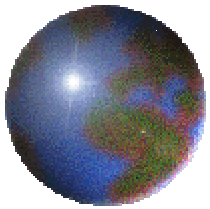


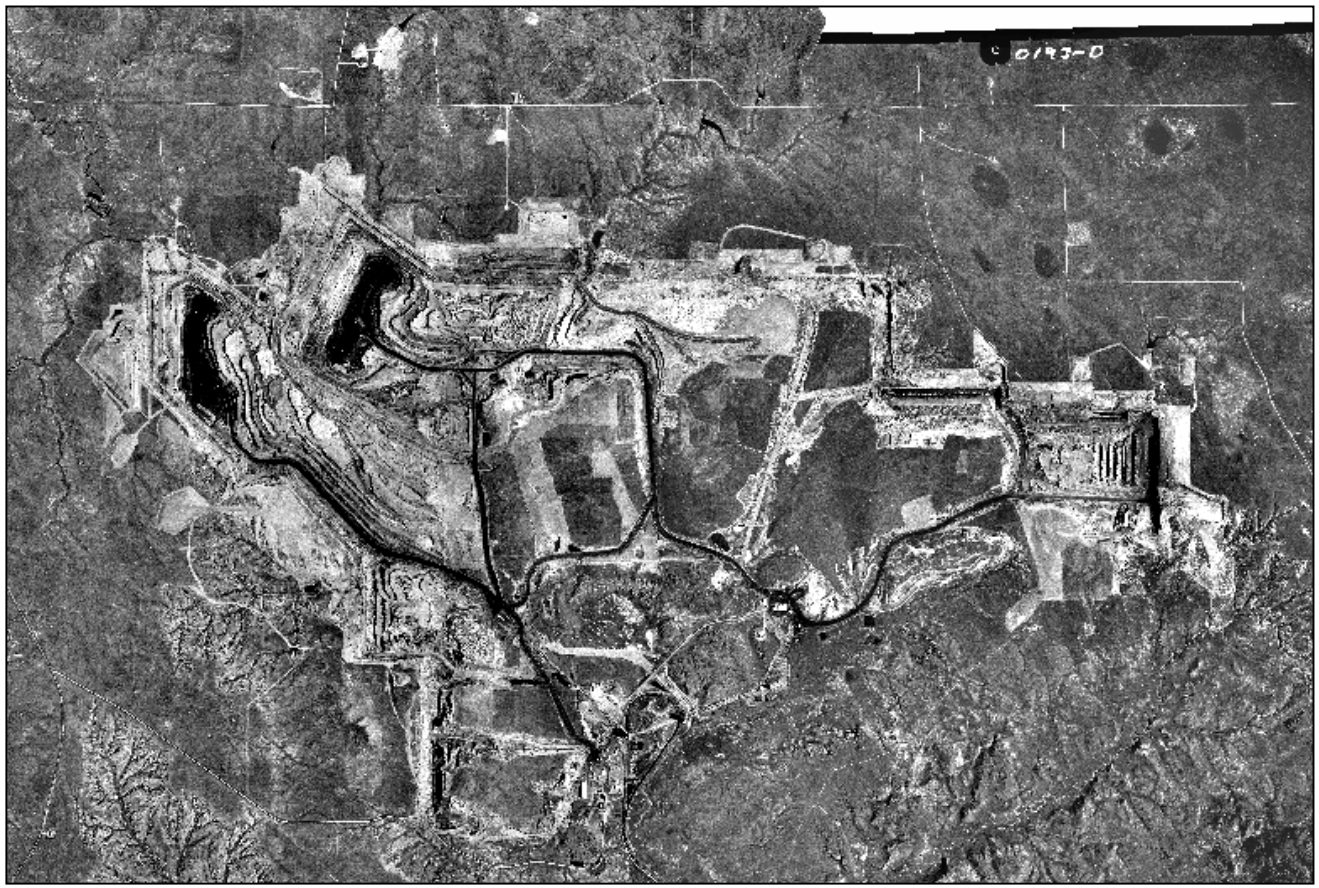
IDENTIFICATION AND QUANTIFICATION OF RECLAIMED VEGETATION IN A SURFACE MINE ENVIRONMENT: 2001 WYOMING CAMPAIGN AT THE POWDER RIVER COAL COMPANY

ELROI CONSULTING
WINTERMOON GEOTECHNOLOGIES, INC.
PEABODY ENERGY – NARC Complex
EARTH SEARCH SCIENCES, INC.

PROJECT RATIONALE

- COMPARE THE UTILITY OF DIFFERENT KINDS OF IMAGERY FOR ASSESSING REVEGETATION SUCCESS:
  - AERIAL PHOTOGRAPHY (1.5-METER SPATIAL RESOLUTION, 1 PANCHROMATIC BAND OF REFLECTANCE)
  - AERIAL HYPERSPECTRAL IMAGERY (5-METER SPATIAL RESOLUTION, 128 NARROW SPECTRAL CHANNELS OF REFLECTANCE)
  - USE KNOWN REVEGETATION REGIONS FOR CONTROL
  - GROUND TRUTH: ACQUIRE SPECTRA OF KNOWN VEGETATION IN SITU (Portable Field Spectrometer)

AERIAL PHOTOGRAPH, ORTHORECTIFIED ACQUIRED IN APRIL, 2001

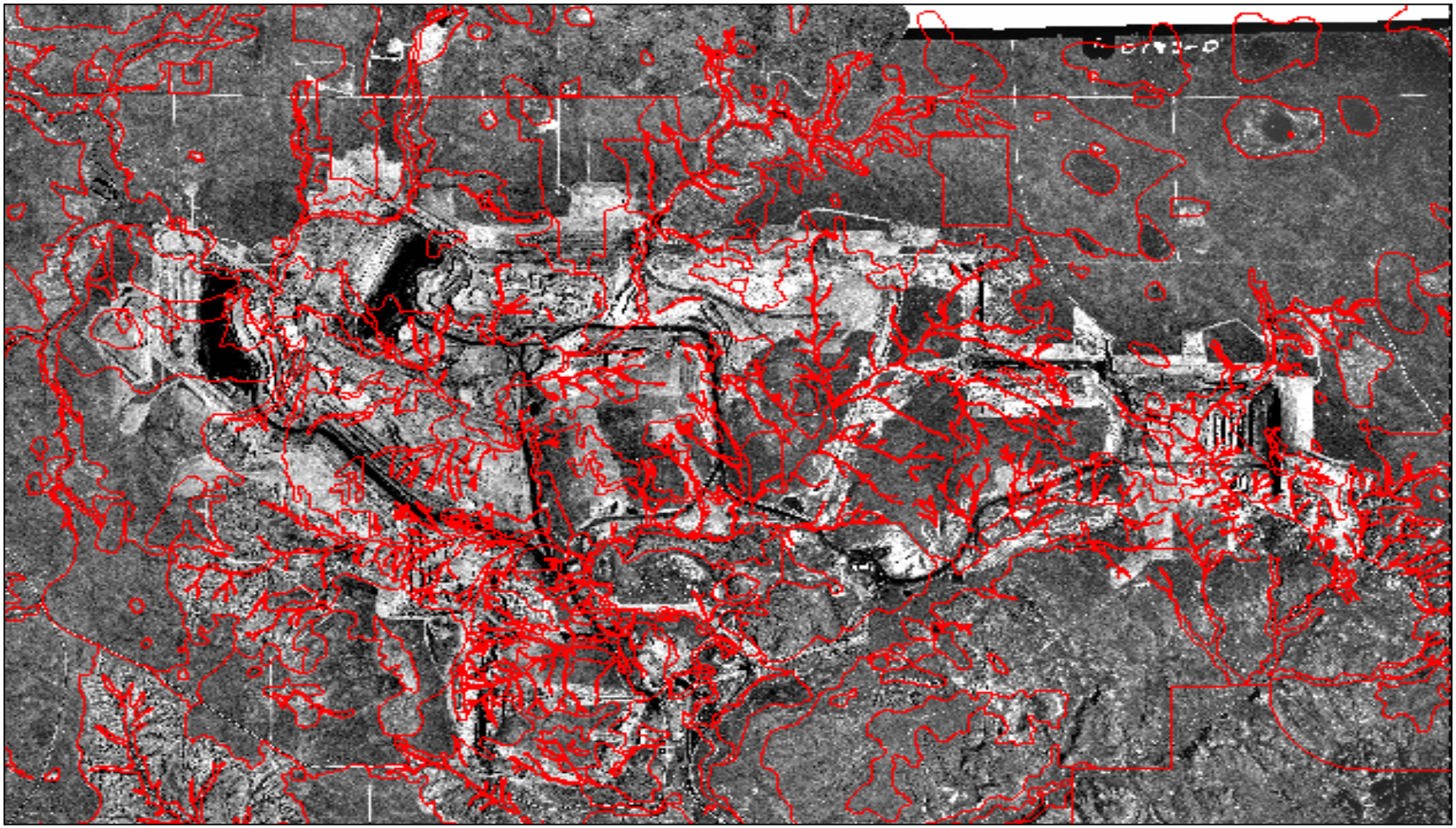


THIS IMAGE IS ‘PANCHROMATIC’: IT DEPICTS REFLECTED ENERGY FROM THE EARTH’S SURFACE IN THE VISIBLE LIGHT RANGE.

THIS IS COMPARABLE TO WHAT A PERSON WITH COLORBLINDNESS WOULD SEE FROM THE AIR.

GREAT SPATIAL DETAIL, POOR ‘LAND COVER’ DETAIL

BASELINE VEGETATION MAPPING

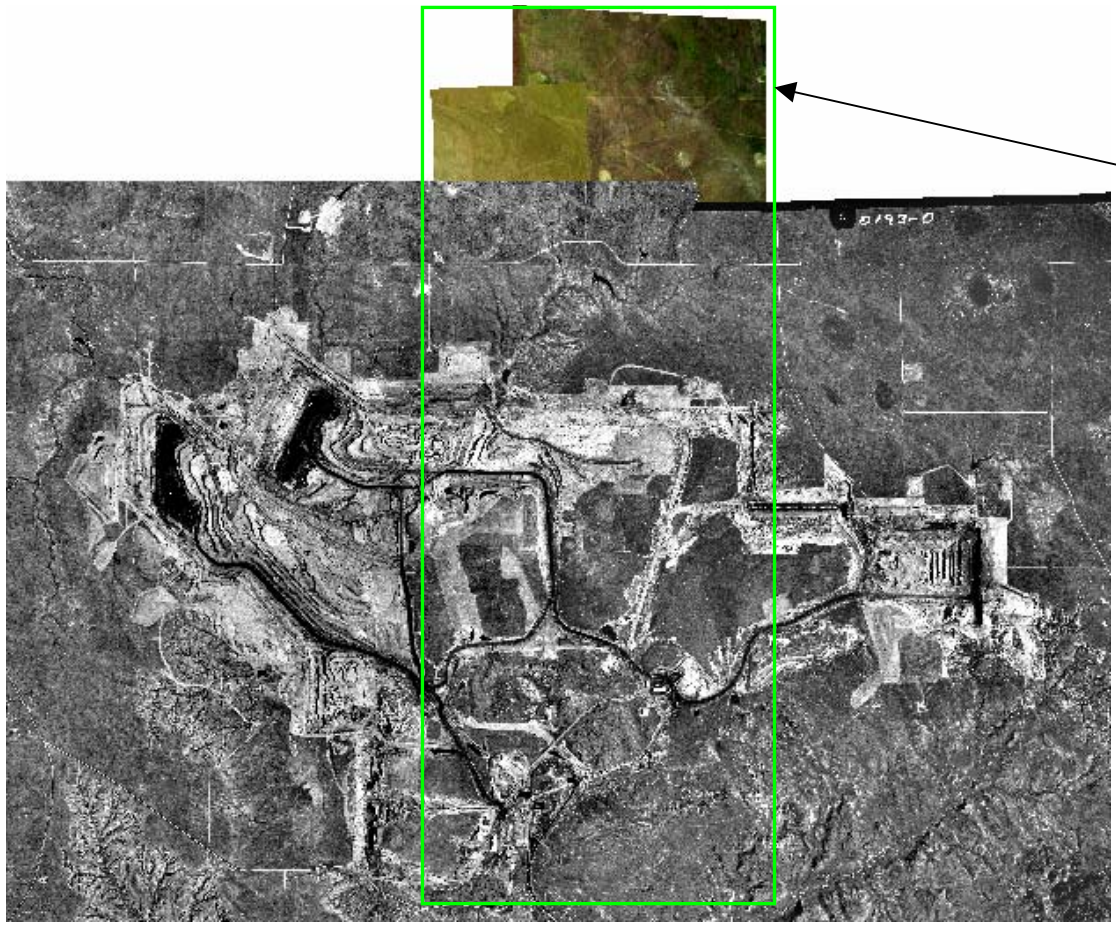


RECLAMATION AREAS IN STUDY YEAR 2001

THE RECLAIMED AREAS WITHIN THE ACTIVE MINE ARE VERY QUITE EVIDENT IN THE AERIAL PHOTO. HOWEVER, WE CANNOT ASSESS THE RELATIVE PLANT VIGOR OF THE RECLAIMED REGIONS.

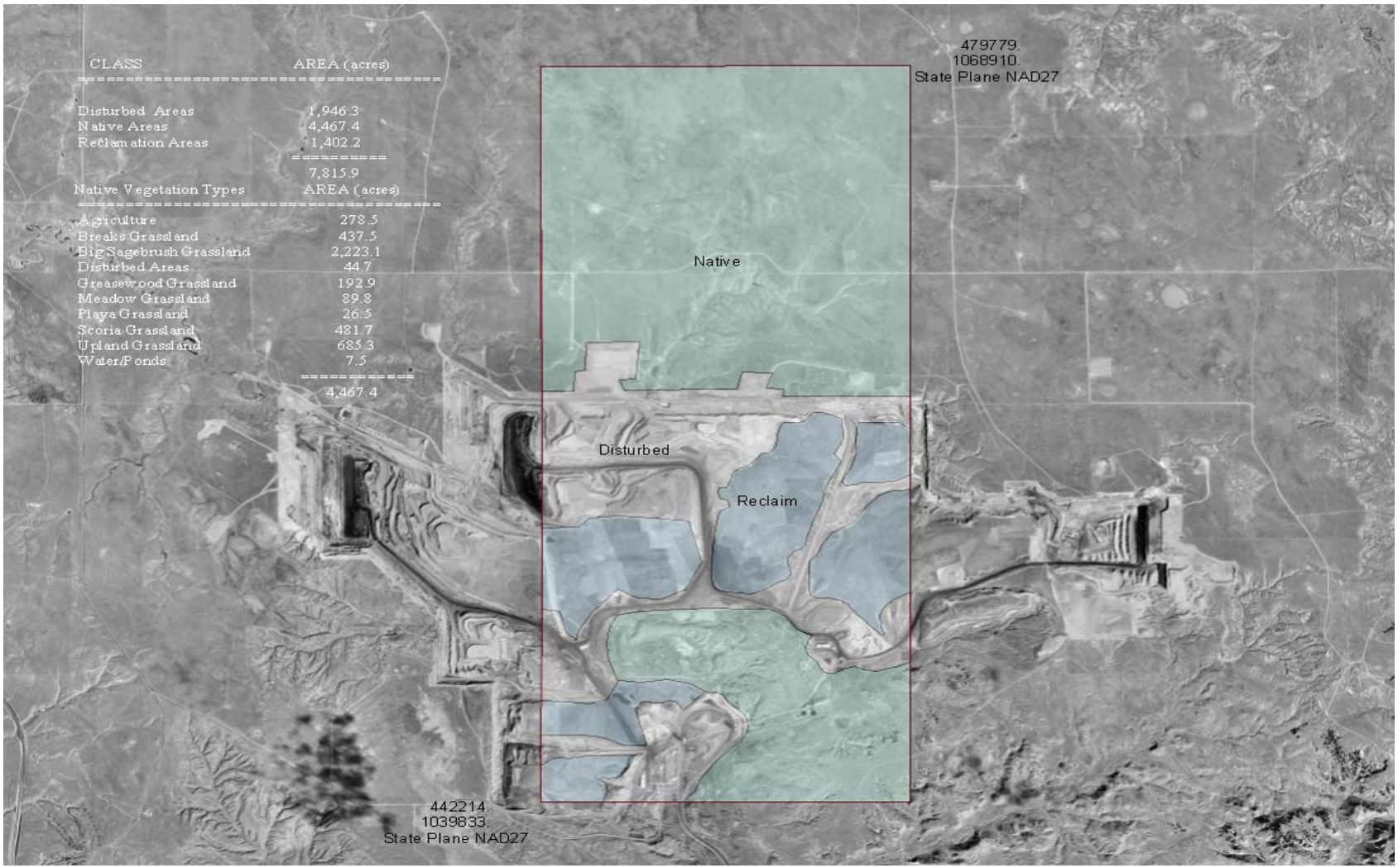
THE HYPERSPECTRAL IMAGERY WILL TELL A DIFFERENT STORY.

DISPLAY OF AERIAL PHOTOGRAPH AND HYPERSPECTRAL COVERAGE



HYPERSPECTRAL
FLIGHT BOUNDARY
JUNE, 2001

Study Area (Native/Disturbed/Reclaimed)



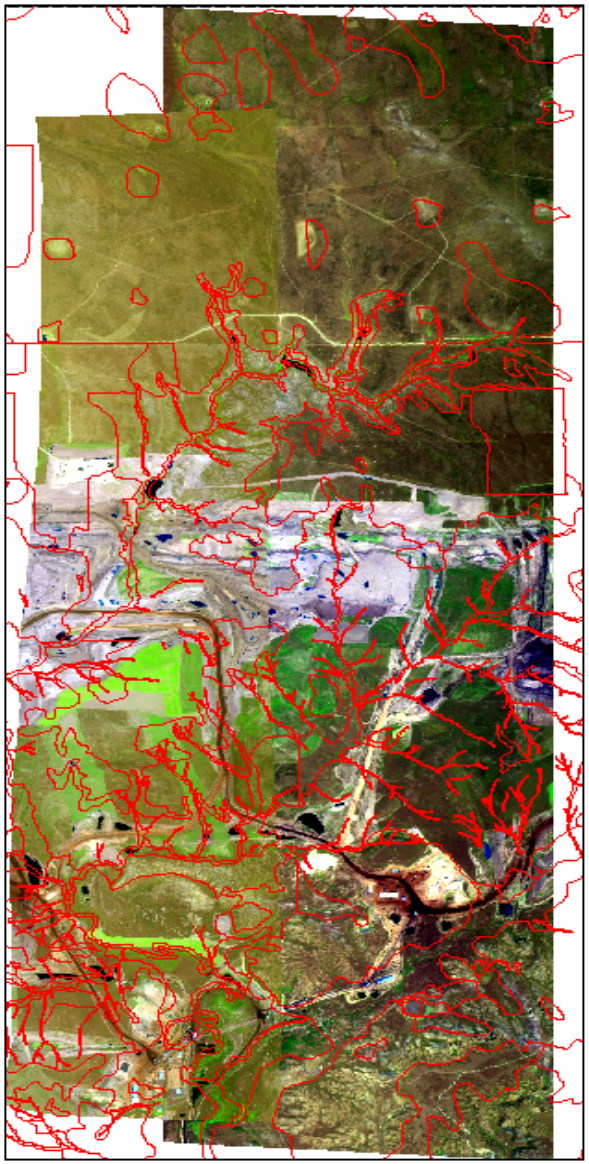
COLOR (RED-GREEN-BLUE) DISPLAY OF THREE INDIVIDUAL CHANNELS OF REFLECTANCE FROM THE HYPERSPECTRAL SURVEY

RED BAND = CHANNEL 87 (MID IR)

GREEN BAND = CHANNEL 44 (NEAR IR –VERY SENSITIVE TO VEGETATION)

BLUE BAND = CHANNEL 17 (VISIBLE GREEN)

THIS IMAGE HAS BEEN GEOREFERENCED TO THE AERIAL PHOTOGRAPH.



BASELINE VEGETATION MAPPING

THE HYPERSPECTRAL DATA ALLOW US TO IDENTIFY VEGETATION COMMUNITIES MUCH MORE EASILY THAN THE PANCHROMATIC AERIAL PHOTOGRAPH.

THE NATIVE AREAS SHOW EXCELLENT CORRELATION WITH THE VEGETATION MAP. THE RECLAIMED AREAS CAN BE EASILY CLASSIFIED INTO DIFFERENT COMMUNITIES. THE PATTERN OF THESE NEW COMMUNITIES DOES NOT YET MATCH THE ORIGINAL VEGETATION MAP, HOWEVER.

STUDY YEAR 2001 RECLAMATION AREAS

WE CAN MAP THE RECLAIMED COMMUNITIES VERY ACCURATELY, AND WE CAN IDENTIFY THE NEW RECLAMATION ACTIVITIES OF 2001 AS WELL.

NOW WE NEED TO STUDY THE DETAILED REFLECTANCE SPECTRA FOR SPECIFIC COMMUNITIES TO DETERMINE THE NATURE OF THE VEGETATION PRESENT (E.G. GRASSES VS. SAGE, VEGETATION VIGOR AND HEALTH, ETC.)

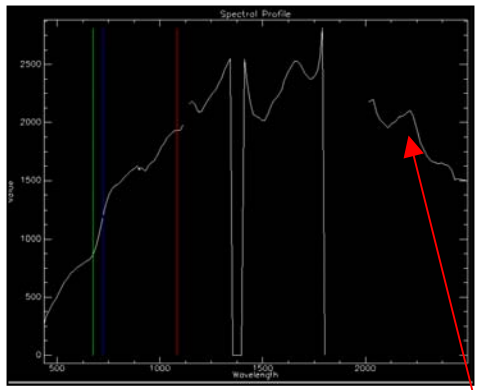
SPECTRAL REFLECTANCE STUDY AREAS

SHOW SPECTRA FOR:

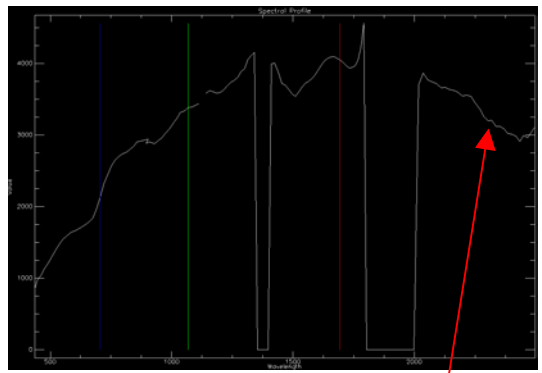
NATIVE SITES #1 AND #2

RECLAMATION SITES #3, #4, #5, #6

SPECTRAL REFLECTANCE NATIVE STUDY AREAS #1 AND #2



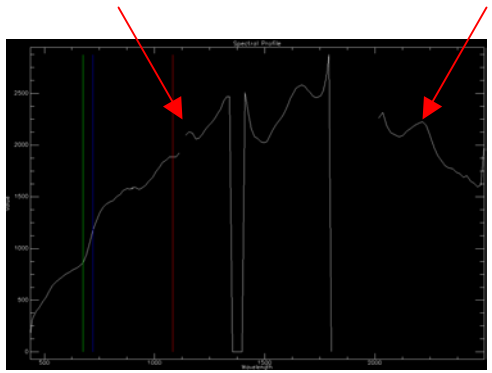
NATIVE SITE #1



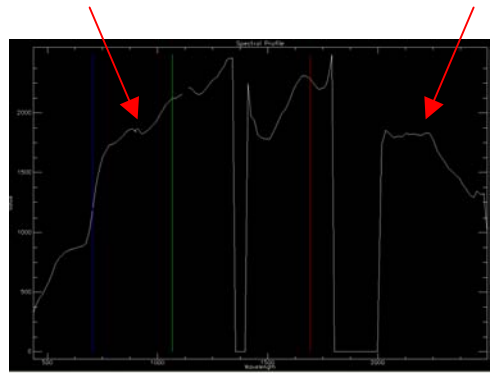
NATIVE SITE #2

NOTE DIFFERENCES IN SPECTRAL CHARACTER

SPECTRAL REFLECTANCE NATIVE STUDY AREAS #3 AND #4

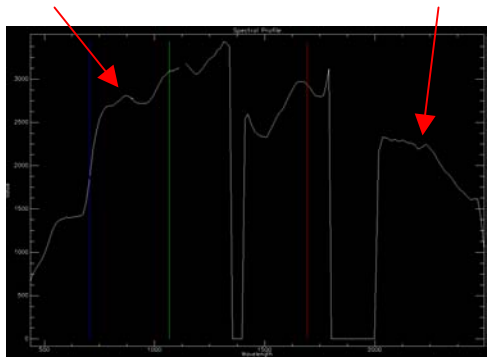


RECLAIMED SITE #3

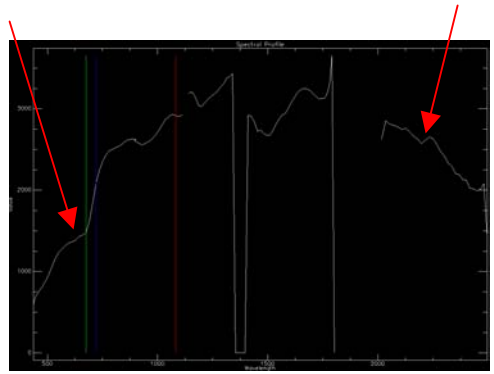


RECLAIMED SITE #4

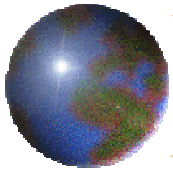
SPECTRAL REFLECTANCE NATIVE STUDY AREAS #5 AND #6



RECLAIMED SITE #5



RECLAIMED SITE #6

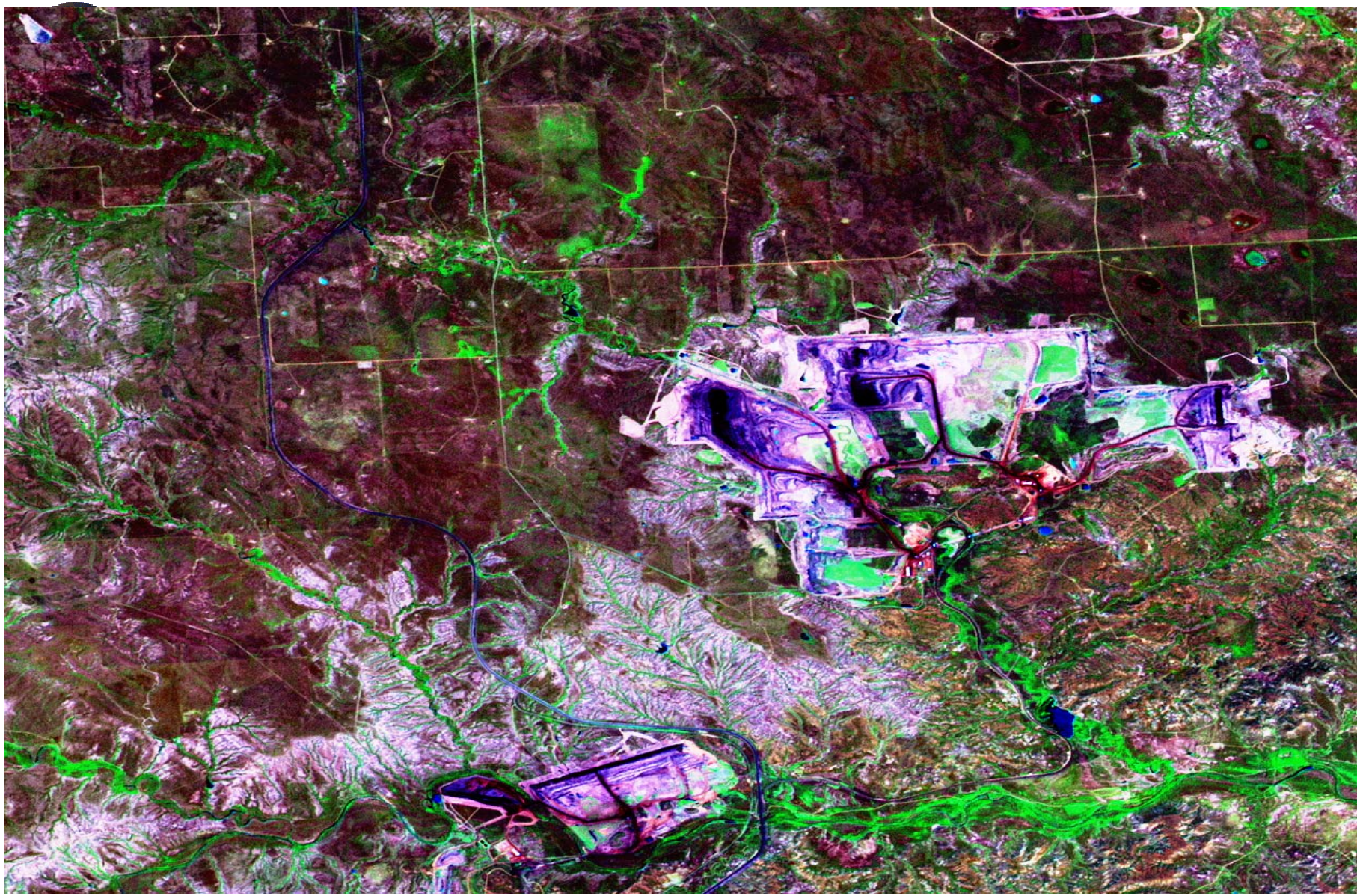


PRELIMINARY RESULTS

THE HYPERSPECTRAL DATA AND SPECTRAL PROFILES CLEARLY IDENTIFY DIFFERENT VEGETATION COMMUNITIES, AS WELL AS CHANGES IN VEGETATION VIGOR AND HEALTH

FOLLOW-ON WORK

WE WILL CONDUCT QUANTITATIVE STUDIES OF THE HYPERSPECTRAL DATA TO CLASSIFY REGIONS OF DIFFERENT VEGETATION 'FAMILIES' AND VIGOR. THESE RESULTS WILL BE COMPARED WITH THE RECLAMATION PARAMETERS TO ASSESS THE RELATIVE SUCCESS OF DIFFERENT SEED MIXTURES AND PLANTING TECHNOLOGIES.



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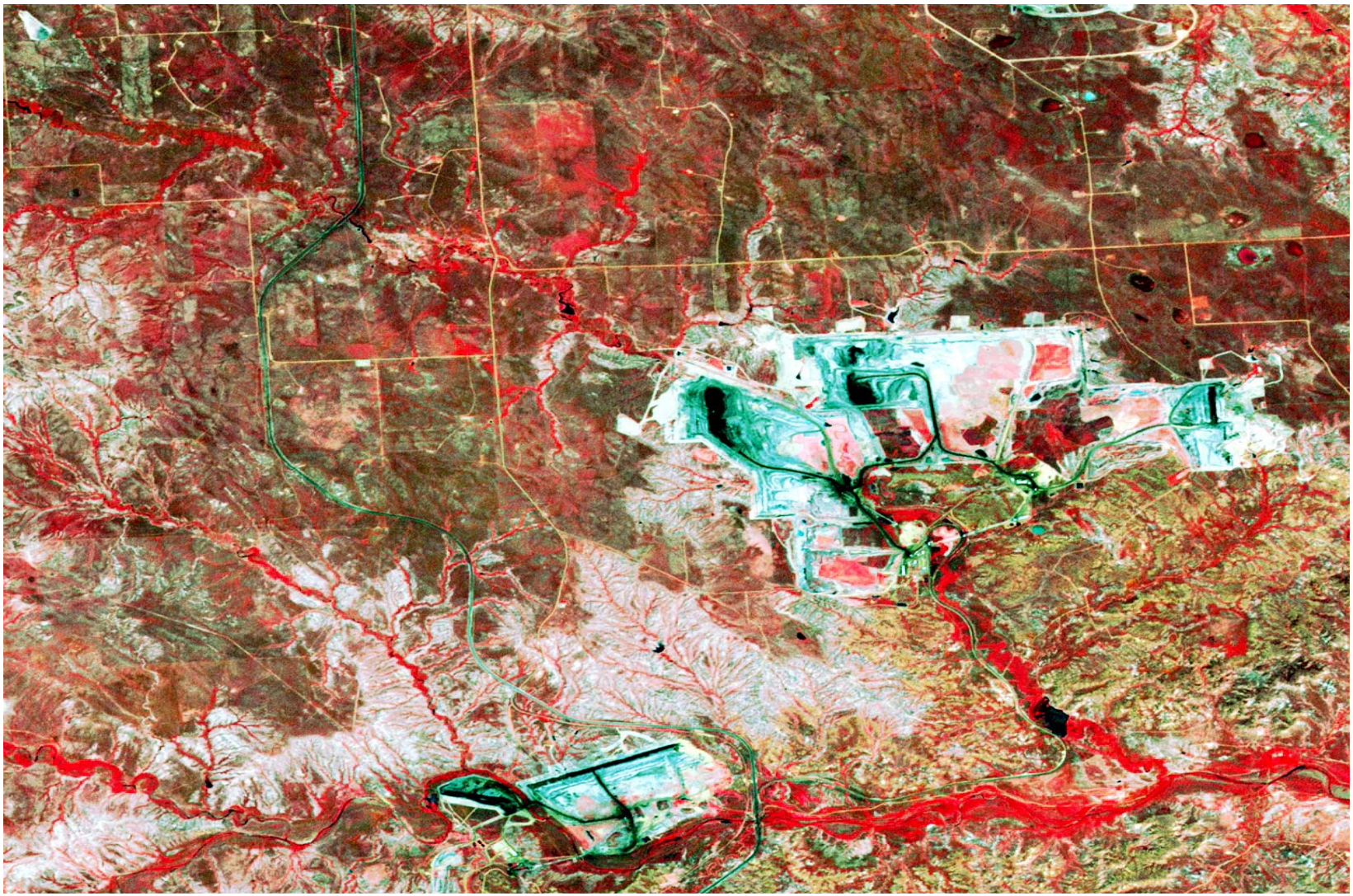

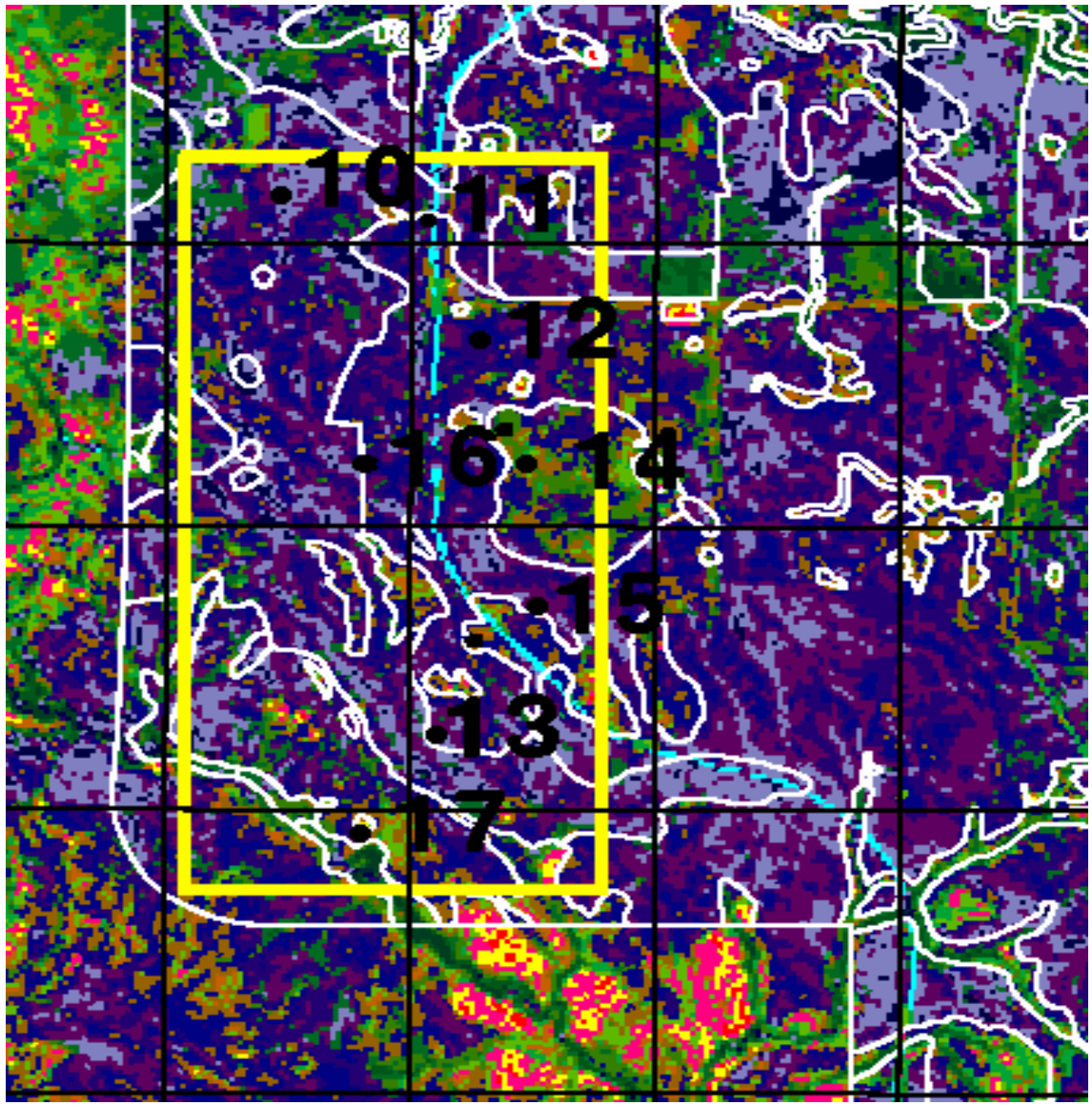
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