

Network Analysis



ISTANBUL **TECHNICAL** UNIVERSITY

Sp. Anly. and Alg. in GIS

Week 11

Res. Assist. Ömer AKIN

Aim of the Study

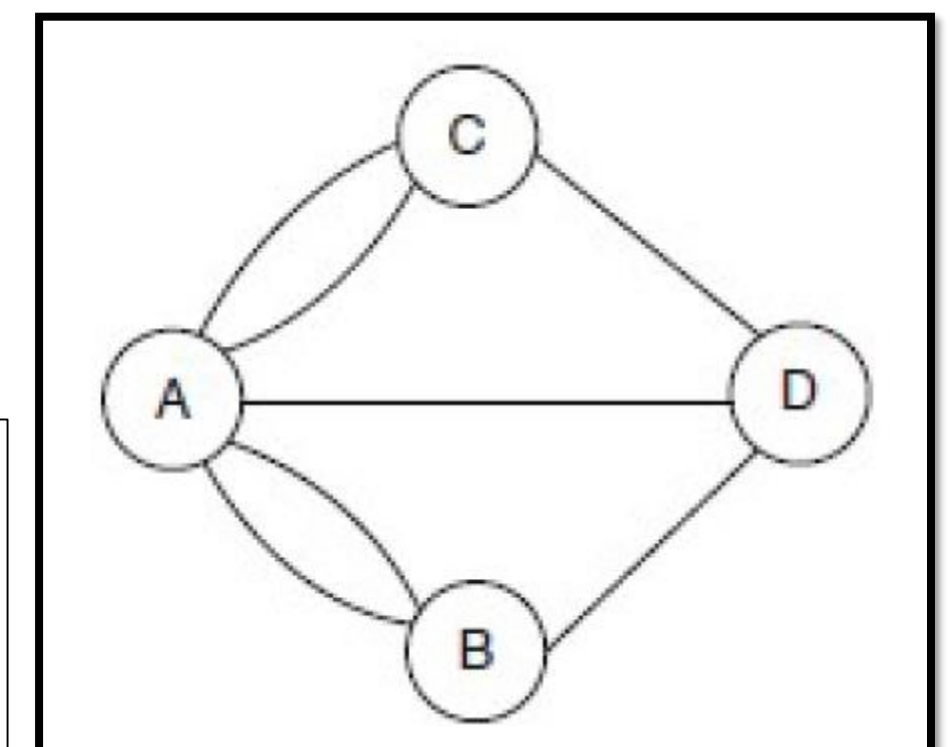


- *Aim of Study:*
 - *Find the shortest route between metrobus stations*
 - *Generate service area towards hospitals*
 - *Generate OD Cost Matrixes to find each stations and hospitals' accessibility by using inverse distance ($1/[length]$) formula*
- *Input Data:*
 - *Hospitals (Vector-Point)*
 - *Metrobus Stations (Vector-Point)*
 - *Road network (Vector-Polyline)*
 - *Study area (Vector-Polygon)*

Network Analysis

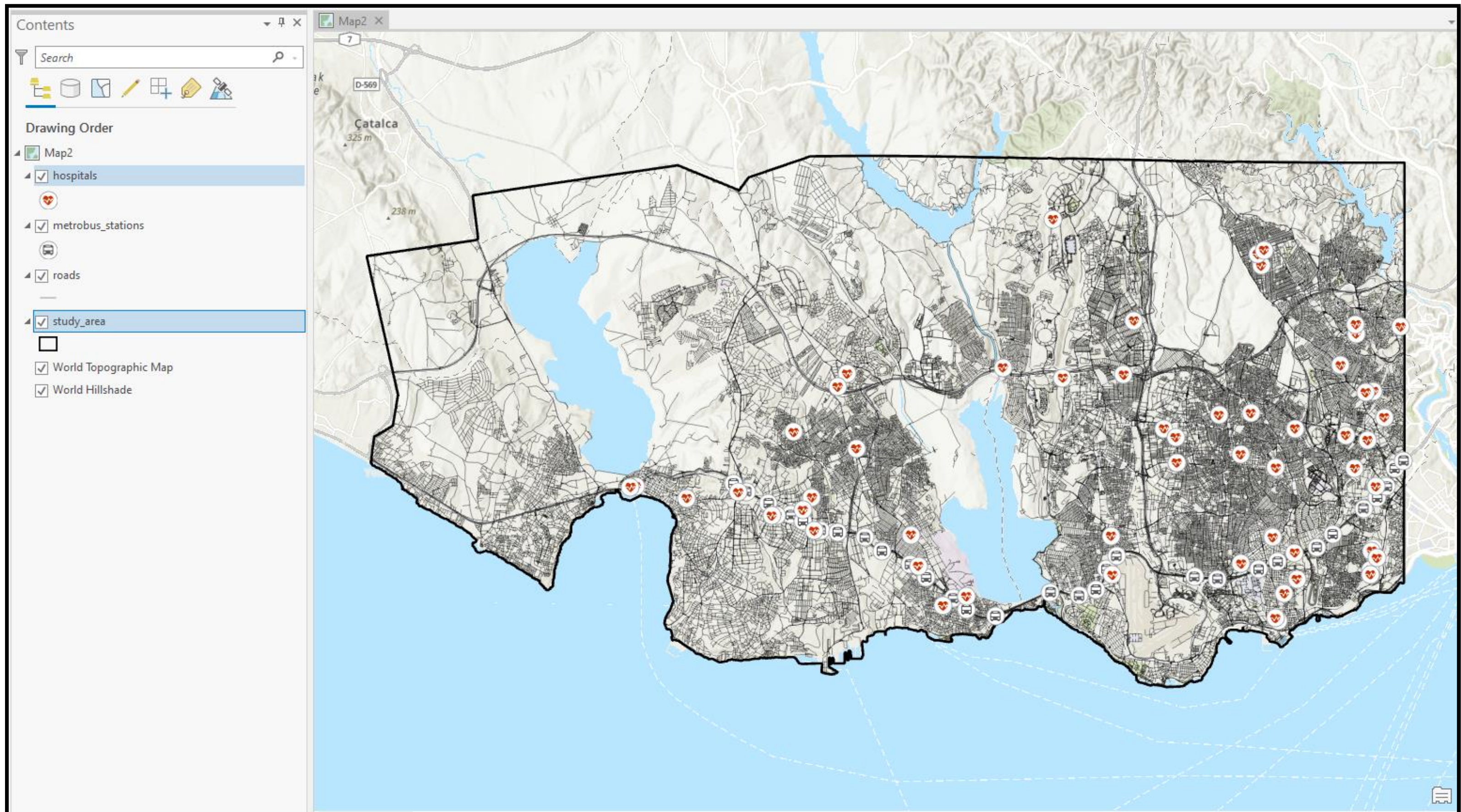
- A network is a system of interconnected elements that represent possible routes from one location to another. It is originated from graph theory where network elements are represented as edges (links) and connecting junctions (nodes).
- It is used for answering such questions
 - What is the quickest way to get from point A to point B?
 - Which houses are within five minutes of a fire station?
 - What market areas does a business cover?
 - Which ambulances or patrol cars can respond quickest to an incident?

Simple Graph Representation



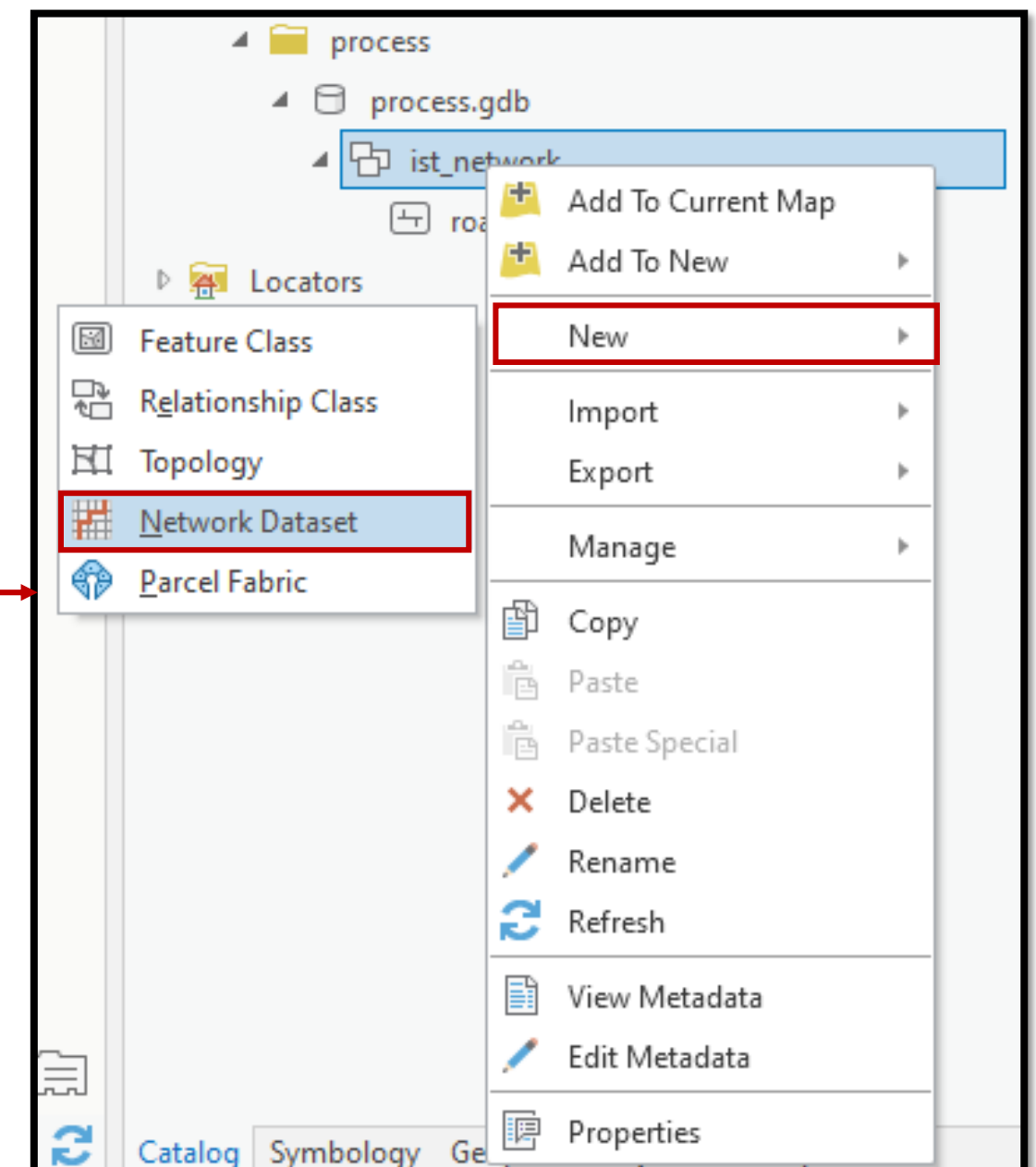
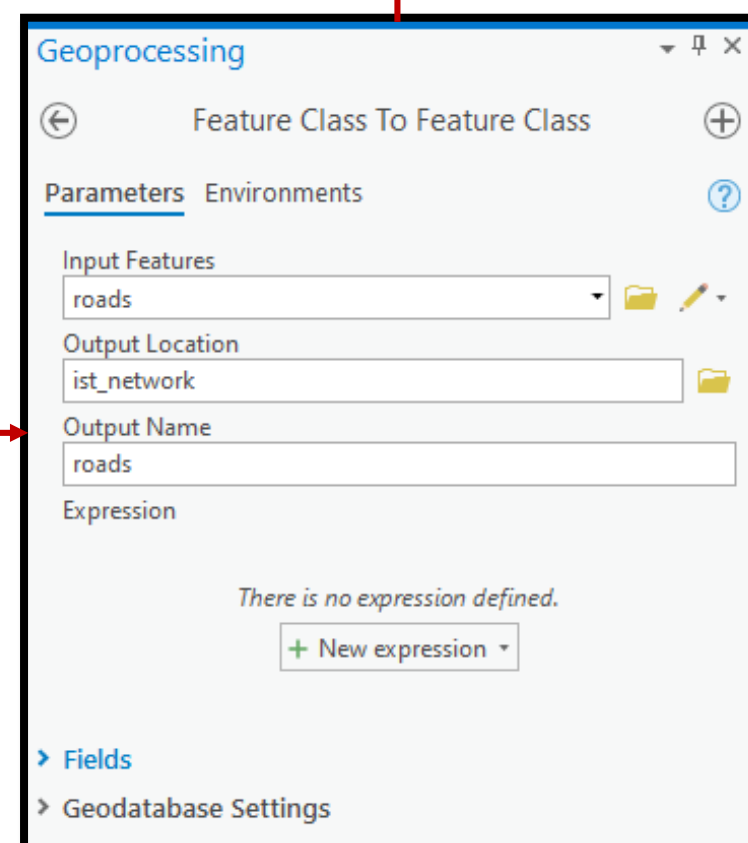
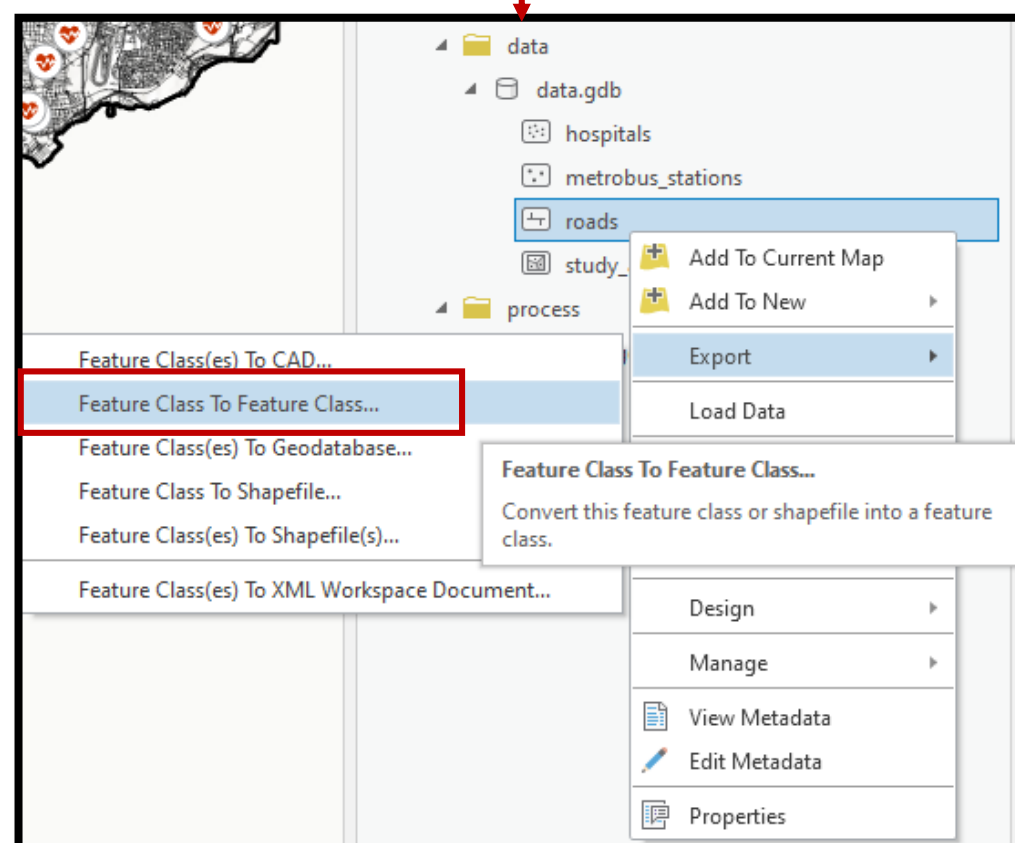
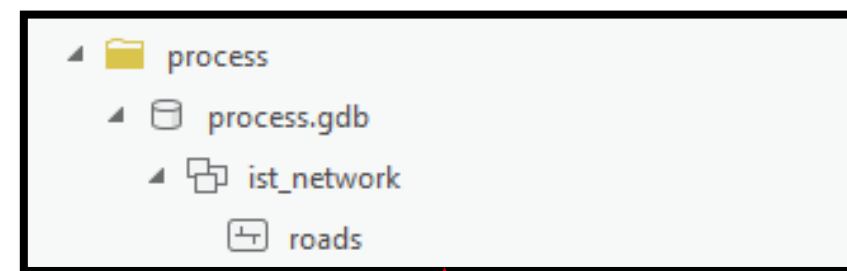
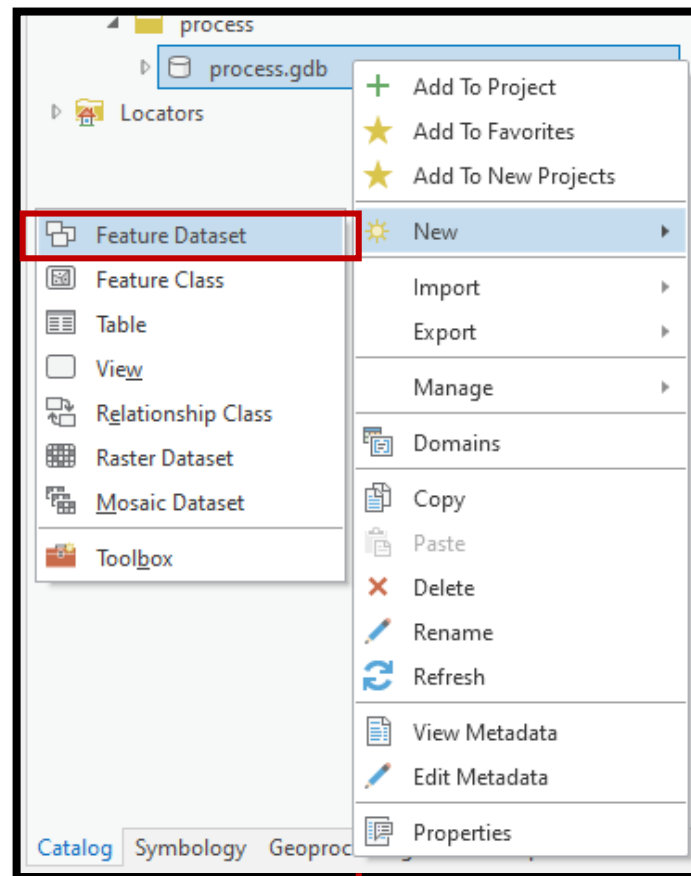
A graph is represented as a set of elements and the connections between them. The elements of the definition are called nodes/vertices or junctions represented as A, B, C and D and the edges or links represented as connections between nodes.

Study Area & Data



Create Network Dataset

- Create a feature dataset inside process.gdb to structure and keep the network structure within.
- Select the appropriate coordinate system of the project (TUREF TM 30) for the feature dataset and name it as “ist_network”
- Then export existing road data into this newly created feature dataset



Create Network Dataset



Geoprocessing

Create Network Dataset

Parameters Environments

Target Feature Dataset
ist_network

Network Dataset Name
network

Source Feature Classes
☒ roads

Elevation Model
No elevation

Run

Network Properties

Network Dataset Properties: network

General

Source Settings

Traffic

Travel Attributes

Directions

Network Dataset

Data Type	File Geodatabase Network Dataset
Database	C:\Lecture\Lab11\process\process.gdb
Feature Dataset	ist_network
Network	network

Build Status

Not Built

The network dataset or its sources have been edited since the last time it was built.

Edges	0
Junctions	0
Turns	0

Sources

roads	Edge
network_Junctions	Junction (System)

Indexes

☒ Service-Area Index

Extent

Spatial Reference

Domain, Resolution and Tolerance

Summary

Data Type: File Geodatabase Network Dataset
Database: C:\Lecture\Lab11\process\process.gdb
Feature Dataset: ist_network
Network: network
Dataset Version: 10.1

Build Status: Not Built
The network dataset or its sources have been edited since the last time it was built.

Edges: 0
Junctions: 0
Turns: 0

Sources:
Edge Sources:
roads
Junction Sources:
network_Junctions

Learn more about network datasets

OK Cancel

If service area analysis will be conducted, check this button

Should be built first

Network Properties



General | **Sources** | Vertical Connectivity | Group Connectivity

Network Dataset is used by network layers in opened maps.

These are the features that participate in your network dataset.

Name

- Edges
 - roads
- Junctions
 - network_Junctions

Connectivity Settings

If there are multiple travel modes in your project, proper node & edge connections are done from the connectivity tabs in this section.

General | Source Settings | Traffic | **Travel Attributes** | Directions

Travel Modes | **Costs** | Restrictions | Descriptors | Time Zone | Hierarchy

Network Dataset is used by network layers in opened maps.

These are the available cost attributes of the network dataset.

Cost

- Distance
 - Length

Units

Kilometers

Properties

Name: Length

Units: Kilometers

Data Type: double

Parameters

Name	Type	Default Value
Click to add new row.		

Evaluators

Source	Type	Value
Edges		
roads (Along)	Field Script	[Shape]
roads (Against)	Same as Along	[Shape]
<Default>	Constant	0
Junctions		
network_Junctions	Same as Default	0
<Default>	Constant	0
Turns		
<Default>	Constant	0

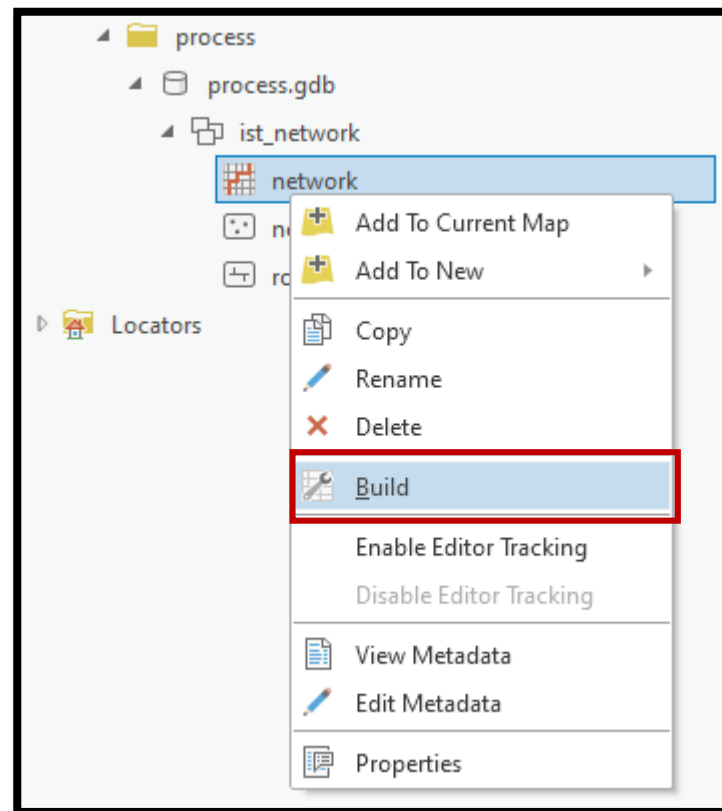
Learn more about cost attribute settings

OK Cancel

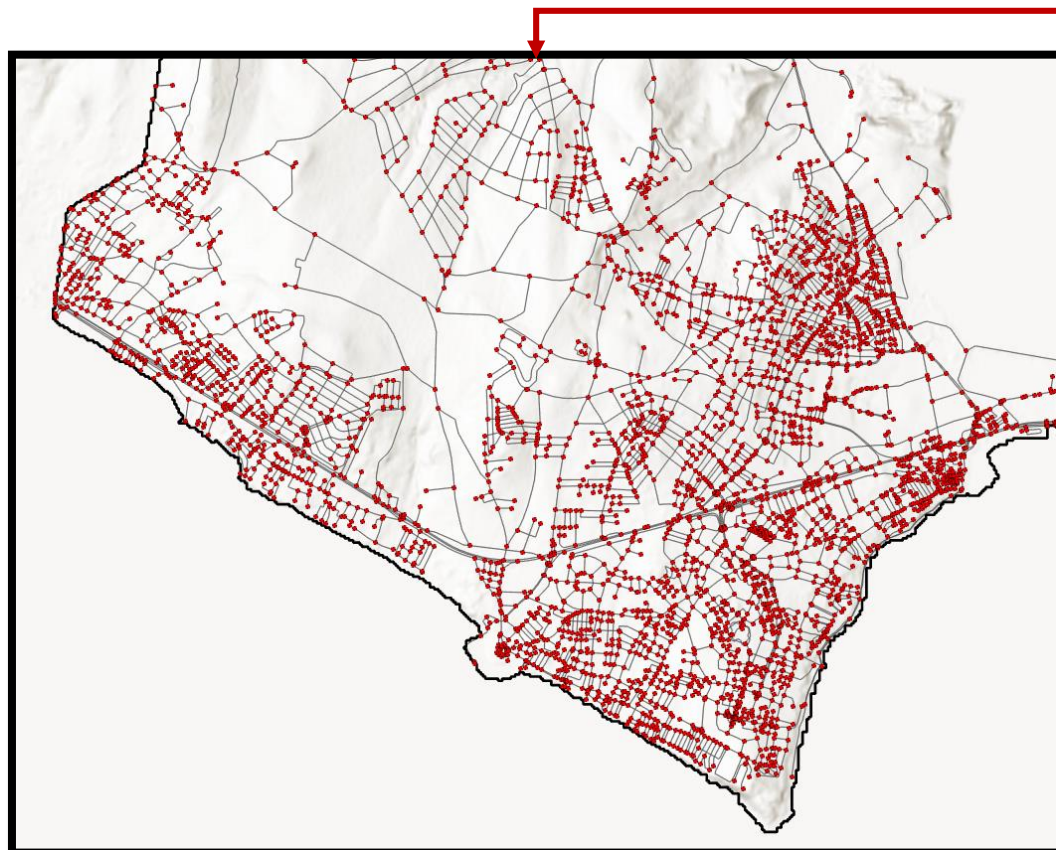
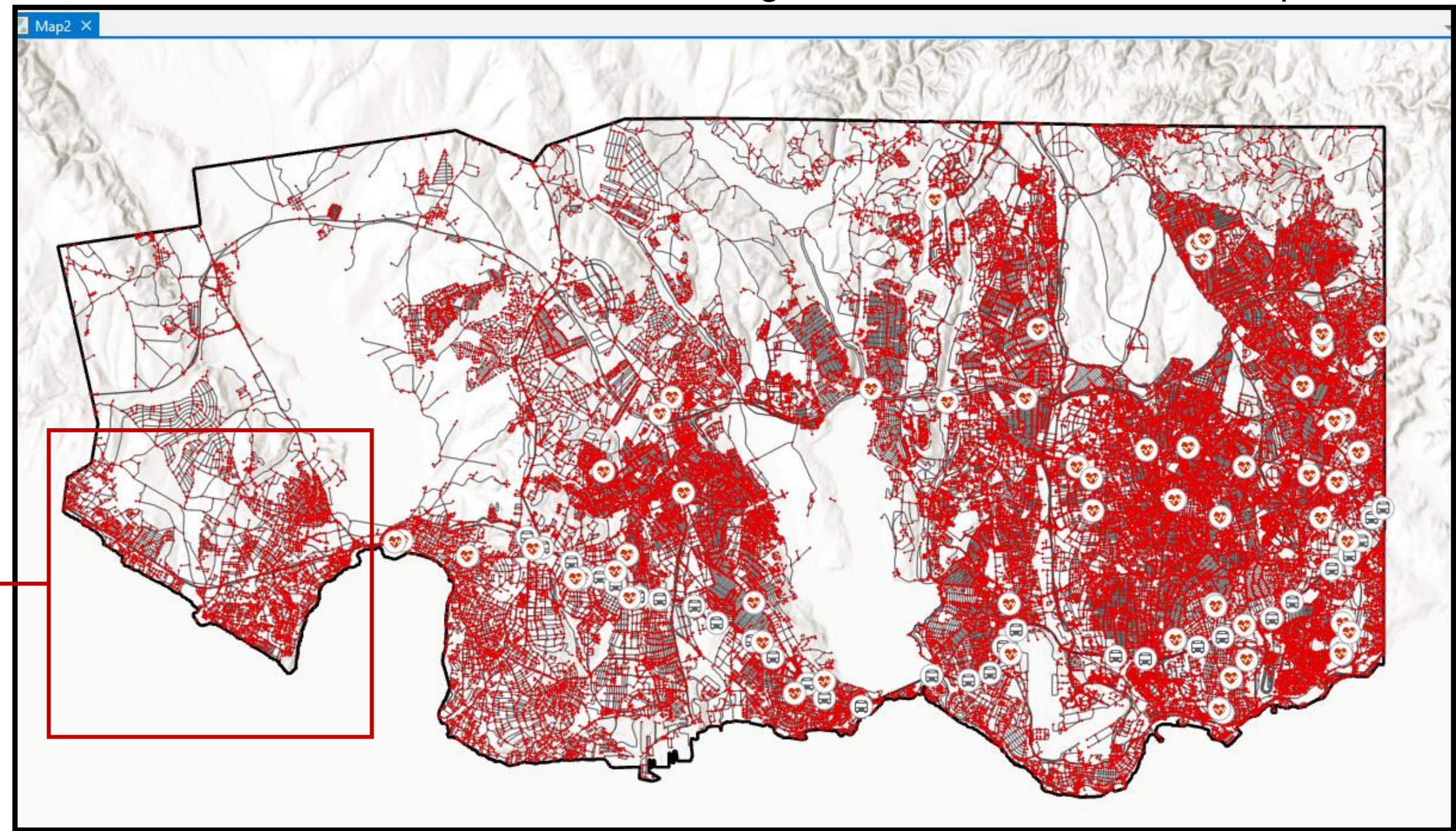
Travel Attributes

Time / cost or distance can be used as a cost distance. In this Project we only have distance information of data, so only Length is selected in below step. If there is more, it can be selected from this section.

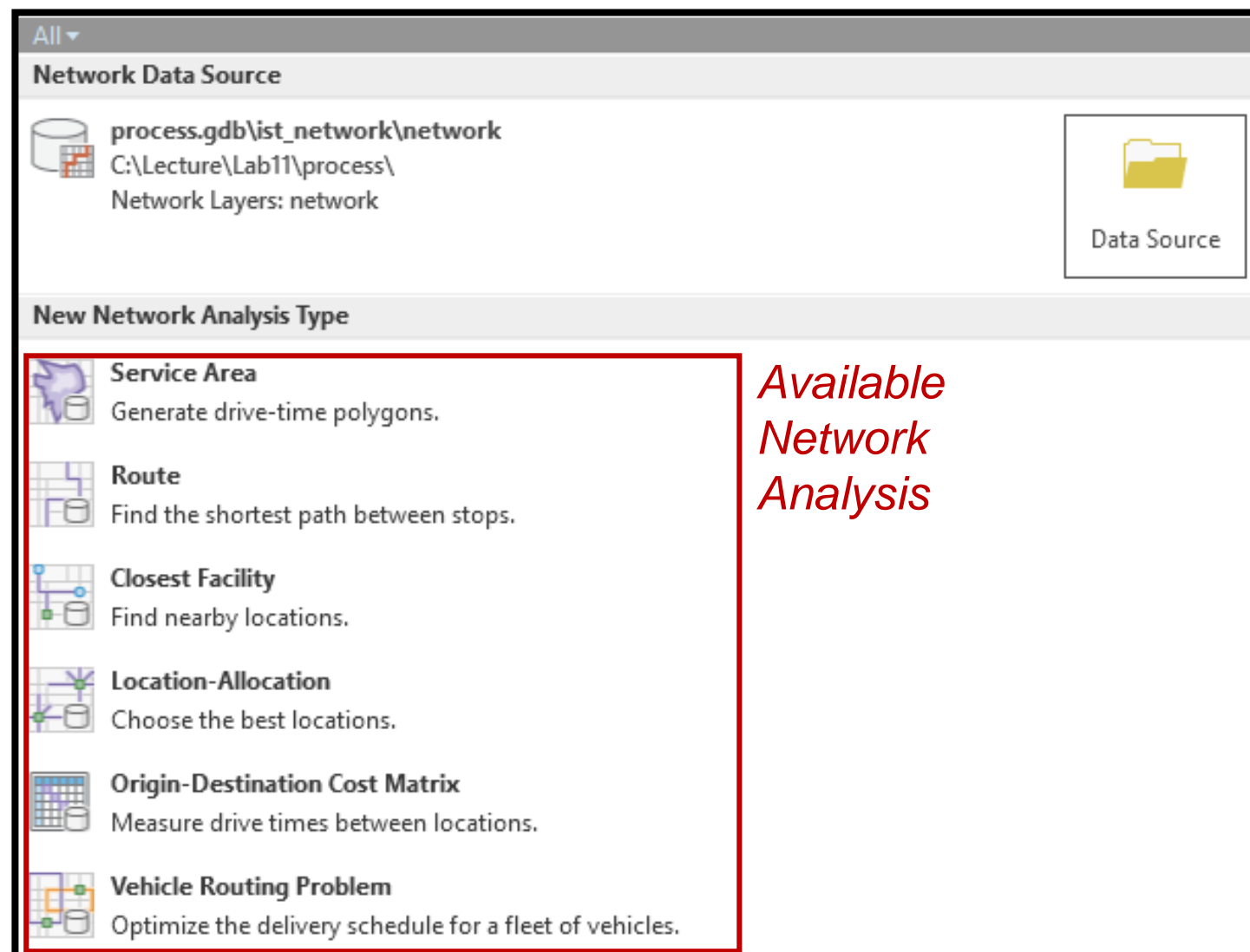
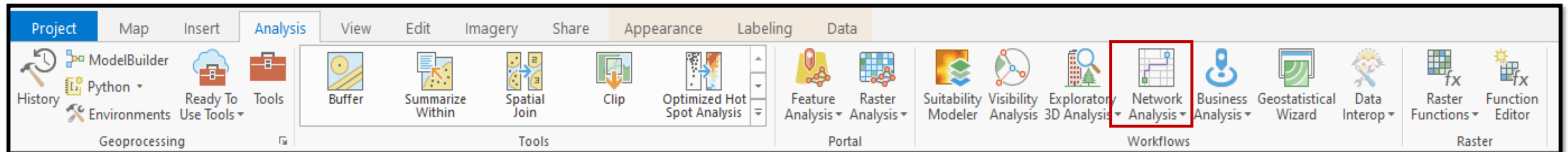
Build Network Topology



Network is built and the junctions (nodes) are created (red points) where the road segments' intersections and end points are.

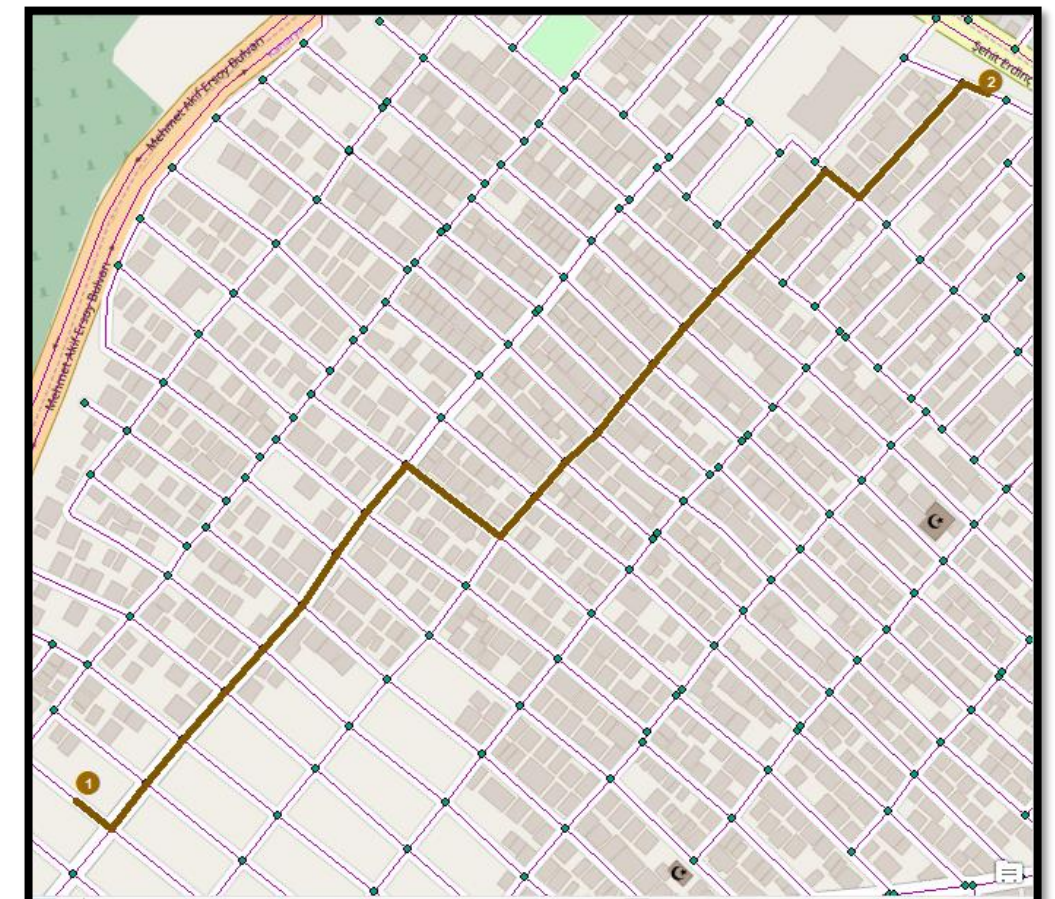


Network Analysis Route



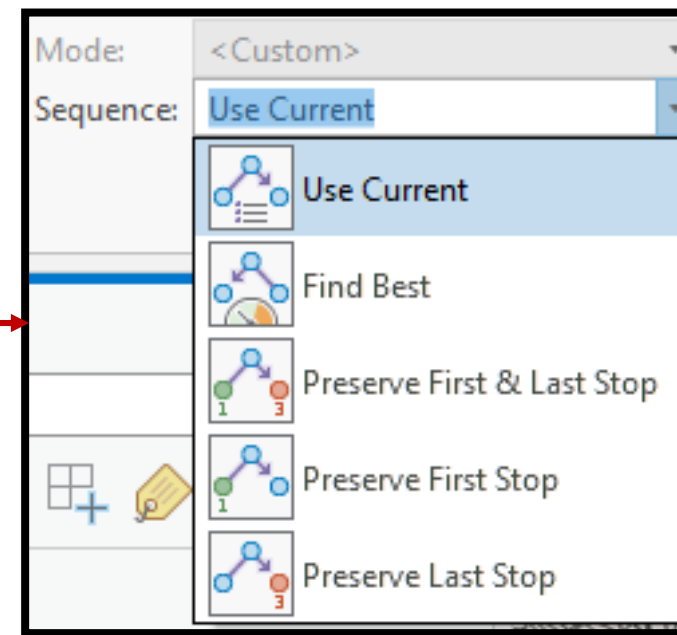
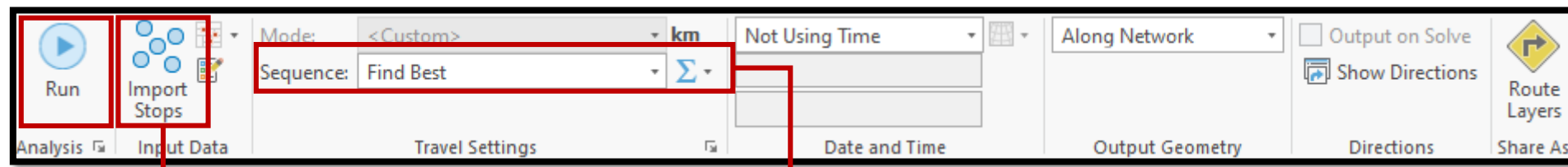
*Available
Network
Analysis*

Route Analysis

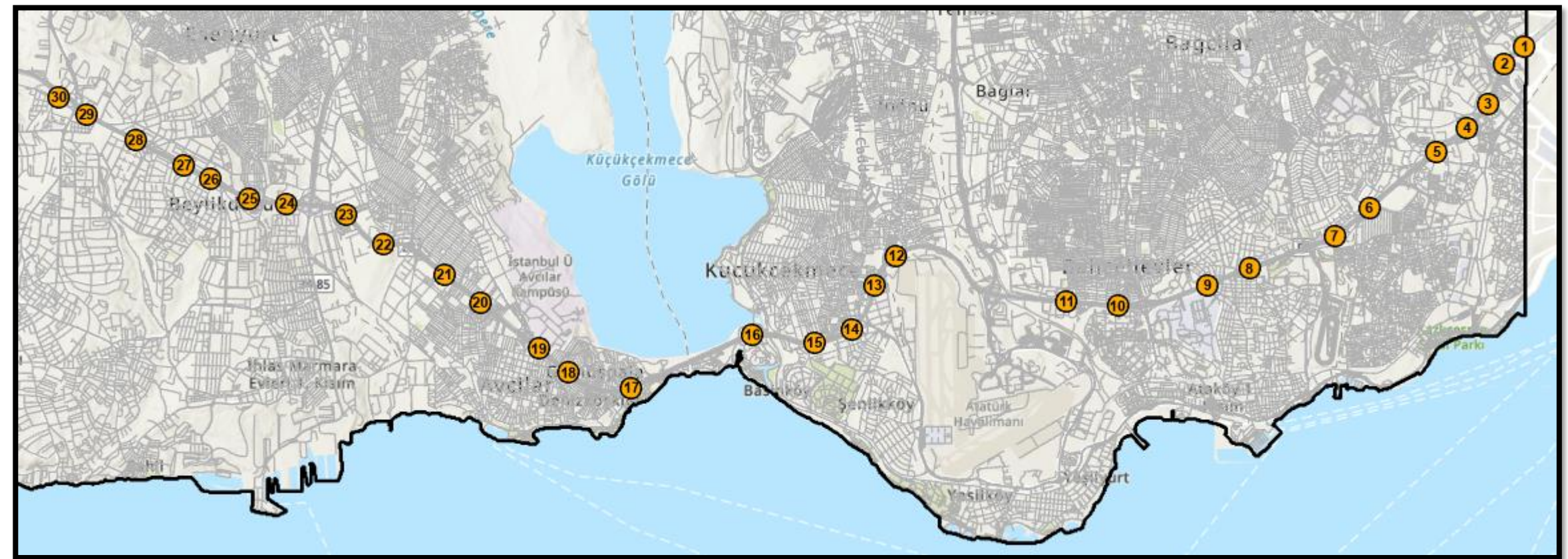
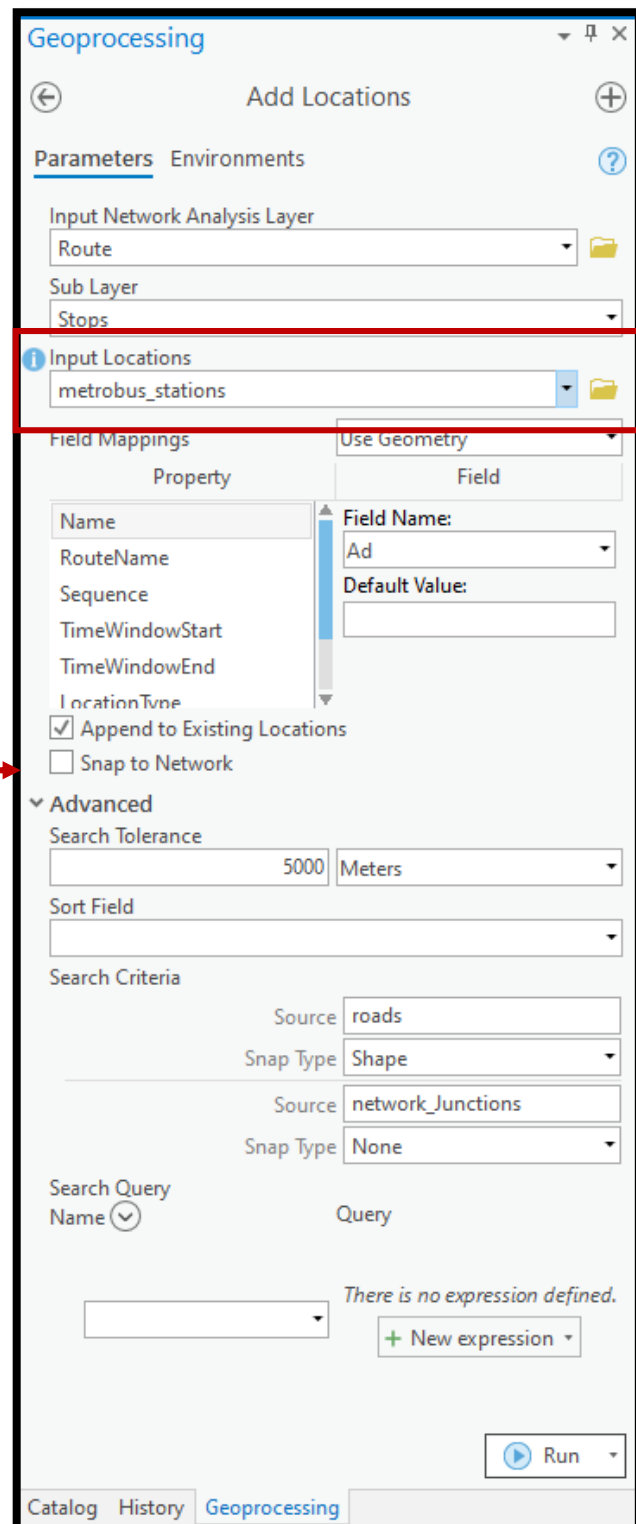
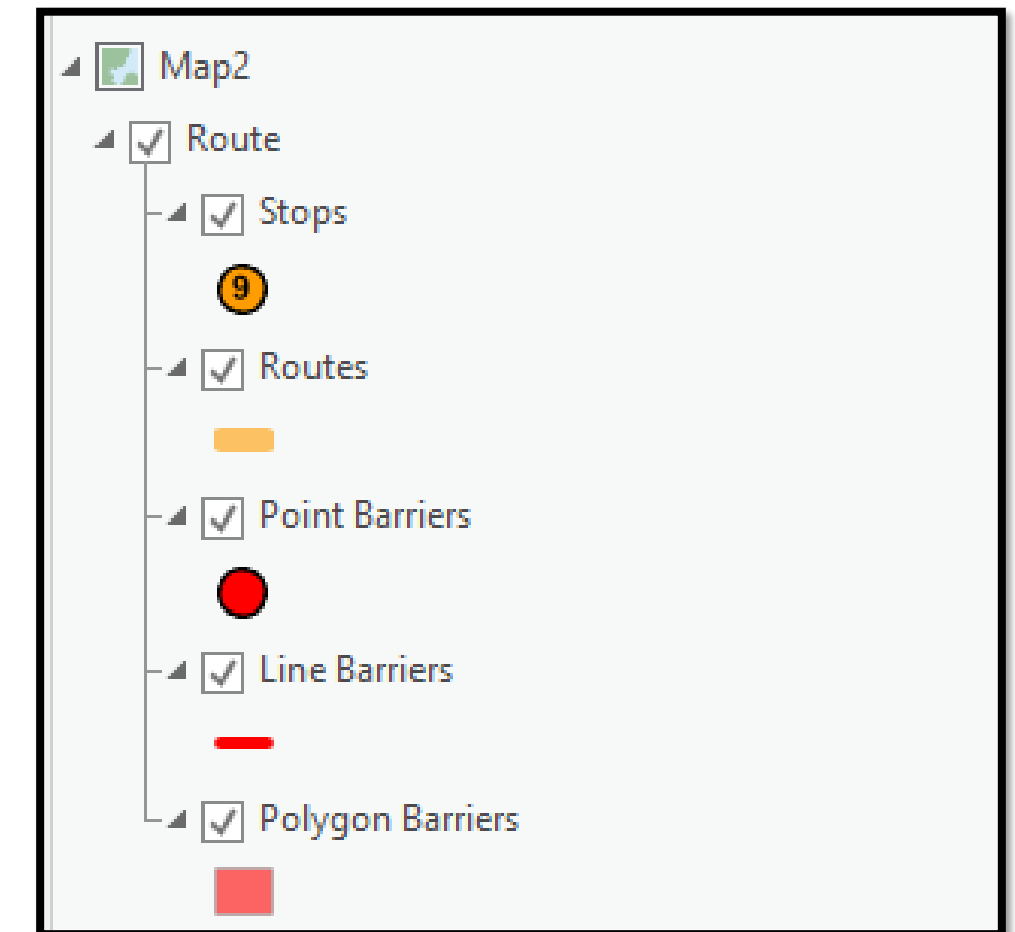


- Solving a route analysis can mean finding the quickest, shortest, or even the most scenic route, depending on the impedance you choose to solve for.
- If the impedance is time, then the best route is the quickest route. If the impedance is a time attribute with live or historical traffic, then the best route is the quickest route for a given time of day and date.

Network Analysis Route

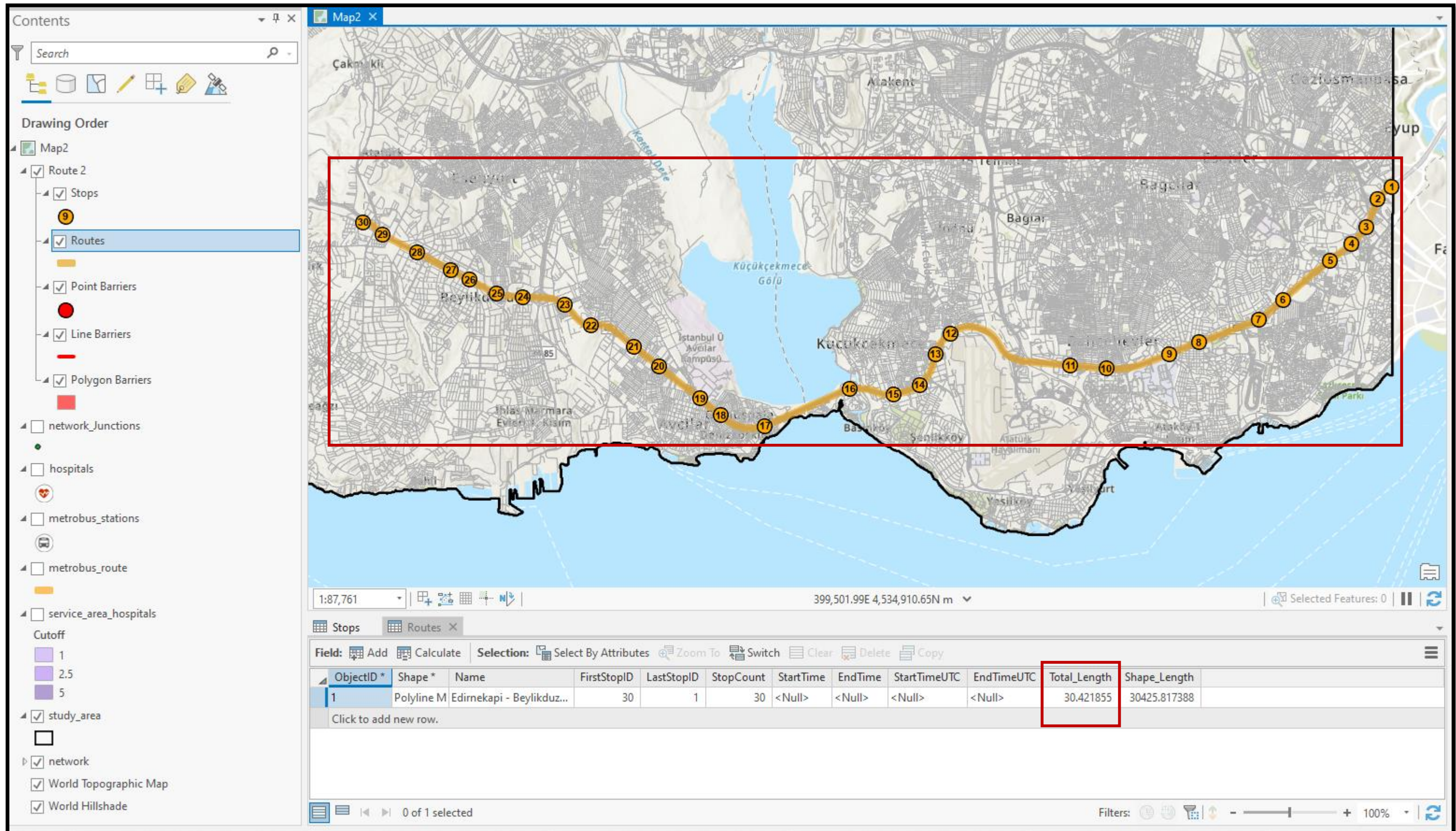


Sequence
Settings



Import *metrobus_stations* layer as stops for getting the shortest path between them

Result of Route Analysis

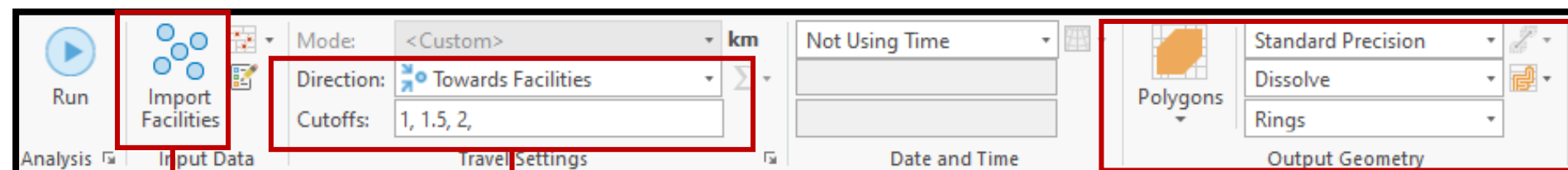


Export route layer into process folder for further analysis & interpretations.

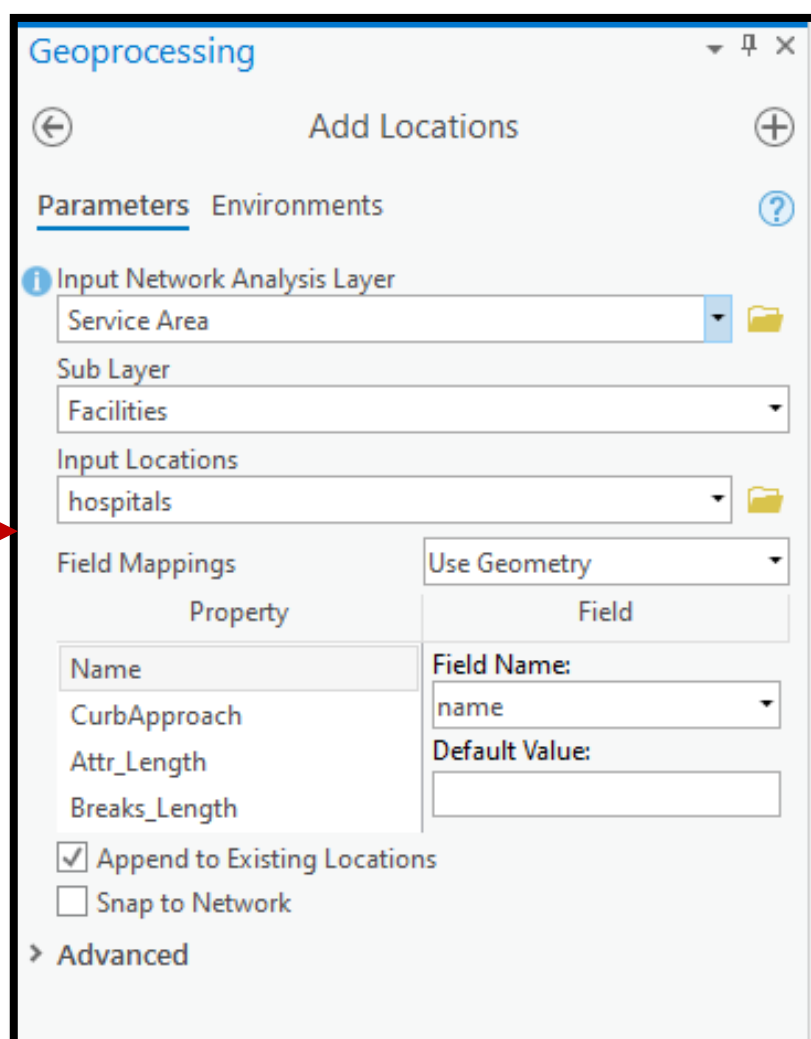
Network Analysis Service Area



- A network service area is a region that encompasses all accessible streets (that is, streets that are within a specified impedance).
- For instance, the 5-minute service area for a point on a network includes all the streets that can be reached within five minutes from that point.



Service Area

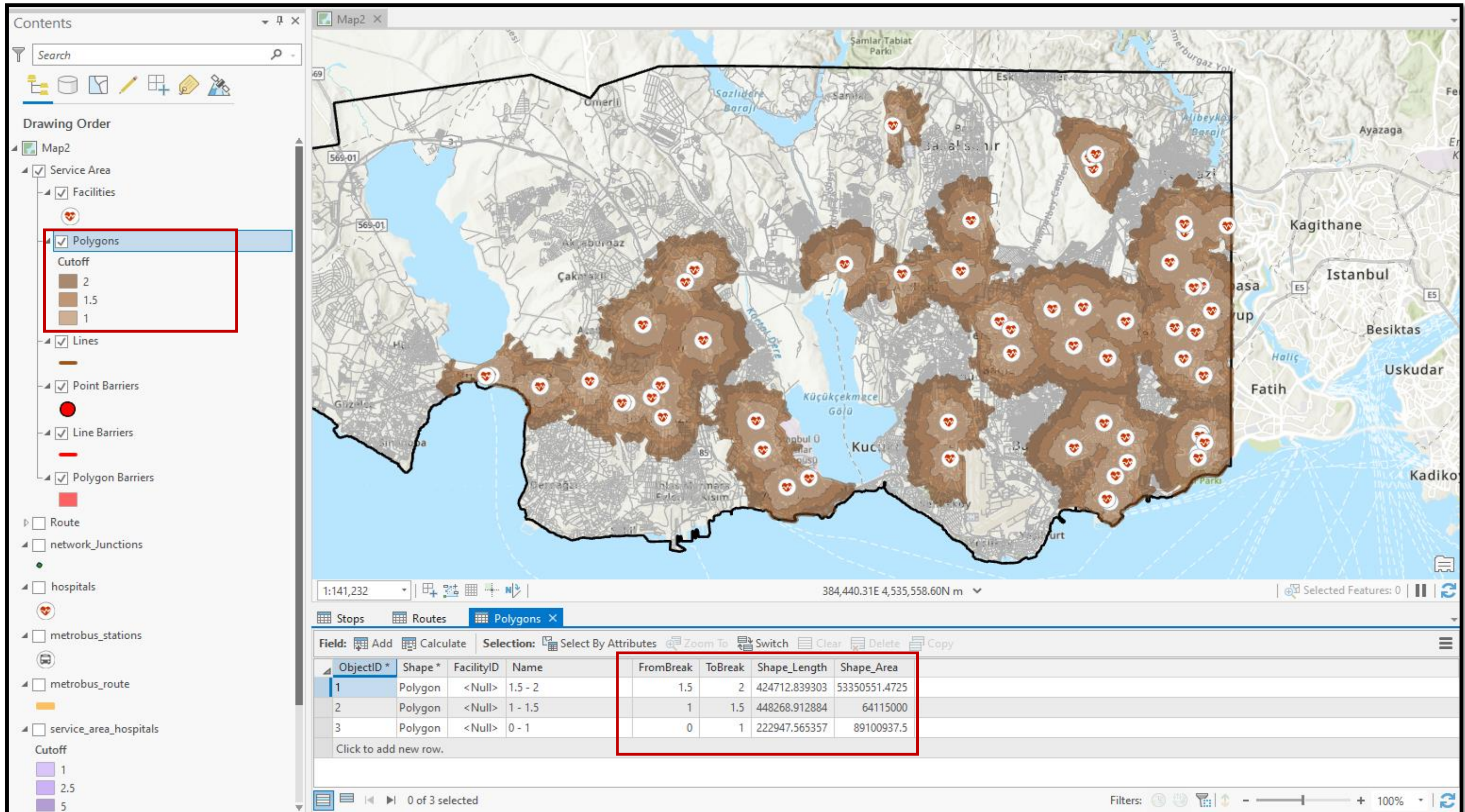


Configure appropriate analysis settings from these sections. Cutoffs is used to generate proximity polygons in selected values. In the example, 1km, 1.5km and 2km proximity polygons will be generated towards facilities.

In this section you may select the precision of the resulted polygons and determine whether your polygons will dissolve or not.

Import *hospitals* layer as facilities for generating service areas towards them

Result of Service Area Analysis

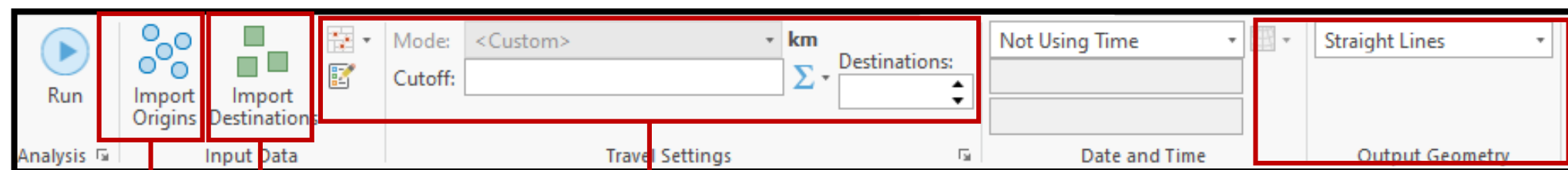


Export service area polygons into process folder for further analysis & interpretations.

Network Analysis

OD Cost Matrix

- An OD cost matrix analysis layer finds and measures the least-cost paths along the network from multiple origins to multiple destinations.
- When configuring an OD cost matrix analysis, you can specify the number of destinations to find and a maximum distance to search.

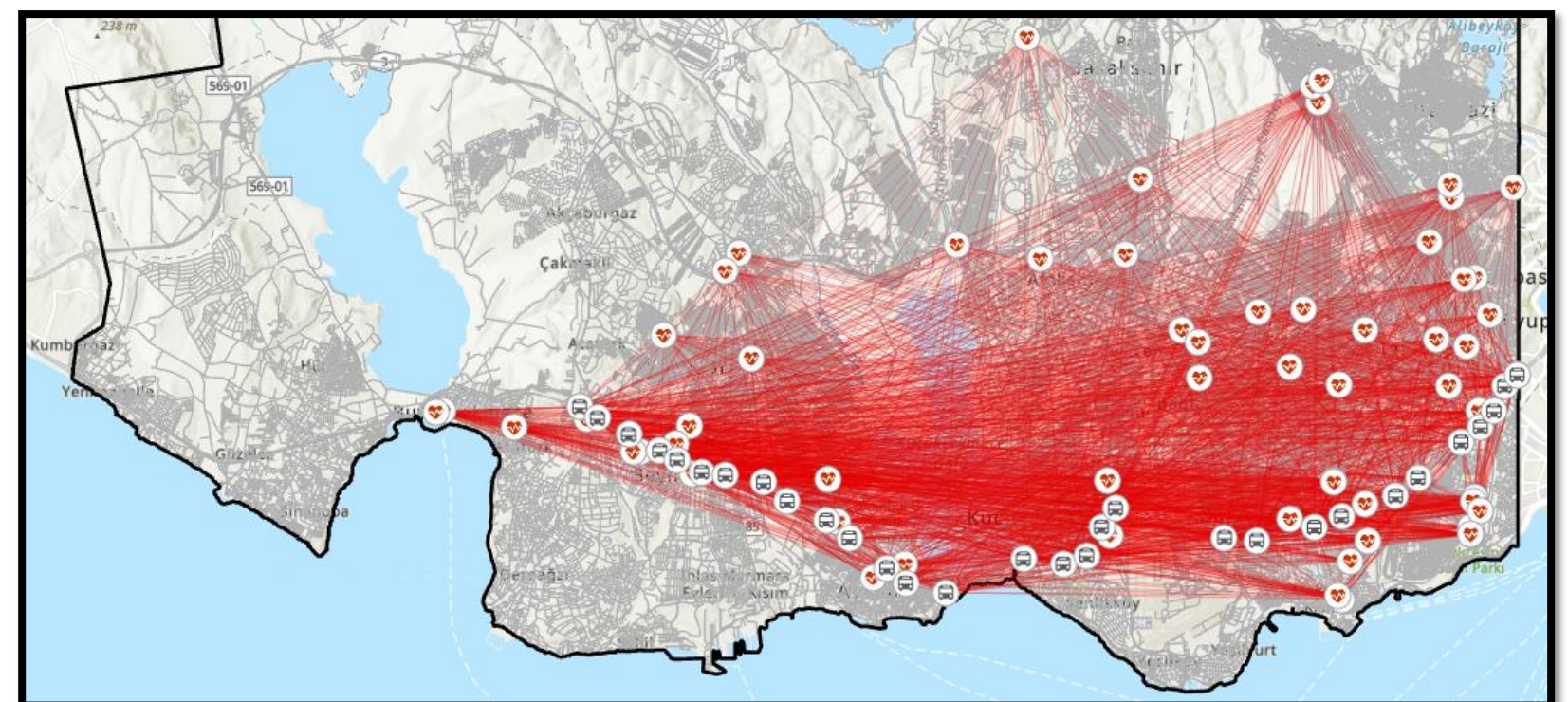
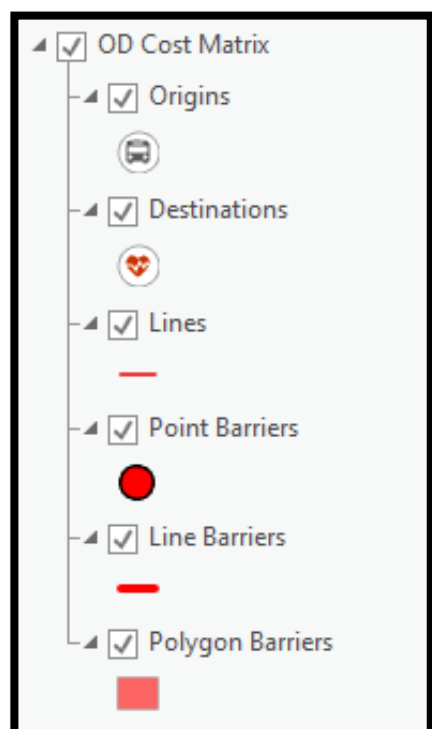


Import metrobus_stations as origins

Import hospitals as destinations

Specify the number of destinations to find and a maximum distance to search.

The result of OD Cost Analysis shown as straight lines to save processing power. The actual cost (distance/time etc.) is calculated and written in the result layer's attributes.



Result of OD Cost Matrix

- For 30 metrobus stations and 61 hospitals, 1830 (30x61) paths are calculated and for each station, closest hospitals are ranked in the resulted attribute table.

ObjectID *	Shape *	Name	OriginID	DestinationID	DestinationRank	Total_Length	Shape_Length
1	Polyline	Beylikduzu Son Durak - Dünya Göz Hastanesi...	1	32	1	0.7621	382.379091
2	Polyline	Beylikduzu Son Durak - Birinci Göz Hastanesi...	1	33	2	2.335123	1903.905649
3	Polyline	Beylikduzu Son Durak - Aile Polikliniği	1	25	3	2.362524	2051.153116
4	Polyline	Beylikduzu Son Durak - Sağlık Ocağı	1	35	4	2.685902	1870.681407
5	Polyline	Beylikduzu Son Durak - Medihaus	1	29	5	3.215624	2828.115312
6	Polyline	Beylikduzu Son Durak - Özel Mediplus Tıp Me...	1	23	6	3.471938	3033.993834
7	Polyline	Beylikduzu Son Durak - Medilife Beylikdüzü H...	1	36	7	3.827033	3563.871993
8	Polyline	Beylikduzu Son Durak - S life hastanesi	1	14	8	4.175307	3015.149112
9	Polyline	Beylikduzu Son Durak - Özel 2000 Tıp Merkezi	1	4	9	4.354514	3733.43508
10	Polyline	Beylikduzu Son Durak - Büyükçekmece Aile S...	1	51	10	4.604407	3932.575882
11	Polyline	Beylikduzu Son Durak - Alataş Polikliniği	1	20	11	5.85483	4865.071111
12	Polyline	Beylikduzu Son Durak - İstinye Üniversite Has...	1	61	12	7.00238	5418.398879
13	Polyline	Beylikduzu Son Durak - Özel Elitium	1	19	13	7.638136	6022.766377
14	Polyline	Beylikduzu Son Durak - Özel Anadolu Hastan...	1	41	14	7.852706	7045.622737
15	Polyline	Beylikduzu Son Durak - Özel Avcılar Hospital	1	9	15	8.208594	7713.392221
16	Polyline	Beylikduzu Son Durak - Özel Medicana Hasta...	1	6	16	10.02552	9251.896236
17	Polyline	Beylikduzu Son Durak - Avcılar Murat Kölük D...	1	15	17	10.565878	9866.939411
18	Polyline	Beylikduzu Son Durak - Dayıoğlu Tıp Merkezi	1	60	18	12.920672	11190.016754
19	Polyline	Beylikduzu Son Durak - İstanbul Tema Hastan...	1	26	19	15.279852	13192.437366
20	Polyline	Beylikduzu Son Durak - İAÜ VM MEDİCALPAR...	1	57	20	16.73877	14872.286536
21	Polyline	Beylikduzu Son Durak - Özel Akgün Tem Hast...	1	56	21	17.539256	15457.02907
22	Polyline	Beylikduzu Son Durak - Vera Tıp Merkezi	1	40	22	17.551661	14541.665224

- By using these information accessibility of stations and hospitals can be found.
- Add a field named “accessibility” and use $1 / \text{Total_Length}$ formula to calculate mean accessibility of each station/hospital

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Domain	Default	Length
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	ObjectID	ObjectID	Object ID	<input type="checkbox"/>	<input type="checkbox"/>	Numeric			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Shape	Shape	Geometry	<input checked="" type="checkbox"/>	<input type="checkbox"/>				1024
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Name	Name	Text	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
<input checked="" type="checkbox"/>	<input type="checkbox"/>	OriginID	OriginID	Long	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	DestinationID	DestinationID	Long	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	DestinationRank	DestinationRank	Long	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Total_Length	Total_Length	Double	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric	Total_Length		
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Shape_Length	Shape_Length	Double	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric			
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Accessibility	Accessibility	Double	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric			

Result of OD Cost Matrix

ObjectID *	Shape *	Name	OriginID	DestinationID	Total_Length	Shape_Length	Accessibility
1	Polyline	Beylikduzu Son Durak - Dünya Göz Hastanesi...			0.7621	382.379091	1.312
2	Polyline	Beylikduzu Son Durak - Birinci Göz Hastanesi...			2.335123	1903.905649	0.428
3	Polyline	Beylikduzu Son Durak - Aile Polikliniği			2.362524	2051.153116	0.423
4	Polyline	Beylikduzu Son Durak - Sağlık Ocağı			2.685902	1870.681407	0.372
5	Polyline	Beylikduzu Son Durak - Medihaus			3.215624	2828.115312	0.311
6	Polyline	Beylikduzu Son Durak - Özel Mediplus Tıp Me...			3.471938	3033.993834	0.288
7	Polyline	Beylikduzu Son Durak - Medilife Beylikdüzü H...			3.827033	3563.871993	0.261
8	Polyline	Beylikduzu Son Durak - S life hastanesi			4.175307	3015.149112	0.24
9	Polyline	Beylikduzu Son Durak - Özel 2000 Tıp Merkezi			4.354514	3733.43508	0.23
10	Polyline	Beylikduzu Son Durak - Büyükçekmece Aile S...			4.604407	3932.575882	0.217
11	Polyline	Beylikduzu Son Durak - Alataş Polikliniği			5.85483	4865.071111	0.171
12	Polyline	Beylikduzu Son Durak - İstinye Üniversite Has...			7.00238	5418.398879	0.143
13	Polyline	Beylikduzu Son Durak - Özel Elitium			7.638136	6022.766377	0.131

- Find the mean and total accessibility for both origins and destinations by using summarize
- Then join this information into original metrobus_stations and hospitals data to map the result

Summary Statistics

Input Table: Lines

Output Table: stations_accessibility

Statistics Field(s):

Field	Statistic Type
Accessibility	Sum
Accessibility	Mean

Case field: OriginID

OK

Summary Statistics

Input Table: Lines

Output Table: hospitals_accessibility

Statistics Field(s):

Field	Statistic Type
Accessibility	Sum
Accessibility	Mean

Case field: DestinationID

OK

Geoprocessing

Join Field

Input Table: metrobus_stations

Input Join Field: OBJECTID

Join Table: stations_accessibility

Join Table Field: OriginID

Transfer Fields:

- SUM_Accessibility
- MEAN_Accessibility

Validate Join

Geoprocessing

Join Field

Input Table: hospitals

Input Join Field: OBJECTID

Join Table: hospitals_accessibility

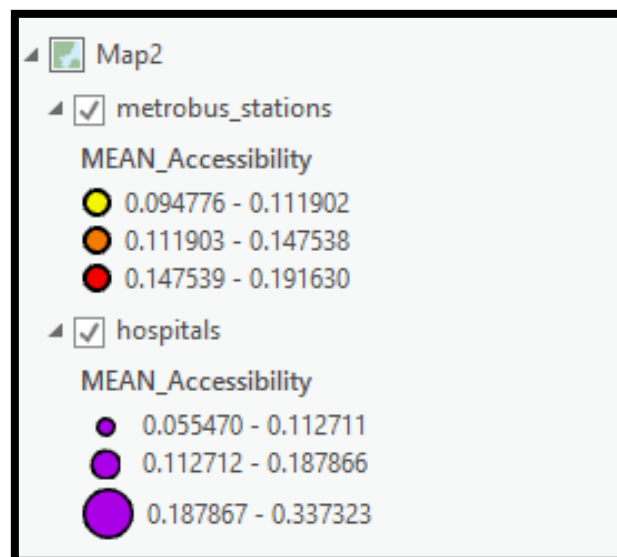
Join Table Field: DestinationID

Transfer Fields:

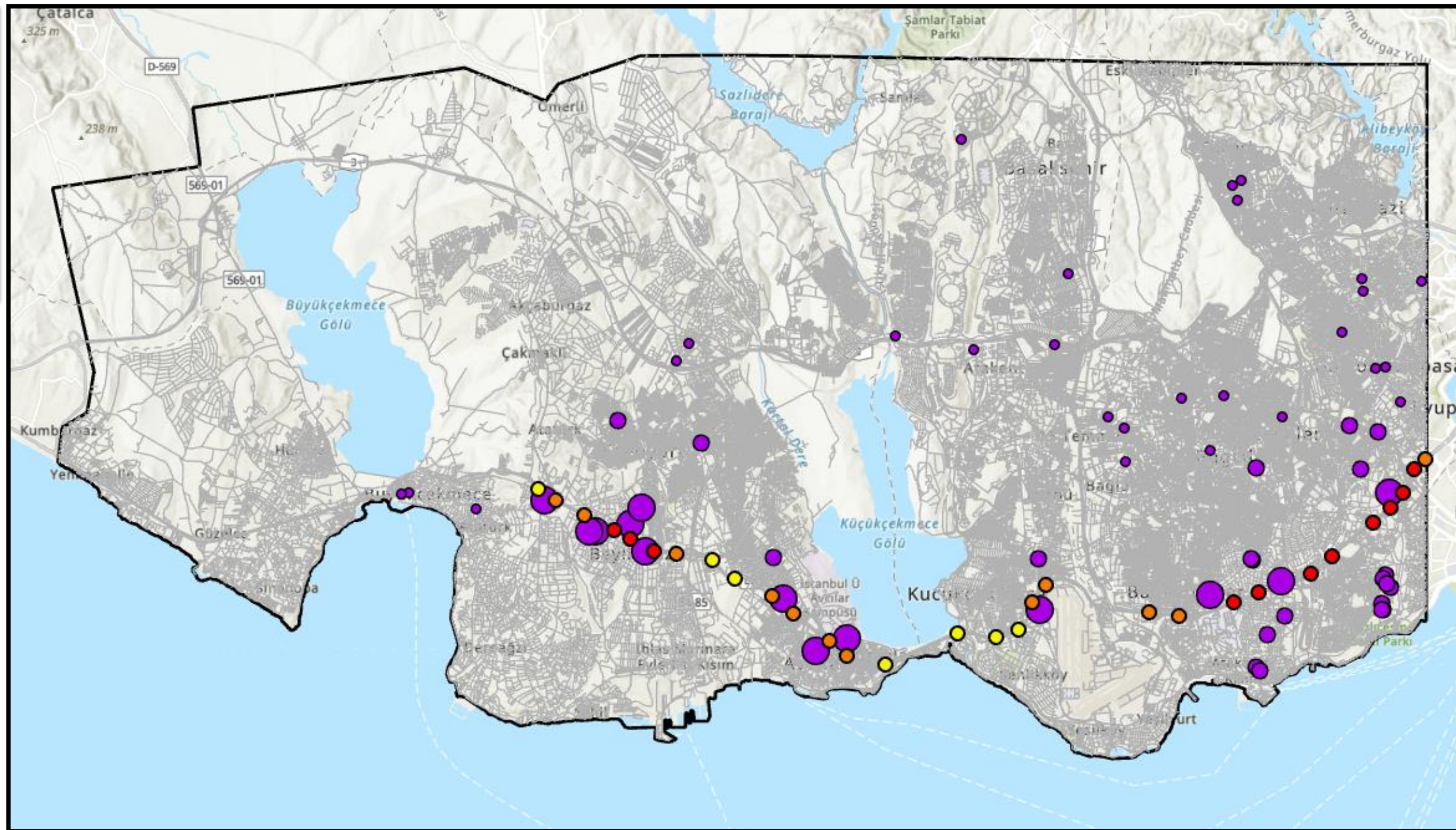
- SUM_Accessibility
- MEAN_Accessibility

Validate Join

Result of OD Cost Matrix



Use proper symbology to interpret the results of accessibility



- *Aim of Study:*
 - *Find the shortest route between metrobus stations*
 - *Generate service area towards hospitals*
 - *Generate OD Cost Matrixes to find each stations and hospitals' accessibility by using inverse distance ($1/[length]$) formula*
- *Output Data:*
 - *Hospitals with Accessibility values (Vector-Point)*
 - *Metrobus Stations with Accessibility values (Vector-Point)*
 - *Network Dataset of Study Area (Network)*
 - *Nodes (Vector-Point)*
 - *Edges (Vector-Polyline)*
 - *Shortest Route for Metrobus (Vector-Polyline)*
 - *Service Area for Hospitals (Vector-Polygon)*



Contact:

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