PART IV

OPERATIONS PLAN

1) Proposed Operational Procedures and Methods for the Mine Over Its Projected Life

Describe the type and method of mining procedures and proposed engineering techniques to be employed in the operation of the proposed mine. Describe the major equipment to be employed and how such equipment will be used in the different aspects of the mining operation. Provide an estimation of the anticipated annual coal production and anticipated coal production by tonnage once the mine is at full operational capacity.

Sunrise Coal, LLC is proposing to develop and operate Bulldog Mine, an unplanned subsidence underground coal mine in Vermilion County, Illinois. The location of the proposed permit and shadow areas are shown on the enclosed maps. The Bulldog Mine will extract the Herrin No. 6 coal seam utilizing conventional room and pillar mining methods. A portal to the underground mine will be created by excavating a slope from the surface to the coal seam. Two air shafts will also be constructed to the underground mining operation.

The overall mining layout is shown on the *Shadow Area Map, Map S*. A room-and-pillar mining system with two walk-through super-sections is planned for extracting coal. Four continuous miners, battery haulage units, and dual-boom bolters will be used for the mining process. The primary equipment in the face area will be supported by other equipment such as supplementary bolters, personnel carriers, supply equipment, scoops and tractors.

Initial surface disturbance will involve removing and stockpiling topsoil in advance of freshwater ponds, treatment ponds, a sediment pond, and access road construction. After adequate topsoil has been removed, the freshwater ponds and a sediment pond will be built at the locations shown on the *Surface Drainage Map, Map D.*

Remaining topsoil will be removed from the surface area and placed in stockpiles prior to developing surface support facilities at the mine site. Sub-soil will be removed from the area as necessary to facilitate mine construction and development. Any stockpiled sub-soil will be segregated from topsoil stockpiles. Tractors/pull scrapers in combination with necessary support equipment will remove and stockpile the topsoil and sub-soil. Signs will be placed on the stockpiles to identify the material stored in the individual piles. Vegetation will be established on the stockpiles to help eliminate erosion caused by wind and water. The stockpiled soil materials will eventually be used to reclaim the area after completion of mining.

If necessary, consolidated overburden from the mine portal slopes will be drilled and blasted using conventional equipment. However, blasting within 50 feet of the surface is not anticipated. Available borehole data indicates the compressive strength of all materials within 50 feet from the surface is low enough to cut the material with a continuous miner. If it is later determined necessary to blast within 50 feet of the surface, a blasting plan will be submitted for Department approval.

As indicated in *Attachment III-2A2* from Part III of this application, the upper layers of consolidated overburden exhibit positive net neutralization potential. This material will be used to construct a road base for the mine access roads. Excess material excavated from the slope will be hauled to the soil stockpile at the location shown on the *Surface Drainage Map, Map D*.

Various equipment including dozers, gob truck, motor grader and a water wagon will provide ongoing support of the surface facilities as necessary.

After the mine slope has been completed, the underground mining operation will begin extracting the Herrin No. 6 coal seam from the mine utilizing a continuous miner, shuttlecars and conveyor belts to mine and transport the coal to the preparation plant for processing. Roof control and support will be achieved in the mine with conventional roof bolters.

Two air shafts (intake and return) will be constructed during mine development. The shafts will be approximately 16 feet in diameter.

Within the shadow area, the Herrin No. 6 coal seam averages approximately 5.9 feet thick. The proposed pillar geometry can be found in Part IV 3)C)2)a) of this application. The operation expects a maximum extraction ratio of 52 percent. The mine is expected to produce approximately 500,000 to 600,000 tons of clean coal during the first year of operation then ramp up to approximately to 1,200,000 tons per year within five years.

2) Mining Operations Plan for the Proposed Permit Area

Describe the proposed mining operations plan for the permit area in terms of the mining sequence, the employment of facilities, establishment and maintenance of erosion control facilities, air pollution control facilities, coal storage, cleaning and loading areas, location and placement of topsoil, spoil, coal waste, or other storage facilities.

Sediment control and erosion will be controlled by the use of drainage ditches, two treatment ponds, two freshwater ponds, and one sediment pond as illustrated on the *Surface Drainage Map, Map D*. At locations where it is not possible to pass runoff through a stilling basin, such as the back slopes and spoil from ditches and ponds, sediment control structures may include rip-rap, straw bales, and/or silt fence. The affected areas will be stabilized and seeded to minimize erosion.

Excavating the mine slope that will provide access to the coal seam will begin after drainage control is established. Other facilities will be constructed on an as needed basis during mine development.

Coal processing will be accomplished through the use of a washing plant utilizing heavy media separation. A conveyor belt will transport run-of-mine coal from underground to a raw coal stockpile. Radial stackers will be used to store both raw coal and clean coal at the locations shown on the *Surface Drainage Map, Map D*. Conveyors will transport coarse refuse to refuse bins located adjacent to the Refuse Impoundment.

Coal from the clean coal stockpile will be loaded onto licensed trucks for highway haulage to various customers. The location of a potential rail loop is indicated on the *Surface Drainage Map, Map D,* but is not being proposed to be constructed at this time. If the rail loop is proposed to be built in the future, Sunrise Coal will obtain the required regulatory approvals.

Fugitive dust will be controlled by frequently watering the roads while they are used during dry, dusty periods. Some portions of the roads may be oiled and chipped periodically, or treated with approved dust suppressant chemicals in order to further control dust pollution.

Soil storage areas are shown on the enclosed *Surface Drainage Map, Map D*. Soil stockpiles will be vegetated to minimize wind and water erosion.

2) A) 1) Describe how each type of overburden (soil horizons, glacial drift and consolidated material) will be handled with regards to shaft excavations.

Topsoil will be placed in stockpiles and stored for future use. Glacial drift will be used as fill material for mine support facilities. Any excess glacial drift will be stockpiled for future use. Consolidated material from the excavation will be used for access road construction and to create a base for parking and material/equipment storage areas. Excess consolidated material will be placed in the soil stockpile at the location shown on the *Surface Drainage Map, Map D.* The stockpiled material will be vegetated to protect the stored material from wind and water erosion.

2) A) 2) If toxic materials have been identified as occurring in the overburden, describe how these materials will be handled to insure proper disposal.

Fifteen unconsolidated strata layers exist in the overburden column near the location where the mine slope will be developed. One-hundred percent of the unconsolidated overburden materials exhibited an excess of tons calcium carbonate equivalent per 1000 tons of unconsolidated material.

Forty-eight consolidated strata layers were sampled in the overburden that exists above the Herrin No. 6 coal seam. Five underburden layers were sampled in the strata below the Herrin No. 6 coal seam.

Forty-four of the forty-eight consolidated overburden strata layers totaling 286.7 feet thick exhibit a weighted average of positive 107.00 tons calcium carbonate equivalent per 1000 tons of material. Only four of the forty-eight consolidated overburden strata layers negative tons calcium carbonate equivalent per 1000 tons of material. The negative calcium carbonate material totaling 26.6 feet thick exhibit a weighted average of negative 35.05 tons calcium carbonate equivalent per 1000 tons of material.

The layers of strata exhibiting negative net neutralization potential exist at depths greater than 285 feet below the surface. This material will be blended with the excavated overburden material that demonstrates positive net neutralization potential and used as a base to provide a solid foundation across the mine site. Considering the overall calcareous nature of the consolidated overburden, and the blending that will occur during the slope development process, special material handling techniques are not considered necessary in the interest of prevention of contamination of groundwater and surface water supplies.

2) B) 1) Locate on the operations map all soil horizon storage areas and/or root medium stockpiles. Identify each storage area as to its content.

Please refer to the *Surface Drainage Map, Map D* for the location of soil stockpiles. Should it become evident that additional soil horizon stockpiles are necessary, mine management will solicit field approval from the Office of Mines and Minerals, Land Reclamation Division field inspector. The stockpiles will be identified in the field with signs showing the type of soil material stored in each stockpile.

2) B) 2) Describe measures to be employed to prevent or minimize exposure of soil stockpiles to excessive water and wind erosion, unnecessary compaction and contamination by undesirable materials.

As soon as possible after completion of topsoil stockpiles, a vegetative cover will be established to control wind and water erosion. Mulch may be used instead of, or in addition to this vegetative cover if necessary to avoid excessive wind and water erosion.

To avoid unnecessary compaction and contamination by undesirable materials, an orderly stockpile construction procedure will be followed. This procedure may include moving the bulk of material during periods of desirable weather conditions, as well as making the fewest amount of passes practical over the stockpiles with soil transfer equipment during stockpile construction.

2) B) 3) Describe methods and treatment measures to be used on exposed areas where topsoil has been removed to prevent excess air and water pollution.

Topsoil will be removed only as far in advance of surface disturbance as necessary to support the mining operation. Provided there is sufficient time between topsoil removal and area utilization, the exposed soil areas will have the vegetation reestablished to prevent excess wind and water erosion.

2) C) The permit map and plans shall show the lands proposed to be affected within the proposed permit through the operation, according to the sequence of mining and reclamation and any change in a facility or feature to be caused by the proposed operations if the facility or feature was shown under 62 Ill. Adm. Code Sections 1783.24 through 1783.25.

Please refer to the maps provided in this permit application for all lands proposed to be affected.

2) D) Show on the permit map or other designated map each area of land for which a performance bond will be posted under 62 Ill. Adm. Code 1800.

A performance bond will be posted for essentially the entire surface permit area.

2) E) Mining Operations Plan for the Proposed Shadow Area

2) E) 1) Provide a map at a scale of 1 inch to 1,000 feet or other scales as approved by the Department identifying the limits of the proposed shadow area (area from which coal is proposed to be extracted by underground mining methods).

The proposed shadow area is shown on the enclosed *Shadow Area Map, Map S*.

2) E) 2) Within the limits of the proposed shadow area identify all areas projected to be mined, at a minimum, during the term of the permit showing the proposed size, sequence and yearly projections for the development of underground workings.

Areas to be mined are shown on the enclosed *Shadow Area Map, Map S*. Along with other points of interest, the map illustrates the location of the proposed boundaries of the shadow area, and sequence of yearly projections for the development of the underground coal reserves.

3) Subsidence Control Plan

3) A) General Requirements

3) A) 1) Within the permit, shadow and adjacent areas are there structures or renewable resource lands?
Yes __X__ No ______

If yes, on the shadow area map described in 2,E, above, or other designated map, provide survey information which identifies all structures and renewable resource lands. Include all topographic features at a maximum contour interval of 10 feet. Identify all surface and subsurface man made features within, passing through, or passing over the area in which underground mining operations are located or will be projected to be located. Such features shall include but are not limited to all buildings, facilities, roads, bridges, major electric transmission lines, pipelines, agricultural drainage tile fields, gas and oil wells and water wells.

If no, provide evidence and support documentation that no structures or renewable resource lands exist as a result of a survey conducted within these areas.

Several structures that will incur limited extraction ratios are identified on the *Shadow Area Map, Map S*. The structures that will be protected by limited extraction ratios include Norfolk Southern Railroad and several homes. The extraction ratio within the influence area of these structures will be limited to 50% or less to minimize potential unplanned subsidence. The influence area will be determined by using appropriate angles of draw for unconsolidated and consolidated overburden as indicated in Part IV 3)C)2)c).

There are no private water bodies (farm ponds) that exceed 20-acre feet in size within the shadow area.

There are six proposed water bodies that will exceed 20-acre feet in volume within the surface permit area. These water bodies will include two freshwater ponds, two treatment ponds, one sediment pond, and the Refuse Impoundment as shown on the *Surface Drainage Map, Map D*. Surface structures proposed to be constructed in support of the underground mining operation will include the mine portal/slope and the preparation plant. No underground mining is proposed to occur under the refuse impoundment. The extraction ratio within the influence area of all other water bodies and structures mentioned above will be limited to 50% to minimize potential unplanned subsidence.

3) A) 2) Within the proposed permit, shadow or adjacent areas does the applicant intend to adopt mining technologies which provide for planned subsidence in a predictable and controlled manner?
Yes ______ No __X__

If yes, provide information requested under "Planned Subsidence", Subsection B.

If no, provide information requested under "Subsidence Unplanned", Subsection C.

If the applicant intends to conduct both planned and unplanned subsidence mining operations both subsections B and C must be addressed.

3) A) 3) Provide geologic descriptions characterizing the thickness and lithology of the coal and overburden geological units throughout the shadow area. Provide stratigraphy test boring and

core sampling log descriptions from the shadow area. Include the elevation and locations of the boring logs.

Please refer to the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012 in *Attachment IV-3A3*. Locations of the borings are shown on Figure 2.4 of the attachment and also on the *Shadow Area Map, Map S.*

3) B) Planned Subsidence

Not applicable, planned subsidence is not proposed for this mining permit.

3) B) 1) Provide a detailed description of the mining technology used to produce planned and predictable subsidence?

3) B) 2) Provide a description of factors (i.e. drift thickness variations, expected variations in extraction height, or presence of faults and their direction (strike & dip) in relation to mine panels, etc.) with supporting documentation which may influence the magnitude, extent and predictability of planned subsidence. Include data on predicted subsidence profiles and post-subsidence contours, including calculations on the predicted angle of draw. Provide a description of measures taken in the field to confirm the accuracy and reliability of predicted subsidence profiles.

3) B) 3) On a plan base map(s), at a map scale of 1 inch to 400 feet provide a map of underground workings which locates all areas where planned subsidence mining operations are to be conducted. Include detailed information in regard to the location,, length, width and height of projected panel development and extraction areas. Give typical percentage of coal removed in planned subsidence extraction areas.

3) B) 4) On the 1 inch to 400 feet plan base map(s) the information regarding the location of features required in Parts a-d below is to be provided in relation to areas of planned subsidence.

3) B) 4) a) Identify all topographic features at a maximum contour interval of 10 feet.

3) B) 4) b) Identify and label all impoundments with a storage capacity of 20 acre-feet or more, or bodies of water with a volume of 20 acre feet or more. In a written narrative provide information which assures compliance with the requirement of Title 62 Ill. Adm. Code 1817.121(d) to permit such proposed mining operations. If no such features exist provide a specific statement indicating such.

3) B) 4) c) Identify and label all public road right-of-ways and cemeteries located within 100 feet measured horizontally of surface areas of predicted planned subsidence. In a written narrative provide information which assures compliance with the requirements of Title 62 Ill. Adm. Code 1761.11 and 12 as may be necessary to permit planned subsidence mining operations within the prohibited area. If no such features exist provide a specific statement indicating such.

3) B) 4) d) Identify and label all occupied dwellings, public buildings and facilities, schools, churches, hospitals, community or institutional buildings, or public parks located within 300 feet measured horizontally of surface areas of predicted planned subsidence. If no such features exist provide a specific statement indicating such. If such features do exist include the following information as may be necessary:

3) B) 4) d) i) Provide a written narrative with support documentation which assures compliance with the requirements of Title 62 Ill. Adm. Code 1761.11 and 12 as may be necessary to permit planned subsidence mining operations within the prohibited area.

3) B) 4) d) ii) Provide a written narrative which assures compliance with the requirements of Title 62 Ill. Adm. Code 1817.121(d) as may be necessary to permit such proposed mining operations in relation to public buildings and facilities, schools, churches and hospitals.

3) B) 5) Describe the anticipated effects of planned subsidence.

3) B) 5) a) Using the predicted magnitude, extent of planned subsidence profiles, post-subsidence contours and angle of draw provided in response to 4,B, above, provide a list of all structures and facilities located within the projected area of influence of the planned subsidence. The list provided must correspond to each panel or extraction area to be mined by planned subsidence mining methods and must cross-reference with surface structures and feature map(s).

3) B) 5) b) Using the predicted magnitude, extent of planned subsidence profiles and post-subsidence contours provided in response to B, 2, above, locate and identify all areas of where surface subsidence impacts are projected to cause disruptions of surface drainage or drainage problems on a map(s) at a 1" to 400' scale.

3) B) 5) c) Describe any other anticipated effects of planned subsidence.

3) B) 6) Describe, if any, measures to be taken on the surface to prevent or minimize the effects of planned subsidence.

3) B) 7) Describe measures to be taken to mitigate or remedy any subsidence-related material damages.

3) B) 7) a) Provide a description of mitigation measures to be taken to repair or compensate the owners of structures or facilities which sustain material damage caused by subsidence, including but not limited to the following:

3) B) 7) a) 1) Compensate the owner of structures or facilities in the full amount of the diminution in value resulting from the subsidence.

3) B) 7) a) 2) Repair, restore, rehabilitate or replace damaged structures or facilities.

3) B) 7) a) 3) Compensation may be accomplished by the purchase prior to mining of a noncancelable premium prepaid insurance policy payable to the surface owner in the full amount of the possible material damage. Documentation of the purchase of such qualifying insurance must be provided.

3) B) 7) b) Provide a description of measures adopted to control and correct material damage resulting from subsidence caused to surface lands, to the extent technologically and economically feasible, by restoring the land to a condition capable of maintaining the value and reasonable foreseeable uses which it was capable of supporting before subsidence. Also provide descriptions of specific repair measures recommended to remedy anticipated material damages detailed in 7,a above.

3) B) 7) c) In conjunction with subsidence control plans to mitigate subsidence-related material damage to land and structures, provide a description of measures to be taken to determine the degree of material damage or diminution of value or reasonable foreseeable use of the surface.

3) C) Subsidence Unplanned (Maximize Mine Stability)

3) C) 1) Describe the method of coal removal which is designed consistent with known technology to maximize mine stability to prevent or minimize subsidence and subsidence related damage so that if subsidence does occur it cannot be considered planned subsidence.

The Bulldog Mine will utilize the room-and-pillar method of underground mining. Solid pillars of coal will be left intact for support, and coal pillar sizes are designed for long term stability of the mine itself and the overlying surface.

Please refer to the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve,* dated May 11, 2012 in *Attachment IV-3A3*.

3) C) 2) On the shadow area map(s) describe in 2,E, above, or other designated map show all areas where coal extraction as described above in 3,C,1 is to occur. Include the following detailed information:

3) C) 2) a) Provide the location of mains, submains and extraction panels giving geometric sizes, dimensions and orientation including lengths, widths, and extraction heights of each.

The proposed mine plan for operations at the Bulldog Mine utilizes the room-and-pillar method of mining. Average extraction height (coal seam thickness) is 5.9 ft.

Sunrise Coal, LLC contracted Marino Engineering Associates, Inc. (MEA) to do a study of the rock overburden, pillar and floor conditions in the shadow area of the Bulldog Mine. The report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve,* dated May 11, 2012 determined that the mine floor was the limiting factor in mine stability.

In the mains and submains, the typical mine plan will include the following geometry for square pillars:

Entry Width = 18 ft
Pillar Width = 52 ft
Extraction Ratio = 45%
Center to Center = 70 ft

In the production areas, the typical mine plan may include the following square pillar geometries resulting in a maximum extraction ratio of 52%:

Room Width = 18 ft
Pillar Width = 42 ft
Center to Center = 60 ft

or

Room Width = 20 ft

Pillar Width = 45 ft
Center to Center = 65 ft

The above mine plan conditions are based on the average geotechnical data and calculations provided in the MEA report dated May 11, 2012 which is located in *Attachment IV-3A3*. As additional data is collected and as the mine is developed, the above mine plan geometries may be altered to meet the safety factors using pillar and floor calculation methods provided in the MEA report.

Sunrise Coal may, in the future, elect to perform two-staged mining as outlined in the attached report prepared by MEA titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve* dated May 11, 2012. The final extraction ratio will be determined based on additional testing and will be subject to IDNR approval.

As noted above, the mine layout will typically be in a square checkerboard configuration but can be any shape. The number of entries may vary in any given main or panel depending upon ventilation needs, overlying critical structures, coal uniformity, etc. Generally, more entries will be used on panels of greater lengths to aid in ventilation, while fewer entries with staggered crosscuts may be used to mine beneath a critical structure. In these areas of reduced extraction, a maximum of 50% extraction will be used under critical structures or protected structures. This reduced extraction will be maintained, not only under the structure per se, but also everywhere the structure is within the zone of influence of the mining. This will be determined by an influence angle of 20°.

Using an influence angle of 20°, the extent of limited extraction beyond the protected feature is calculated below.

Based on the average depth to bottom of the coal from the attached MEA Report.

(tan20°) x 366 ft = 133 ft

Based on the maximum depth to the bottom of the coal from the attached MEA Report.

(tan20°) x 390 ft = 142 ft

From the above calculations, Sunrise will use a 150 ft offset for all structures requiring additional protection.

Please refer to the MEA report located in *Attachment IV-3A3* and the *Shadow Area Map*.

3) C) 2) b) Identify and label all impoundments with a storage capacity of 20 acre-feet or more, or bodies of water with a volume of 20 acre feet or more, public buildings and facilities, churches, schools and hospitals. In a written narrative provide information which assures compliance with the requirements of Title 62 Ill. Adm. Code 1817.121(d) as may be necessary to permit such proposed mining operations. If no such features exist provide a specific statement indicating such.

Several structures that will incur limited extraction ratios are identified on the *Shadow Area Map, Map S*. The structures that will be protected by limited extraction ratios include Norfolk Southern Railroad and several homes. The extraction ratio within the

influence area of these structures will be limited to 50% or less to minimize potential unplanned subsidence.

There are no public buildings and facilities, churches, schools and hospitals located within or adjacent to the shadow area.

There are no gas/petro transmission lines or oil or gas wells in the shadow area.

There are no existing private water bodies (farm ponds) that exceed 20-acre feet in size within the shadow area.

There are six proposed water bodies that will exceed 20-acre feet in volume within the surface permit area. These water bodies will include two freshwater ponds, two treatment ponds, one sediment pond, and the refuse impoundment as shown on the *Surface Drainage Map, Map D*. Surface structures proposed to be constructed in support of the underground mining operation will include the mine portal/slope and the preparation plant. No underground mining is proposed to occur under the refuse impoundment. The extraction ratio within the influence area of all other water bodies and structures mentioned above will be limited to 50% to minimize potential unplanned subsidence.

3) C) 2) c) Provide calculations for the estimated potential angle of draw.

Based on past underground mining experience in the State of Illinois, an angle of 20° has been chosen for the damage limit for the Bulldog Mine.

The following calculation is based on the average depth to bottom of the coal from the Marino Engineering Associates, Inc. (MEA) report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, located in *Attachment IV-3A3*.

$$(\tan 20°) \times 366 \text{ ft} = 133 \text{ ft}$$

The following calculation is based on the maximum depth to the bottom of the coal from the attached MEA Report.

$$(\tan 20°) \times 390 \text{ ft} = 142 \text{ ft}$$

From the above calculations, Sunrise will use a 150 ft offset for all structures requiring additional protection.

3) C) 3) Provide information regarding proposed mining extraction geometries, including information on the dimensions of pillars, extraction widths of rooms, entries, and crosscuts, etc., for all mains, submains, panel entries and all development areas. Provide information regarding the highest extraction percentage for each of the mining geometries proposed by the operator, if variations are proposed. Information is to include specific details of the effects of any proposed second mining operations on final mining geometries and extraction percentages. Map(s) at a scale of 1 inch to 400 feet (other scales as approved by the Department) are to be provided representing all proposed extraction geometries, including any proposed second mining.

3) C) 3) a) Provide information regarding the design engineering of the various mining geometries proposed in 3,C,3 above in maximizing mine stability to prevent subsidence. Include the following:

The design engineering for determining the mining geometries is provided in the Marino Engineering Associates, Inc. (MEA) report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, located in *Attachment IV-3A3*. Mining configurations are shown on the *Shadow Area Map, Map S*.

In the mains and submains, the typical mine plan will include the following geometry for square pillars:

Entry Width = 18 ft
Pillar Width = 52 ft
Extraction Ratio = 45%
Center to Center = 70 ft

In the production areas, the typical mine plan may include the following square pillar geometries resulting in a maximum extraction ratio of 52%:

Room Width = 18 ft
Pillar Width = 42 ft
Center to Center = 60 ft

or

Room Width = 20 ft
Pillar Width = 45 ft
Center to Center = 65 ft

The above mine plan conditions are based on the average geotechnical data and calculations provided in the MEA report dated May 11, 2012. As additional data is collected and as the mine is developed, the above mine plan geometries may be altered to meet the safety factors using pillar and floor calculation methods provided in the MEA report.

3) C) 3) a) i) Detailed information regarding the specific methodology used to calculate mine stability with support documentation and design calculations.

Mine Stability calculations, including methodology and support documentation are provided in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012. The report is located in *Attachment IV-3A3*.

3) C) 3) a) ii) Data concerning actual coal strengths typical of the coal to be mined and as this information relates to pillar design and stability.

Coal strength data typical for the coal to be mined and stability calculations for the coal safety factor are in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*, dated May 11, 2012. The report is located in *Attachment IV-3A3*. This report provides the coal

strength data and pillar strength calculations. This study determined that the floor conditions dictated the stability of the overburden as it related to surface subsidence.

3) C) 3) a) iii) Data regarding the strength and geotechnical characteristics of the actual mine floor and subfloor as it relates to mine design and stability. Information is to be included describing the thickness and lithology of the floor and subfloor units.

Data concerning floor strength and geotechnical characteristics, thickness, and lithology is included in the Marino Engineering Associates, Inc. report titled *Roof Overburden, Pillar and Floor Conditions for the Allerton Coal Reserve*. The report is located in *Attachment IV-3A3*.

3) C) 4) Provide detailed descriptions of subsidence control measures that will be taken to prevent or minimize subsidence and subsidence-related damage which includes, but is not limited to the following:

3) C) 4) a) Backstowing or backfilling, include map locations;

No backstowing or backfilling is not proposed within the shadow area.

3) C) 4) b) Leaving areas in which no coal is removed within the shadow area, including a description of the overlying area to be protected by solid coal blocks left in place. Identify any such areas by map locations;

Occupied dwellings and other sensitive surface features may be provided additional protection against subsidence. Protective measures could include: leaving solid blocks of coal larger than normal pillars, reducing mining width, and/or eliminating crosscuts. Mine areas in areas which require greater protection, will have no more than 50% extraction. Areas where the additional support will be provided will be determined by using an influence angle of 20° extended downward from the outline of the features which will be protected.

There are no gas/petro transmission lines or oil or gas wells above the shadow area.

3) C) 4) c) Surface measures taken to prevent material damage or lessening of the value of reasonably foreseeable uses of the surface;

No surface measures are proposed within the shadow area. In the event surface subsidence does occur which impairs the present land use, surface measures may be taken to minimize subsidence related damage. Such measures could include: provide positive drainage, provide road fill and ditch grading, drainage tile for subsurface drainage.

3) C) 4) d) Monitoring, if any, to determine the commencement and degree of subsidence so that other appropriate measures can be taken to prevent or reduce material damage. Include map locations of any proposed monitoring sites.

No monitoring of the surface or underground workings is proposed at this time. Monitoring will be on a case by case basis should any subsidence occur.

3) C) 5) Describe measures to be taken to mitigate or remedy any subsidence-related material damages.

3) C) 5) a) Provide a description of mitigation measures taken to repair or compensate the owners of structures or facilities which may be materially damaged by subsidence, including but, not limited to the following:

3) C) 5) a) i) Compensate the owner of structures or facilities in the full amount of diminution in value resulting from the subsidence.

3) C) 5) a) ii) Repair, restore, rehabilitate or replace damaged structures or facilities.

3) C) 5) a) iii) Compensation may be accomplished by the purchase prior to mining of a noncancelable premium prepaid insurance policy payable to the surface owner in the full amount of the possible material damage. Documentation of the purchase of such qualifying insurance must be provided.

The underground mining areas of the Bulldog Mine have been designed for long term stability and against unplanned subsidence areas. Damage to structures caused by subsidence is not planned or anticipated. However, should subsidence cause damage to a structure or facility, mitigation and/or remediation would be pursued by Sunrise Coal, LLC.

In the event that a surface owner or the company feels subsidence has damaged a structure, an independent consultant will be employed by the company to evaluate the damage and provide an assessment as to whether the damage was subsidence related. If the consultant determines that the damage is subsidence related, and both parties agree with the assessment, Sunrise Coal, LLC will retain a competent contractor to inspect and assess any damages and estimate the cost of repair or replacement. The lower of the two estimates will be pursued as the appropriate mitigation and/or remediation of damages.

If repair of the structure is deemed the appropriate mitigation and/or remediation, Sunrise Coal, LLC will pay the cost of rehabilitating or restoring the structures to its pre-mining condition. If replacement is deemed the appropriate mitigation and/or remediation, Sunrise Coal, LLC will promptly pay the structure owner the replacement cost in accordance with the contractor’s estimate.

In cases of documented unplanned subsidence where differences of opinion occur between the damaged party and Sunrise Coal, LLC, a qualified professional, mutually acceptable to both parties, will impartially assess the degree of material damage from mine subsidence and provide cost estimates for repair or replacement.

Sunrise Coal, LLC does not intend to purchase any structure prior to mining, nor will they pursue the option of purchasing non-cancelable insurance policies. However, Sunrise Coal, LLC reserves the right to mitigate and/or remedy subsidence damages using any or all available options.

3) C) 5) b) Provide a description of measures adopted to control and correct material damage resulting from subsidence caused to surface lands, to the extent technologically and economically feasible, by restoring the land to a condition capable of maintaining the value and reasonably foreseeable uses which it was capable of supporting before subsidence.

The underground mining areas of the Bulldog Mine have been designed for long term stability and against unplanned subsidence areas. Damage to surface lands caused by subsidence is not planned or anticipated. However, should surface subsidence occur, mitigation and/or remediation would be pursued by Sunrise Coal, LLC.

Regardless of the corrective measures employed to correct the surface subsidence, Sunrise Coal, LLC will restore the pre-mining land use capabilities of all affected surface lands to the extent technologically and economically feasible, and to the extent required by law.
Aerial photography showing topographic contours of the mine area will be used to determine pre-mining surface features. The aerial photography can be utilized to compare pre-mining contours to possible subsidence areas.

Upon proof that subsidence has caused damage to the pre-mining land use capabilities, Sunrise Coal, LLC will inspect the area for the effects on pre-mining drainage patterns and land use capabilities. Sunrise Coal, LLC will then develop a plan to restore the affected area to pre-mining land use condition to the extent economically and technologically feasible and required by law.

Also see the response to Part IV 3)C)5)a).

3) C) 5) c) In conjunction with the requirements to mitigate subsidence-related material damage to land, and structures provide a description of measures to be taken to determine the degree of material damage or diminution of value or reasonable foreseeable uses of the surface.

Underground mining areas of the Bulldog Mine have been designed for long term stability and are designated Unplanned Subsidence Areas. Damage to surface lands and structures caused by subsidence is not planned or anticipated. No pre-mining structure or area surveys are planned for the mining area.

Aerial photography showing topographic contours of the mine area will be used to determine pre-mining surface features. The aerial photography can be utilized to compare pre-mining contours to possible subsidence areas.

4) Existing Structures

4) A) Provide a description of each existing structure proposed to be used in connection with or to facilitate the surface coal mining and reclamation operations. The description shall include the following:

Not applicable, this mining operation does not propose using any existing structures.

4) A) 1) Locate the structure on the operations map or other designated map,

4) A) 2) provide plans of the structure detailing its current, pre-mining condition,

4) A) 3) provide approximate dates, beginning and completion for construction of the structure, and

4) A) 4) provide a showing that the structure meets the performance standards of either 62 Ill. Adm. Code Sections 1810 through 1828 or 62 Ill. Adm. Code Sections 280-300 (Interim Regulation Program). The showing shall monitor data or other substantiating evidence.

4) B) For each structure proposed to be modified or reconstructed for use in connection with or to facilitate the surface coal mining and reclamation operations a compliance plan is required which shall include the following:

Not applicable, this mining operation does not propose using any existing structures.

4) B) 1) Design specifications for reconstruction or modification of the structure to meet the design and performance standards of 62 Ill. Adm. Code Sections 1810 through 1828.

4) B) 2) A schedule for reconstruction or modification of the structure showing dates for beginning and completing interim steps as well as final reconstruction,

4) B) 3) provisions for monitoring the structure during and after modification to ensure that the performance standards of 62 Ill. Adm. Code Sections 1810 through 1828 are met, and

4) B) 4) a showing that the risk of harm of the environment or to public health or safety is not significant during the period of modification or reconstruction.

5) Support Facilities

5) A) Locate on a mining operations map each of the areas to be permitted for surface disturbance to facilitate the mining operation. Map shall include all support facilities including buildings, structures, conveyors, parking areas, coal preparation plants, yards, railroad spurs, on-site rail yards, each air pollution collection and control facility, each facility to be used to protect and enhance fish and wildlife and related environmental values, and each explosive storage and handling facility.

Please refer to the *Surface Drainage Map, Map D* for the location of all support facilities.

5) B) Indicate acreage of each type of facility within permit area such as: buildings, roads, railroads, parking areas, pavements, loading an unloading facilities, sanitary facilities, and undeveloped areas. (Summation of above areas should equal total support facility area.)

Facility	**Acres**
Mine Entries	**0.5**
Soil Storage	**47.5**
Sedimentation Ponds/Ditches	**36.0**
Access Roads	**7.1**
Office/Parking Areas	**4.2**
Equipment/Material Storage Areas	**13.5**
Coal Handling Facility	**25.6**
Coal Waste Facility	**84.4**
Undeveloped Support Area	**103.2**
Undisturbed Support Area	**68.3**
Total Support Area	**390.3**

5) C) Transportation Facilities

5) C) 1) Provide a detailed description on mining operations map or other map and show location of the following:

5) C) 1) a) Proposed road(s), conveyor system(s), or rail system.

The location of all roads and conveyor systems is shown on the *Surface Drainage Map, Map D*. A rail system is not being proposed at this time, however a potential location of a rail loop is indicated on the *Surface Drainage Map, Map D*.

5) C) 1) b) Related sediment control facilities.

Please refer to the *Surface Drainage Map, Map D*, hydrology calculations and surface drainage control narrative.

5) C) 1) c) Earth borrow locations and/or locations for deposition of excess excavation.

Excess excavation deposition areas are not anticipated. However, spoil material excavated from the boxcut will be deposited in the areas, and at the locations discussed above in the response to Part IV-1.

Earth borrow areas are not proposed for this mine site.

5) C) 2) Provide specifications and plan-profiles of existing gradeline, proposed road centerline, ditch flow lines, road cut, fill embankment, culvert, bridge and drainage structures. Provide typical cross sections where appropriate.

Please refer to the enclosed plan, profile and cross-section detail drawings for the listed items that are relevant to this mine site. Also, see the Culvert Design Calculations sheet, Part IV-Page 37.

5) C) 3) For all transportation facilities to be constructed, provide construction details for all sediment control facilities to be constructed to prevent additional contributions of suspended solids to streamflow or to runoff outside the permit area.

Runoff and/or sedimentation control facilities that may be constructed along roads will be minor centralized flow channels. Straw bale checks combined with vegetative ground cover may be used as necessary to control additional contributions of suspended solids.

Construction details for all other sediment control facilities are shown on the plan, profile and cross-section detail drawings included herein.

5) C) 4) Discuss the revegetation of ditch and borrow areas involved in construction.

Revegetation of areas disturbed for ditch construction will be planted and/or seeded to establish a diverse, effective and permanent vegetative ground cover. If necessary to aid seed germination and/or erosion control, the disturbed areas will also be mulched to enhance the revegetation efforts.

5) C) 5) Discuss the estimated life of each facility and how materials will be removed when the facility becomes inactive.

The anticipated maximum life of the transportation facilities is approximately 25 years, or as long as the mine is actively producing coal. Reclamation of these facilities will be done concurrently with the general reclamation of the area, and in accordance with the

approved reclamation plan as soon as practicable after it is no longer needed for mining and reclamation operations. Other support area reclamation will be completed within 12 months following active use, which will vary according to each specific facility.

5) C) 6) Provide a report of appropriate geo-technical analysis where approval from the Department is required for alternative specifications or steep cut slopes under 62 Ill. Adm. Code 1817.150.

No alternative specifications or steep cut slopes are being proposed.

5) C) 7) Provide a description of measures to be taken to protect the inlet end of a ditch relief culvert, other than use of a rock headwall, and for alteration or relocation of a natural drainageway for approval by the Department under 62 Ill. Adm. Code 1817.150.

If necessary to aid in the function of culverts, the inlet end will be protected by a rock or grouted rip-rap headwall. No other culvert inlet protection is proposed.

6) Waste Material

To insure compliance with 62 Ill. Adm. Code 1817.41(a), and to demonstrate that dissolved contaminants are minimized in runoff from the refuse disposal area, Best Management Practices (BMP's) as specified in the June 2007 SIU study entitled, "Identification and Assessment of Best Management Practices in Illinois Mining Operations to Minimize Sulfate and Chloride Discharges" shall be implemented. Each BMP to be implemented from the cited study is identified and discussed in *Attachment IV-6*.

6) A) Identify the nature of all waste material including shaft excavation material and non-coal waste to be disposed of within the permit area. Give the net neutralization potential.

The nature of the coal processing waste material generated at this facility will include a coarse refuse waste stream and a fine slurry refuse waste stream. The coal waste by-product anticipated by the coal processing operation will consist of roof and floor out-of-seam dilution associated with loading the coal seam, and shales, coal partings and pyritic materials separated from the coal as it is screened, sized and processed through the coal processing plant. Material comprising the out-of-seam dilution will primarily be shales and/or underclays. Because of the type of rock, coal and minerals, net neutralization potentials of the out-of-seam dilution can be expected to range from the positive to negative side of the acid base scale. Refuse consisting of a combination of shales, shale partings and pyritic materials will generally exhibit negative net neutralization potential. Extremes of the negative net neutralization potentials can range from slightly less than negative to a maximum of approximately 35 tons calcium carbonate equivalent per 1000 tons of refuse material. *Attachment III-2A2* lists the net neutralization potential for the immediate roof and floor materials that will comprise the majority of breaker rock.

Acid-base accounting data contained in *Attachment III-2A2* indicate the overburden present at the location where the mine slopes will be constructed is generally positive in net neutralization potential. Only four of the overburden layers of strata, totaling less than twenty-seven feet thick, exhibit negative net neutralization potentials.

Fifteen unconsolidated strata layers exist in the overburden column near the location where the mine slope will be developed. One-hundred percent of the unconsolidated overburden

materials exhibited an excess of tons calcium carbonate equivalent per 1000 tons of unconsolidated material.

Forty-eight consolidated strata layers were sampled in the overburden that exists above the Herrin No. 6 coal seam. Five underburden layers were sampled in the strata below the Herrin No. 6 coal seam.

Forty-four of the forty-eight consolidated overburden strata layers totaling 286.7 feet thick exhibit a weighted average of positive 107.00 tons calcium carbonate equivalent per 1000 tons of material.

The layers of strata exhibiting negative net neutralization potential are at depths greater than 285 feet from the surface. This material will be placed in the soil stockpile at the location shown on the *Surface Drainage Map, Map D.* The waste material will be blended with the excess consolidated overburden that demonstrates positive net neutralization potential. Considering the overall calcareous nature of the consolidated overburden, and the blending that will occur during the slope development process, special material handling techniques are not considered necessary in the interest of prevention of contamination of groundwater and surface water supplies.

Additional waste material will be generated from the roof and floor during normal underground mine development. During initial mine development this waste will be removed from underground and deposited with the gob/coarse refuse. After developing a few mine panels, the underground waste material will remain underground and will be deposited in the abandoned crosscuts.

Non-coal waste will be hauled from the site by a licensed waste hauler.

6) B) Coal processing waste bank dams shall be designed to comply with requirements of 62 Ill. Adm. Code 1817.81 through 1817.84. For coal processing waste dams and embankments each plan shall comply with the requirements of MSHA, 30 CFR 77.216-1 and 77.216-2, and shall contain the results of a geo-technical investigation as prescribed under 62 Ill. Adm. Code 1784.16(e).

Please refer the report completed by Patriot Engineering and Environmental, Inc. in *Attachment IV-6B* for the details of the Refuse Impoundment design.

6) C) Indicate location of all areas in which such materials including shaft excavation material and non-coal waste (including those under Subtitle C of RCRA) are to be disposed of on the mining operations map. Indicate all streams, creeks, and surface water impoundments within such areas or which receive runoff from such areas. Provide acreage of disposal area and borrow areas. Indicate location of borrow area on mining operations map.

The *Surface Drainage Map, Map D* identifies the location of the Refuse Impoundment which will receive coarse and fine refuse, Treatment Pond #2 which will receive any discharge from the Refuse Impoundment, and Treatment Pond #1 which will receive mine pumpage. As previously stated, sub-soil from the mine slope excavation may be used as fill material to construct mine support facilities, and suitable consolidated material may be used as a sub-base to construct access roads. Non-toxic, non-combustible material will be utilized as construction materials where possible. The mine support facilities and access roads are illustrated on the *Surface Drainage Map, Map D.*

Refuse disposal area acreage is included in the table at Part IV-5)B). No borrow areas are currently proposed for this site.

6) D) Provide construction details for all impoundments and structures to contain such waste material. Provide typical cross-sections of all proposed levees, dams and excavations.

Please refer the report completed by Patriot Engineering and Environmental, Inc. in *Attachment IV-6B* for the details of the Refuse Impoundment design.

All vegetation, topsoil, roots, and soft sub-soil will be removed from the proposed Refuse Impoundment area. The soils will be stockpiled in accordance with applicable regulations.

The Refuse Impoundment will be a partially incised impoundment. After the topsoil is removed, approximately 24 feet of subsoil will be excavated. Clay soil from the excavation will be used to construct the embankment for the first phase of the Refuse Impoundment. Coarse refuse will be used to construct the embankment for the remaining phases. Before fill for the embankment is placed, a relatively impermeable soil liner will be constructed using the clayey soils encountered on site. The soils will be placed in 6-8 inch loose lifts and compacted until four (4) feet of clayey fill has been placed and compacted. The four (4) feet of clay fill should provide a liner with a permeability of approximately 1×10^{-7} cm/sec. If the in situ soils do not produce liner having a permeability of 1×10^{-7} cm/sec. or less, lime or Portland cement will be added to the soil to achieve the required permeability. The coarse refuse embankment is planned to be constructed utilizing 3H:1V side slopes eventually to an elevation of approximately 75 feet above the surrounding ground elevation. Coarse refuse will be hauled by trucks and/or scrapers and spread in layers not to exceed 2 feet in thickness. Compaction will be accomplished by vibratory action created by the trucks and/or scrapers and spreading equipment. The embankment will be constructed in a manner that will promote unimpeded surface water runoff.

Engineering design details for Treatment Pond #1 and Treatment Pond #2 are shown in the pond design section on page 35. These impoundments will be incised. Approximately 25 to 30 feet of subsoil will be removed from within the impoundment to construct Treatment Pond #1. Approximately 15 to 20 feet of subsoil will be excavated from within the impoundment to construct Treatment Pond #2. Then, a soil liner, identical to the Refuse Impoundment liner, will be constructed using the excavated subsoil.

Construction details for the compacted clay liners under the raw coal, clean coal, and prep plant areas are illustrated on *Clean Coal, Raw Coal & Prep Plant Area Profile Section, Map PP-1.* These clay liners will be constructed in an identical manner as the clay liners under the treatment ponds and refuse impoundment.

Construction details for the compacted clay liners under the drainage ditches are illustrated on *Collector Ditches #5, #6, #7, #8 Plan, Profile & Cross Section, Map P-5.* These liners will be constructed as per the liners in the above mentioned structures. However, instead of a compacted clay liner, the applicant may install an impermeable geomembrane liner with a minimum thickness of 20 mils in the drainage ditches.

A quality assurance/ quality control plan detailing the clay liner installation is included in *Attachment IV-6D.*

6) E) Indicate location and provide details for diversions as necessary to divert surface water around such areas on the mining operations map.

All surface water collector ditches are shown on the *Surface Drainage Map, Map D*. Collector ditch engineering designs and details are discussed in the responses to Part IV-7) Surface Drainage Control, and are shown on the plan, profile and cross-section detail drawings included herein.

6) F) Provide details of diversions or other devices designed to collect surface runoff from waste disposal sites and transport same to appropriate treatment facility.

Construction details for all other sediment control and treatment facilities, including collector ditches, are discussed in Part IV-7) Surface Drainage Control, and are shown on the plan, profile and cross-section detail drawings included herein.

6) G) Provide details of such treatment facilities and identify points of discharge.

Construction details for all other sediment control and treatment facilities, including collector ditches, are discussed in Part IV-7) Surface Drainage Control, and are shown on the plan, profile and cross-section detail drawings included herein.

6) H) For disposal areas explain measures to be taken to avoid pollution of surface or groundwater due to leaching through levees or dams and through underlying soil.

Also, all structures which contain and/or convey waste or runoff from waste shall have a four (4) foot thick clay liner compacted to a minimum 95% of the maximum standard laboratory density with a permeability of a minimum of 1 X 10^{-7} cm/sec. An impermeable geomembrane liner with a thickness of 20 mils may be used under the drainage ditches in lieu of a four (4) foot compacted clay liner.

These measures will help prevent pollution of surface and groundwater due to leaching through levees or dams and through underlying soil.

6) I) Describe estimated life of each area.

It is extremely difficult to estimate the life of the disposal areas at this time. Several elements can become key factors in the amount of waste material generated. Most notably these elements include realized prep plant efficiencies, out-of-seam dilution during initial mine development and after initial mining panel development, any unforeseen coal partings present in the No. 6 coal seam.

At any rate, it is anticipated the proposed Refuse Impoundment is adequate to provide sufficient disposal volume for 5+ years of prep plant operation. Should additional waste volume be required, the applicant will solicit engineering design approval from IDNR, IEPA and MSHA prior to constructing additional disposal sites.

6) J) Coal preparation:

6) J) 1) Give a general description of the coal processing operation at this facility.

The Bulldog Mine coal processing plant will utilize heavy media separation to process the

coal. Run-of-mine coal will be transported from the underground mine to the plant via a conveyor, where it will be stockpiled by a radial stacker. Clean coal from the plant will also be stockpiled though the use of a radial stacker. Impurities removed from the coal will exit the processing plant as either gob/coarse refuse or as fine coal slurry refuse. Coarse refuse will be transported to refuse bins located adjacent to the Refuse Impoundment. Slurry will be pumped to the Refuse Impoundment.

Coal from the clean coal stockpile will be loaded onto licensed trucks for highway haulage to various customers. The location of a potential rail loop is indicated on the *Surface Drainage Map, Map D*, but is not being proposed to be constructed at this time. If the rail loop is proposed to be built in the future, Sunrise Coal will obtain the required regulatory approvals.

Please refer to the *Surface Drainage Map, Map D* for the location of the coal processing plant and associated facilities.

6) J) 2) Describe the fresh water (makeup) and slurry circuits for this operation and indicate if a discharge occurs. If a discharge does occur, it should be included on Schedule A. If a discharge does not occur, a detailed description of how this will be accomplished must be submitted.

It is anticipated that the coal processing plant will require approximately 200 gpm of water usage and the underground mine will require approximately 100 gpm of water usage. It is the intent of Sunrise Coal to collect and store runoff from precipitation events to use for plant operation. The location of this facility in East-Central Illinois farm country will require the operator to store water in the ponds to insure adequate water supply for operation. The watersheds in this area are characterized by mildly sloping land, and the agricultural fields are drained with subsurface tile systems. The operator will direct flows from existing field drain piping to the freshwater ponds. All the ponds will be storage ponds. They have been designed with seven (7) to nine (9) feet of freeboard at normal pool elevations for this purpose. The operator intends to use the water in the freshwater ponds, treatment ponds, and sediment pond as makeup water for coal processing. Water from the Refuse Impoundment will be recycled to the plant for use as well. This system will be basically a closed loop system as it is anticipated the ponds will discharge only during heavier rainfall events. Area farmers have indicated there is little flow in the drain tiles during the growing season when the crops are in the fields. So it is anticipated that water will be stored during the fall and winter for use through the growing season.

If at any time the quantity of water in the ponds becomes insufficient for operation, Sunrise Coal will purchase water from the City of Homer. Water from the City of Homer will be available to Sunrise Coal at the rate of 300 gpm so the supply will be sufficient if for some reason water cannot be pumped from the ponds.

Normal operating conditions will result in no discharge from the Refuse Impoundment. In the unlikely event the Refuse Impoundment does discharge, the discharged water will flow to Treatment Pond #2 and be re-circulated back to the preparation plant. Excess water contained in Treatment Pond #2 will be allowed to discharge to Freshwater Pond #2. Water discharging from Freshwater Pond #2 will be sampled and analyzed at an IEPA approved laboratory in accordance with the approved NPDES permit for this facility as will water discharging from Freshwater Pond #1 and Sediment Pond #1.

6) J) 3) What safeguards are provided to prevent the discharge of slurry fines and untreated slurry water

during emergency situations (e.g. power outages, mechanical equipment breakdown, plant shutdowns, etc.)? Also indicate where the slurry would go by gravity flow in the event of an emergency discharge, and the environmental impact this would have.

Clear water from the Refuse Impoundment will be pumped to the prep plant for make-up water and/or discharged to Treatment Pond #2. This will help to insure the water level in the Refuse Impoundment is drawn down thus providing surge volume in the impoundment in the event of a power failure or mechanical breakdown.

Should an unforeseen event occur, a discharge of slurry fines and untreated slurry water will be intercepted by Collector Ditch #7 and Collector Ditch #8 that direct surface water runoff to Treatment Pond #2 which discharges to Freshwater Pond #2. Any slurry fines that may enter the surface drainage control system will be contained in Treatment Pond #2. Effluent water quality from Freshwater Pond #2 will meet the requirements of the approved NPDES permit for this facility.

7) Surface Drainage Control

7) A) 1) Locate on the mining operations map or on a separate drainage map all proposed drainage control systems. Show drainage patterns of all affected mining areas.

All proposed drainage control systems and drainage patterns of all affected mining areas are shown on the *Surface Drainage Map, Map D.*

7) A) 2) Will all surface drainage from the affected mining area be collected and treated prior to leaving the permit area?

Yes ___X___ No _______

If yes, delineate how and where surface drainage will be collected and treated, and list permit numbers and type of permit that the drainage control systems are operated under. If above answer is no, explain how regulatory compliance will be achieved without treatment, i.e., address the requirements of Section 1817.46(e).

All affected area surface drainage from within the permit area will be collected and treated at the sediment pond, treatment ponds, and freshwater ponds before being discharged from the permit area. Please refer to the *Surface Drainage Map, Map D* for delineation of how and where surface drainage will be collected and directed to the ponds.

7) B) Will all surface drainage from unaffected areas be intercepted and diverted around the affected mining area?

Yes _______ No ___X___

If no, please discuss.

Drainage from unaffected areas to the south, east, and west of the permit area is a combination of natural surface flow and flow through drain tile in agricultural fields. This drainage will be intercepted and directed to the freshwater ponds for use in the coal processing operations as shown on the *Surface Drainage Map, Map D*.

7) C) Describe the timing in which all construction of the sediment ponds and surface drainage control structures will be complete. Include a discussion of the vegetation stabilization of these structures.

Initial surface disturbance will involve removing topsoil for the construction of the sediment pond, treatment ponds, and freshwater ponds. After the topsoil is removed, the ponds will be constructed. Then construction of the slope will commence. The remaining drainage control structures will be constructed as the roads, refuse area, and plant areas are constructed. The roads will be constructed with the material from the slope construction.

The ponds and surface drainage control structures will be vegetated after construction using the following seed mixture:

Fescue	**20 lbs./ac.**
Orchard Grass	**10 lbs./ac.**
Cover Crop	**15 lbs./ac.**

7) D) Overland Flow Diversions

For all diversions of overland flow, shallow groundwater flow, and ephemeral streams which divert surface water around the mining area, and all collection drains that transport affected area runoff into water-treatment facilities, provide the following:

7) D) 1) Typical cross sections bottom width, side slopes and depth.

Please refer to *Collector Ditches #1, #2, #3 & #4 Plan, Profile & Cross Sections, Map P-4* and *Collector Ditches #5, #6, #7 & #8 Plan, Profile & Cross Sections, Map P-5*.

7) D) 2) Proposed flow line slopes.

Please refer to *Collector Ditches #1, #2, #3 & #4 Plan, Profile & Cross Sections, Map P-4* and *Collector Ditches #5, #6, #7 & #8 Plan, Profile & Cross Sections, Map P-5*.

7) D) 3) Runoff and diversion capacity calculations.

The ditch calculations for Collector Ditches #1 through #6 are based on a 10 year-24 hour rainfall event to comply with the requirements of Illinois Administrative Code Section 1817.43.

The ditch calculations for Collector Ditches #7 and #8 are based on a 100 year-6 hour rainfall event to comply with the requirements of Illinois Administrative Code Section 1817.84.

All the ditches are vegetated channels. Following is the design summary for the various ditches. Also included in this application are the SEDCAD Version 4 software printouts of the computations for the designs.

DESIGN SUMMARY

For Collector Ditch #1, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Sta. 0+00 to 21+65

Drainage area = 9.8 acres
10 yr.-24 hr. rainfall = 4.26 inches

Curve Number = 79
Topography = short grass
Q = 10.3 cfs
Velocity = 0.5 to 1.1 fps

For Collector Ditch #2, Segments 1 and 2, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 16+50

Drainage area = 335.5 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 78
Topography = crops
Q = 89.1 cfs
Velocity = 1.2 to 2.1 fps

Ditch Segment 2, Sta. 16+50 to 29+52

Drainage area = 156.7
10 yr-24 hr rainfall = 4.26 inches
Curve Numbers = 78, 79
Topography = crops, short grass
Q = 127.9 cfs
Velocity = 1.5 to 2.5 fps

For Collector Ditch #3, Segments 1 and 2, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 12+50

Drainage area = 20.0 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 85
Topography = gravel surface areas, short grass
Q = 37.9 cfs
Velocity = 1.0 to 1.9 fps

Ditch Segment 2, Sta. 12+50 to 24+36

Drainage area = 20.0 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Numbers = 79
Topography = short grass
Q = 51.2 cfs
Velocity = 1.1 to 2.1 fps

For Collector Ditch #4, Segments 1, 2 and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 2+88

Drainage area = 2.6 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Numbers = 85

Topography = gravel surface areas
Q = 6.9 cfs
Velocity = 0.3 to 0.8 fps

Ditch Segment 2, Sta. 3+38 to 13+50

Drainage area = 16.7 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 85
Topography = gravel surface areas
Q = 37.2 cfs
Velocity = 0.8 to 1.6 fps

Ditch Segment 3, Sta. 13+50 to 32+49

Drainage area = 20.0 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = short grass
Q = 47.7 cfs
Velocity = 1.0 to 1.8 fps

For Collector Ditch #5, Segments 1 and 2, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 4+40

Drainage area = 4.8 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Numbers = 79
Topography = gravel surface areas, short grass
Q = 7.5 cfs
Velocity = 0.6 to 1.5 fps

Ditch Segment 2, Sta. 5+35 to 9+44

Drainage area = 8.2 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = gravel surface areas, short grass
Q = 21.4 cfs
Velocity = 1.1 to 2.3 fps

For Collector Ditch #6, Segments 1 through 5, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 13+65

Drainage area = 10.9 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = gravel surface areas, short grass
Q = 25.0 cfs
Velocity = 0.6 to 1.2 fps

Ditch Segment 2, Sta. 14+00 to 25+50

Drainage area = 17.7 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = gravel surface areas, short grass
Q = 39.0 cfs
Velocity = 0.8 to 1.5 fps

Ditch Segment 3, Sta. 25+50 to 35+50
Drainage area = 4.9 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = short grass
Q = 50.1 cfs
Velocity = 0.9 to 1.7 fps

Ditch Segment 4, Sta. 35+50 to 41+10
Drainage area = 8.3 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = short grass
Q = 58.8 cfs
Velocity = 1.0 to 1.8 fps

Ditch Segment 5, Sta. 41+10 to 48+00
Drainage area = 4.1 acres
10 yr-24 hr rainfall = 4.26 inches
Curve Number = 79
Topography = short grass
Q = 61.0 cfs
Velocity = 1.0 to 1.8 fps

For Collector Ditch #7, Segments 1, 2 and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment 1, Sta. 0+00 to 0+52
Drainage area = 1.5 acres
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 85
Topography = coarse refuse, short grass
Q = 7.1 cfs
Velocity = 0.4 to 0.9 fps

Ditch Segment 2, Sta. 1+40 to 21+00
Drainage area = 23.5 acres
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 85
Topography = coarse refuse, short grass
Q = 117.1 cfs
Velocity = 1.6 to 2.7 fps

Ditch Segment 3, Sta. 21+00 to 30+98

Drainage area = 8.2 acres
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 85
Topography = coarse refuse, short grass
Q = 155.2 cfs
Velocity = 1.9 to 3.9 fps

For Collector Ditch #8, Segments 1, 2 and 3, the following are the design calculations. Calculations were performed using SEDCAD Version 4 software.

Ditch Segment #1, Sta. 0+00 to 11+50
Drainage area = 5.3 acres
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 69
Topography = short grass
Q = 17.0 cfs
Velocity = 0.4 to 1.0 fps

Ditch Segment 2, Sta. 11+50 to 28+00
Drainage area = 6.5 acres
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 69
Topography = short grass
Q = 37.8 cfs
Velocity = 0.7 to 1.4 fps

Ditch Segment 3, Sta. 28+00 to 49+12
Drainage area = 5.2 acre
100 yr-6 hr rainfall = 4.96 inches
Curve Number = 69
Topography = short grass
Q = 54.3 cfs
Velocity = 0.8 to 1.6 fps

7) D) 4) Details of proposed erosion and sediment control measures to be employed.

For permanent diversion also include:

7) D) 5) Watershed limits upstream from the diversions.

There are no permanent diversions.

7) D) 6) Plan profile drawings of the proposed diversion showing existing gradeline, proposed diversion bottom gradeline and water surface at design storm.

There are no permanent diversions.

7) E) Sediment pond Design:

Please refer to the pond design section on Part IV-Page 35 and the following maps:

- ***Sediment Pond #1 Plan, Profile & Cross Sections, Map P-1***
- ***Freshwater Pond #1 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Freshwater Pond #2 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) F) 1) Discuss the design basis for the sediment pond(s) calculations.

<u>Sediment Pond Design</u>

Sediment Pond #1, Treatment Pond #1, and Treatment Pond #2 will be used for sediment control. These ponds are located downstream of the mine operation areas which allows the impoundments to collect all runoff from the mine operations for treatment before discharging. All the ponds are incised but will have a 3-4 feet embankment dam constructed of clay material from the proposed pond excavations. The minimum width of the top of dam is 10 feet for these impoundments. The locations of the ponds are shown on the *Surface Drainage Map, Map D* and are described below:

- **Sediment Pond #1 is located in the northeasternmost portion of the permit area north of Road 800 North and west of Road 200 East. This impoundment will receive runoff from the yard and parking areas and soil stockpiles. Collector Ditches #3 and #4 will direct drainage to this pond.**
- **Treatment Pond #1 is located in the northwest portion of the permit area between Haul Roads #1 and #2. This impoundment will receive runoff from coal storage areas and soil stockpiles. Collector Ditches #5 and #6 will direct drainage to this pond.**
- **Treatment Pond #2 is located in the southeast portion of the permit area. This impoundment will receive runoff from soil stockpiles and the Refuse Impoundment. Collector Ditches #7 and #8 will direct drainage to this pond.**

Sediment Pond Construction:

- **Sediment Pond #1 will be an incised impoundment. The pond will receive surface runoff from approximately 80 acres. This will not include any runoff from “waste” areas as a “drainage divide” will be created along the western side of this area to prevent runoff from coal storage areas and mine operations from entering. The principal spillway will be an 18 inch pipe which will flow to an existing 18 inch drain tile. The emergency spillway will be a 4 feet wide grass lined open channel spillway. The sediment pond will be a temporary impoundment.**
- **Treatment Pond #1 will be an incised impoundment. The pond will receive surface runoff from the mine operation areas including pumpage from the mine. The spillway will be 4 feet wide grass lined open channel spillway. Collector Ditches #5 and #6 will direct drainage to this pond. This pond will be a temporary impoundment.**
- **Treatment Pond #2 will be an incised impoundment. The pond will receive surface runoff from soil stockpiles and the Refuse Impoundment. The spillway will be a 10 feet wide grass lined open channel spillway. Collector Ditches #7 and #8 will direct drainage to this pond. This pond will be a temporary impoundment.**

Sediment storage:

Calculations for each watershed were performed to estimate sediment loads to the ponds. A factor of 0.035 ac-ft of sediment per acre of affected drainage area per year was used to estimate the sediment storage volumes required for each impoundment.

Drainage areas:

The watershed areas were determined from available topographic mapping and mapping prepared from field surveys performed by the applicant.

Precipitation runoff:

The designs are based on the precipitation expected from a 10 year, 24 hour, Type II distribution storm. Using Illinois State Water Survey Bulletin 70, this precipitation generates 4.26 inches of rainfall.

The overflow structures were designed based on the expected precipitation from a 25 year-6 hour, Type II distribution storm. Using Illinois State Water Survey Bulletin 70, this precipitation event generates 3.78 inches of rainfall. SEDCAD 4 analyses demonstrating that the spillways can safely discharge a 25 year-6 hour precipitation event is included herewith.

Expected runoff was determined using the commercially available software known as SEDCAD Version 4. This software is used by the Office of Surface Mining in 24 states.

Sediment volume:

Sediment volumes were determined by summing the expected storm runoff volume with estimated mine pumpage and adding the volume necessary for the sediment storage. Mine pumping is estimated at 0.44 ac-ft per day (100 gallons per minute). This value is determined from previous mine applications and in field experience from this region. The required Sediment storage volume is determined using the soil loss factor of 0.035 ac-ft per acre per year of affected drainage area. Multiplying this factor by a 3 year time period to size the impoundment has been accepted by the Department for previous submittals. Ponds are designed for a 10 hour detention time for the summed storm runoff and mine pumpage. Comparing this volume with the volume at pool elevation will determine the years of available storage in the pond.

Spillway sizing: Spillways were sized to accommodate the expected discharge as determined from the above referenced SEDCAD Version 4 software.

Submit calculations used in spillway designs and determination of inflow volume and pond volume.

Please refer to the pond design, Part IV-Page 35.

7) F) 2) Submit a typical section of the embankment(s), details of the principal and emergency spillways and a plan view of each pond at a scale of 1 inch = 200 ft. or larger showing pond bottom contours and points of inflow.

Please refer to the following drawings for the pond plan views and details:

- ***Sediment Pond #1 Plan, Profile & Cross Sections, Map P-1***
- ***Freshwater Pond #1 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Freshwater Pond #2 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) F) 3) For all sedimentation ponds provide design information showing compliance with the

requirements of 62 Ill. Adm. Code 1817.46. Each plan shall, at minimum, comply with the requirements of MSHA, 30 CFR 77.216-1 and 77.216-2.

Please refer to the pond design section, Part IV-Page 35.

7) G) If sediment removal becomes necessary, explain how the sediment will be removed, where it will be disposed of, and what disposal methods will be used.

If sediment removal becomes necessary for continuation of adequate pond performance, sediment will be removed utilizing a small dredge, a dragline or other excavation equipment designed to effectively remove sedimentation. The large surface area and depth of the ponds would easily accommodate using a small dredge to remove sediment buildup, deposit the sediment in an approved location, and effectively restore the pond volume to its original size. A small dredge could easily be mobilized and placed quickly into operation should the need arise.

Sediment removed from the pond will be deposited in the Refuse Impoundment.

7) H) Will pH adjustment be necessary on any of the discharges in order to meet the applicable State and Federal Standards?
Yes ______ No ___X___

If yes, a discussion of the situation is necessary, along with a detailed basis of design. The basis should include a detailed description of the proposed treatment facilities, process flow diagrams, and design calculations.

7) I) Does a perennial or intermittent stream occur within the proposed permit area?
Yes ______ No ___X___

If yes, is an exception to the 100 foot buffer zone being requested or is a stream diversion being proposed. For exception to the 100 foot buffer zone, indicate how compliance with Section 1817.57 will be assured. For a stream diversion, complete Part V 6) of the application form.

7) J) Permanent and Temporary Impoundments, Ponds, Banks, Dams and Embankments

7) J) 1) All temporary and permanent impoundments must meet the requirements of 62 Ill. Adm. Code 1817.49. Will the mining operation involve the construction of any impoundments other than those waste retention?
Yes ___X___ No ______

If yes, Include the following information:

7) J) 1) a) Locate on mining operations map all impoundments, dam locations, and watershed limits, indicate which impoundments are proposed to be permanent and complete Part V 3)D) of the application.

All impoundments, dam locations, and watershed limits are illustrated on the enclosed maps. No permanent impoundments are proposed for this mine site.

7) J) 1) b) Provide construction and maintenance details of dams, spillways, seepage control measures, and erosion control measures for inlets and outlets. Employ maps and cross sections where

necessary. Where design plans for proposed structures are not provided, submit a certification statement providing a schedule for submission of detailed design plans for each structure.

Please refer to the pond design, Part IV-Page 35. Also, refer to the following drawings for the pond plan views and details:

- ***Sediment Pond #1 Plan, Profile & Cross Sections, Map P-1***
- ***Freshwater Pond #1 & Treatment Pond #1 Plan, Profile & Cross Sections, Map P-2***
- ***Freshwater Pond #2 & Treatment Pond #2 Plan, Profile & Cross Sections, Map P-3***

7) J) 2) Describe proposed reclamation plans for each structure, including a time table and plans for removal and disposal of material. Each plan shall:

7) J) 2) a) Be prepared by or under the direction of, and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified, licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 2) b) contain a description, map, and cross-section of the structure and its location,

Please refer to the *Surface Drainage Map, Map D.*

7) J) 2) c) contain preliminary hydrologic and geologic information required to assess the hydrologic impact of the structure,

The sediment pond, freshwater ponds, and treatment ponds are incised impoundments with low profile (3-4 feet high) embankments that will be constructed of clay materials from the pond excavations. No bedrock or aquifers will be disturbed so there will be no hydrologic impact.

The Refuse Impoundment is partially incised. The first phase embankment will be constructed clay soil from the excavation. The remaining phases of the embankment will be constructed of coarse refuse. No bedrock or aquifers will be disturbed so there will be no hydrologic impact.

7) J) 2) d) if underground mining has occurred, the plan shall contain a survey describing the potential effect on the structure from subsidence of the subsurface strata resulting from the post underground mining operations,

There is no planned subsidence at this mine. The extraction ratio within the influence area of the impoundments will be limited to 50% or less. The pillar sizes are larger than the minimum required to help insure adequate stability. There is also a considerable limestone layer between the mine and the impoundment which will provide for stability. It should be noted that no underground mining will occur beneath the Refuse Impoundment as no mining will take place in the permit area south of Road 800 North.

7) J) 2) e) for structures where the detailed design plans are not submitted to the Department with the general plan, the plan shall contain a certification statement which includes a schedule setting forth the dates that detailed design plans are to be submitted. For these structures, the

detailed design plans must be submitted to the Department and approved in writing prior to the beginning of construction.

7) J) 3) For each structure that meets or exceeds the size or other criteria of MSHA, 30 CFR 77.216(a), the detailed design plan shall:

7) J) 3) a) Be prepared by or under the direction of and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified, licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 3) b) include any design and construction requirements for the structure, including any required geo-technical information,

Please refer the report completed by Patriot Engineering and Environmental, Inc. in *Attachment IV-6B* for the details of the Refuse Impoundment design.

7) J) 3) c) describe the operation and maintenance requirements for each structure, and

The Refuse Impoundment will be operated as part of a closed circuit system as the water from the pond will be pumped backed to the prep plant for make-up. If there is a discharge, it will report to Treatment Pond #2 and it will also be pumped back to the plant. As for maintenance, particular attention will be given to potential seepage, keeping the spillway free of debris, and erosion of embankment areas and side slopes.

7) J) 3) d) describe the timetable and plans for removal of each structure if appropriate.

When permanent cessation of the mining operation occurs, removal of the Refuse Impoundment will be part of the final reclamation. The spillway will be removed. Toxicity testing will be performed to determine the net neutralization potential of the waste material. An appropriate quantity of lime will be incorporated into the surface of the slurry before covering the waste material with 4 feet of non-toxic, non-combustible soil materials.

7) J) 4) For each structure that does not meet the size or other criteria of MSHA, 30 CFR 77.216(a), the detailed plan shall:

7) J) 4) a) Be prepared by or under the direction of and sealed by a qualified registered professional engineer licensed under the Illinois Professional Engineering Act,

The plans have been prepared by a qualified licensed Illinois Professional Engineer. The plans are considered sealed by virtue of the engineering certification herein.

7) J) 4) b) include any design and construction requirements for the structure, including any required geo-technical information,

Design and construction requirements for the structures are included in the pond design section beginning at Part IV-Page 35.

7) J) 4) c) describe the operation and maintenance requirements for each structure, and

Operation of the ponds will consist of effluent monitoring and frequent inspection by qualified personnel as required by regulation. Particular attention will be given to potential seepage, trash removal from spillway areas, and erosion of embankment areas and side slopes.

7) J) 4) d) describe the timetable and plans for removal of each structure if appropriate.

When a pond is no longer needed it will be drained, backfilled, topsoiled, and seeded in accordance with the reclamation plan.

7) K) If any of the following questions are answered yes, a permit may be needed from Illinois Department of Natural Resources, Office of Water Resource Management.

7) K) 1) Will the mining operation involve the construction of any levees, dikes, haul roads or other similar structures or the placement of any fill along or in the flood plain of any stream serving a drainage area of ten (10) square miles or greater at the point of construction?
Yes _______ No ___**X**___

7) K) 2) Will the mining operation involve any relocation or diversion of or any construction activity in, over, under or along the banks of any stream serving a drainage area of ten (10) square miles or greater at the point of construction?
Yes _______ No ___**X**___

7) K) 3) Is there any urban development (residential, commercial or industrial uses) in the areas immediately surrounding the mining operation?
Yes _______ No ___**X**___
(If yes, please re-answer questions 1 and 2 above applying a one (1) square mile drainage area limit.)

7) K) 4) Will the mining operation involve the construction, major modification, or removal of any dam which in the event of failure would have probability for loss of life or additional economic loss in excess of that which would occur downstream of the dam in the absence of the dam?
Yes _______ No ___**X**___

7) K) 5) Will the mining operation involve the construction, major modification, or removal of any dam 25 feet or more in height?
Yes ___**X**___ No _______

7) K) 6) Will the mining operation involve construction, major modification, or removal of any dam which would have an impounding capacity of 50 acre feet or more?
Yes ___**X**___ No _______

8) Provide a plan detailing fugitive dust control practices to be employed during proposed surface coal mining and reclamation operations as required under 62 Ill. Adm. Code 1817.95.

The mine site supervisor will monitor weather and wind conditions, and will be responsible for taking necessary action to control fugitive dust.

Exposed surface areas will be protected and stabilized to effectively control erosion and air pollution during site preparation, and mining and reclamation operations. Water trucks will be used when necessary to control fugitive dust on all heavily traveled areas during dry or dusty

periods. All roads or other heavily traveled areas will be surfaced with a durable non-toxic material.

Measures used to control fugitive dust at the coal handling site will include using water spray bars at the coal conveyor transfer points, frequent road watering during dry dusty conditions, and if necessary spraying water on the coal stockpiles.

POND DESIGN

Design of the treatment ponds, sediment pond, and freshwater ponds was discussed previously in Part IV. A calculation report for the actual pond sizing follows, as well as the printout from the storm routing for the pond, which was developed from the SEDCAD Version 4 software. Table #1 summarizes the pond design as well as answers questions in Part IV relative to embankment height, storage volume, etc. Table #2 illustrates the sediment control calculations.

TABLE #1

NPDES Discharge No.	Pond	Total Drainage Area (Acres)	Calculated Inflow from Design Storm (AC-FT)	Pit Pumpage (GPM)	Sediment Storage Volume (AC-FT)
NA	Treatment #1	95.0	13.2	100	10.0
NA	Treatment #2	48.2	16.2	NA	5.1
003	Sediment #1	79.2	12.1	NA	8.3
001	Freshwater #1	502.0	58.7	NA	NA
002	Freshwater #2	140.0	15.8	NA	NA

Pond	Total Volume Below Pool Elev. (AC-FT)	Embankment Height from Upstream Toe to Emergency Spillway (FT)	Principal Spillway	Pond Size (Acres)
Treatment #1	130.0	NA (Incised)	Open Channel	7.4
Treatment #2	75.2	NA (Incised)	Open Channel	8.6
Sediment #1	21.2	NA (Incised)	18” Pipe	2.3
Freshwater #1	119.9	NA (Incised)	24” Pipe	7.2
Freshwater #2	20.2	NA (Incised)	18” Pipe	4.3

TABLE #2

Pond	Total Drainage Area (Acres)	Year Usage	Sediment Factor (AC-FT/ACRE)	Sediment Storage (AC-FT)
Treatment #1	95	3	0.035	130.0
Treatment #2	48.2	3	0.035	75.2
Sediment #1	79.2	3	0.035	21.2

SEDIMENT CONTROL CALCULATIONS

Treatment Pond #1
Estimate 0.035 ac-ft/ac/yr, use 3 year design
Drainage area = 95 acres
Top of dam elevation = 678.0
Principal spillway elevation = 671.0
Mine Pumping = 0.44 ac-ft
Runoff = 13.2 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

(13.2) + (0.44) (10/24) + (0.035)(95)(3) = 23.4 ac-ft
Volume at pool elevation 671.0 = 130.0 ac-ft

Treatment Pond #2
Estimate 0.035 ac-ft/ac/yr, use 3 year design
Drainage area = 48.2 acres
Top of dam elevation = 683.0
Principal spillway elevation = 674.0
Mine pumping = 0.0 ac-ft
Runoff = 16.2 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

(16.2) + (0) + (0.035)(48.2)(3) = 21.3 ac-ft
Volume at pool elevation 674.0 = 75.2 ac-ft

Sediment Pond #1
Estimate 0.035 ac-ft/ac/yr, use 3 year design
Drainage area = 79.2 acres
Top of dam elevation = 679.0
Principal spillway elevation = 673.0
Mine pumping = 0.0 ac-ft
Runoff = 12.1 ac-ft from SEDCAD Version 4 program

Volume required is the required storm storage plus mine pumping for 10 hours plus drainage area runoff times the sediment factor.

(12.1) + (0) + (0.035)(79.2)(3) = 20.4 ac-ft
Volume at pool elevation 673.0 = 21.2 ac-ft

CULVERT DESIGN CALCULATIONS

The following summarizes the design of the pipe culverts to be installed as part of the mining operation within the permit area.

The following table summarizes the design for the various culverts. Culvert sizing was done using SEDCAD Version 4 software. Culvert locations are indicated on the *Surface Drainage Map, Map D.* Details on the collector ditches are shown on *Collector Ditches #1, #2, #3 & #4 Plan, Profile & Cross Sections, Map P-4* and *Collector Ditches #5, #6, #7 & #8 Plan, Profile & Cross Sections, Map P-5*. Details on the haul roads are shown on *Haul Roads #1, #2, #3 & #4 Plan, Profile & Cross Sections, Map HR-1*.

Culvert Location/Number	Total Design Flow (CFS)	Design Headwater Depth (FT)	Culvert Size
Collector Ditch #4 Sta. 2+88 to 3+38	**6.9**	**1.9**	**18”**
Collector Ditch #5 Sta. 4+40 to 5+35	**7.5**	**1.9**	**19”**
Collector Ditch #6 Sta. 13+68 to 14+00	**25.0**	**2.8**	**36”**
Treatment Pond #1 Spillway Ditch Sta. 3+90 to 4+40	**14.9**	**2.1**	**36”**
Collector Ditch #7 Sta. 0+52 to 1+40	**4.0**	**1.4**	**18”**

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-3A3

ROOF OVERBURDEN, PILLAR AND FLOOR CONDITIONS FOR THE ALLERTON COAL RESERVE

ROOF OVERBURDEN, PILLAR AND FLOOR CONDITIONS FOR THE ALLERTON COAL RESERVE

VERMILION COUNTY, IL

Prepared for: Mr. Sam Elder
Sunrise Coal, LLC
1183 East Canvasback Drive
Terre Haute, IN 47802

Prepared by: Gennaro G. Marino, Ph.D., P.E.
Abdolreza Osouli, Ph.D.

Date: May 11, 2012

MARINO ENGINEERING ASSOCIATES, INC.
1101 EAST COLORADO AVENUE
URBANA, ILLINOIS 61801
217-384-2288

Attachment IV-3A3

May 11, 2012

MEA is a leading expert in mine subsidence engineering. With over 31 years of experience, MEA's staff has provided services across the full scope of mine subsidence engineering, including significant work in research, site subsidence studies, mine stability design and failure analyses, prediction of subsidence displacement and damage potential, subsidence damage evaluation, repair design, and mine grouting design and monitoring. Being foremost in this field, MEA staff have authored over 70 publications on related topics and have worked in coal fields across the U.S.

MEA has also been hired by mining companies and others to provide consulting services on active or new operations for both room-and-pillar and longwall mining in addition to low to high extraction old works. These services are included in those listed above. Because of the amount of coal mining related work MEA has done, it has designed and developed a cross-hole radar to detect mine voids for cases where mining may exist.

Having worked extensively on old coal mines and both low and high extraction active mines, MEA is uniquely qualified and separates itself from other geotechnical and mining engineering companies across the U.S. MEA also has expertise in a full scope of services in geotechnical and pavement engineering, as well as construction material testing and monitoring.

Attachment IV-3A3

May 11, 2012

-PREFACE-

This report was prepared for and is the property of Sunrise Coal Company, LLC and cannot be used in any fashion without their permission.

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May 11, 2012

1.0 INTRODUCTION

At the request of the Sunrise Coal Company, Inc., MEA has conducted a geotechnical investigation of the allowable pillar strength and bearing capacity of the mine floor and in turn the allowable extraction conditions for the Allerton Reserve which is located between Homer and Allerton in Vermilion County, IL (see Figure 1.1).

The scope of work for this project included the sampling and testing of the coal and floor materials to determine their composition and engineering properties. This data was used to assess the range of floor profile conditions and representative rock mechanics properties of the various floor materials. Laboratory testing was performed by both Mr. E. Sprouls, P.E., and MEA. The vast majority of the retrieved core was logged by C. Hutchison. Using the lab data and geologic hole conditions, the floor stratigraphy was determined and analyzed for bearing strength across the application area. Because the dominant mode of long term instability is the mine floor, the analysis in this report focuses on this mechanism of failure. The pillar strength was also checked herein. It should be noted that roof stability in rooms is not discussed in this report. Because the mine depth will be greater than 245 ft room-roof, collapse resulting in surface subsidence is not expected.

In the following section, the coal and floor geology across the coal reserve is discussed. In Section 3, rock mechanics properties of the coal and floor are summarized. Then using the data discussed in Sections 2 and 3, the allowable floor bearing strength across the reserve is analyzed in Section 4. In Section 5, a similar analysis is performed for the coal pillar. Using the allowable capacities in Sections 5 and 6, the critical stability design requirements across the reserve are given in Section

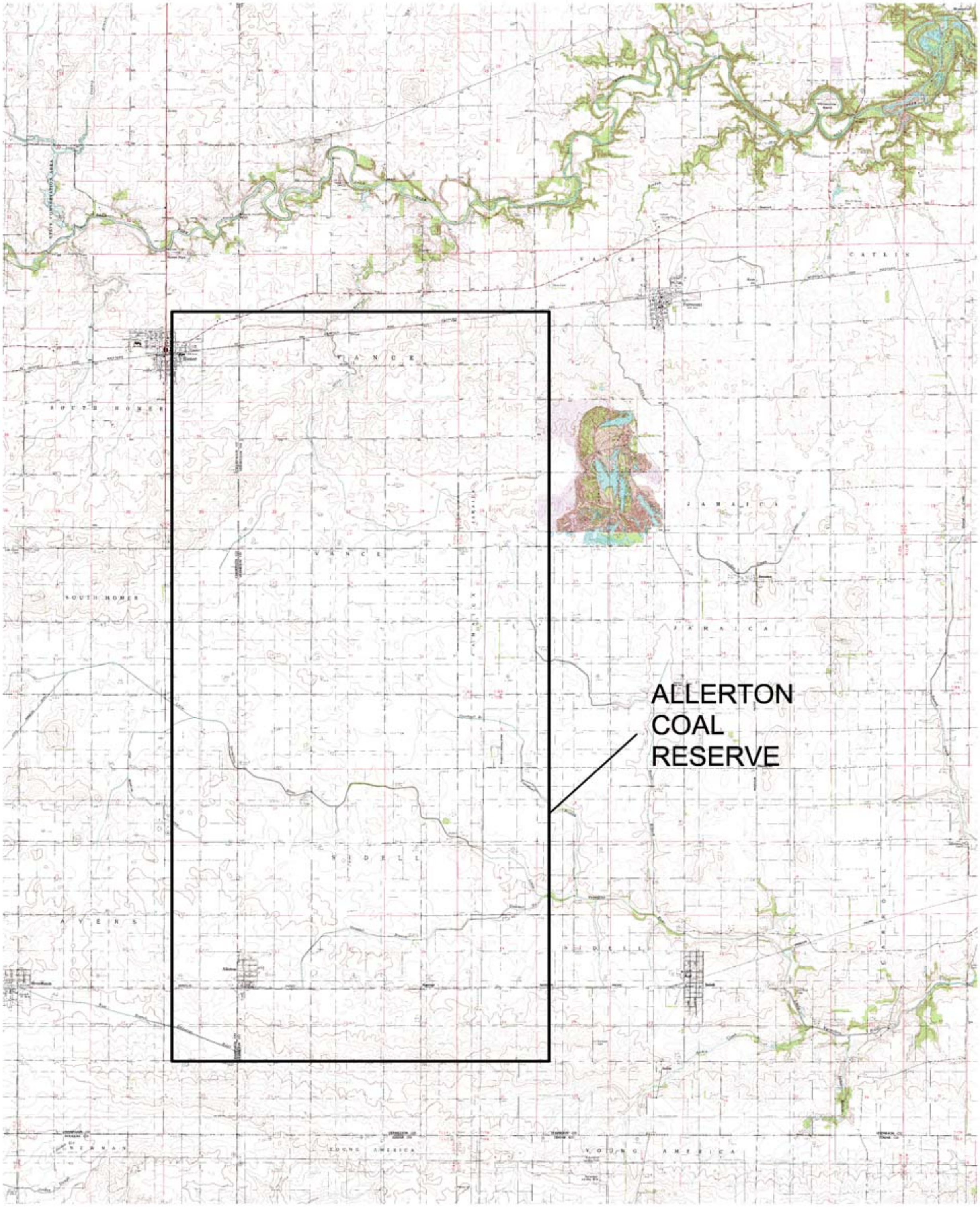

FIGURE 1.1 LOCATION OF ALLERTON COAL RESERVE

7. The following sections consist of the summary and conclusions of this investigation (Section 8) and the references (Section 9). A comprehensive table with the available floor information on a hole to hole basis is provided in Appendix A. Swell test results and associated particle size distributions from lab tests run on the immediate fine-grained floor material are given in Appendix B.

2.0 COAL AND FLOOR GEOLOGY

2.1 Regional Geology

The Allerton Coal Reserve is associated with the Illinois Basin. The Basin (formed from layers of rocks) includes all of the central and southern parts of the state (see Figure 2.1). Regional arches, shelves, and dome-like features are present in the Illinois Basin. Structure within the basin is shown in Figure 2.2 and consists mostly of anticlines and synclines which are typically wide and gentle, with dips of 1 to 2 percent. As can be seen in Figures 2.1 and 2.2, the site is situated between the LaSalle Anticline Belt to the west and the Marshall Syncline to the east. No significant faults are present in the project area. Along the LaSalle Anticline, however, strata dip is on the order of 20 percent. The deepest part of the basin sediment is present at the southeastern end of the state where most of the formations thicken. In most places the regional dip of the formations are extremely gentle at 10 to 30 feet/mile.

The Pennsylvanian system is the youngest large bedrock system in the Illinois Basin. Within the Pennsylvanian System is the Carbondale Formation which contains four major coal members. These coal seams make up 92 percent of the coal in the Pennsylvanian System. Units (or coal measures) of the Carbondale Formation extend over wide areas. Abrupt lateral changes exist, however, where sandstone occupies erosion channels. Figure 2.3 shows a generalized geologic column.

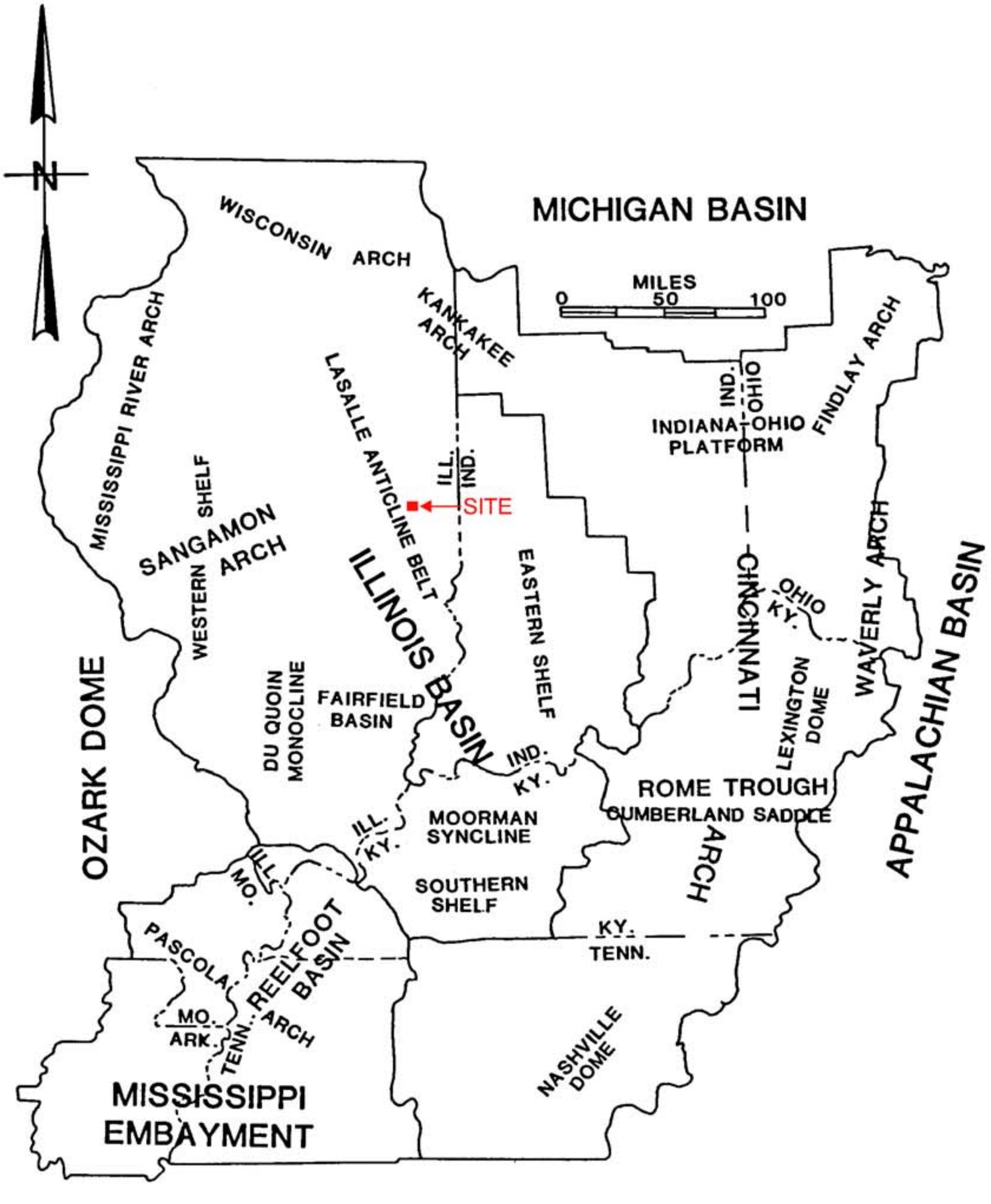

FIGURE 2.1 STRUCTURAL FEATURES OF THE EASTERN INTERIOR REGION (SPECK, 1979)

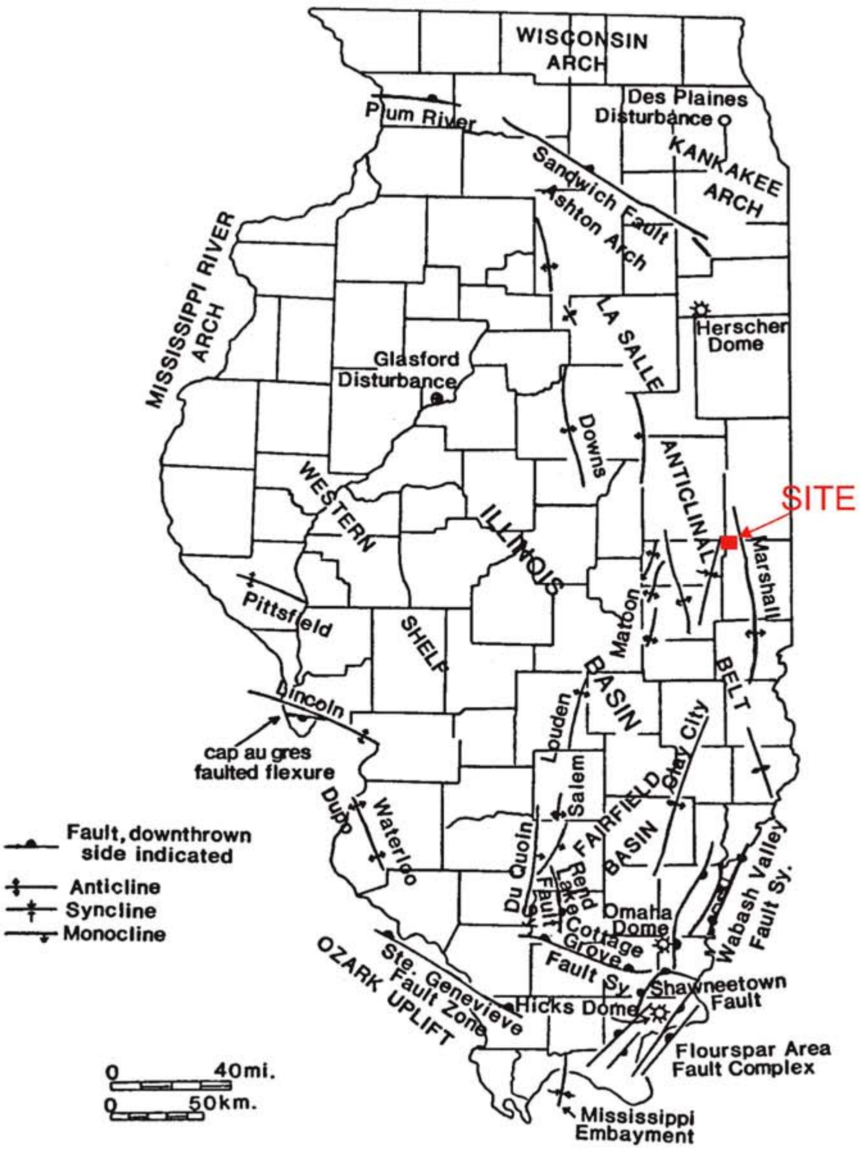

FIGURE 2.2 STRUCTURAL FEATURES WITHIN THE ILLINOIS BASIN (KRAUSSE, ET AL., 1979)

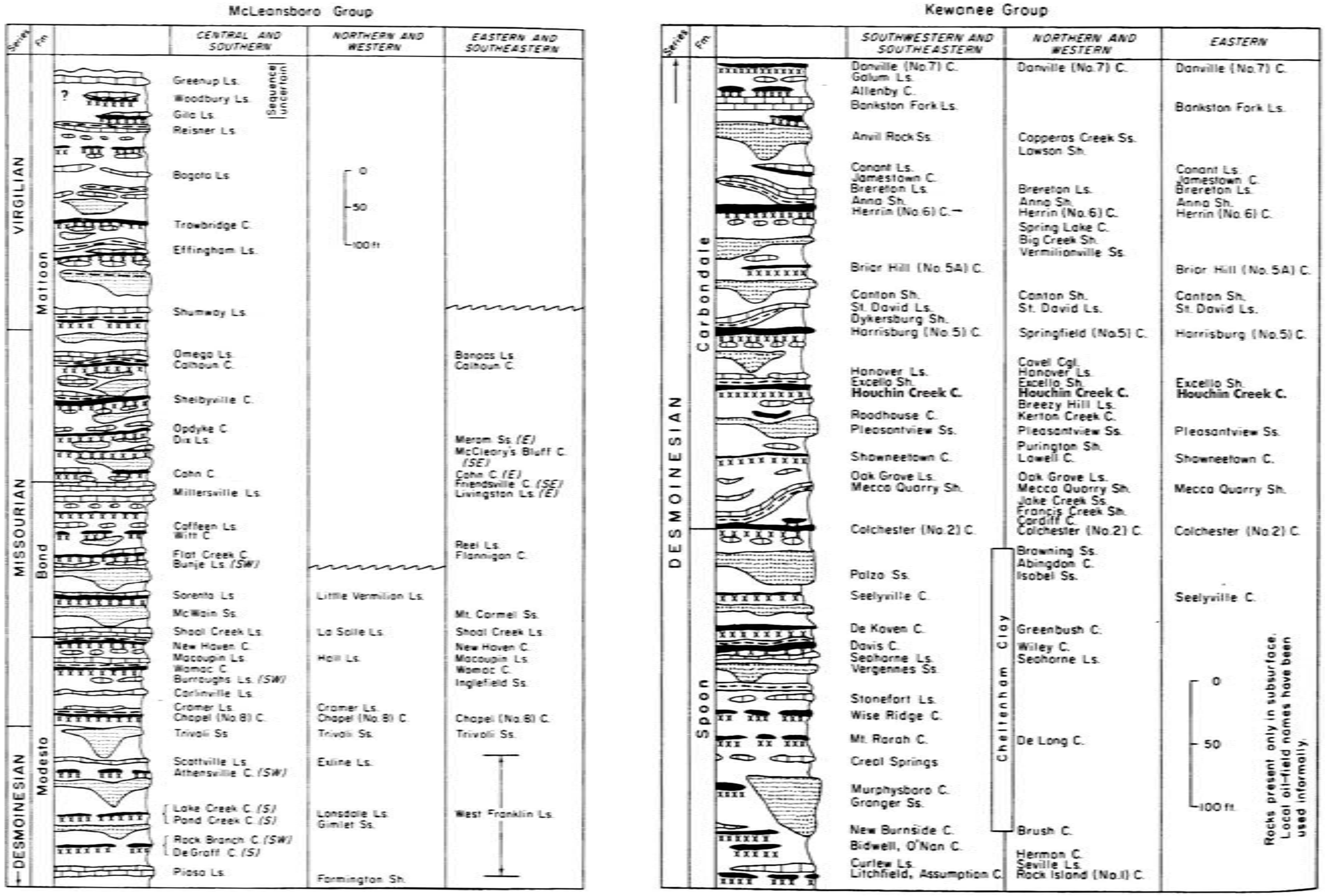

FIGURE 2.3 GENERALIZED GEOLOGIC COLUMN (Kosanke, et al., 1960)

The coal measures have been deposited in cyclothems[1] and consist of mostly clastic rocks[2]. Therefore, vertical lithologic changes are common. The coal measure rocks are primarily sandstone, siltstone, claystone and shale which make up 90 to 95 percent of the formation while less than 2 percent is comprised of coal, underclay and limestone. More than fifty cyclothems have been discerned in the Illinois Basin.

Across the state this seam is deeper than 1000 ft in the Fairfield Basin (see Figure 2.2). However, Herrin No. 6 occurs at depths of typically 330 to 380 ft below ground surface on the project site. On the periphery of the Basin outcrops of the Herrin and other coal seams can be found. The Herrin No. 6 Coal is named after Herrin, Illinois where the coal was extensively mined by 1912 (Willman, et al., 1975). Coal seam thicknesses are typically up to 8 ft and are relatively constant over large parts of a region.

The dip of the Herrin No. 6 seam across the reserve investigated very generally dips to the east toward the Marshall Syncline (see Figure 2.2). This dip is roughly 6-20 ft/mile across the application area.

The bedrock surface is covered by varying thickness of glacial deposits from the Quaternary period. Glaciation covers most of Illinois with deposits typically up to 50 ft thick and over 200 ft in thickness in buried bedrock valleys. Sediments of the Wisconsinian stage predominantly exist in the northeast to east central Illinois. Illinoisian glacial deposits cover 90 percent of Illinois, and are extensive in the west and to the south of the limit to the Wisconsin movement. These Illinoisian and Wisconsinian

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[1] Cyclothems are a series of beds deposited during a sedimentary cycle of the type that prevailed during the Pennsylvanian Period. Nonmarine sediments, often including bituminous coal, commonly occur in the lower half of a cyclothem, while marine sediments in the upper half. Most cyclothems are incomplete.

[2] Clastic rock means a sedimentary rock composed principally of fragments derived from pre-existing rocks and transported mechanically to their own places of deposition; eg. sandstone, shale.

deposits are covered with widespread Wisconsin loess. Pre-Illinoisian deposits are irregularly distributed and of unknown extent in Illinois. The soil cover above the reserve area typically ranges from 20 ft to 85 ft.

2.2 Subsurface Investigation Program

The locations of the borings drilled in and around the Allerton Coal Reserve are shown in Figure 2.4. A total of 44 borings are shown. The logging of the coal measures geology to this point had been performed by Mr. C. Hutchison, Sunrise Coal, LLC. All of the holes were drilled by Sunrise Coal, LLC except SA-29, SA-31, SA-39, SA-42, SA-88, SA-89, SA-91, SA-92, and SA-93, which were drilled by Magnum Drilling Services of Evansville, Indiana. SA-2, SA-4, and SA-5 were drilled in November 2009. SA-12 to SA-63 were drilled from April 14, 2010 to December 9, 2010. SA-67 to SA-97 were drilled from June 15, 2011 to October 28, 2011. Of the holes drilled by Magnum Drilling Services, SA-29, SA-31, SA-39, and SA-42 were drilled May to June 2010 and SA-88, SA-89, SA-91, SA-92, and SA-93 were drilled in October 2011.

To provide a better understanding of the floor conditions, a few of the holes were relogged and analyzed further by MEA. Rock mechanics testing of floor material were conducted by Mr. E. Sprouls, P.E. and MEA.

The core was logged for recovery length (rate of recovery), fractures, lithology, hardness, and other pertinent details. Also, on some of the core, Rock Quality Designation (RQD), Recovery rates, and Rock hardness were determined by Sunrise drillers. In the later holes cored, the hardness was based on the AASHTO Classification System. The AASHTO rock hardness classification is given in Table 2.1.

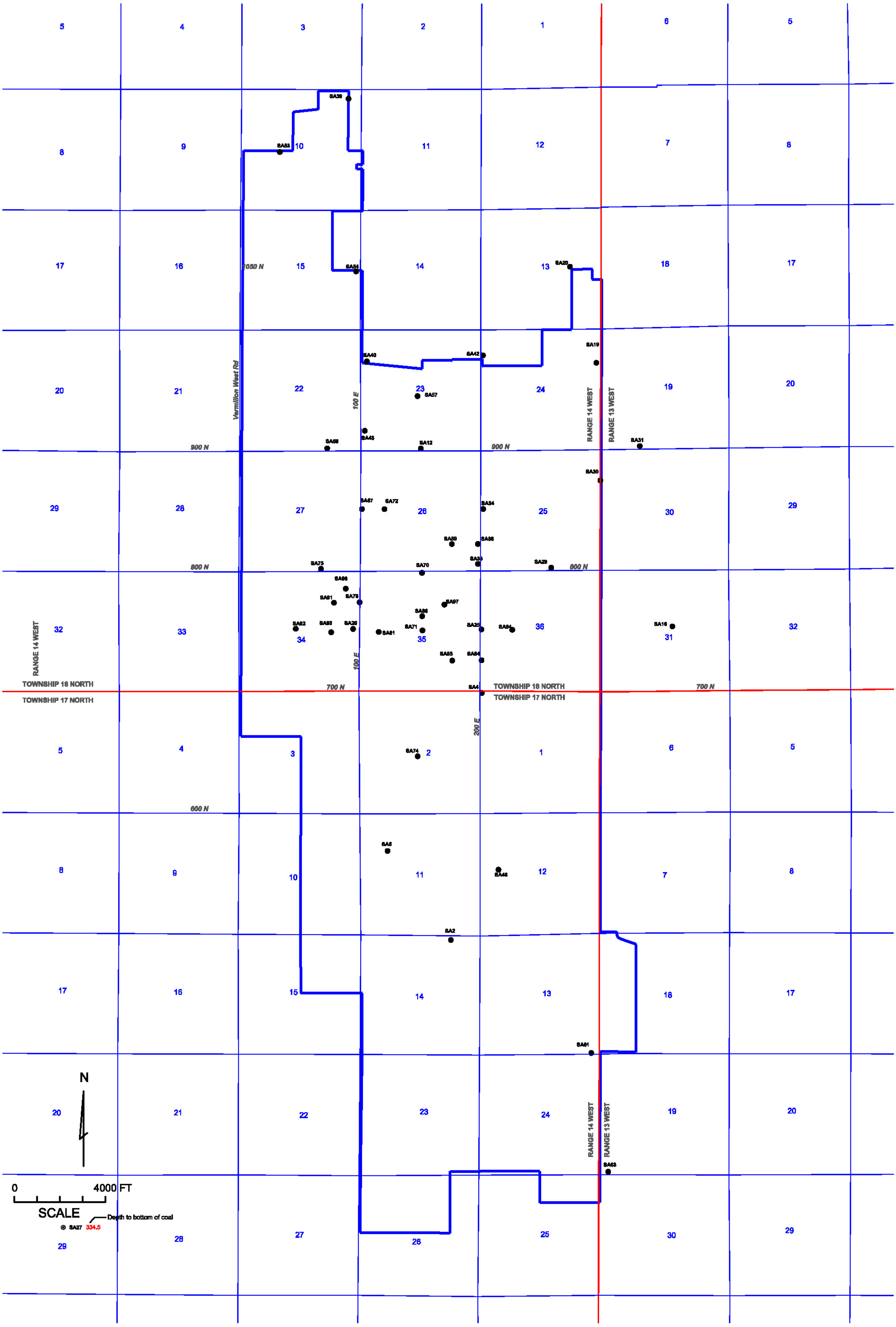

FIGURE 2.4 BORING LOCATION PLAN

Attachment IV-3A3

TABLE 2.1 AASHTO ROCK HARDNESS CLASSIFICATION[1]

Very Hard	Cannot be scratched by knife or sharp pick. Breaking of hand specimens requires several hard blows of the geologists pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimen.
Moderately Hard	Can be scratched by knife or pick. Gouges or grooves to 6 mm (0.25 inch) deep can be excavated by hand blow or point of geologists pick. Hand specimens can be detached by moderate blows.
Medium	Can be grooved or gouged 2 mm (0.05 inch) deep by firm point. Can be excavated in small chips to pieces about 25 mm (1 inch) maximum size by hard blows of the point of a geologists pick.
Soft	Can be gouged or grooved readily by knife or pick. Can be excavated in fragments from chips to several inches in size by moderate blows of a pick point. Small, thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1 inch or more in thickness can be broken by finger pressure. Can be scratched readily by fingernail.

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[1] Manual on Subsurface Investigation, Published by the American Association of State Highway and Transportation Officials, Washington, D.C., 1998.

2.3 Rock Classification

In order to determine the actual floor bearing conditions across the site, it was necessary to determine in the lab the detailed makeup of the various floor strata and their relevant characteristics. Because of the moisture sensitivity of the immediate floor, the most significant rock descriptions made in the lab were of rock plasticity and durability.

Classification, as it relates to rock plasticity and durability of the clastic floor material is difficult, if not impossible, to ascertain from mere visual or brief tactile inspection. These characteristics can only be estimated based on visual and textual observations on the slaked rock after submersion. Also, rock type adjustments can be made based on representative samples tested for Atterberg Limits or based on the estimated Liquid Limit of the rock in a moisture softened state. The Liquid Limit boundaries given in Table 2.2 denote changes in rock type are based on equivalent increments of residual strength as it empirically relates to the Liquid Limit (Marino and Osouli, 2012). This relationship is shown in Figure 2.5. It is important to note that depending upon the actual fine-grained rock type, there is a considerable difference in the resulting shear strength at confining pressures expected below the pillar. With no discernible difference in appearance, the shear strength for a silty mudstone is 2 to 3 times that for floor material classified as a claystone.

Floor durability observations were made on submersed floor samples. These observations were used to determine the DuroIndex of the submerged samples (Marino and Osouli, 2012). These durability classifications are given in Table 2.3.

Using the above criteria, the floor core was reclassified. Field logs were modified by MEA based on laboratory rock classification of the floor materials for Borings SA-57,

TABLE 2.2 ROCK CLASSIFICATION BASED ON ROCK PLASTICITY

	LIQUID LIMIT
SILTSTONE/SANDY SHALE	28%
SILTY MUDSTONE/SILTY SHALE	29 to 40%
MUDSTONE/SILTY CLAYEY SHALE	>40 to 50%
CLAYSTONE/CLAYEY SHALE	>50 to 100%
FINE GRAINED CLAYSTONE	>100%

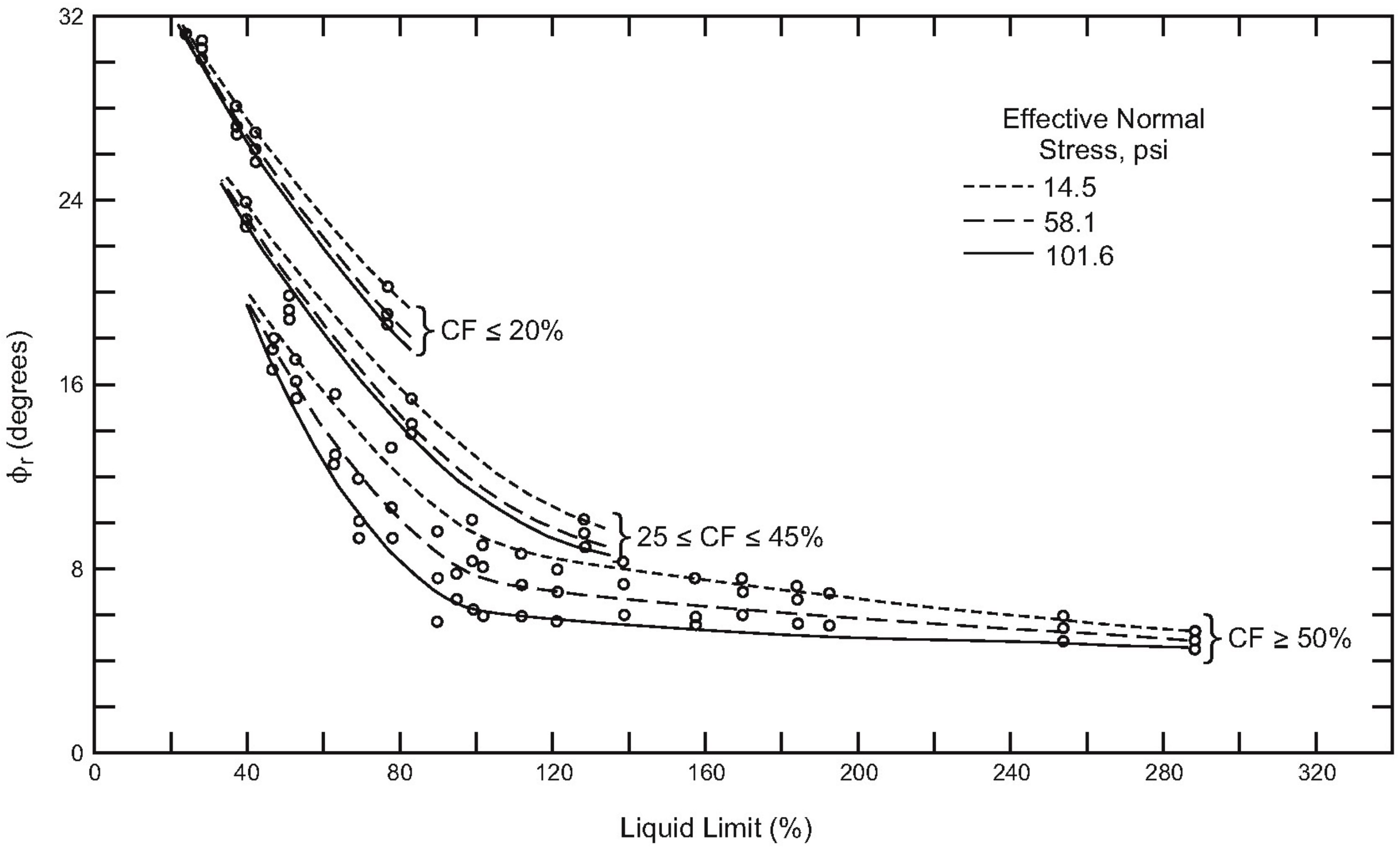

FIGURE 2.5 RESIDUAL FRICTION ANGLE VERSUS LIQUID LIMIT FOR VARIOUS SOILS AND ROCKS (Terzaghi, Peck and Mesri, 1996)

TABLE 2.3 DUROINDEX CLASSIFICATION

Very Non-durable (V.N.D.) - rapid complete disintegration in water within 15 minutes

Non-Durable (N.D.) - complete disintegration in water for 24 hrs or more

Moderately Non-Durable (mod. N.D.) - fragmental breakdown in water with only trace of sample less than fine gravel size for 24 hrs or more

Slightly Non-Durable (sli. N.D.) - separation along partings (this may be found to exist in the rock core which exhibits fissile cracking resulting in core discs some as thin as 0.02 ft or less) or full-body cracking resulting in sound particles, all greater than fine gravel size in 24 hrs or more

Durable (D) - remains intact and sound upon submersion with only 1-2% of the entire sample broken down in 24 hrs or more

Notes:

1. Submersion of coarse gravel-sized or greater rock samples in water but no greater than 1 inch thick of 2-4 in. diameter rock core.
2. This classification testing is done from just exposing rock to soaking. The rock specimen should be placed in the bowl of water where the vertical axis of the core is horizontal (or the plane of deposition is made vertical).
3. Particles are judged to be sound, if they are difficult to break between fingers.
4. Trace is defined as up to 10% by weight of the whole sample.

SA-67, SA-70, SA-71, SA-74 to SA-75, SA-78, SA-81, SA-85 to SA-86, SA-89, and SA-91 to SA-93. Based on this data and core logs provided to MEA, rock classification at the remaining holes was approximated. To assess the hole to hole classification, a detailed spreadsheet depicting all the available data was prepared and is provided in Appendix A. Moreover, to clarify floor material descriptions there was extensive communication with Mr. C. Hutchison.

2.4 Herrin No. 6 Coal

From borings drilled to date, the depth to the Herrin No. 6 Coal ranged from 318 ft to 383 ft (typically from 344 to 377 ft). Much of the project area contains 5 to 7 ft of coal. However, in the northern half of the application area, the coal appears to be on average about 1 ft thicker than the southern half.

2.5 Floor Profile

Based on the boring and laboratory information available, the floor stratigraphy across the reserve was analyzed. This is an important assessment as it is directly related to determining the actual allowable floor bearing. In comparing the variation in floor support across a reserve, the floor capacity for the most resistant floor conditions can be 2 times or more than the least resistant. Therefore, the most cost effective means to support the proposed room and pillar mine is to accommodate the important variations in the floor geology. Conventional design methods, however, assume some arbitrary “average” floor condition which results in under-designed and over-designed areas and therefore areas of both active and abandoned works from more significantly exposed to pillar punching.

The coal measures relative to this floor study are below the Herrin No. 6 Coal. A general geologic column showing the various geologic names of the rock beds is shown in Figure 2.3. Over much of the application area, the most immediate floor material consists of a gray mudstone to silty mudstone (MS-$MS) as defined in Table 2.2 based on rock plasticity testing. Changes in gradation or rock plasticity laterally or with depth are impossible to discriminate from visual and brief textural characteristics. But, based on more detailed laboratory testing, it was found that the range in rock plasticity was relatively limited. All of these fine-grained rocks were found to be non-durable and weak.

The depth of this fine-grained rock unit is more typically 2 to 10 ft but can more locally reach 13 ft or more. These fine-grained rocks, in addition to being significantly moisture sensitive (i.e. non-durable), are weak even when fresh. Also present in the unit are intermittent beds of limited thickness of mainly limestone, shale, and carbonaceous shale. In most instances, these rocks were found to be durable and of higher strengths, but significantly less in quantity and thickness.

The weak fine-grained floor rock is soft to medium hard which is locally found to be slickensided with a varying amount of limestone nodules. Based on the rock cores retrieved to date and discussions with C. Hutchison, the slickensided zones appear isolated/localized. The presence of slickensides significantly reduces the field strength of even fresh fine-grained rocks.

In addition to assessing the geotechnical properties of the most immediate fine-grained rock layers, it is important to classify and determine the depth and thickness of the first resistant (durable) rock zone as this layer(s) can restrict shearing in the floor and consequently increase the overall bearing capacity. Furthermore, a sufficiently thick durable zone will mitigate the deterioration of underlying non-durable materials. A durable rock zone was identified as a rock layer(s) which has a cumulative thickness of greater than about 2 ft and is of sufficient laboratory tested durability. In other words, floor materials which make up the durable zone do not lose significant strength when exposed to moisture under nominal vertical pressure in the room and under the pillar.

It is important to note that the estimates of the geologic-geotechnical conditions are based on the available data given in this report. Because in certain areas of the reserve the data is either absent or scarce, these conditions can only be speculated. It appears, however, there is sufficient information to approximate the range of floor conditions present.

The first resistant floor strata appears to be essentially a limestone, silty shale or sandstone unit. The deeper sandstone unit may be only locally relevant when the shallower limestone or shale units were not present. The limestone and shale units appear to be most prevalent in the central and southern areas, respectively, of the application area.

The limestone unit, below the MS-$MS, basically consists of a hard, light gray to gray limestone which can contain silty to sandy facies interbedded or intercalculated with some medium to moderately hard silty shale. The individual limestone beds are typically 0.5 to 2.5 ft in this unit. Although there are alternate beds of limestone and shale in places, the unit generally becomes more shaley with depth. The unit thickness is typically 2 to 4 ft when mudstone to silty mudstone underlies this unit. Where the MS-$MS is not present, interbeds of mainly gray silty shale followed by fine-grained sandstone exists below the limestone unit. With these materials present, the total thickness of resistant strata can reach more than 8 ft.

In other areas across the reserve, the most immediate resistant floor unit below the No. 6 Coal is basically a gray, medium to moderately hard, silty shale which can also be sandy in places This unit can be present immediately beneath the coal to a depth of about 7 ft where it is overlain with MS-$MS. Also, the carbonaceous zone which is below the limestone unit appears present, at least in places, within the shale unit, but is slightly shallower.

Where the limestone or shale resistant units are not present, the mudstone-silty mudstone extends to deeper depths below the No. 6 Coal. This would result in the lower gray, moderately hard, fine-grained sandstone unit being the most immediate resistant material. Obviously, given the MS-$MS thickness, this is the worst floor bearing condition.

3.0 GEOTECHNICAL PROPERTIES OF THE HERRIN NO. 6 COAL AND MINE FLOOR

3.1 Scope

The Herrin Coal was tested for uniaxial compression strength. More importantly, however, rock mechanics testing was performed on the floor core in order to assess the appropriate bearing conditions across the reserve. This testing included the determination of moisture contents (MC) (ASTM D-2216) with depth, slake durability (SD) (ASTM D-4644), DuroIndex (DI) (followed the specifications outlined in Table 2.3), Atterberg Limits (ASTM D-4318), swell characteristics (in general, in compliance with ASTM D-4546 except for loading sequence to accommodate the maximum swell pressure through free well phase), clay fraction (CF) (ASTM D-1140), indirect tensile strengths (ITS) (ASTM D-3967), point load strengths (PLS) (ASTM D-5731) and uniaxial compression strengths (UCS) (ASTM D-2938). All the ITS and some of the MC, Atterberg Limits and UCS tests were conducted by Mr. E. Sprouls from November to December, 2009 for SA-2, SA-4, and SA-5; from April 2010 to January 2011 for SA-12 to SA-63; and from June to November, 2011 for SA-67 to SA-97. All other tests were conducted by MEA. Of these tests, MC, AL, DI, and PLS tests were conducted from July 2011 to January 2012 except the tests on samples of SA-57 which were conducted from October to November 2010. Swell tests and clay fracture tests were conducted from January to April 2012. All the laboratory data, except the swell related data was compiled in a summary table on a per hole basis and are given in Appendix A. The swell related data is provided in Appendix B.

3.2 Herrin Coal Strengths

The Herrin Coal was tested for uniaxial compression by Mr. E. Sprouls. The strength results are provided in Table 3.1. The UCS of coal samples ranged from 548 psi to 6,856 psi and averaged 2,094 psi for 71 samples tested.

3.3 Floor Properties

The moisture content, Atterberg Limits, unconfined compression strength, clay fraction, indirect tensile strengths, and point load strengths for each floor rock unit are summarized in Table 3.2.

The most prominent fine-grained rocks in the immediate floor are silty mudstone to mudstone. The Liquid Limit for these fine-grained rocks ranges from 31% to 52% with an average of 41%, indicating the unit description of mudstone to silty mudstone (MS-$MS) based on Table 2.2. Within one standard deviation, the liquid limit and plasticity index for this fine-grained unit only range from 36% to 46% and 16% to 27% respectively, across the application area. The moisture contents in MS-$MS range from 1.5% to 12.9% with an average of 6.1% (see Table 3.2). Obviously MC in the range of 1% to about 4% were mainly limestone nodules in the MS-$MS. Removing these tests, the average MC becomes 6.4%. The mudstone to silty mudstone rocks have an average unconfined compression strength of about 1,465 psi. The strength appeared greater in core described as containing more than 50% limestone nodules. The only two indirect tensile strengths show an average strength value of 250 psi for silty mudstone. This strength was consistent with the average axial PLS of 52 psi when considering the ITS being 5 times the PLS. This strength ratio was found to be the best fit for the silty shale roof.

TABLE 3.1 HERRIN NO. 6 COAL UNIAXIAL COMPRESSIVE STRENGTHS

E. SPROULS TESTS RESULTS

Hole #	Run #	Depth (ft.)	Strength[1] (psi)
SA-4	4	354.00	2175
SA-4	4	355.80	1593
SA-4	4	357.50	1693
SA-5		345.00	1697
SA-5		347.00	1069
SA-5		349.00	976
SA-5		351.00	6856
SA-12	3	356.70	1905
SA-12	3	358.70	1664
SA-12	3	361.20	1259
SA-16	4	377.90	1785
SA-16	4	379.90	3130
SA-16	4	382.00	1429
SA-19	3	354.00	2210
SA-19	3	357.00	1482
SA-19	3	359.50	1973
SA-20		363.00	2925
SA-20		365.20	1586
SA-20		367.50	1530
SA-26	4	368.00	2684
SA-26	4	370.70	630
SA-26	4	373.50	2153
SA-29	4	382.80	3045
SA-29	4	384.20	2507
SA-29	4	356.50	1501
SA-30	3	366.80	1919
SA-30	3	368.80	2748
SA-30	3	370.70	1941
SA-31	2	346.20	2847
SA-31	2	348.20	2075
SA-31	3	349.90	963
SA-33	3	372.00	3364
SA-33	3	374.30	2181
SA-33	3	376.70	3421
SA-39		321.00	1537
SA-39		323.00	2309
SA-39		325.00	1530
SA-40		333.60	2733
SA-40		335.60	3265
SA-40		337.60	2705
SA-42	3	350.20	2394
SA-42	3	352.00	864
SA-42	3	354.00	1041
SA-43	4	356.70	2387
SA-43	4	360.10	1352
SA-43	4	361.50	2036
SA-46	3	368.50	2118
SA-46	3	370.50	2082
SA-46	3	372.60	2868
SA-54	3	334.20	1523
SA-54	3	336.40	1584
SA-54	3	338.60	548
SA-61		373.20	2749
SA-61		374.60	1310
SA-61		376.00	2885
SA-63	2	328.20	4030
SA-63	2	330.20	2783
SA-63	2	332.20	2380
SA-72	2	357.00	1969
SA-72	2	359.50	667
SA-72	2	362.00	1664
SA-94	1	367.50	2620
SA-94	2	370.00	1296
SA-94	2	373.00	1756
SA-96	3	365.50	3010
SA-96	3	367.50	1967
SA-96	4	370.50	1487
SA-96	4	371.50	2276
SA-97	3	376.00	1655
SA-97	3	378.30	2323
SA-97	3	381.00	2027

[1] Coal Strengths are for an L/D equal to one.

TABLE 3.2 PHYSICAL AND ENGINEERING PROPERTIES FOR VARIOUS FLOOR ROCK TYPES

Rock Unit	Liquid Limit (%)	Plasticity Index (%)	Clay Fraction[3] (%)	Unconfined Compression Strength (psi)	RQD (%)	Indirect Tensile Strength (psi)	Point Load Strength (psi)		Natural Moisture Content (%)
							Dia.	Axial	
Mudstone to Silty Mudstone	41 31-52 (28)	21.7 10.5-32 (28)	29.2 27.5-30 (3)	1465.2 258-3436 (10)	52[1] 0-83 (6)	248.5 201-296 (2)	4.4 <0.6-21.2 (11)	52.2 22.3-107.1 (6)	6.1 1.5-12.9 (323)
Limestone	-	-	-	3083 398-8608 (7)	-[2]	680 (1)	-	10.9 (1)	3.9 0.9-6.4 (31)
Shale	-	-	-	2530.3 322-6374 (6)	67[2] 39-83 (7)	-	20.5 6.3-34.7 (2)	235.2 (1)	4.9 3.0-8.3 (42)
Sandstone	-	-	-	-	76[2] 69-83 (2)	-	-	-	5.0 2.1-7.4 (10)

[1] RQD values are given for core runs which contain 90% or more of the MS-$MS unit

[2] RQD values for core runs for all floor materials. The holes which contain 30% or more of this unit were considered

[3] Clay defined by particle sizes no more than 0.002 mm

Notes:

41 – average
31-52 – range
(28) – number of measurements

Rocks were also tested in stronger, durable zones logged as limestone, nodular limestone, silty to sandy shale with lenses of sandstone and sandstone (see Table 3.2). The average MC for limestone and shale units were 3.9% and 4.9%, respectively. For both the limestone and shale floor materials there are some higher moisture contents than expected (see Table 3.2). These moistures are the result of the presence of argillaceous or clay content in some of the selected samples. The uniaxial compressive strength (UCS) for the limestone ranges from 398 to 8,608 psi (ave. 3,083 psi). The UCS ranged from 322 to 6,374 psi and averaged 2,530 psi for the floor shales. These floor shales were clayey, silty and sandy, and carbonaceous in places. Where the shale unit has clayey material, the UCS is 4 to 5 times less than sandy shales. Similar strength variation exists in the limestone which can contain fine-grained intercalations. The limestone and shale units were determined to be resistant layers, except where clayey non-durable materials were present. Rocks with significant clay or argillaceous content are not sufficiently resistant or durable and were not considered as such in floor stability analyses.

For the sandstone unit, the measured moisture contents ranged from 2.1% to 7.4% with an average of 5.0%. Again, the higher water contents most likely represent argillaceous facies.

The rock fracturing in the floor was also summarized. RQD[3] was measured by the driller for some of the borings provided in this report (see Table 3.2). For core runs which were in the floor, the reported RQD ranged from 0 to 98% with an average of

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[3] The Rock Quality Designation (RQD) is the percent of the total length of sound rock core which is of a length of 4 in. or more bounded by natural fractures (not core breaks) of the core run, or some identified core length (Deere, 1989)

73%. The value of 0 was recorded in two holes (SA-84 and SA-85) where the MS-$MS floor core was described as soft to very soft containing significant broken zones. In core runs with more than 90% of the mudstone-silty mudstone unit, the average RQD was 52% (6 holes) with a range of 0 (next lowest 71%) to 83%. Excluding the hole with zero RQD, the average becomes 78%.

3.4 Floor Swell Properties

Much of the fine-grained floor material which is present beneath the Herrin No. 6 Coal of the project site has a severe range in mechanical properties once the coal is mined out. With little confinement and exposure to moisture, such as in mine rooms, these fine-grained rocks can have egregious swell potential and consequently reduce to a soil-like consistency. Also, in floor areas with little confinement, such as in mine rooms where expansive rocks are exposed to moisture (i.e., pooling mine water), a significant suction pressure can result. This suction in effect, in addition to rock fractures, causes moisture penetration and, consequently, can result in fairly rapid rock softening. However, with confinement such as beneath the coal pillar core, these floor materials can remain fairly intact.

From our experience in investigating the floor in a number of abandoned coal mines in the Illinois Coal Basin, these non-durable fine-grained rocks can exhibit the complete range from the fully softened to intact phase. Figure 3.1 is an example of the dramatic difference of the immediate floor moisture profiles taken in the room and below the pillar. These borings were drilled in abandoned workings in the No. 6 Coal Seam where pooled water was present on the mine floor in Vermilion County, IL.

To quantify the swell potential with applied pressure, two one-dimensional tests were performed on the floor MS-$MS in a consolidometer. The results of these tests are summarized in Table 3.3 with the swell related data given in Appendix B. Also, both swell pressure versus strain curves have been superimposed and depicted in Figure 3.2. It should be noted that each load decrement was sustained until the latter stages of secondary (or tertiary) swell before reducing the load. As can be seen in Figure 3.2, swell pressures at zero vertical strain can be higher than 500 psi with free swell strains estimated up to about 31%. Although these deformation characteristics are fairly dramatic from an engineering perspective, only nominal change in the rock's consistency (i.e. nominal straining) occurs with fairly significant reduction in load (see Figure 3.2). This has been quantified on Table 3.3 by the stress (σ_{smc}) at the point of maximum curvature of the vertical swell pressure versus vertical swell strain plot. This stress point for both samples tested was 35 and 40 psi at only 2 and 3% swell strain, respectively. For the tested rocks, the liquid limit was near the overall average for the reserve at 40% and 41% with the clay fraction at 30%. Therefore, these swell test results should be most representative of the floor materials across the mine application area. The most significant differences were related to initial dry density and moisture content which could explain why the swell pressure for the sample from Boring SA89 appears higher (see Table 3.3 and Figure 3.2).

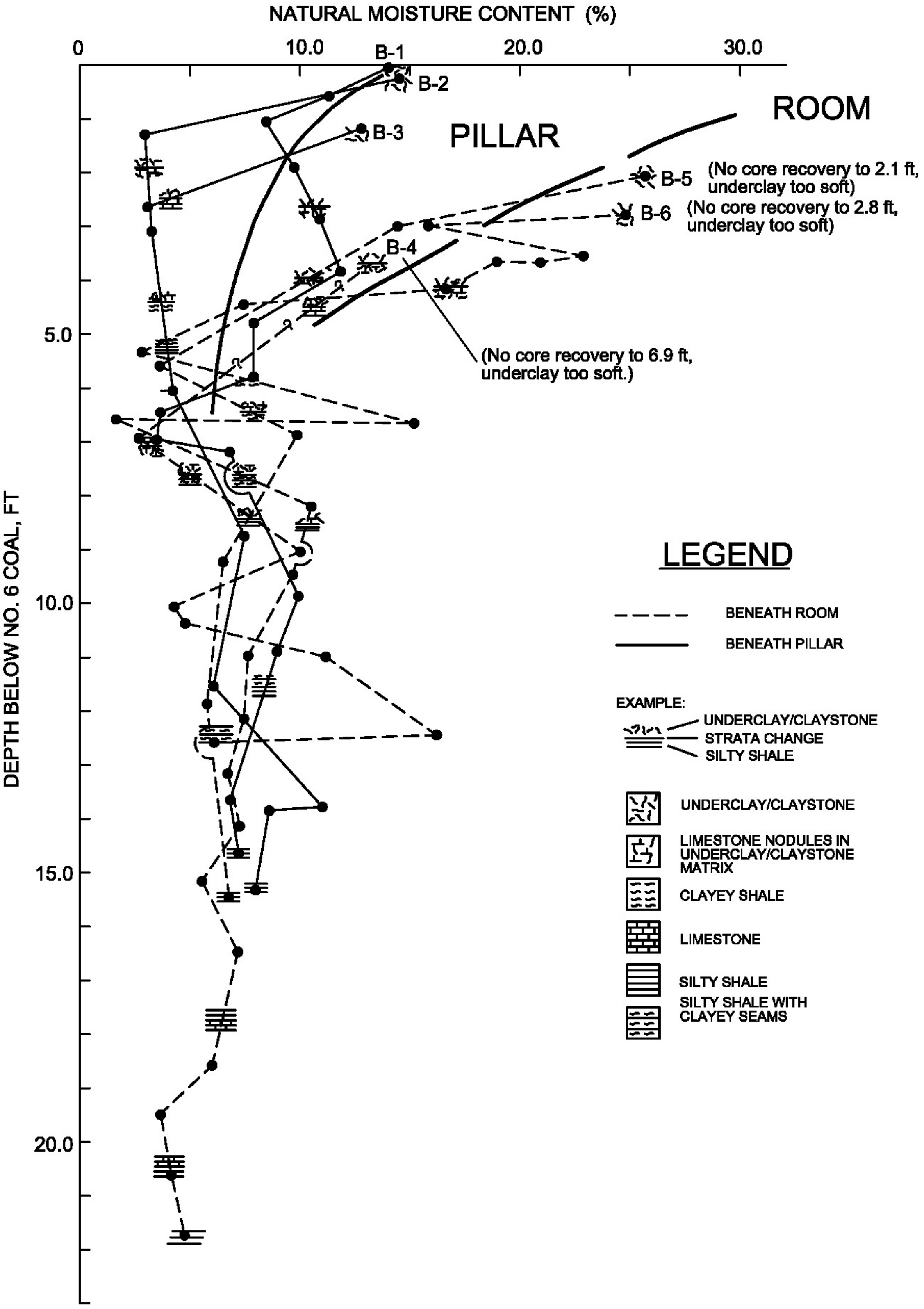

FIGURE 3.1 MOISTURE CONTENT PROFILES FOR FLOOR STRATA BENEATH PILLARS AND ROOMS FOR MINE IN NO. 6 COAL SEAM NEAR DANVILLE, ILLINOIS (MARINO, ET AL., 1982, AND MARINO AND DEVINE, 1985)

Attachment IV-3A3

TABLE 3.3 ONE-DIMENSIONAL SWELL TEST ON INTACT FLOOR SAMPLES

Sample	LL (%)	PI (%)	CF (%)	MC_i (%)	DD_i (pcf)	σ_{smax} (psi)	σ_{smc} (psi)	ε_{smax} (%)
SA-75, 383.8 ft	40	23	30	5.3	141.3	525	40	21
SA-89, 391.6 ft	41	23	30	4.3	149.0	>350	35	31

Definitions:

CF = percent clay fraction where clay particles are defined by particle sizes of 0.002 mm or less

DD_i = Dry Density

σ_{smax} = swell pressure at zerio strain

σ_{smc} = low strain swell pressure at point of maximum curvature of vertical swell pressure versus strain

ε_{smax} = maximum swelling strain at nominal pressure

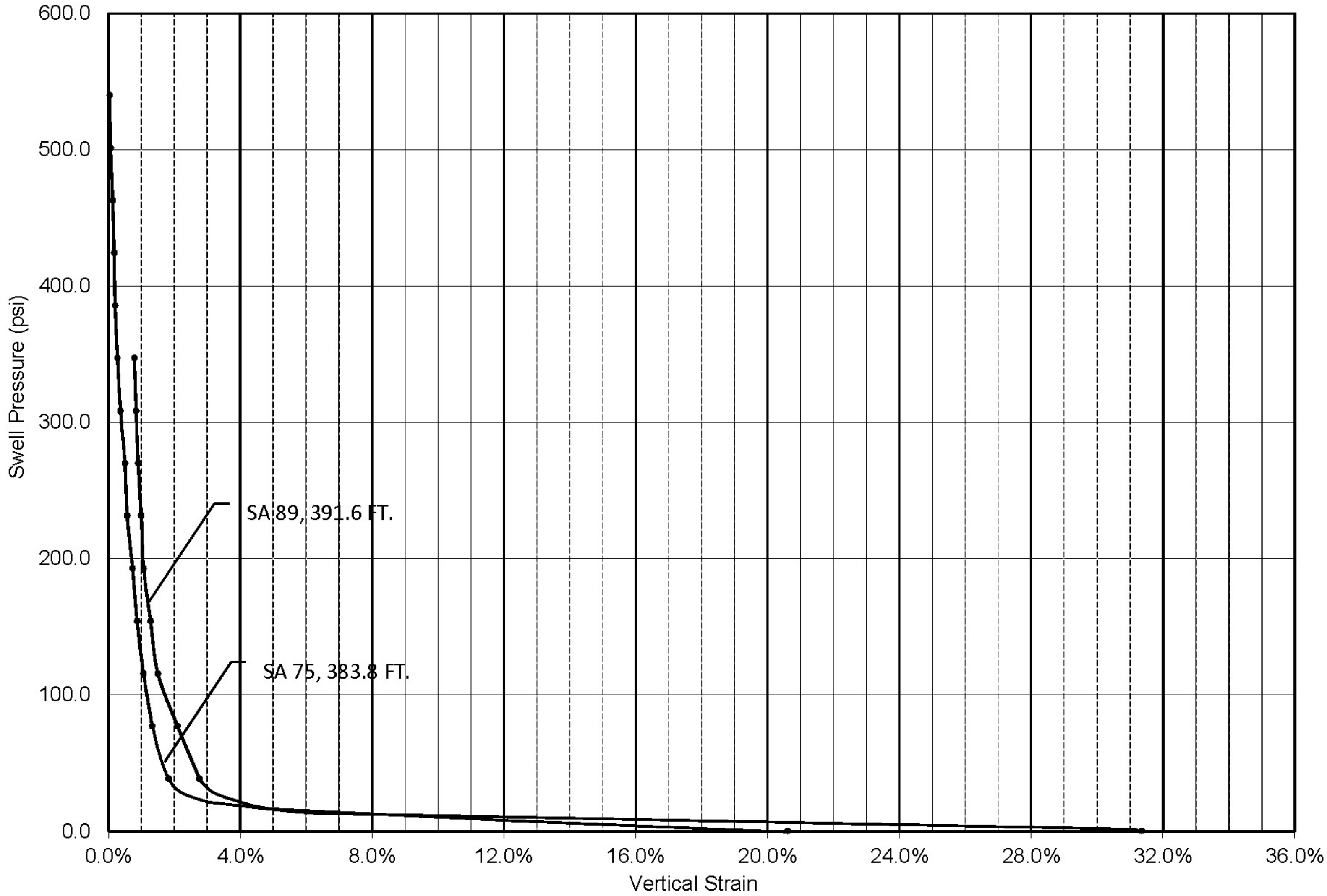

FIGURE 3.2 SWELL PRESSURE VERSUS VERTICAL STRAIN CURVES FOR THE MUDSTONE-SILTY MUDSTONE FLOOR

4.0 MINE STABILITY ANALYSIS

Surface subsidence is caused by subjacent mine instability. There are three modes of mine instability which are prominent in the Illinois Coal Basin. These are roof collapse above the rooms, pillar crushing, and floor bearing failure.[4] These failure modes are conceptually depicted in Figure 4.1. Therefore, in this report an evaluation of the long-term stability considering these various failure modes of the proposed subjacent mining was performed. Sag subsidence can result from any of the above three failure modes. Because of the depth of the coal reserve, however, pit subsidence from room-roof collapse is not expected. Bauer and Hunt, 1981, have reported that pit events have not been observed over abandoned mines at depth greater than 165 ft.

Small sag events result when the upward progression of subsidence from room-roof collapse breaches the bedrock surface. However, if the rock overburden is sufficiently thick, the upward progression is “choked off” by the bulking effect of the subjacent collapsed rubblized roof materials. In a study of active coal mines across the US, Molinda, et al. found that 71% of roof falls occurred in room intersections. Whittaker and Reddish, 1989, modeled the roof caving process for a mine room intersection to determine the maximum height of caving where:

$$z = \frac{4}{(k-1)\pi D^2}\{2W_r M^2 \cot\varphi + MW_r^2\} \tag{4.1}$$

where: z = ultimate caving height

k = bulking factor, assumed at 1.5 for silty shale

D = diameter of collapse-chimney, assumed equal to W_r

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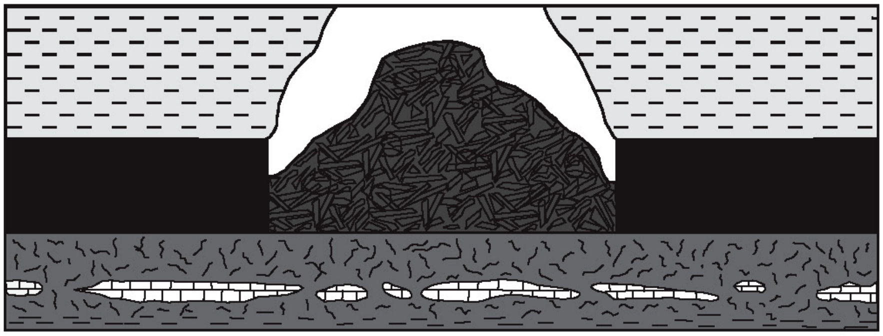
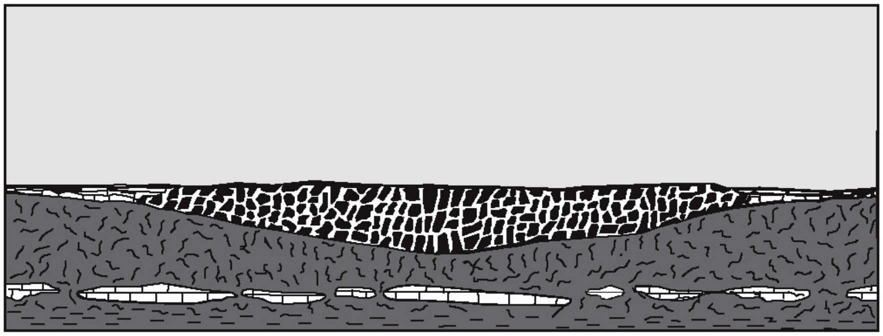
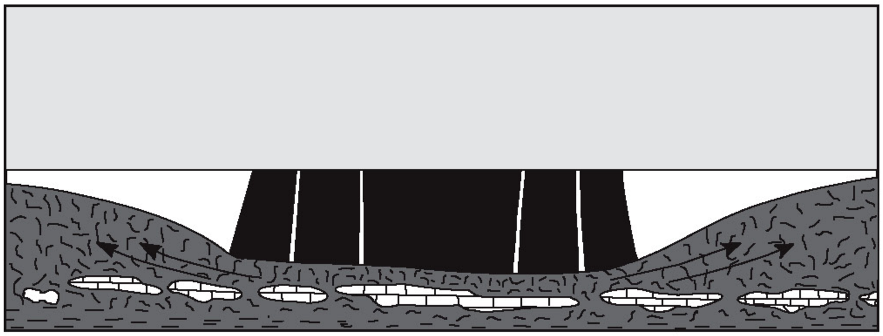
[4] Bearing failures (“roof squeezes”) in the mine roof can also result when the immediate roof contains a sufficient amount of weak material. In fact, mine plans have been modified to address this mine stability issue. For example, this ground control problem was reported in the western portion of the Appalachian Coal Field (i.e. eastern Ohio) where a significant amount of claystone was found above the Pittsburgh Coal No. 8 Seam (Paul and Plein, 1935). It should be noted, however, that this is not a common bearing condition found in the area of the project site.



ROOF FAILURE ABOVE ROOM



PILLAR CRUSHING



PILLAR PUNCHING

FIGURE 4.1 SKETCHES OF THE THREE PRINCIPAL MODES OF FAILURE OF ROOM-AND-PILLAR MINE WORKINGS WHICH CAN RESULT IN SURFACE SUBSIDENCE

W_r = width of mine rooms, ft

M = excavated height of mine rooms, assumed equal to 6.5 ft

φ = angle of repose of caved rock within mine rooms adjoining collapse area. The angle of repose of the fallen roof material is assumed to equal 30°.

Note Equation (4.1) cannot be used if an overlying aquifer would be breached during the caving process. This would add a downward groundwater flow to the caved materials and therefore exacerbate the problem.

Considering the limit of the upward propagation of subsidence based only on bulking of the cave material, the height of caving is given below using Equation 4.1 with different room width, W_r:

W_r = 18 ft, z = 37 ft

W_r = 20 ft, z = 35 ft

W_r = 25 ft, z = 31 ft

Note, z increases with decreasing W_r because the spread of rubble in the room is a function of extraction height and does not increase with room width. Since the rock cover above the No. 6 Coal is at least 200 ft based on the project borings, Equation 4.1 indicates that bulking of caved material will alone preclude surface subsidence from this mechanism of failure. Therefore, room-roof stability does not play a role in the potential for surface subsidence.

5.0 PILLAR STRENGTH ANALYSIS

The capacity of the proposed coal pillars for Allerton Reserve is assessed using the Mark- Bieniawski pillar strength relationship (Mark, 1999):

$$S_p = S_1(0.64 + 0.54 W_p / H_p - 0.18\left(W_p{}^2 / L_p H_p\right)) \qquad (5.1)$$

where: S_p = pillar strength

W_p = pillar width

L_p = pillar length

H_p = pillar height

S_1 = in situ coal cube strength - 900 psi is assumed based on Mark (1990). Based on Mark and Barton (1997), the laboratory tests measure the intact coal strength that is apparently irrelevant to the in situ strength.

This pillar strength equation and use of 900 psi cube strength are the industry standards and are used in both the ARMPS and LA model programs.

The vertical pressure exerted by the overburden on these pillars can be determined from the tributary pressure, $\sigma_{pt,}$ where:

$$\sigma_{pt} = \frac{WD_s(S) + WD_{rx}(RX)}{1 - e} \qquad (5.2)$$

where: σ_{pt} = tributary pressure in psi

WD_s = average wet density of the soil cover = 135 pcf

S = soil cover thickness

WD_{rx} = average wet density of the rock cover = 165 pcf

RX = rock cover thickness

e = extraction ratio

Therefore, the safety or stability factor, SF, becomes for first mining conditions:

$$SF = \frac{S_p}{\sigma_{pt}} \qquad (5.3)$$

For a long-term stability a factor of safety of 2.0 is recommended.

Using the above equations and considering a safety factor of 2.0, the allowable extraction ratio on a hole to hole basis assuming square pillars and 18 ft and 20 ft wide rooms is provided in Tables 5.1 and 5.2, respectively.

TABLE 5.1 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH FOR SQUARE PILLARS AND 18 FT WIDE ROOM USING PILLAR STRENGTH CRITERIA

SECTION/BOREHOLE	OVERBURDEN SOIL THICKNESS, FT	OVERBURDEN ROCK THICKNESS, FT	DEPTH OF COAL, FT	THICKNESS OF COAL, FT	VERTICAL OVERBURDEN STRESS$^{1.}$, PSI	STRESS IN PILLAR, PSI	ALLOWABLE COAL PILLAR STRENGTH$^{2.}$, PSI	PILLAR WIDTH, FT	EXTRACTION RATIO
	S	Rx	D_{coal}	t_{coal}	σ_v	S_{tp}	S_{pa}	W_P	e
SA4	52	302	354	3.93	395	1244	1245	23.2	0.68
SA5	74	271	345	6.75	380	990	991	29.3	0.62
SA12	43	314	357	6.17	400	1049	1051	29.1	0.62
SA16	113	265	378	4.77	410	1172	1172	26.0	0.65
SA19	34	320	354	5.87	398	1067	1068	28.3	0.63
SA20	50	312	362	5.96	405	1065	1069	28.9	0.62
SA26	32	335	367	6.61	414	1040	1041	30.8	0.60
SA29	80	303	383	4.6	422	1204	1207	26.1	0.65
SA30	35	332	367	3.85	413	1281	1283	23.6	0.68
SA31	28	318	346	4.2	391	1206	1206	23.8	0.68
SA33	41	331	372	5.22	418	1142	1142	27.5	0.63
SA39	95	224	319	6.25	346	976	975	26.5	0.65
SA40	32	301	333	5.53	375	1060	1061	26.4	0.65
SA42	38	312	350	6.2	393	1037	1040	28.8	0.62
SA43	35	321	356	6.53	401	1026	1032	30.0	0.61
SA46	156	211	367	6.28	388	1028	1028	28.7	0.62
SA54	55	279	334	6.45	371	996	996	28.2	0.63
SA61	126	247	373	4.48	401	1189	1190	25.0	0.66
SA63	119	209	328	5.22	351	1052	1052	24.6	0.67
SA72	43	314	357	6.43	400	1034	1035	29.6	0.61
SA94	57	310	367	6.22	409	1055	1058	29.7	0.61
SA96	23	342	365	6.90	414	1024	1025	31.4	0.60
SA97	51	324	375	6.35	419	1063	1063	30.4	0.61

Notes:

1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using Mark-Bieniawski (1999) pillar strength formula. Safety factor of 2 was assumed. Pillars assumed to be square. Coal strength of 900 psi assumed.

TABLE 5.2 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH FOR SQUARE PILLARS AND 20 FT WIDE ROOM USING PILLAR STRENGTH CRITERIA

SECTION/BOREHOLE	OVERBURDEN SOIL THICKNESS, FT	OVERBURDEN ROCK THICKNESS, FT	DEPTH OF COAL, FT	THICKNESS OF COAL, FT	VERTICAL OVERBURDEN STRESS^{1}, PSI	STRESS IN PILLAR, PSI	ALLOWABLE COAL PILLAR STRENGTH^{2}, PSI	PILLAR WIDTH, FT	EXTRACTION RATIO
	S	Rx	D_{coal}	t_{coal}	σ_v	s_{tp}	S_{pa}	W_P	e
SA4	52	302	354	3.93	395	1300	1300	24.6	0.70
SA5	74	271	345	6.75	380	991	991	32.5	0.62
SA12	43	314	357	6.17	400	1051	1051	32.2	0.62
SA16	113	265	378	4.77	410	1172	1172	28.9	0.65
SA19	34	320	354	5.87	398	1068	1068	31.4	0.63
SA20	50	312	362	5.96	405	1069	1069	32.0	0.62
SA26	32	335	367	6.61	414	1041	1041	34.2	0.60
SA29	80	303	383	4.6	422	1207	1207	28.9	0.65
SA30	35	332	367	3.85	413	1283	1283	26.2	0.68
SA31	28	318	346	4.2	391	1259	1259	25.2	0.69
SA33	41	331	372	5.22	418	1142	1142	30.6	0.63
SA39	95	224	319	6.25	346	975	975	29.5	0.64
SA40	32	301	333	5.53	375	1061	1061	29.3	0.65
SA42	38	312	350	6.2	393	1081	1081	30.3	0.64
SA43	35	321	356	6.53	401	1071	1071	31.5	0.63
SA46	156	211	367	6.28	388	1028	1028	31.9	0.62
SA54	55	279	334	6.45	371	996	996	31.3	0.63
SA61	126	247	373	4.48	401	1190	1190	27.7	0.66
SA63	119	209	328	5.22	351	1052	1052	27.4	0.67
SA72	43	314	357	6.43	400	1035	1035	32.9	0.61
SA94	57	310	367	6.22	409	1058	1058	32.9	0.61
SA96	23	342	365	6.90	414	1065	1065	33.1	0.61
SA97	51	324	375	6.35	419	1106	1106	32.1	0.62

Notes:

1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using Mark-Bieniawski (1999) pillar strength formula. Safety factor of 2 was assumed. Pillars assumed to be square. Coal strength of 900 psi assumed.

6.0 FLOOR BEARING CAPACITY ANALYSIS

6.1 Introduction

The methodology used to analyze the floor bearing capacity is described in Marino and Osouli, 2012. The most relevant information to the design of the mine floor has been provided, however, herein.

The geotechnical analysis given herein considered the influence of softening in order to determine the allowable bearing capacity of the No. 6 Coal mine floor. Given the pressure versus swelling strain characteristics discussed in Section 3.4, the geotechnical properties of the floor fine-grained rock will correspondingly vary because of the confining pressure changes from under the mine room to pillar. Under soaking with little to no confining pressures, the floor materials can soften to soil-like consistency. Consequently, the conventional equations used to determine floor bearing capacity are not very accurate, as they assume uniform material properties.

The inherent limitations of other methods to estimate the floor bearing strength, which results from their assumptions are as follows: 1) assume one or two homogenous layers; 2) assume layers are frictionless cohesive materials; and 3) use Mohr-Coulomb failure criterion. Plate strength tests also have shortcomings as the ultimate bearing load is affected by 1) the rate of loading or strain; 2) only the immediate floor is sheared zone below the plate; 3) an accentuated effect of fairly thin harder zones or lenses, or nodules within the zone of shearing; and 4) uncertainty about long-term strength parameter values.

In addition to the above, the use of the Vesic-Speck Method (Speck, 1979), which is used in the Illinois Basin also has shortcomings. This method estimates the floor bearing strength from floor moisture. No consideration is made for moisture increase when the floor becomes wet and softened. As can be seen in Figure 3.1, the floor moisture clearly increases over time. Furthermore, the assessment of the thickness of the weak floor based on the moisture profile seems entirely arbitrary.

In order to model the behavior of the floor under pillar induced stress, extensive FEM analyses had been performed. Because of the swelling and softening properties of the MS-$MS unit, the model construction considered the floor with fully softened, partially softened and unsoftened zones (see Figure 6.1).

The analysis of the mine floor bearing capacity includes the use of numerical analysis where the material stiffness and strength can be selected in locations anticipated to have different ranges in confining stress. The ultimate bearing capacity was then determined by making a correction for these material changes based on results from 2-dimensional FEM analysis to the capacity calculated from well-established bearing equations. The FEM adjustment or correction was taken as the ratio for the softened to unsoftened average peak pillar stress for certain pillar to room width ratios, W_p/W_r, and floor conditions.

To model the floor profile conditions, the following factors had to be evaluated:

- The immediate floor thickness of the non-durable, weak, fine-grained rock.
- Representative material properties of the immediate, non-durable, weak floor profile.
- The thickness of the underlying durable, bearing resistant zone.
- Representative material properties of the bearing resistant zone.

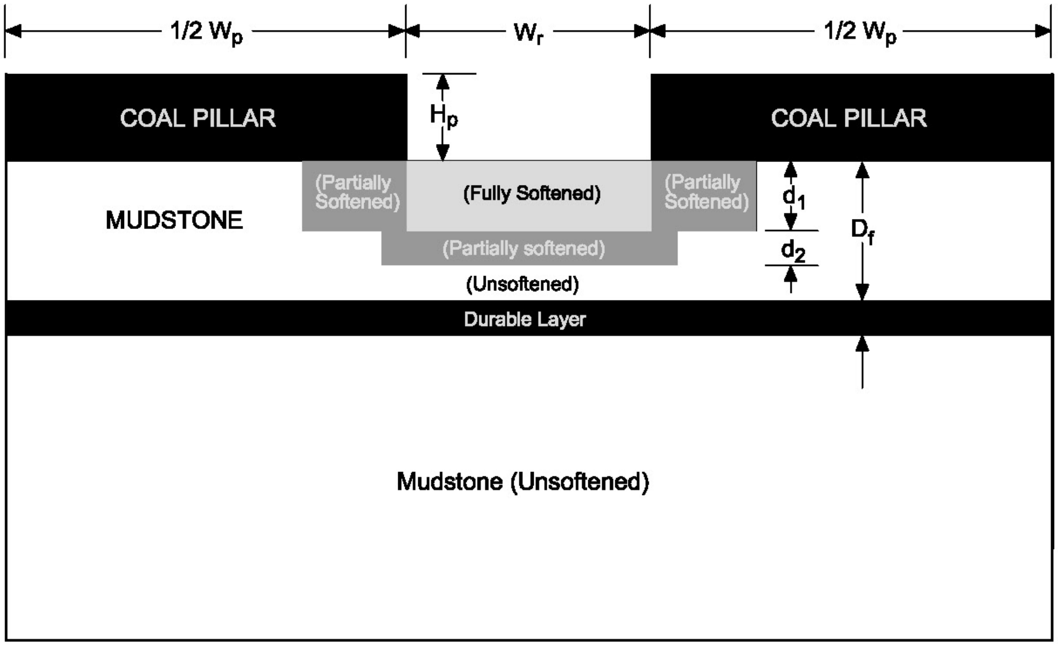


FIGURE 6.1 PILLAR - FLOOR MODEL GEOMETRY SHOWING SOFTENED, PARTIALLY SOFTENED, UNSOFTENED AND DURABLE (RESISTANT) ZONES.

- Representative material properties of the underlying weak, fine-grained rock of unlimited extent.

The thickness or depth of the non-durable weak floor, D_f, was established for each project boring where sufficient data was available. Thickness was determined by the depth to the first resistant bearing layer. The most immediate bearing resistant zone in the mine floor was defined by about 2 ft or greater of durable rock. The rock was considered durable if it had an overall DuroIndex rating of slightly non-durable to durable.

6.2 Material Properties

The FEM analysis results used in this investigation assumed the immediate, non-durable, weak floor material to be a mudstone with the following characteristics:

Ave. Liquid Limit: 44%
Ave. Plasticity Index: 25%
Ave. Clay Fraction: 28%
Ave. Natural Moisture Content: 7.0%

The immediate non-durable floor in the Allerton Reserve has the following properties:

Ave. Liquid Limit: 41%
Ave. Plasticity Index: 21.7%
Ave. Clay Fraction: 29%
Ave. Natural Moisture Content: 6.1%

As can be seen from comparing the above characteristics, the modeled material is more plastic than at the project site. Also, based on the swell tests performed, the average pressure of MS-$MS unit at the maximum swell stress-strain curvature (σ_{smc}) is less (i.e. 38 psi compared to 50 psi). Therefore, it would be expected that the softening potential would be less and overall strength would be greater than the assumed model properties.

Another material analysis which was performed was to determine the weighted average fully softened friction angle (Skempton, 1977, Terzaghi, et. al., 1996). This friction angle was determined on a hole to hole basis for the immediate MS-$MS unit (see Appendix A). The fully softened friction angle was assumed based on the liquid limit and the presence and intensity of slickensides. Where abundant slickensides were present, the friction angle was reduced to the residual value. The friction angles assumed for the various beds within the mudstone-silty mudstone unit are provided in Table 6.1. From the available borehole and laboratory data, the overall MS-$MS unit average friction angle is 27°. This weighted average friction angle for modeled case was between 26° and 27° and therefore lower than for the Allerton Reserve. Therefore, based on the above, the use of the analysis results provided in Marino and Osouli, 2012 should be conservative for floor design for the Allerton Reserve.

Consolidated-drained triaxial tests were run on various fine-grained floor samples of the modeled reserve. Each sample was allowed to swell by inundating it in water under a slight back pressure. The changes in length of the sample were noted against time to study the swelling of the material. Because these were indurated fine-grained rocks, this stage took a considerable amount of time to complete. Once the sample reached the latter stages of secondary swell, it was sheared under drained triaxial loading conditions by applying a vertical load. Based on these tests, an unsoftened

TABLE 6.1 FULLY SOFTENED FRICTION ANGLES ASSUMED FOR BEDS IN THE MUDSTONE-SILTY MUDSTONE UNIT

Unit	Friction Angle
SILTY MUDSTONE	
SLI $MS, FREQ SLK	25
CB, $MS, DISC SLKS	26
$MS, DISC SLKS	26
$MS , OCC SLK	27
V.$MS, DISC SLKS	27
SLI $MS DISC SLKS	27
$MS	28
SLI, $MS	28
$MS w/20% LS NOD	28
MUDSTONE TO SILTY MUDSTONE	
MS-$MS, MANY DISC SLKS	23
MS-$MS, SLKS	23
MS-$MS, DISC SLKS	25
$MS-MS, DISC SLKS	25
CB, MS-$MS, DISC SLKS	25
MS-$MS, OCC SLKS	26.5
$MS-MS, OCC SLKS	26.5
MS-$MS, FEW SLKS	26.5
MS-$MS, SM DISC SLKS	26.5
MS-$MS, FEW, SM, DISC SLKS	27.5
MS-$MS	27.5
CB, MS-$MS	27.5
MUDSTONE TO SILTY MUDSTONE W/ LS	
MS-$MS w/ NOD?, SLKS throughout	23
MS-$MS, trace LS NOD, Several SLKS	23
MS-$MS, w/ 10% LS NOD, DISC SLKS	25
MS-$MS, trace LS NOD, OCC SLKS	26.5
MS-$MS, w/ LS NOD, DISC SLKS	27.5
MS-$MS, 10% LS NOD	27.5
MS-$MS, w/30% LS NOD	27.5
MS-$MS w/ 40% LS NOD	29
MS-$MS w/ LS NOD, sparse DISK SLKS	30
MS-$MS w/ 50% LS NOD	30
MS-$MS w/ LS NOD	32.5
MUDSTONE	
MS-DISC SLKS	26
MS	27
LIMESTONE	
LS	35
LS NOD at base	35
NOD LS	35
NOD LS, MAS	35
SHALE	
Sandy SH	28
CB SH	28

friction angle of 29° and cohesion of 109 psi were assumed in the FEM model for the mudstone (see Figure 6.2).

As can be seen in Figure 6.2, there is a significant difference in the strength of the fully softened (remolded) and the intact phases of the rock material despite both phases being subjected to confining pressures of up to 500 psi. The p-q[5] diagram in Figure 6.2 also shows a consistent trend of increased triaxial strength for intact samples with a decrease in rock plasticity. Also, the difference in rate of increase and magnitude of the modulus with confining pressure between the fully softened reconstituted and intact samples are shown in Figure 6.3.

The stiffer and stronger fine-grained intact floor rocks compared to compacted samples of the same material is essentially due to aggregation of clay particles over geologic time. In fact, it is interesting to note that the method of sample preparation affected the Liquid Limit with the pulverized samples having a Liquid Limit 2 to 4% higher than the air slaked samples thus indicating additional breakdown of aggregated particles resulted when the floor rock was pulverized and then soaked. The effect of particle aggregation could also be seen, at least in part, with the increase in the Liquid Limit with the number of slake cycles the sample had undergone.

Based on the D_f data at the boring locations, the depth of weak, non-durable rock, varies across the reserve from 0 to 13 ft or more. The shallowest durable beds appear to exist in the southern and central parts of the application area. Depth to the resistant zone in these areas seem to be less than 4 ft. The resistant zones encountered were units described as limestone, shale or sandstone and are also

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[5] p-q diagram is a scheme for plotting the state of stress at a point by plotting $(\sigma_1-\sigma_3)/2$ versus $(\sigma_1+\sigma_3)/2$

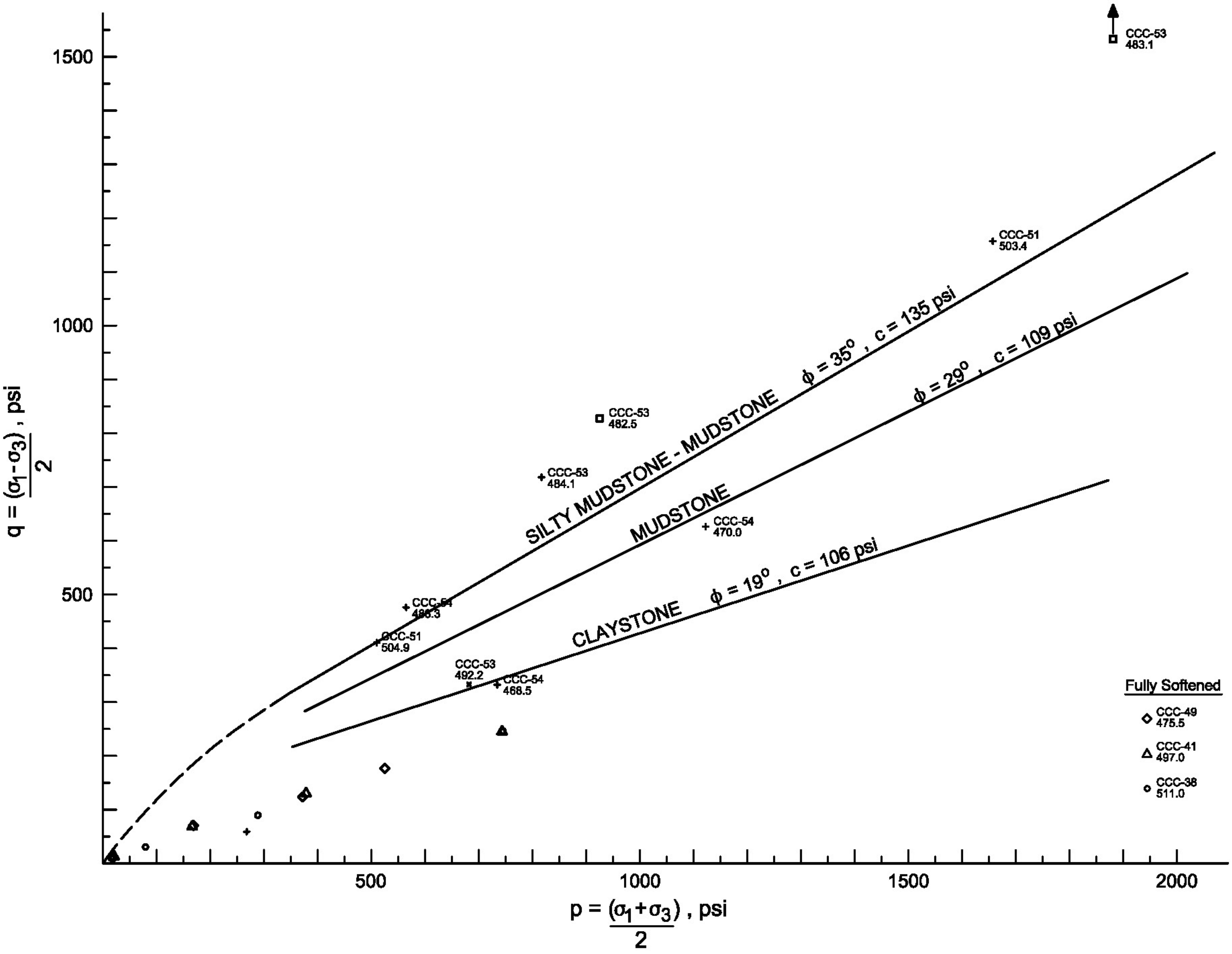

FIGURE 6.2 SOAKED FULLY-SOFTENED COMPARED TO INTACT (CONSOLIDATED-DRAINED) TRIAXIAL TEST RESULTS ON FINE-GRAINED FLOOR SAMPLES

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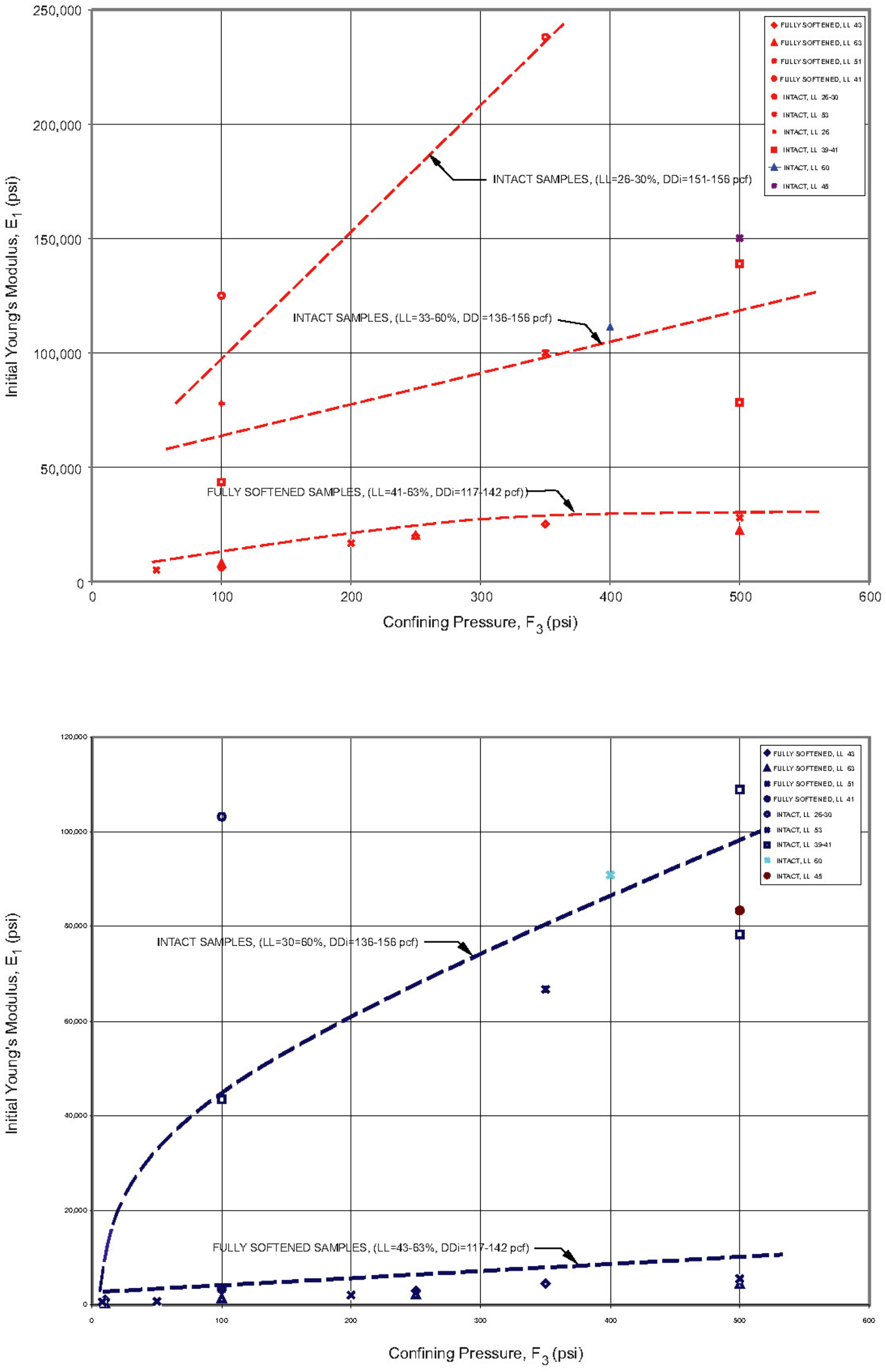

FIGURE 6.3 EFFECT OF CONFINING PRESSURE ON INITIAL AND OVERALL YOUNG'S MODULUS FOR FINE-GRAINED FLOOR MATERIALS

discussed in Section 2. In the northern part of the application area, little data is available.

Based on the triaxial testing summarized above, the mudstone was assumed in the modeling to have a rock density of 135 pcf with the following strength properties presented in Table 6.2.

In the numerical model, the Young’s Modulus for the various mudstone stages was determined according to its overall value and its relationship with confining pressure as shown in Figure 6.3. Also, in order to incorporate the reduction in strength from peak to residual condition, strain softening model elements were used in the numerical analysis to reach a residual state.

Several resistant units were considered in the modeling. These were a carbonaceous zone, siltstone-sandstone and silty limestone. Their associated properties assumed in the FEM analysis are given in Table 6.3. Rock densities were taken at 100 pcf for the carbonaceous zone and 150 pcf for the other resistant materials. The initial Young’s Modulus for both the siltstone-sandstone and silty limestone and for the No. 5 carbonaceous zone were assumed to be 1.5 x 10^5 psi and 1.0 x 10^5 psi, respectively. The increase in modulus with confining pressure assumed in the floor model for these rocks was extrapolated for siltstone from the triaxial data. Strain softening elements were also used for the durable rock layers as well as for the fine-grained materials.

TABLE 6.2 STRENGTH PROPERTIES OF MUDSTONE

MUDSTONE	FRICTION ANGLE		COHESION	
	Peak	Residual	Peak	Residual
Fully Softened	25•	19•	0	0
Partially Softened	29•	19•	50 psi	0
Unsoftened	29•	19•	109 psi	0

Attachment IV-3A3

TABLE 6.3 ASSUMED STRENGTH PROPERTIES FOR DIFFERENT MATERIALS

	FRICTION ANGLE		COHESION	
	Peak	Residual	Peak	Residual
No. 5 CARBONACEOUS ZONE	16•	16•	1,650 psi	0
SILTSTONE-SANDSTONE	35•	35•	2,910 psi	0
SILTY LIMESTONE	35•	35•	3,810 psi	0

6.3 FEM Model Geometry and Loading Conditions

The effect of floor softening on the ultimate bearing capacity of coal mine floor was evaluated using a 2-dimensional numerical analysis. The FEM analysis was carried out with SMAP-2D which has the versatile ability to simulate geotechnical and structural problems. As shown in Figure 6.1, the 2-dimensional numerical model consists of a room and two half-width coal pillars, with a floor of softened and unsoftened mudstone which may include a durable, resistant layer. This room-and-pillar configuration was taken to allow passive wedge development across the centerline of the entry, as well as to eliminate other boundary condition effects with modeling. Also, the numerical model contained two half-width coal pillars based on the assumption of symmetric behavior of mudstone underlying the coal pillar. Plane strain behavior was assumed for the numerical model and a symmetric mesh about vertical centerline was used. The vertical boundaries at the centerlines of two coal pillars are horizontally constrained. The bottom horizontal boundary which is located around 2.5 times of opening width below the room was constrained in the vertical direction as shown in Figure 6.4.

The analysis considered a room width, W_r, equal to 20 ft and pillar width, W_p, based on pillar to room width ratios, W_p/W_r, of 1, 2, 3, 4, 5, and 6. Assuming 20 ft room width provides slightly less bearing resistance than for 18 ft and is therefore conservative if smaller room widths are considered. The height of the pillar was taken as 8 ft. The depth of model below the coal mine was equal to 50 ft which is around 2.5 times of width of the excavation.

FEM analyses were performed on both softened and unsoftened floor cases. In the room, the immediate mine floor is assumed to become fully softened and to reach a

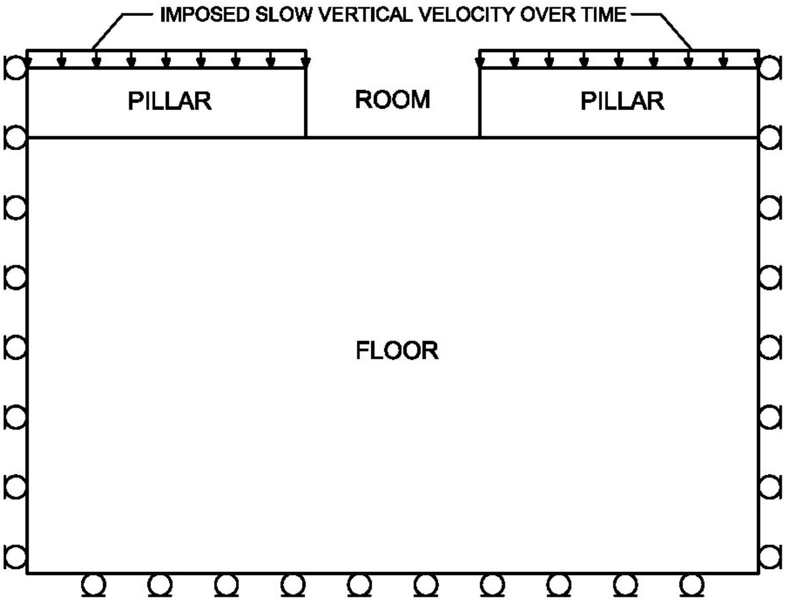

FIGURE 6.4 FLOOR LOADING AND BOUNDARY CONDITIONS ASSUMED IN THE FEM ANALYSIS

depth of one half of room width based on Marino and Choi, 1999. Also, at the same depth as the fully softened zone, a 10 ft wide partially softened zone adjacent to the softened zone and under the pillar were assumed. A partially softened zone was taken under the pillar because of the significant drop of confining pressure below the pillar perimeter (see Figure 6.1). A 5 ft partially softened zone was also placed below the fully-softened material below the room in the FEM model. The effect of floor softening was then studied by comparing the ultimate bearing stress for both softened and unsoftened profile cases.

In the modeling, the rock type, depth, D_f, and thickness, T, of the bearing resistant durable layer were varied. The durable layer was assumed not to be softened and restricted the depth of floor softening to the depth of the durable layer. Taking into consideration the range of floor conditions, the ultimate bearing pressure was determined for certain D_f/W_p and W_p/W_r ratios.

In the FEM analyses, all floor materials are considered homogeneous, isotropic, and non-linear with elasto-plastic characteristics. Elements used to simulate material behavior in the engineering model in SMAP have non-linear, elasto-plastic, as well as strain-softening properties. The engineering model requires peak and residual shear strength and can simulate the gradual strain softening to residual condition after failure (peak). The engineering model can also simulate the non-linear relationship between modulus and confining pressure for both loading and unloading conditions. In addition to being more representative of the actual material properties, use of this type of element allows for a more definitive load-displacement failure to be determined compared to the ever increasing bearing load obtained with displacement when merely using an elasto-plastic element. The coal pillars were considered to be elastic in the model having a relatively stiff modulus in order to simulate rigid body behavior during settlement.

The coal mine was assumed to be located 500 ft below a horizontal ground surface, and the overburden stress is applied on the top of the coal layer to simulate the overburden load. To account for these pre-mine geostatic stresses, the numerical model had to be stabilized before extraction. During the stage of initial stabilization, the overburden pressure of 555 psi (which is equivalent to about 500 ft of cover) was applied incrementally in order for the model to reach the geostatic conditions and to reduce the dynamic loading effect. The assumed initial state of stress is expected to have little effect on the modeling results.

The mine entry was sequentially excavated after the overburden loading on top of the numerical model was stabilized. During the sequential coal extraction, the two coal pillars were constrained from vertical settlement in order to prevent uneven initial settlement of coal pillars during the coal extraction stage. After coal extraction, the tops of pillars were vertically displaced downward by applying a very slow velocity so that significant dynamic forces were not generated in the elements. This loading condition is analogous to a plate load test. During the imposed constant rate of settlement, the average vertical stress in elements across the coal pillar was calculated with vertical displacement of the pillar. From the plot of average pillar stress versus displacement, the ultimate bearing strength of the mine floor was determined.

Before carrying out a detailed analysis, a careful study for determining mesh configuration was done. Numerous testing runs had to be executed to study the stability of the mesh and to see if the FEM model converged to the right solution. This was done mainly by changing the element size and determining the element size at which less than 5% change in the results occurred upon changing the element size. Moreover, analyses of the computed trends as discussed in Section 6.4 are reasonable, which also validates the results obtained. Once the proper mesh configuration was determined, the numerical analysis was carried out for different durable layer types, thicknesses and depths for the softened condition. It is important to point out that some of these cases were run several times to check mesh stability. In addition to the listed cases, additional analysis was done using the same meshes for the unsoftened floor material case (with no resistant zone). Computer runs were done for durable rock type; carbonaceous shale, siltstone/sandstone and limestone units. For each rock unit, the analysis was done for different combinations of durable rock thickness (T) and depths (D_f). In addition to the above, other FEM runs were done for no durable layer for both softened and unsoftened cases. Some of the investigated cases, especially for pillar to room width ratios greater than 3, required intensive computing resources and took computation trial times as long as 3 weeks to finish.

6.4 FEM Analyses Results

To investigate the effect of durable layer type, thickness and depth on floor stability, a series of plots were constructed using the data obtained from the FEM. The plots show the relationship between the pillar to room width ratio (W_p/W_r) and the bearing capacity ratio (C_s). The bearing capacity ratio (or the correction for softening and the presence of durable layer) is defined as the ratio of the maximum mobilized floor strength for the softened condition with a durable layer to the unsoftened maximum mobilized floor strength without a durable layer.

Figure 6.5 shows the effect of floor softening on the floor resistance where no durable zone is present. Even at a high W_p/W_r ratio of 6, the bearing capacity ratio only reaches 0.91.

Figures 6.6a through 6.6d show the plots for durable carbonaceous zone layer cases. These figures show that at W_p/W_r ratio equal to 1, the thickness and depth of the durable layer has no effect on the bearing capacity ratio. It is interesting to note that the C_s value for the no durable layer case and all durable layer cases was found to be the same and equal to about 0.28. The only exception was the case when D_f was 5 ft; in this case the C_s value was determined to be 0.5 at W_p/W_r equals to 1. Figure 6.6 shows that for D_f equal to or greater than 15 ft and for T values of 2 to 3 feet there is little increase ranging from 2 to 10% in C_s values when compared to the case of nondurable floor. On the other hand, for D_f of 10 ft or less, the increase in C_s values ranges from 10 to 60%. At D_f of 20 ft, the plots for T values of 2 and 3 ft coincided perfectly showing that at such depth the variation in thickness from 2 to 3 ft has no effect on C_s value.

A similar finite element analysis was done for the siltstone/sandstone durable zone and the results are presented in Figures 6.7a and 6.7b. The analysis was done for two durable zone thicknesses of 2 and 6 ft for W_p/W_r values ranging from 1 to 4. For a durable layer thickness of 2 ft, the beneficial effect of the durable zone vanishes at a depth of 12 ft and greater. Changing the durable layer thickness from 2 ft to 6 ft caused appreciable increase in C_s values.

Finally the analysis was done for a 2 ft thick limestone durable layer located at 3 different depths of 10, 14 and 18 ft. The analysis shows that at D_f of 10 ft, the C_s value is 6% higher than the C_s value for no durable layer case. For D_f values of 12 and

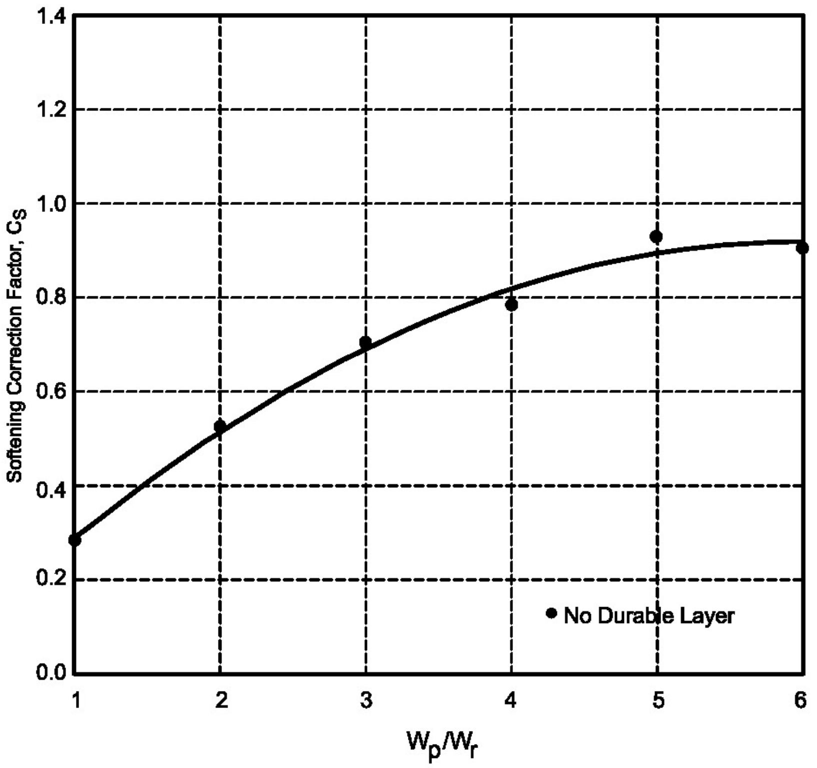

FIGURE 6.5 THE EFFECT OF FLOOR SOFTENING WITH NO DURABLE ZONE ON THE BEARING CAPACITY RATIO (C_S)

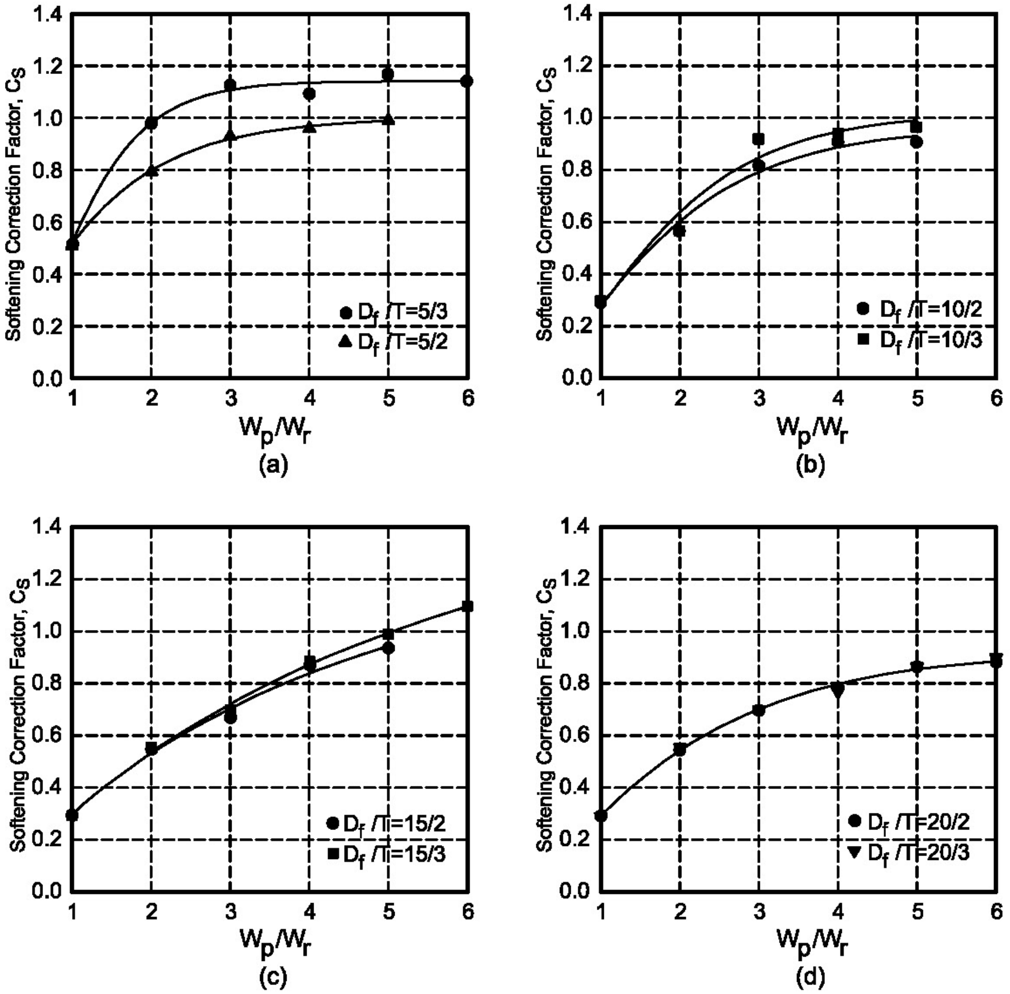

FIGURE 6.6 VARIATION OF C_s WITH W_p/W_r FOR DIFFERENT DEPTHS AND THICKNESSES OF THE DURABLE CARBONACEOUS ZONES

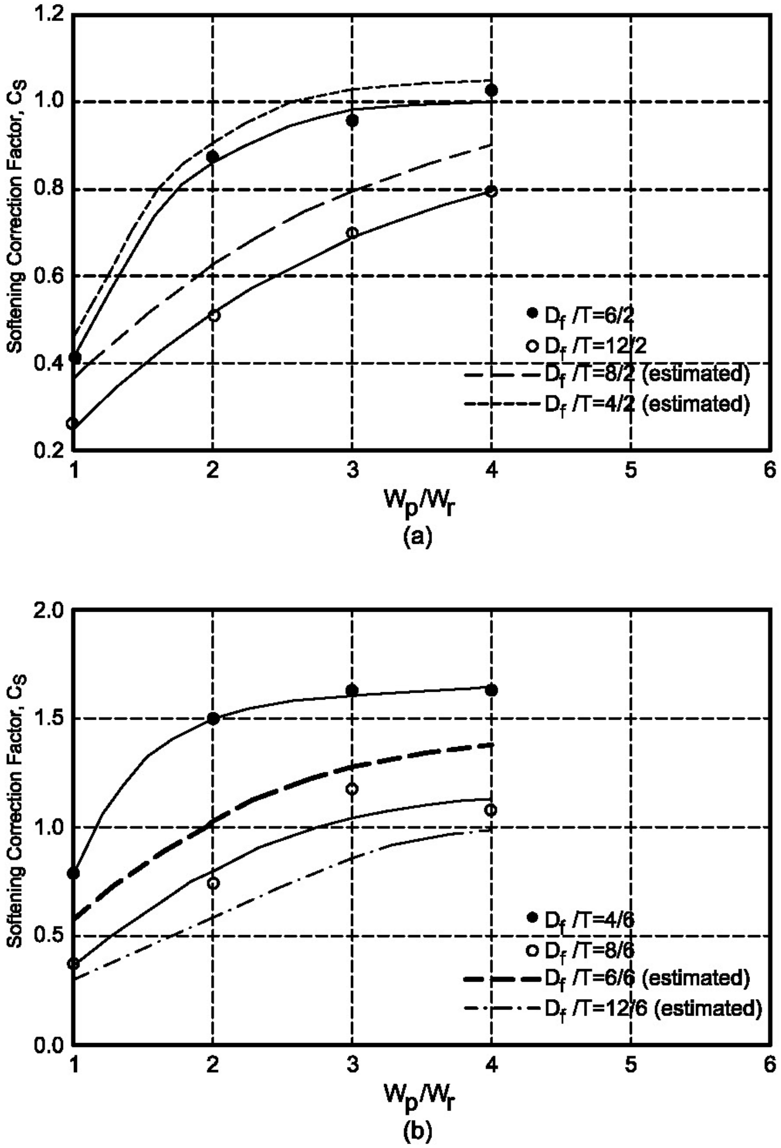

FIGURE 6.7 VARIATION OF C_S WITH W_p/W_r FOR DIFFERENT DEPTHS AND THICKNESSES OF THE DURABLE SILTSTONE/SANDSTONE ZONES

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greater, a durable limestone layer of 2 ft did not seem to improve C_s values at the same W_p/W_r and was roughly the same as that of the no durable layer case. The results of the analysis are presented in Figure 6.8.

Using the results obtained from the finite element analysis it was possible to develop a series of best fit curves that describe the relationships between W_p/W_r and C_s for different combinations of durable layer thicknesses, rock types and depths. As can be seen from the previous plots these curves nicely fit the analysis results. Developing these curves is critical for determining the extraction ratios for different combination of durable zones types, thicknesses and depths. This is described in detail in Section 6.6 which covers the floor design analysis.

6.5 Operation Bearing Strength Assessment

The above laboratory strength and FEM parameters assessment do not include insitu effects or a comparison with actual failure capacities. In order to calibrate bearing capacity assessments discussed above, a reduction factor, R, should be applied for the rock mass condition.

Operational strength assessment for fine grained mine floors have been discussed in Ganow (1975) and Speck (1979). Ganow (1975) compared uniaxial compression strength of fine grained floor material of fissure versus intact samples and estimated R to be in the range of 0.35 for “underclays” and 0.6 for “shale”. The reduction factor was also determined by Speck (1979) by comparing triaxial strengths and plate load tests performed on the Illinois Coal Basin floor. Speck (1979) determined for “underclay” that 0.15 to 0.22 and 0.43 were appropriate for R value in two different mine sites. It should be noted the lower R range was in an Illinois Basin mine which

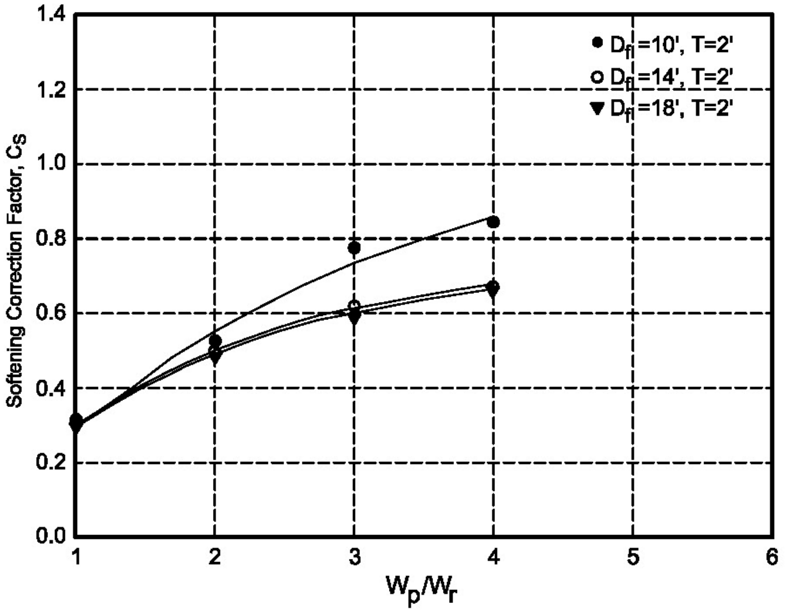

FIGURE 6.8 VARIATION OF C_s WITH W_p/W_r FOR TWO FT THICK SILTY LIMESTONE LAYER LOCATED AT DIFFERENT DEPTHS

reportedly contained ‘highly fissured underclay’ floor. For “claystone” the R value of 0.6 was determined. Another method to evaluate the rock mass strength was developed by Hoek-Brown (1980) and modified by different researchers (Hoek, Kaiser and Bawden, 1993; Hoek and Korzulovic, 2001; Hoek et al., 2002). Using the 2002 version of Hoek-Brown failure criterion and the characteristics of non-slickensided mudstone floor, R was determined to be between 0.63 to 0.89.

Based on the reported reduction factors and considering an essentially non-slickensided mudstone floor, a reduction factor of 0.4 is estimated for the project site. There were two holes (SA-84 and SA-85) which have been reported to have highly fractured MS-$MS with an RQD of zero. Of the holes which were drilled to sufficient depth and where RQD measurements were not taken, SA-34 appears to have encountered a fairly broken MS-$MS unit and therefore is assumed to have a low RQD value. For these three low RQD holes, R was reduced to 0.25.

6.6 Floor Design Analysis

Because of the weak floor conditions throughout the reserve, the size of the pillars and thus the allowable extraction ratio can be controlled by the allowable floor bearing capacity. The procedure used to determine the floor bearing capacity for this project site is provided below.

1. The overburden vertical stress (σ_V) is determined using the following equation:

$$\sigma_V = WD_s(S) + WD_{rx}(RX) \qquad (6.1)$$

where: WD_s = average wet density of the soil cover = 135 pcf

S = soil cover thickness

WD_{rx} = average wet density of the rock cover = 165 pcf

RX = thickness of rock layer above top of coal

2. Pillar stress (σ_{tp}) is determined using the following tributary pressure equation:

$$\sigma_{tp}=\frac{\sigma_v}{(1-e)} \tag{6.2}$$

where: e = extraction ratio for a checkboard pattern

$$= 1-\frac{W_p^2}{(W_p+W_r)^2}$$

3. The softening correction factor (C_s) is determined using the plots presented in Figures 6.5 to 6.8.

4. For the chosen W_p, the ultimate bearing capacity (q_u) is determined using Prandtl bearing capacity equation for a semi-half space (Vesic, 1975):

$$q_u=cN_c\delta_{sc}+0.5WDW_PN_\gamma\delta_{S\gamma} \tag{6.3}$$

where: c = cohesion

N_c = bearing capacity factor

δ_{sc} = shape correction factor = $1+W_p/L_pN_c$

WD = wet density

N_γ = bearing capacity factor

$\delta_{s\gamma}$ = shape correction factor = $1-0.4(W_p/L_p)$

This equation considers the shape factors for a square pillar (i.e. δ_{sc} =1.59 and $\delta_{s\gamma}$ = 0.6). Using appropriate material values for mudstone (□ = 29°, c = 109 psi) and the project site, the Prandtl is summarized to:

$$q_u \text{ (psi)}= 4828+0.47\ (W_p) \tag{6.4}$$

where: W_p is in inches

5. The allowable bearing capacity (q_a) is determined using the following equation considering field reduction factor of 0.4 and a safety factor of 2:

$$q_a = 0.2\ C_s q_u \qquad (6.5a)$$

For the localized condition of a highly fractured MS-$MS, R is assumed a 0.25. This accordingly reduces the above equation to:

$$q_a = 0.125\ C_s q_u \qquad (6.5b)$$

The calculated allowable floor bearing, on a hole to hole basis assuming square pillars and a room width of 18 ft and 20 ft are provided in Tables 6.4 and 6.5, respectively.

As noted above in this section, the resistant zones and depths across the reserve are somewhat different than those modeled to obtain C_s values. Using the available C_s relationships provided in Figures 6.4 to 6.7, conservative C_s assumptions were made where project conditions are not represented. For example, the weaker carbonaceous zone C_s correlation was used for the stronger limestone unit at shallower depths as no such correlation was available for the limestone (see Figure 6.6a). Another example was the use of the siltstone-sandstone plot for the shallow limestone unit (see Figure 6.7a). The C_s correlation used to determine q_a for the floor conditions of each hole is noted in Tables 6.4 and 6.5.

As can be seen in Table 6.4, the allowable extraction ratios calculated for the known floor conditions range from 33 to 58%. This represents a difference in allowable floor support capacity of 1.6 times the weakest (not including where nominal to small D_f exist where it would be even higher). The lower extraction ratios (i.e. 33-38%) are related to highly fractured weak immediate floor conditions. Based on review of the

TABLE 6.4 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH ASSUMING SQUARE PILLARS AND 18 FT WIDE ROOM USING BORE HOLE DATA

BOREHOLE	OVERBURDEN SOIL THICKNESS (ft)	OVERBURDEN ROCK THICKNESS (ft)	DEPTH OF COAL (ft)	THICKNESS OF COAL (ft)	DURABLE ROCK TYPE	VERTICAL OVERBURDEN STRESS[1] (psi)	THICKNESS OF DURABLE LAYER (ft)	RATIO OF PILLAR TO ROOM WIDTH	THICKNESS OF NON-DURABLE LAYER (ft)	BEARING CAPACITY CORRECTION FACTOR	ULTIMATE BEARING CAPACITY[2] (psi)	STRESS IN PILLAR (psi)	ALLOWABLE BEARING CAPACITY[3] (psi)	ROOM WIDTH (ft)	PILLAR WIDTH (ft)	EXTRACTION	REMARKS
	S	Rx	D_{coal}	t_{coal}		σ_v	T	W_P/W_r	D_f	C_s	q_u	s_{tp}	q_a	W_r	W_P	e	
SA-2	150	232	382	6.20	NOD LS	406	5.62	1.89	2.45	0.98	5020	950	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-25	48	323	371	5.58	S SH	415	4.37	1.89	5	0.98	5020	971	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-34	24	344	368	5.71	$S - LS	417	3.15	3.72	3.84	1.04	5206	671	677	18	67	0.38	Fig6.7a, Df/T=4/2 used
SA-53	76	242	318	6.00	S SH (1.25') - SS	349	18.15	2.11	6.9	0.76	5043	757	766	18	38	0.54	Fig6.7b, Df/T=8/6 used
SA-57	35	300	335	6.09	CB $ SH (0.35') - S SH	377	2.62	2.11	5.1	0.82	5043	818	827	18	38	0.54	Fig6.6a, Df/T=5/2 used
SA-58	25	322	347	6.32	LS	393	2.58	1.94	2.92	0.9	5026	900	905	18	35	0.56	Fig6.7a, Df/T=4/2 used[5]
SA-63	119	209	328	5.22	$ SH	351	2.13	2.00	3.45	0.8	5031	790	805	18	36	0.56	Fig6.6a, Df/T=5/2 used
SA-67	28	331	359	6.16	LS (0.45') - $S(2.45')-LS(1.6')	406	4.5	1.89	2.99	0.98	5020	949	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-70	61	311	372	5.02	NOD LS	414	1.76	1.89	2.24	0.98	5020	968	984	18	34	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-71	47	329	376	6.72	LS (0.75') - $ SH	421	3.25	1.94	5.68	0.99	5026	966	995	18	35	0.56	Fig6.6a, Df/T=5/3 used
SA-74	61	286	347	6.25	L SH (0.37') - $ SH	385	5.05	1.83	3.63	0.94	5015	919	943	18	33	0.58	Fig6.6a, Df/T=5/3 used
SA-75	30	342	372	7.00	LS	419	1.65	2.06	1.82	0.92	5037	927	927	18	37	0.55	Fig6.7a, Df/T=4/2 used[5]
SA-78	34	338	372	6.20	S LS (0.64') - $ SH	419	3.65	2.11	3.36	0.91	5043	911	918	18	38	0.54	Fig6.7a, Df/T=4/2 used
SA-81	38	333	371	6.80	NOD LS	417	2.25	2.33	3	0.85	5065	851	861	18	42	0.51	Fig6.6a, Df/T=5/2 used[6]
SA-84	119	258	377	3.18	NOD LS	407	2.4	4.06	4.37	0.97	5240	632	635	18	73	0.36	Fig6.6a, Df/T=5/2 used[6]
SA-85 [7]	49	314	363	5.8	NOD LS	405	2	4.56	10	0.9	5291	603	595	18	82	0.33	Fig6.8 used
SA-86	64	319	383	6.70	LS (0.5') - $ SH	426	3.3	1.94	5.35	0.99	5026	976	995	18	35	0.56	Fig6.6a, Df/T=5/3 used
SA-88	31	336	367	6.35	SS	414	2.3	3.11	12.45	0.72	5144	722	741	18	56	0.43	Fig6.7a, Df/T=12/2 used
SA-89	44	336	380	5.50	LS (0.55') - $ SH	426	2.3	2.83	7.7	0.77	5116	779	788	18	51	0.45	Fig6.6b, Df/T=10/2 used
SA-91	26	344	370	7.20	Coal (1.4') - S SH (1.75') - SS(4.95')	419	13.1	1.89	5.4	0.98	5020	980	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-92 [4]	33	319	352	6.70	LS (0.7') - $ SH (1') - LS (0.25')	396	1.95	2.61	6.7	0.75	5093	757	764	18	47	0.48	Fig6.6b, Df/T=10/2 used
SA-93	33	320	353	6.60	LS (0.5') - $ SH	397	4.05	1.89	4.35	0.98	5020	929	984	18	34	0.57	Fig6.6a, Df/T=5/3 used
SA-96	23	342	365	6.90	LS(1.95')-S SH(0.55')	414	5.9	1.89	5.6	0.98	5020	967	984	18	34	0.57	Fig6.6a, Df/T=5/3 used

Notes:

1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using 4828.4+0.47*W_p, W_p in inches for considering softening effect.
3. Calculated using q_a=0.2$C_s q_u$ except for SA-34, SA-84, and SA-85 where q_a=0.125$C_s q_u$ was used.
4. The soil cover depth was not reported in the log and assumed based on hole SA-93 log.
5. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable siltstone/sandstone zone.
6. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable carbonaceous zone.
7. Durable layer was not encountered down to termination depth which was at 9.47-ft of the floor. A 2ft thick durable nodular limestone was assumed at a depth of 10-ft. The C_s value of 0.9 was estimated since there was not any C_s data available for Wp/Wr of greater than 4.

TABLE 6.5 ALLOWABLE EXTRACTION RATIO AND PILLAR WIDTH ASSUMING SQUARE PILLARS AND 20 FT WIDE ROOM USING BORE HOLE DATA

BOREHOLE	OVERBURDEN SOIL THICKNESS (ft)	OVERBURDEN ROCK THICKNESS (ft)	DEPTH OF COAL (ft)	THICKNESS OF COAL (ft)	DURABLE ROCK TYPE	VERTICAL OVERBURDEN STRESS[1] (psi)	THICKNESS OF DURABLE LAYER (ft)	RATIO OF PILLAR TO ROOM WIDTH	THICKNESS OF NON-DURABLE LAYER (ft)	BEARING CAPACITY CORRECTION FACTOR	ULTIMATE BEARING CAPACITY[2] (psi)	STRESS IN PILLAR (psi)	ALLOWABLE BEARING CAPACITY[3] (psi)	ROOM WIDTH (ft)	PILLAR WIDTH (ft)	EXTRACTION	REMARKS
	S	Rx	D_{coal}	t_{coal}		σ_v	T	W_P/W_r	D_f	C_s	q_u	s_{tp}	q_a	W_r	W_P	e	
SA-2	150	232	382	6.20	NOD LS	406	5.62	1.85	2.45	0.96	5037	964	967	20	37	0.58	Fig6.6a, Df/T=5/3 used[6]
SA-25	48	323	371	5.58	S SH	415	4.37	1.90	5	0.98	5043	967	988	20	38	0.57	Fig6.6a, Df/T=5/3 used
SA-34	24	344	368	5.71	$S - LS	417	3.15	3.75	3.84	1.05	5251	669	689	20	75	0.38	Fig6.7a, Df/T=4/2 used
SA-53	76	242	318	6.00	S SH (1.25') - SS	349	18.15	2.10	6.9	0.76	5065	760	770	20	42	0.54	Fig6.7b, Df/T=8/6 used
SA-57	35	300	335	6.09	CB $ SH (0.35') - S SH	377	2.62	2.10	5.1	0.82	5065	821	831	20	42	0.54	Fig6.6a, Df/T=5/2 used
SA-58	25	322	347	6.32	LS	393	2.58	1.95	2.92	0.90	5048	899	909	20	39	0.56	Fig6.7a, Df/T=4/2 used[5]
SA-63	119	209	328	5.22	$ SH	351	2.13	2.00	3.45	0.80	5054	790	809	20	40	0.56	Fig6.6a, Df/T=5/2 used
SA-67	28	331	359	6.16	LS (0.45') - $S(2.45')-LS(1.6')	406	4.5	1.90	2.99	0.98	5043	946	988	20	38	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-70	61	311	372	5.02	NOD LS	414	1.76	1.90	2.24	0.98	5043	964	988	20	38	0.57	Fig6.6a, Df/T=5/3 used[6]
SA-71	47	329	376	6.72	LS (0.75') - $ SH	421	3.25	1.95	5.68	0.99	5048	965	1000	20	39	0.56	Fig6.6a, Df/T=5/3 used
SA-74	61	286	347	6.25	L SH (0.37') - $ SH	385	5.05	1.80	3.63	0.93	5031	931	936	20	36	0.59	Fig6.6a, Df/T=5/3 used
SA-75	30	342	372	7.00	LS	419	1.65	2.05	1.82	0.92	5060	929	931	20	41	0.55	Fig6.7a, Df/T=4/2 used[5]
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SA-88	31	336	367	6.35	SS	414	2.3	3.10	12.45	0.72	5178	723	746	20	62	0.43	Fig6.7a, Df/T=12/2 used
SA-89	44	336	380	5.50	LS (0.55') - $ SH	426	2.3	2.85	7.7	0.77	5150	777	793	20	57	0.45	Fig6.6b, Df/T=10/2 used
SA-91	26	344	370	7.20	Coal (1.4') - S SH (1.75') - SS(4.95')	419	13.1	1.90	5.4	0.98	5043	976	988	20	38	0.57	Fig6.6a, Df/T=5/3 used
SA-92[4]	33	319	352	6.70	LS (0.7') - $ SH (1') - LS (0.25')	396	1.95	2.65	6.7	0.75	5127	751	769	20	53	0.47	Fig6.6b, Df/T=10/2 used
SA-93	33	320	353	6.60	LS (0.5') - $ SH	397	4.05	1.85	4.35	0.96	5037	942	967	20	37	0.58	Fig6.6a, Df/T=5/3 used
SA-96	23	342	365	6.90	LS(1.95')-S SH(0.55')	414	5.9	1.90	5.6	0.98	5043	963	988	20	38	0.57	Fig6.6a, Df/T=5/3 used

Notes:
1. Density of 135 pcf and 165 pcf was assumed for the soil and rock overburden, respectively.
2. Calculated using 4828.4+0.47*W_p, W_p in inches for considering softening effect.
3. Calculated using q_a=0.2$C_s q_u$ except for SA-34, SA-84, and SA-85 where q_a=0.125$C_s q_u$ was used.
4. The soil cover depth was not reported in the log and assumed based on hole SA-93 log.
5. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable siltstone/sandstone zone.
6. Since C_s values for a case where thin non-durable layer followed by a limestone layer was not available, C_s values were conservatively assessed using available computed relationship for a durable carbonaceous zone.
7. Durable layer was not encountered down to termination depth which was at 9.47-ft of the floor. A 2ft thick durable nodular limestone was assumed at a depth of 10-ft. The C_s value of 0.9 was estimated since there was not any C_s data available for Wp/Wr of greater than 4.

available data, these areas appear relatively isolated. Excluding these fracture areas, the calculated ratio ranged from 42 to 58% at the boreholes.

Table 6.5 shows the allowable extraction ratios for the known floor conditions assuming a 20 ft room width range from 32 to 59%. Excluding the localized fracture areas, the calculated extraction ratio range from 43 to 59% at the boreholes.

As reflected in Tables 6.4 and 6.5, there is considerable variation in the allowable extraction ratios (e_a) with corresponding changes in the floor conditions, as discussed above, across the application area. In determining e_a, conservative assumptions were made including:

- Using established bearing capacity relationship for mudstone. Based on the Allerton floor testing, the weak immediate floor is less plastic than mudstone and overall classifies as a slightly silty mudstone (or mudstone-silty mudstone). It is expected that the triaxial strength of this less plastic rock would be greater than for the mudstone.
- Less plastic floor will also tend to result in a more limited softening effect under the perimeter of the pillar.
- In determining the softening correction factor (C_s), thicker weak floor were assumed in places. This was done because bearing capacity relationships had not been established for thinner layers (e.g. D_f < 4-5 ft) of non-durable floor on top of the first resistant layer.
- In places, the durable layer was assumed to be of weaker materials. No established relationships for C_s have been generated for the stronger durable layer at the project depths.

- Resistant or durable layer depths were not extrapolated between C_s correlation lines. Depths were taken to the nearest but deeper C_s vs. W_p/W_r curve.

7.0 PILLAR-FLOOR STABILITY MINE DESIGN REQUIREMENTS

7.1 Allowable Coal Extraction

In Sections 5 and 6, the allowable coal extraction across the reserve has been calculated based on the pillar and floor strength, respectively. The floor stability condition is controlling the allowable extraction in this reserve assuming square pillars with a room width of 16-20 ft. It should be noted, however, where resistant floor is immediately below the No. 6 Coal, or just below, the floor capacity would clearly exceed the pillar strengths. The vast majority of the extraction area is between 40% to 55% extraction. The main area of lowest extraction where D_f was the deepest was estimated at 40-45%.

As discussed in Section 6.6, it is believed that these calculated allowable extraction ratios for floor stability are conservative. No triaxial strength testing was performed for the long term stability analysis at the time of issuing this report. Therefore, having assumed strength characteristics for a more plastic rock would underestimate the softened bearing capacity. Also, adjustments on the ultimate floor bearing capacity for softening effects, as discussed in Section 6.6, were overestimated. Therefore, with appropriate triaxial strength testing and more site specific FEM analyses, a better estimation and potentially improved allowable extraction can be achieved.

7.2 Design Extraction Ratios

Based on the available data provided in this report, to achieve long-term stability across the application area (excluding significantly fractured floor areas), an average e_a of 52% would be recommended. The extraction ratio may change across the reserve due to variation in geologic conditions. Further geotechnical investigation and testing data will be provided where typical site conditions are not encountered. One fairly localized fractured floor area was identified in the middle portion of the application area where the recommended extraction would be on the order of 35%[6]. Given the restricted extraction in this area, it may be cost effective to place the slope bottom coal in this area.

Because of the variable floor conditions, the proposed Sunrise Mine is most adaptable to a two-staged mining process. This room-and-pillar process would include initial mining at the expected minimum uniform extraction ratio. The second stage mining can be done by corner fendering or slabbing the stage-one pillars upon retreat. A schematic of this is depicted in Figure 7.1.

The final or second stage extraction would depend on the site specific floor conditions. Because the spacing of the project borings is too widely spaced to accurately assess the site specific conditions (e.g. the continuity of the rock beds in the floor), in-mine floor sampling is recommended if greater than the nominal floor bearing capacity is assumed. Further, in-mine drilling and sampling is recommended to determine the weak floor condition and first bearing resistant zone. The location of these holes and determination of the floor conditions should be made by a qualified independent geotechnical engineer.

This more efficient mine design will typically result in an increase of 5 to 10% higher extraction using the 2 staged mining process. Upward to 58% has been estimated using stability analysis results provided herein.

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[6] Except for the area mentioned above, extensive, slickensided or fractured conditions in the immediate floor are assumed to be too localized to substantially affect the resulting bearing capacity. If this is found to be otherwise the case (e.g. found in areas greater than 100 ft wide) from the in-mine floor sampling, an adjustment in floor design may be required.

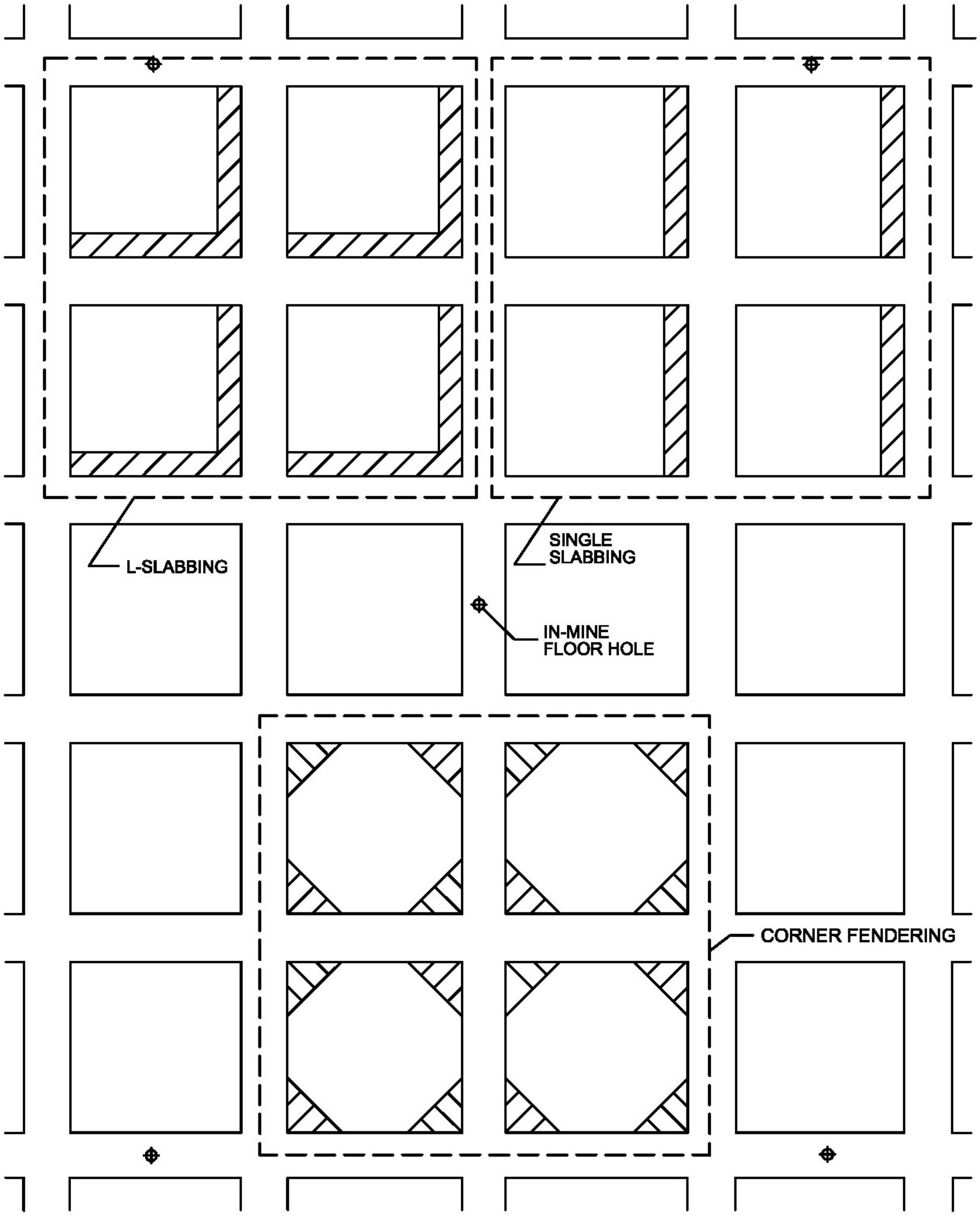

FIGURE 7.1 SCHEMATIC OF SECOND STAGE ROOM-AND-PILLAR MINING AFTER IN-MINE FLOOR EVALUATION

Consequently, there is a significant advantage to two-staged mining as final room widths, W_{r2} can be reasonably expanded with little concern for subsidence related to room collapse upon abandonment in deeper mines. Moreover, this same methodology can be used for other coal mines at this depth or greater where no surface subsidence is a requirement.

Figure 7.2 includes a graph (shown to the left) depicting the relationship comparing square pillar widths (W_p) (which controls floor and pillar stability) for one-time mining, (W_{p1}), and that after two staged mining (W_{p2}) for different extraction ratios. Extraction ratio contours are for both stage-one (e_1) and stage-two mining (e_2). As can be seen from this plot, there is a significant fundamental advantage to two staged mining in obtaining greater overall coal extraction without sacrificing surface subsidence potential. For example, for the same extraction ratio of 50% W_{p1} = 43 ft vs W_{p2} = 72 ft with final cut of rooms to 30 ft wide. This is in addition to less required permanent roof support.

The second graph to the right in Figure 7.2 depicts what initial mining configuration is required, assuming a stage-one mine room width (W_{r1}) of 18 ft, and a constant center-to-center spacing (c/c) for the targeted final extraction ratio and pillar room width after stage-two mining. This graph will be very helpful to establish initial mining configurations while considering the final layout after stage-two mining. Going across to the left graph, the extraction ratio can be determined for the same square pillar width if one time mining is done. For example, say 72 ft squares and 30 ft rooms, or an extraction ratio of 50%, are targeted as above, the initial extraction will be 32% assuming 18 ft rooms and 84 ft pillars. As you can see from these correlations, after the

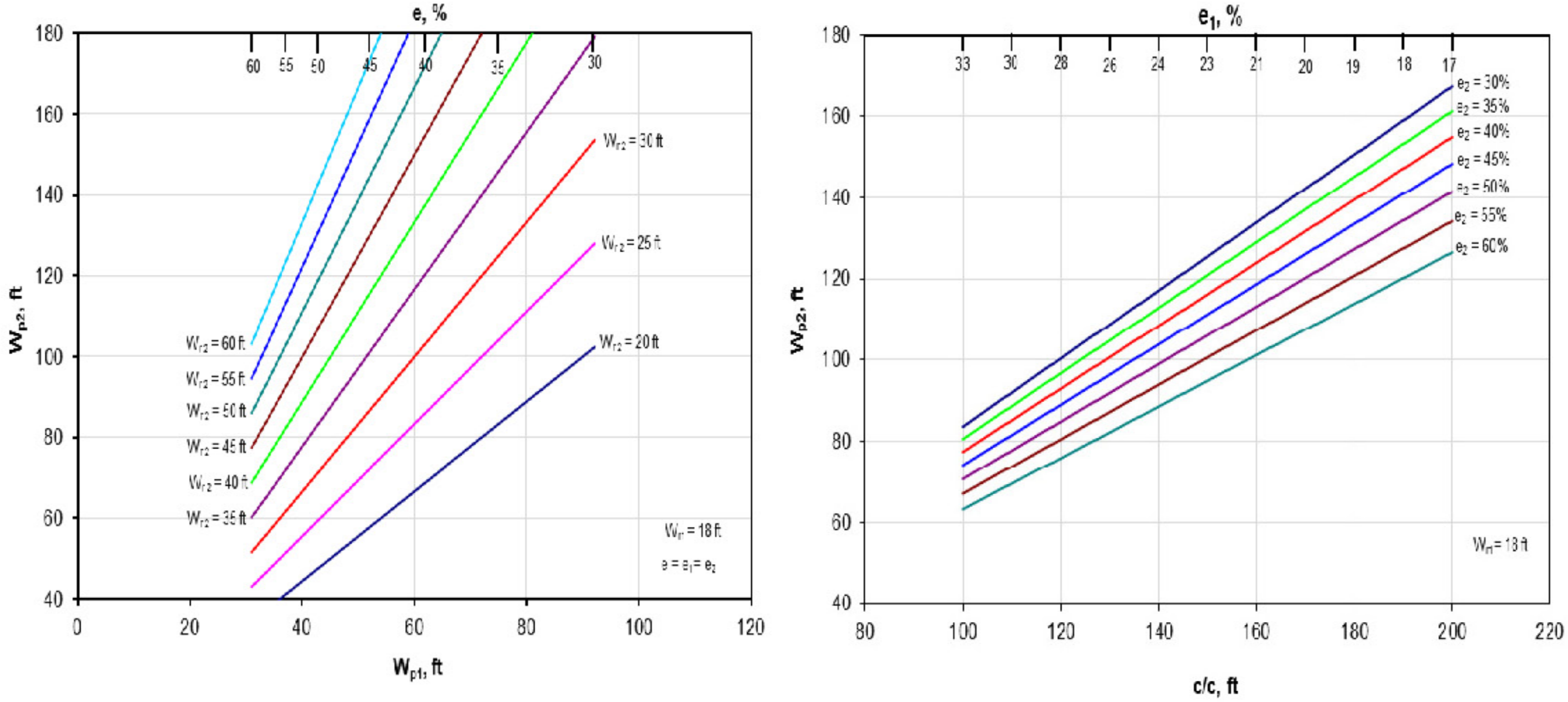

FIGURE 7.2 TWO STAGED MINING ROOM-AND-PILLAR RELATIONSHIPS (ASSUMING SQUARE PILLARS AND "L" SLABBING)

mine is opened, it would be prudent to perform this mining as soon as practical to optimize the mine plan for second staged mining upon retreat.

7.3 Roadway Stability

Roadway stability in the form of severe rutting and muddy conditions may be present in mine floor areas which are exposed to significant traffic and moisture. These roadway conditions can be mitigated by providing drainage away from areas of concern, installing gravel with possibly a geofabric/grid reinforced base, or possibly the use of cement stabilization. Leaving a coal floor may be another option.

8.0 SUMMARY AND CONCLUSIONS

At the request of Sunrise Coal Co., Marino Engineering Associates, Inc. (MEA) has performed a mine stability analysis for a proposed room-and-pillar mine in the Herrin No. 6 Coal in Vermilion County, Illinois. The coal reserve is located just south of Oakwood, IL and is called the Allerton Reserve herein.

The Herrin Coal in the Allerton Reserve ranges in depth from typically 344 to 377 ft, but can be as shallow as 318 ft. Within the permit application area the coal ranges from typically 5 to 7 ft and is generally thicker to the north.

The No. 6 Coal was cored throughout the reserve. In the analyses performed herein, information from a total of 44 core holes were used. The continuous coring in these holes was commenced in the roof and overburden and continued into the floor of the No. 6 Coal.

Recovery rates were recorded and RQD measurements were taken in some of the cored holes. Select core was tested for moisture content, indirect tensile strength, point load strength, uniaxial compressive strength, rock durability, rock plasticity, and rock swell.

Because surface subsidence must be prevented in the application area, the design focus is on long-term stability of the proposed room-and-pillar workings. Mine roof, pillar and floor conditions were assessed across the application area. As discussed in Section 4 of this report, room-roof collapse should not result in surface subsidence. Even if a room collapse occurred, the proposed mine would be too deep and the rock overburden would be too thick for the collapse to affect the ground surface. Therefore, for the purposes of this analysis, a room-roof stability analysis was not performed.

Pillar strengths across the application area were also calculated. Considering long-term stability, allowable extraction ratios were determined at the hole locations assuming square pillars and a room width of 18 ft. Allowable extraction ratios ranging from 60% to 68% were determined. See Section 5.

As expected, the most controlling component of mine support exists in the floor. Therefore, based on the information and design methodology presented herein, the long-term support capacity of the floor was less than that for the coal pillar, and thus was the support element which restricted the extraction across the application area. See Section 7.1.

In determining the floor support across the application area, a detailed analysis was performed of the engineering geological conditions. A key factor in assessing floor support is determining the depth of the weaker non-durable immediate floor material immediately above the first resistant durable zone. Across the permit application area, the thickness of this non-durable material appears to be essentially non-existent to depths possibly greater than 13 ft (typically in the 2 to 10 ft range). The most immediate resistant zone was also variable, ranging from a limestone, shale or sandstone unit. See Section 2.5.

The engineering properties of an immediate non-durable floor material also play a key role in the ultimate support capacity of the floor. Based on the rock plasticity (i.e. liquid limit determinations) the non-durable floor material was found to be fairly consistent across the application area and overall classify as a slightly silty mudstone or mudstone-silty mudstone (MS-$MS). From our experience, depending upon the rock plasticity, the triaxial strength can vary up to about 3 times the lowest.

Another key factor in assessing the floor bearing capacity, which should not be ignored, is the rock fracturing. The amount of in place fracturing in the rock determines the rock mass strength. The fracturing condition alone can affect the ultimate strength of the floor by up to 200% or more. Based on the known fracturing conditions across the reserve, the rock mass strength was assessed to be 40% of the intact rock strength except in a localized extensively fractured area. In this area, the field reduction factor was taken at 25%. See Section 6.5.

For long stability, as well as while the mine is active, floor softening should be considered. In this regard, the Vesic-Speck Method (Speck, 1979), which is used in the Illinois Basin has its shortcomings. This method estimates the floor bearing strength based on moisture content of fresh rock. No consideration is made for moisture increase when the floor becomes wet and softened, nor is there any adjustment for variations in fracturing or slickensides. Furthermore, the assessment of the thickness of the weak floor based on the moisture profile seems entirely arbitrary.

The methodology used to analyze the bearing capacity of the softened floor condition is discussed primarily in Sections 6.3 to 6.6. Corrections to the bearing capacity equation have been established for softening, fracturing, and depth and thickness of a durable zone for various pillar to room ratios. The softening correction was developed for a mudstone floor with or without a durable zone. Therefore, employing this correction factor should be conservative as the floor at the project site is less plastic. Moreover, the presence of a durable zone was underestimated.

Considering the softened floor condition and the available data, allowable extraction ratios calculated across the application area ranged from about 40 to 58% except where highly fractured floor was encountered. The extraction assessed in much of the application area ranged from 45 to 55%. The fractured floor area appears to be fairly localized and would restrict coal extraction to about 35%. To design for long-term stability, an average extraction ratio of 52% is recommended. This rate may change across the reserve based on further geotechnical testing and presence of localized fractured zones. With greater exposure to unplanned subsidence, a higher uniform extraction can be used. See Section 7.2.

Given the variability of the floor support conditions, the permit application area is more adaptable to a two-staged mining process. This would be the most cost effective process consisting of an initial development at a lower extraction followed by a second stage of mining upon retreat. During stage two, the rooms would be widened according to the floor strength. The floor strengths in an area would be determined after stage one by in-mine coring and index testing of the floor.

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May 11, 2012

APPENDIX A

HOLE SUMMARY TABLE INCLUDING ROCK MECHANICS TESTING RESULTS ON FLOOR

Attachment IV-3A3

HOLE SUMMARY OF FLOOR CONDITIONS AND PROPERTIES

DRAFT 4/2/12

Boring Name	Recovery (%)	RQD (%)	Top Depth (ft)	Material Description (MEA)	Thickness (ft)	Friction Angle	Weighted Ave. Friction Angle	Resistance	Duro Index	Duro Index Depth (ft)	MC (%)	MC Depth (ft)	AL	AL Depths (ft)	UCS/IT (psi)	UCS/IT Depth (ft)	Size correct Point Load Index (lbf/in^2)	Point Load Depth (ft)	Point Load Depth Above Floor (ft)	Type
SA2-171414	96	?	381.73	#6 COAL	6.2				-	-	-	-	-	-	-	-				
			387.93	CARBONACEOUS MUDSTONE TO SILTY MUDSTONE	0.35	27.5	27.5	NR	-	-	-	-	-	-	-	-				
			388.28	MUDSTONE TO SILTY MUDSTONE	2.1	27.5		NR	-	-	8.4, 6.9, 6.0, 6.1	388.5, 389.0, 389.5, 390.0	-	-	-	-				
			390.38	NODULAR LIMESTONE INTERCALTED WITH SHALE	5.62			R	-	-	6.1, 3.6, 3.8, 6.4, 5.1, 5.7	390.5, 391.0, 391.5, 392.0, 393.5, 394.5	-	-	680 (IT)	392.5				
			396	EOB	-			-	-	-	-	-	-	-	-	-				
SA4-171402	73	?	353.99	#6 COAL	3.93				-	-	-	-	-	-	-	-				
			357.92	CARBONACEOUS MUDSTONE TO SILTY MUDSTONE	2.08	27.5	27.5	NR	-	-	8.5	358.5	-	-	-	-				
			360	EOB	-			-	-	-	-	-	-	-	-	-				
SA5-171411	?	?	344.98	#6 COAL	6.75															
			351.73	MUDSTONE - SILTY MUDSTONE,DISC SLKS	3.05	25	27.7	NR			8.1, 8.5, 8.7, 5.7, 5.6, 6.5	352.0, 352.5, 353.0, 353.5, 354.0, 354.5								
			354.78	LIMESTONE	0.33	35		R							398 (UCS)	355				
			355.11	MUDSTONE TO SILTY MUDSTONE	0.7	27.5		NR												
			355.81	LIMESTONE	0.9	35		R												
			356.71	MUDSTONE TO SILTY MUDSTONE	1.2	27.5		NR												
			357.91	CARBONACEOUS MUDSTONE TO SILTY MUDSTONE	2.09	27.5		NR							258 (UCS)	358				
			360	EOB	-			-												
SA12-181423	100	?	356.67	#6 COAL	6.17															
			362.84	CARBONACEOUS MUDSTONE - SILTY MUDSTONE	0.35	27.5	25.8	NR			7.5	363								
			363.19	MUDSTONE - SILTY MUDSTONE, DISC SLKS	3.5	25		NR			6.8, 6.3, 6.8, 6.5, 6.1, 6.3, 4.5	363.5, 364.0, 364.5, 365.0, 365.5, 366.0, 366.5								
			366.69	MUDSTONE - SILTY MUDSTONE WITH LIMESTONE NODULES	0.31	32.5		NR												
			367	EOB	-			-												
SA16-181331	100	?	377.86	#6 COAL	4.77															
			382.63	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.2	25	27.1	NR			5.6, 5.4	383.0, 383.5								
			383.83	MUDSTONE TO SILTY MUDSTONE	6.17	27.5		NR			4.1, 4.1, 4.0, 2.8, 2.5, 3.0 (dried out?	384.0, 384.5, 385.0, 385.5, 386.5, 387.0,			1720, 1799, 1105 (UCS)	386.0, 387.5, 389.0				
			390	EOB	-			-												
SA19-181424			353.94	#6 COAL	5.87															
	100	?	359.81	MUDSTONE - SILTY MUDSTONE, DISC SLKS	2	25	28.4	NR			8.2, 8.3, 7.1, 6.6	360.0, 360.5, 361.0, 361.5								
			361.81	MUDSTONE - SILTY MUDSTONE WITH LIMESTONE NODULES, sparse DISC SLKS	4.29	30		NR			5.7, 5.8				475 (UCS)	363				
	100	?	366.1	EOB	-															
SA20-181413	?	?	362.14	#6 COAL	5.96															
			368.1	MUDSTONE - SILTY MUDSTONE, DISC SLKS	3.9	25	25	NR			4.9, 4.0, 3.5, 3.4, 3.6	368.5, 369.0, 369.5, 370.0, 370.5			1396 (UCS)	371				
			372	EOB	-			-												
SA25-181435	99	?	371.05	#6 COAL	5.58						7.8*	376.5*								
			376.63	MUDSTONE - SILTY MUDSTONE	2.9	27.5	27.5	NR			7.4, 7.4, 7.1, 7.9, 5.8	377.0, 377.5, 378.0, 379.0, 379.5								
			379.53	MUDSTONE - SILTY MUDSTONE	2.1	27.5		NR			9.6, 8.0, 5.6, 6.6	380.0, 380.5, 381.0, 381.5								
			381.63	SANDY SHALE	4.37			R							2755, 1298 (UCS)	382.0, 383.0				
			386	EOB	-															
SA26-181434	100	?	367.36	#6 COAL	6.61															
			373.97	MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.43	25	25	NR			8.2	374								
			374.4	EOB	-			-												
SA29-181425	100	?	382.5	#6 COAL	4.6															
			387.1	MUDSTONE - SILTY MUDSTONE	1.45	27.5	30.5	NR			6.8, 5.9, 6.5	387.5, 388.0, 388.5								
			388.55	MUDSTONE - SILTY MUDSTONE WITH LIMESTONE NODULES	2.15	32.5		NR			6.9, 7.1, 4.4, 4.7	389.0, 389.5, 390.0, 390.5								
			390.7	EOB	-			-												
SA30-181425	100	?	366.75	#6 COAL	3.85															
			370.6	MUDSTONE - SILTY MUDSTONE	1.1	27.5	27.5	NR			8.2, 7.9	371.0, 371.5								
			371.7	MUDSTONE - SILTY MUDSTONE	3.3	27.5		NR			7.8, 4.9, 5.6, 8.7, 6.6, 5.9	372.0, 372.5, 373.0, 373.5, 374.0, 374.5								
			375	EOB	-			-												
SA31-181330	100	?	346.2	#6 COAL	4.2															
			350.4	MUDSTONE - SILTY MUDSTONE	3.1	27.5	27.5	NR			8.3, 6.5, 7.3, 4.0, 5.2	350.5, 351.0, 352.0, 352.5, 353.0								
			353.5	SANDY SHALE	11.2			R			5.6, 3.9	353.5, 354.0			6374, 3130 (UCS)	354.5, 356.5				
			364.7	EOB	-			-												
SA33-181426	98	?	372	#6 COAL	5.22															
			377.22	MUDSTONE - SILTY MUDSTONE, DISC SLKS	2.78	25	25	NR			7.5, 8.1, 6.9, 6.4, 5.5	377.5, 378.0, 378.5, 379.0, 379.5								
			380	EOB	-			-												
SA34-181425	96	?	368.3	#6 COAL	5.71															
			374.01	MUDSTONE - SILTY MUDSTONE	3.55	27.5	27.5	NR			7.3, 8.2, 8.6, 7.7, 5.4, 9.9	374.0, 374.5, 375.0, 375.5, 376.0, 376.5								
			377.56	MUDSTONE - SILTY MUDSTONE	0.29	27.5		NR			7.5	377.6								
			377.85	SILTSTONE - LIMESTONE	3.15			R?			3.7, 2.2, 4.4, 4.6, 3.7, 4.3	378.1, 378.6, 379.1, 379.6, 380.1, 380.6								
			381	EOB	-			-												
SA39-181410	?	?	319.4	#6 COAL	6.25															
			325.65	CARBONACEOUS MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.85	25	25.0	NR			6.6, 6.4, 5.8	326.0, 326.5, 327.0								
			327.5	MUDSTONE - SILTY MUDSTONE, DISC SLKS	7	25		NR			5.3, 4.4, 4.5, 3.8, 3.4, 4.3, 6.8, 6.9, 8.3, 6.9, 6.5, 9.8, 7.	327.5, 328.0, 328.5, 329.0, 329.5, 330.0, 331.0, 331.5, 332.0, 332.5, 333.0, 333.5, 334								
			334.5	EOB	-			-												
SA40-181423	?	?	332.82	#6 COAL	5.53															
			338.35	MUDSTONE - SILTY MUDSTONE, DISC SLKS	4.65	25	25.0	NR			6.4, 5.5, 5.0, 3.3, 3.1	338.5, 339.0, 339.5, 340.0, 340.5								
			343	EOB	-			-												
SA42-181423	100	?	349.5	#6 COAL	6.2															
			355.7	MUDSTONE - SILTY MUDSTONE WITH NODULES?, SLKS THRU-OUT	2.9	23	24.9	NR			6.0, 7.2, 7.0, 4.2, 3.2, 4.1	356.0, 356.5, 357.0, 357.5, 358.0, 358.5								
			358.6	NODULAR LIMESTONE, MASSIVE	0.5	35		R							1901 (UCS)	359				
			359.1	MUDSTONE - SILTY MUDSTONE, DISC SLKS	3.3	25		NR			5.2, 4.7, 4.7, 5.3, 6.3, 5.6	359.5, 360.0, 360.5, 361.0, 361.5, 362.0								
			362.4	EOB	-			-												
SA43-181423	95	?	356.28	#6 COAL	6.53															
			362.81	CARBONACEOUS MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.22	25	27.2	NR			8.9	363								
			363.03	MUDSTONE - SILTY MUDSTONE	1.97	27.5		NR			7.5	363.5								
			365	MUDSTONE - SILTY MUDSTONE	-			NR												
				EOB	-			-												
SA46-171412	100	?	367.03	#6 COAL	6.28															
			373.31	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.3	25	31.2	NR			7.9, 8.2, 6.1	373.5, 374.0, 374.5								
			374.61	MUDSTONE - SILTY MUDSTONE WITH LIMESTONE NODULES	6.39	32.5		NR			5.1, 3.7, 4.5, 4.4, 6.0, 3.7, 5.3	375.0, 375.5, 376.0, 376.5, 377.0, 377.5, 379.0			8608, 3329 (UCS)	378.0, 379.5				
			381	EOB	-			-												
SA53-181410	?	?	318	#6 COAL	6															
			324	CARBONACEOUS MUDSTONE - SILTY MUDTSONE, DISC SLKS	0.5	25	27.3	NR			7.6	324.1								
			324.5	MUDSTONE - SILTY MUDSTONE	6.4	27.5		NR			6.6, 4.1, 6.9, 3.4, 5.9, 6.6, 5.7, 5.5, 3.3, 5.8, 6.0, 5.5, 3.	324.6, 325.1, 325.6, 326.1, 326.6, 327.1, 327.6, 328.1, 328.6, 329.1, 329.6, 330.1, 330								
			330.9	SANDY SHALE	1.25	28		R							1303 (UCS)	331.1				
			332.15	SANDSTONE	16.9			R												
SA54-181415	100	?	333.86	#6 COAL	6.45															
			340.31	MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.5	25	25.0	NR			7.3	340.5								
			340.81	MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.5	25		NR			6.1	341								
			341.31	MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.69	25		NR			4.1	341.5								
			342	EOB	-			-												
SA57-181423	100	?	335.19	#6 COAL	6.09															
			341.28	CARBONACEOUS MUDSTONE - SILTY MUDSTONE, DISC SLKS	0.5	25	27.7	NR			10.2	341.28								
			341.78	SLI SILTY MUDSTONE, DISC SLKS	1.3	26		NR			8.1, 7.2	341.78, 342.2	40/22	341.78						
			343.08	NODULAR LIMSTONE	0.4	35		R												
			343.48	SLI SILTY MUDSTONE	1.45	28		NR	MND	343.8	6.1	343.48	39/20	343.48						
			344.93	SLI SILTY MUDSTONE	1.45	28		NR			3.2	344.93			296, 201 (IT)	346.25, 346.33				
			346.38	CARBONACEOUS SILTY SHALE	0.35			R												
			346.73	SANDY SHALE	2.27			R			6.5	346.73								
			349	EOB	-			-												
SA58-181422	100	?	347.18	#6 COAL	6.32															
			353.5	MUDSTONE - SILTY MUDSTONE, SM DISC SLKS	1	26.5	26.5	NR												
			354.5	MUDSTONE - SILTY MUDSTONE	1.22			R												
			355.72	NODULAR LIMESTONE, SLIGHTLY SHALEY	0.7			NR-R												
			356.42	LIMESTONE	2.58			R												
			359	EOB	-			-												
			373.17	#6 COAL	4.48						8.8*	377.5*								
			377.65	MUDSTONE - SILTY MUDSTONE, FEW, SM, DISC SLKS	2.55	27.5	25.8	NR			8.4, 8.9, 8.4, 5.0, 4.0	378.0, 378.5, 379.0, 379.5, 380.0								
			380.2	MUDSTONE - SILTY MUDSTONE WITH 50% LIMESTONE NODULES	1.3	30		NR-R			4	380.5			323, 3436 (UCS)	380.5, 381.0				
			381.5	MUDSTONE - SILTY MUDSTONE, MANY DISC SLKS	3.5	23		NR			4.8, 5.1, 5.6, 4.9, 5.6, 5.5, 5.9	381.5, 382.0, 382.5, 383.0, 383.5, 384.0, 384.5								

SA61-171413	?	?	385	EOB	-			-												

			328.2	#6 COAL	5.22															
			333.42	MUDSTONE - SILTY MUDSTONE	0.9	27.5	27.5	NR			8.9, 7.2	333.5, 334.0								
			334.32	MUDSTONE - SILTY MUDSTONE WITH 10% LIMESTONE NODULES	2.55	27.5		NR			5.3, 4.8, 5.5, 4.8, 4.9	334.5, 335.0, 335.5, 336.0, 336.								
			336.87	SILTY SHALE	2.13			R			4.6, 4.8, 5.2, 4.8	337.0, 337.5, 338.0, 338.								
SA63-171424	98	?	339	EOB	-			-												

			359.35	#6 COAL	6.16															
			365.51	SILTY MUDSTONE - MUDSTONE, DISC SLKS	0.89	25	26.1	NR	MND	366.3	7.2	366								
			366.4	SILTY MUDSTONE - MUDSTONE, OCC SLK	2.1	26.5		NR			6.1, 3.8	367.0, 368.1	39/22	366.6						
			368.5	LIMESTONE	0.45			R												
			368.95	SILTSTONE	2.45			R	MND	369.05	4.1, 4.8, 4.4, 3.8	369.0, 369.25, 370.0, 371.	33/18	369.25						
			371.4	LIMESTONE	1.6			R												
SA67-181426	99	?	373	EOB	-			-												

			372.14	#6 COAL	5.02															
			377.16	MUDSTONE - SILTY MUDSTONE, OCC SLK	1.54	26.5	26.5	NR	SND to MND	377.95	10.6, 7.7	377.2, 378.3	43/24	378.1						
			378.7	MUDSTONE - SILTY MUDSTONE, OCC SLK	0.7	26.5		NR			3.7	379.2								
			379.4	NODULAR LIMSTONE	1.76			R			4.3	380.2								
			381.16	MUDSTONE - SILTY MUDSTONE	3.84			NR	SND	381.8	8	382	37/18	382						
SA70-181435	88	71	385	EOB	-			-												

	98	98	376.35	#6 COAL	6.72															
			383.07	MUDSTONE - SILTY MUDSTONE	1.7	27.5	30.1	NR	MND	383.85	9.1, 8.2	383.1, 384.0	46/27	384						
			384.77	NODULAR LIMSTONE	1.53	35		R			6.0, 3.1	385.05, 386.1								
			386.3	MUDSTONE - SILTY MUDSTONE	0.25	27.5		NR												
			386.55	NODULAR LIMSTONE	0.45	35		R												
			387	MUDSTONE - SILTY MUDSTONE	1.75	27.5		NR	MND	388.1	2.5, 5.5	387, 388								
			388.75	LIMESTONE	0.75			R			1.6	389.05	47/27	388.3						
			389.5	SILTY SHALE	2.5			R			3.9, 3.4	390.0, 391.0								
SA71-181435	90	55	392	EOB	-			-												

			356.6		6.43															
			363.03	CARBONACEOUS SILTY MUDSTONE, SLKS	1.02	26	27.2	NR			8.3	363.5	31.1/11.1	363.75						
			364.05	SILTY MUDSTONE	1.85	28		NR			8.3, 6.2, 5.4, 4.5	364, 364.5, 365, 365.5								
			365.9	SILTY MUDSTONE, SLKS	0.1	26		NR												
SA72-181426	100	74	366		-															

	100	88	346.82	#6 COAL	6.25															
			353.07	MUDSTONE - SILTY MUDSTONE, FEW SLK	2	26.5	24.9	NR	MND to ND	355	7.8, 8.4, 8.0	353.1, 354.1, 355.0	52/32	354.9						
			355.07	MUDSTONE - SILTY MUDSTONE, trace LIMESTONE NODULES, SEVERAL SLK	1.63	23		NR			5.4	356								
			356.7	LIMEY SHALE	0.37			R			3	357								
			357.07	SILTY SHALE	3.93			R	SND	357.1	4.4, 3.2, 4.6	358.0, 359.0, 360.1								
			361	CARBONACEOUS SHALE WITH 20% LIMESTONE NODULES	0.75			R			6.6	361								
			361.75	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.25			NR												
SA74-171402	96	74	363	EOB	-			-												

	100	98	371.53	#6 COAL	7															
			378.53	MUDSTONE - SILTY MUDSTONE, SLKS	0.55	23	25.4	NR			9.4	378.53								
			379.08	MUDSTONE - SILTY MUDSTONE, trace LIMESTONE NODULES, OCC SLK	1.27	26.5		NR	MND	379.25	4.8	379.5	43/25	379.1						
			380.35	LIMESTONE	1.65			R			3.8, 2.3	380.5, 381.6								
			382	MUDSTONE - SILTY MUDSTONE, trace LIMESTONE NODULES, DISC SLKS	3.35			NR	MND	384.9	4.0, 5.3, 5.3	382.5, 383.5, 384.5	40/23, 46/28	383.8, 384.8						
			385.35	CARBONACEOUS SHALE	0.55			R			7.9	385.5								
			385.9	MUDSTONE - SILTY MUDSTONE	2.1			NR			7.6	386.1								
SA75-181427	83	83	388	EOB	-			-												

	100	89	372.14	#6 COAL	6.2															
			378.34	MUDSTONE - SILTY MUDSTONE, OCC SLK	0.66	26.5	27.3	NR												
			379	MUDSTONE - SILTY MUDSTONE WITH 30% LIMESTONE NODULES	2.7	27.5		NR			6.2, 6.4	380.4, 381.4								
			381.7	SANDY LIMESTONE	0.64			R												
			382.34	SILTY SHALE	2.36			R	SND to MND	382.34	4.4, 3.9, 5.2, 5.6	382.4, 382.7, 383.4, 384.3								
			384.7	CARBONACEOUS SHALE	0.2			R												
			384.9	SHALEY COAL	0.45			R												
			385.35	MUDSTONE - SILTY MUDSTONE, SM. DISC SLKS	0.65			NR			7.3, 6.4	385.4, 386.0								
SA78-181434	100	77	386	EOB	-			-												

	97	?	371	#6 COAL	6.8															
			377.8	MUDSTONE - SILTY MUDSTONE, OCC SLK	2.3	26.5	26.5	NR	ND	379	7.5, 7.7, 8.3	377.80, 378.80, 379.8	44/27	379.1						
			380.1	MUDSTONE - SILTY MUDSTONE, trace LIMESTONE NODULES, OCC SLK	0.7	26.5		NR	ND	380.8	5.9, 4.0, 2.4	380.80, 381.20, 382.8								
			380.8	NODULAR LIMESTONE	2.25			R												
			383.05	MUDSTONE - SILTY MUDSTONE, SM. DISC SLKS	0.9			NR												
			383.95	LIMESTONE	0.45			R			5.6	383.8								
			384.4	SILTY SHALE	1.4			R			4.4, 4.3	384.80, 385.80								
SA81-181435	96	?	385.8	EOB	-			-												

	100	92	376.63	#6 COAL	3.18															
			379.81	SLI SILTY MUDSTONE	1.57	28	27.7	NR			11.8, 12.9	379.5, 380.0	40/14.6	379.75						
			381.38	MUDSTONE - SILTY MUDSTONE	1.8	27.5		NR			12.0, 12.6	380.5, 381.0								
			383.18	MUDSTONE - SILTY MUDSTONE	1	27.5		NR			12.2, 1.5	381.5, 382.0								
			384.18	NODULAR LIMESTONE	2.4			R			1.4, 3.9	382.5, 383.0								
			386.58	MUDSTONE - SILTY MUDSTONE	0.5			NR			5.3, 5.1, 6.6, 5.0	383.5, 384.0, 384.5, 385.								
			387.08	CLAY SHALE	2.25			NR							322 (UCS)	385.5				
			389.33	CARBONACEOUS SHALE	0.29			NR												
			389.62	MUDSTONE - SILTY MUDSTONE	-			NR												
SA84-181435	73	0		EOB	-															

	99	98	362.73	#6 COAL	5.8															
			368.53	MUDSTONE - SILTY MUDSTONE, with LIMESTONE NODULES, DISC SLKS	4.7	27.5	28.1	NR	MND	371	5.2, 3.0, 8.4, 6.8, 5.4, 4.	369.35, 370.35, 371.35, 371.80, 371.95, 372.6	35/17	371.25			<0.6, <0.6, 22.29	369.35, 371.8, 371.9	8.65, 6.2, 6.05	A,A,B
			373.23	LIMESTONE	0.5	35		R			5.8	373.4								
			373.73	MUDSTONE - SILTY MUDSTONE	0.28	27.5		NR			4.3	373.8					<0.6, 47.13	373.80, 373.90	4.2, 4.1	A,B
			374.01	SILTY MUDSTONE	3.99	28		NR			3.3, 4.4, 6.8, 7.3, 10.1, 9.	373.9, 374.3, 375.35, 375.50, 376.10, 377.0	36/18	374.5			<0.6	375.5	2.5	A
SA85-181435	89	0	378	EOB	-			-												

	100	85	383.25	#6 COAL	6.7															
			389.95	MUDSTONE - SILTY MUDSTONE	0.95	27.5	27.2	NR			8.8	390								
			390.9	SLI SILTY MUDSTONE, FREQ SLKS	2	25		NR	MND-ND	391.9	6.4, 6.0	391.10, 392.0	41/23	391.7						
			392.9	LIMESTONE	0.7	35		R			4.3	392.9								
			393.6	MUDSTONE - SILTY MUDSTONE, SM., DISC SLKS	1.7	26.5		NR			4.9, 5.1	394.0, 395.0								
			395.3	LIMESTONE	0.5			R												
			395.8	SILTY SHALE	2.8			R			4.4, 3.3, 3.7	396.0, 397.0, 398.0								
			398.6	CLAYEY SHALE	1.4			NR			6.9, 6.8	399.0, 400.0								
SA86-181435	95	68	400	EOB	-			-												

	100	57	366.6	#6 COAL	6.35															
			372.95	MUDSTONE - SILTY MUDSTONE, OCC SLK	3.45	26.5	27.7	NR			7.3, 7.5, 7.6, 9.9, 8.2, 7.6, 7.1	373.0, 373.5, 374.0, 374.5, 375.0, 375.5, 376.	41/18	372.75						
			376.4	LIMESTONE, nodular at base	0.9	35		R			2.1, 1.5	376.5, 377.0								
			377.3	MUDSTONE - SILTY MUDSTONE with 40% LIMESTONE NODULES	3.1	29		NR			4.0, 4.2, 3.1, 4.7, 5.4, 3.4	377.5, 378.0, 378.5, 379.0, 379.5, 380.								
			380.4	MUDSTONE - SILTY MUDSTONE, OCC SLK	5	26.5		NR			5.2, 5.1, 5.4, 5.4, 4.3, 4.2, 4.8, 4.7, 4.9, 3.	380.5, 381.0, 381.5, 382.0, 382.5, 383.0, 383.5, 384.0, 384.5, 385.0, 385.5, 386.								
			385.4	FINE GRAINED SANDSTONE	2.3			R			3.2	385.5			2258 (UCS)	386				
SA88-181426	100	83	387.7	EOB	-															

			379.5	#6 COAL	5.5															
			385	MUDSTONE, DISC SLKS	1.9	26	28.0	NR			8.1, 7.0	385.0, 385.95	48/32	385.95						
	100	86	386.9	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.8	25		NR			6.3, 6.4	387.0, 388.0								
			388.7	NODULAR LIMESTONE	1.3	35		R			1.0	389								
			390	SLI SILTY MUDSTONE	2.7	28		NR	ND	391	4.7, 4.7, 4.6	390.10, 391.25, 392.1	41/23	391.15						
			392.7	LIMESTONE	0.55			R			0.9	393								
			393.25	SILTY SHALE	1.75			R	MND	393.9	4.4	394								
			395	SILTY SHALE, DISC SLKS	3.3			NR	ND	396	6.6, 6.5, 4.7, 5.8	395.0, 396.10, 397.0, 398.								
SA89-181426	100	62	398.3	EOB	-			-												

	100	86	370.3	#6 COAL	7.2												69.27	377.5	18.5	B
			377.5	MUDSTONE, DISC SLKS	1.05	26	27.6	NR	ND	378.5	3.9, 5.8	377.50, 378.05	49/29	378.3			<0.6	378.05	17.95	A
			378.55	MUDSTONE - SILTY MUDSTONE WITH 50% LIMESTONE NODULES	0.75	30		NR			6.3, 2.4, 2.3	378.55, 379.05, 379.2					21.15, 32.6	379.05, 379.25	16.95, 16.75	A,B
			379.3	MUDSTONE - SILTY MUDSTONE	3.6	27.5		NR	MND	380.8	5.1, 5.4, 2.6, 4.9, 4.6, 4.3, 6.0, 4.9, 6.	379.50, 379.95, 380.10, 380.50, 380.80, 381.50, 381.85, 381.95, 382.5	38/22	380.6			.16, 107.05, <.6, 18.67, 69.07	379.95, 380.10, 380.8, 381.85, 381.9	16.05, 15.9, 15.2, 14.15, 14.0	A,B,A,A,B
			382.9	COAL	1.4			R			10.3	383.5								
			384.3	SANDY SHALE, OCC SLK	1.75			R	MND-ND	385.1	5.7, 4.4, 3.8	384.50, 385.20, 385.5					6.33	385.2	10.8	A
			386.05	SANDSTONE	4.95			R			2.8, 4.7, 7.2, 7.4, 6.3	386.50, 387.50, 388.50, 389.70, 390.5								
			391	SANDSTONE	5			R			2.1, 2.6, 6.1	391.50, 392.50, 393.50								
SA91-181434	100	83	396	EOB	-			-												

	100	62	351.5	#6 COAL	6.7															
			358.2	MUDSTONE, DISC SLK	2	26	27.1	NR	MND	359.25	8.6, 7.2, 8.9	358.20, 359.30, 360.	45.0/23	359.1						
			360.2	SILTY MUDSTONE, with 10% LIMESTONE NODULES	0.85	28		NR			5.2	361								
			361.05	NODULAR LIMESTONE	0.95	35		R												
			362	MUDSTONE - SILTY MUDSTONE, DISC SLKS	2.9	25		NR	ND	363.3	5.8, 4.7, 5.0	362.0, 363.0, 364.0	38/19	363.55						
			364.9	LIMESTONE	0.7			R			6.3	364.9								
			365.6	SILTY SHALE	1			R	MND	365.9	5.3	366								
			366.6	LIMESTONE	0.25			R												
			366.85	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.35			NR			5.3, 7.3	367.0, 368.10								
			368.2	COALY SHALE	0.2			R												

SA92-181434	97	?	368.4	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.6			NR			6.6, 5.1	369.0, 370.0								
			370	EOB	-			-												

SA93-181434	100	90	352.5	#6 COAL	6.6															
			359.1	CARBONACEOUS SHALE	0.2	28	28.3	NR			8.3	359.1								
			359.3	MUDSTOINE - SILTY MUDSTONE	0.3	27.5		NR												
			359.6	SLI SILTY MUDSTONE	1.8	28		NR	MND-ND	360.4	10.1, 10.3, 8.5, 3.7	360.0, 360.90, 360.95, 361.45	46/24	360.3			<0.6	360.95	16.95	A
	100	69	361.4	NODULAR LIMSTONE	0.45	35		R									10.94	361.45	16.45	B
			361.85	MUDSTONE	1.6	27		NR	MND-ND	362.4	4.8, 4.7, 3.2, 5.1	362.0, 362.55, 362.70, 363.0	41/21	362.25			3.91, 35.12	362.55, 362.7	15.35, 15.2	A,B
			363.45	LIMESTONE	0.5			R												
			363.95	SILTY SHALE	3.25			R	MND	365.4	3.8, 3.9, 4.0, 3.3, 4.5, 6.8	364.10, 365.0, 365.48, 365.6, 366.0, 367.0					34.71, 235.15	365.48, 365.6	12.42, 12.3	A,B
			367.2	CARBONACEOUS/COALY SHALE	0.3			R												
			367.5	SILTY MUDSTONE	4.2			NR			6.9, 8.3, 9.2, 5.5	368.0, 369.0, 370.0, 371.10								
			371.7	SANDSTONE	6.2			R			4.6, 6.4	372.20, 373.10								
			377.9	EOB	-			-												

SA94-181436	99	97	367.43	#6 COAL	6.22															
	88	62	373.65	CARBONACEOUS SHALE	0.15	28	27.6	NR												
			373.8	SLI SILTY MUDSTONE, DISC SLKS	5.2	27		NR			7.2, 4.8, 6.7, 6.3, 4.2, 5.2, 4.2,	374.0, 374.5, 375.0, 375.5, 376.0, 376.5, 377.0	40.4/20.3	374.25						
			379	NODULAR LIMESTONE	0.65	35		R			4.5	377.5								
			379.65	MUDSTONE - SILTY MUDSTONE, DISC SLKS	1.2	25		NR			5.5, 5.2	378.0, 378.5								
			380.85	LIMESTONE	0.15	35		R?												
			381	MUDSTONE - SILTY MUDSTONE	-	27.5		NR												
				EOB	-			-												

SA96-181434	100	96	365.1	#6 COAL	6.9															
	100	39	372	V. SILTY MUDSTONE, DISC SLKS	1.8	27	27.7	NR			5.9, 7.5, 6.2, 6.0	372.0, 372.5, 373.0, 373.5	31/10.5	372.25						
			373.8	SILTY MUDSTONE with 20% LIMESTONE NODULES	3.8	28		NR			3.3, 4.4, 5.4, 3.9, 4.6, 5.7, 5.4	374.0, 374.5, 375.0, 375.5, 376.5, 377.0, 377.5			811 (UCS)	376				
			377.6	LIMESTONE	1.95			R							2066, 1191 (UCS)	378.0, 379.0				
			379.55	SANDY SHALE	0.55			R												
			380.1	CARBONACEOUS SHALE	0.13			R												
			380.23	COALY SHALE	0.22			R												
			380.45	SANDY SHALE	3.05			R												
			383.5	EOB	-			-												

SA97-181435	100	?	375.24	#6 COAL	6.35															
			381.59	SILTY MUDSTONE, OCC SLK	1.46	27	28.2	NR			6.8, 7.3, 5.3	382.0, 382.5, 383.0	37/14	382.25						
			383.05	MUDSTONE - SIILTY MUDSTONE with 10% LIMESTONE NODULES, DISC SLKS	1.2	25		NR			5.9, 5.9	383.5, 384.0								
			384.25	LIMESTONE	0.5	35		R							2842 (UCS)	384.5				
			384.75	MUDSTONE - SILTY MUDSTONE	1.85	27.5		NR			5.4, 4.1, 6.0, 5.6	385.0, 385.5, 386.0, 386.5								
			386.6	LIMESTONE	0.6	35		R							4576 (UCS)	387				
			387.2	MUDSTONE - SILTY MUDSTONE	0.8	27.5		NR												
			388	EOB	-															

Definitions:

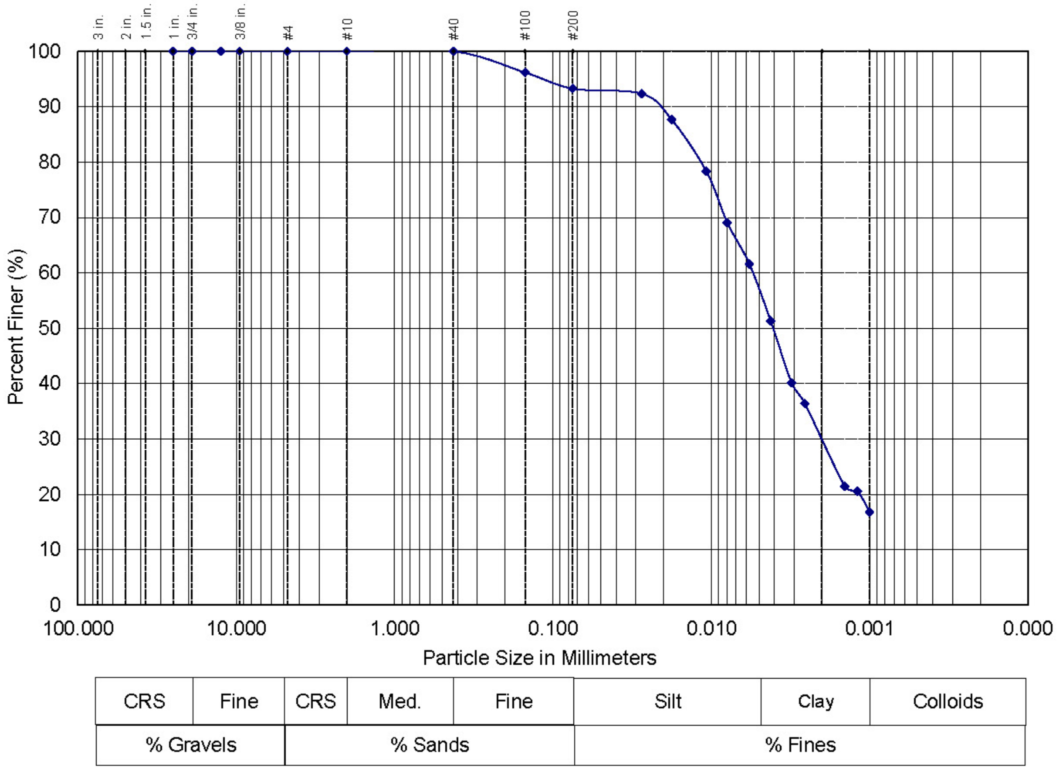
$ = silty
ANG = angular
ARG = argillaceous
BDD = bedded
BDPL = bedding planes
BK = black
BN = brown
BOT = bottom
CALC = calcareous
CB = carbonaceous
CL = core loss
CO = coal
CONC = concretion
DISC - discontinuous
DK = dark
DR = drill hole without sampling
EL = electronic log
EVY = every
F. = fine
FIS = fissile
FOS = fossils or fossilferous
FRAC'D = fractured
FRAGS = fragments
FREQ = frequent
GR = gray
HD = hard
INBD = interbeds
INCL = inclusions
IN PLS = in places
LAM = laminated
LN = lense
LS = limestone
MAS = massive
MED = medium bedded
MIC = micceous
MOD = moderately
ND = no data
NOD = nodule
PLT = plant
PR = poorly
PTS = parts
PYR = pyritized, pyrite
RGH = rough
SH = shale
SID = siderite
SLI = slight
SLK = slickensidened or slickensides
SM = small
SMS = seams
SO = soft
STKS = streaks
T. = trace
THBD = thin bedded
V. = very
VNLT = veinlets
WK = weak

APPENDIX B

ONE DIMENSIONAL SWELL TEST DATA

MEA
Soil and Rock Mechanics Laboratory

Particle Size Distribution Report



Sieve Size	Sieve Opening(mm)	Pecent Retained	Percent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00100	83.21	16.79
Hydrometer	0.00119	79.48	20.52
Hydrometer	0.00143	78.55	21.45
Hydrometer	0.00257	63.62	36.38
Hydrometer	0.00311	59.89	40.11
Hydrometer	0.00422	48.70	51.30
Hydrometer	0.00574	38.44	61.56
Hydrometer	0.00791	30.98	69.02
Hydrometer	0.01076	21.65	78.35
Hydrometer	0.01780	12.32	87.68
Hydrometer	0.02747	7.66	92.34
200	0.08	6.73	93.27
100	0.15	3.82	96.18
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion

MUDSTONE - SILTY
MUDSTONE

Atterberg Limits

LL= 39.8%
PL= 16.9%
PI= 22.9%

Classification

USCS: CL
AASHTO:

Remarks

Sieve Method

ASTM D 422,
hydrometer and sieve
analysis on portion passing
#10 sieve , (section 7.0)

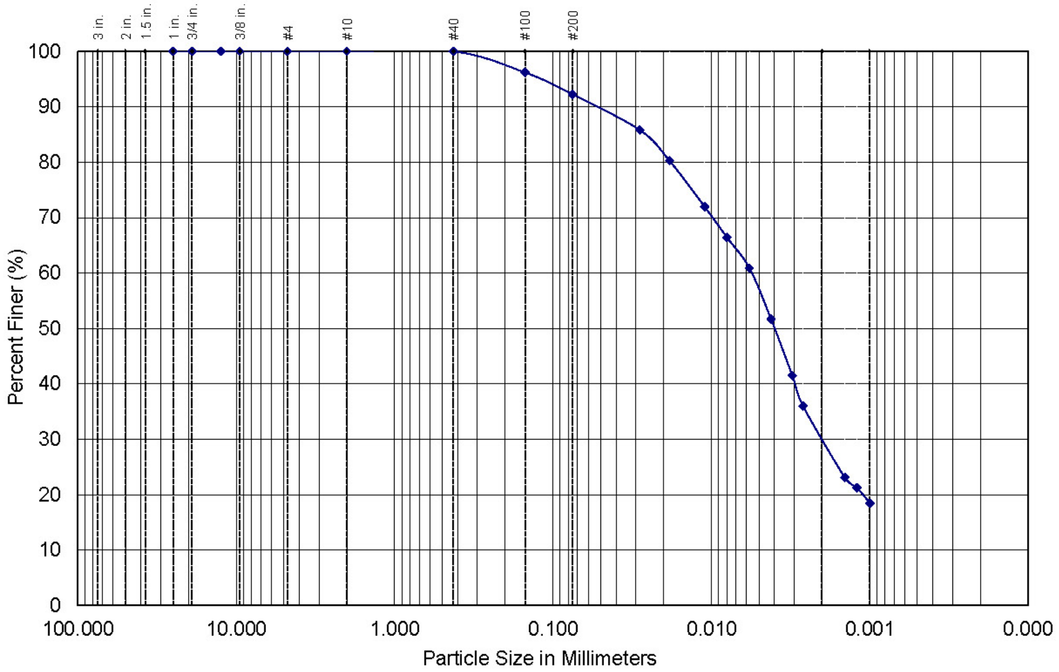
Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.

Sample ID: SA-75
Depth: 383.8'
Checked by: B.P.U.

MEA
Soil and Rock
Mechanics
Laboratory

Particle Size Distribution Report



CRS	Fine	CRS	Med.	Fine	Silt	Clay	Colloids
% Gravels		% Sands			% Fines		

Sieve Size	Sieve Opening(mm)	Pecent Retained	Pecent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00099	81.55	18.45
Hydrometer	0.00120	78.79	21.21
Hydrometer	0.00143	76.94	23.06
Hydrometer	0.00263	64.03	35.97
Hydrometer	0.00308	58.49	41.51
Hydrometer	0.00419	48.35	51.65
Hydrometer	0.00574	39.13	60.87
Hydrometer	0.00796	33.59	66.41
Hydrometer	0.01101	28.06	71.94
Hydrometer	0.01834	19.76	80.24
Hydrometer	0.02822	14.22	85.78
200	0.08	7.77	92.23
100	0.15	3.81	96.19
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion

SLIGHTLY SILTY MUDSTONE

Atterberg Limits

LL= 41.0%
PL= 18.3%
PI= 22.7%

Classification

USCS: CL
AASHTO:

Remarks

Sieve Method

ASTM D 422,
hydrometer and sieve
analysis on portion passing
#10 sieve , (section 7.0)

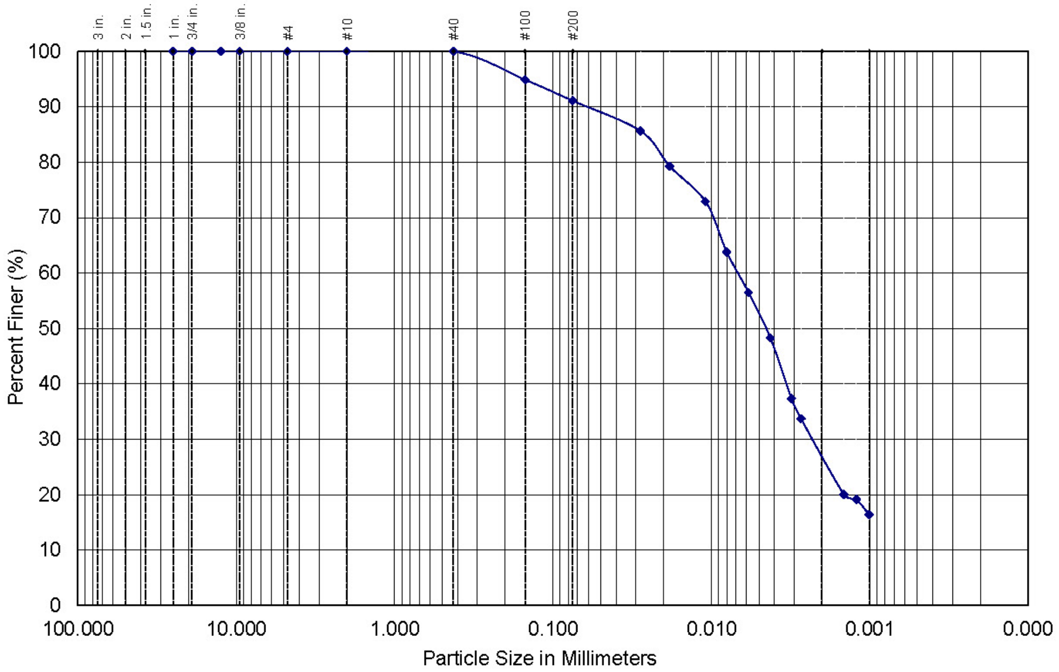
Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.

Sample ID: SA-89
Depth: 391.15'
Checked by: B.P.U.

MEA
Soil and Rock
Mechanics
Laboratory

Particle Size Distribution Report



CRS	Fine	CRS	Med.	Fine	Silt	Clay	Colloids
% Gravels		% Sands			% Fines		

Sieve Size	Sieve Opening(mm)	Pecent Retained	Percent Passing
End plate	End plate	100.00	0.00
Hydrometer	0.00101	83.60	16.40
Hydrometer	0.00121	80.87	19.13
Hydrometer	0.00145	79.96	20.04
Hydrometer	0.00271	66.30	33.70
Hydrometer	0.00312	62.65	37.35
Hydrometer	0.00424	51.72	48.28
Hydrometer	0.00582	43.53	56.47
Hydrometer	0.00798	36.24	63.76
Hydrometer	0.01087	27.13	72.87
Hydrometer	0.01826	20.75	79.25
Hydrometer	0.02795	14.38	85.62
200	0.08	8.91	91.09
100	0.15	5.12	94.88
40	0.43	0.00	100.00
10	2.00	0.00	100.00
4	4.75	0.00	100.00
3/8"	9.50	0.00	100.00
1/2"	12.50	0.00	100.00
3/4"	19.00	0.00	100.00
1"	25.00	0.00	100.00

Sample Describtion

MUDSTONE

Atterberg Limits

LL= 41.0%
PL= 20.0%
PI= 21.0%

Classification

USCS: CL
AASHTO:

Remarks

Sieve Method

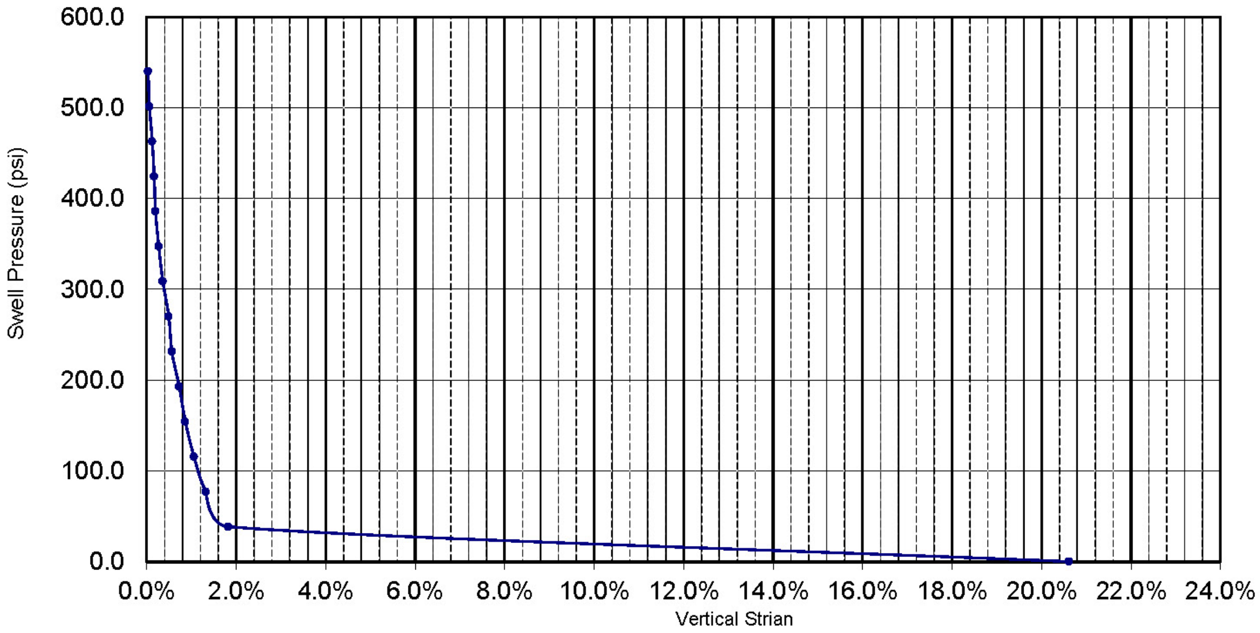
ASTM D 422,
hydrometer and sieve
analysis on portion passing
#10 sieve , (section 7.0)

Date Completed: 05 Feb. 2012

Client: Sunrise Coal
Project: Allerton Reserve
Tested by: M.M.

Sample ID: SA-93
Depth: 362.3'
Checked by: B.P.U.

SOIL AND ROCK MECHANICS LABORATORY



Note: Final Sample Height for calculating free swell vertical strain estimated for 1,000 years.

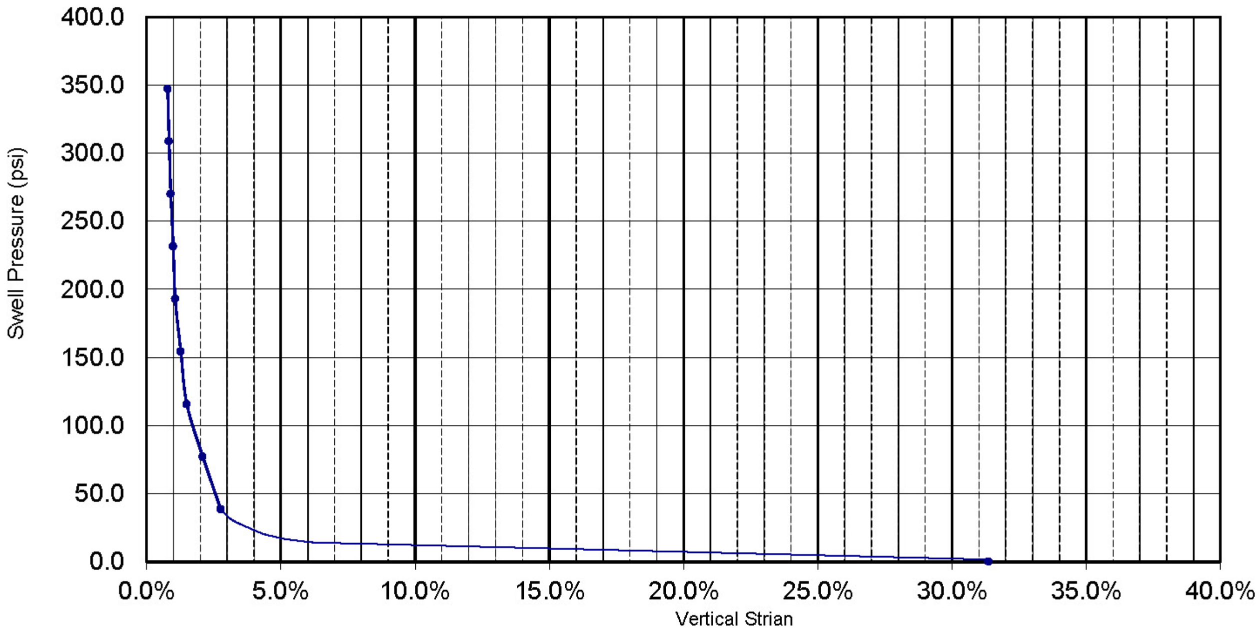
SWELL TEST RESULTS

Sample Identification :	SA-75
Sample Depth :	383.8'
Sample Classification :	MUDSTONE - SILTY MUDSTONE
USCS :	CL
Liquid Limit :	39.8%
Plasticity Index :	22.9%
Dry Density, pcf(before test) :	141.3
Dry Density, pcf(after test) :	120.0

	Before test :	After Test :
Moisture Content :	5.3%	9.5%
Void Ratio :	0.19	0.40
Saturation :	74.5%	85.0%
Specific Gravity :	2.7 (est.)	

Project: Allerton Reserve		Date: 25-Jan-12

SOIL AND ROCK MECHANICS LABORATORY



Note: Final Sample Height for calculating free swell vertical strain estimated for 1,000 years.

SWELL TEST RESULTS

Sample Identification :	SA-89
Sample Depth :	391.6'
Sample Classification :	SLIGHTLY SILTY MUDSTONE
USCS :	CL
Liquid Limit :	41.0%
Plasticity Index :	22.7%
Dry Density, pcf(before test) :	149.0
Dry Density, pcf(after test) :	111.5

	Before test :	After Test :
Moisture Content :	4.3%	9.9%
Void Ratio :	0.13	0.28
Saturation :	89.7%	102.3%
Specific Gravity :	2.7 (est.)	

Project: Allerton Reserve

Date: 6-Feb-12

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Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-6

"BEST MANAGEMENT PRACTICES" TO MINIMIZE DISSOLVED CONTAMINANTS IN RUNOFF FROM REFUSE DISPOSAL AREAS

Attachment IV-6

"Best Management Practices" To Minimize Dissolved Contaminants In Runoff From Refuse Disposal Areas

The SIU study entitled, "Identification and Assessment of Best Management Practices in Illinois Mining Operations to Minimize Sulfate and Chloride Discharges" discusses several Best Management Practices (BMP's) that may be used at mine sites to reduce the amount of sulfate and chloride present in mine discharges. As noted in the study, not all BMP's listed can be implemented at all mines due to site-specific conditions. However, Sunrise Coal intends to implement as many BMP's as practical to insure that their refuse disposal area does not unduly contaminate the mine's effluent discharges.

As noted in the SIU study, sulfide minerals such as pyrite and marcasite will oxidize in the presence of oxygen and water to form highly acidic, sulfate-rich discharges. Controlling water and/or oxygen access to the sulfide minerals will help to control the amount of sulfates generated. However, in contrast to sulfates that are generated from oxidation, chlorides are naturally present within the coal. Fragmenting the coal during mining and processing procedures leads to the liberation of chlorides into mine drainage. Sulfate and chloride discharges are independent from one another; however both may occur due to the presence of both sulfide minerals and chlorides in Illinois coal.

In order to reduce the sulfate and chloride discharges, Sunrise Coal intends to implement the following BMP's listed in the SIU study for their refuse impoundment.

- <u>Systematic Covering of Older Coarse Refuse</u> - Fresh coarse refuse material typically does not generate a significant amount of sulfates for a period of 3 to 12 months. Sunrise Coal will systematically cover older coarse refuse material with fresh coarse refuse material in order to prevent oxidation and thereby reducing the amount of sulfates generated.

- <u>Compaction of Coarse Refuse Material</u> - The coarse refuse material will be transported via conveyor from the preparation plant to the refuse bins located adjacent to the refuse impoundment. The coarse refuse material will then be hauled by trucks and spread by tracked dozers in layers not to exceed 2 feet in thickness. Compaction of the coarse refuse material will be accomplished by the vibratory action created by the equipment hauling and spreading the refuse material.

- <u>Minimize Long-Term End-Dumping</u> - End-dumped and un-compacted coarse refuse piles will acidify and generate sulfates more rapidly than compacted coarse refuse. Sunrise Coal will avoid long-term, end-dumping of coarse refuse. Coarse refuse material will instead be compacted as described in the above bullet labeled "Compaction of Coarse Refuse Material."

- <u>Alkaline Amendments for Coarse Refuse Material</u> - Any coarse refuse material that does become acid before being compacted and covered will be treated with an alkaline amendment, such as lime, in order to restore non-acidic conditions. Mine management will routinely monitor the coarse refuse material for the formation of acid salts. If acid salts are present, pH test strips or a pH metering device will be used to verify the acidity level of the coarse refuse material. An appropriate amount of lime to restore non-acidic conditions will then be incorporated into the refuse material before any fresh refuse material is added. Additionally, alkaline amendments may be added as a preventative measure to minimize or delay the initiation of acid generation. This would be beneficial in areas that have not recently been covered with fresh coarse refuse material.

Upon completion of refuse disposal in this impoundment, toxicity testing will be performed and the appropriate amount of alkaline amendment will then be incorporated into the surface of the refuse material. If necessary, based on the toxicity testing, the alkaline amendment may be added over 2 to 3 seasons in order to develop a non-acid producing weathered coarse refuse surface zone. After all of the alkaline amendment has been added, the impoundment will be covered with 4 feet of non-toxic, non-combustible soil material.

- Alkaline Recharge Trenches (ART) - The establishment of ART infiltration zones in out-slope runoff and erosion control channels can intercept and counteract the acid seep pathways that can develop on side slopes and toes of coarse refuse disposal areas. Considering all of the previously mentioned measures that will be used to control sulfate containing acid mine drainage, Sunrise Coal does not anticipate a need to construct ARTs. However, the refuse impoundment will be monitored closely, and if the need arises ARTs will be installed as necessary.

- Maintain Adequate Water Depth - During active disposal of slurry, Sunrise Coal will maintain an adequate water depth within the refuse impoundment to maximize retention time allowing, differential separation of slurry constituents based on their particle size and specific gravity. This practice will help minimize "black water" return and the downstream scour and transport of fine grained pyrite.

- Sequential Movement of Discharge Point - Sunrise Coal will routinely move the discharge point of the pipe where slurry enters the impoundment in order to obtain a better slurry distribution and to maximize the available storage capacity. The practice will minimize the exposure of unsaturated coarse grained pyrite.

- Alkaline Amendments for Fine Refuse Material - After all of the fine refuse generated by coal processing has been disposed of in the impoundment, toxicity testing will be performed to determine the net neutralization potential of the waste material. An appropriate amount of alkaline amendment, such as lime, will then be incorporated into the surface of the slurry material. If necessary, the alkaline amendment may be added over 2 to 3 seasons. After all required alkaline amendment has been added, the impoundment will be covered with 4 feet of non-toxic non combustible soil materials.

"Best Management Practices" To Minimize Dissolved Contaminants In Runoff From Refuse Disposal Areas

- <u>Neutralization of Acid/Sulfate Run Off and Water Management</u> - Normal operating conditions will result in no discharge from the Refuse Impoundment. In the unlikely event that the Refuse Impoundment does discharge, the discharged water will flow to Treatment Pond #2 and be re-circulated back to the preparation plant. Excess water contained in Treatment Pond #2 will be allowed to discharge to Freshwater Pond #2. Taking the previously mentioned BMP's into consideration, it is not anticipated that any acid drainage from the mine's refuse pile will have a negative effect on Freshwater Pond #2. However, the water quality of Treatment Pond #2 and Freshwater Pond #2 will be routinely monitored, and if the need arises, the acid run off from the gob/coarse refuse pile will be neutralized with the proper alkaline amendment. This will help to ensure that any effluent discharge leaving the mine site will be in full compliance with all water monitoring requirements.

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-6B

REFUSE IMPOUNDMENT DESIGN INFORMATION

Sunrise Coal, LLC
Bulldog Mine
Permit No. 429

ATTACHMENT IV-6D

QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR CLAY LINER INSTALLATION

Attachment IV-6D

QUALITY ASSURANCE/QUALITY CONTROL PLAN
SUNRISE COAL, LLC
BULLDOG MINE
CLAY LINER INSTALLATION

Purpose

The purpose of this plan is to establish the process necessary to ensure a clay liner is constructed in all structures used for waste disposal, storage of materials containing contaminants, and /or conveyance and containment of runoff from waste or other materials containing contaminants at Bulldog Mine in Vermilion County, Illinois. The liner shall be a minimum of four (4) feet in thickness and have a permeability of $1X10^{-7}$ cm/sec. or less. The structures which shall have liners shall be, but not necessary limited to, the following:

1. Refuse Impoundment (Slurry Pond)
2. Treatment Pond #1
3. Treatment Pond #2
4. Raw and clean coal storage areas
5. All drainage control structures (ditches) connecting such structures

Scope

This plan provides the work necessary to construct a minimum four (4) foot thick clay liner to meet the required permeability in all structures where required. The clayey soils encountered at this site will be used to provide adequate liner material under the structures. Should the in situ soils not produce a liner having a permeability of $1X10^{-7}$ cm/sec. or less, bentonite or Portland cement shall be added to the soil to achieve the required permeability.

Liner Specifications

At the locations where a liner is to be installed, the topsoil shall be stripped to a depth of 8-12 inches. All roots shall be grubbed and the area shall be graded to the design elevations. Any soft, spongy, or otherwise unsuitable soil encountered shall be excavated and replaced with adequate clayey soil. The soil subgrade shall be scarified to a depth of approximately four (4) inches with a construction disk. Preparation of the area to receive the liner and placement of the fill shall be performed using tractors, backhoes, dozers, pans and/or graders.

After scarifying, four (4) inches of clayey fill soil shall be placed and compacted to 95% of the maximum standard laboratory dry density as determined by ASTM Method of Test D-698. Moisture content of the fill soils shall range within two (2) percent below and three (3) percent above optimum moisture content. Compaction shall be achieved using a sheepsfoot roller to compact the lift. Compaction shall be determined by ASTM Method of Test D6938 (Nuclear Density).

Additional fill shall be placed in 6-8 inch loose lifts, each lift being compacted and tested as stated above, until four (4) feet of clayey fill has been placed and properly compacted.

At least one (1) test shall be taken for every 7,500 cubic yards of material placed. The tests shall

Attachment IV-6D

QUALITY ASSURANCE/QUALITY CONTROL PLAN
SUNRISE COAL, LLC
BULLDOG MINE
CLAY LINER INSTALLATION

be taken on a grid pattern to insure that all liner areas will be tested. If tests indicate the proper compaction has not been achieved, the area will be re-processed and re-tested until it is acceptable. The limits of the area to be re-processed shall be delineated by performing additional tests on the areas immediately adjacent to the failed test area until samples that meet the compaction requirement are obtained.

After the liner is in place, thin walled Shelby tube samples shall be taken and the permeability determined by ASTM Method of Test D5084. At least one (1) test shall be taken for every 7,500 cubic yards of material placed. The tests shall be taken on a grid pattern to insure that all liner areas are tested. If any tests indicate the liner does not meet the permeability of $1X10^{-7}$ cm/sec, the area shall be re-processed and re-tested until it is acceptable. The limits of the area to be re-processed shall be delineated by performing additional tests on the areas immediately adjacent to the failed test area until samples that meet the permeability requirement are obtained