FINAL PROJECT REPORT

SUITABLE LOCATION TO CONSTRUCT A THERMAL POWER PLANT DRIVEN BY COAL IN WYOMING STATE

COURSE GIS 6112

Submitted by

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OBJECTIVE

The main objective of the project is to create a database showing the suitable city in Wyoming state to start a new thermal power plant driven by coal. To achieve the objective the required data obtained from Wyoming Geospatial hub (https://www.geospatialhub.org/). All the shape files obtained are considered most recent as they were last updated in 2019.

The requirement to construct the thermal power plant include:

1. The location has potential coal fields with area 100000acers to reduce the cost of the transport and have a stream station with no flooding status as the water is fed to cool the steam in a thermal plant.
2. The location is to be free of any forest burn areas to not have a dangerous effect on the power plant in future run.
3. The new power plant must be constructed in a location where there are no pre-existing power plants that are driven by coal or have max capacity greater than 200MW.
4. The final requirement is to choose a city which does not have any tourist building and have a stream station within 2 miles close by to the location.

STUDY AREA (DATA) AND METHODOLOGY

The study area chosen for the construction is Wyoming sate as the state have 16 operating coal mines and also good potential coal. The data for the study is downloaded from the Wyoming Geo Hub (https://www.geospatialhub.org/). The data used have seven shapefiles including state (polygon boundary, brown), county (polygon boundaries, light brown), cities (multi point data, light blue circle with a dot), potential coal fields (multi polygon data, black hatched) , stream stations (multi point data, blue triangle), burn areas (multi polygon data, orange gradient) and existing power plants (multi point data, green diamond). The study area with all the features above mentioned are shown in Figure 1 which was plotted in QGIS.

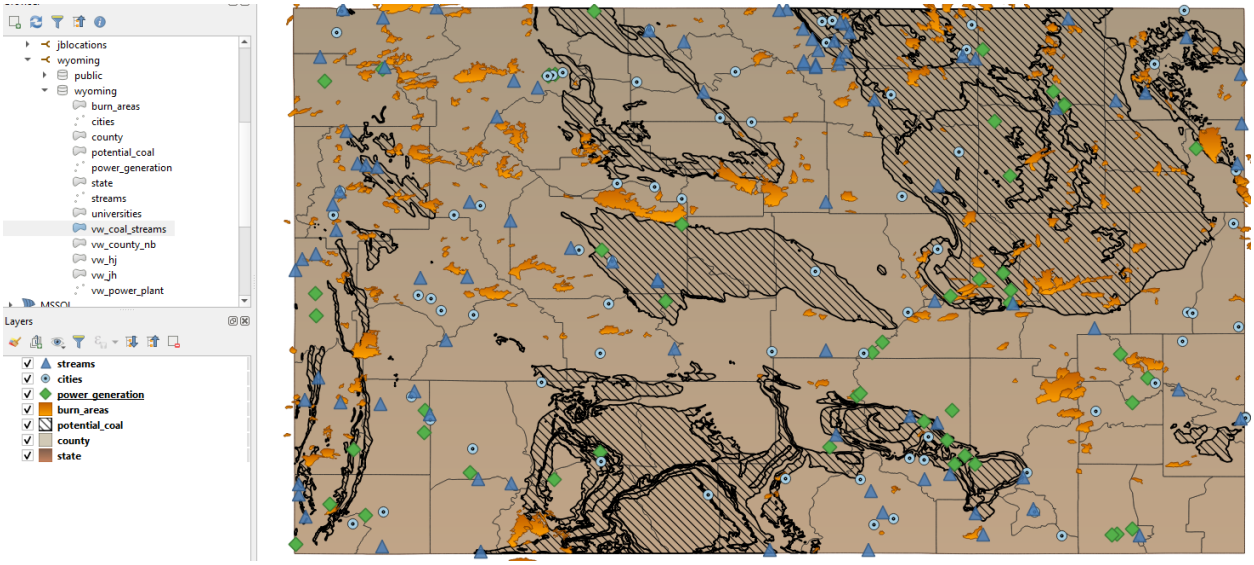

Figure 1: Study Area of the project showing all the shapefiles state (polygon boundary, brown), county (polygon boundaries, light brown), cities (multi point data, light blue circle with a dot), potential coal fields (multi polygon data, black hatched) , stream stations (multi point data, blue triangle), burn areas (multi polygon data, orange gradient) and existing power plants (multi point data, green diamond) in QGIS.

The tables are cross joined in pg admin, a management tool of PostgreSQL to create a final relational database. Cross join is used as there is no common attribute between any of the two shapefiles. The resulted tables are saved as view and are further used in quires based on the requirements. The workflow followed to obtain the objective using the shapefiles is demonstrated in the E-R diagram shown in Figure-2.

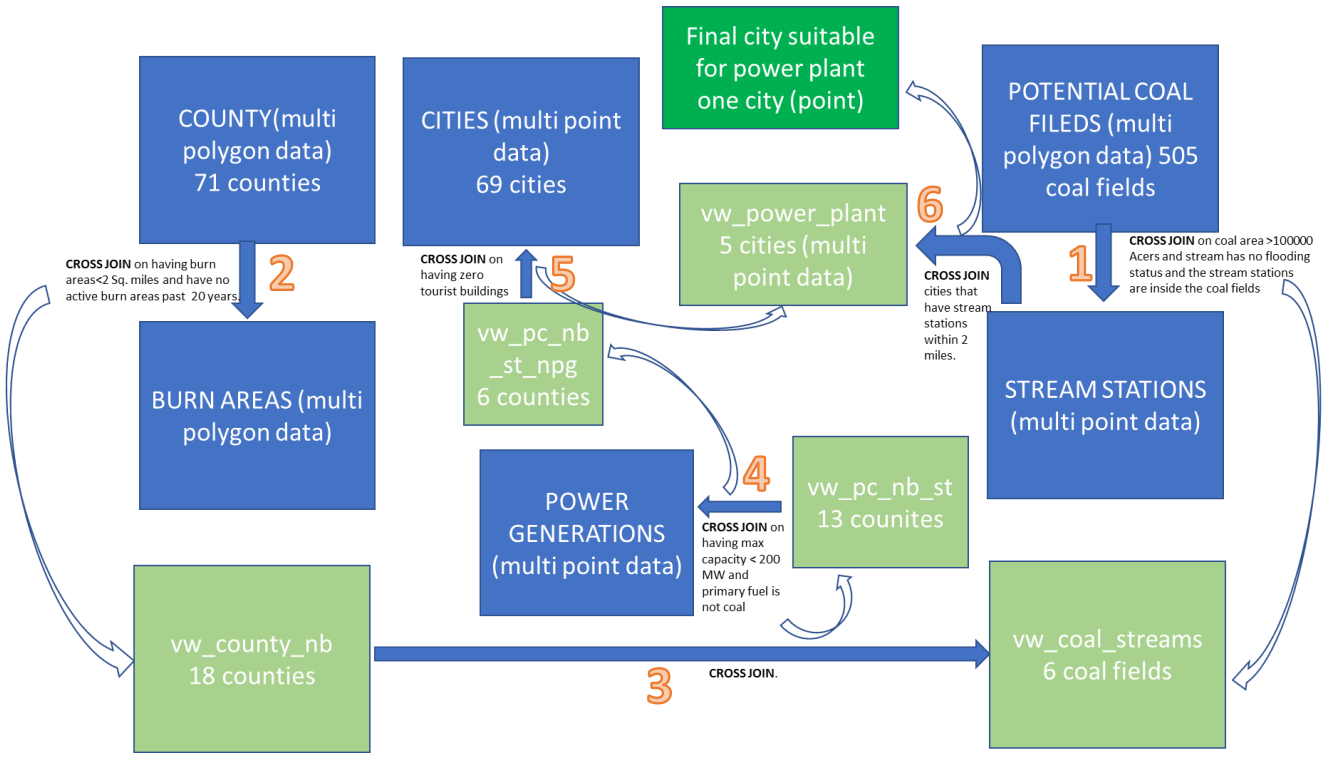

Figure 2: WORKFLOW to obtain the database to find the suitable site for power plant. Solid arrows in blue showing the cross joins used to join the data tables (blue) and the curved arrows directing toward the resulted view tables (light green) from the queries. Orange numbers indicate the query sequence followed.

RESULTS

To obtain the first requirement which is to have the potential coal fields with area more than 100k acres and have the stream stations which have no flooding status. A query (Query 1) is used to obtain the requirement which resulted in six potential coal fields fulfilling the requirement. The result from the query and resulted map showing six coal fields is shown in light maroon color in Figure 3. A view (vw_coal_streams) is created based on the query.

Query 1:

```
SELECT DISTINCT wyoming.potential_coal.gid, wyoming.potential_coal.geom,
wyoming.potential_coal.ACREAGE FROM wyoming.streams
CROSS JOIN wyoming.potential_coal WHERE potential_coal.ACREAGE>100000 AND streams.Status LIKE
'no_flooding%' AND ST_Contains(potential_coal.geom, streams.geom);
```

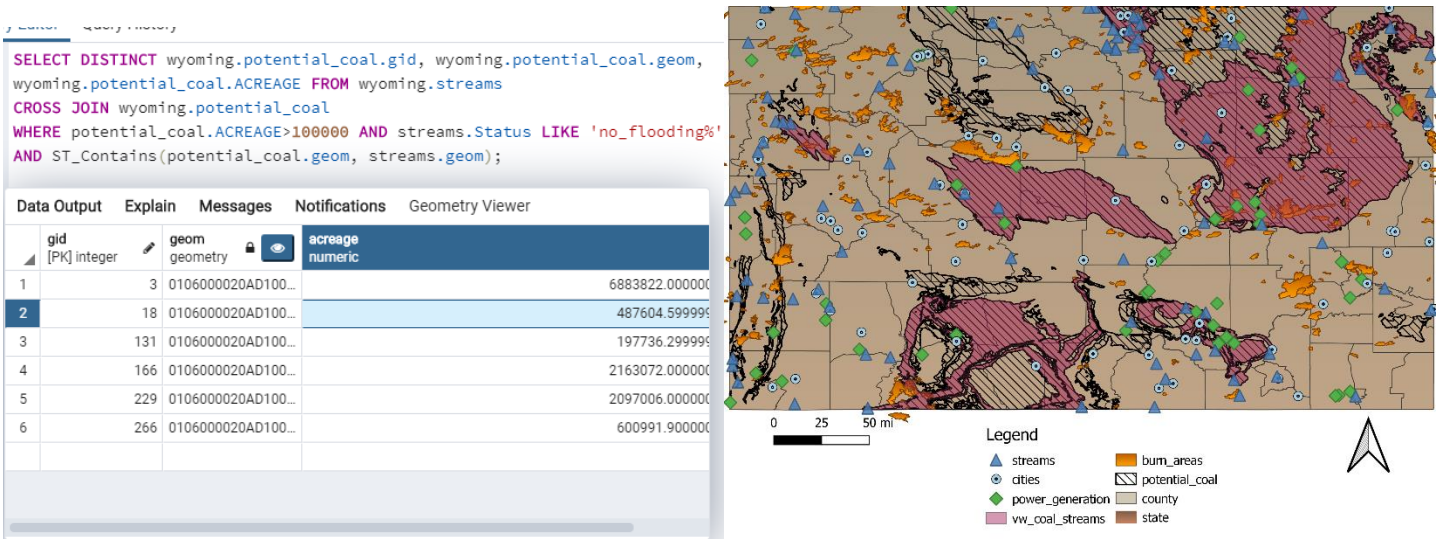

Figure 3: Six potential coal fields have area>100k acers and streams having no flooding status query (left) map (right) vw_coal_stream shown in light maroon. The resulted map has coal fields with stream stations.

To obtain the second requirement which to have the counties free of burn areas Query 2 is used make a cross join of the counties shapefile and burn areas shapefile having the burn area less than 2 Sq. miles and the burn areas which are not active since past 20 years because the burn areas large area might be harmful for the future run of a power plant and can cause huge losses if any forest fire occurs. The following query and resulted map are shown in the Figure 4 which has resulted 18 counties (Figure 4 (right) in green color) out of 71. A view (vw_county_nb) is created based on the query.

Query 2:

```
SELECT DISTINCT wyoming.county.gid, wyoming.county.geom
FROM wyoming.burn_areas CROSS JOIN wyoming.county
WHERE burn_areas.AREA_<2 AND burn_areas.YEAR<2000
AND ST_Contains(county.geom, burn_areas.geom);
```

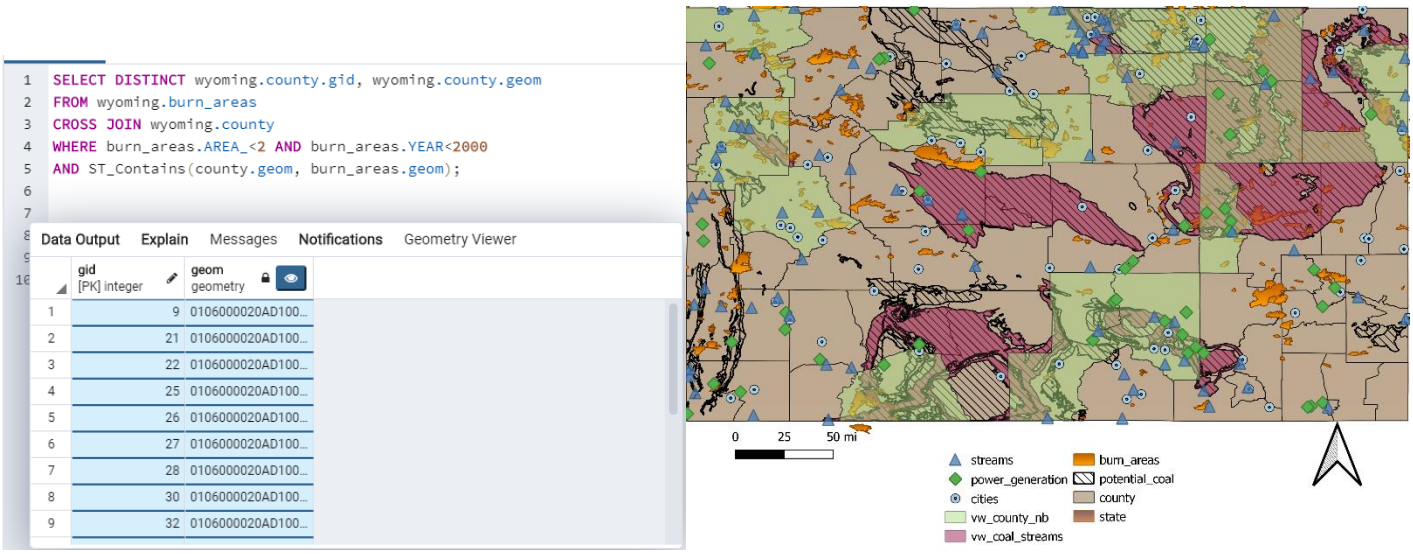

Figure 4: The query used to obtain the counties free from burn areas (left) the resulted 18 counties shown in green (vw_county_nb) in the map (right). The resulted has counties with no burn areas.

The two views (vw_coal_stream and vw_county_nb) which were created earlier are cross joined based on the following query 3 resulted in 13 counties can be seen in the map (Figure 5 right shown in green color). The query is created in such the counties have the resulted potential coal fields with streams in the county which will reduce the transport cost of the coal from mines. A view (vw_hj) is created using the query which is further used.

Query 3:

SELECT DISTINCT wyoming.vw_county_nb.gid, wyoming.vw_county_nb.geom

FROM wyoming.vw_coal_streams CROSS JOIN wyoming.vw_county_nb WHERE

vw_coal_streams.ACREAGE>100000 AND ST_Intersects(vw_county_nb.geom, vw_coal_streams.geom);

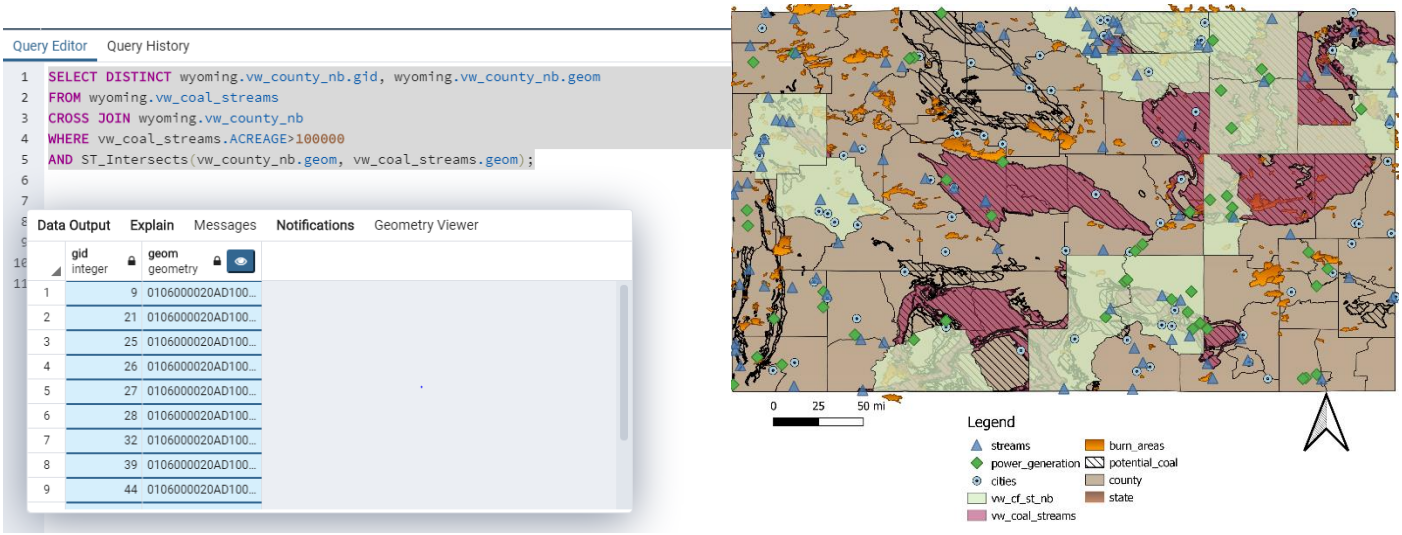

Figure 5: 13 counties obtained using the query (left) and results shown in green (vw_cf_st_nb, the view is renamed in the QGIS for better understanding the results) in map (right). The resulted map has counties with coal fields, streams, and no burn areas.

To obtain the countries to exclude the existing power generation plants which have the max capacity greater than 200MW and also not have the primary fuel as coal using a query 4 (Figure 6 left) which resulted in six counties in green (Figure 6 right). The reason to choose the requirement is because already existing power plants in the counties are not a good target to have a new power plant. A view is created from the resulting query named as vw_jh.

Query 4:

```
SELECT DISTINCT wyoming.vw_hj.gid, wyoming.vw_hj.geom
FROM wyoming.power_generation
CROSS JOIN wyoming.vw_hj WHERE power_generation.MAX_CAPACI<200 AND
power_generation.PRIMARY_FU!='COAL%' AND ST_Intersects(vw_hj.geom, power_generation.geom);
```

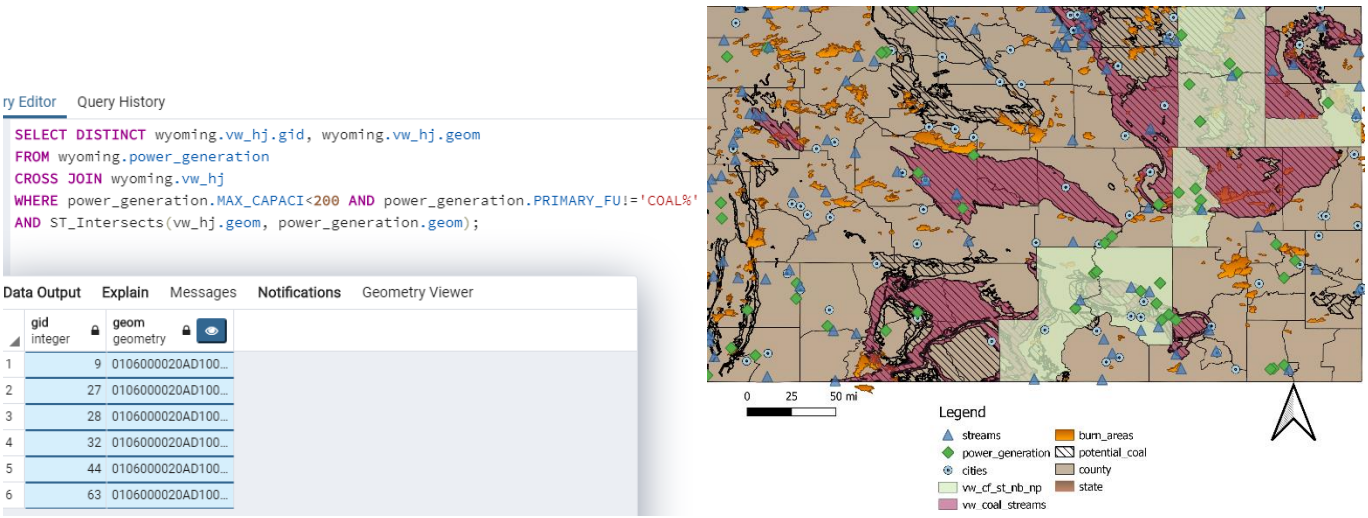

Figure 6: Resulted 6 counties shown in green, vw_cf_st_nb_np (right) using the query (left) max capacity<200MW power stations and does not have coal as primary fuel. The resulted counties have coal fields, streams, no burn areas, and no existing power stations based on the query 4.

To obtain the cities in the selected 6 counties that have no tourism places a following query 5 (Figure 7 top) is used by cross joining the vw_jh and cities shapefiles. This query is used because having the powerplant in a county that have tourism spot might have negative impact on the tourism economy. The query (Figure 7 top) has resulted 5 cities (Red diamond in Figure 7 bottom) on which a vw_power_plant is created.

Query 5:

```
SELECT DISTINCT wyoming.cities.gid, wyoming.cities.geom, wyoming.cities.city
FROM wyoming.vw_jh CROSS JOIN wyoming.cities
WHERE cities.NumCBldg=0 AND ST_Contains(vw_jh.geom, cities.geom);
```

```
SELECT DISTINCT wyoming.cities.gid, wyoming.cities.geom, wyoming.cities.city
FROM wyoming.vw_jh
CROSS JOIN wyoming.cities
WHERE cities.NumCBldg=0 AND
ST_Contains(vw_jh.geom, cities.geom);
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	gid [PK] integer	geom geometry	city character varying (25)
1	24	0101000020AD100...	Elk Mountain
2	25	0101000020AD100...	Rawlins
3	27	0101000020AD100...	Carbon
4	28	0101000020AD100...	Newcastle

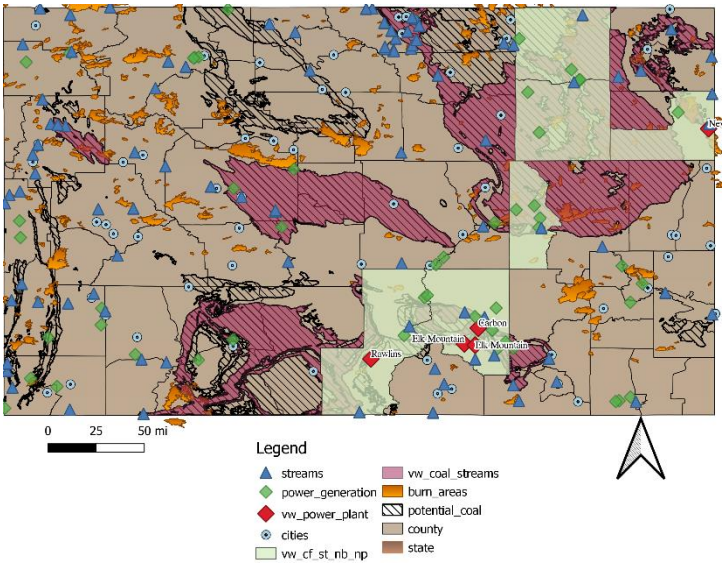

Figure 7: Five cities in red diamond (bottom) in the selected counties suitable for the power plant obtained using the query (top). The resulted map has five cites (vw_power_plant) have the coal fields, streams, no burn areas, no existing power stations and have no tourist buildings

I want to choose only one city from the resulted 5 based on the requirement that have the stream station within a proximity of 2 miles to the city. A following query 6 is used which resulted in only one city, New Castle.

Query 6:

SELECT DISTINCT wyoming.vw_power_plant.gid, wyoming.vw_power_plant.geom, wyoming.vw_power_plant.city FROM wyoming.streams CROSS JOIN wyoming.vw_power_plant WHERE ST_DWithin(ST_Transform(streams.geom,102358), ST_Transform(vw_power_plant.geom,102358),5280*2);

The result from the query which used ST_Transform to transform the spatial reference to the Wyoming SRID 102358 to convert to feet is shown in the Figure 8. The final city, Newcastle which has fulfilled all the

requirements mentioned in the objective is shown the Figure 8 (top) and the resulted map obtained from QGIS is shown in Figure 8, blue star (bottom)

```
SELECT DISTINCT wyoming.vw_power_plant.gid,  wyoming.vw_power_plant.geom,
wyoming.vw_power_plant.city FROM wyoming.streams
CROSS JOIN wyoming.vw_power_plant WHERE ST_DWithin(ST_Transform(streams.geom,102358),
ST_Transform(vw_power_plant.geom,102358),5280*2);
```

Data Output | Explain | Messages | Notifications | Geometry Viewer

	gid integer	geom geometry	city character varying (25)
1	28	0101000020AD100...	Newcastle

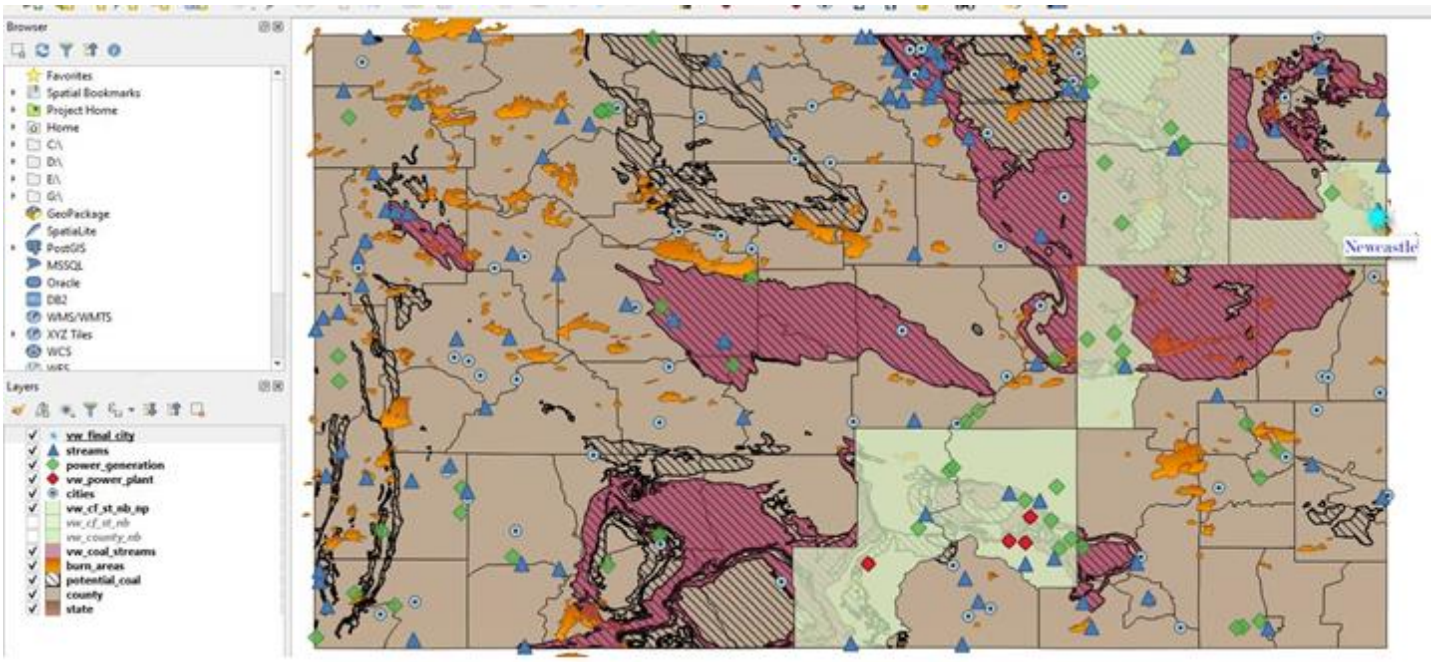

Figure 8: The query result (top) of the final suitable city that have stream station within 2 miles proximity to construct the power plant is shown in blue star in the map (bottom) platted in QGIS. The resulted map has one city have the coal fields, streams, no burn areas, no existing power stations, no tourist buildings and have streams within 2 miles.

CONCLUSIONS

The objective of the project is to obtain the database to find the suitable city to construct the thermal power plant driven by coal. The suitable site is chosen to have the potential coal fields with area more than 100000 acers and have a stream station within the proximity of 2 miles. The potential coal fields within the county is important as it reduces the transport cost of coal from them mine to the plant. The stream location close to the thermal plant

is important because there is a constant feed of water to cooldown the steam. The location is suitable if it is free from the burn areas that are not active in past 20 years and are as small as less than 2 Sq. miles in area so that the plant does not have any future damages caused by the forest fire. The location is also considered as such there are no tourist buildings in the city because the construction of the plant may cause the negative impact on the tourism economy. The location which has no active power generation stations that have power capacity more than 200 MW and has coal as primary fuel is considered as most appropriate. The Map in the Figure 9 showing the city (blue star), Newcastle is the city fulfilling all the requirements and is the most appropriate city to construct the new thermal plant driven by coal as a primary fuel in Wyoming state.

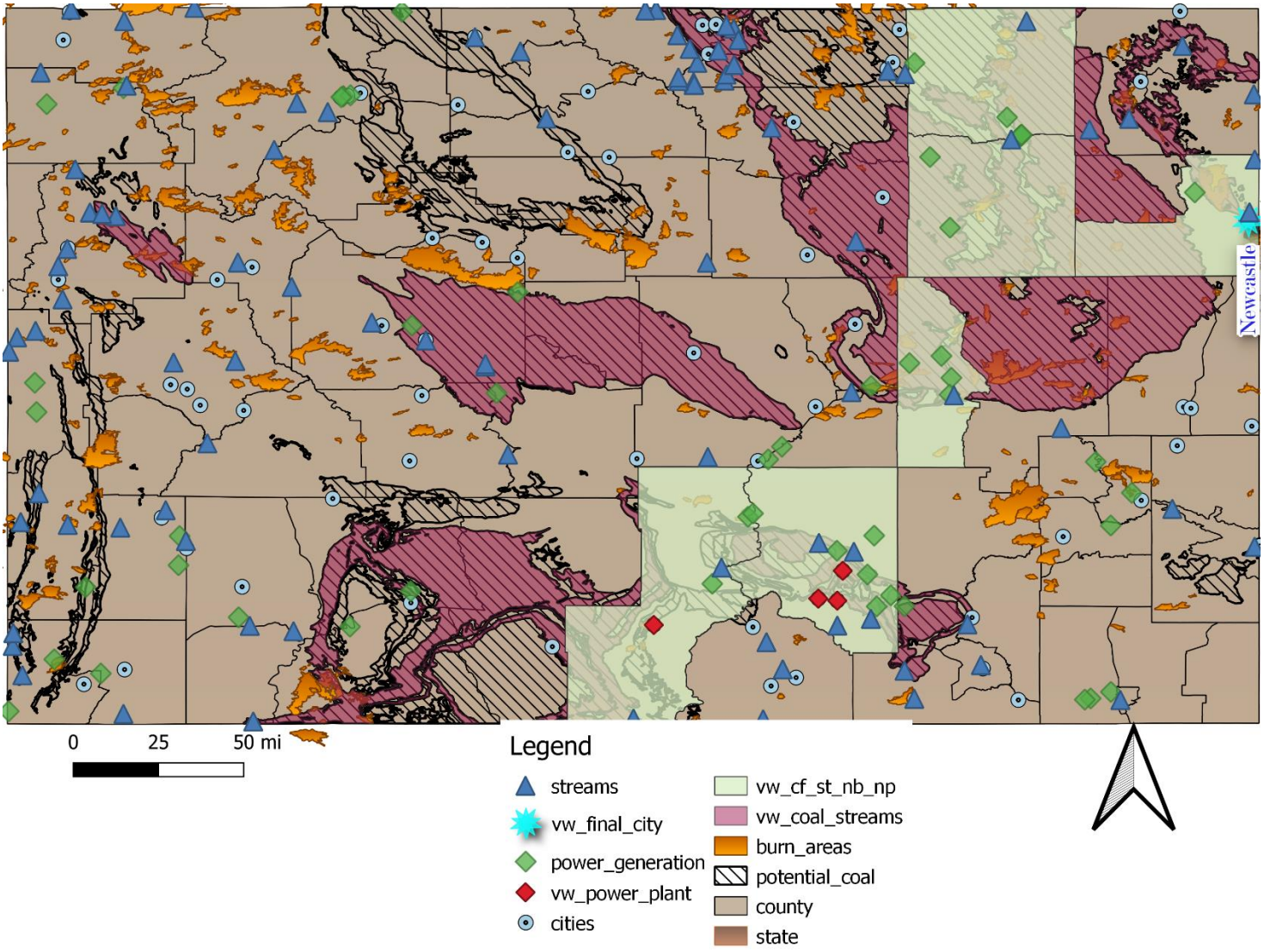

Figure 9:The city, Newcastle (blue start) is the suitable location for the thermal power plant construction driven by coal in Wyoming state.