ATTACHMENT 2

EVALUATION PROCEDURES, INFORMATION REVIEW

The items provided below were developed for the review of existing and proposed impoundments. However, based on site-specific conditions and the spatial relationship of the impoundment and adjacent underground mine(s), some of the items may not be applicable. This attachment can be used as a check list to ensure the completeness of the review.

1. Permit Review (Including the Impoundment and Embankment Plan Approved by the RA and MSHA)_ The following items should be considered:

- Permit history/chronology of embankment design and verification of original permit design and revisions with MSHA file. This will determine whether the RA has approved all MSHA-approved modifications. It may also provide information concerning the underground mines, as well as information on the geology.
- Geologic and geotechnical information (including minable coal seams, location of core holes, and overburden and mine floor type/ characteristics). Include the embankment foundation investigation from the mine plans, as well as the pool area.
- Subsidence control plan for underground mine if permitted under the SMCRA permanent program). Subsidence analysis prepared for the impoundment permit. In addition to pillar stability, this may provide information on the mining geometry, seam height, coal strength, and pillar size.
- Information concerning underground mines within 500 feet of the impoundment, including the reliability of the maps, extent of information on the maps, and the correlation of the maps with the surface maps.
- Blasting and mining activities (proposed and historical) in the impoundment area--generally those activities within 500 feet of underground mine outcrop barriers (the reviewer is advised to discuss the blasting levels with the RA's blasting specialists.)
- Stability analyses (embankment design, impoundment, etc.). The stability analyses may provide information related to foundation soils/rocks, which may provide information related to outcrop barrier and overburden material.
- NPDES or other related permits associated with surface water discharges, including those from underground mine works. (Note any chemical treatment systems related to drainage/seepage from the impoundment into the underground works.)
- Probable hydrologic consequences (PHC) information (including surface/subsurface monitoring points). This will identify the location of the ground and surface water monitoring points and allow the reviewer to determine whether those points could provide information concerning seepage/leakage from the impoundment (and whether new points should be added to better determine the hydrologic impacts related to seepage/leakage). This may also identify seeps/discharge that may be related to the impoundment.
- Flooding or breach analyses of downstream areas. This information would allow a relative assessment of the impacts of a breakthrough if the breakthrough occurs in

the same watershed as the breach analyses and is similar in volume to the breach volume. It would also allow a relative assessment of another watershed where a breakthrough could discharge if that watershed is similar to the watershed for the dam breach analysis.

- For cases where seeps/discharges exist, compare the water quality parameters of slurry and seeps/discharges. This may identify similar characteristics between the slurry and seeps/discharges.
- Plans for sealing underground mine openings, including horizontal and vertical boreholes, gas wells, etc. Generally, the plans should provide specific information on impoundment pool depths and also provide specific closure methods that consider the pool depths. The plans may also contain information on the design assumptions and width of the barrier between adits or augers and adjacent underground works.
- Special conditions related to the construction and maintenance of the impoundment.

2. Aerial Photographs and Videos

- Photos and videos for indications of surface disturbance in the impoundment area; e.g., roads and diversions (roads and diversions along or across the contours may reduce the outcrop barrier), adits, portals, contour cuts, auger holes, natural benches (may show up on videos), old refuse and spoil banks (may give an indication of activity that may not otherwise show on the photos/videos).
- Photos for joints, lineaments, subsidence fractures or features, etc.

3. Surface Maps

- Historical maps of impoundment areas. This may show surface disturbance (roads, diversions, etc.) in the impoundment area that may decrease the outcrop barrier width. This may show contour cuts, which decrease the separation between the impoundment and the underground mines. This may show augers, adits, and other underground openings that should be sealed.
- Limits of backfilled areas. This may provide information on underground mine floor elevations and the barrier between the highwall and the underground works.
- Reliability of the cropline. Note that the cropline drawn on the maps may not be surveyed; may not have been located using mine elevations at the immediate area;. may be based on USGS quadrangle contour elevations (which may have an error of approximately one-half contour interval).
- Indications of natural benches located at/near the coal elevation. Natural benches may reduce the outcrop barrier width and the overburden height at the edge of the underground mine.
- Extent of prior refuse disposal. Note coarse refuse or a slurry delta deposited along the outcrop barrier (or over below-drainage underground works). This may affect the potential for seepage into the underground mine. The weight of the coarse refuse may also be a consideration with respect to pillar and roof stability.

- Extent of residential development and other critical features located downstream of the possible sites where breakthroughs could exit the underground mine.

4. **Underground Mine Maps (for each mine located beneath or adjacent to the impoundment and embankment)** Make sure the most current map is available. However, note that the most current map may not contain some of the detail provided on the earlier versions; therefore, it is appropriate to review some of the earlier maps to comprehensively consider all conditions. The following items should be considered in the assessment:

   - Name of the mine.
   - Date of the mining.
   - Extent of mined area.
   - Pillar size, entry width, and mining height.
   - Indications of second mining, including remining operations that recover internal mine barrier pillars.
   - Indications that unmapped works were encountered.
   - Indications that the works were not surveyed (e.g., dashed instead of solid lines for the works).
   - Indications of roof, floor, and water problems.
   - Indications of horizontal or vertical borings through the outcrop barrier, coal barrier, or mine roof.
   - Punchouts/breakouts from the underground mine to the surface.
   - Extent of augering.
   - Outcrop barrier width and overburden thickness (thickness of competent rock) at the edge of the underground mine; barrier between contour mine and underground mine; barrier between house coal or small drift mine and underground mine; barrier between auger holes and underground mine. Note that the upper portions of the overburden, possibly 50 feet or more, may be highly weathered and, consequently, not appropriate to be considered as competent rock.
   - Are coal barrier pillars separating the mine adjacent to the impoundment from other mines? If there is a breakthrough, could the barrier fail? If the impoundment leaks into the underground works, will the barrier prevent/inhibit seepage? This provides information pertinent to determining possible impact areas (if a breakthrough occurs). It also provides information to determine where to monitor for seepage.
   - Maps, scaled and with reference points, to allow overlay/superimposition with impoundment plan view. Note, that where the scales are different or there are insufficient reference points, the reviewer may not be able to accurately/confidently overlay the maps--even when reducing during photocopying. The permittee should be requested to prepare maps that are suitable for overlaying or, alternately, provide certified cross-sections and maps showing the impoundment and underground mine.
   - Cross-sections showing the relationship of the impoundment to the underground mine.

- The history and extent of slurry injections or discharges into the mine works assists in determining hydraulic connectivity. For example, mine drainage that passes through or over injected slurry may have the same chemical characteristic as the impounded water/slurry and could erroneously indicate seepage.
- Exploration performed to verify extent of mine workings (borings, geophysical).
- Existence/extent and elevation of any impounded water against seals or down-dip outcrop, including the outcrop adjacent to the impoundment. The underground mine may dip toward the impoundment and create a high hydraulic head on the outcrop barrier adjacent to the impoundment. A high head may also develop at sealed mine openings located in the impoundment area. The high head may adversely affect the stability of the barrier and seals and reduce their capability to withstand the pressures created by the impoundment.
- Reliability of the cropline. Note that the cropline drawn on the maps may not be surveyed; may not have been located using mine elevations at the immediate area; may be based on USGS quadrangle contour elevations (which may have an error of approximately one-half contour interval).
- Floor elevation/structural contour and pool potential of the underground works. This is necessary for determining the flow direction of seepage water. This also determines whether a breakthrough could be contained within the mine and, if not, at what points it will discharge to the surface. It may also provide information on the quantity of discharge. This should also provide information, in the event of a breakthrough, on the head that could develop at portal seals and other underground openings. It should also provide information on the head that could develop at the underground mine down-dip outcrop barrier. This is necessary to determine whether the outcrop barrier could fail as a result of a breakthrough. The above information is also necessary for determining what surface areas could be affected if a breakthrough occurs.

5. **Subsidence Analysis** The follow items relate to the potential for subsidence, the type of subsidence that could occur, the lateral extent of the subsidence, and the type of surface features (e.g., sinkholes and open cracks) that could occur as a result of subsidence.

- Geologic section, with overburden strata types and thickness.
- Pillar stability.
- Floor strength.
- Roof fall and sinkhole potential.
- Potential zones of pillar crushing, pillar collapse, or floor punch/squeeze.
- Deformation and strain/stress isopleths.
- Barrier boundaries where pillar failure can cause beam-type failure and consequently overburden cracking.
- Barrier boundaries where joints or fractures could cause blocky roof falls and sinkholes.
- Potential for joints or fractures to open in response to subsidence.

- Evaluation of the effect of the maximum weight of the overburden, embankment, slurry, water, or other impounded material through all planned stages on pillar loading.

6. Outcrop or Coal Barrier Stability

- Ability of outcrop or coal barrier abutting the impoundment to withstand pressures from the impoundment that could cause a "blow-in."
- Ability of outcrop or coal barrier abutting the impoundment to withstand water pressures from the underground mine that could cause a "blow-out."
- Outcrop barrier width in the downdip areas of the underground works and the stability of the barrier in the event of a breakthrough.
- Ability of the barrier between underground mines to contain or retard slurry leaks.

7. Liners and Seepage Barrier Stability

- Source of the liner/barrier material(s) (e.g., soil, slurry, coarse refuse, fabric, etc.).
- Geotechnical properties (e.g., strength, permeability, classification, etc.).
- Placement details (thickness, compaction effort, use of graded filters or filter fabric, underdrains, etc.).
- Seepage analysis, based upon maximum hydrostatic head on liner from maximum design pool.
- Worst-case subsidence analysis, showing the amount of strains generated on the liner/barrier.
- Stability analyses of hillside with liner/barrier--based on liner/barrier properties, natural soils conditions beneath the liner, bedrock, foundations, seepage, etc. Analyses should show the effect on the safety factor from the subsidence-induced strains.
- Procedures for slurry excavation in order to begin liner/barrier construction at an elevation below the slurry and coal seam.
- Procedures related to the construction of any cofferdams or dikes to isolate liner/barrier during its construction.
- Slurry discharge location(s) for controlling slurry fines deposition against liners/barrier.
- Details/timing of liner/barrier construction progression in advance of slurry deposition.
- Underground mine monitoring details and schedule to assure liner/barrier effectiveness.

8. Mine Opening Seal Stability (This applies to openings in the impoundment area as well as the portals if located outside the impoundment area. The portal seals outside the impoundment area should be reviewed to determine if they could contain a breakthrough)

- Type of seal and seal drains (wet, dry, bulkheads, etc.).
- As-built seal certifications or construction notes. (As a word of caution, if information on the closure is not available, it may be unsafe to assume that the closure was constructed as required by the permit.)
- Grouting plans.
- Pneumatic stowing plans.

9. Current Monitoring Data

- Location, depth, historical readings, for ground and surface water monitoring wells, and the presence of abnormal trends. For the ground and surface water monitoring locations, the points of interest are those that could be affected by seepage from the impoundment.
- Piezometer readings. Abnormally low localized piezometer readings or depressions, could indicate leakage, and high localized readings could indicate underground mine drainage into the embankment.
- Pool levels from the weekly inspection reports. Changes in the pool levels, other than those related to normal discharges into the pool and plant make-up water, may indicate leakage.
- Underground mine discharge information. Spikes in the discharge and changes in the chemistry could indicate impoundment leakage or precipitation events.
- Geochemical analysis of the slurry. Were any of the slurry components unexpectantly identified at the monitoring locations?

10. Certification, Inspection, and Enforcement Review

- Current, intermediate, and maximum permitted elevations of embankment/impoundment stages. This enables a reviewer to determine: the past, present, and future spatial relationship of the pool and underground works; and, when seepage/leakage into underground works could have started. This among other things gives a time frame for the review of ground and surface water monitoring reports.
- Weekly inspection reports required by MSHA; the construction, quarterly, and annual inspections and certifications require by the RA; and the RA's inspection reports. The information from the reports and certifications is pertinent to various items in the preceding sections.
- Historical files for inspection and enforcement history may be related to seepage/drainage into the underground works (include RA, OSM, and MSHA).
- Have impoundment failures occurred previously?
- Analyses of prior impoundment failures, including remedial measures.

11. Field review

- Augers, adits or other underground mine entries for haulage, ventilation, or access. Site conditions for such features that could be inundated in the future should be

considered, including development of certified sealing plans. The seal construction should be inspected to ensure compliance with the plans.

- Subsidence features. Features that could be inundated in the future that are above the pool may also indicate the potential for similar features below the pool surface. A plan should be required to address such features.
- Geologic anomalies (stress relief fractures, joints, lineaments, faults, , etc.). These features may provide a direct path for slurry/water drainage into the underground works. A plan should be required to address such features.
- The presence of deep colluvial or residual soil within the impoundment area. Deep soils reduce the effective width of outcrop barriers and the overburden at the limits of the mine. If the permit does not reflect the conditions, revised plans may be necessary.
- Other surface disturbances from prior surface mining, construction, oil/gas activity.
- Surface deformation monitoring of hillsides (e.g., survey monuments and inclinometers).