Engineering

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SURFACE GROUND MOVEMENT OVER RECLAIMED MINE AREAS

In coal mining states, there are vast areas of land that have been reclaimed with the stripped out non-coal overburden materials (i.e., mine spoils). This land reclamation process is typically performed concurrently with the strip mining of the coal seam(s). The surface mining to reclaimed land process is illustrated in Figure 1. In more modern mines, as the surface mining typically advances in one direction(s), the cut soil overburden and blasted non-coal rock materials are transported and placed in the abandoned pit areas.

Typical mine regulations related to placement of mine spoils only require the mine operator to restore the land to its pre-mining use, and to contour the reclaimed land to pre-existing contours. The pre-mining use of these surface mine areas is typically agricultural or just forested areas; this allows placement of indiscriminate fill with no compaction requirements. Therefore, the only compaction the fill receives is in the form of earth moving equipment in transit. These standards are far below those regulations which are required of engineered fill used to support surface structures.

In these reclaimed lands the depths of the mine spoil can vary. In older strip mines, pit depths were more limited given the extraction methodology available at the time in addition to the difficulty in removing harder overburden rock. From our experience, mine spoil depths from these older mines are on the order of 60 ft., but with more advanced mechanization of overall surface mining process, its not usual to have pit depths reaching 250 ft. with corresponding mine spoil depths. Moreover, surface mining for example of metals can represent even much deeper pit bottoms and associated thicknesses in mine spoil in these reclaimed lands.

These reclaimed lands represents the placement of deep, uncontrolled and undocumented fill where there is little to no monitoring or oversight of these land reclamation operations. Therefore, reclaimed lands can be too unstable to support infrastructure given these uncontrolled/undocumented depths of mine spoil which can vary significantly and randomly in soil composition, thickness, and density both vertically and laterally.

The ability of these lands to support infrastructure greatly depends on the expected nature and magnitude of the movement (both vertical and horizontal displacements) over the project life, and the sensitivity and response of the infrastructure to those movements. Therefore, to assess the most important site feasibility factor of the potential future damage, it is necessary to predict the expected breadth, magnitude and differential of the vertical and horizontal displacements the structure will be exposed to over the life span of the project. Moreover, it is important to note that predictions of these ground movements that can

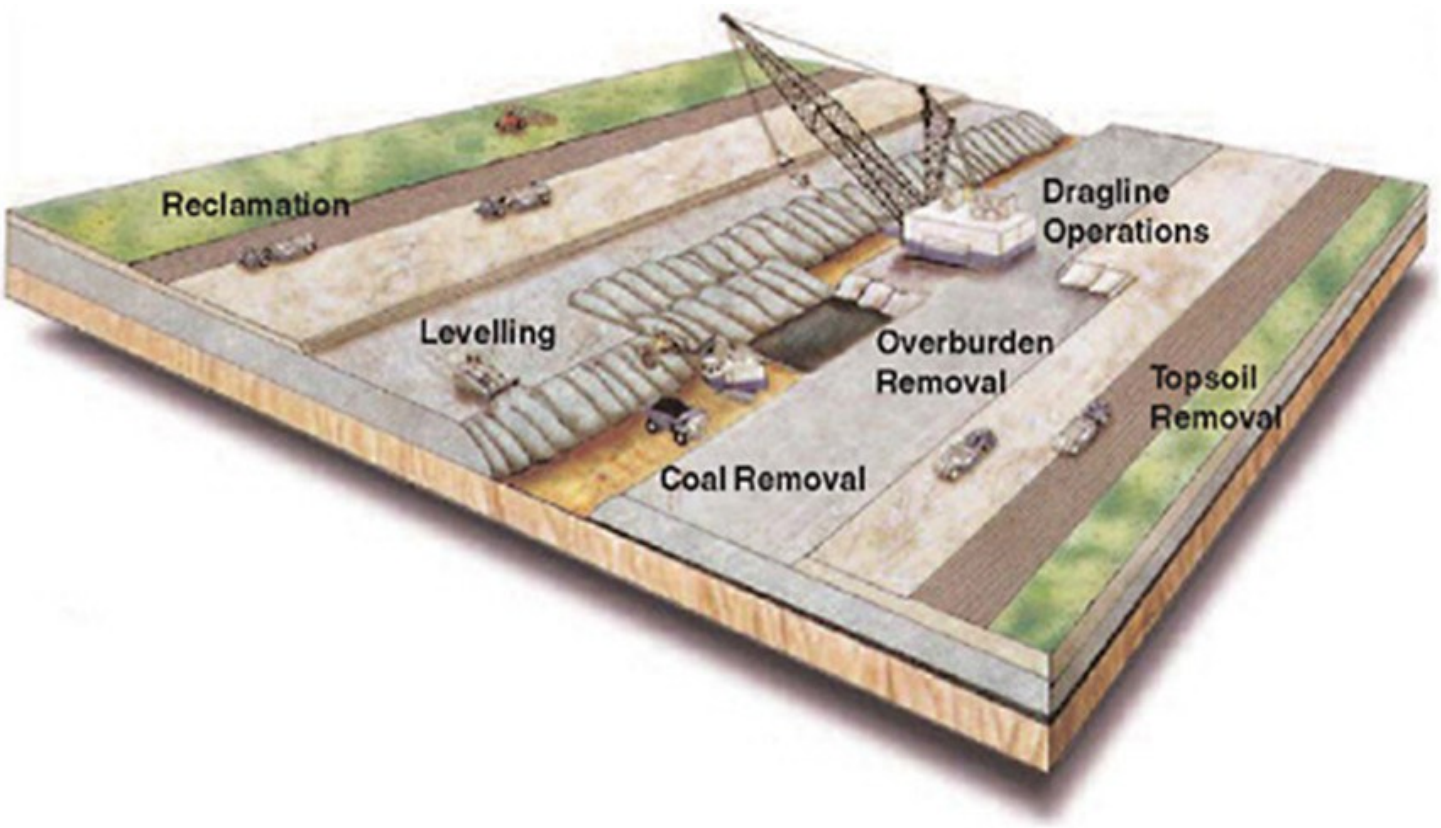

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FIGURE 1 ILLUSTRATION OF SURFACE MINING OPERATIONS

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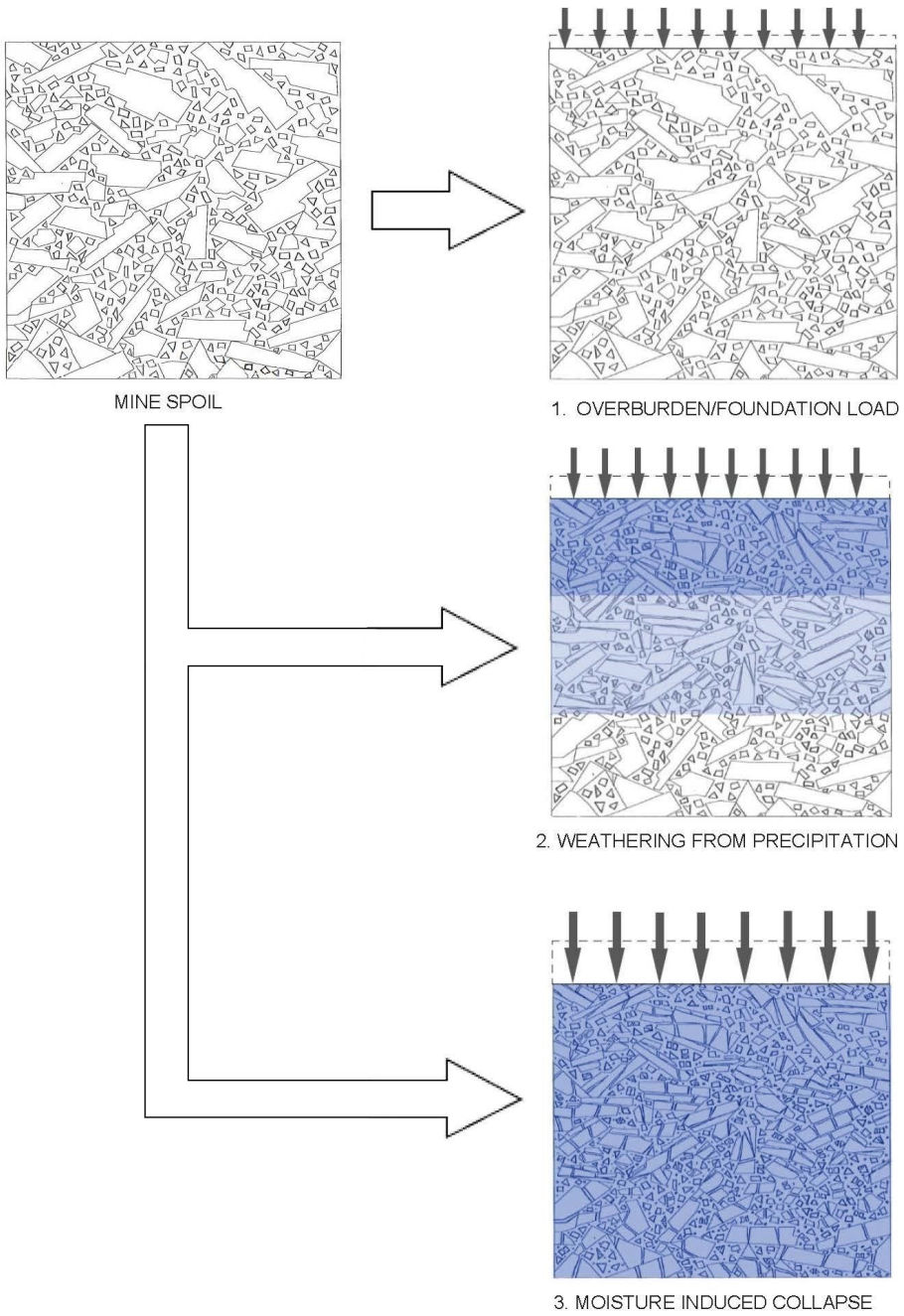

FIGURE 2 THE SOURCES OF SURFACE MOVEMENT FROM MINE SPOIL

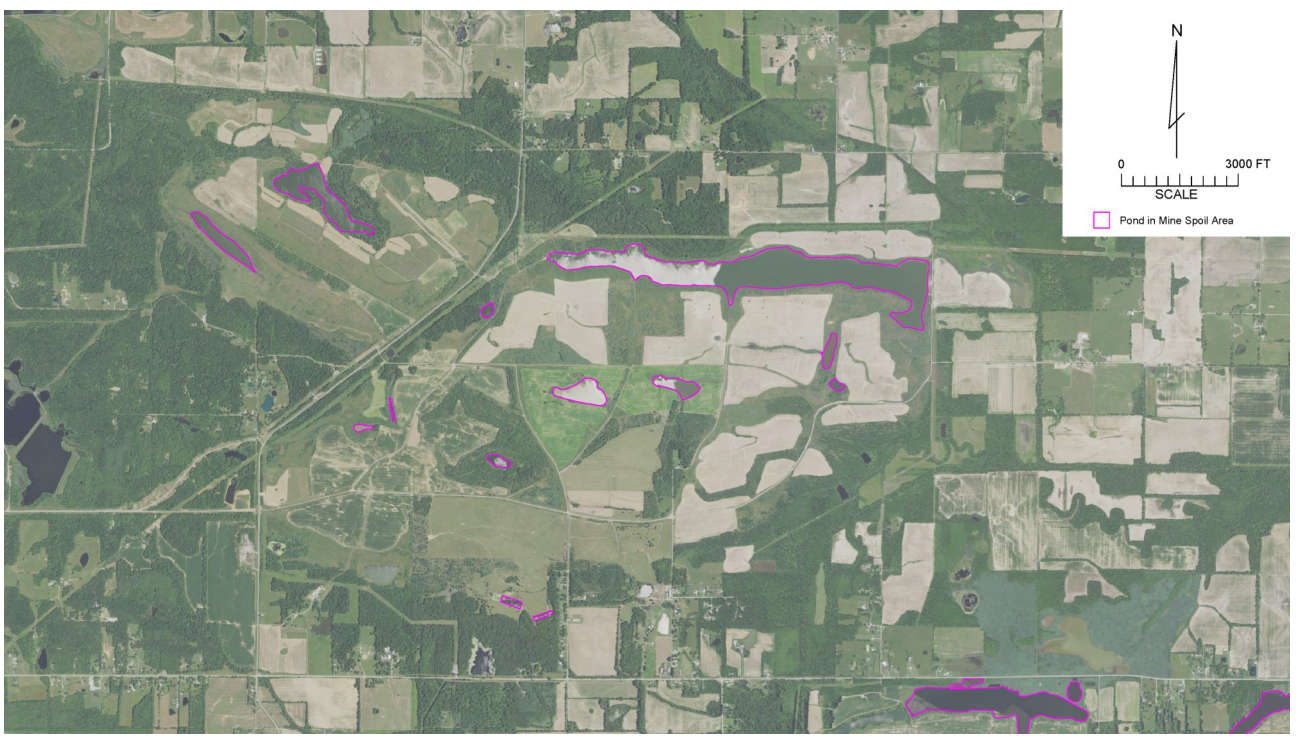

FIGURE 3 AERIAL IMAGE OF A RECLAIMED STRIP MINE AREA SHOWING PONDED AREAS CAUSED BY MINE SPOIL SETTLEMENT

be expected during the life of the project are significantly site dependent.

There are a number of factors which can play a significant role in assessing the ground movement that can be expected. These include: age of the reclaimed works, mine spoil depth, surface drainage, groundwater conditions, mine pit configuration, and mine spoil conditions. The main sources of mine spoil instability are: 1. Compression from foundation and overburden weight with depth (Source 1); 2. Swell or compression from weathering mine spoil particles from near surface changes in ground moisture (Source 2); and 3. Collapse of the spoil soil structure from the initial exposure to a significant moisture increase. From the collapse alone (i.e., Source 3), the ultimate surface settlement can be on the order 1-9% of the initial height of the mine spoil. Figure 2 illustrates these 3 sources of ground movement from mine spoils. Figure 3 shows an example of a site where ponded surface areas resulted from subsidence of mine spoil.

CONCLUSION:

When contemplating development over reclaimed surface mined areas, the considerable potential for ground movement during the of the project life should be properly evaluated by a qualified expert. The amount and nature of the ground movement varies widely from site to site and even within the project boundaries. This assessment and potential mitigation measures alone can determine the viability of the site for development for solar or wind farms, pipelines, surface structures, buildings, or other types of infrastructure.

Other MEA Publications that may be of Interest:

Are Solar or Wind Farms Feasible Over Mined-Out Areas?
https://meacorporation.com/are-solar-or-wind-farms-feasible-over-mined-out-areas/
How to Handle Geohazard Risks
https://meacorporation.com/how-to-handle-geohazard-risks/
Property Management System for Geotechnical Risks
https://www.meacorporation.com/wp-content/uploads/Update-44.pdf

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FOR MORE INFORMATION: There is a significant amount of additional information that is available on the above subject. For more information, please contact MEA at the address listed below.

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