

Ex. 4 How could REA (and other) data inform a strategy for placement of soil and permafrost monitoring stations to best inform future NEPA?

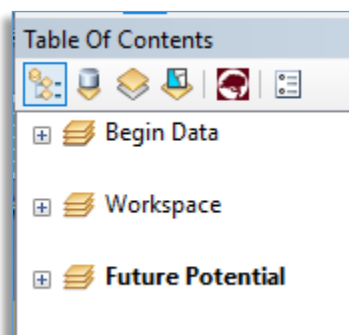
This exercise will examine how potential locations for monitoring station sites might be determined at the broad scale with some initial criteria. Site accessibility, land management status, and future mining potential were given as initial criteria that could be used to determine potential site locations. Also, ideally the system of monitoring stations would be statistically representative of BLM lands. The GIS analysis component of this exercise merges the initial criteria and calculates the spatially balanced locations of potential sites.

Many questions are asked in this exercise to engage both resource specialists and/or GIS specialists to think about the data used, the analyses, and options that could be included to understand the REA data and to encourage people to think in terms of broad scale analyses and the landscape approach. We encourage you to work in teams to promote discussion with your peers and your instructors to make the most of this time.

This exercise is set up to work in Desktop ArcMap (NOT the Citrix ArcMap – no teal title bar!).

Using ArcMap, open the map document: C:\tmp\CYR_2013\Exercises\permafrost\CYR_Permafrost.mxd.

There are three Data Frames in the Table of Contents:



Begin Data: for GIS users who want to work through the analysis, change parameters, etc. This part of the exercise is not for the faint of heart!

Workspace: all of the intermediate data sets, you can change parameters here, use additional data, adjust the inclusion probability raster, etc. This part of the exercise is for the adventurous explorer types!

Future Potential: The (final product) analysis of potential locations of monitoring stations (randomPts200) with some other REA permafrost

data that you might consider when locating future monitoring stations. This focuses on REA layers to expose you to more of the data. This part of the exercise is for the futurists!

Right click on the data frame that you would like to use and click Activate– the data frame title will become Bold. Click on the + sign next to it to show data list in the Table of Contents.

Overview of GIS Process Steps

More detailed steps using GIS are given in **Begin Data Frame** section.

1. I have provided spatial data: CYR analysis boundary, transportation (alternative, roads, and trails), generalized land management, future mining potential, existing borehole locations.
2. What other data sets might you use?
3. Preprocess data and merge (transportation, generalized land management, future mining potential). Reclass values table for all inputs:

Land Management		Other Data	
BLM	5	All Transportation	5
FWS, NPS, Mil	1	Future Mining Potential	1-6
Other	0	NoData	0

4. Create inclusion probability raster which indicates where potential site locations would be most appropriate. Higher values in this raster indicate better areas to locate sites, e.g., sites that are accessible or sites that BLM manages. Values in the probability raster will be calculated between 0 and 1.
5. Use Geostatistical Analyst to calculate potential site points using inclusion probability raster
6. Check the final data, the potential site locations – does it pass the smell test? What would you do differently?

Begin Data Frame

Steps for GIS users – adjust as you prefer.

1. In Windows Explorer, go to c:\tmp\CYR\permafrost\ and open CYR_permafrost_resourced.mxd
2. Explore the data sets provided. Do you need anything else? Are all available to display or are any connections broken (!). You should have data for generalized land management, transportation, roads, trails, boreholes, CYR analysis boundary, Federal Protected Areas.
3. Create a raster of Generalized Land Management Status land. In ArcToolbox, click on **Conversion Tools\To Raster\Feature to Raster**. Fill in as below and use a raster cell size of 60 m:
 - a. Click on **Environments...**, Click **Processing Extent**. Use the dropdown arrow to select Same as CYR Analysis Boundary. Click on **Raster Analysis** and use the drop down arrow by **Mask** to select CYR Analysis Boundary again. Click OK.

 Feature to Raster

Input features
Generalized Land Management Status (2015)

Field
STATUS_TYP

 Output raster
C:\tmp\CYR_NOS\permafrost\GenLandMgmt.img

Output cell size (optional)
60

- 4.
5. Use **ArcToolbox\Spatial Analyst Tools\Reclass\Reclassify** to change the STATUS_TY values for GenLandMgmt.img => GenLandMgmt_5.img. Change the New Value for each Old Value based on these inputs:
 - a. BLM: 5
 - b. FWS, NPS, Military: 1
 - c. All others: 0.
 - d. We assume some level of collaboration with other federal entities.

 Reclassify

Input raster
GenLandMgmt.img

Reclass field
STATUS_TYP

Reclassification

Old values	New values
Fish and Wildlife Service	1
Bureau of Land Manageme	5
National Park Service	1
Native Selected	0
State Patent or TA	0
State Selected	0
Military	1
NoData	NoData

Output raster
C:\tmp\CYR_NOS\permafrost\GenLandMgmt_5.img

☐ Change missing values to NoData (optional)

6. **Merge** the Transportation layers into one shapefile.
 - a. TransportRdsTrails.shp: **ArcToolbox\Data Management Tools\General\Merge**
 - i. Inputs: Primary Roads, Secondary Roads, Current Alternative Transportation, Primary Trails, Secondary Trails.
7. **Buffer** the merged transportation layers to 50m on each side. You can select a different width—consider what distance is accessible from roads and trails.
 - a. TransportRdsTrails_b50.shp: **ArcToolbox\Analysis Tools\Proximity\Buffer**
 - i. Inputs: TransportRdsTrails.shp
 - ii. Fill in the box as shown

The screenshot shows the 'Buffer' tool dialog box with the following configuration:

- Input Features:** TransportRdsTrails
- Output Feature Class:** C:\tmp\CYR_NOS\permafrost\TransportRdsTrails_b50.shp
- Distance [value or field]:** 50
- Linear unit:** ☒ Linear unit (selected), ☐ Field
- Side Type (optional):** FULL
- End Type (optional):** ROUND
- Method (optional):** PLANAR
- Dissolve Type (optional):** ALL
- Dissolve Field(s) (optional):** (empty)

8. Create a raster of the transportation (TransportRdsTrails_b50.shp) => TransportRdsTI_5.img. In ArcToolbox, click on **Conversion Tools\To Raster\Feature to Raster**.
 - a. Fill in as below using a raster cell size of 60 m:
 - b. Click on **Environments...**, Click **Processing Extent**. Use the dropdown arrow to select Same as CYR Analysis Boundary. Click on **Raster Analysis** and use the drop down arrow by **Mask** to select CYR Analysis Boundary again. Click OK and OK again.

 Feature to Raster

Input features
 TransportRdsTrails_b50

Field
 Id

 Output raster
 C:\tmp\CYR_NOS\permafrost\TransportRdsTI_5.img

Output cell size (optional)
 60

c.

9. Use **ArcToolbox\Spatial Analyst Tools\Reclass\Reclassify** to change the 0 values to 5s in TransportRdsTI.img => TransportRdsTI_5.img
 - a. Change the New Value from 1 to 5 in the box below – roads and trails are important so we want to make sure that these areas have a high chance of being selected.
 - b. Change the NoData to 0 and click OK.

 Reclassify

Input raster
 TransportRdsTI.img

Reclass field
 Value

Reclassification

Old values	New values
0	5
NoData	0

Classify...
 Unique
 Add Entry
 Delete Entries

Load... Save... Reverse New Values Precision...

 Output raster
 C:\tmp\CYR_NOS\permafrost\TransportRdsTI_5.img

☐ Change missing values to NoData (optional)

10. Convert FutureMiningPotential to raster using **ArcToolbox\Conversion Tools\To Raster\Polygon to Raster** => FutureMiningPotential.img.

- a. Click on **Environments...**, Click **Processing Extent**. Use the dropdown arrow to select Same as CYR Analysis Boundary. Click on **Raster Analysis** and use the drop down arrow by **Mask** to select CYR Analysis Boundary again. Click OK.
11. Use **ArcToolbox\Spatial Analyst Tools\Reclass\Reclassify** to reclass FutureMiningPotential.img values of NoData to 0 => FutureMiningPotential_6.img.

Reclassify

Input raster
FutureMiningPotential.img

Reclass field
Value

Reclassification

Old values	New values
1	1
2	2
3	3
4	4
5	5
6	6
NoData	0

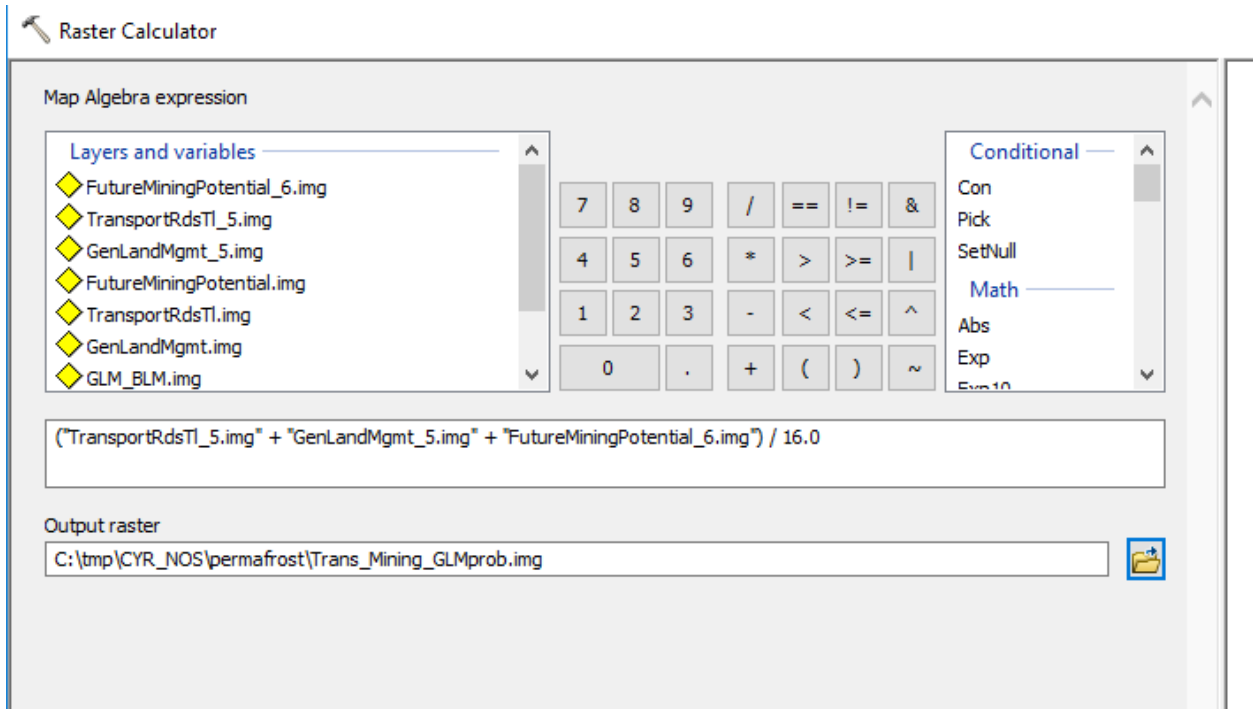
Classify...
Unique
Add Entry
Delete Entries
Load... Save... Reverse New Values Precision...

Output raster
C:\tmp\CYR_NOS\permafrost\FutureMiningPotential_6.img

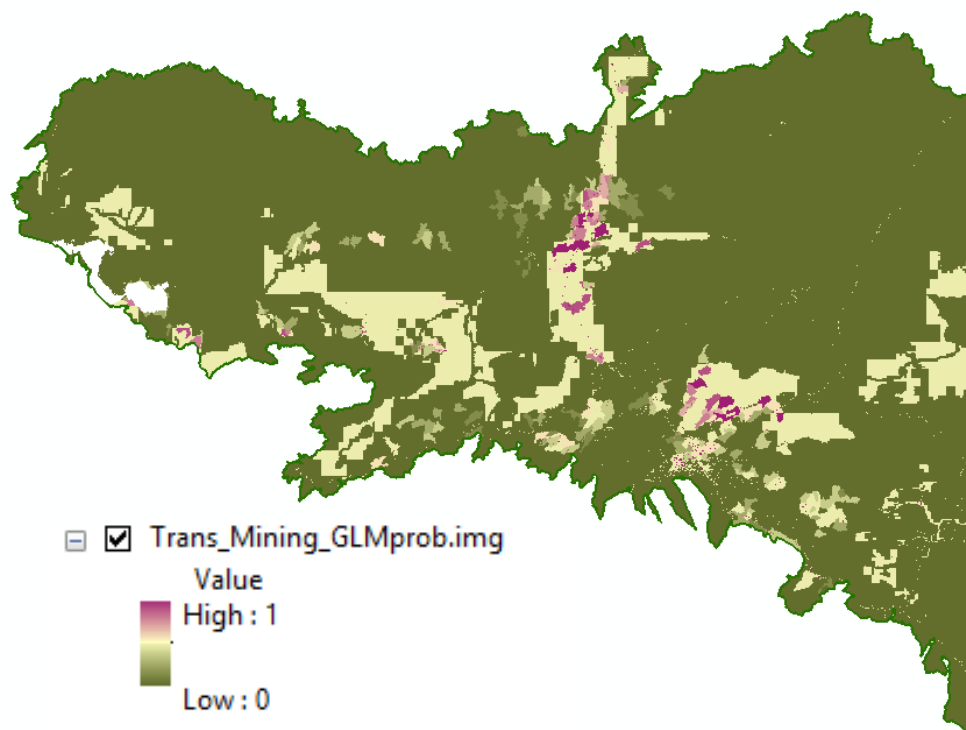
☐ Change missing values to NoData (optional)

OK Cancel Environments... << Hide Help

12. At this point you should have rasters for Transportation, Future Mining Potential, and Generalized Land Management all created from CYR REA data and reclassified for their importance in the probability raster (and to remove any NoData values). Preprocess any other data sets that you think are useful in this calculation.
13. Using **ArcToolbox\Spatial Analyst\Map Algebra\Raster Math**, sum these rasters and divide by the maximum possible value which is 16.0 (using the suggested data sets and values) to get values between 0 and 1. I used 16.0 to create a float grid from the 3 integer rasters. Integer rasters use less storage space but the probability raster requires values between 0 and 1 so more precision is needed.



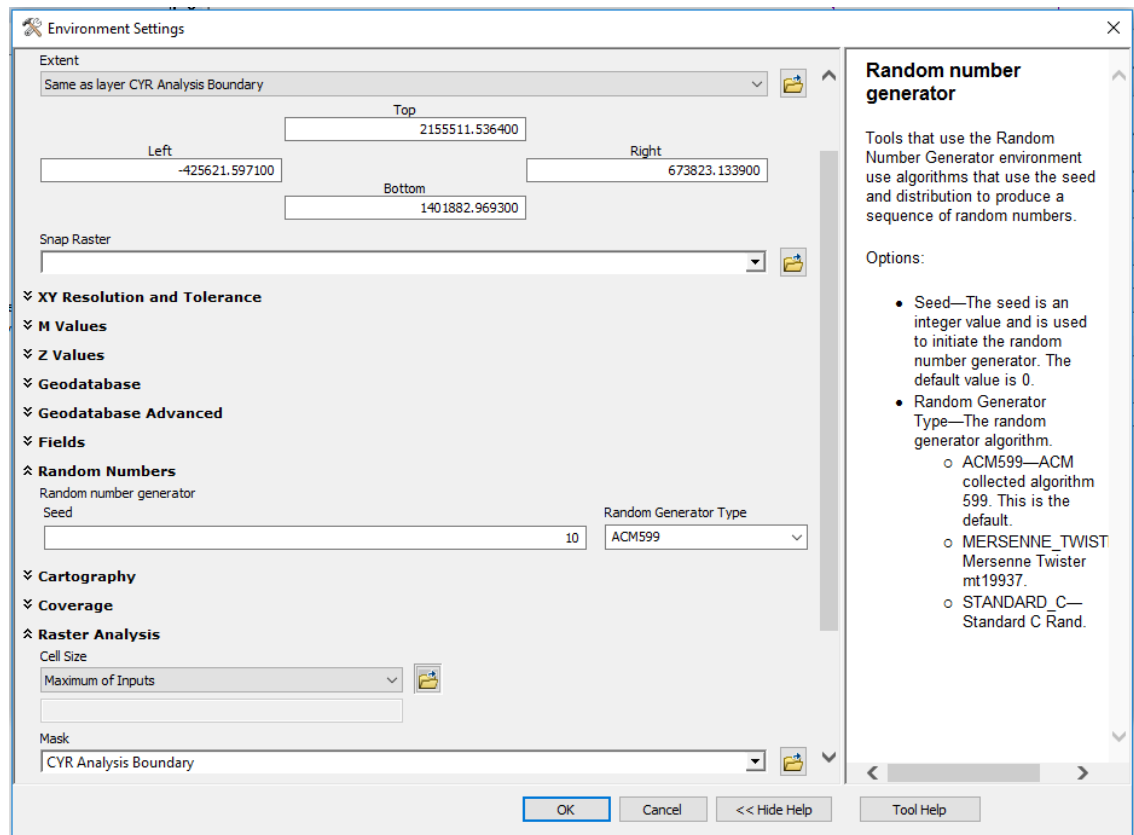
14. Here is the inclusion probability raster:



15. Calculate the number of cells in the extent of Trans_Mining_GLMprob.img: 50329 columns * 33461 rows = 1,684,058,669. 1% of total cells = 16,840,586.

16. Go to **ArcToolbox\Geostatistical Analyst Tools\Sampling Network Design\Create spatially Balanced Points**

- a. Setup the Environments... Extent, Raster Analysis, and Random Numbers. Set the Random number generator seed to 10. From the Help: If the random number seed is set to a fixed number greater than 0, then the tool will produce the same set of sample locations each time it is run, until the seed value is changed. Setting the random number seed value to a fixed number > 0 is useful when you want to generate candidate sampling networks so you can choose the one that works best for your needs.



- b. Enter the number of output points you would like. The guidelines recommend that you select no more than 1% of the total number of cells ~ 16 million! These are the potential new bore hole sites that would need to be explored further.

Create Spatially Balanced Points

Input inclusion probability raster
Trans_Mining_GLMprob.img

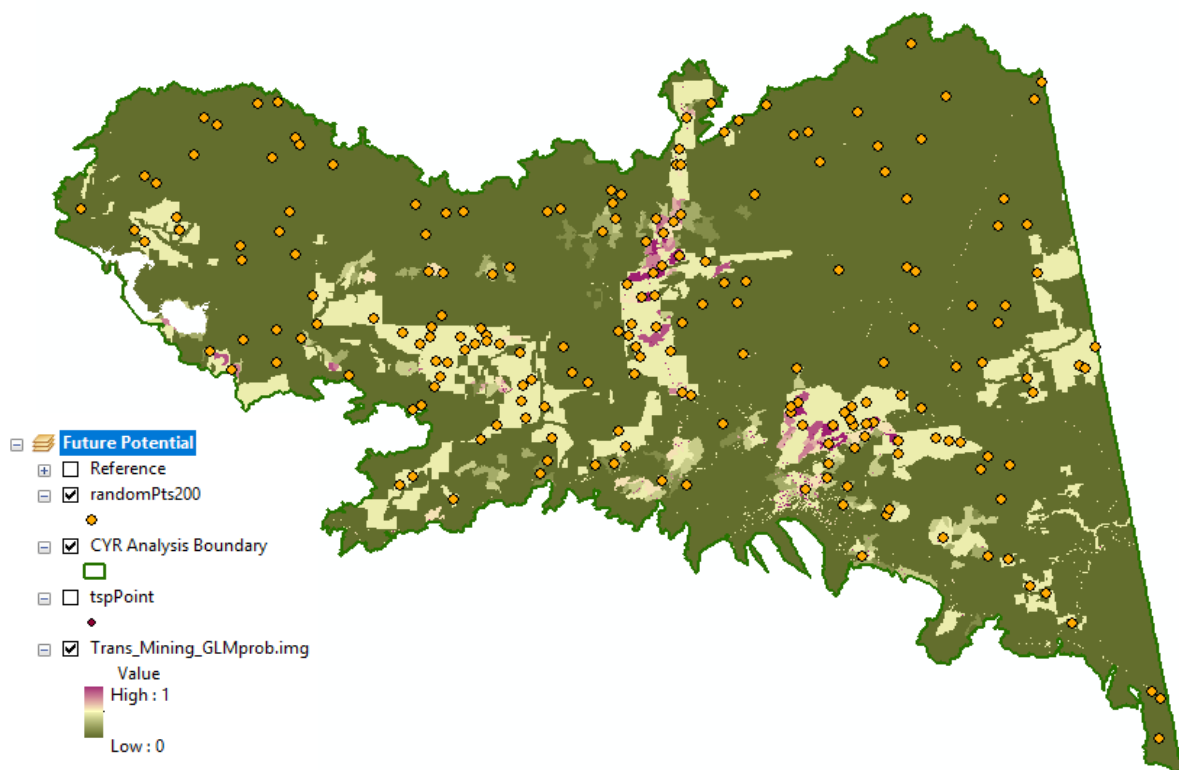
Number of output points
5000

Output point feature class
C:\tmp\CYR_NOS\permafrost\randomPts5k.shp

17. Here are 5,000 pts:



18. That might be a few too many! Note how the points are clustered around BLM lands and the Dalton Highway. Try 200 points:



19. 200 pts is a little more manageable. How many points will you generate?

Workspace Data Frame

20. The display should appear like the map above.

- The 200 yellow points are the spatially balanced locations for potential monitoring sites.
- The green/yellow/pink background (Trans_Mining_GLMprob.img) is the inclusion probability raster. This is the input raster to the function to create spatially balanced sample points.
- The group Inputs contains the initial input data for the inclusion probability raster. Display these layers to see how points cluster on BLM land, around roads and areas of high mining potential.
- How would you adjust the inclusion probability raster

21. You can adjust the number of station locations by rerunning from Step 15. You would need to re-create the inclusion probability raster to change anything else. These changes might be including other data sets or changing the importance of existing inputs (see Begin Data Frame for details).

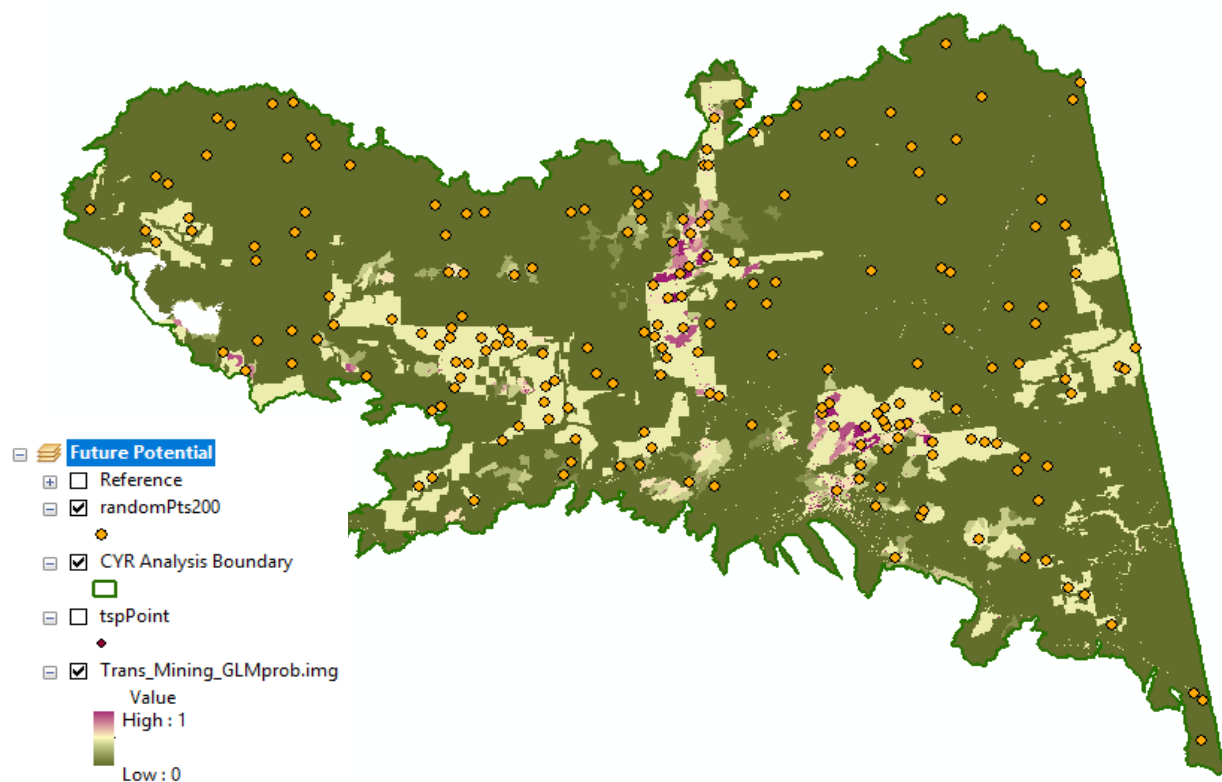
22. What other data might you use? Here are some examples to think about:

- USGS Existing borehole points (tspPoint) $n=73$ within the CYR boundary. We know nothing from the data about their current condition – are they still used? Could BLM use them or collaborate with the owners? How should we include them in this analysis?

Should new bore holes be located away from them or close by? I chose to leave them for visual and qualitative comparison after the initial analysis. How would you use them?

- b. The presence of airstrips might increase the accessibility of some study sites. Should they be used? How?
- c. Should the sites be close to weather stations?

Future Potential Data Frame



1. In Future Potential are the final 200 pts (randomPts200), the CYR analysis boundary, and the inclusion probability raster (Trans_Mining_GLMprob.img).
2. In the **Input Data Group** are the initial data sets – transportation including roads and trails, mining potential, and land management. How do the potential site locations relate to these?
3. I have added the **Context Data Group**: the BLM Field Offices, Large Streams, and Connected Large Lakes from the REA. Also try out Terrain with Labels base map for context; Terrain is only available if the laptop is on the Internet. What other data can you add from the REA to provide more context to help view the potential sites?

4. Several additional data sets from the CYR REA will be of interest for future considerations:
 - a. Change in Permafrost Extent at 1 m Depth from 2010s to 2060s
 - b. Permafrost Thaw at 1 m Depth from the 2010s to 2060s
 - c. Thermokarst Potential in Areas Projected to Thaw to At Least 1 M Depth by the 2060s
 - d. Long-term Future (2060) Landscape Condition
 - e. Long-term Future (2060) Landscape Intactness
5. Turn on these data sets and compare them with the potential site points – should any of these data be included in the analysis?
6. Some other questions to consider: What other REA data sets can be used? What data additional to the REA could be useful?
7. What other questions could be addressed using these data and this type of analysis?