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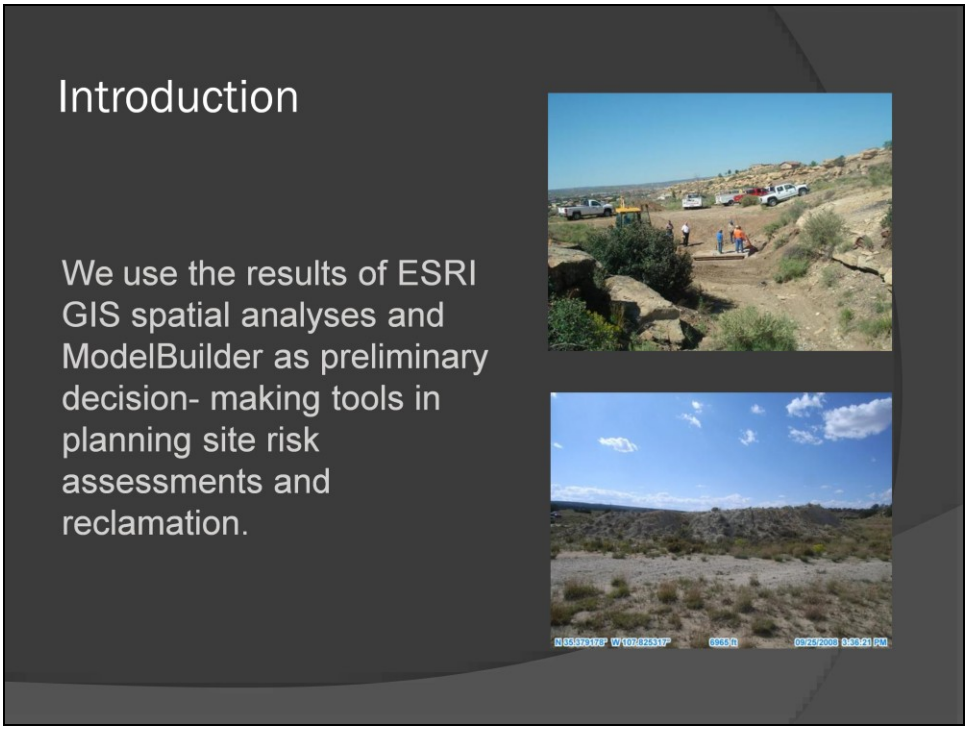
Presenting "**Modeling Reclamation Priorities of Abandoned Mines in New Mexico"**

Note: Presentation time – 15min

New Mexico Mining and Minerals Division and Abandoned Mine Land Program

We are collaborating with state, federal and tribal agencies to inventory and prioritize the reclamation of abandoned coal and legacy uranium mines in New Mexico.



NM has a legacy of abandoned or inactive uranium and coal mine sites.

Funds become available periodically and our programs benefit from a priority list of sites. We have received funds from Federal collaborators, USFS, BLM and OSMRE and our state Mining Act Reclamation Program.

We use the results of ESRI GIS tools in the spatial analysis and model building as preliminary decision-making tools in planning site risk assessments and reclamation.

Analysis Approach

Projects

- Legacy Uranium Mine Inventory Project
- Gallup Coal Inventory Project

Two scales of analysis for each project

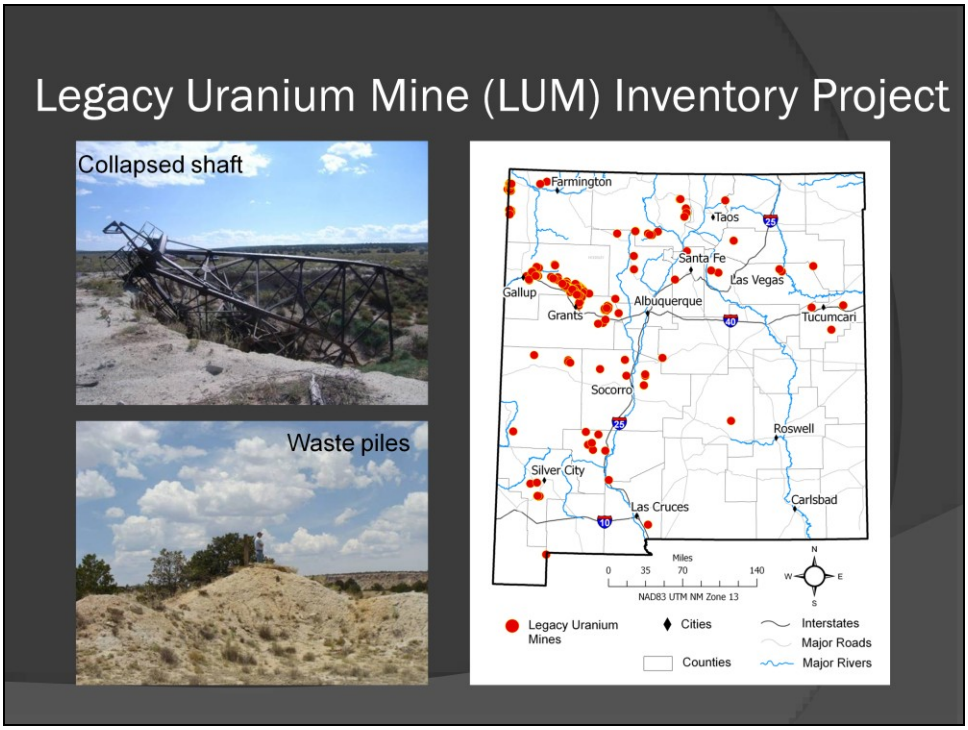
- State-wide
- Regional site assessments

We have two inventory projects that would benefit from a priority analysis.

New Mexico Legacy / Abandoned Uranium Mine Inventory Project and

Gallup Coal Inventory Project

For each project – Analyzed the sites over the state and selected a region for a more detailed analysis.

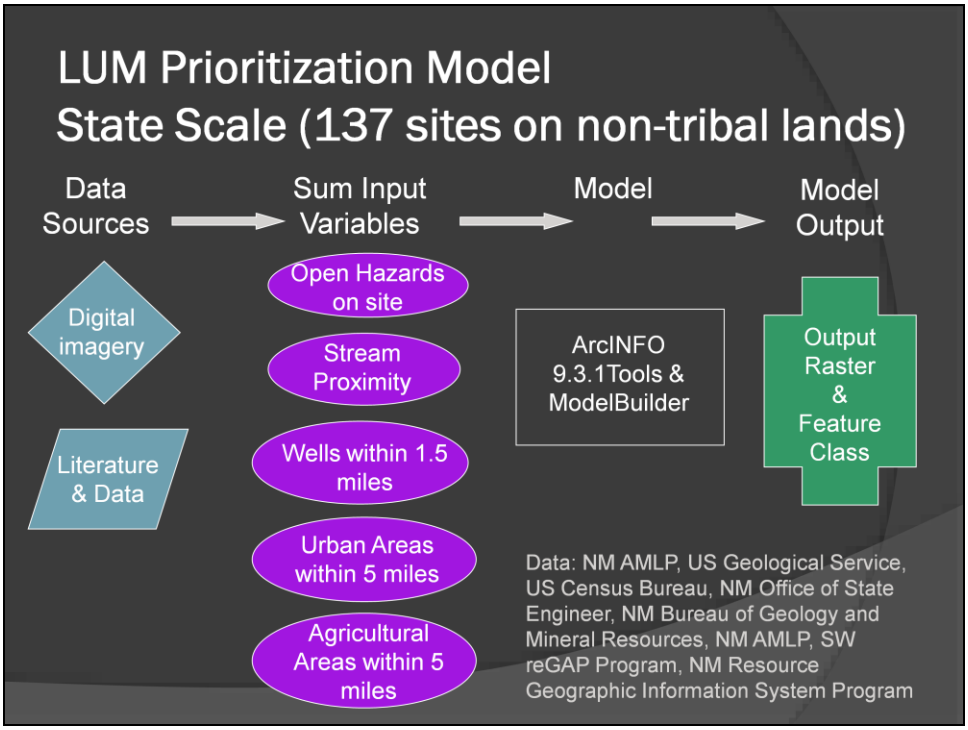


MMD identified 259 AUMs with verifiable production, as seen in the state map, and 466 disturbances with no verifiable production

Uranium was mined in 19 of the 33 counties in New Mexico.

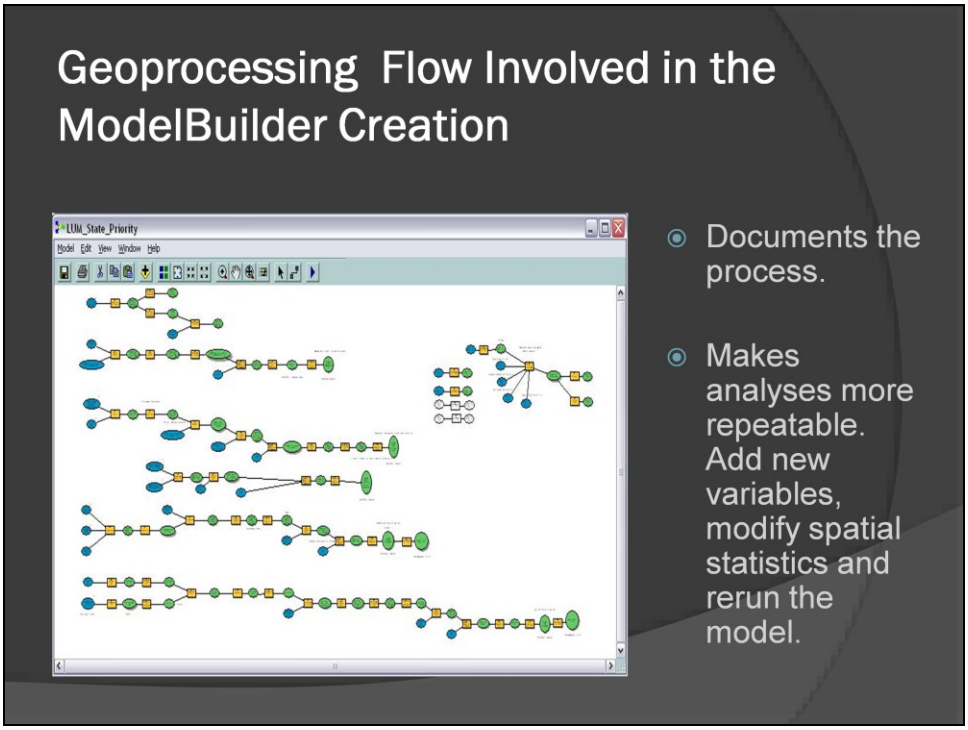
Background

- Over 333 million pounds of U_3O_8 mined 1940-2002 in New Mexico.
- Most uranium mines operated and closed with no reclamation requirements or guidelines.
- Needed to identify what sites the state can address.
- Where to apply limited funds first in reclamation work.



First we examined 137 sites on non-tribal lands – the areas that we the state have potential to reclaim.

+Open hazards at the mining disturbance included open shafts, adits, trenches and pits. A hazard to people crossing the site.
+Stream proximity - closer the stream, the greater potential of contamination spreading.
+Wells within 1.5 miles radius of a site. Wells include those used in domestic consumption, municipal use, irrigation/ agricultural use, livestock use. All possible sources of contamination is the wells are in close proximity.
+Urban areas with 5 miles radius.
+Agricultural areas with 5 miles radius.

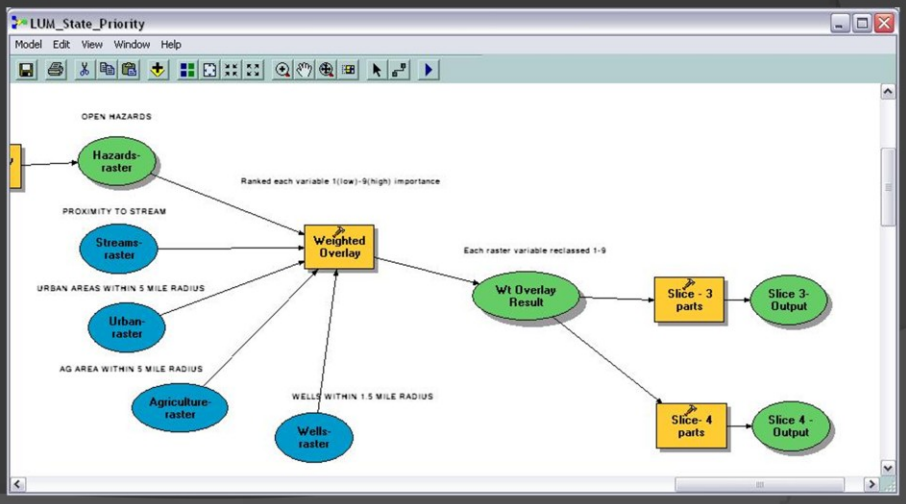


In this analysis – I converted vector files to raster files (ESRI Grid) so that I could use the Weighted Overlay tool to rank and combine variables.

All my data was stored as feature classes in a personal geodatabase and the agriculture area data were raster data created by our regional SW re-gap program (New Mexico State University). Years of imagery approx 1999-2001. I enhanced the data by adding agriculture I observed from 2009 aerial images.

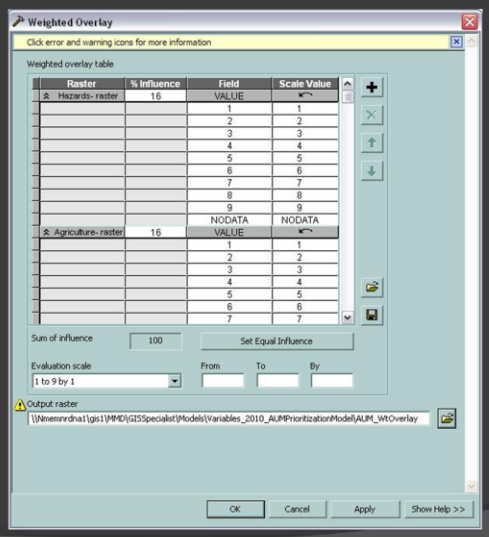
In order for the rasterization of the vector data through ModelBuilder to work properly, I needed to convert feature classes to shapefiles and then rasterize.

ModelBuilder Final Steps– Weighted Overlay Spatial Analysis Tool



The last steps of the model where I used the Weighted Overlay Spatial Analysis Tool and the Slice tool to reclassify the results into 3 or 4 ranking classes.

Weighted Overlay Dialog Box

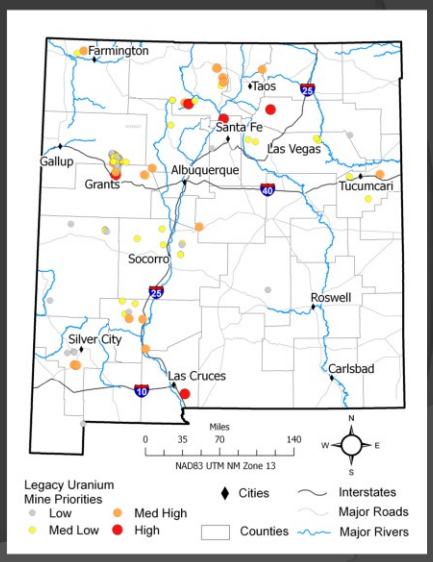


- Overlays and adds all the rasterized variables using a common ranking scale.
- Weighted each according to importance (percent influence).

26% weighting for Streams and wells
16% for all other variables.

Classified from 1 (low rank) to 9 (highest rank) using natural breaks in the data.

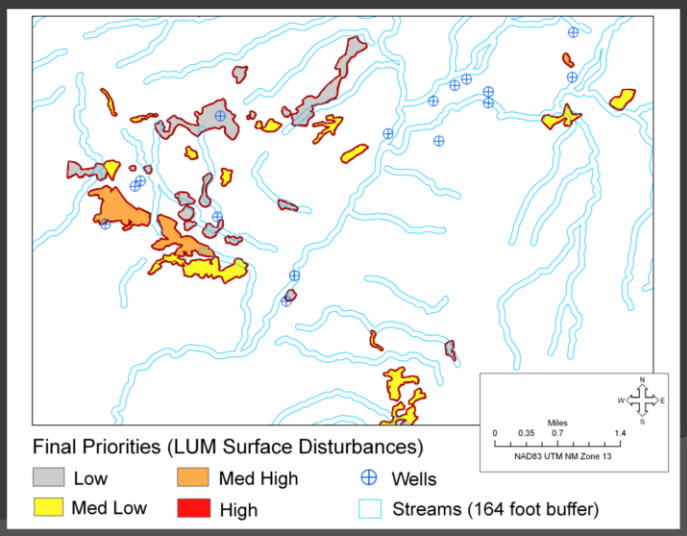
Preliminary Priority Results (n=137)



4 % or 5 High priority sites are shown in red. One site may be composed of several disturbances in fairly close proximity.
21% Med high sites (n=29) are shown in orange.
39% Med low sites (n=53) are yellow
36% Low priority (n=51) are gray

All 5 high priority sites lie with urban boundaries and or very close proximity to Agricultural fields.

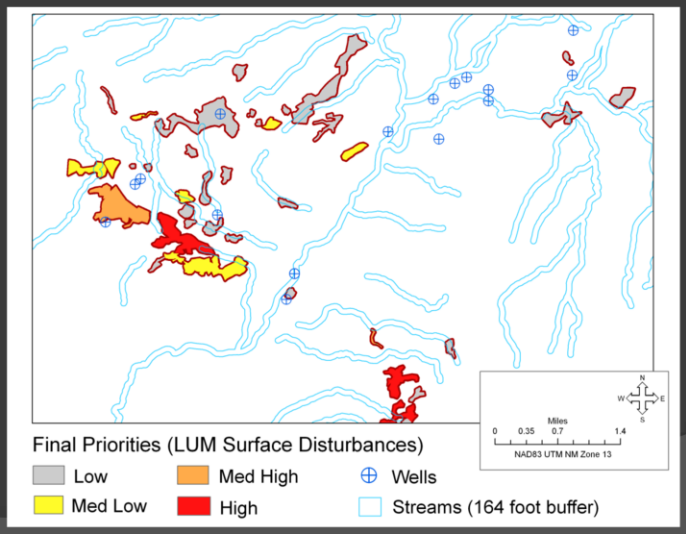
Ambrosia Lake Final Priority Ranking – State-wide Analysis



Example of changes in priority ranks within one region of Ambrosia Lake , depending on the variable– a high density LUM area near Gallup and Grants.

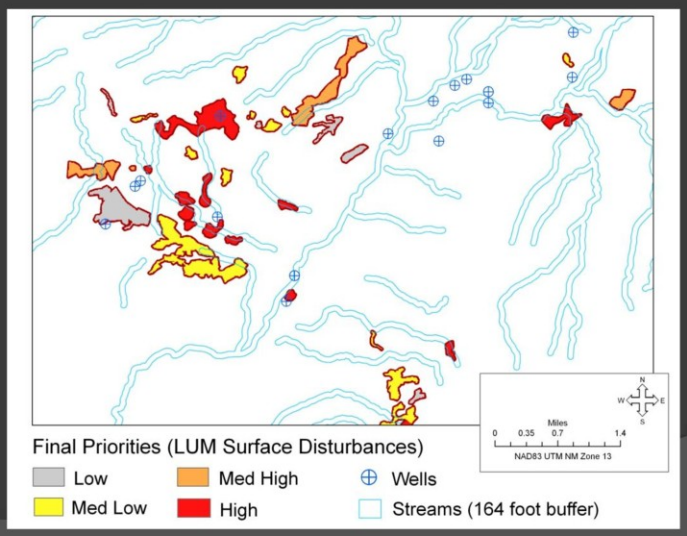
0 disturbance ranked High and 3 were med high

Priority Ranking – Unsafeguarded Hazards



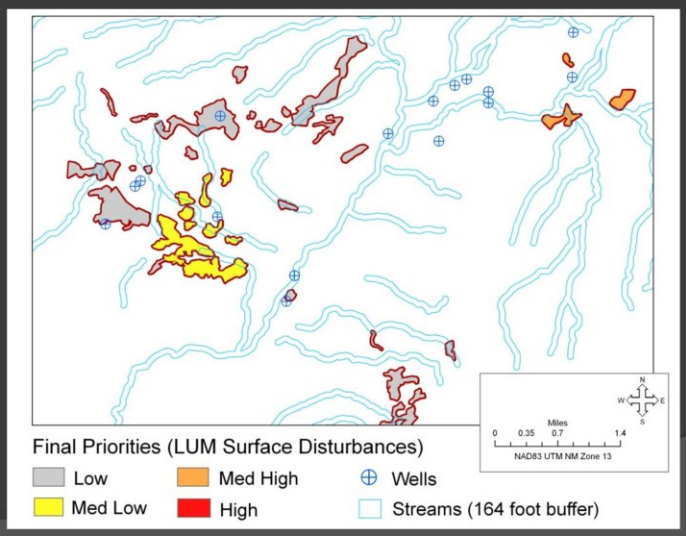
In terms of unsafeguarded hazards- 3 disturbances rank high and 1 med high

Priority Ranking – Proximity to Streams

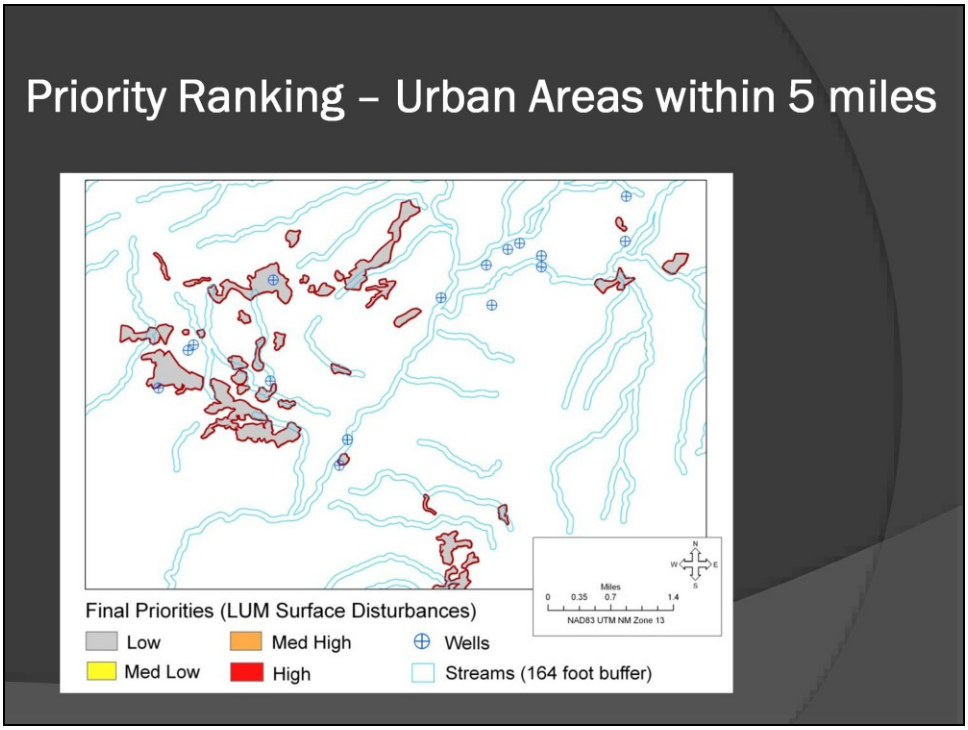


12 of the disturbances in this regional view were high ranks in proximity to streams and 4 medium high

Priority Ranking –Wells within 1.5 miles

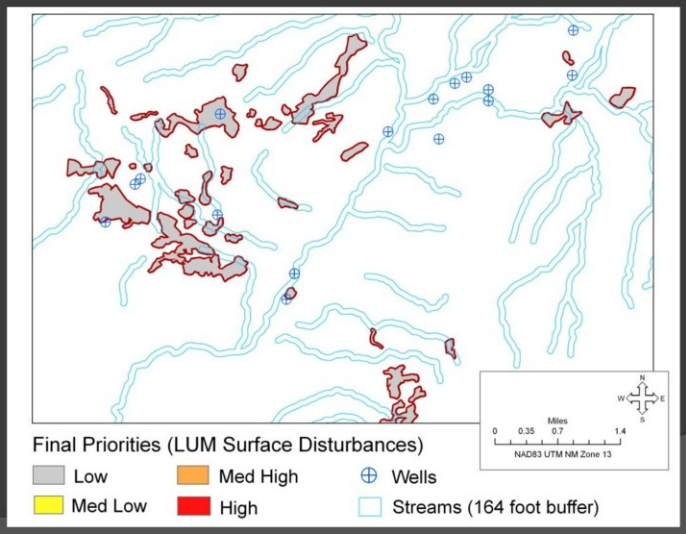


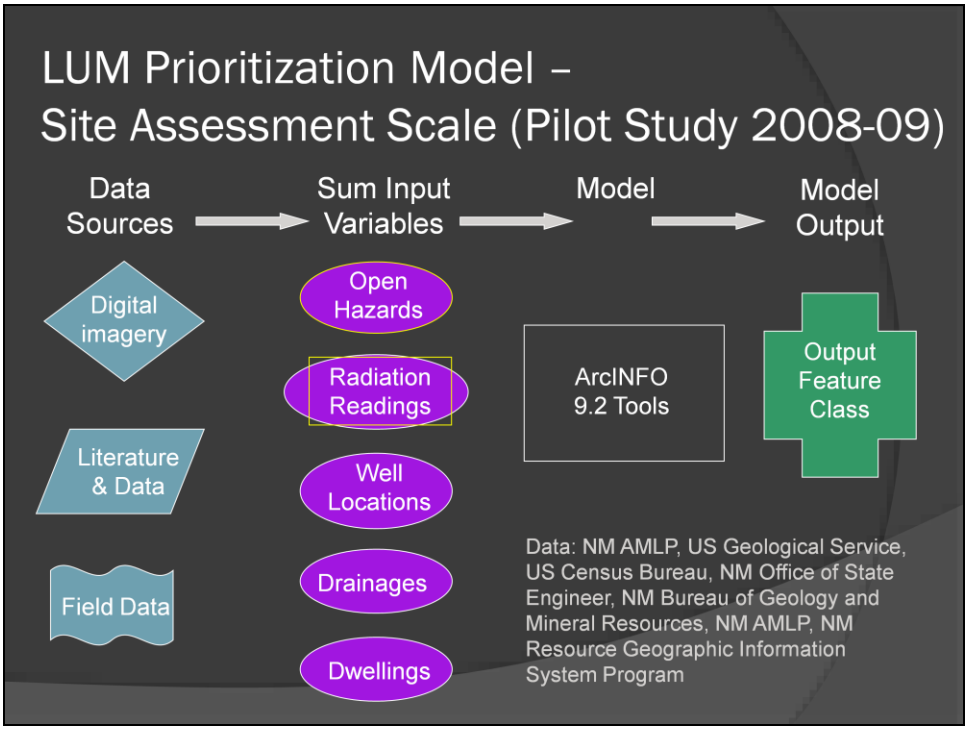
0 high and 3 med high



None high or med high since considerable urban areas were distant from this site.

Priority Ranking – Agricultural Areas within 5 miles





Our second scale of analysis for this project was a site assessment analysis . The goal was to get a prioritization ranking for regional areas so that we could sent our contractors to do a more detailed cleanup estimates.

Initially our model was not done with ModelBuilder and with all vector data as a tabular analysis.

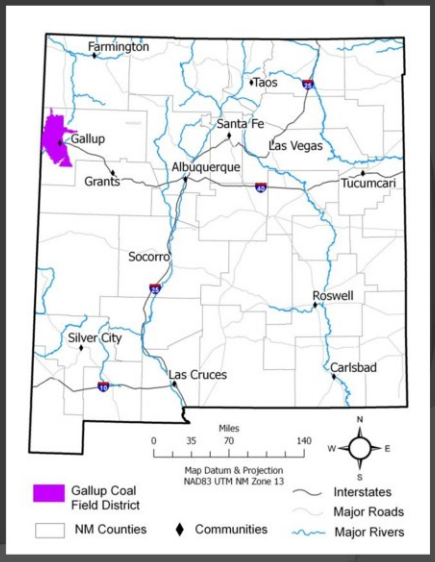
Initially, five variables were used in our model.

These variables included:
•Number of open/unsafeguarded hazards,
•Radiation readings at 1 meter distance from the ground (Gamma exposure rates μιχροR/hour),
•Distance to nearest domestic well,
•Distance to the nearest drainages **and their distribution**, and
•Number **and distribution** of dwellings within a 5 mile radius of mine site.

•Scores from the five variables were combined for each mine.
•Priority was based on the ranking of the scores for each site. The largest score, ranked the highest in priority, was given a value of one; the lowest scores were given a priority of **increasing value until the largest score was ranked the lowest in priority**. Our maps classified the range of priorities into 4 groups: high (1), medium (2), medium-low (3) and low (4).
•ArcInfo 9.2 Spatial Analyst was used to calculate statistics and metrics.

Gallup Coal Inventory Project

Weaver Mine, Gallup, NM
circa 1910
(Courtesy of New Mexico Bureau of Geology & Mineral Resources)

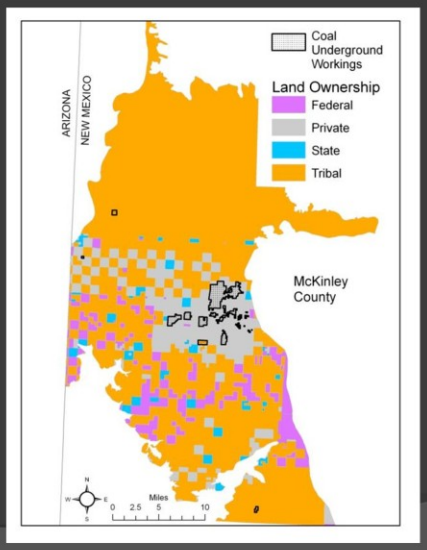


Our second Prioritization work involves the Gallup Coal Inventory Project that our New Mexico Abandoned Mine Land Program is conducting in McKinley County.

Background

- Estimated more than 15,000 abandoned mines in New Mexico. Inventories needed.
- The Gallup Coal Field District was the site of underground coal mining in the early 1880's to late 1950's.
- Old workings within and outside of Gallup city limits with subsidence since the 1980's.
- Inventories of 1980-1990's needed revisiting.

Gallup Coal District and Land Ownership



Patchwork of land ownership- may impact priorities.

Surface ownership and percent of the district area.

Federal – 8%
Private – 14%
State – 2%
Tribal – 76%

Surface ownership and percent of the district area.

Federal – 8%
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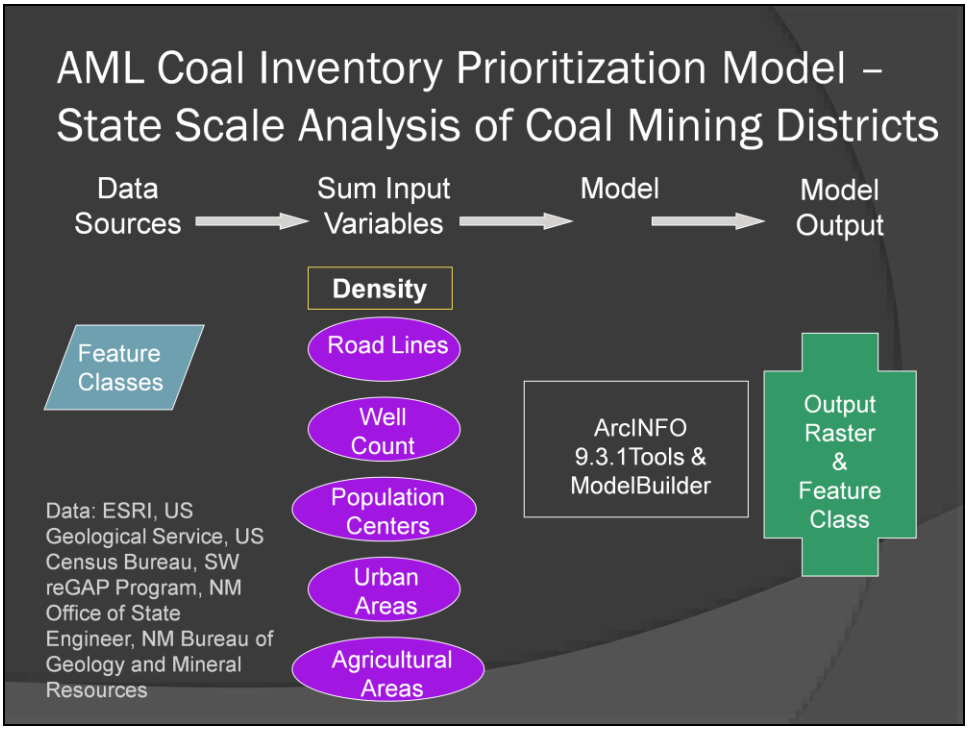
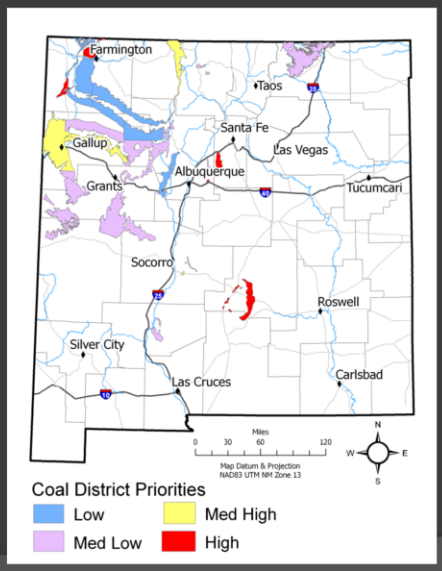


First we wanted to characterize the ranking of coal districts in NM to see the more immediate need for the mine feature inventory. Coal districts are areas that have historic mine activity recorded, but most have little of the mine features inventoried . We modified the state-wide Legacy Uranium Mine Prioritization model to examine possible importance.

Since the coal districts vary considerable in area – we used density measures for the variables
+ road line density
+ Well count density
+density of population center density (points that include villages as well are large population centers
+urban area density
+agricultural area density

Results – Priority Coal Districts



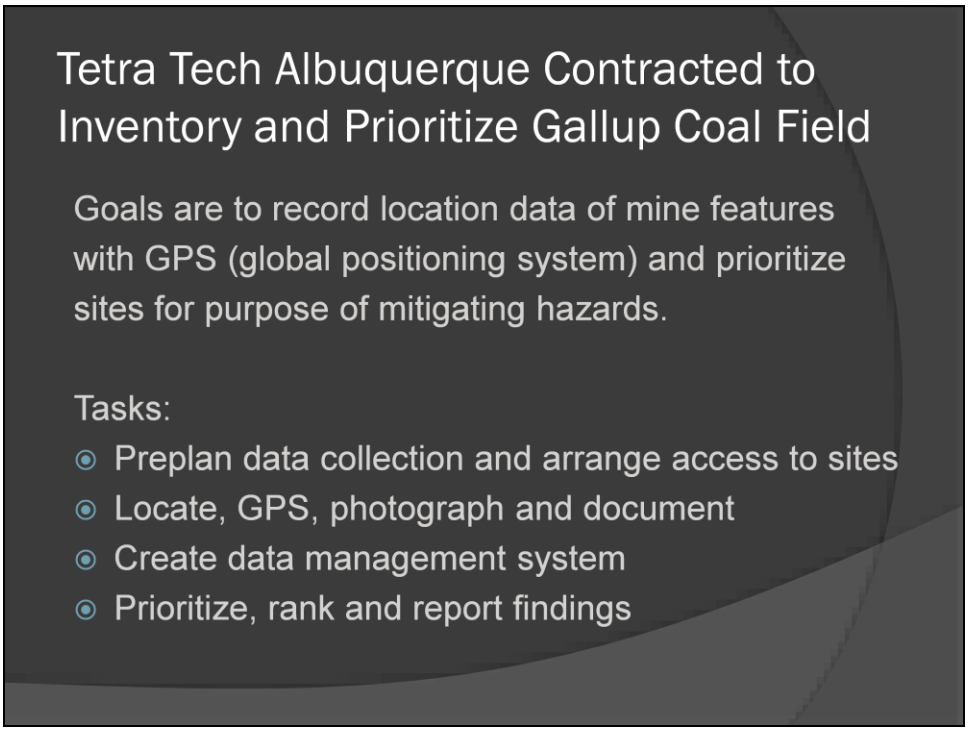
- Gallup Coal Field District ranked medium-high in priority.
- Factors that elevated it's priority
  - Previous work
  - Urban location
  - Subsidence issues

The coal fields that ranked higher than the Gallup area contained greater densities of wells (stock tanks, dwelling sources, etc) for their size, even though they did not encompass as much urban area.

Gallup Coal Field District ranked medium-high in priority based on un-weighted sum of model variables.

Chosen by NM AMLP for mine feature inventory and reclamation prioritization.

Factors that elevated rank – AMLP previous work locale, the Gallup population and the subsidence issues of old Coal mine workings.



Goals are to record location data of mine features with GPS (global positioning system) and prioritize sites for purpose of mitigating hazards.

Tasks:

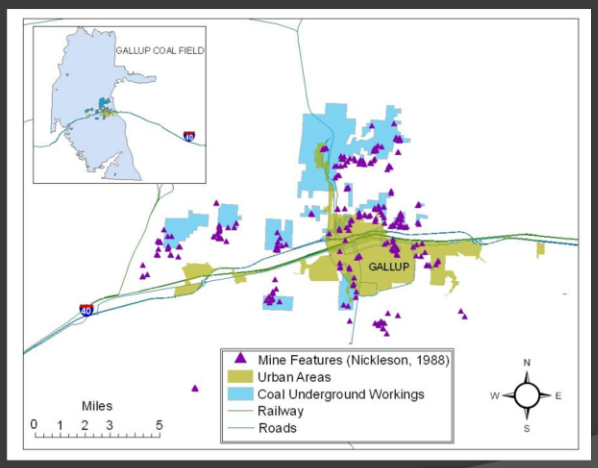
Preplan data collection and arrange access to sites

Locate, GPS, photograph and document

Create data management system

Prioritize, rank and report findings

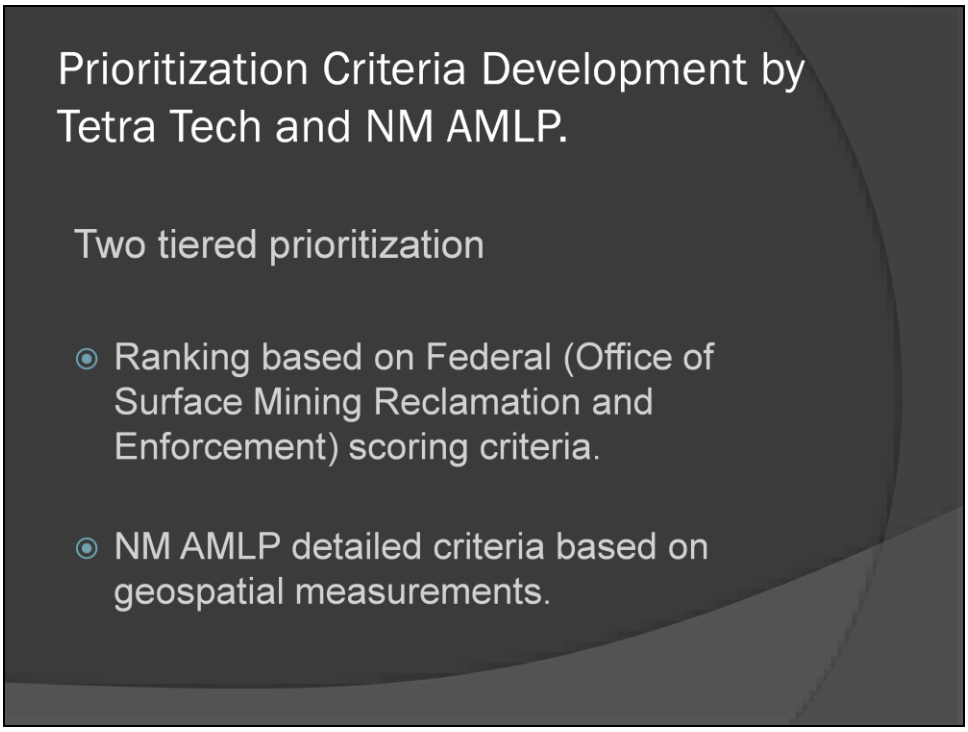
Map of Gallup Area – In-progress Site Assessments



- Mine features previously inventoried in 1980's.
- Start of GPS collections.

Mine features previously inventoried

Features will be revisited and the coal field district inventoried.



Two tiered prioritization (Developed by NM AMLP and their contractor Tetra Tech)

Ranking based on Federal (Office of Surface Mining Reclamation and Enforcement) scoring criteria:

Priority 1, 2 or 3.

Federal funding is available to mitigate features that meet one or more criteria that vary according to the type of feature. Priority 1 indicates mitigation is required to protect public health, safety, general welfare, and property from extreme danger. Priority 2 requires mitigation to protect against adverse effects. Priority 3 requires mitigation to protect the environment.

So, for example, an adit might be ranked Priority 1 (extreme hazard) if it is less than 300 feet from an occupied structure. If it's farther than 300 feet, it could be Priority 2 (adverse effect) if there is evidence of public visitation.

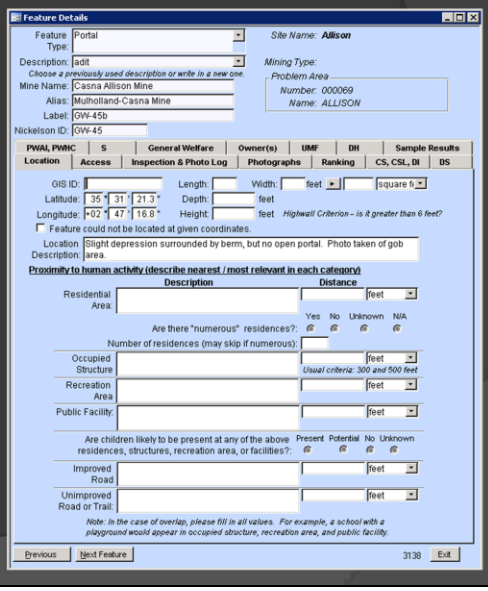
Second ranking criteria - NM AMLP detailed criteria based on geospatial measurements.

Ranking further describe the urgency of the hazard posed by a feature. The federal priority system might rank an adit as Priority 2 because it shows evidence of visitation, but makes no distinction between one many miles from occupied structures and one 400 feet from a school.

Thus the GIS attributes must contain sufficient information to answer a variety of questions. Tetra Tech has developed a series of forms to facilitate data

Inventory Data Management System

- Field forms integrated with the inventory database
- Geodatabase to store GIS features
- Automatic tabular priority ranking system



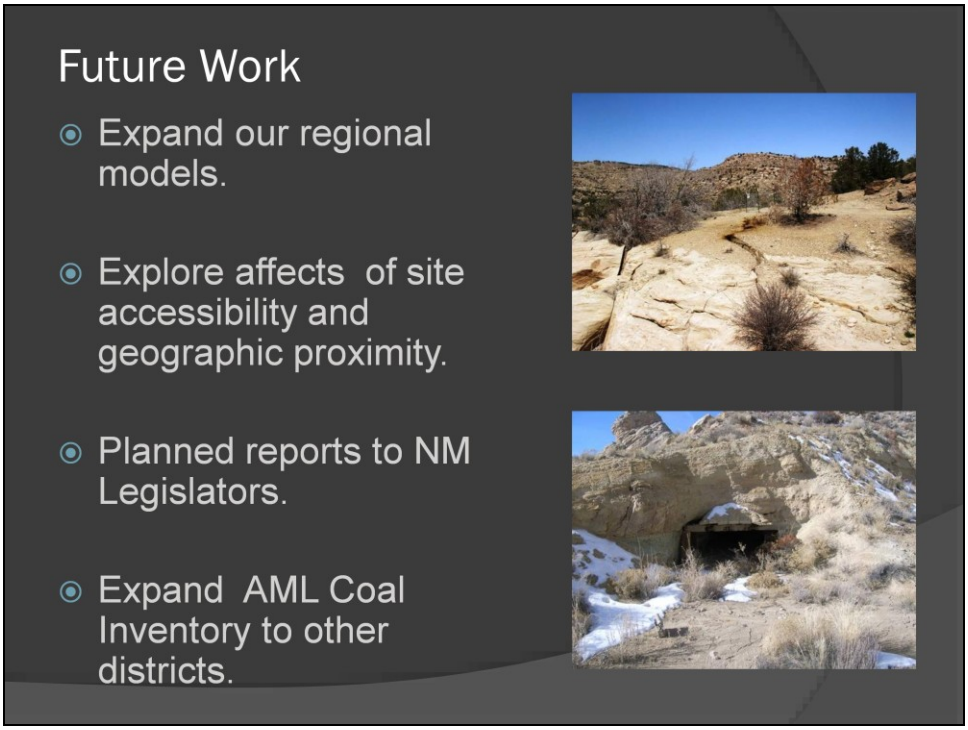
Our contractor Tetra Tech has developed an Inventory Data Management System. System of priorities tabular.

It includes:

Field forms integrated with the inventory database (MS Access)

A Geodatabase to store GIS features

Automatic priority ranking system that calculates the sum of ranks and allows the user to change the scoring criteria.



Future Plans -

Expand the regional input variables in the model to **include the number and volume of waste rock piles, depth to groundwater, location up/down gradient to wells and radiation at surface contact.**

Investigate and include variables of site accessibility, land ownership and geographic proximity.

Expand AML Coal Inventory to other districts.

Acknowledgements

- OSMRE Technical Innovation and Professional Services for support.
- Navajo Abandoned Mine Land Reclamation Department for training in health physics and radiation surveys.
- U.S. EPA for further health physics training.
- Private land owners who have provided site access.
- Our Team of Contractors – Tetra Tech Albuquerque and their GIS Manager, Simon Cardinale and INTERA and their GIS Specialist Chris Park.

Questions?