The Maryland Coal Mine Mapping Project: Providing Access to Historic Maps for Today's Uses

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ABSTRACT

Frostburg State University, the Maryland Bureau of Mines (BOM), and the Maryland Power Plant Research Program have undertaken a cooperative venture to provide access to the historical record of coal mining in Western Maryland using GIS and geospatial databases. Consolidating, cataloging, and indexing these materials will be accomplished for the purpose of 1) providing for the public safety, 2) facilitating plans for use of coal combustion products in mine restoration, 3) identifying subsidence prone areas, 4) facilitating environmental restoration efforts by BOM, and 5) aiding in the location and proximity of mine portals to proposed and/or existing wind turbine sites for the purposes of determining bat habitats.

A geodatabase containing spatial and bibliographic data is being constructed to provide access to the historical records. Georeferenced, vector point shapefiles are created using ArcGIS 8.3, and usually represent entries, shafts (if known), or the general location of a mine. Each point location is linked to the scanned image of the hardcopy source map and attribute tables for each point contain pertinent information specific to the individual mine. Using ArcCatalog, shapefiles are grouped together into layers, according to 1:24,000 USGS Quadrangle, as well as by watershed and mine type. FGDC compliant metadata is created for the point coverages by quadrangle and posted on the Maryland Mapping Resource Guide Clearinghouse node. ArcIMS, a web based GIS and mapping service, will be used to serve up and deliver the data to many users and allow them to do location based analyses.

INTRODUCTION

The Maryland Department of the Environment (MDE), Bureau of Mines (BOM) in partnership with Frostburg State University and the Department of Natural Resources Power Plant Research Program, have developed an Environmental Data Management System (EDMS) and Geographic Information System (GIS) database to provide access to Maryland’s historic coal mining maps.

In early 2003, initial contact was made between the Maryland Bureau of Mines (BOM) and the Lewis J. Ort Library at Frostburg State University (FSU) to evaluate the
possibility of creating a digital record of historic coal mining maps in Maryland. The BOM had a large collection of maps, many of which were in poor physical condition, that were obtained through the Bureau’s permitting process. FSU had a somewhat smaller collection of maps that had been obtained in 1987 as part of the J.J. Rutledge (the first Superintendent of Mining in Maryland) Collection.

The primary goal of the project was to capture in an electronically retrievable form, the vital data and information contained within the mining industry records for the state of Maryland. The records consist of approximately 500 historic mine maps, 1,000 mining related maps, several hundred photographs, 125 years of Bureau of Mines Annual Reports, and over 500 permitting documents. Libraries have the tools and personnel best suited to organizing, tracking, and preserving vast amounts of data, subsequently the BOM determined that the best way to preserve and catalog this information was through an agreement with the Lewis J. Ort Library at FSU.

BRIEF HISTORY OF COAL MINING IN MARYLAND

Maryland’s coal formations are part of the great Appalachian coal field which extends from Northern Pennsylvania to central Alabama, a distance of some 800 miles. Reports from early explorers of the 18\textsuperscript{th} century described Western Maryland as having, “inexhaustible beds”, “easy to dig”, and “coal of good quality”. In 1755, George Washington described the Georges Creek Coal Basin as possessing “the fuel of the future”-so much mineral wealth as to “astonish the countries of the Old World”\textsuperscript{1}.

The first shipments from the Maryland coal fields were made in the early 1820’s when small amounts of the bituminous coal were transported by barges down the Potomac River. After construction of the Baltimore and Ohio Railroad in 1842 and the Chesapeake and Ohio Canal in 1850, the production of coal from Maryland mines increased very rapidly to meet the rising demands for cheap fuel in the eastern cities.

Deep mine production in Western Maryland peaked between 1900 and 1918, when thousands of miners extracted as much as 5.5 million tons a year from the ground. Thereafter, annual production was at 4 to 4.5 million tons until after World War I. By this time, the region’s primary coal seam, the Pittsburgh Vein, or “Big Vein” as the local miners called it, was exhausted and production dropped off. By 1941, hundreds of underground mines had been abandoned and the industry adopted surface mining as the predominant method of extraction\textsuperscript{2}.

Maryland now has 450 abandoned mines that predate the Surface Mine Control and Reclamation Act (SMCRA) of 1977. Many of these abandoned mines have left a terrible legacy for area residents. Acidic discharges high in concentrations of heavy metals have left waterways in the area severely impaired. Blackened gob piles, abandoned mine equipment, localized subsidence areas, highwalls, barren landslide areas, erosion, open pits with standing water, and stream sedimentation are reminders of the early days of coal mining. This paper describes the approach the Bureau of Mines, in partnership with Frostburg State University, has taken to collect, catalog,
preserve, and provide access to Maryland’s coal mining records via a web-based interactive GIS and Environmental Data Management System.

COAL MINE MAPPING PROJECT DEVELOPMENT

A Memorandum of Agreement for implementation of the coal mine mapping project was developed between the Maryland Department of the Environment (MDE), Bureau of Mines (BOM) and FSU with funding coming from the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources. Finalized in October 2003, the Agreement established a tentative timeline, staffing and equipment requirements, and deliverable results. The initial goal of the project was to create a digital collection of historic coal mine maps that could be located and viewed by searching in a database accessible through both the FSU Library’s catalog and a Bureau of Mines Web site. The overall methodology envisioned four phases to the project.

Phase I (Collection and Appraisal) began in October 2003 and ended in February 2005. The critical aspects of this phase were hiring the mapping specialist, consolidating all known coal mine maps, purchasing the color scanning hardware and software, and developing the methodology for capturing the information found on each map.

Site visits were made to the Mine Map Repository of the Office of Surface Mining (OSM) in Pittsburgh, PA and the Division of Mineral Resources of the Virginia Department of Mines, Minerals and Energy to obtain information on procedures and equipment requirements, and the Head of the Ort Library’s Cataloging Department, was selected to participate in a map cataloging internship at the Library of Congress. In March 2004, the mapping specialist recommended that we use Geographic Information System technology to create an interactive database that would allow data input, management, and display of geospatial data. An Environmental Data Management System (EDMS) will be simultaneously created to provide the information needed for GIS development as well as house other relevant data in the collection that will not be part of the GIS. Rather than establish a separate FGDC Clearinghouse, the Maryland Mapping Resource Guide (MMRG), an existing FGDC Clearinghouse node, agreed to post the project’s metadata (May 2004).

Phase II of the project (Preservation, Cataloging, and Indexing) was envisioned as the phase in which the actual scanning of maps would occur. However, as a result of testing, establishing work flow and defaults for scanning, this phase has run concurrently with Phase I. At the current time, Phase II has been expanded to include scanning of mining related maps and engineering drawings, creating Optical Character Recognition (OCR) searchable .pdf files of the Maryland BOM annual reports, and implementing the necessary hardware and software requirements to make the maps interactive through the Internet.

Phase III (Consolidation and Interpretation), will consist of; 1) completing the database linkage of all maps, photos, and documentation, 3) development of the Coal Mine Mapping Project web site, 3) categorizing and interpreting relevant materials into a
useful and organized historical record, and 4) preparation of the final report summarizing technical information and relevant events in Maryland’s mining history that will assist in understanding and interpreting the maps, documents and photographs. Phase IV (Maintenance) will include adding any newly discovered maps and/or data to the collection, maintaining a fully functioning web presence, and providing assistance to users of the collection.

APPLICATIONS OF THE MINE MAPPING PROJECT

The MCMMP was designed as a tool to allow quick and direct access to historic mine maps and associated mine information for use in solving today’s problems. The Maryland Power Plant Research Program, Geospatial Research Group and Maryland Bureau of Mines have all been successful in locating historic mine maps through MCMMP and using this information for more involved applications and analysis.

Abandoned Mine Restoration using Coal Combustion Products

Acidic discharges of water high in concentrations of metals have left approximately 450 miles of the regions waterways severely impaired. Many of these mountain streams can no longer support life because of the toxic conditions caused by Acid Mine Drainage (AMD). The untreated AMD, in many places, discharges directly from the mines into the streams. Current remediation technologies treat the acid mine drainage after it has formed and exited the mine. Although these systems are generally quite effective in neutralizing acidity and removing metals from the water, they do not offer lasting solutions and often require continuous maintenance. The PPRP has recently demonstrated that the injection of a cementitious grout made from Coal Combustion Products (CCP’s) into abandoned mines can provide permanent solutions to Maryland’s AMD problems along with restoring original surface and groundwater flow patterns, and preventing mine subsidence, mine fires, and outgassing.

As a result of a demonstration project that injected a CCP slurry into the abandoned, underground, Frazee Mine atop Winding Ridge in Maryland, the PPRP proved that after injection into the mine, the slurry set up into a low grade cement that permanently covered the exposed pyritic surfaces of the mine pavement, walls and roof thereby reducing AMD formation inside the mine. However, before injection can take place, significant site characterization must be done. The internal mine geometry must be known, all shafts and entries located, the regional hydrogeology determined, and water quality data need to be collected and analyzed. In the case of the Frazee Mine, a small mine abandoned more than 30 years ago, no mine map was readily available and the mine geometry had to be established by interviewing miners who had worked in the mine, by exploratory drilling, and down-hole camera observations. Digital copies of the mine maps available through the library catalog and/or the GIS will allow engineers easy access to mine maps and site information to determine whether a particular site is suitable for CCP injection.
**AMD Remediation**

Many studies have shown that a significant reduction in species richness and species diversity occurs in streams that are impacted by AMD. By providing greater access to historic mine maps and mine location data, government and groups involved in natural resource management can pinpoint a mine or mine openings that may be discharging AMD into a stream and quickly target their remediation strategies. Many of the AMD remediation projects in Maryland have been successful in treating AMD discharges, improving the overall water quality of impacted streams, and creating habitat suitable for the return of a native biological community.

**Mine Safety**

The recent Quecreek Mine disaster in Pennsylvania demonstrated that inadequate information on historic underground mines can seriously affect safety in today’s mines. Easily accessible digital mine maps are an important tool for mining companies that could be used to determine where adjacent mining in the same seam has taken place, as well as mining in seams above and below the seam where the current mining is located.

**Mine Subsidence**

An unfortunate consequence of more than 200 years of unregulated underground mining is surface subsidence. Subsidence is the movement of the earth's surface caused by the collapse of underground mine tunnels or shafts. Wherever coal has been mined, underground voids are left behind. Overlying layers of rock and earth will sink or shift to fill these voids. When that sinking or shifting reaches the earth's surface, it is called mine subsidence. Subsidence may occur regardless of the age of the mine, the depth, or how much coal was mined or left behind. When buildings are constructed above mines, subsidence can damage the foundations of homes, buildings, and roads; dislocate underground utilities, and can be a potential risk to public safety. Internet access to underground mine maps will be an important tool for residential and commercial builders to determine if a specific location can be built upon without doing exploratory drilling.

**Bat Conservation**

Abandoned underground mines provide important habitat for many bat species. Bats use abandoned underground mines for rearing young in the summer, hibernating in the winter, gathering for courtship and mating, roosting, and rest stops during spring and fall migrations. In Maryland, biologists have been concerned with erecting energy producing wind turbine sites near bat habitat because of mortality potential. Before a wind turbine site is chosen, bat habitats must be determined to minimize impact to these animals. The interactive web map is instrumental in pinpointing mine shafts or openings that could potentially harbor bat colonies.
Public Awareness

Public awareness of coal mined areas among individuals and communities is also an important benefit of making this information available over the web. For example, several citizen-based watershed groups such as the Georges Creek Watershed Association and the Braddock Run Watershed Group do land and water restoration projects in their communities. These are usually volunteer groups with grant funded budgets. Volunteer groups can use this database as an information source to determine if a site may have caused water quality impairments within their watershed. The interactive mine map can also assist groups in selecting locations in need of environmental reclamation, devising sampling strategies to monitor water quality, and better understanding the dynamics of their watershed.

MAP CATALOGING DATA IN THE MARC FORMAT

One of the most critical aspects of Phase I was defining who the anticipated users of the map would be, how those users would search for the map images, and what types of information they expected to find. The definition of these parameters was necessary in order to develop the types of information that needed to be gleaned from each map during the scanning process.

It was determined that there were three principle types of users that we could expect to look for our map images. The most likely user, in our estimation, would be the mining/mapping professional, developer, or contractor. This user would be primarily interested in the geospatial data that could be found on any given map image. The second most likely user was the professional researcher or student who had an interest in the historical value of the map such as the name of the mining company, personal names associated with the creation of the map, information on adjacent mines, and property lines. In other words, this type of user would be most interested in the bibliographic information related to the map. The least likely user was determined to be the casual user of the Internet who would be searching for map images out of curiosity or for possible use in a school report or similar research. This user would not require either geospatial or bibliographic information in great detail.

Based on this analysis, Map Data and MARC Data Collection Worksheet (Figure 1) was designed that would capture all geospatial and bibliographic information related to each of the maps as they were going through the scanning process. The Content Standards for Digital Geospatial Metadata established by the Federal Geospatial Data Committee (FGDC) would also be implemented to provide proper documentation of the geospatial data.

Access to the digital map images through the Library’s catalog is provided through the bibliographic record. This record is created using a variety of library standards for cataloging including the international Anglo-American Cataloging Rules (AACR2), the Library of Congress Subject Headings (a controlled thesaurus for subject access), and
the most common metadata standard for libraries, Machine-Readable Cataloging or MARC.

AACR2 establishes the format rules for describing not only the physical aspects of maps (size, scale, coordinates) but the bibliographic aspects such as the map’s title, cartographer’s name, date of creation, and any corporate names. Additionally, the AACR2 provides guidelines on the creation of additional notes in the bibliographic record which are not specifically covered in other cataloging rules. This provided the project the flexibility to provide additional optional, and often critical, information regarding the mine maps including the UTM number as well as its corresponding coordinate, mine elevations, flooding data, and mine geometry and hydrology.

There is also a summary note option in each record that was used extensively for the mapping project to meet two specific purposes. The first purpose was to provide a standardized note in every map record that describes the mapping project and all agencies and institutions involved. The second summary note in each record describes the unique attributes of the specific mine depicted on the map such as the coal basin, specific mine and surface features, coal company information, and personal names of people related to the mine and/or the creation of the map.

AACR2 also provides guidelines for the creation of additional access points, standardized subject terms and personal or corporate names that allow the researcher to limit their search to the specific topic or names and improve their chances of retrieving all relevant maps (e.g. a search to find all maps on the same mine, regardless of the date of creation of the map or all the maps related to a specific coal company). Many of these access points are already established and maintained in the Library of Congress Subject Headings or in the Library of Congress Authority File. For those coal mines or coal mine companies that did not have established names in the Library of Congress databases, the names were researched in the Maryland Bureau of Mines Annual Reports to determine the common spelling and form of the names in order to create a local authority file. This local authority file then improves the chances for retrieving all the bibliographic records on specific mines or coal mine companies despite the fact that the names may be spelled differently on different maps.

All of the information compiled through the application of the AACR2 standards is then entered into the MARC record format for maps (Figure 2). The MARC record uses mnemonic and numeric tag descriptions to indicate what type of information can be found in each specific field. Examples of mnemonic and numeric tag information include codes for the type of projection and relief of a map, title, coordinates and access points. The MARC tag information and related internal codes, impact the researcher’s ability to retrieve the bibliographic records through the various indexes and by keyword searching.

Keyword searching was one of the primary reasons for the creation of extensive notes. The majority of MARC tag fields, including title, summary notes and access point fields, are searchable by this method in online catalogs. The details and descriptive terms
included in the MARC record improve the retrieval rate of related documents when the keyword search is executed.

The MARC format has allowed us to provide access for all three of our identified users in an unprecedented manner. Since the MARC record is the foundation of online catalogs, the users, in addition to immediate access through the union catalog of the University System of Maryland and Affiliated Institutions (USMAI), have access to WorldCat, a worldwide database created and maintained by over 9,000 OCLC member institutions. In mid-November 2004, the Internet search engine Google launched its Google Scholar service. This service searches both open access and proprietary scholarly content and search results may include not only the direct source identified, but also indirect sources such as books and journals cited by the direct source. The search results provide bibliographic information, an abstract, or full text, depending on the permissions and licensing granted by the source.

GEOGRAPHIC INFORMATION SYSTEM AND ENVIRONMENTAL DATA MANAGEMENT SYSTEM

*Environmental Data Management System (EDMS) Development*

An Environmental Data Management System was developed for the primary purposes of preserving mining data, providing information about underground mines that have the potential to impact water quality and public safety, and supply the descriptive and bibliographic information about those mines and their associated maps and documents. The data contained in the EDMS includes, a categorical index of all materials in the collection, an inventory of processed materials, the bibliographic records for all the materials, the completed data collection worksheets, pertinent existing databases from other organizations, and the QA/QC plan for the project.

The EDMS uses several relational databases to accomplish data management tasks. The library at FSU used the University of Maryland and Affiliated Institutions Bibliographic Standards and the Anglo-American Cataloging Rules (AACR2) to catalog the mine maps in a MARC format. The library catalog contains the relevant bibliographic information for each map. An MS Access based directory was developed to index all the digital mining and mining related materials in the collection. This directory is used internally to identify duplicate mine maps, locate the archived copy of a mine map within the library, track all of the digital images of the maps, and assist in the GIS development.

Many of the maps had already been described, labeled, and input into the Office of Surface Mining’s Mine Map Repository database. This database became instrumental in helping to quickly catalog the mine maps. It reduced time spent trying to obtain specific information about a mine from the maps which were often hard to read and in poor condition (i.e. torn, burned, faded, stained, and moldy). A regularly updated inventory of materials used in the project was created in a spreadsheet format. The inventory database was useful in categorizing and prioritizing materials for inclusion in the EDMS.
GIS Database Development

To make this assorted data available to state and federal regulators, and the general public in an easy to use, homogenous format, a number of steps were required to compile the information from the various sources into a single database based on the spatial location of the mines. A Geographic Information System was chosen as the type of database best suited to the task because of its ability to integrate data with a spatial component, perform data input/output, management, and analysis. In addition to being a spatial database, a GIS can link attributes to the spatial data. Attributes, which are found in an attribute table, define the characteristics of a geographic feature. For example, a point feature that represents the location of a mine’s airshaft has an absolute x,y coordinate, and associated attributes such as mine name, mining company, coal seam mined, and in our case, an active hyperlink to the scanned image of the original mine map.

The first step in creating the GIS was to scan all of the mine maps. Digital images of the original mine maps were created by scanning each one on a 54”, large format scanner in an uncompressed .tiff format at a resolution of 200 dpi. Lower resolutions were found to be insufficient for zooming in. Maps that were too large to be scanned by a single pass were folded and scanned in two or more sections. The resulting image files were then merged digitally using Adobe Photoshop and saved as a single file in order to preserve the character of the original map. The unprocessed digital images were saved to DVD’s for archival purposes and stored in the FSU library. After an archival copy was saved, the digital images were compressed into .jpegs and color processed to reduce files to a size suitable for use on the web (Figure 3).

While most geographers and researchers today are equipped with a GPS unit to record geospatial coordinates, such is not the case with historical collections. The majority of the historic mine maps needed to have coordinates assigned to them based on surface or descriptive features (if any) that appear on the map. Once there was a scanned image to work with, the GIS specialist began the task of retrospective georeferencing, the process of assigning coordinates to the historic mine maps. Point shapefiles were created and named for the individual mine they represented and assigned absolute x,y coordinates in ArcMap. The point coverage represents entries, shafts (if known), and/or the general location of a mine. Polygon shapefiles represent the area of the underground mines. Using ArcCatalog, shapefiles were grouped together into layers. All coverages in the database are stored in UTM (Universal Transverse Mercator) zone 17 north coordinates in units of meters.

Description of GIS Database

Based upon the need to display images and photos, make customized maps, and query databases, a web based interactive mine map using ArcIMS will be created to provide access to GIS coverages and the Environmental Data Management System. The interactive mine map will contain base maps such as USGS Topographic Quads and
digital orthophotos as well as various data layers that can be turned on or off by the user. Currently the database has a logical collection of data layers that are further broken down into group layers for ease of use by the general public. For example, a layer such as Underground Mine Points (one point represents an entry, shaft, or general location of an underground mine) is separated into group layers by watershed and 7.5’ USGS Quadrangle. If a user was not interested in viewing all underground mines in Maryland but rather just the underground mines in the Georges Creek Watershed or the Barton Quadrangle, they could choose to view only that group of points in their geographic area of interest without having to go through a series of complicated GIS manipulations. Table 1 is a list by county of all USGS 7.5’ Quadrangles in the Maryland Mine Map GIS (some quads occur in both counties).

In addition, layer labels and feature attributes are spelled out in a clear and comprehensible text without the use of codes or other naming conventions. Layers can be viewed over base maps to enable the user to perform geographic analysis, environmental assessments or integrate this data with other data sources for display, query, and analysis using a standard internet web browser. The organizational structure of the layers in the GIS database is shown in Figure 4.

Each point/polygon has a corresponding attribute table that can be viewed by clicking on the point or polygon with the identify tool. Attribute tables for each point/polygon were created to hold bibliographic information corresponding to that specific mine such as mine name, mining company, and seam mined, as well as hyperlinks to the scanned mine maps, photos, and documents. This is important for users that are interested in viewing the scanned image of the original mine. Including key bibliographic information in the attribute tables means a user can search for a mine in the interactive map by typing in a specific mine name, mining company, coal seam, or mine type and clicking on the find tool. The result of which is a readout of all the attribute tables that include a match to the query. The information used to build the attribute tables was made available through the EDMS.

The GIS also includes FGDC (Federal Geographic Data Committee) compliant metadata (data about data) for all of its data layers and the website is equipped with a searchable metadata catalog. Metadata for the project is also posted on the Maryland Mapping Resource Guide website, a central clearinghouse of GIS files and metadata for the state of MD.

SUMMARY

The Maryland Coal Mine Mapping Project to date has proven to be a highly successful cooperative venture among several state agencies to provide widespread access to the historical record of coal mining in the state. The EDMS and web-based GIS have proven to be useful tools with many benefits. The interactive mine map enables the user to perform geographic analysis, environmental assessments and integrate this project’s data with other data sources for display, query, and analysis in a standard internet web browser. Consolidating, cataloging, and indexing these materials in an easily accessed
database facilitates the Bureau of Mines efforts, especially when targeting areas for reclamation. The EDMS successfully brings together information about mines and mining that is currently very difficult to locate or use.

Two separate but complementary methods of searching the mining data provide a wide range of user access. Creating a detailed set of metadata to FGDC standards ensures access by experienced researchers, people in the coal industry, and/or GIS skilled users accustomed to using an FGDC Clearinghouse to search for information. The creation of a MARC record for each map has significantly increased accessibility to historical or casual researchers more concerned with the people, names, and companies associated with specific mines.

As the project moves into the next phase, the historical record of coal mining in Maryland will be enhanced even further. Scanning and indexing of mining related maps, engineering drawings, photographs and the Bureau of Mines annual reports will supplement the mining data already available.
REFERENCES


[5] Ibid.


ID #_________

Map Data and MARC Data Collection Worksheet

Image File Name/URL _________________________ (MARC 856u) Image Scan Resolution (d.p.i.) _______ (MARC 500) Physical Size (cm) _____________ (MARC 300c)

Map Title__________________________________________________________________________________________________________________________________ (MARC 245)

Map Source: B of M ____ Rutledge Collection ____ OSM____ Other _______ (MARC 561)

Map Created by (Company Name): _______________________________________ (MARC 500 and 710)   Scale: __________ (MARC 034a and 255a)

Date Published ______ (MARC 260c) Date of Representation ______ (MARC 500) Base Date______ (MARC 250) Revision Date _____ (MARC 250)

Mine Closure Date ______ (MARC 500) Primary Mine Name______________________________ (MARC 500/610/710) Secondary/Alternate Mine Name (MARC 500/610/710)_________________

Names of ADJACENT mines found on map (MARC 500/610/710)_____________________________________________________________

Relief Code ______ (MARC 008)  Legend (Y/N)___ (MARC 500)

Type of Cartographic Material Code _______ (MARC 008)

Blueprint (Y/N)__ Color (Y/N)__  Negative (Y/N) __ (MARC 300b)

Projection Code ______ (MARC 255 and 008)

Other Format Available (microfiche?) _______ (MARC 533)   (Microfilm?)_______

Latitude/Longitude Point? (MARC 500)   North Latitude:______ Degrees ______ Minutes _____ Seconds

West Longitude:______ Degrees _______ Minutes ______Seconds

Property Lines or Boundaries? ____________ State Plane? Northing ___________ Easting ____________

Coal Basin: Georges Creek ___ Upper Potomac ___ Lower Youghiogheny ___ Upper Youghiogheny ___ Casselman_____ Other____________________ (MARC 500/650)

Geographic Features: (MARC 520, 651 and 691) __________________________________________________________________________________________________________________

Man-Made Features: (MARC520, 651651 and 691) ________________________________________________________________________________________________________________

Additional Notes ____________________________________________________________________________________________________________________________________________

Mine Size:

Small _____ (less than 435,600 ft. squared or 10 acres)

Medium_____ (between 435,600 ft. squared and 4,600,000 ft squared or between 10 and 100 acres)

Large_____  (more than 4,600,000 ft squared or more than 100 acres)

Standard Coalbed/Seam Name_____________ Mining Method: Surface _____ Underground_____

Company Coalbed/Seam Name ____________ Room and Pillar (Old- prior to 1950)_____

Former Coalbed/Seam Name______________ Room and Pillar (modern – after 1950) _____

Subsequent Coalbed/Seam Name__________ Room and Pillar (Mixed)_____

Long Wall _____

Overburden Analysis ___ Sulfur Content of Mine Pavement ___ Portals ___ Roof Falls ___ Thickness Data ___

Sump and/or Pumping Reports ______ Surface Subsidence _______ Elevation Data _______ Crop Line ___ Adjacent Mines ___

Gas Wells Present ___ Power Lines ___ Water ___ Boreholes Present ___ Mine Fires ___

Elevation of Water Lines____ Drains _____ Ventilation Data _______ Mined/Worked Out Areas ___

Figure 1. Map Data and MARC Data Collection Worksheet
<table>
<thead>
<tr>
<th>record format</th>
<th>Map</th>
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<tr>
<td>author</td>
<td>Manor Mining &amp; Manufacturing Company.</td>
</tr>
<tr>
<td>title</td>
<td>Map. Lloyd Mine No. 1 in District No. 13, Garrett County, Maryland [cartographic material].</td>
</tr>
<tr>
<td>cartographic data</td>
<td>Scale 1:100 (W 79°12′00″/N 39°23′44″)</td>
</tr>
<tr>
<td>published</td>
<td>[Kitzmiller, Md.]: Manor Mining &amp; Mfg., [1966]</td>
</tr>
<tr>
<td>description</td>
<td>1 map: col.; 76 x 61 cm.</td>
</tr>
<tr>
<td>all locations</td>
<td>Frostburg State University Archives Map 306378 Holdings Availability</td>
</tr>
<tr>
<td>location</td>
<td>Mode of access: World Wide Web.</td>
</tr>
<tr>
<td>internet link</td>
<td>map image: <a href="http://mirror.frostburg.edu/minemapping/minemapimages/Scan306378.jpg">http://mirror.frostburg.edu/minemapping/minemapimages/Scan306378.jpg</a></td>
</tr>
<tr>
<td>notes</td>
<td>Part of the Coal Mine Mapping Project, a joint project by the Maryland Bureau of Mines, the Maryland Power Plant Research Program and Frostburg State University, to create digital images of maps of historic coal mines located in Allegany and Garrett County, Md. Shows small underground, modern room and pillar (after 1950) coal mine in the Upper Potomac coal basin, located in Garrett County in the Kitzmiller Quadrangle. Accesses the Upper Kittanning/Clarion coal seam. Shows crop lines, ventilation data, Clarion Seam Highwall, Wolf Den Run, lease lines, and mine buildings. Adjacent lands part of Military Lot 120 or owned by Frazee Brothers Coal &amp; Surface.</td>
</tr>
</tbody>
</table>

**Figure 2.** MARC Tags in Cataloging Record
Figure 3. Digital image of scanned mine map.
Figure 4. Organizational structure of grouped data layers in the GIS

- Mine Map GIS
  - Mine Type Data Layer (Surface or Underground)
    - Mines by Watershed Data Layers (points or polygons)
      - Mines by 7.5' USGS Quadrangle Data Layers (points or polygons)
      - Individual mine shapefiles (points or polygons)
<table>
<thead>
<tr>
<th>Allegany County</th>
<th>Garrett County</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Barton</td>
<td>1. Accident</td>
</tr>
<tr>
<td>2. Cumberland</td>
<td>2. Barton</td>
</tr>
<tr>
<td>3. Frostburg</td>
<td>3. Bittinger</td>
</tr>
<tr>
<td>4. Lonaconing</td>
<td>4. Davis</td>
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<td>5. Westernport</td>
<td>5. Deerpark</td>
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<td>6. Friendsville</td>
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<td>7. Gorman</td>
<td></td>
</tr>
<tr>
<td>8. Grantsville</td>
<td></td>
</tr>
<tr>
<td>9. Kitzmiller</td>
<td></td>
</tr>
<tr>
<td>10. McHenry</td>
<td></td>
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<tr>
<td>11. Mt. Storm</td>
<td></td>
</tr>
<tr>
<td>12. Oakland</td>
<td></td>
</tr>
<tr>
<td>13. Sang Run</td>
<td></td>
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<tr>
<td>14. Table Rock</td>
<td></td>
</tr>
<tr>
<td>15. Westernport</td>
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</tbody>
</table>

Table 1. 7.5 minute x 7.5 minute USGS Quadrangles in the Maryland Mine Map GIS