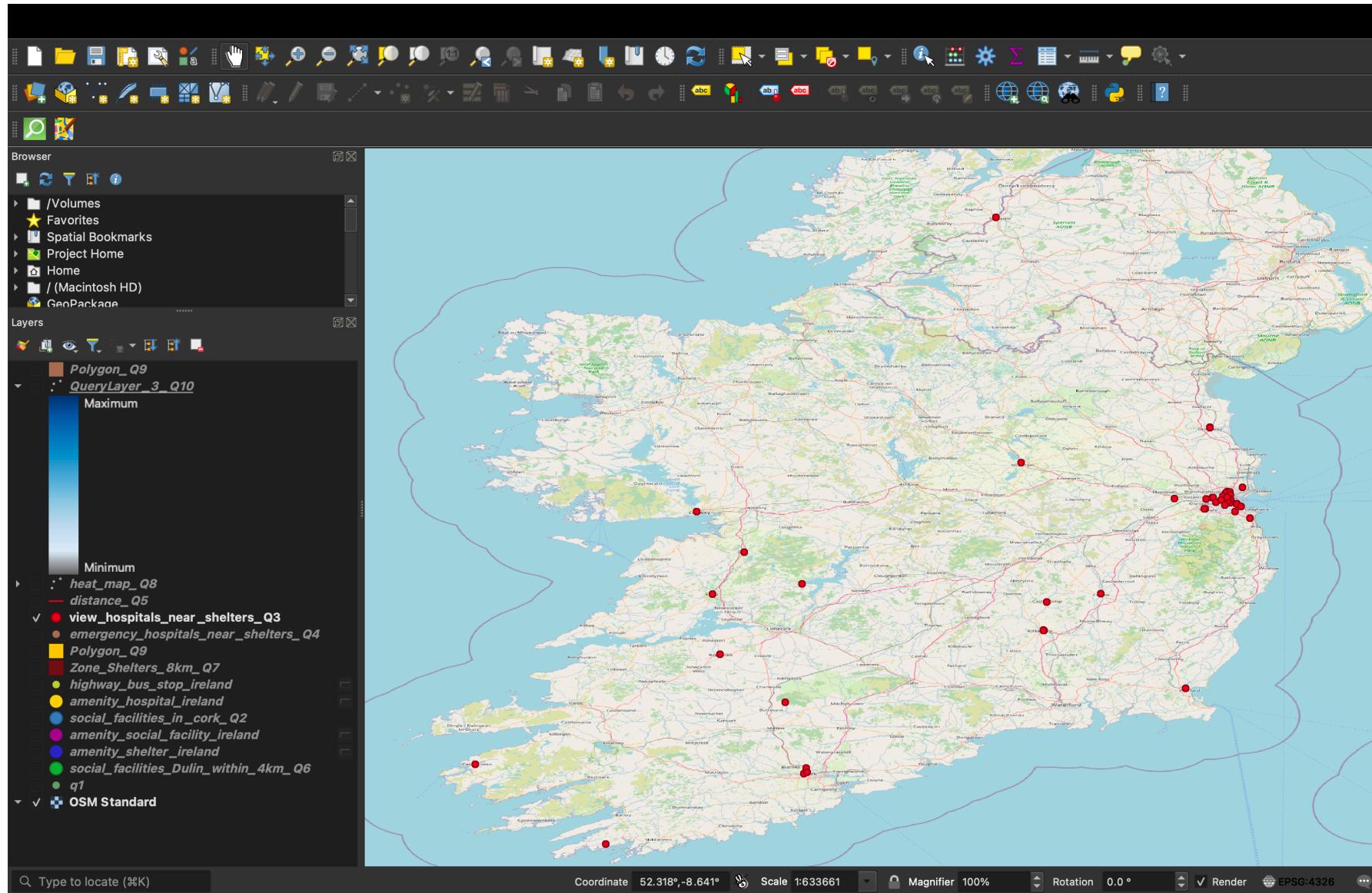
- This query establishes a spatial relationship between hospitals and shelters by identifying all pairs of hospitals and shelters that are within a 5-kilometer distance of each other. A view is created to store the results, including the unique identifiers for each hospital and shelter, their respective geometries, and the computed distance between them.
- The purpose of this query is to analyze the proximity of shelters to healthcare facilities, which is critical for emergency planning and support services. For example, in disaster management scenarios, it is essential to know which shelters have quick access to nearby hospitals.

The screenshot shows a database interface with a toolbar at the top and a query editor below. The query editor displays the following SQL code:

```
4  CREATE VIEW view_hospitals_near_shelters AS
5  SELECT
6      ROW_NUMBER() OVER () AS id, -- Creates a unique identifier
7      h."full_id" AS hospital_id,
8      s."full_id" AS shelter_id,
9      ST_Distance(h."wkb_geometry", s."wkb_geometry") AS distance,
10     h."wkb_geometry" AS hospital_geom,
11     s."wkb_geometry" AS shelter_geom
12  FROM
13      amenity_hospital_ireland h
14  JOIN
15      amenity_shelter_ireland s
16  ON
17      ST_DWithin(h."wkb_geometry", s."wkb_geometry", 5000);
18
```

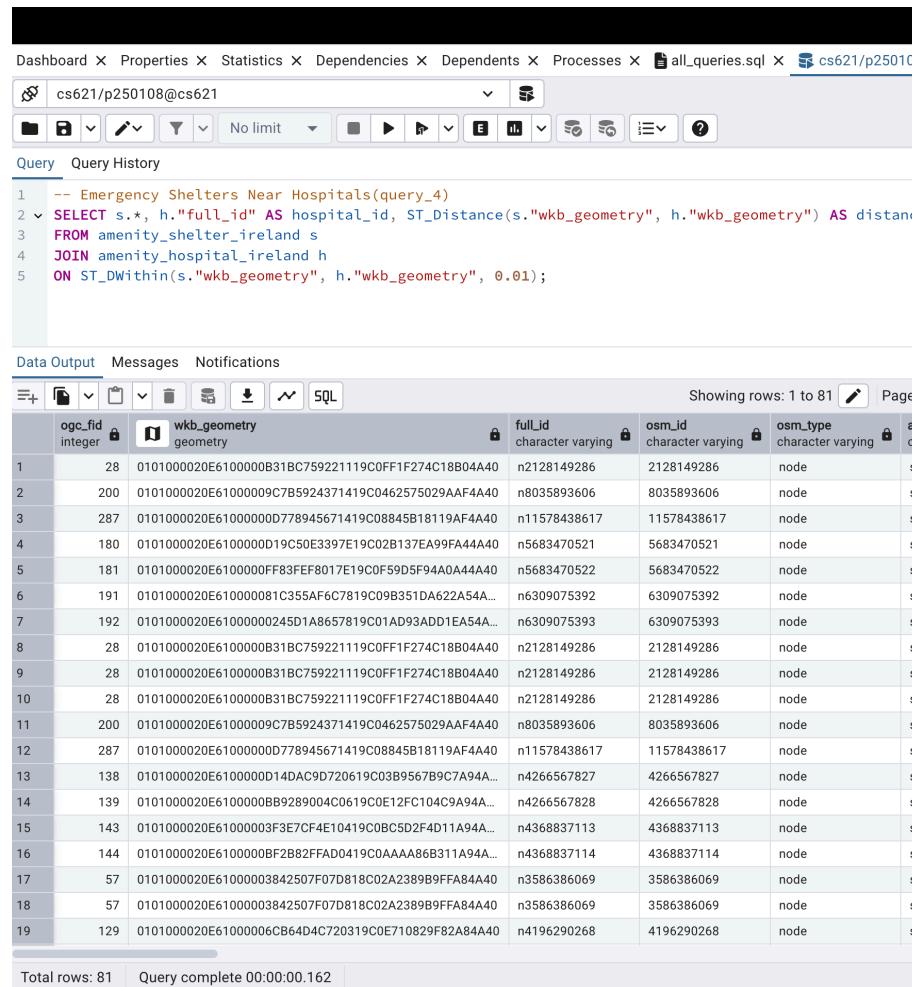
Below the code, there are tabs for "Data Output", "Messages", and "Notifications". The "Messages" tab is selected, showing the message "Query returned successfully in 139 msec."

In QGIS, this query's results can be visualized with lines connecting hospitals and shelters that are within the specified distance. Points represent the locations of hospitals and shelters, while the lines indicate the relationships where the distance condition is met.



# Query 4 - Emergency Shelters Near Hospitals

- This query identifies emergency shelters located within a very close proximity—10 meters—of hospitals. By joining the shelter and hospital datasets using the `ST_DWithin` function, the query ensures that only those shelters with an immediate spatial relationship to a hospital are included in the results.
- The primary objective of this query is to support emergency response planning. Shelters situated near hospitals are vital for situations where medical care needs to be quickly accessible to displaced or vulnerable individuals. These locations may serve as high-priority zones during crises, such as natural disasters or public health emergencies.



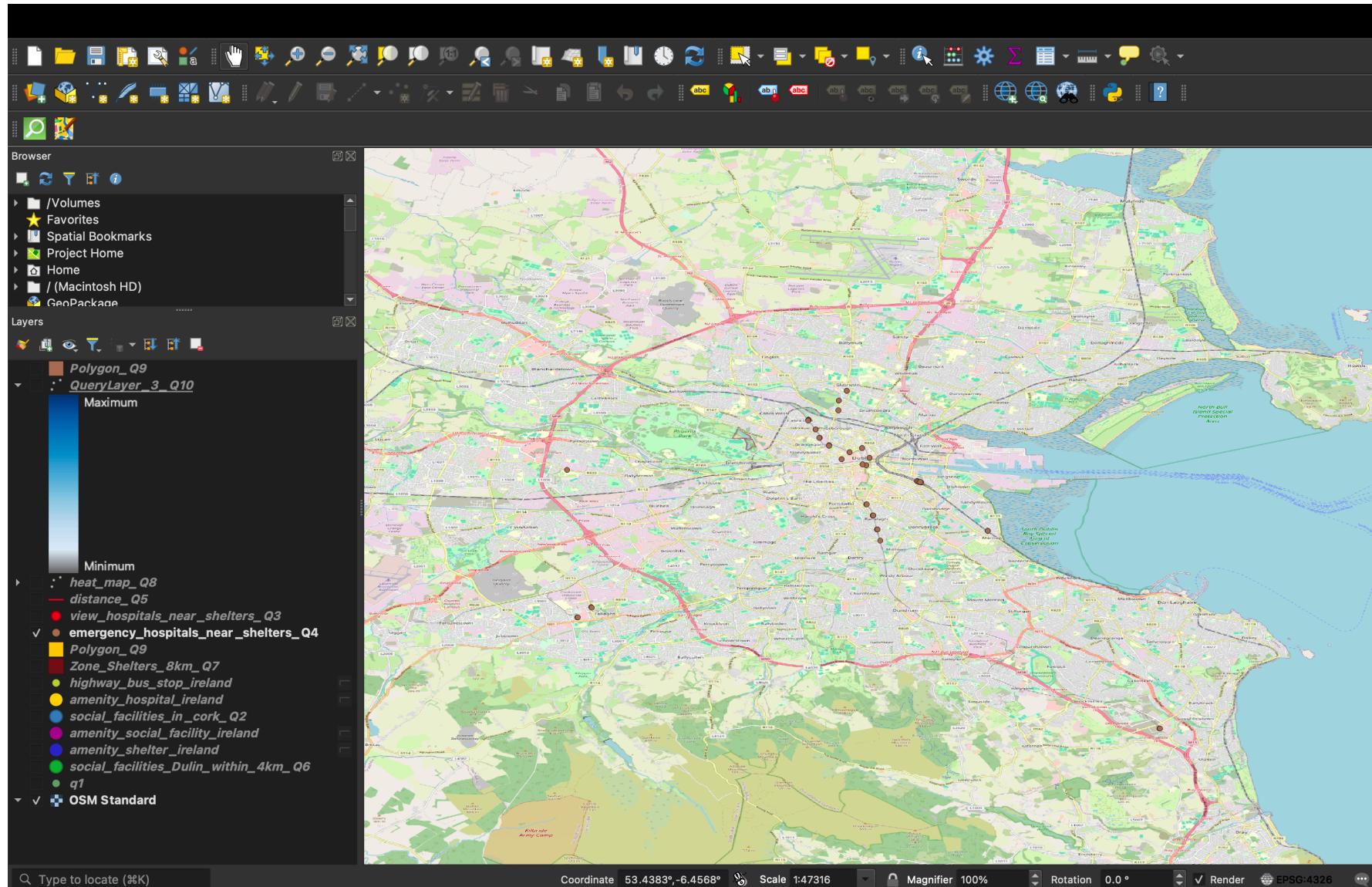
The screenshot shows a PostgreSQL database interface with the following details:

- Toolbar:** Includes icons for file operations, search, and navigation.
- Query Editor:** Shows the SQL query:
 

```
-- Emergency Shelters Near Hospitals(query_4)
SELECT s.* , h."full_id" AS hospital_id, ST_Distance(s."wkb_geometry", h."wkb_geometry") AS distance
FROM amenity_shelter_irland s
JOIN amenity_hospital_irland h
ON ST_DWithin(s."wkb_geometry", h."wkb_geometry", 0.01);
```
- Data Output:** A table showing the results of the query, with 81 rows. The columns are:
 

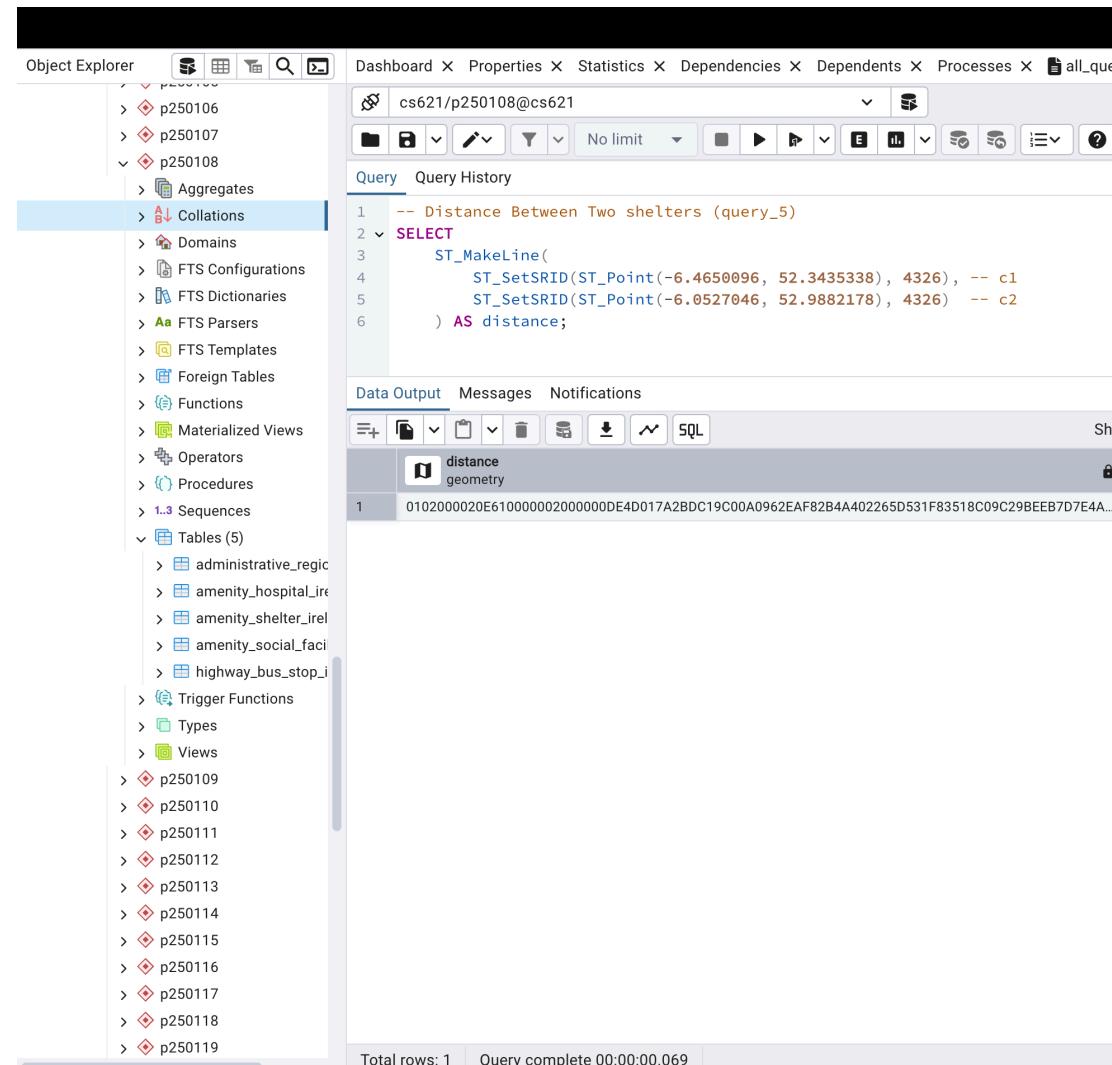
ogc_fid	wkb_geometry	full_id	osm_id	osm_type
1	28	n2128149286	2128149286	node
2	200	n8035893606	8035893606	node
3	287	n11578438617	11578438617	node
4	180	n5683470521	5683470521	node
5	181	n5683470522	5683470522	node
6	191	n6309075392	6309075392	node
7	192	n6309075393	6309075393	node
8	28	n2128149286	2128149286	node
9	28	n2128149286	2128149286	node
10	28	n2128149286	2128149286	node
11	200	n8035893606	8035893606	node
12	287	n11578438617	11578438617	node
13	138	n4266567827	4266567827	node
14	139	n4266567828	4266567828	node
15	143	n4368837113	4368837113	node
16	144	n4368837114	4368837114	node
17	57	n3586386069	3586386069	node
18	57	n3586386069	3586386069	node
19	129	n4196290268	4196290268	node
- Total rows:** 81
- Query complete:** 00:00:00.162

When visualized in QGIS, the results can be represented as overlapping point features for hospitals and shelters. The close proximity between these facilities makes their relationship critical for response teams.



# Query 5 - Distance Between Two Shelters

- This query calculates the straight-line distance between two specific shelters, represented by their geographic coordinates. Using the `ST_MakeLine` function, the query creates a line segment connecting the two shelter locations. This line represents the shortest path between the points in geometric terms, without considering physical barriers or road networks.
- The purpose of this query is to analyze spatial relationships and distances between specific shelters. It is useful for logistics planning, such as determining travel distances, evaluating accessibility, or connecting related facilities.



The screenshot shows a SQL management studio interface. The Object Explorer on the left lists database objects including tables, views, and triggers. The central Query window contains the following SQL code:

```

-- Distance Between Two shelters (query_5)
SELECT
    ST_MakeLine(
        ST_SetSRID(ST_Point(-6.4650096, 52.3435338), 4326) -- c1
        ST_SetSRID(ST_Point(-6.0527046, 52.9882178), 4326) -- c2
    ) AS distance;

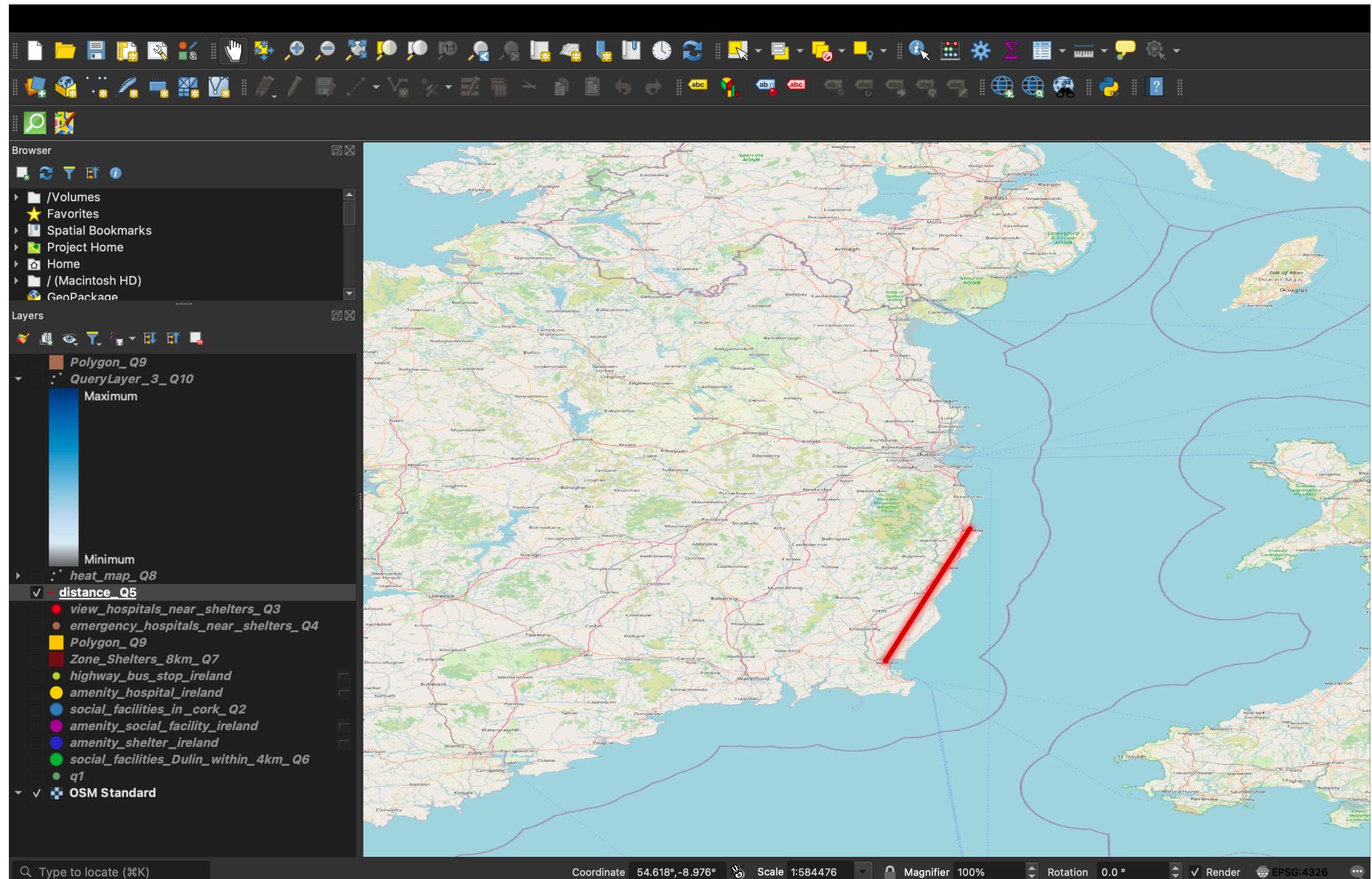
```

The Data Output tab shows the results of the query:

distance	geometry
0102000020E6100000200000DE4D017A2BDC19C00A0962EAF82B4A402265D531F83518C09C29BEB7D7E4A...	

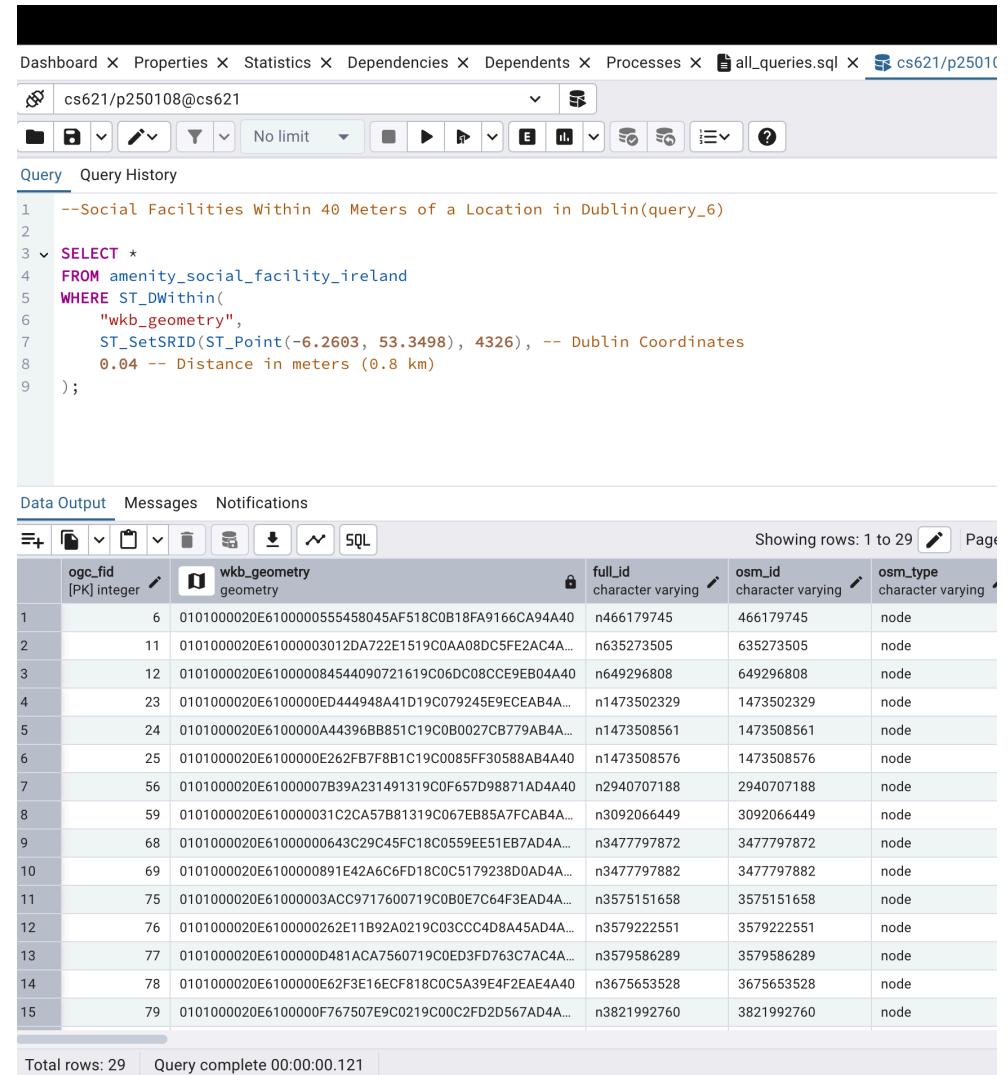
Total rows: 1    Query complete 00:00:00.069

When visualized in QGIS, the result appears as a line feature on the map, connecting the two shelters.



# Query 6 - Social Facilities Near a Location

- This query identifies social facilities that are located within a close radius (40 meters) of a specific location in Dublin, defined by the coordinates (-6.2603, 53.3498). By using the `ST_DWithin` function, the query checks if the geometries of the social facilities fall within this tight spatial boundary.
- The purpose of this query is to pinpoint social facilities that are in immediate proximity to a given location. It is especially useful for fine-grained analysis, such as evaluating the accessibility of services in a highly localized area, or for planning purposes in densely populated urban environments.



The screenshot shows a PostgreSQL database interface with the following details:

- Query History:** The query is titled "--Social Facilities Within 40 Meters of a Location in Dublin(query\_6)".
- SQL Query:**

```

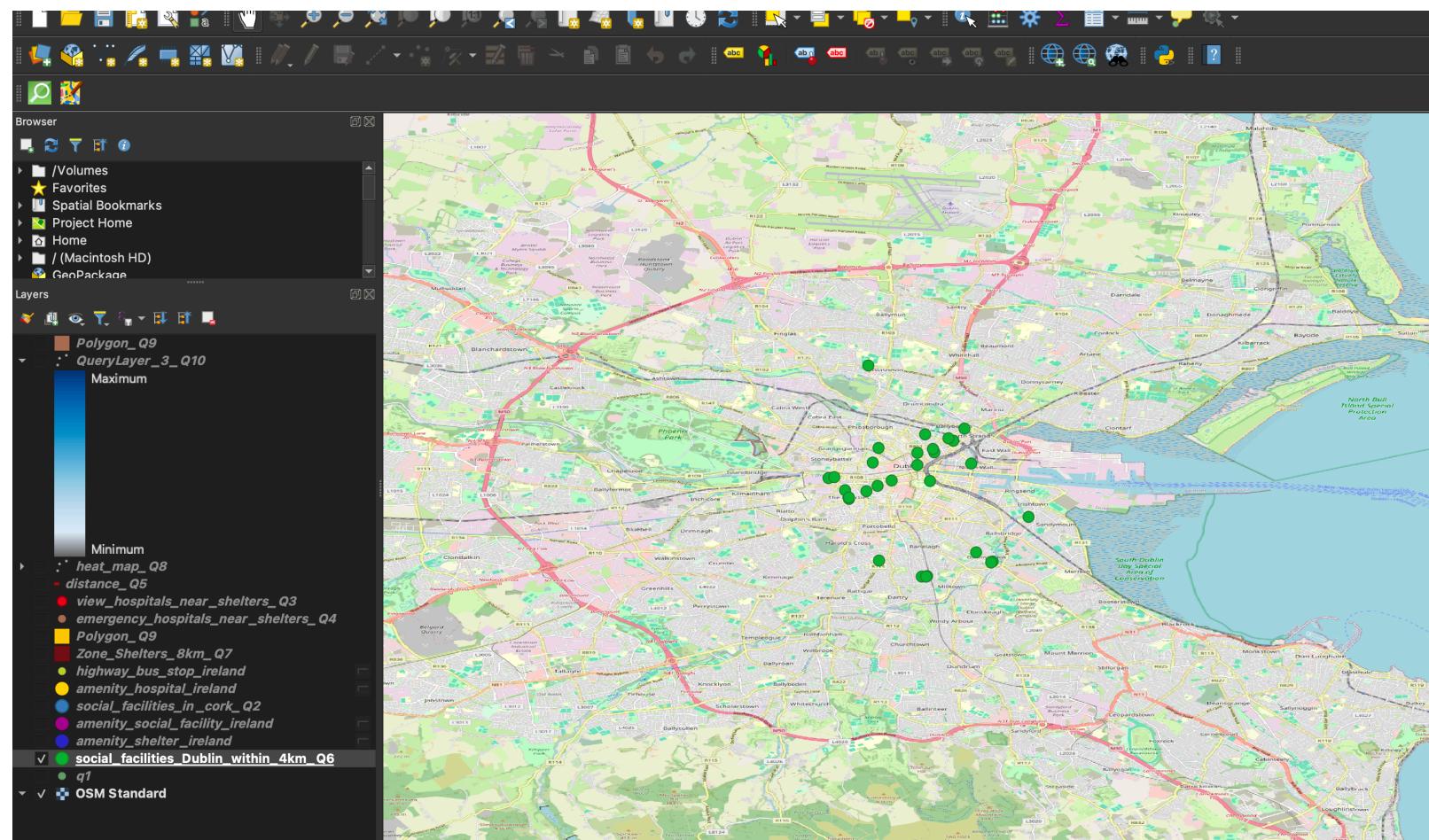
1 --Social Facilities Within 40 Meters of a Location in Dublin(query_6)
2
3 SELECT *
4 FROM amenity_social_facility_irland
5 WHERE ST_DWithin(
6     "wkb_geometry",
7     ST_SetSRID(ST_Point(-6.2603, 53.3498), 4326), -- Dublin Coordinates
8     0.04 -- Distance in meters (0.8 km)
9 );

```
- Data Output:** The results table has columns: ogc\_fid [PK] integer, wkb\_geometry geometry, full\_id character varying, osm\_id character varying, and osm\_type character varying.
- Results:** The table displays 15 rows of data, each representing a social facility with its unique identifier, geometry, and OpenStreetMap (OSM) information.

ogc_fid [PK]	wkb_geometry	full_id	osm_id	osm_type
1	6	n466179745	466179745	node
2	11	n635273505	635273505	node
3	12	n649296808	649296808	node
4	23	n1473502329	1473502329	node
5	24	n1473508561	1473508561	node
6	25	n1473508576	1473508576	node
7	56	n2940707188	2940707188	node
8	59	n3092066449	3092066449	node
9	68	n3477797872	3477797872	node
10	69	n3477797882	3477797882	node
11	75	n3575151658	3575151658	node
12	76	n3579222551	3579222551	node
13	77	n3579586289	3579586289	node
14	78	n3675653528	3675653528	node
15	79	n3821992760	3821992760	node

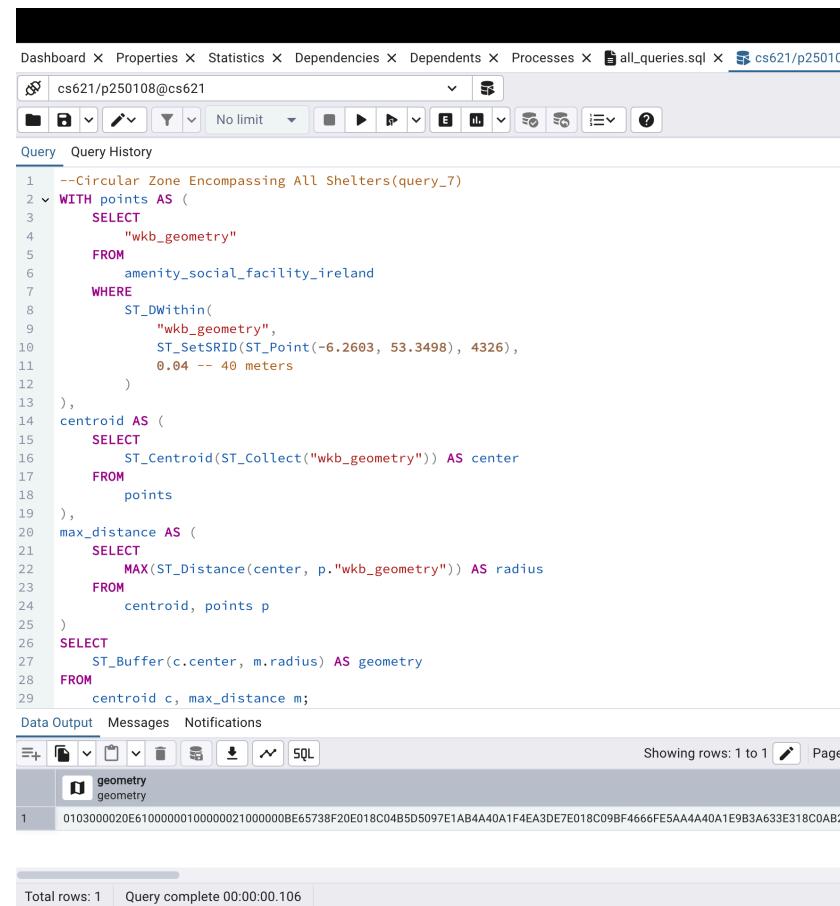
Total rows: 29    Query complete 00:00:00.121

When visualized in QGIS, the query results are displayed as point features representing social facilities near the specified location. This visualization can also include a circular boundary showing the 40-meter radius, providing a clear spatial context. Such maps are particularly valuable for community planners, urban developers, or researchers focusing on hyperlocal service distribution.



# Query 7 - Circular Zone Encompassing All Shelters

- This query creates a circular zone that encompasses all shelters within a 40-meter radius of a specific location in Dublin. It uses a combination of PostGIS functions, including `ST_Collect` to aggregate all shelter geometries, `ST_Centroid` to determine the center of these geometries, and `ST_Buffer` to create a circular boundary that covers the maximum distance from the center to any shelter.
- The result of this query is a circular zone that visually represents the spatial extent of shelters in the area, based on the given radius. This kind of analysis is valuable for defining service areas, planning coverage zones, or understanding the geographic distribution of facilities relative to a central point.

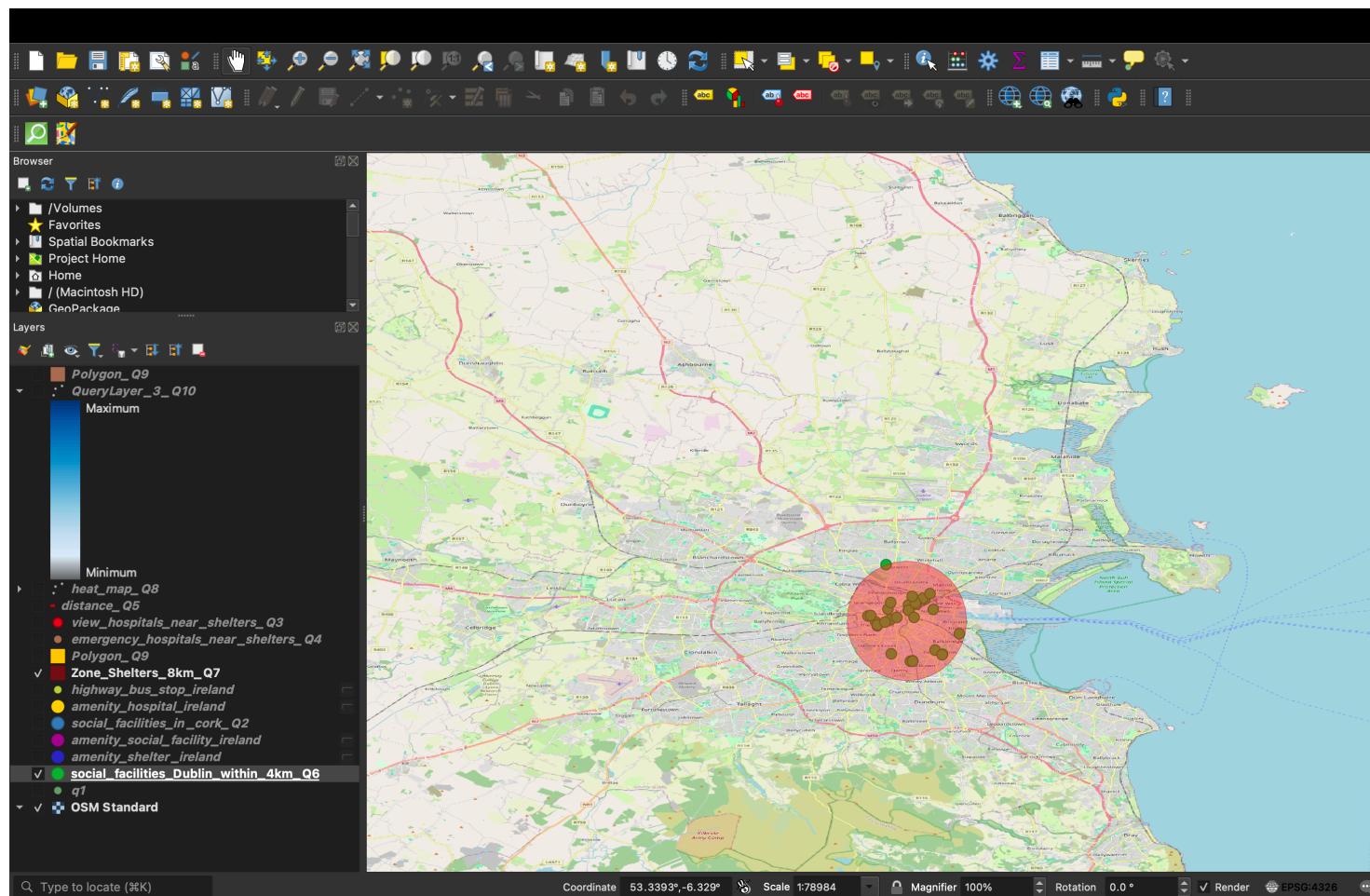


```

Dashboard X Properties X Statistics X Dependencies X Dependents X Processes X all_queries.sql X cs621/p250108@cs621
Query History
Query
1 --Circular Zone Encompassing All Shelters(query_7)
2 WITH points AS (
3   SELECT
4     "wkb_geometry"
5   FROM
6     amenity_social_facility_irland
7   WHERE
8     ST_DWithin(
9       "wkb_geometry",
10      ST_SetSRID(ST_Point(-6.2603, 53.3498), 4326),
11      0.04 -- 40 meters
12    )
13  ),
14 centroid AS (
15   SELECT
16     ST_Centroid(ST_Collect("wkb_geometry")) AS center
17   FROM
18   points
19  ),
20 max_distance AS (
21   SELECT
22     MAX(ST_Distance(center, p."wkb_geometry")) AS radius
23   FROM
24   centroid, points p
25  )
26 SELECT
27   ST_Buffer(c.center, m.radius) AS geometry
28   FROM
29   centroid c, max_distance m;
Data Output Messages Notifications
Showing rows: 1 to 1
Total rows: 1 Query complete 00:00:00.106

```

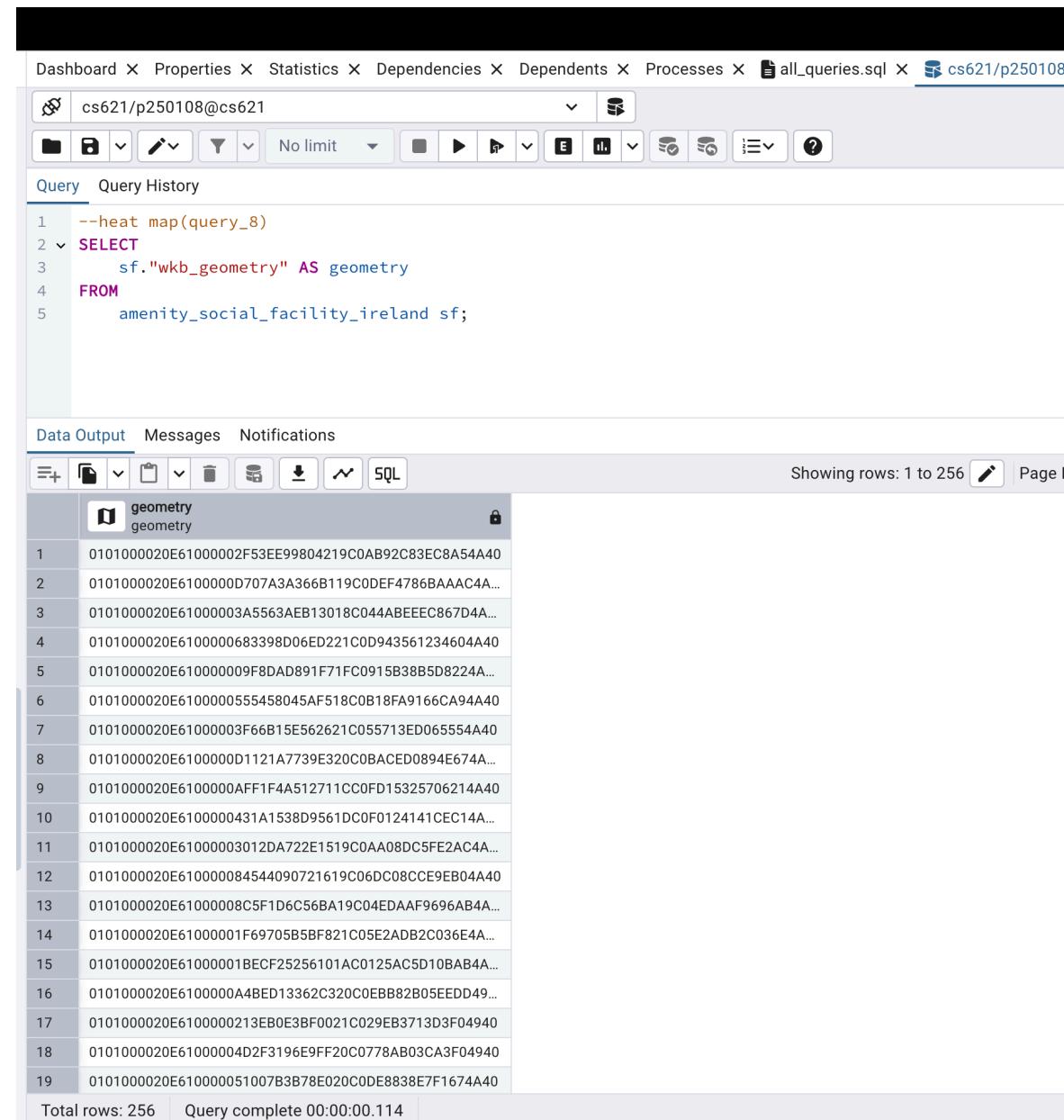
In QGIS, the output is a polygon feature that overlays the map, depicting the circular boundary. The shelters within the boundary can also be visualized as point features, offering a complete picture of the spatial relationship. This visualization can help urban planners and policymakers assess whether the shelters are effectively clustered or spread out, and whether additional shelters are needed within the defined area.



# Query 8 - Heat Map of Social Facilities

This query generates the necessary data to create a heat map of social facilities. By selecting the geometries of all social facilities in the dataset, the query provides the spatial input required to visualize the density and distribution of these facilities across a given area.

The purpose of this query is to analyze patterns in the concentration of social facilities. Heat maps are effective tools for identifying areas with high or low densities of services, which can inform urban planning, resource allocation, and community development.



The screenshot shows a database query interface with the following details:

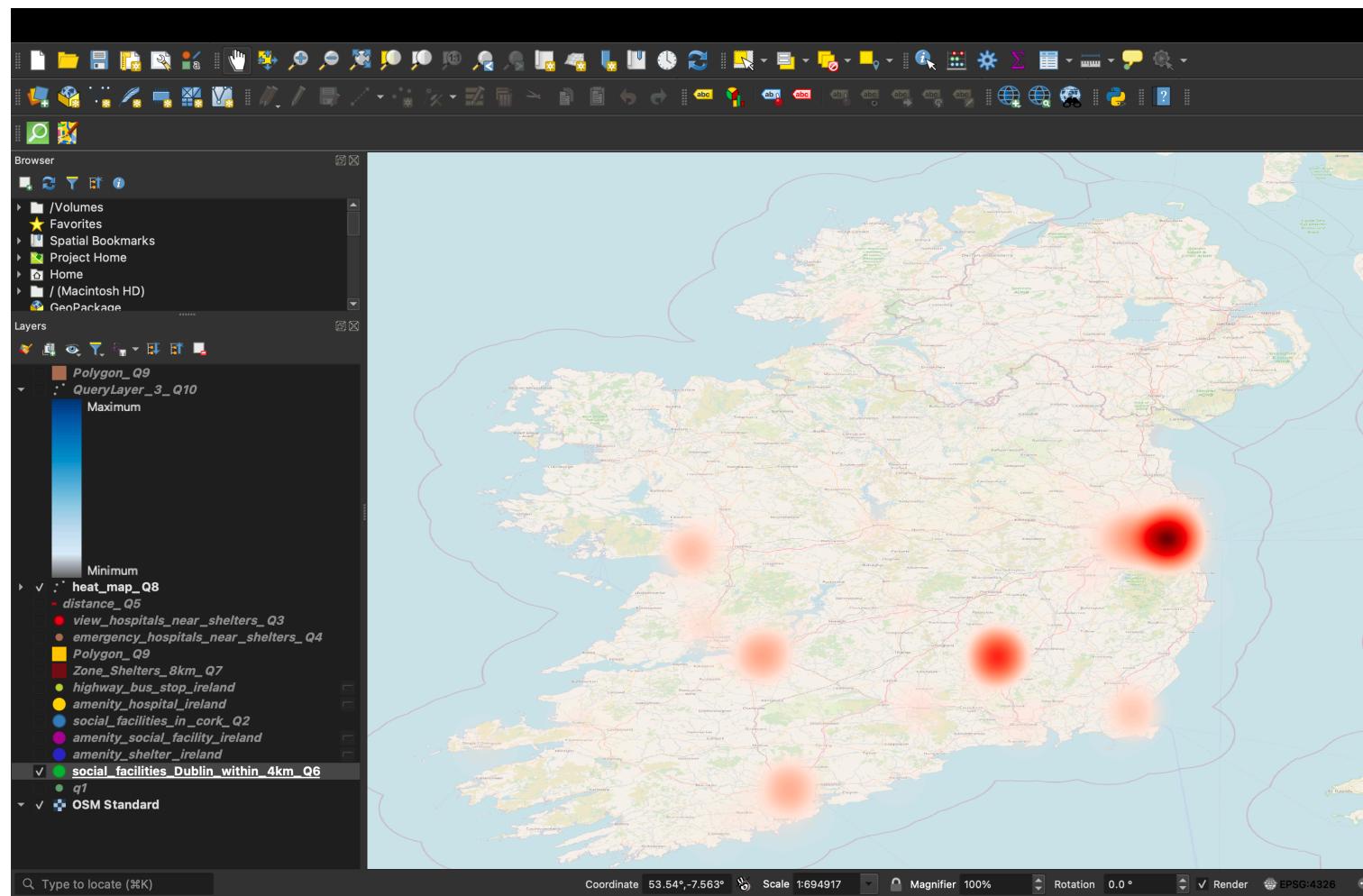
- Query History:** The query is titled "--heat map(query\_8)" and contains the following SQL code:
 

```

1 --heat map(query_8)
2 SELECT
3     sf."wkb_geometry" AS geometry
4 FROM
5     amenity_social_facility_irland sf;
      
```
- Data Output:** The results are displayed in a table with one column labeled "geometry". The first 19 rows of the table are shown below:
 

	geometry
1	0101000020E61000002F53EE99804219C0AB92C83EC8A54A40
2	0101000020E6100000D707A3A366B119C0DEF4786BAAC4A...
3	0101000020E61000003A5563AEB13018C044ABEEC867D4A...
4	0101000020E6100000683398D06ED221C0D943561234604A40
5	0101000020E610000009F8DAD891F71FC0915B38B5D8224A...
6	0101000020E6100000555458045AF518C0B18FA9166CA94A40
7	0101000020E61000003F66B15E562621C055713ED065554A40
8	0101000020E6100000D1121A7739E320C0BACED0894E674A...
9	0101000020E6100000AFF1F4A512711CC0FD15325706214A40
10	0101000020E6100000431A1538D9561DC0F0124141CEC14A...
11	0101000020E61000003012DA722E1519C0AA08DC5FE2AC4A...
12	0101000020E610000084544090721619C06DC08CCE9EB04A40
13	0101000020E61000008C5F1D6C56BA19C04EDAAF9696AB4A...
14	0101000020E61000001F69705B5BF821C05E2ADB2C036E4A...
15	0101000020E61000001BECF25256101AC0125AC5D10BAB4A...
16	0101000020E6100000A4BED13362C320C0EBB82B05EEDD49...
17	0101000020E6100000213EB0E3BF0021C029EB3713D3F04940
18	0101000020E61000004D2F3196E9FF20C0778AB03CA3F04940
19	0101000020E610000051007B3B78E020C0DE8838E7F1674A40
- Total rows:** 256
- Query complete:** 00:00:00.114

When visualized in QGIS, the query results are processed into a heat map, where regions with higher concentrations of social facilities are represented with warmer colors (e.g., red or yellow) and less dense regions with cooler colors (e.g., blue). This visualization helps to highlight service clusters and potential underserved areas.



# Query 9 - Bounding Polygons for Social Facilities

- This query creates bounding polygons for social facilities in Dublin and Cork, offering a visual representation of the spatial extent of these amenities. It uses the `ST_ConvexHull` function to generate a convex polygon that encompasses all the facilities' geometries within a specified distance from a central point.
- For Dublin, the query defines a bounding polygon within 10 kilometers of the city center, while for Cork, it defines a polygon within a 10-kilometer radius. These polygons outline the geographic boundaries of the facilities, highlighting their distribution patterns.
- The purpose of this query is to assess the overall spatial coverage of social facilities in these cities. Bounding polygons are useful for understanding the extent of service areas, identifying outliers, and comparing urban regions' infrastructure.

When visualized in QGIS, the polygons appear as shaded areas overlaying the map, with social facilities displayed as point features within them. These visualizations provide a clear overview of service coverage and can help planners identify gaps or overlaps in the distribution of social infrastructure.

The screenshot shows the QGIS interface with a map of Ireland. Two yellow shaded polygons are overlaid on the map, representing the service coverage areas for Dublin City and Cork City. The map includes a network of roads, rivers, and place names. On the left, the 'Query History' panel displays the SQL code used to generate these polygons. The code defines two convex hulls: one for Dublin City (Polygon\_1) and one for Cork City (Polygon\_2), both centered on specific coordinates with a radius of 10 km.

```

1 --polygons(query_9)
2 --Bounding Polygon of Social Facilities in Dublin City(Polygon_1)
3 SELECT
4     ST_ConvexHull(ST_Collect(s."wkb_geometry")) AS bounding_polygon
5 FROM
6     amenity_shelter_irland s
7 WHERE
8     ST_DWithin(
9         s."wkb_geometry",
10        ST_SetSRID(ST_Point(-6.2603, 53.3498), 4326),
11        1000 -- Adjust the distance (10 km in this example)
12    );
13
14 --Bounding Polygon of Social Facilities in Cork City(Polygon_2)
15 SELECT
16     ST_ConvexHull(ST_Collect(sf."wkb_geometry")) AS bounding_polygon
17 FROM
18     amenity_social_facility_irland sf
19 WHERE
20     ST_DWithin(
21         sf."wkb_geometry",
22         ST_SetSRID(ST_Point(-8.4863, 51.8985), 4326),
23         0.1 -- 10 km radius
24    );

```

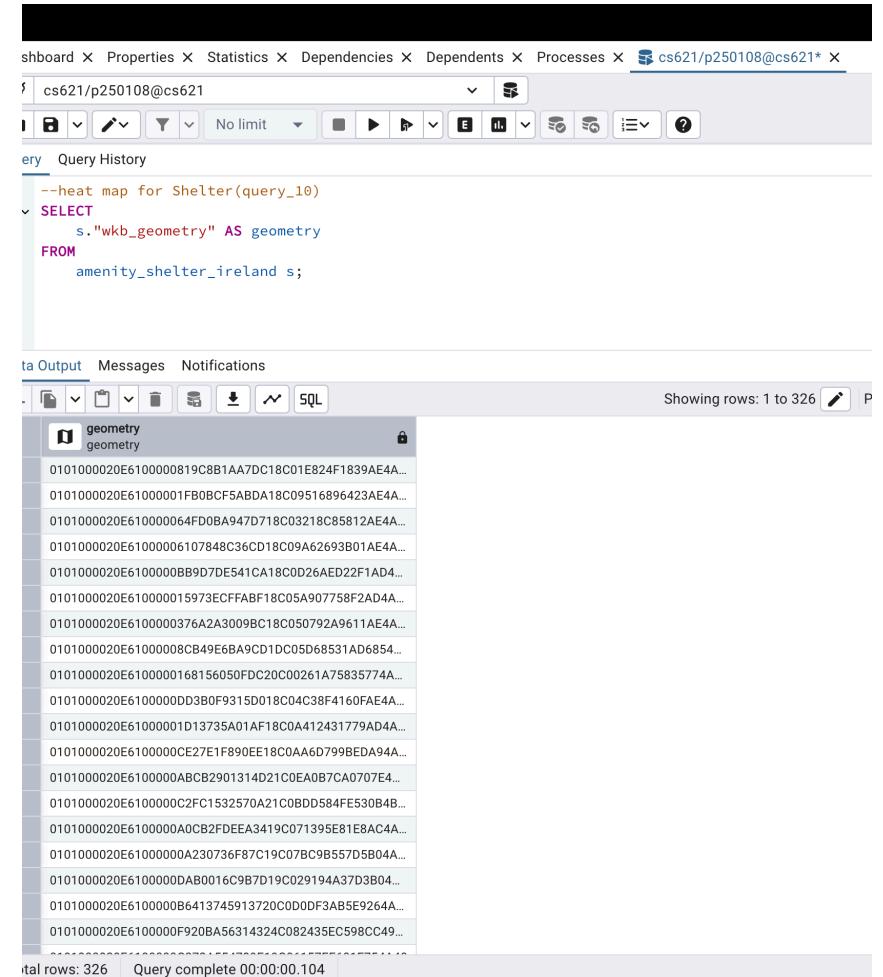
The 'Data Output' section shows the results of the query, listing the geometry type as 'bounding\_polygon'. The results table contains one row with a long hexagonal string representing the geometry.

bounding_polygon	geometry
1	0103000020E610000001000000070000000381295EC0E220C064027E8D24EF49408B68E0EC7BF20C0EA7019DC7BF049404D2F3196E9FF20C077E

The bottom status bar indicates 'Query complete 00:00:00.100'.

# Query 10 - Heat Map for Shelters

- This query focuses on generating data to create a heat map for shelters. By selecting the geometries of all shelters in the dataset, it provides the spatial input required for visualizing the density and distribution of shelter locations across an area.
- The purpose of this query is to analyze spatial patterns in shelter placement, helping identify areas with a high concentration of shelters and regions that may lack sufficient shelter facilities. This information is crucial for emergency planning, resource allocation, and social infrastructure development.



The screenshot shows a database management system interface with the following details:

- Toolbar:** Includes tabs for shboard, Properties, Statistics, Dependencies, Dependents, Processes, and a connection dropdown set to cs621/p250108@cs621\*.
- Query History:** Shows the query: `--heat map for Shelter(query_10)`
- SQL Editor:** Displays the SQL code:
 

```
--heat map for Shelter(query_10)
SELECT
    s."wkb_geometry" AS geometry
FROM
    amenity_shelter_irland s;
```
- Output Tab:** Shows the results of the query. The first few rows are:
 

geometry
0101000020E6100000819C8B1AA7DC18C01E824F1839AE4...
0101000020E61000001FB0BCF5ABDA18C09516896423AE4...
0101000020E610000064FD0BA947D718C03218C85812AE4...
0101000020E61000006107848C36CD18C09A62693B01AE4...
0101000020E6100000BB907DE541CA18C0D26AD22F1AD4...
0101000020E610000015973ECFFABF18C05A907758F2AD4...
0101000020E6100000376A2A3009BC18C050792A9611AE4...
0101000020E61000008CB49E6BA9C1DC05D68531AD6854...
0101000020E6100000168156050FDC20C00261A75835774...
0101000020E6100000DD3B0F9315D018C04C38F4160FAE4...
0101000020E61000001D13735A01AF18C0A412431779AD4...
0101000020E6100000CE27E1F890EE18C0AA6D799BEDA94A...
0101000020E6100000ABC2901314D21C0EA0B7CA0707E4...
0101000020E6100000C2FC1532570A21C0BDD584FE530B4B...
0101000020E6100000A0CB2FDEEA3419C071395EB1E8AC4...
0101000020E6100000A230736F87C19C07BC9B557D5B04...
0101000020E6100000DAB0016C9B7D19C029194A37D3B04...
0101000020E6100000B6413745913720C0D0DF3AB5E9264A...
0101000020E6100000F920BA56314324C082435EC598CC49...
- Statistics:** Total rows: 326 | Query complete 00:00:00.104

In QGIS, the results of this query are used to create a heat map, where regions with more shelters are displayed in warmer colors (e.g., red or orange), while less dense areas are shown in cooler colors (e.g., green or blue). The heat map visually emphasizes clusters of shelters and helps planners understand how evenly these resources are distributed.

