EVOLVE-Central Appalachia (Evolve-CAPP) - Basinal Resource Assessment

Evolve CAPP Project Outreach Event
August 4, 2023
Julian, WV

Presented by:
Marshall Miller & Associates
Kevin Andrews, CPG – Vice President
Scott Peterson, CPG – Senior Principal Geologist

Outline

- Introduction
- Database Compilation
- Data Review
- Preliminary Inventory Estimation
  - Initial Basic Methodology
  - Inventory Estimation Examples
- Extension Phase
  - Gap Sampling
  - Inventory Estimate Update

ACKNOWLEDGEMENT

"This material is based upon work supported by the Department of Energy under Award Number DE-FE0032055."

DISCLAIMER

Introduction

The Evolve-CAPP Project = developing and implementing strategies to enable the Central Appalachian Basin to realize its full economic potential for producing high-value, non-fuel, carbon-ore (CO) products, rare earth elements (REE), and critical minerals (CM).

- The Basinal Assessment of CORE-CM Resources is a state-of-the-art geological model and comprehensive database that will be used to identify, locate, and quantify in-situ resources in the basin.
- Restrictive aspects of resource recovery, such as physical and legal restrictions, are being considered in estimating recoverable resources.
- A gap analysis of missing or unavailable data that could not be fully integrated in the initial assessment due to budget, access, or other constraints during the assessment effort is planned.
- An extension of the characterization and data acquisition plan to fully characterize the basin's CORE-CM potential will address gaps in data. The plan will be developed with input from project team members and relevant stakeholders, including land and mineral holding companies and coal operators, who maintain sampling programs as part of their normal operations.

Introduction

From Karmis, M. – October 27, 2021 Project Kickoff Meeting:

Subtask 2.1

Preliminary Basinal Resource Estimate

- Identify CORE-CM, and other important minerals, most likely available within the study area and develop a comprehensive database of existing data sources
- Preliminary quantification of CORE-CM resources using a geologic model based on individual volumetric representations of coal seam of interest that captures the spatial variability of properties such as stratigraphic thickness, mineral concentration and recovery factors
- Restrictive aspects of resource recovery, such as ownership and legal restrictions, will be considered in estimating potentially recoverable resources and will be included in the Initial Basinal Resource Assessment deliverable
- E-CAPP team has significant experience in developing resource assessment studies for the coal and gas sectors, based on accepted international standards and reporting to the SEC

Introduction

From Karmis, M. – October 27, 2021 Project Kickoff Meeting:

Subtask 2.2

Basinal Resource Gap Analysis

- Gap Analysis is conducted throughout data collection, classification and assessment tasks
  - Collect – Organize – Classify – Prioritize – Estimate – Analyze

Subtask 2.3

Characterization and Data Acquisition Plan

Sampling Plan Development: NETL approval - Environmental Questionnaires will identify the sampling organization, county, sampling site, and methodology. **Samples may also be donated by industry.**

Establishing E-CAPP Sample Storage Lab in Abingdon, Virginia, as a joint VaDOE/VCCER-VT Facility

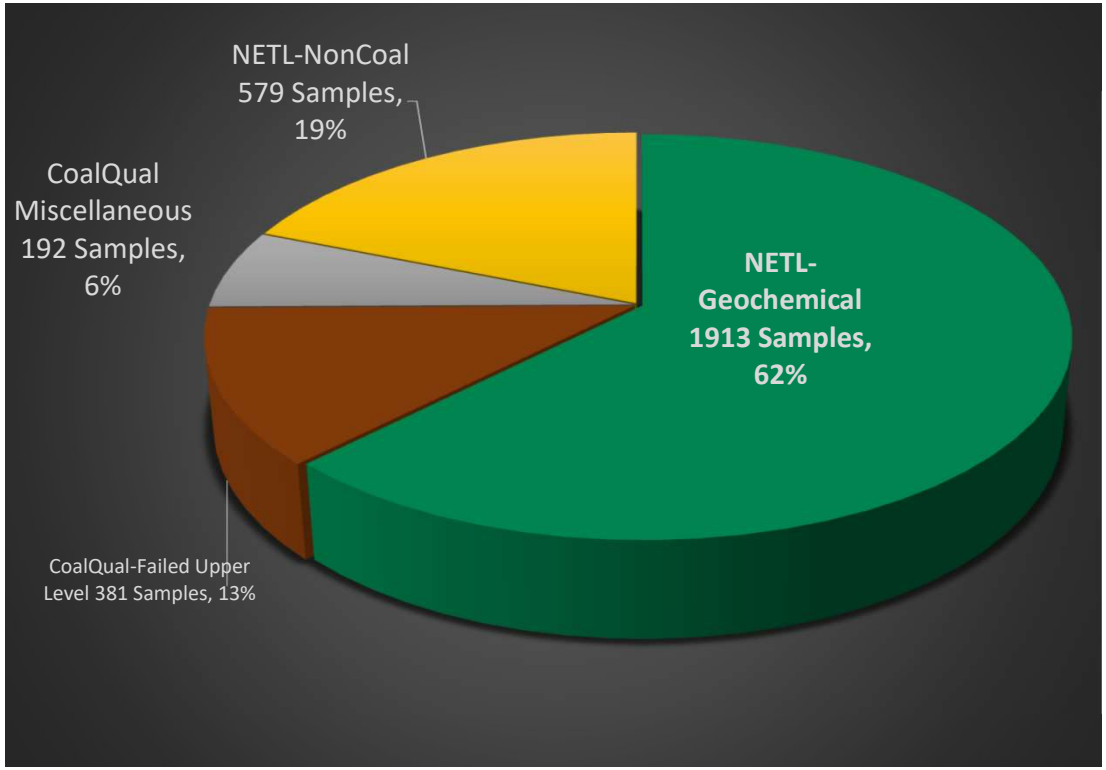
Database Compilation – Data Sources

Databases Incorporated to Date

- NETL-Geochemical (CoalQual)
- NETL-NonCoal
- CoalQual – Failed Upper Level
- CoalQual - Miscellaneous

NETL Sub-Databases Still to be Added into Comprehensive Database

- Non-Coal
- Major Chem
- Other Chem
- Unknown Chem



Data Review

Ranking	Kentucky	Samples	Ranking	Tennessee	Samples	Ranking	Virginia	Samples	Ranking	West virginia	Samples
	UNKNOWN	196		UNKNOWN	60		UNKNOWN	36		UNKNOWN	262
	NO DATA ENTERED	90	1	BIG MARY	7	1	DORCHESTER	71	1	EAGLE	66
1	FIRE CLAY	49	2	PEWEE	5	2	CLINTWOOD	67	2	SEWELL	65
2	PEACH ORCHARD	43	3	MASON	4	3	UPPER BANNER	38	3	POCAHONTAS NO 3	51
3	HAZARD	36	4	REX	4	4	LYONS	35	4	NO 5 BLOCK	49
4	RICHARDSON	35	5	WINDROCK	4	5	KENNEDY	31	5	BECKLEY	46
5	UNNAMED	35	6	BLUE GEM	3	6	JAWBONE	25	6	COALBURG	44
6	UPPER ELKHORN NO 3	29	6	COAL CREEK	3	7	LOWER BANNER	24	7	REDSTONE	42
7	JELLICO	27	6	GLEN MARY	3	8	SPLASHDAM	23	8	NO 2 GAS	39
8	BLUE GEM	24	6	JELLICO	3	9	BLAIR	18	9	CAMPBELL CREEK	34
9	FIRE CLAY RIDER	22	6	POPLAR LICK	3	9	NORTON	18	10	STOCKTON	33
9	HAZARD NO 7	22	7	NEMO	2	10	IMBODEN	16		WINIFREDE	28
10	UPPER PEACH ORCHARD	19	7	WALNUT MOUNTAIN	2		POCAHONTAS NO 3	15		POCAHONTAS NO 6	26
	UPPER ELKHORN NO 2	18	8	JORDAN	1		JEWELL	11		FIRE CREEK	24
	BROAS	17	8	JOYNER	1		TILLER	11		ALMA	23
	HINDMAN	16	8	LANTANA	1		HAGY	10		CEDAR GROVE	21
	WHITESBURG	16	8	LOW SPLINT	1		RAVEN	10		PITTSBURGH	21
	LOWER PEACH ORCHARD	15	8	PIONEER	1		TAGGART	10		POWELLTON	19
	MANCHESTER	15	8	POPLAR CREEK	1		COVE CREEK	7		PEERLESS	17
	WILLIAMSON	13	8	STRAY	1		PARDEE	7		HERNSHAW	16
	FRANCIS	11					JAWBONE-TILLER	6		NO DATA ENTERED	14
	HADDIX	11					KELLY	6		LITTLE RALEIGH	12
	HAZARD NO 8	10					LOWER SEABOARD	6		POCAHONTAS NO 4	12
	POND CREEK	10					NO DATA ENTERED	6		UPPER CEDAR GROVE	12
	UPPER ELKHORN NO 1	10					UPPER HORSEPEN	6		LOWER CEDAR GROVE	11
	LILY	9					LEE	5		UPPER NO 5 BLOCK	11
	LOWER ELKHORN	9					MERRIMAC	5		LOWER KITTANNING	8
	STEARNS	9					MIDDLE HORSEPEN	5		LOWER NO 5 BLOCK	8
	AMBURGY	9					WILSON	5		SEWELL A	8

Classification of REE and CM Elements

Table 2-2. Recovery Potential Classification/Prioritization for Minerals Specifically in Central Appalachian Basin

Recovery Potential Classification	Minerals
High Recovery/High Resource Potential (HRP)	Cerium (Ce), Cesium (Cs), Dysprosium (Dy), Erbium (Er), Europium (Eu), Gadolinium (Gd), Hafnium (Hf), Lanthanum (La), Neodymium (Nd), Praseodymium (Pr), Rubidium (Rb), Samarium (Sm), Scandium (Sc), Terbium (Tb), Ytterbium (Yb), Yttrium (Y), Zirconium (Zr)
Moderate	Aluminum (Al), Antimony (Sb), Arsenic (As), Chromium (Cr), Cobalt (Co), Gallium (Ga), Germanium (Ge), Holmium (Ho), Lithium (Li), Lutetium (Lu), Manganese (Mn), Nickel (Ni), Thulium (Tm), Vanadium (V)
Low	Barite, Beryllium (Be), Fluorspar, Graphite, Iridium (Ir), Magnesium (Mg), Niobium (Nb), Palladium (Pd), Platinum (Pt), Rhodium (Rh), Ruthenium (Ru), Tantalum (Ta), Titanium (Ti), Zinc (Zn)
Unknown	Bismuth (Bi), Indium (In), Tellurium (Te), Tin (Sn), Tungsten (W)

Summary of "Top Ten" Coal Seams with HRP Suite PPM Averages

	KENTUCKY			
	COUNT	MAX	MIN	AVERAGE
BLUE GEM	41	193.01	25.05	68.88
UPPER ELKHORN NO 2	33	191.05	44.92	72.44
JELLICO	42	170.06	44.07	91.84
UPPER ELKHORN NO 3	44	261.06	45.27	111.84
UNKNOWN-BITUMINOUS C	46	485.25	40.93	117.91
PEACH ORCHARD	62	323.30	45.54	133.58
HAZARD NO 7	30	212.49	40.99	135.81
HAZARD	59	420.31	50.79	140.85
BROAS	31	661.07	65.72	148.87
HINDMAN	30	413.30	71.79	164.93
FIRE CLAY	89	732.51	45.44	189.56

	TENNESSEE			
	COUNT	MAX	MIN	AVERAGE
REX	2	46.75	32.10	39.43
BLUE GEM	2	44.10	44.04	44.07
MASON	3	61.66	34.78	45.64
PEWEE	4	72.14	50.45	63.30
JELLICO	3	99.63	43.62	79.90
COAL CREEK	2	117.34	52.65	84.99
POPLAR LICK	3	140.83	34.94	100.11
BIG MARY	4	230.84	78.89	135.63
WINDROCK	2	232.17	55.74	143.95
WALNUT MOUNTAIN	2	186.24	141.95	164.10

	VIRGINIA			
	COUNT	MAX	MIN	AVERAGE
LYONS	35	210.98	30.39	81.41
BLAIR	18	149.24	47.06	82.07
DORCHESTER	71	273.42	30.70	91.12
CLINTWOOD	67	394.08	30.41	93.18
NORTON	18	159.34	39.39	94.20
KENNEDY	18	278.48	37.57	96.70
UPPER BANNER	31	320.15	56.04	124.21
SPLASHDAM	24	498.31	48.20	124.30
LOWER BANNER	19	413.96	34.49	131.04
JAWBONE	17	321.39	43.17	165.73

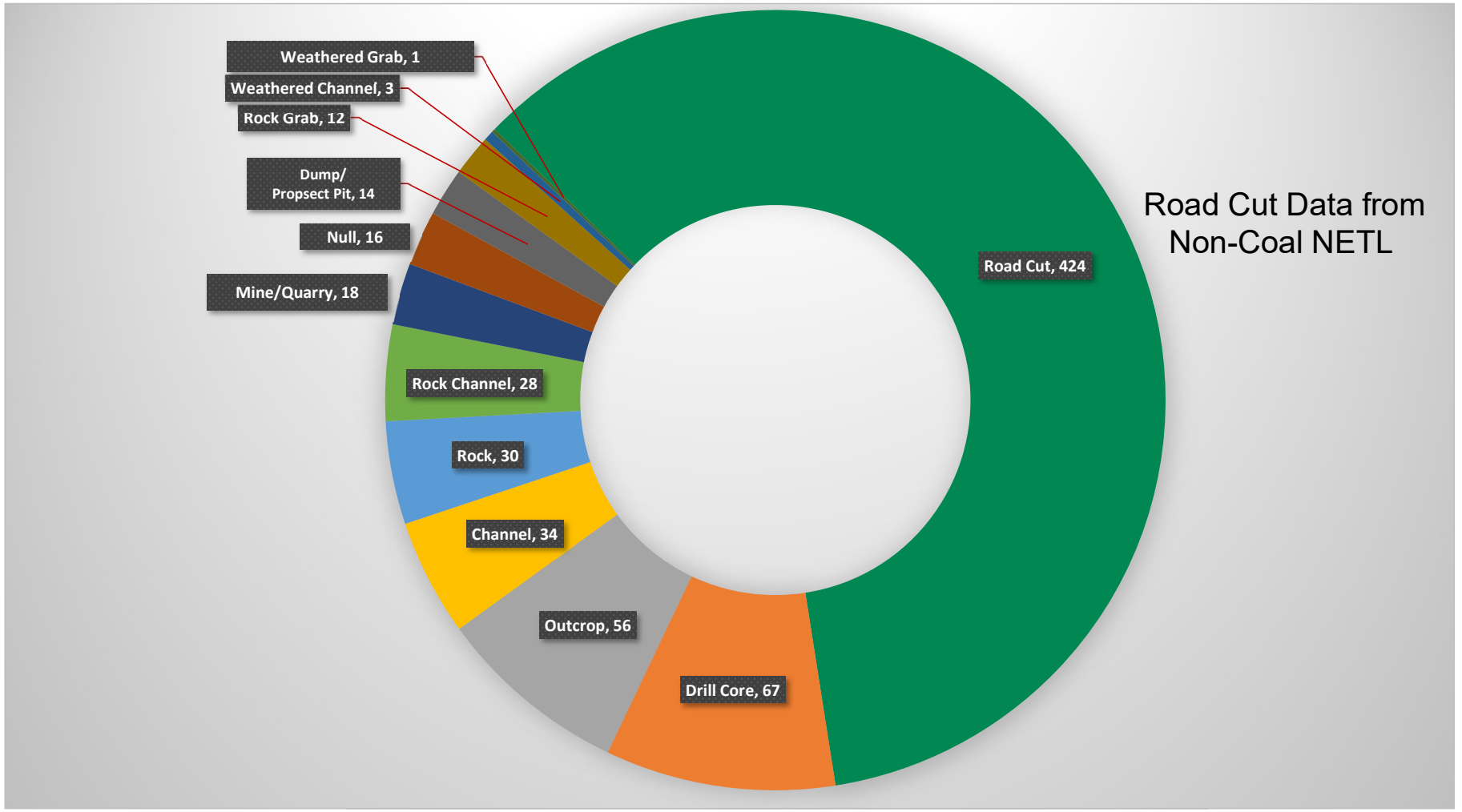
	WEST VIRGINIA			
	COUNT	MAX	MIN	AVERAGE
REDSTONE	42	453.77	43.67	104.65
BECKLEY	43	344.60	30.12	111.41
SEWELL	51	484.58	37.37	122.94
POCAHONTAS NO 3	48	396.95	47.17	136.72
NO 2 GAS	37	840.13	60.41	154.99
EAGLE	54	833.07	52.64	156.91
CAMPBELL CREEK	30	766.85	46.51	196.15
COALBURG	39	846.04	52.16	203.98
NO 5 BLOCK	38	1,389.71	51.44	245.11
STOCKTON	27	712.13	70.17	247.86

Unknown Coal Bed Data: Non-Coal Samples

Data Review
Material Types for Unknown Coal Bed Data

Material	Count	Material	Count	Material	Count	Material	Count
Alluvium	1	Clay	61	Mud	18	Siltstone	1
Barite Nodules	6	Clay and Powdered Shale	36	Mud Pebble Conglomerate	1	Silty Sandstone	1
Bituminous Coal	50	Clayey Siltstone	1	Nodule	2	Silty Shale	2
Bituminous Rock	2	Claystone	36	Null	133	Silty Claystone	10
Black Shale	20	Core of Nodule	2	Ohio Shale	12	Tonstein	98
Brecciated Ironstone	1	Diatreme Breccia	1	Phosphatic Claystone	4	Trachyte	1
Brecciated Limestone	1	Fault Gouge Limestone Coal	1	Rock	6	Tuff	3
Carbonaceous (Organic)	46	Ferruginous Claystone	2	Sandstone	4	Underclay	1
Carbonaceous Sandstone	3	Flintclay	45	Sandy Siltstone	3	Vitrinite	2
Carbonaceous Shale	1	Laminated Limestone	1	Semi Flintclay	3		
Carbonaceous Siltstone	2	Manganese Ore	16	Shale	43		
Carbonate - Dolomite	2	Micaceous Sandstone	3	Shale Pig	1		
Carbonaceous Claystone	1	Micaceous Siltstone	2	Sideritic Nodule	2		
Chert	4	Mineralized Limestone	2	Silicified Carbonaceous Shale	2		

Data Review – Unknown Seams Data



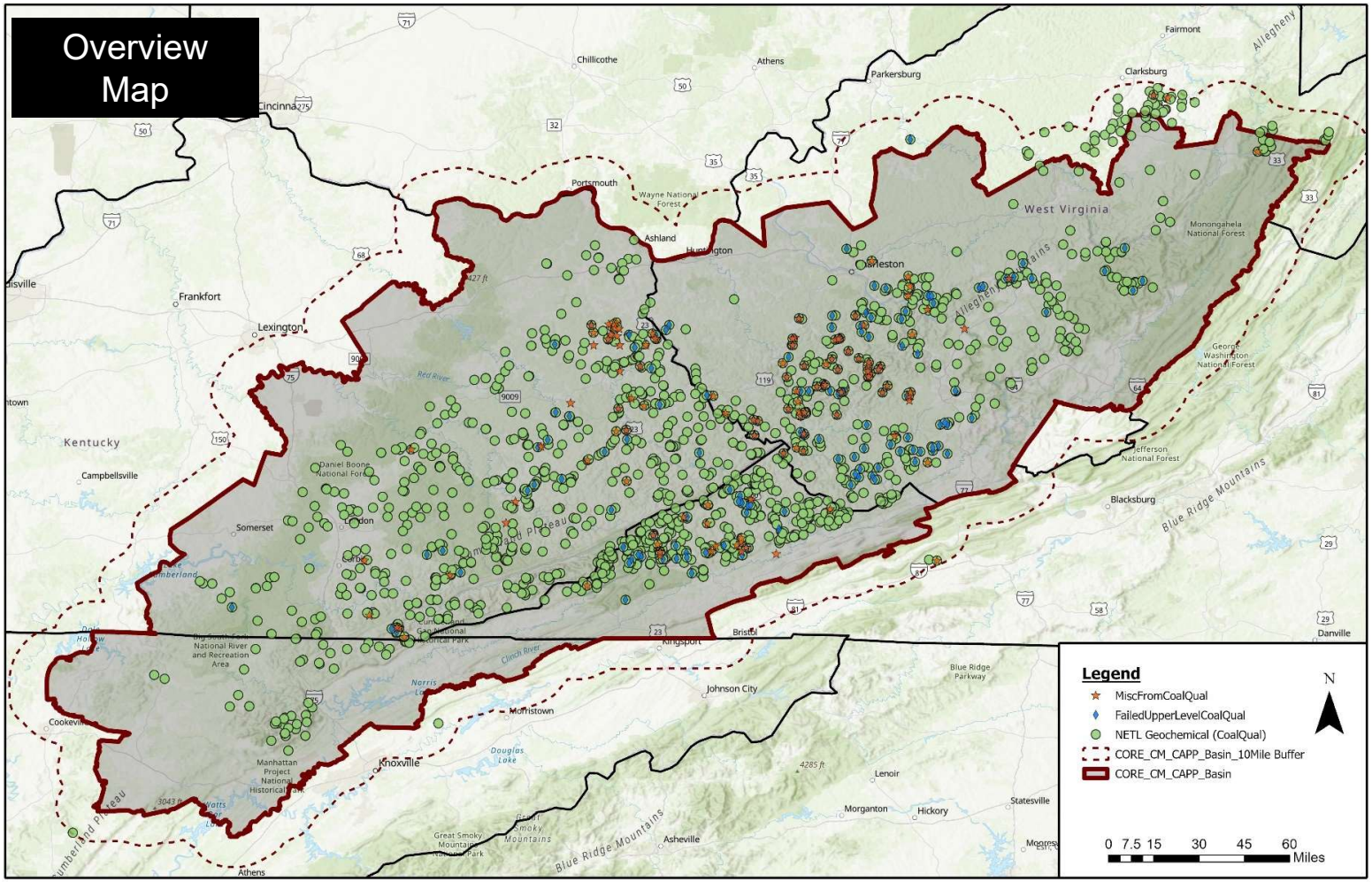
Samples - many of the samples are in the same location

Sample Type	Number of Samples	Number of Individual Sampling Sites
Road Cut	424	92
Drill Core	67	9
Outcrop	56	22
Channel	34	28
Rock	30	4
Rock Channel	28	11
Mine/Quarry	18	13
None	16	6
Dump/Prospect Pit	14	1
Rock Grab	12	6
Weathered Channel	3	3
Weathered Grab	1	1

Preliminary Resource Assessment – Example #1

West Virginia
Eagle Coal Seam
Barium

Preliminary Resource Assessment – Example #1



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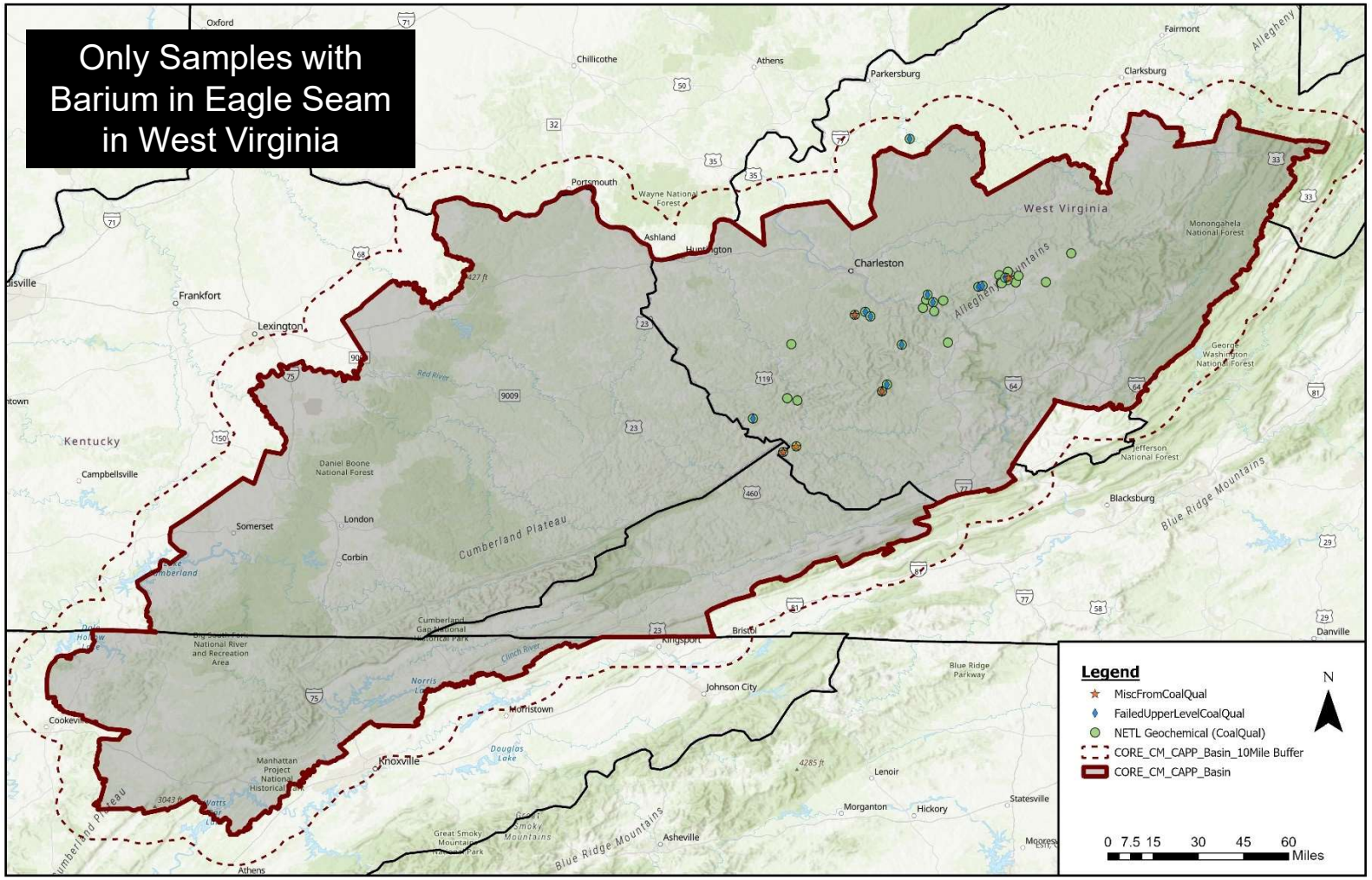
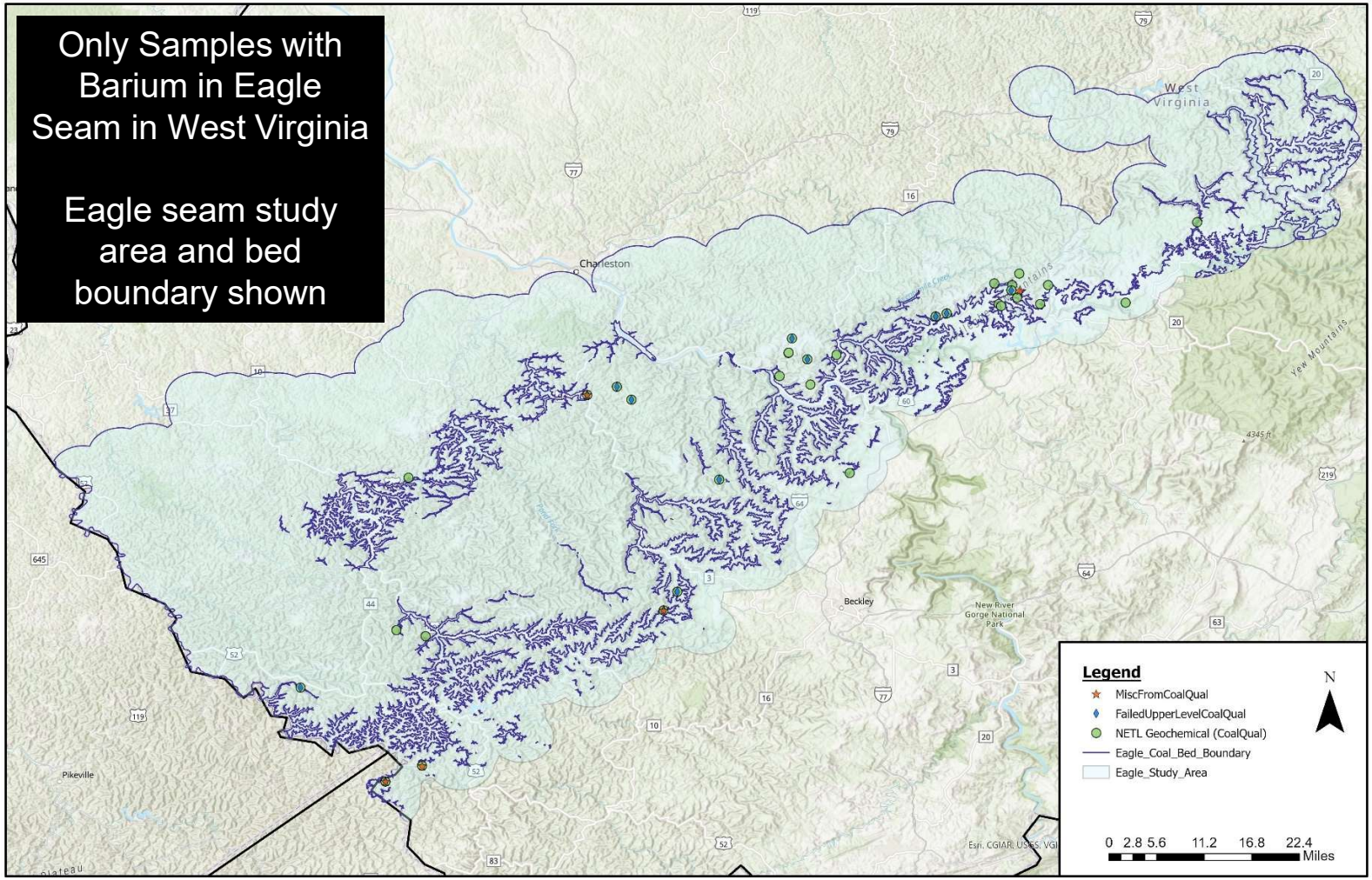


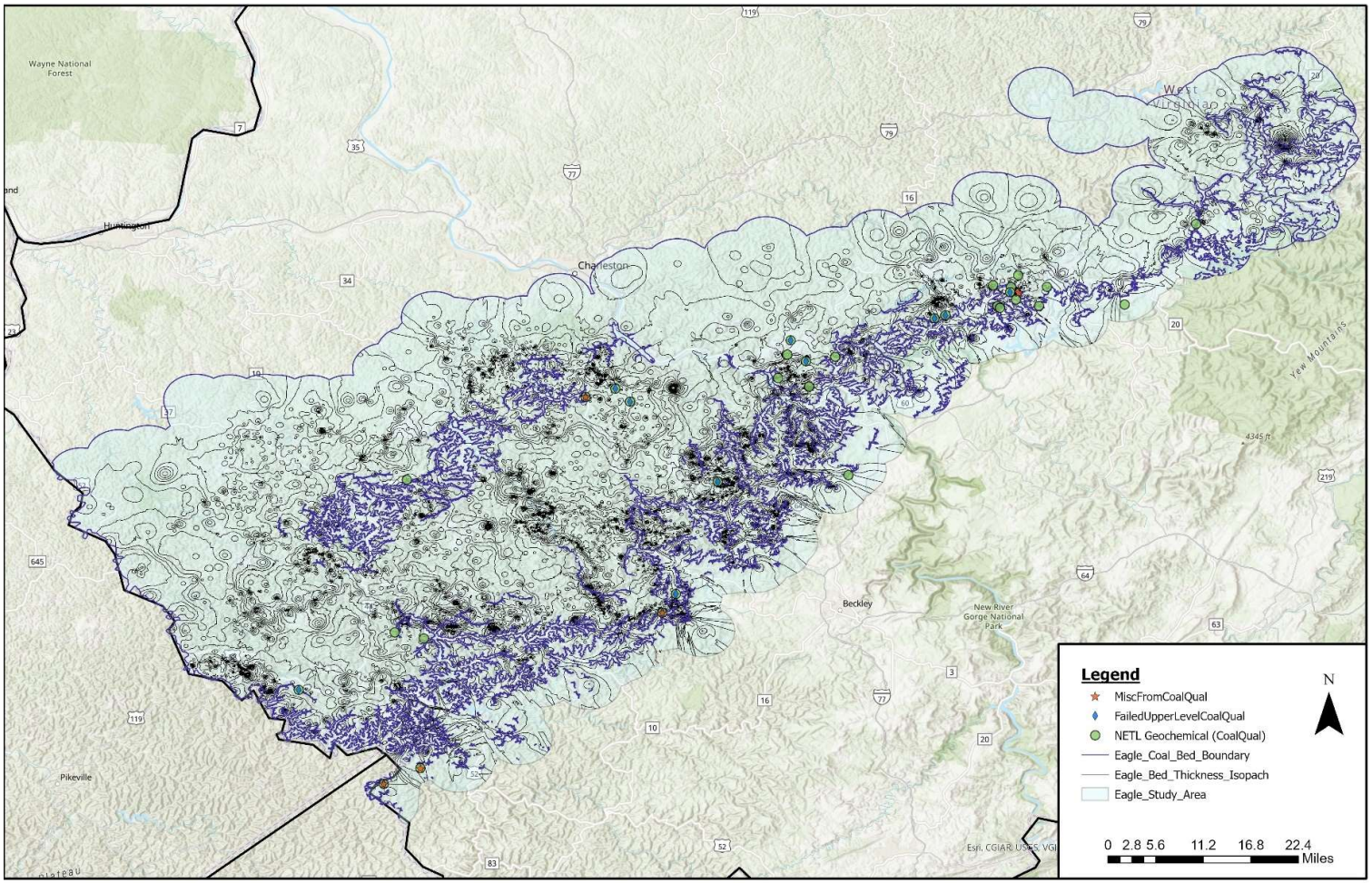
Preliminary Resource Assessment – Example #1



Preliminary Resource Assessment – Example #1

Only Samples with Barium in Eagle Seam in West Virginia

Eagle seam study area, bed boundary and thickness isopach shown

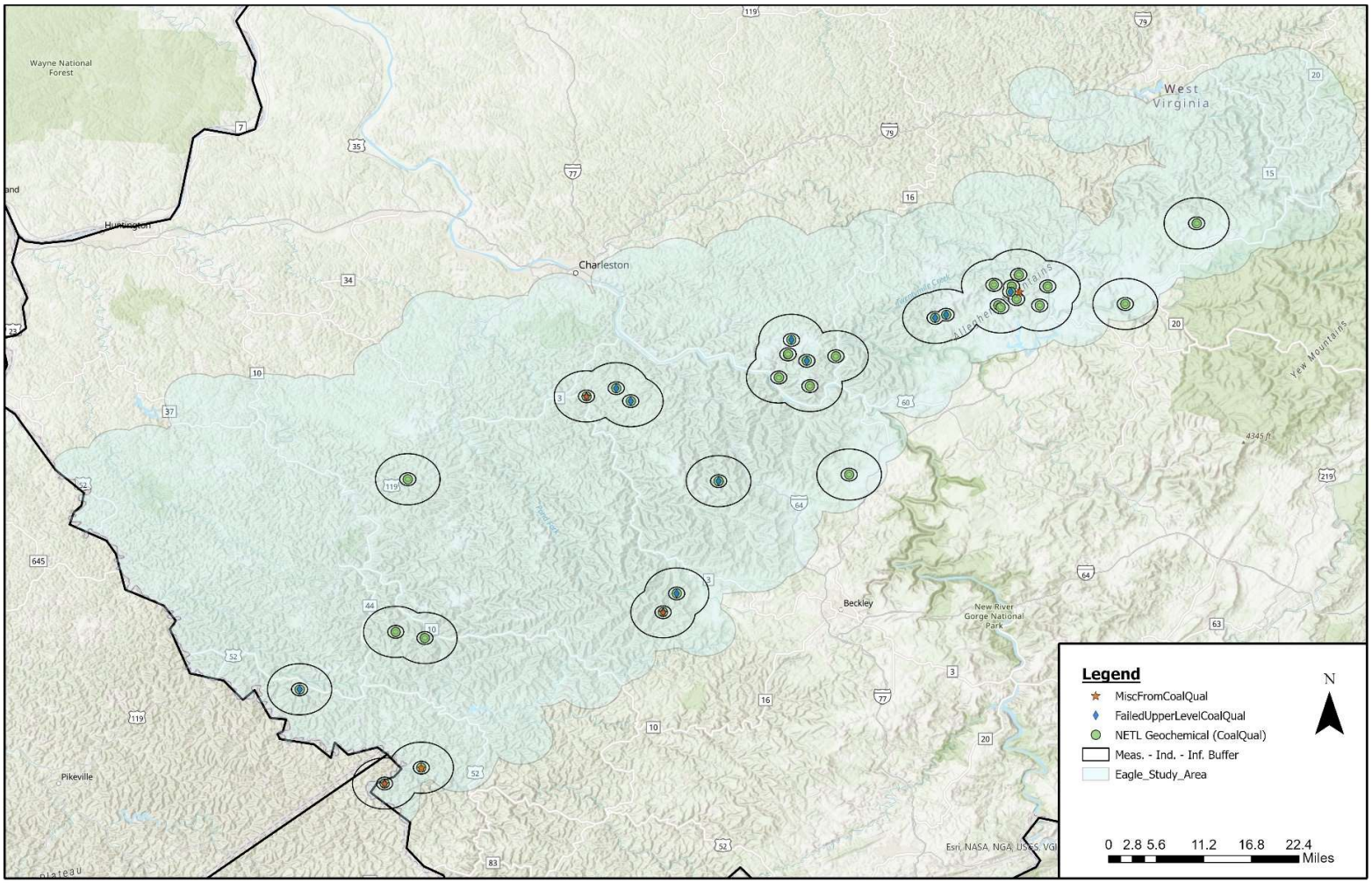


Preliminary Resource Assessment – Example #1

Only Samples with Barium in Eagle Seam in West Virginia

Eagle seam study area and measured, Indicated, Inferred buffers shown.

Measured – ¼ Mile
Indicated – ¾ Mile
Inferred – 3 Miles

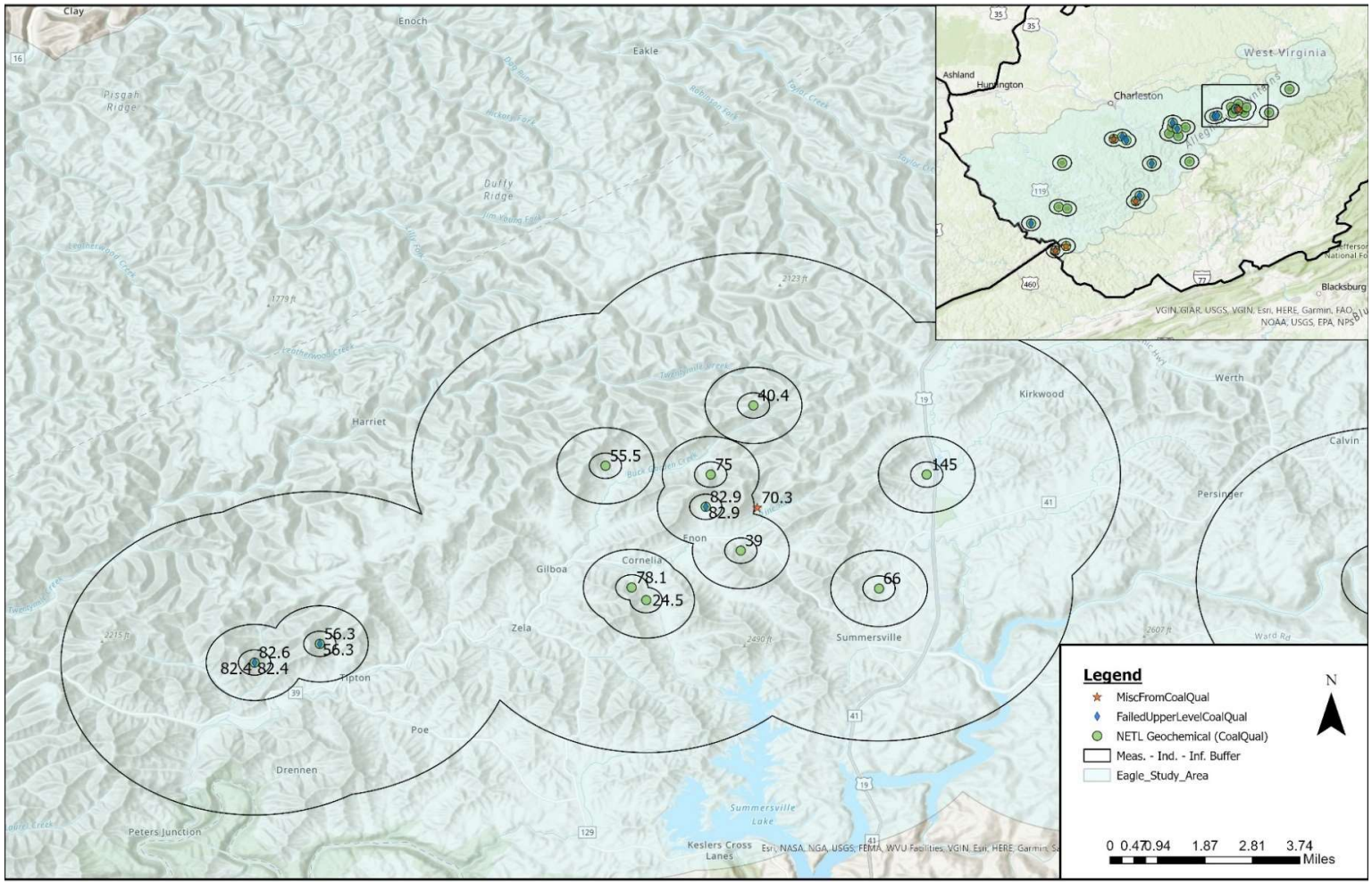


Preliminary Resource Assessment – Example #1

Only Samples with Barium in Eagle Seam in West Virginia

Eagle seam study area and measured, Indicated, Inferred buffers shown. Zoomed in view

Measured – ¼ Mile
Indicated – ¾ Mile
Inferred – 3 Miles



Extension Phase - Sampling

- The sampling phase funded July 2023
- Developed in cooperation with VT, NETL and Stake Holders
- Collaborate with Industry Partners and others to Identify specific sampling areas
- Sampling to include drill core, outcrops, coal plant waste streams
  - Surface and Underground Mine Sampling
  - Downhole geophysical logging - screening
  - X-ray Diffraction (XRD) Analysis of drill core

Rare Earth Elements (REE) to be Analyzed

Rare Earths	Symbol
Lanthanum	La
Cerium	Ce
Praseodymium	Pr
Neodymium	Nd
(Promethium)	Pm (short
life)	
Samarium	Sm
Europium	Eu
Gadolinium	Gd
Terbium	Tb
Dysprosium	Dy
Holmium	Ho
Erbium	Er
Thulium	Tm
Ytterbium	Yb
Lutetium	Lu
Scandium	Sc
Yttrium	Yb

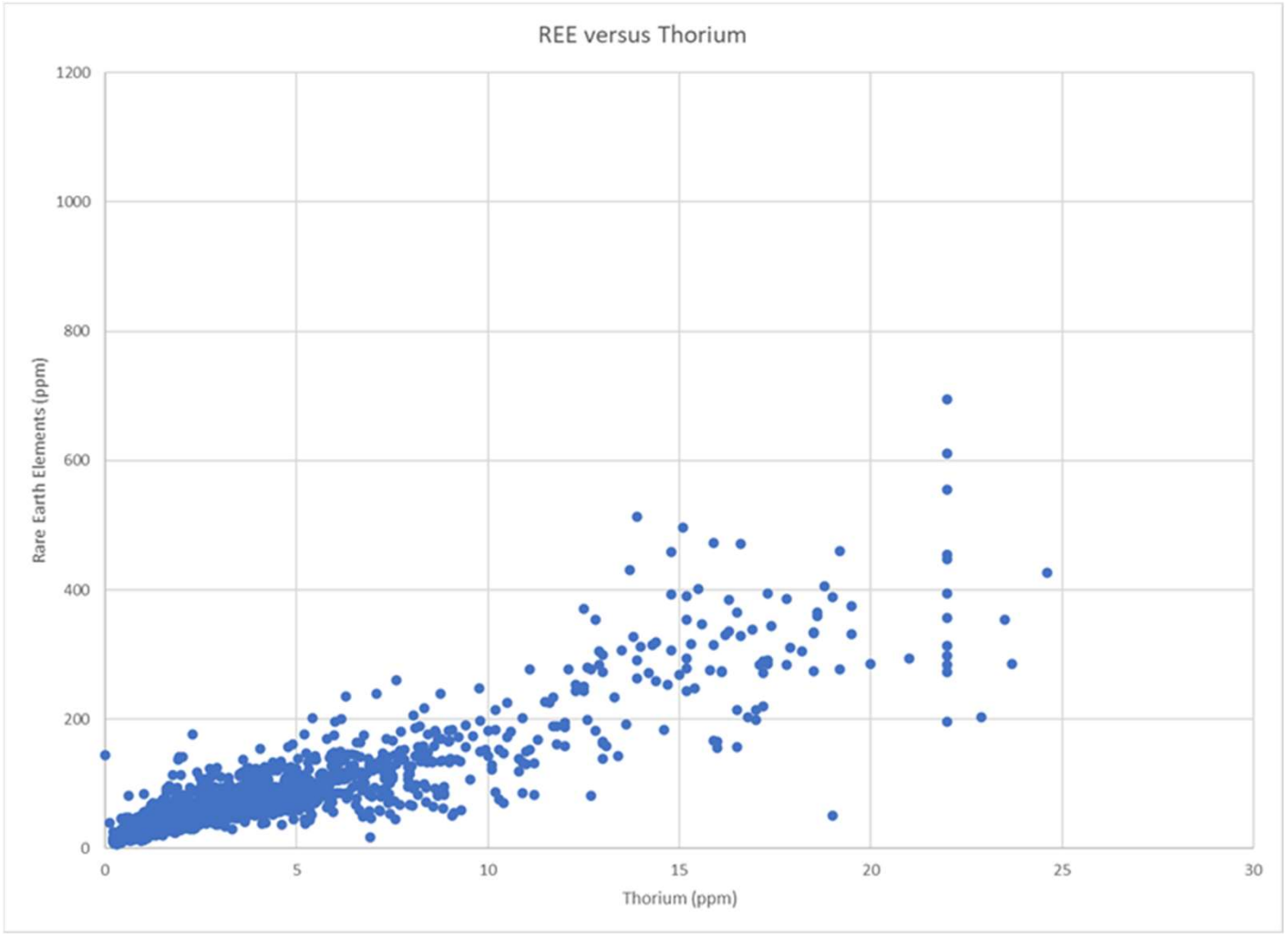
Critical Minerals (CM) to be Analyzed

Critical Minerals				
aluminum (bauxite)	chromium	helium	potash	tellurium
antimony	cobalt	indium	rare earth elements group	tin
arsenic	fluorspar	lithium	rhenium	titanium
barite	gallium	magnesium	rubidium	tungsten
beryllium	germanium	manganese	scandium	uranium
bismuth	graphite (natural)	niobium	strontium	vanadium
cesium	hafnium	platinum group metals	tantalum	zirconium

Downhole Geophysical Logging

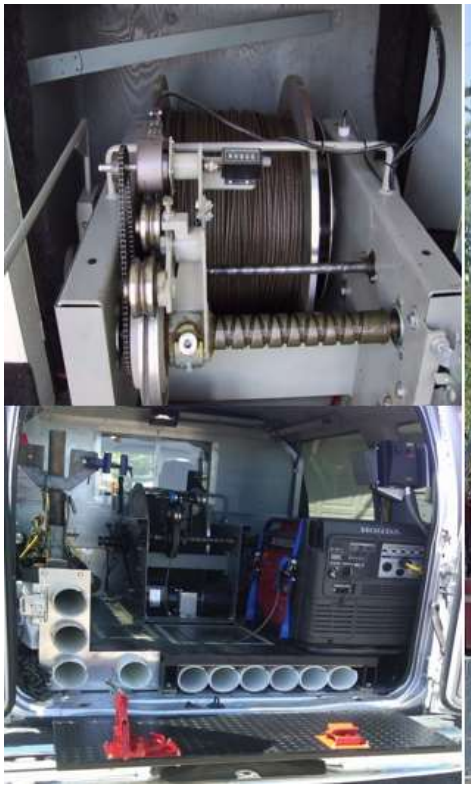
- Screening to quickly identify zones of interest over plus 1000 feet of vertical stratigraphy.
- Utilize a Spectral Gamma downhole geophysical logging tool
  - Determines the relative percentage of rays From Thorium verses Uranium verses Potassium in the rock
  - Evolve-CAPP database, indicates a direct relationship between Thorium and REE, as well as Uranium and REE
- MM&A very capable to perform the geophysical logging through Geologic Logging Systems

Preliminary Graph Illustrating Strong Direct Relationship Between Thorium and REE Content



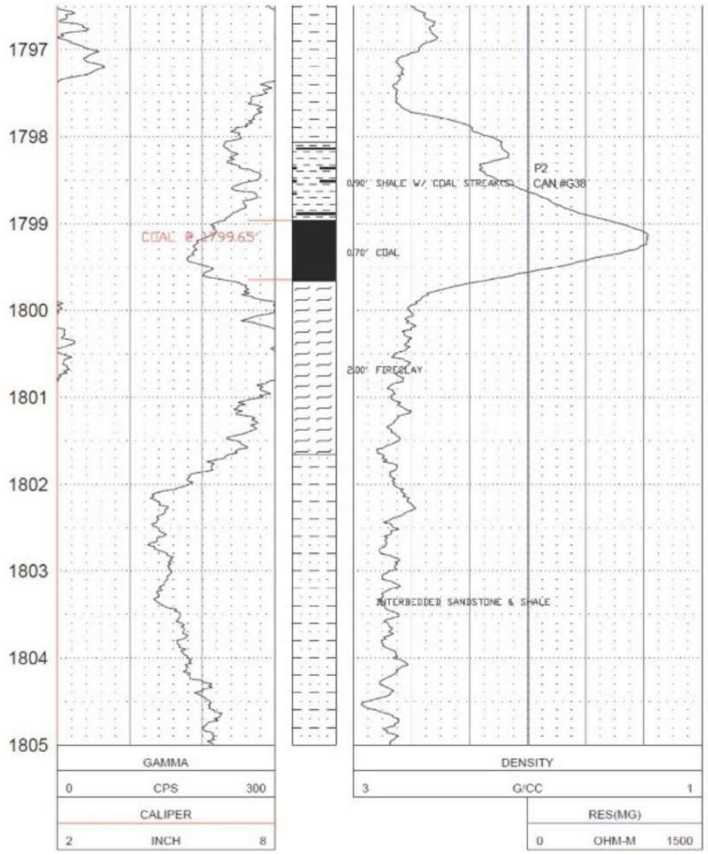
Geologic Logging Systems (GLS)

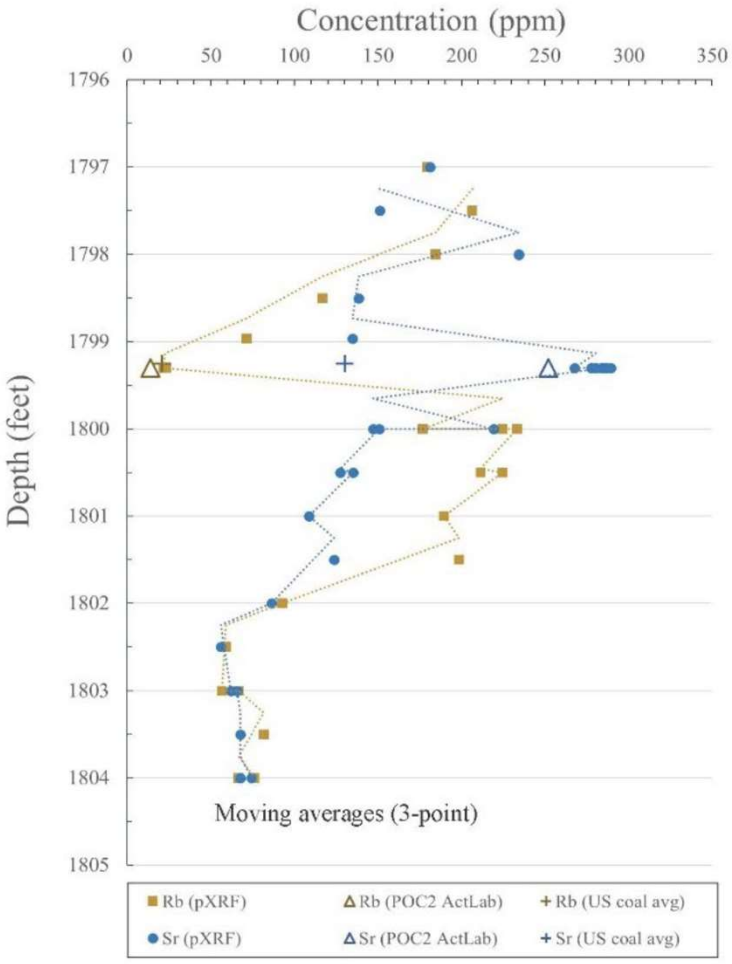
- GLS has logged thousands of drill holes in Appalachia
- Excellent working relationship with the mining community and clients
- Utilizes many downhole geophysical tools and can rent specific tools



XRD Core Analysis over the Pocahontas 2 Coal Seam Interval

Core Hole C-1 (BU-5150), TD=1,855'
Buchanan County: Pocahontas 2 coal seam





Summary

- The work is very much ongoing.
- Classification of data is required.
- Development of sampling plan in progress.
- Development of resource classification criteria in progress.
- Gap Analysis is developing as work progresses.
- Comments?

End of Presentation