ATTACHMENT II-F

GROUNDWATER HYDROLOGY

As stated in the Geohydrology and Susceptibility of Major Aquifers to Surface Water Contamination in Alabama; Area 4; U.S.G.S. Water Investigations Report 88-4133, Area 4 can be grouped into two types of major aquifers the Knox-Shady and the Tuscumbia-Fort Payne. The complex geologic structure has disrupted the regional continuity of the formations so that each major aquifer type occurs repeatedly in different parts of the Area 4. Individual aquifers are associated with the major valleys separated by ridges consisting of the more impermeable rock types of sandstone, quartzite, shales and slates. The same major aquifer type may be present in adjacent valleys but not be hydraulically connected because of faulting and folding. Two other aquifers, the Pottsville and the Piedmont, are used for water supply within Area 4 but are not considered major aquifers. Rocks classified as aquifers are generally carbonates, and the highest yields are from wells that have intercepted interconnected solution cavities. The Pottsville aquifer consist of the Pottsville Formation which is made up of weathered sandstones, siltstone, shales, coal seams and underclays. As shown in Table 1. of the above referenced publication the Pottsville sandstone yields moderate amounts of water to drilled wells. The quality is variable, ranging from calcium to sodium bicarbonate in character and is frequently high in iron concentration.

Regionally, the primary source of recharge to groundwater is rainfall which averages about 53 inches per year, but a large part of this is lost either by direct runoff to streams immediately after a rain or by evapotranspiration to the atmosphere. A relatively small amount of the total rainfall infiltrates to the water table to recharge the aquifers. Groundwater movement in the Warrior Basin is generally from areas of higher elevation, along bedding planes, toward stream channels. Most of the recharge to the major aquifer discharge through seeps and springs. This discharge provides the base flow for streams.

Locally, groundwater within the proposed permit and adjacent areas occurs above and below the Jagger Coal Seam. Groundwater within the proposed Shannon Mine No. 4 exists in the Pottsville Formation strata (primarily shale and some sandstone) and with the Jagger Bedrock located below the lowest coal seam to be mined.

As mentioned in the Geology Section, personnel of Twin Pines, LLC drilled groundwater monitoring site MW-1722 and MW-1723 in May 2011 utilizing a Failing 1500 air rotary drill with 7-7/8 inch bit and a 4-3/4 inch drill bit. For a description of how groundwater monitoring sites MW-1722 and MW-1723 were cased see attached Casing Specifications. See Hydro/Geo Map for the location of groundwater monitoring sites MW-1722 and MW-1723. Groundwater monitoring site MW-1722 and MW-1723 were cased by qualified personnel of Twin Pines, LLC as shown on the attached 'Casing Specifications'. Groundwater

monitoring site MW-1722 is located down dip and MW-1723 is located updip of the proposed permit area. Groundwater monitoring site MW-1722 and MW-1723 monitors the aquifer located below the Jagger Coal Seam which is the lowest seam to be mined at this site. Very little groundwater was encountered during exploration drilling at this proposed mine site due to the extensive mining of the Blue Creek Coal Seam. Groundwater that was encountered during drilling was associated with the coal seams and the sandstone unit below the Jagger Coal Seam. During the drilling of groundwater monitoring well MW-1722 water was encountered at 26 feet (approximately 5 gpm), 33 feet (approximately 5 gpm), 58 feet (approximately 5 gpm), below the surface. During the drilling of groundwater monitoring well MW-1723 water was encountered at 73 feet (approximately 5 gpm) below the surface. As stated in the Geohydrology and Susceptibility of Major Aquifers to Surface Water Contamination in Alabama; Area 4; U.S.G.S. Water Investigations Report 88-4120, recharge for the major aquifers in this area is rainfall. In this are the movement of shallow groundwater is controlled by gravity, dip of the strata, and faulting/fracture zones, so that water moves from points of higher elevations to points of lower elevations. The deeper groundwater movement is controlled by gravity, faulting/fracture zones and changes in the hydraulic head. In this area the deeper groundwater will move from areas of high hydraulic head to areas of low hydraulic head.

Groundwater levels recorded at monitoring wells MW-1722 and 1723 reveals that groundwater below the Jagger Coal Seam at the proposed mine site exists under

confined conditions due to the sharp contrast of the permeability within the aquifer. The lithology for this aquifer is primarily a sandstone and shale interval found below the Jagger Coal Seam.

Personnel from the PERC Engineering Laboratory have sampled groundwater monitoring site MW-1474 and MW-1477 on three (3) occasions between the dates 05/23/11 and 07/01/11 (see attached data). Samples were taken with either a hand bailer or a submersible pump after development. Water level is measured prior to development. Practices employed by PERC Engineering concerning the volume of groundwater extracted at groundwater monitoring sites prior to sampling is outlined as follows: Where recharge of groundwater is sufficient, three well volumes of groundwater (measured from the static depth) are pumped prior to sampling so the sample obtained is from recharge. Where recharge is slow, and three well volumes cannot be obtained within the monitoring cycle (usually monthly), only one well volume will be pumped. The well will then be allowed to recharge and a sample will be obtained after a volume equal to the volume of the pump line has been discharged. In infrequent instances where recharge is very limited, and the volume of water in the well is too small to be pumped to the surface, a 'bottom sampler' is employed to bail as much water as possible from the well. The well will then be allowed to recharge and the bottom sampler will again be used to obtain a sample when ample groundwater is present to be collected. Depth to water, and pH, are measured in the field, and the sample is split into two separate containers: a 473 ml plastic bottle is acidified and utilized for metals

analysis, and a one quart plastic bottle is utilized for all other analysis. Both are stored in an ice chest for transport to the PERC Engineering Laboratory. Samples from MW-1722 and MW-1723 were taken to the PERC Engineering Laboratory and are analyzed according to ASTM specifications. Parameters tested include pH, iron, manganese, conductivity, sulfates, acidity, and alkalinity. For the Groundwater results see the attached groundwater analysis.

Averages for selected parameters from groundwater samples taken at selected monitoring wells within and adjacent to the proposed permit area are shown below:

Interval Measured:	pH*** (S.U.):	FeT (mg/l):	SpC (umhos):	SO4 (mg/l):
Below Jagger Seam				
MW-1722	6.47	6.70	154	1
MW-1723	6.28	16.32	441	117

*** median

Groundwater quality in the Pottsville Formation was described by Thomas J. Hill in "Hydrologic Assessment, Eastern Coal Province Area 23, Alabama" on page 59. The following is an excerpt from his findings:

Parameter:	Max:	Min:	Ave:
FeT (mg/l)	7.40	0.10	0.89
pH (S.U.)	9.40	6.40	8.40*
SpC (umhos)	1760	37	504
SO4 (mg/l)	37.0	0.20	11.0

*median

A comparison between averages shown for groundwater below the Jagger Seam at the Shannon Mine No. 4 vs. Pottsville Formation averages show that the local groundwater is of lower pH, higher mineralization, slightly higher specific conductivity, and higher sulfate concentrations than the Pottsville averages shown above. As shown above, local groundwater is of lower quality than the Pottsville averages and as such is probably not reliable as a domestic source from a quality standpoint. The quality exhibited above is indicative of groundwater which is previously affected by pre-law coal mining operations.

A well inventory conducted by PERC Engineering Co., Inc. in June of 2011, revealed that there were sixty four (64) structures inventoried within a ½ mile radius of the proposed permit area as shown on the Well Inventory Map. Of the sixty four (64) structures inventoried sixty-two (62) were residences and two (2) were non-residences (Office and Church). Of the sixty-two (62) residences, four (4) residences have groundwater wells. SM4-17 and SM4-20 use their well for secondary purposes, SM4-36 & SM4-37 use the same well as their primary source of groundwater, and SM4-39 uses their well as a primary source of groundwater. One (1) residence SM4-14 has a well but does not use it as a source of water, Two (2) residences were abandoned, seven (7) residences were unoccupied, thirteen (13) residences were not at home. Forty-four (44) residences use municipal water supplied by the Warrior River Water Authority as their primary source of water. Of the forty (44) residences that use municipal water four (4) were

unoccupied and fourteen (14) were not at home and information was taken from neighbors or relatives. See attached Well Inventory Summary for pertinent information about the well inventory. These residences are located updip of the proposed mining operation and are not expected to be affected by this operation.

Groundwater movement for all aquifers in the vicinity of the Shannon Mine No. 4 should be in the direction of the predominant dip and plunge of the local strata, which as stated in Part II-E is to the southwest.