OFFICE OF SURFACE MINING
APPALACHIAN REGIONAL COORDINATING CENTER

CRITERIA FOR EVALUATING THE POTENTIAL FOR IMPOUNDMENT LEAKS INTO UNDERGROUND MINES (EXISTING AND PROPOSED IMPOUNDMENTS)

Prepared by
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(in cooperation with Kentucky, Virginia, and West Virginia State Regulatory Authorities)

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CRITERIA FOR EVALUATING THE POTENTIAL FOR IMPOUNDMENT LEAKS INTO UNDERGROUND MINES (EXISTING AND PROPOSED IMPOUNDMENTS)

As a result of several breakthroughs over the last few years, and the latest in Martin County, Kentucky, the Office of Surface Mining (OSM) developed an action plan for initiating an effort to assure that impoundment breakthroughs into underground mine works do not occur in the future. To accomplish the objectives spelled out in the OSM action plan, ARCC has established specific tasks concerning identification and technical evaluation of impoundment breakthrough potential, correction of identified problems, and oversight of the state programs to ensure that the Surface Mining Control and Reclamation Act of 1977 requirements related to impoundments are being fully met. These tasks will be accomplished with a maximum level of coordination among the Region's Field Offices, states, and the Mine Safety and Health Administration (MSHA), in order to ensure consistency and to minimize duplication of effort to the extent possible.

Task 2 of ARCC's Implementation Plan provides for a joint technical committee comprised of OSM, state and MSHA technical representatives. The committee, using their combined expertise along with information gained from the Kentucky and Virginia experiences, will:

- Develop criteria that should be considered in re-evaluating existing high-risk impoundments over or adjacent to underground mine works.

This review is being conducted concurrent with the National Academy of Science (NAS) "Study on Preventing Coal Waste Impoundment Failures and Breakthroughs." The NAS study may provide information pertinent to the impoundment review, and consequently, it may be necessary for the Regulatory Authorities (RA) to reconsider the findings of some of their reviews. However, because of the serious adverse effects that can occur as a result of breakthroughs, OSM does not believe it is prudent to delay the impoundment review until the completion of the NAS study.

This paper was prepared to implement Task 2. The Lexington Field Office in coordination with ARCC, the Knoxville Field Office, and the Kentucky, Virginia, and West Virginia RAs prepared the paper. The paper will be used for the evaluation of impoundments according to Task 3 of the ARCC Implementation Plan.

A. OBJECTIVE

The objective of this paper is to provide the RAs with criteria for evaluating impoundments to prevent unplanned and unpermitted discharges into underground mines. Such events have the potential to harm underground miners, and may also result in discharges from the underground mines to the surface. Discharges to the surface may harm people and adversely affect property and the environment.

B. SCOPE

RAs should distribute this paper to their permit reviewers and inspection personnel to assist in evaluating breakthrough potential for existing or proposed impoundments. Distribution to industry, consultants, and others involved in new application development or modification to existing structures to minimize breakthrough potential is also recommended.

The immediate focus of this paper concerns the review of existing water, sediment, and slurry impoundments and impounding structures that meet the MSHA criteria of 30 CFR 77.216(a). According to the criteria, "MSHA class" impoundments: 1) store 20 acre-feet or more of water, sediment, or slurry; or 2) impound water, sediment, or slurry to a depth of 20 feet or more above the upstream toe of the embankment.

The review should include all MSHA class impoundments that are currently covered by a surface mining bond, including impoundments that have been reclaimed and are pending final bond release. This includes acid mine drainage treatment ponds, coal waste/flyash facilities, etc., in addition to water, sediment and slurry impoundments.

OSM believes it is prudent for the RAs to also review the breakthrough potential for non-MSHA class impoundments during the normal course of inspection and permitting activities. Some states may have several hundred impoundments that do not meet MSHA class criteria. However, because these impoundments do not contain as much water and solids as MSHA class structures, OSM does not believe it is necessary in most cases to perform the same in-depth review as is necessary for MSHA class structures. The Soil Conservation Service Technical Release (TR) No. 60, hazard classification for the non-MSHA class structures, may not have a direct correlation with the adverse effect that could occur as a result of a breakthrough. Also, the hazard ratings may not be directly related to the amount of water stored by the impoundments. The hazard ratings are primarily based on the damage that could occur as a result of dam failure. Consequently an impoundment may have a low hazard rating under TR No. 60 due to lack of dwellings in the watershed downstream from the dam, but that impoundment may pose considerable risk to residences in other watersheds that could be effected by a breakthrough. Based on potential dam failure impacts, TR No. 60, classifies impoundments as Class C (high hazard), Class B (medium hazard), and Class A (low hazard).

The RAs should conduct the impoundment reviews in cooperation with MSHA, whenever possible. OSM technical assistance may also be requested. The RA and MSHA District Manager may find it appropriate to establish procedures to coordinate the inspections and plan revisions.

Some of the RAs may have previously reviewed the impoundment in a manner consistent with these review criteria. OSM does not expect the RA to conduct another review in such cases. However, it is anticipated that the OSM Field Office will review, under its oversight responsibility, the RA's findings.

C. BACKGROUND

There have been several unplanned and unpermitted, discharges from impoundments into underground mines. Attachment 3 provides a description of six of the events. Four of the six events resulted in discharges to the surface.

Following the three events in Virginia during 1996, OSM drafted guidelines for the evaluation of breakthrough potential. The guidelines were drafted in cooperation with the Virginia Division of Mined Land Reclamation (DMLR). DMLR also developed evaluation procedures and used them to evaluate the MSHA-class impoundments in Virginia. As a result of DMLR's review, they required some operators to prepare remediation plans. OSM met with MSHA and discussed evaluation procedures.

Following the events in Virginia, MSHA issued Program Information Bulletin (PIB) No. P00-16, December 1, 2000 (Attachment 4). The PIB was issued to make the industry aware of the dangers associated with unintentional slurry releases and to address precautionary measures to alleviate the potential problem. MSHA also developed procedures for the evaluation of the breakthrough potential in Procedure Instruction Letter (PIL) No. I97-V-11, effective December 1, 1997. The PIL has been reissued as No. I99-V-3 (Attachment 5). The PIL uses Bureau of Mines Information Circular (IC) 8741, *Results of Research to Develop Guidelines for Mining Near Surface and Underground Bodies of Water* (Attachment 7) to evaluate breakthrough potential. Using the PIL, MSHA conducted a review of the MSHA class impoundments. OSM advised the states to coordinate with MSHA and to keep current with MSHA's actions to ensure that the RA's concerns were addressed and that any permit revisions would be made as necessary. MSHA required remedial action for some impoundments based on its review. MSHA also prepared an inventory that listed the impoundments and their risk rating according to the PIL guidance. Following the October 2000 Martin County Coal Corporation event, MSHA conducted another round of field reviews generally using the PIL evaluation procedures.

D. EVALUATION PRIORITY

The RA review will be conducted according to the following priority:

1. Sites with previous problems (e.g., uncontrolled seepage, drainage to/from adjacent underground mines, subsidence features near the impoundment).

2. Unless a higher priority is assigned by the RA based on its knowledge of an impoundment, or on information provided by the public, the remaining sites should be reviewed in the order established by the "Evaluation Priority Level" assigned by MSHA during the 1997/1998 and 2000 evaluations. For the priority levels, see Attachment 3 of the PIL No. I99-V-3.

The RAs are advised to compare their inventory with the MSHA inventory to ensure that all MSHA class impoundments are listed. If the MSHA inventory does not include all the impoundments, the RAs will assign a Priority Level to the impoundments using the PIL, except that "manmade barriers" should not be automatically used to lower a Risk Potential. At this time, OSM does not believe it is prudent to assign a lower priority based on a manmade barrier in consideration that a manmade barrier was in-place at the time of the October 2000 Martin County Coal Corporation (MCCC) breakthrough. However, the RA, after conducting a technical review of the adequacy of the design and construction of such a barrier, may determine that it is justifiable to assign a lower risk rating.

Based on the RA's knowledge of an impoundment, the RA may believe a higher Priority Level is warranted and that an expedited review should be conducted. Some factors that might warrant an expedited review would be the heightened potential for affecting the general public, major public facilities, and sensitive environmental areas. In the interest of RA's time and travel considerations, the RA may also review a lower priority site(s) located in the vicinity of a higher priority site.

During the RA's review of an impoundment, the RA should establish a Priority Level based on its review findings. The "Executive Summary of Findings" form (Attachment 1) contains space for the Priority Level assigned by MSHA's and a "Remediation Priority Level" assigned by the RA (see section F.2.e). The RA's remediation priority contains: 1) a prefix which classifies the relationship of the impoundment and adjacent underground mines, and 2) the RA's assigned Priority Level. (The RAs may develop and use a form of their own design, however, it should contain similar items as contained in the Executive Summary.)

E. FAILURE MECHANISMS

Potential failure mechanisms include but are not limited to:

1. Failure of sealed underground mine openings - The opening seal (rock/soil or other material) fails, thus allowing water/slurry to flow in an uncontrolled manner into the underground works. Underground mine openings include, but are not limited to, unintentional "punchouts," (i.e., an intentional or unintentional void or tunnel-like connection of the underground mine to the surface), portals, horizontal drainage and ventilation borings, vertical utility or ventilation borings, adits (another term for a type of underground mine entry) and underground mines), and auger holes that connect with underground mines.

2. Breakthrough at an unsealed underground mine opening - Water/slurry flow into a mine opening that has not been sealed. These openings may have only been covered with soil.

3. Breakthrough at coal barriers (e.g., outcrop barriers; barriers between contour and underground mines; barriers between auger holes and underground mines; barriers between small drift mines or house coal adits - Pressures resulting from deposition of water/slurry/other materials may cause a failure at the coal barrier and allow water/slurry to enter the mine in an uncontrolled manner.

4. Breakthrough at strata overlying the coal seam - Water/slurry flow into a mine through natural fractures and joints and mining-induced fractures (e.g., roof falls, sinkhole subsidence, and trough subsidence).

The failure mechanisms apply to impoundments that have a considerable clear water pool depth and also to impoundments that have minimal clear water or have been reclaimed. The slurry in these structures may remain near or above the liquid limit for extended periods of time. Slurry at or above the liquid limit can flow as a viscous fluid if not contained. Reclaimed slurry impoundments may be a risk for breakthrough, resulting from long-term pillar deterioration, earthquake, or other factors that may affect the loading and stability of an impoundment and adjacent underground mine.

F. EVALUATION PROCEDURES

The following procedures are structured in consideration that the evaluations will be conducted by the RA's technical staff with possible assistance from OSM and cooperation with MSHA. Consequently, the procedures focus on the review items rather than the specific analytical tools. Attachment 1 is an "Executive Summary of Findings." The attachment also contains space for some basic information pertinent to impoundments. As previously noted, the RAs may develop their own forms.

1. Information Review

Attachment 2 contains numerous review items that are applicable to impoundments where the water/slurry elevation is above, or will be above, the elevation of the underground mines. The items may not be applicable depending on the site-specific conditions and the spatial relationship of the impoundment and underground mines. The attachment can be used as a checklist to ensure the completeness of the review.

The potential for a breakthrough is limited in cases where the mines are outside the "zone of no extraction" (Zone A) and the "zone of extraction using the guidelines" (Zone B) shown in IC 8741, see Figure 1.

Figure 1 (from IC 8741)

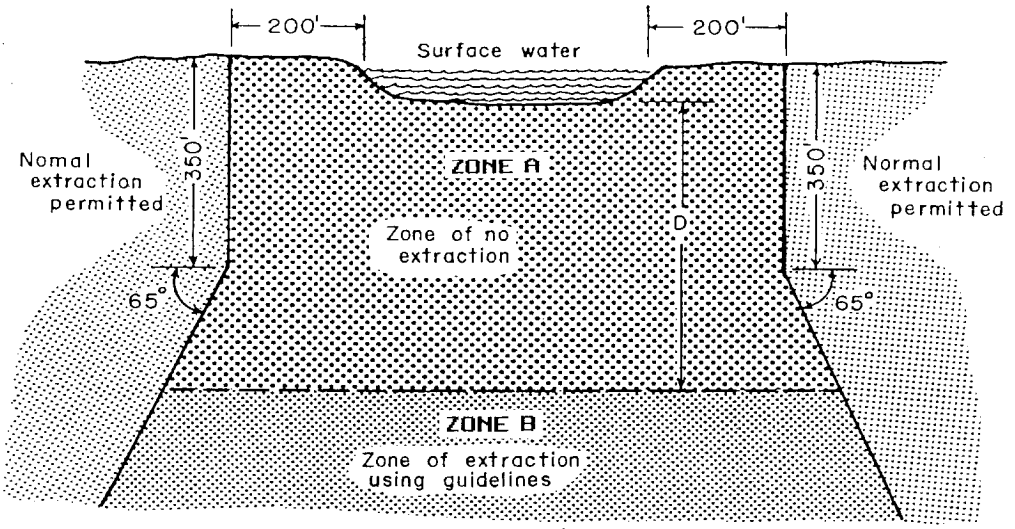

FIGURE 1. - Safety zone beneath body of surface water.

Where: (s) is the entry width, (t) is the entry/mining height, and (p) is panel width. Zone A and B added to figure by LFO.

The first step to take in the review is to determine the elevation of the underground mines, if any, with respect to the elevation of the actual and planned water/slurry elevation. For cases where the water/slurry will be below the elevation of the underground mine, the review write-up can be limited to the information that supports that finding. However, during the course of the review of such sites, it is prudent to review the outcrop barrier of works located above the impoundment and assess their potential to blow-out into the impoundment.

It is also logical to limit the review of impoundments where the underground mines are a considerable distance from the impoundment, provided that there are no other underground works, adits, auger holes, surface mines, shafts, or borings between (or in/around) the impoundment and the underground mine.

2. Assessment of Breakthrough Potential

The breakthrough potential is a function of a number of factors (e.g., proximity of the underground mine; location of the mine with respect to natural fracture systems, such as

side hill and valley bottom stress relief fractures; type/thickness of outcrop barrier and overburden material; floor, pillar, and roof stability; outcrop barrier stability; subsidence potential and the type(s) and location of potential subsidence; seepage and piping potential through fractures, the outcrop barrier, and overburden). Numerous research addresses these items. It is beyond the scope of this paper to list the research and its applicability to individual factors.

The evaluation, and the assessment of breakthrough potential, will be performed by the RA's technical staff, with possible assistance as needed from OSM. Because of the variety of conditions, the following does not provide a "cookbook" on how to evaluate the critical components related to potential failures.

The RAs are advised to use the PIL primarily for rating purposes. The RAs actual technical evaluations should be based on engineering principles applicable to the specific site conditions. Pillar stability calculations should be made with currently recognized formula such as those included in OSM's Surface Deformation Prediction System (SDPS), and the pillar loading should consider not only the weight of overburden, but also the overlying weight of the water and slurry.

During the course of site classification and evaluation, the RAs are encouraged to examine the outcrop barriers of mines located above the impoundment. These outcrop barriers should be examined to determine if there is a potential that they could blowout into the impoundment. A blowout could cause adverse impoundment impacts, such as overtopping, failure of the upstream face, wave run-up, and/or erosion. The examination should include: 1) a review of the underground maps to determine head potential, 2) a review of the surface and underground maps to determine approximate outcrop barrier width—give special attention to the manner used to delineate the cropline and whether the underground maps indicates unsurveyed areas, 3) a review and the land surface for features that reduce the barrier width, 4) seepage that may indicated a narrower barrier than indicated on the maps or a higher head potential than expected, and 5) geologic information concerning the composition of the outcrop barrier material.

The evaluation priority is addressed in Section D. However, in order to further aid in the assignment of appropriate personnel during the technical review, the following site classification system is recommended. These classifications are also recommended for use in conjunction with inventories to enable a third party to visualize the location of the underground works relative to the impoundment. The site should be classified before the assessment is conducted.

a. **Site Classification Aa**: water/slurry elevation at or above the elevation of the underground mines and 1) there is mining within the "zone of no extraction" (Zone A) shown in IC 8741, Figure 1, and 2) there is mining within the "zone of extraction using the guidelines" (Zone B) of IC 8741, Figure 1.

1. What are the likely failure mechanisms?

2. Identify the critical components (e.g., outcrop barrier width and stability, competent overburden thickness, water/slurry depth, subsidence potential) related to the failure mechanisms. Make note of any components that cannot be assessed because of the absence or reliability of data.

3. Provide an assessment of the critical components and determine if a failure is possible.

4. If a failure is possible, identify the type and location of the possible failure and describe the potential impacts (e.g., will breakthrough and be retained in underground mine; will discharge from underground mine and possibly damage dwellings; will be retained in mine but the mine's down-dip outcrop barrier may not handle the head).

5. If a failure is possible, describe the possible magnitude of the potential impacts.

6. What is the operator's opinion concerning the potential for a breakthrough?

7. What measures has the operator taken, or plans to take, to prevent a breakthrough?

8. What measures have MSHA or the RA required?

9. If the operator has taken action to prevent a breakthrough, provide an assessment of the reliability of the measures taken.

10. Is additional remediation necessary? If yes, describe the action required by the RA.

11. For underground mines located above the impoundment, is there an outcrop barrier blowout potential? If yes, describe the action required by the RA.

12. Based on the above, assign a "Remediation Priority" for the site. See G. below.

b. **Site Classification Ab**: water/slurry elevation at or above the elevation of the underground mine(s) and 1) there is mining within the "zone of no extraction" (Zone A), however 2) there is no mining within the "zone of extraction using the guidelines" (Zone B).

The assessment for this classification is generally the same as for Site Classification Aa.

c. **Site Classification Ac**: water/slurry elevation at or above the elevation of the underground mine(s) and 1) there is no mining within the "zone of no extraction" (Zone A), however 2) there is mining within the "zone of extraction using the guidelines"(Zone B).

The assessment for this classification is generally the same as for Site Classification Aa.

d. **Site Classification B**: water/slurry elevation below the elevation of the underground mine, and the mine is within the "zone of no extraction" (Zone A). The permit allows the water/slurry elevation to exceed the elevation of the underground mine. There is no mining within the "zone of extraction using the guidelines" (Zone B).

The assessment for this classification is generally the same as for Site Classification Aa. However, the potential for breakthrough will not exist until the pool is above the elevation of the underground mine.

e. **Site Classification C**: water/slurry elevation above, or will be above the elevation of the underground mine; however, the mine is outside the "zone of no extraction" (Zone A). There is no mining within the "zone of extraction using the guidelines" (Zone B).

The sites have a limited potential for water/slurry to discharge into underground mines. No further assessment required unless there is an outcrop barrier blowout potential from an underground mine above the impoundment.

f. **Site Classification D**: water/slurry elevation below the elevation of the underground mine, and the permit does not allow the water/slurry elevation to exceed the elevation of the underground mine floor. There is no mining within the "zone of extraction using the guidelines" (Zone B).

The sites do not have a potential for water/slurry to discharge into underground mines. No further assessment required unless there is an outcrop barrier blowout potential from an underground mine above the impoundment.

g. **Site Classification E**: no adjacent or subjacent underground mines.

h. **Remediation Priority.** The Remediation Priority will be used for inventory purposes as well as for assignment of technical resources necessary for the plan reviews.

For Site Classifications A and B, the Remediation Priority is a combination of the site classification and the evaluation priority based on MSHA's PIL. For example, a Remediation Priority of Aa-AIH2 means: 1) this a "site classification **Aa**" impoundment, 2) it has an **A** priority level according to the PIL, 3) the underground mine lies below the impoundment–Category **I**, 4) the impoundment has a **(H)** high potential for breakthrough, and 5) the breakthrough could impact (impact **2**) the safety of the general public.

Based on the RA's findings, the RA's "breakthrough risk potential" rating and "impact potential" may be different than the rating given by MSHA. For example the RA may determine that the outcrop barrier is narrower than previously report or that the RA may identify old adits exist within the impoundment area that were not previously show on the mine maps.

For Site Classifications C, D, and E the Remediation Priority is the site classification followed by NRR for "no remediation required," e.g., C-NRR.

MSHA's PIL rating system is summarized below.

Category:

I. Deep mining where the coal seam does not intersect the surface of the impoundment.
II. Deep mining where the coal seam intersects the surface of the impoundment.
III. Auger mining where the coal seam intersects the surface at the impoundment.

Impact Potential:

1. Breakthrough impacts the safety of miners on mine property.
2. Breakthrough impacts the safety of the general public.
3. Breakthrough impacts property (major roads, utilities, structures).
4. Breakthrough floods and is safely retained within abandoned mine.

Evaluation Priority:

Priority Level	Category	Breakthrough Risk Potential (refer to PIL for specifics)	Impact
A	I, II, III	High	1, 2
B	I, II, III	High	3
C	I, II, III	Moderate	1, 2
D	I, II, III	High	4
E	I, II, III	Moderate	3, 4
F	I, II, III	Low	1, 2, 3
G	I, II, III	Low	4
H	I, II, III	High	5
I	I, II, III	Moderate	5
J	I, II, III	Low	5

G. REMEDIATION PLANS

Because the remediation plans will be site-specific, and the remedial measures may vary considerably from site to site, the following section describes the general process for the plans and does not attempt to delineate specific remedial measures.

For sites where assessment identifies a high breakthrough potential, the RA should require the operator to prepare a plan to address the conditions. Because the plans may require both MSHA and RA approval, the RA should coordinate the plan requirements (and review of plans, once submitted) with MSHA. MSHA may not be reviewing low risk sites, however coordination with MSHA is still encouraged to ensure that the MSHA and RA plan revisions are consistent.

During the development of the remedial requirements, the reviewer may find that the permit and other data sources do not provide sufficient information to evaluate the breakthrough potential. This may be related to the reliability of the underground maps; the absence of information related to mining activities along the outcrop barrier or under the impoundment; the reliability of the cropline location; insufficient information to determine subsidence potential, etc. For such sites, the RA should require the operator to take the actions to develop and provide the reliable data necessary to enable the RA to complete the breakthrough evaluation. This may require exploratory drilling, surveying, geophysical, or other evaluations and the preparation and certification of maps and cross-sections that accurately show the relationship of the impoundment and underground mine.

When exploration is required to fully analyze a site, the exploration should be conducted at a sufficient number of locations to ensure that the data fully represents the site conditions. The

drilling should be to a sufficient depth to identify all mined coal seams. When drilling is conducted, it is recommended that continuous soil samples and rock cores be obtained and stored in secured facilities. The soil samples and rock cores should be tested for strength parameters and permeability. The use of geophysical or other methods must be "ground-truthed" by sufficient drilling or other validation techniques (e.g., entry into the mine and documentation of geometry, conditions, etc.).

For sites that have a high potential for breakthrough that could cause harm to people, property, and environmental features, the RA should require the operator to take immediate action to prevent the breakthrough. These measures may be temporary or permanent actions to allow stopgap attention to the high-potential situation until such time as an adequate evaluation and longer-term remedial plan is implemented.

H. EMERGENCY ACTION PLANS

MSHA requires the impoundment operators to submit an Emergency Action Plan (EAP) (see Attachment 6-- Program Information Bulletin No. P94-18 issued June 18, 1994). The EAP addresses the hazard area and the procedures for notifying and coordinating actions when a hazardous condition develops. The RA's regulatory program may also require an emergency action plan.

During the impoundment breakthrough review, the RA should review the operator's EAP submitted to MSHA and, if a plan is required by the RA, the plan submitted to the RA. This review should examine the plans to ensure that they cover impacts downstream from portals, blowouts, or other sites where breakthroughs result in surface discharges of water, slurry, and/or other impounded materials. Reviews of EAPs should also consider impacts associated with embankment failure. If plans have been submitted to both MSHA and the RA, the RAs should review both plans to ensure that they are consistent.

ATTACHMENTS

1. Impoundment Review–Executive Summary of Findings.
2. Evaluation Procedures, Information Review.
3. Breakthrough Events 1994 to 2000.
4. MSHA Program Information Bulletin No. P00-16, Unintentional Release of Water or Slurry From Impoundments Into Active or Abandoned Mines.
5. MSHA Procedure Instruction Letter No. I99-V-3, Evaluating Breakthrough Potential and Impact of an Unintentional Release of Water or Slurry From an Impoundment: District Response Procedures.
6. MSHA Program Information Bulletin No. P94-18, Emergency Action Plan.
7. Bureau of Mines Information Circular 8741, Results of Research to Develop Guidelines for Mining Near Surface and Underground bodies of Water.

8. ARCC Implementation Plan January 19, 20001, "Prevention of Impoundment Leaks into Underground Mines."

ATTACHMENT 1

IMPOUNDMENT REVIEW--EXECUTIVE SUMMARY OF FINDINGS

Date(s) of review: _____

1) State _____. County
2) Impoundment Name _____.
   a. Downstream Receiving Stream(s): (1) of impoundment:
      (2) of breakthrough points:

   b. Watershed Size: acres
   c. Impoundment Storage volume: (1) current: acre-feet; (2) maximum: acre-feet
3) Permittee _____.
4) Permit No. _____. 5) MSHA ID. No. _____.
6) MSHA's Risk Rating _____.
7) RA's Remediation Priority _____. (Rate site based on worst-case situation.)

8) Site Classification Codes (the classification code is included in the Remediation Priority):
Aa--pool above UG mine; UG mine(s) located within IC 8741 "zone of no extraction" (Zone A); and UG mine(s) located within the "zone of extraction using guidelines" (Zone B).
Ab--pool above UG mine; UG mine(s) located within "zone of no extraction," (Zone A) ; and UG mines are not located within the "zone of extraction using guidelines" (Zone B).
Ac--pool above UG mine; UG mine(s) not located within "zone of no extraction," (Zone A); and UG mine(s) are located within the "zone of extraction using guidelines" (Zone B).
B--pool below UG mine but permitted to go above UG mine and UG mine within "zone of no extraction," (Zone A) ; and UG mines are not located within the "zone of extraction using guidelines" (Zone B).
C--pool above or will be above UG mine and UG mine is not within "zone of no extraction," (Zone A); and UG mines are not located within the "zone of extraction using guidelines" (Zone B)
D--pool below UG mine and is not permitted to exceed floor elevation of UG mine; and UG mines are not located within the "zone of extraction using guidelines" (Zone B).
E—no adjacent or subjacent underground mines.

9) Impoundment Type: ☐ Slurry, ☐ Water, ☐ Other (AMD Treatment, CCB Disposal, etc.).
10) Current Freeboard _____ ft.
11) Decant: ☐ Yes, ☐ No. 12) Open/Emergency Spillway: ☐ Yes, ☐ No.
12) Is water/slurry currently being added to the impoundment? ☐ Yes, ☐ No.
13) Is precipitation runoff diverted around impoundment? ☐ Yes, ☐ No.
14) Are the ground or surface water monitoring stations located to provide information on leakage from the pond into the mine? ☐ Yes, ☐ No.

15) Findings. Check the boxes where the review indicated a potential for:
a. □ breakthrough due to failure of seals to underground mine works,
b. □ breakthrough at unsealed underground mine openings,
c. □ breakthrough at UG mine outcrop barrier,
d. □ breakthrough at barrier between highwall and UG mine,
e. □ breakthrough at barrier between auger holes and UG mine,
f. □ breakthrough at barrier between adit and UG mine,
g. □ breakthrough at strata overlying the coal seam through natural fractures,
h. □ breakthrough at strata overlying the coal seam through mining-induced fractures.

16) If the impoundment breaks into the UG mine, is a discharge to the surface possible?
a. □ Yes (through open portals),
b. □ Yes (by causing failure of UG mine's portal backfill ____ feet high),
c. □ Yes (by causing failure, based on 50+H, of the UG mine's outcrop barrier _____ ft wide),
d. □ No (the above-drainage UG mine has the capacity to contain the water/slurry,
e. □ No (the below-drainage UG mine has the capacity to contain the water/slurry.

17) Are there any indications of?
a. □ leakage into the UG works,
b. □ drainage from the UG portals,
c. □ leakage through the UG mine's outcrop barrier.

18) Is there a potential for overlying underground mines to blow-out into the impoundment?
□ Yes, □ No.

19) Has a breakthrough previously occurred at this impoundment? □ Yes, □ No.

20) Attach narrative describing adverse conditions identified in 15, 16, 17, 18, and 19.

21) Has the RA or MSHA previously required remediation with respect to a potential breakthrough? □ Yes, □ No. Describe.

22) Would the remediation required by the RA or MSHA address the current breakthrough concerns identified by the RA? □ Yes, □ No, □ N/A. Describe.

23) Address the status of the RA or MSHA-required remediation (include appropriate dates).

24) Address the remediation action taken by the RA and the status of the action (include appropriate dates).

25) Does an early warning system exist to alert of sudden changes in water level? □ Yes, □ No.

26) Is there an Emergency Action Plan (EAP) with phone numbers of appropriate:
a. □ individuals living downstream of the embankment and the possible underground mine discharge points,
b. □ facilities (e.g., public water supplies),
c. □ agencies.

27) Does the EAP cover areas where a breakthrough could discharge? □ Yes, □ No.

28) Describe the affected downstream locations if: (a) dam breach occurred; (b) breakthrough resulted in discharge to other streams. Description should note type (home, school, business, industry, etc.), number, and location of properties and distance downstream, location above bank-full condition, anticipated flood stage at structure; presence of water supply intakes, high quality or special stream value, and other pertinent information.

Impoundment, coal seam, and mining information. (1) All distances are in feet.

Feature	Elevations (for coal seams, give floor elev.) (msl)	Coal Seam Thickness (T) & Mining Height (H)	Mining Info (2)	Outcrop Barrier-- Width (W) & Vertical Dist. (D) From Edge of Barrier to Surface, e.g. 50W, 25D	For Mines Below Impoundment. Vertical Dist. Mine Roof to Surface	Barrier Width (e.g., between auger and UG mine) & Over-burden, e.g. 20W,50D	Coal Seam, Mine Name/Number, and Mining Date	Remediation Priority by Seam
Dam, Max Permitted (M) and Current (C)								
Pool Level, Max Permitted (M) and Current (C)								
Slurry Level, Current								
Coal Seam (Above Current Pool)								
Coal Seam (Above Current Pool)								
Coal Seam (Within Pool)								
Coal Seam (Within Pool)								
Bottom of Impoundment								
Coal Seam Below Impoundment Bottom								
Coal Seam Below Impoundment Bottom								

NOTES: (1) For all fields, where you have not been able to verify the information, add a **NV** for "not verified" to your entry. (2) Mining Information: specify the types of activity along the coal croplines and below the impoundment: **C** contour mine. **R D** road or diversion at/near the cropline. **Auger** auger holes. **Adit** adits, house coal mines, etc (generally short entries that do not connect with a conventional underground mine). **Portal** portals to underground mine. **PO** punchouts from the underground (UG) mine into the impoundment area. Mining method and recovery--e.g., UG1st (50x50) and UG2nd/2B (30x40). **UG1st (#x#)** UG works--pillars not pulled (i.e., area first mined) in the panel(s) under/adjacent to the impoundment; give pillar size. **UG2nd/#B (#x#)** UG works-ventilation bleeder pillars retained around the perimeter of the panels and adjacent to the outcrop barrier, and pillars pulled outby the bleeder row; give size of bleeder pillars and number of bleeder rows, e.g., 2 rows of 30x40 pillars UG2nd/2B (30x40). **UG2nd (#x)** UG works--pillars pulled (i.e., area second mined) under/adjacent to the outcrop, and size of pillars.

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).

ATTACHMENT 3

BREAKTHROUGH EVENTS 1994 TO 2000

This list may not include all of the events.

SITE 1: Water and coal slurry from an impoundment at Martin County Coal Corporation (MCCC), Permit No. 680-8002, Martin County, Kentucky, discharged into an underground mine, traveled down dip through the workings and discharged from abandoned entries in the preparation plant area and an adjacent watershed.

BACKGROUND: On May 22, 1994, water/slurry from MCCC's impoundment drained through an opening (fracture or subsidence feature) at the edge of the underground mine. The outcrop barrier was about 60 feet wide and the overburden was about 15 feet in depth. The water/slurry was about 28 feet above the mine roof at the time of the event. About 50 million gallons drained into the underground mine in the Coalburg seam. Water/slurry discharged from the underground mine at three locations; from two portals and through a two- to three-foot wide coal barrier between the underground mine and a contour bench. The discharge from one of the locations passed through a sediment pond causing some erosion. The discharge at another location cause a freshwater pond to fail. The discharge from the third location was controlled, at least partly, by a berm constructed by MCCC after the event. In response to the event, MCCC proposed, and obtained approval of, a seepage barrier adjacent to the underground works. The seepage barrier was constructed by blasting a contour bench and pushing the spoil over the hillside down to the slurry level.

SITE 2: Slurry from an impoundment discharged into an underground mine at Lone Mountain Processing, Inc. (LMP) Permit No. 1301411, St. Charles, Lee County, Virginia.

BACKGROUND: On August 9, 1996, coal slurry from LMP's impoundment drained through a highwall opening above the coal seam. The opening occurred when strata immediately above the coal seam in the highwall was pushed back into an undetected/unknown mine entry. The coal barrier separating the pre-existing surface mine and the underground mine was less than five feet. The slurry drained into and through the abandoned underground mine works in the Darby (a.k.a. Number 5 or Taggart) seam. Most of the leak was contained within the mine. The duration and impact of the discharge was minimal. An earthen liner was backfilled/constructed along the entire mine bench to preclude additional leakage into the underground workings.

SITE 3: Slurry from an impoundment at LMP Permit No. 1301411, St. Charles, Lee County, Virginia, discharged into an underground mine, traveled down dip through the workings and discharged from an abandoned entry into an adjacent watershed.

BACKGROUND: After the earthen liner was placed on the mine bench by LMP following the August 1996 leak, the slurry impoundment filled to a level above the liner. On October 24, 1996, slurry from the impoundment drained suddenly through a subsidence crack beneath the

slurry pool into the same subjacent underground workings that contained the August 1996 leak. The slurry traveled through the abandoned underground mine works and exited an open portal on Gin Creek. The Virginia Division of Mined Land Reclamation (DMLR) estimated the initial discharge at 3,000 gallons per minute. Company officials reported that the leak from the impoundment was stopped within two hours; however, the black water discharge from the mine continued for approximately one week after the initial event. The discharge deposited sludge in Gin Creek, Straight Creek, Stone Creek, North Fork of the Powell River, and the Powell River. The sludge-laden water killed fish in the upper four tributaries (approximately nine miles). The Powell River is considered as critical habitat to several Federally listed threatened or endangered mussel and fish species. The earthen liner was extended up the hillside and covered with coarse refuse to preclude further problems.

SITE 4: Slurry discharge through an underground mine and into an adjacent watershed from an impoundment at Consolidation Coal Company Permit No. 1400047, Oakwood, Buchanan County, Virginia.

BACKGROUND: On November 26, 1996, Consolidation Coal Company (Consol) experienced a coal slurry spill from its slurry impoundment similar in nature to the October 24, 1996, spill at LMP's operation. Consol reported as much as four million gallons of slurry was lost from the impoundment at their Buchanan No. 1 operation between November 26 and November 28. Company representatives theorized that slurry entered old auger holes or an old mine portal along a highwall within the impounding area, traveled through abandoned underground works and escaped from a bond-released Jewell Smokeless Coal Corporation mine entry, Permit No. 1201067. The Jewell Smokeless mine portal is located across a ridge approximately 900 feet northwest of the impoundment. Downstream of the discharge point is the Island Creek Coal Company VP-8 mine. Employees discovered black water threatening to run into one of the mine's active shafts. Company employees diverted the flow from the shaft into the Right Fork of Garden Creek. The spill has affected North Branch, Garden Creek, and the Levisa River. DMLR sampled a one-mile portion of Garden Creek and the Levisa River and found 1,150 dead fish. The incident also impacted the Corps of Engineers Fish Trap Reservoir. Consol constructed a cofferdam to isolate the slurry in the impoundment from the area of the suspected leak. The slurry was excavated from behind the cofferdam and seals were placed in the auger holes and mine entries. Coarse refuse was placed above the seals.

SITE 5: Slurry discharged into an underground mine adjacent to an impoundment at a Harlan Cumberland Coal Company mine, Harlan County, Kentucky.

BACKGROUND: On September 21, 1994, Harlan Cumberland slurry impoundment broken into its own underground mine and flooded abandoned and active mine areas. There were not any miners in the works at the time of the event. An estimated 23 million gallons of water and slurry entered the mine. The water entered through a previously sealed mine opening; apparently the mine entry collapsed inside the seal. There was about 26 feet of overburden at the breakthrough location. The plans for sealing the breakthrough location included exposing the coal seam if possible, backfilling the exposed works, covering with geotextile filter cloth, covering with coarse refuse, and finally building a slurry delta.

SITE 6: Slurry from an impoundment at MCCC's Permit No. 680-8002, Martin County, Kentucky, discharged into an underground mine, traveled through the workings and discharged from an abandoned entry and also through the portal for an active beltway.

BACKGROUND: On October 11, 2000, coal slurry from MCCC's impoundment drained through an opening (fracture or subsidence feature) at the edge of the underground mine. The outcrop barrier was about 65 feet wide, however, a considerable portion of the outcrop barrier was composed of weathered material. The coal slurry was about 100 feet above the mine roof at the time of the event. About 250 million gallons drained into underground mine in the Coalburg seam. Slurry discharged from the underground mine at two locations. The discharge from both locations damaged the sediment pond and impacted in excess of 75 miles of stream and several municipal water supplies. The failure occurred through the seepage barrier built after the May 1994 event (see Site 1).

ATTACHMENT 4

U.S. Department of Labor

Mine Safety and Health Administration
4015 Wilson Boulevard
Arlington, Virginia 22203-1984

ISSUE DATE: December 1, 2000

PROGRAM INFORMATION BULLETIN NO. P00-16

FROM: MARVIN W. NICHOLS, JR.
Administrator
for Coal Mine Safety and Health

MARK E. SKILES
Director of Technical Support

SUBJECT: Addressing the Potential for and Prevention of the Unintentional Release of Water or Slurry From Impoundments Into Active or Abandoned Mines

Who needs this information?
Coal Mine Safety and Health (CMS&H) enforcement personnel, Technical Support personnel who review impoundment plans, independent contractors, and coal mine operators should be aware of this information.

Why is MSHA issuing this bulletin?
MSHA is issuing this bulletin to add to information provided in a previous Program Information Bulletin (PIB P97-4), "Unintentional Release of Water or Slurry From Impoundments Into Active or Abandoned Mines." This bulletin provides additional information regarding precautionary measures to alleviate this potential problem.

Why is this bulletin necessary?
In 1994, an unintentional breakthrough occurred at a coal waste impoundment. In late 1996, within a two-month period, two incidents of water and slurry flowing uncontrolled into abandoned underground mines resulted in release of the material into downstream waters. In response to these unintentional releases, MSHA issued PIB P97-4. This bulletin outlined the potential dangers associated with constructing an impounding structure in the vicinity of underground mines, provided precautionary measures that should be taken by operators to alleviate the hazards, and described the measures that MSHA would take to evaluate all impoundment plans.

In the past three years, additional evaluations have been performed by mine operators, and all impoundments with breakthrough potential have been identified. Design plans for these sites have been, and continue to be, under review. However, on October 11, 2000, another unintentional release of water and slurry into an underground mine resulted in significant environmental damage in adjacent streams. Accurately identifying and mitigating the potential for future similar incidents remains MSHA's concern. This bulletin is intended to further clarify the problems and describe issues that should be addressed during the mine or impounding structure planning phase.

Background Information Since 1994, four unintentional releases of water and slurry have occurred when water and slurry from an impoundment broke through into adjacent and underlying underground mine workings. The initial events resulted in inundation of abandoned underground mines and minor environmental damage. In 1997, MSHA issued Procedure Instruction Letter I97-V-11, "Evaluating Breakthrough Potential and Impact of an Unintentional Release of Water or Slurry From an Impoundment; District Response Procedures" to instruct enforcement personnel regarding this issue. The latest event, in October 2000, resulted in material flowing through an active portion of a mine and major environmental damage. In each case, water and slurry flowed through the mines and discharged at old portal locations on the other side of the mine into adjacent hollows.

In general, potential problems can exist with impoundments located close to underground mine workings whenever:

1. mining has taken place in a coal seam that is completely below the level of the impoundment and water or slurry can enter the mine through subsidence features, shafts, slopes, or other openings;

2. mining has taken place in a coal seam that outcrops within the impoundment and water or slurry can enter the mine through subsidence

features, inadequately sealed openings, or inadequate outcrop barriers;

3. auger mining has taken place in a coal seam that has been deep mined and that outcrops within the impoundment and water or slurry can enter the mine through inadequate barriers left between the ends of the auger holes and the underground workings; or

4. surface contour strip mining has taken place in a coal seam that has been deep mined and that outcrops within the impoundment and water or slurry can enter the mine through barriers that have been reduced in size due to the strip mining.

An additional problem is the pooling of water or slurry within an underground mine in an area with an inadequate outcrop barrier or seal. This impounded material could constitute a hazard due to the force and the damage that could result if a blow-out were to occur. The elimination or minimization of the inundation hazard to workers in active mines or to persons immediately downstream of potential discharge locations remains MSHA's primary concern. However, as noted in the previous bulletin, significant hazards may also extend to structures or utilities or the environment located downstream of the potential discharge locations.

What should be done to prevent future unintentional releases? To mitigate the potential dangers associated with this problem, the following issues should be thoroughly addressed during the mine or impounding structure planning stages:

1. New mining, both underground and auger, proposed in the vicinity of water or slurry impoundments must be carefully surveyed, mapped, and certified. Old maps of existing workings have been found to be highly inaccurate in several cases. The importance of having accurate mine maps in situations such as this cannot be overstated. Mine maps of questionable accuracy should be treated as unknowns and any analyses performed should assume that the worst possible conditions exist. When necessary, the accuracy of mine maps should be verified through the use of collaborating information or through additional field exploration.

2. Mine operators should carefully and thoroughly evaluate the adequacy of all barriers left between the impoundment and the underground mine workings. Where the underground mine is located totally below the elevation of the site or is located in an adjacent hillside that outcrops within the impoundment, the adequacy of the mine strata and overburden should be evaluated. This includes addressing the stability of remaining pillars and immediate floor and roof, the potential for roof falls to propagate to the surface, and the effect of subsidence features that intercept the surface within the impoundment. In the case of the underground mine being located in a seam that outcrops within the impoundment area, the natural or man-made barrier at the outcrop should be evaluated for the maximum anticipated design hydraulic head that will exist on that barrier. The adequacy of these barriers should be certified by a professional engineer.

3. When subsidence analyses are performed, the potential surface tension zones should be identified. It is in these areas where surface cracks may open which could allow water or slurry to flow into the mine. Several reviewed designs have assumed that the fine refuse will have a sealing effect on any cracks. This may be true for narrow cracks or for wide cracks in low head conditions. However, slurry should not be considered capable of long-term plugging of wide surface cracks.

4. Old impounding sites may contain slurry that is several hundred feet thick. Slurry that has been deeply buried should still be considered capable of fluid movement unless data and analyses are submitted showing the opposite. Although the slurry itself may appear stable, water seeping through the slurry into cracks in the natural hillside could eventually create a piping situation where a direct and substantial flow path is created from the pool into the underground mine. Consolidation of the slurry may not be adequate to prevent a breakthrough of the material into a mine.

5. Mine operators may opt to conservatively assume that water or slurry will enter the underground mine, and they will therefore control the material through the use of underground bulkheads. Similar to the outcrop barrier situation, all areas where the impounded material may collect should be evaluated. All bulkheads should be designed and maintained for the maximum anticipated hydraulic head that may be present as a result of the pool level in the impoundment. The adequacy of all hydraulic bulkheads should be certified by a professional engineer.

6. Underground slurry injection worsened the outflow condition in several of the previous breakthrough incidents. In these cases, water or slurry flowed from the impoundment into the area of underground storage. This increased the slurry available for outflow. If located in an area susceptible to inundation from an impoundment, the bulkheads designed to contain the underground slurry should be capable of withstanding the maximum hydraulic head attributable to the impoundment.

7. When contour strip mining operations will remove a portion of the natural outcrop barrier, the remaining barrier should be evaluated for breakthrough potential. When these natural outcrop barriers are reduced, man-made barriers should be considered. Any man-made barrier should be designed to be capable of withstanding the maximum hydraulic head created by the impounded water and slurry.

What is the authority for this bulletin?
Federal Mine Safety and Health Act of 1977; 30 CFR 77.216.

Who are the contact persons for this bulletin?
Coal Mine Safety and Health, Division of Safety
Billy G. Foutch, (703) 235-1915

Pittsburgh Safety and Health Technology Center
Kelvin Wu, (412) 386-6903

Is this bulletin on the Internet? This information may be viewed on the Internet by accessing the MSHA home page

(http://www.msha.gov) and then choosing Statutory and Regulatory Information/Compliance Assistance Information/Program Information Bulletins.

Who will receive this bulletin?
Program Policy Manual Holders
Coal Mine Operators
Coal Independent Contractors

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ATTACHMENT 5

U.S. Department of Labor

Mine Safety and Health Administration
4015 Wilson Boulevard
Arlington, Virginia 22203-1984

EFFECTIVE DATE: 12/01/1997

EXPIRATION DATE: 03/31/2001
(Reissue of I97-V-11)

PROCEDURE INSTRUCTION LETTER NO. I99-V-3

FROM: MICHAEL J. LAWLESS
Acting Director of Technical Support

ROBERT A. ELAM
Administrator
for Coal Mine Safety and Health

SUBJECT: Evaluating Breakthrough Potential and Impact of an Protection
Unintentional Release of Water or Slurry From an
Impoundment; District Response Procedures

Scope

This procedure instruction letter applies to Coal Mine Safety and Health (CMS&H) enforcement personnel, impoundment specialists, and Technical Support personnel.

Purpose

The purpose of this procedure instruction letter is to provide guidance for district personnel responsible for evaluating impoundments that were previously identified to have a potential for breaking into an active or abandoned coal mine(s). This letter also sets forth precautionary measures to be instituted by the Agency to ensure the stability of mine waste disposal facilities.

Also, this letter identifies the Agency's responsibility when a potentially dangerous unintentional release of water or slurry from an impoundment has occurred.

Procedure Instruction

A Flowchart and Categorization Criteria have been developed to enable district specialists to classify all impoundments identified with some breakthrough potential. The classification is based on the category of the potential and the impact that a breakthrough might have on an adjacent or underlying

mine. The criteria to be used for categorizing the breakthrough potential of each site is found in Attachment 1. When the criteria references Information Circular 8741 (IC 8741) the flowchart in Attachment 2 is used. The flowchart was prepared to enable district specialists to easily classify any site when IC 8741 must be used.

Once the breakthrough category and potential have been determined, the impact potential should be determined by assigning a value from the table provided in Attachment 3. Also, a priority code listed on the same table should be assigned to each site.

Since it is possible for an impoundment site to have more than one area with breakthrough potential, each location must be categorized and the most severe potential used for prioritization. Impoundment sites where the embankment itself could be affected by the sudden outrush of water or slurry are to be given the highest priority. Once all sites have been identified on a priority listing, the pertinent information is to be reported to the Pittsburgh Safety & Health Technology Center. For this submittal, the format below should be used on a hard copy form as well as in an electronic spreadsheet structure:

> Site Name, State, District, Impoundment I.D., Category, Potential, Highest Level of Impact, Priority Level (an example of the reporting format would be as follows: Brushy Fork Impoundment, KY, 07, xxxxxxx-xx, III, High, 1, A).

Where a mine's impoundment plan does not adequately address the breakthrough potential, the mine operator responsible for that impoundment shall be notified that the plan must be revised. This plan modification shall be done in accordance with the plan revision procedures described in MSHA's Program Policy Manual, Volume V, Page 3c, 4/1/90 (Release V-2).

The technical review of all newly submitted impoundment plans will include an emphasis on evaluating the potential of a water or slurry breakthrough into adjacent mines prior to the district manager granting approval of such a plan.

If an unintentional breakthrough does occur at an impoundment site, then the mine operator is required to immediately notify the district manager and submit a Mine Accident, Injury and Illness Report, MSHA Form 7000-1, in accordance with 30 CFR 50.10 and 50.20. When the district manager is notified, enforcement personnel shall be sent to the site immediately and issue the appropriate citations or orders to ensure the safety of miners and the public.

Background

The Agency's classification criteria for this evaluation was developed by a joint committee consisting of CMS&H and Mine Waste and Geotechnical Engineering Division personnel. The criteria to identify the breakthrough potential of an impoundment is derived from general rules of practice and from the Bureau of Mines Information Circular 8741 (IC 8741).

Renewed emphasis was placed on the potential safety and health concerns when the potential of water or slurry breaking into underground mine workings was again realized when two unintentional releases of slurry occurred in a two-month period. In both instances the accident inundated adjacent, abandoned underground mines. In each case the slurry rapidly discharged from old mine portals that were located in hollows adjacent to the impoundment sites.

The potential for such events occurring in the future remains a concern for the Agency, especially since active impoundments continue to increase in elevation and may overtop worked-out coal seams

or seams that are presently being mined. If the extent of mine workings is not adequately mapped, the safety barriers left in place may not be substantial enough to resist the hydraulic pressure of the material impounded in the future.

Authority
Federal Mine Safety and Health Act of 1977, 30 CFR 77.216, 30 CFR 75.1716, 30 CFR 50.10, and 30 CFR 50.20.

Filing Instruction
This letter should be filed behind the tab marked "Procedure Instruction Letters" in the binder entitled Program Handbooks and Procedure Instruction Letters.

Issuing Office and Contact Person
Coal Mine Safety and Health, Division of Safety
Roger Schmidt, 703-235-1337

Technical Support, Mine Waste and Geotechnical Engineering Division, Kelvin Wu, 412-892-6903

Distribution
PPM Holders Within Coal Mine Safety and Health and Technical Support

Attachment 1

Breakthrough Potential

The following criteria should be used to assign a breakthrough potential rating.

I. Deep mining where the coal seam does not intersect the surface at the impoundment	
High Potential	Any site where mining is located vertically within 100 feet beneath any portion of the impoundment.
Moderate Potential	Any site where the distances outlined in Bureau of Mines Information Circular 8741 are not met.
Low Potential	Any site where the distances outlined in Bureau of Mines Information Circular 8741 are met or exceeded.

The primary concern in this situation is sinkhole formation in the pool area. Although sinkhole formation is difficult to predict, it is more likely where the separation between mine and ground surface contains less than 100 feet of intact rock. A secondary concern is slurry and water flow through subsidence cracking. We do not believe a sudden inrush of slurry will occur through subsidence cracks; however, cracks may be enlarged by water flow.

II. Deep mining where the coal seam intersects the surface at the impoundment

High Potential	Any site where a vertical column of intact rock between the mine and the original ground surface in the impoundment is less than or equal to 100 feet. OR Any site where the coal barrier thickness at the outcrop is less than 50 feet. OR Any site where no manmade barrier has been designed for the anticipated maximum hydraulic head (for example, where a site is only sealed for compliance with 30 CFR §75.1711)
Moderate Potential	Any site where a vertical column of intact rock between the mine and the original ground surface in the impoundment is less than the criteria specified in IC 8741, but exceeds 100 feet. OR Any site where the coal barrier thickness equals or exceeds 50 feet, but is less than 50 feet + hydraulic head. OR Any site where a manmade barrier has been designed, but actual hydraulic head on the barrier exceeds the design value.
Low Potential	Any site where the vertical distance between the mine and the original ground surface in the impoundment meets or exceeds the criteria specified in IC 8741. AND Where the coal barrier thickness at least equals 50 feet + hydraulic head. OR Any site where a manmade barrier has been designed for the maximum anticipated hydraulic head.

Once again, the formation of sinkholes played an important role in the selection of this criteria. It is envisioned that a mine under a gently sloping ground surface could have an overburden of less than 100 feet in the impoundment area. The 50 foot barrier thickness rule is simply a general rule of thumb in use by the mining industry. This criteria for barrier thickness is mentioned in several references. Where a mine entry exists, we believe the manmade barrier should be designed by a qualified engineer for the maximum anticipated hydraulic head that the barrier will be exposed to. Typical manmade barriers would include any structure constructed to separate the impoundment

from the mine environment. These structures could be soil, rock, or other construction materials such as reinforced concrete.

III. Auger mining where the coal seam intersects the surface at the impoundment	
High Potential	Any site where a manmade barrier has not been designed as a cover for the auger holes. AND Where the coal barrier thickness (between the end of the auger holes and any deep mine) is less than 50 feet.
Moderate Potential	Any site where a manmade barrier has not been designed or has not been designed for the maximum anticipated hydraulic head. AND Where the coal barrier thickness (between the end of the auger holes and any deep mine) equals or exceeds 50 feet but is less than 50 feet + hydraulic head. OR Any site where a manmade barrier has been designed for the maximum anticipated hydraulic head. AND Where the coal barrier thickness (between the end of the auger holes and any deep mine) is less than 50 feet + hydraulic head.
Low Potential	Any site where a manmade barrier has been designed for the maximum anticipated hydraulic head. AND Where the coal barrier thickness (between the end of the auger holes and any mine) equals or exceeds 50 feet + hydraulic head.

Attachment 2 - Flowchart for Application of IC 8741 [PDF]

Attachment 3

Impact Potential

In addition to a site's breakthrough potential, a breakthrough impact should be indicated. The following items should be considered when assessing a site's breakthrough impact:

1. Breakthrough impacts the safety of miners on mine property.

2. Breakthrough impacts the safety of the general public.

3. Breakthrough impacts property (major roads, utilities, structures).

4. Breakthrough impacts the environment.

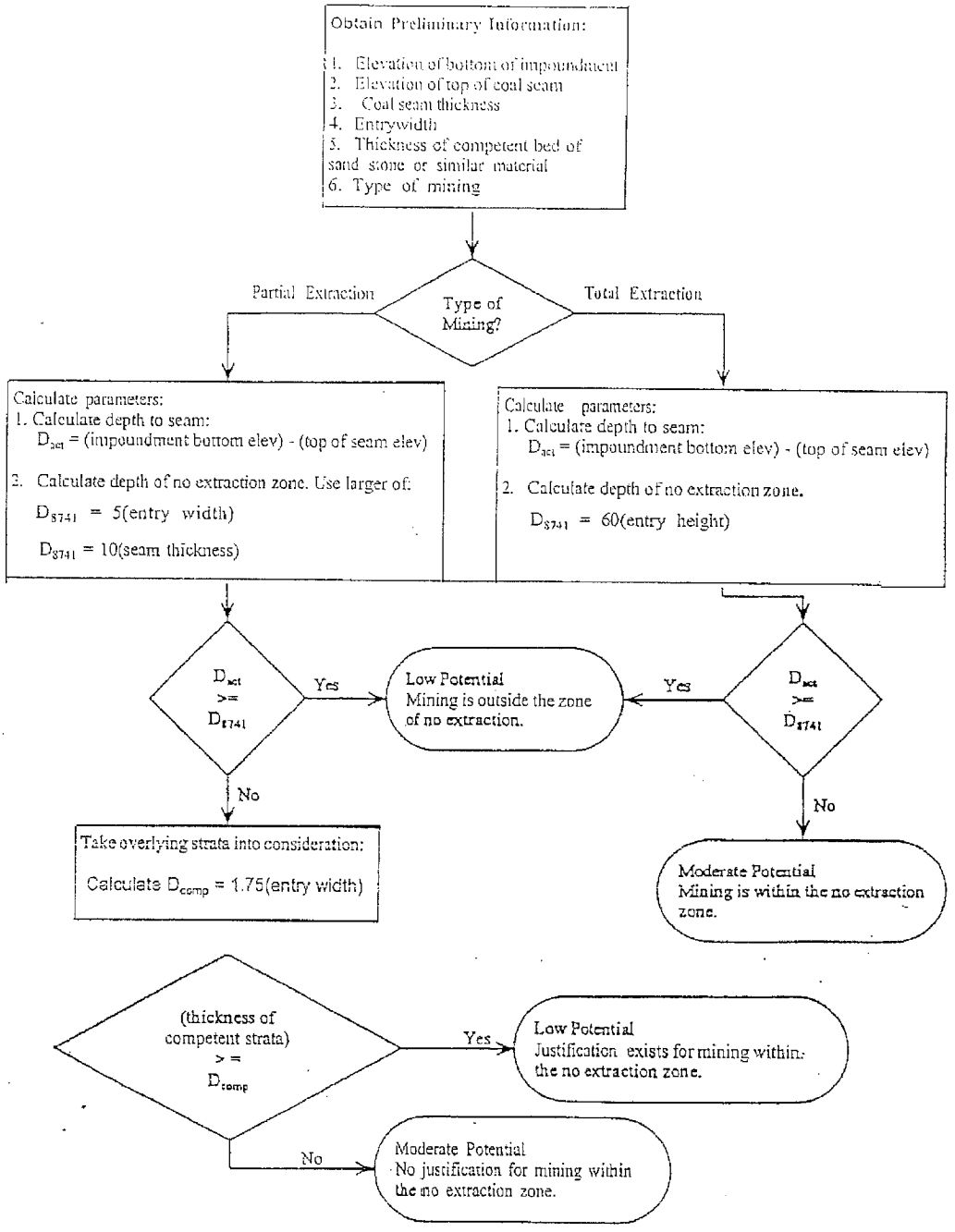
5. Breakthrough floods and is safely retained within abandoned mine.

Evaluation Priority

After a breakthrough potential and impact potential have been assigned to a site, an evaluation priority rating can be assigned. The following table provides the assignment criteria.

Priority Level	Category	Potential	Impact
A	I, II, III	High	1, 2
B	I, II, III	High	3
C	I, II, III	Moderate	1, 2
D	I, II, III	High	4
E	I, II, III	Moderate	3, 4
F	I, II, III	Low	1, 2, 3
G	I, II, III	Low	4
H	I, II, III	High	5
I	I, II, III	Moderate	5
J	I, II, III	Low	5

Flowchart for Application of IC 8741



ATTACHMENT 6

U.S. Department of Labor

Mine Safety and Health Administration
4015 Wilson Boulevard
Arlington, Virginia 22203-1984

ISSUE DATE: June 18, 1994

PROGRAM INFORMATION BULLETIN NO. P94-18

FROM: MARVIN W. NICHOLS, JR. Marvin W. Nichols Jr.
Administrator
for Coal Mine Safety and Health

SUBJECT: Emergency Action Plans Recommended by the National Dam Safety Program of 1979 for Downstream Areas of Coal Mine Waste Impoundments

Scope
This program information bulletin applies to Coal Mine Safety and Health (CMS&H) enforcement personnel and coal mine operators who own, operate, or control an impoundment that constitutes a hazard to life or property in the event of failure.

Purpose
The purpose of this program information bulletin is to inform CMS&H enforcement personnel and mine operators of the need to develop an Emergency Action Plan (EAP) for impoundments that constitute a hazard to life and property in the event of failure.

Information
The Mine Safety and Health Administration (MSHA) is encouraging mine operators to develop EAPs in accordance with the Emergency Action Planning Guidelines for Dams. The EAPs should include the following:

-a delineation of the hazard area, so that the area requiring warning or evacuation is known in advance;

-procedures for identification and evaluation of potential emergencies;

-procedures for notification of key personnel and officials;

-arrangements for coordination of warning and evacuation activities with State and local officials;

-contingency planning for preventive action, including sources of equipment, material, labor, and engineering expertise; and

-training of all involved personnel and periodic testing of the emergency action plan, as well as a regular review and update of the plan.

MSHA recommends that the mine operator keep the EAP at the mine site where the impoundment is located. MSHA also recommends that the mine operator, in cooperation with State or local government officials, conduct a comprehensive review of the adequacy of the EAP at intervals not exceeding one year. In addition, the mine operator is encouraged to provide MSHA with an EAP approval document from the appropriate State or local regulatory authority when a plan for a new impoundment, or the annual report required by 30 CFR 77.216-4, is submitted.

In order for a mine operator to comply with present MSHA regulation 77.216-3(e), the operator must submit and obtain approval for a plan to examine each impoundment that meets the size or hazard criteria specified in 77.216(a). To meet this requirement, the mine operator may elect to submit an EAP if each program element, including inspection of an impoundment and action taken if a potentially hazardous condition develops, is specifically addressed in the submittal.

Background
Criteria for a comprehensive EAP are described in many State regulations promulgated to comply with the National Dam Safety Program of 1979. The Emergency Action Planning Guidelines for Dams. FEMA Report No. 64 (February 1985), found in the Federal Guidelines for

Dam Safety, define the need and provide guidance for the development of an EAP. These guidelines are available from the Publications Branch, Federal Emergency Management Agency (FEMA), P.O. Box 70274, Washington, DC 20024.

In Presidential Executive Order No. 12148, all federal agencies were directed to adopt and implement these federal guidelines for dam safety. The directive dictates that agencies report progress toward implementation to the director of FEMA on a biennial basis.

Authority
Public Law 95-164, CFR 30, Part.77.216
Public Law 95-620, CFR 6, Section 601(i)

Issuing Office and Contact Person
Coal Mine Safety and Health, Safety Division
Roger Schmidt, (703) 235-1337

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Program Policy Manual Holders
Coal Mine Operators
Coal Special Interest Groups

IC 8741

Bureau of Mines Information Circular/1977

Results of Research To Develop Guidelines for Mining Near Surface and Underground Bodies of Water

UNITED STATES DEPARTMENT OF THE INTERIOR

Information Circular 8741

Results of Research To Develop Guidelines for Mining Near Surface and Underground Bodies of Water

By Clarence O. Babcock and Verne E. Hooker

UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary

BUREAU OF MINES

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SPECIAL NOTE

The section on mine maps (pages 11-13) is synopsized from existing Federal regulations (30 CFR 75.1200). This section is included to emphasize the importance of mine maps in relation to mining under or near bodies of water and is not intended as an additional mapping requirement or as a proposed amendment to current regulations.

Panel and pillar mining, being used in the United Kingdom, is not yet extensively used in the United States. This system which works well in deep coal, has much less application here, particularly in the eastern part of the country where the biggest tonnage is relatively shallow. The panel width used has been so wide that only deep coal can qualify for mining by this method. However, if this method is imported, as the longwall method was in the past, some guidelines for its use will be available. The method should find use where the coal is at the necessary depth, because higher recovery is possible than with room-and-pillar methods.

RESULTS OF RESEARCH TO DEVELOP GUIDELINES FOR MINING NEAR SURFACE AND UNDERGROUND BODIES OF WATER

by

Clarence O. Babcock[1] and Verne E. Hooker[2]

ABSTRACT

This Bureau of Mines publication presents guidelines for mining near surface and underground bodies of water. The guidelines were based on information developed under contract in three phases of study, as follows: (1) Collection and documentation of data from worldwide sources; (2) application of existing guidelines, foreign, Federal, and State, to case histories of previous inundations; and (3) development of recommended guidelines for underground coal mining near bodies of water aimed at maximum efficient utilization of underground coal resources consistent with minimizing inundation hazards. While the contract guidelines were for the mining of coal seams, they may also be used for mining any tabular sedimentary mineral deposit. Tables are given for the determination of the size of coal pillars needed; for other bedded deposits, similar tables could be determined based on their strength properties.

INTRODUCTION

The need for practical safety guidelines when mining near bodies of water is growing because of increasing mineral demands and an increasing number of water impoundments near mineral resources. Accordingly, the Bureau of Mines generated a program for the development of potential recommended guidelines for mining in close proximity to bodies of water. The objective was maximum efficient utilization of underground coal resources consistent with minimizing inundation hazards.

It should be emphasized that an empirical approach to data collection was used in developing these recommendations. The basic engineering concepts are sound; however, when there is sufficient engineering data or mining experience available, these conservative recommendations should be modified. Further research is under consideration to refine the engineering conditions on which the recommendations are based.

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[1]Mining Engineer.
[2]Supervisory geophysicist.
Both authors are with the Denver Mining Research Center, Bureau of Mines, Denver, Colo.

Two contracts on the subject were initiated in May 1975 and completed in September 1976.[3] Results of the contracts were evaluated and compiled by the authors into a single comprehensive set of recommended technical guidelines relative to surface waters, surface structures, and abandoned workings.

These recommended guidelines cover total extraction by longwall or retreat pillar robbing, partial extraction by room and pillar, partial extraction by panel mining, and a combination of these methods. Some of the important variables involved are the solid rock cover above the coal seam(s), allowable tensile strain at the bottom of the water body, the number of seams that may be mined or restricted, and the allowable proximity of faults, old workings, etc.

SURFACE WATERS

Total Extraction Mining

A total extraction mining system is defined as the extraction of the whole minable thickness of a coal seam or other bedded mineral deposit over a large enough area so that the lateral dimensions in any direction are equal to or greater than the depth of mining. The method of extraction, whether by longwall, continuous, or conventional mining, is not relevant to this definition.

The following guidelines are recommended with respect to total extraction mining. These guidelines require the establishment--by drilling or otherwise--of the thickness of solid rock cover above the proposed total extraction workings. If it is desired to have overlying material(s) other than solid rock cover included in the minimum depth stipulation, it is necessary to demonstrate the nature and permeability of such materials. Where the word "coal" or "seam" is used, it also applies to any bedded mineral deposit.

1. Any single seam of coal beneath or in the vicinity of any body of surface water may be totally extracted, whether by longwall mining or by pillar robbing, provided that for each 1-foot thickness of coal seam to be extracted, a minimum of 60 feet of solid strata cover exists between the proposed workings and the bed of the body of surface water.

2. Where more than one seam of coal exists, all may be worked by total extraction provided that for each 1 foot of the aggregate coal and rock thickness of all seams to be extracted, a minimum thickness of 60 feet of solid strata cover exists between the proposed workings in the uppermost seam and the bed of the body of

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[3] Skelly and Loy (Harrisburg, Pa.). Guidelines for Mining Near Surface Waters (Contract HO252083). BuMines Open File Rept. 29-77, 1977, 190 pp.; available for consultation at the Bureau of Mines libraries in Denver, Colo., Twin Cities, Minn., Pittsburgh, Pa., Spokane, Wash., and Carbondale, Ill.; at the Central Library, U.S. Department of the Interior, Washington, D.C.; at the libraries of the Morgantown Energy Research Center--ERDA, Morgantown, W. Va., and the Training Facility--MESA, Beckley, W. Va.; and from the National Technical Information Service, Springfield, Va., PB 264 728/AS.

K. Wardell and Partners (Newcastle, United Kingdom). Guidelines for Mining Near Surface Waters (Contract HO252021). BuMines Open File Rept. 30-77, 1977, 59 pp.; available for consultation at the Bureau of Mines libraries in Denver, Colo., Twin Cities, Minn., Pittsburgh, Pa., Spokane, Wash., and Carbondale, Ill.; at the Central Library, U.S. Department of the Interior, Washington, D.C.; at the libraries of the Morgantown Energy Research Center--ERDA, Morgantown, W. Va., and the Training Facility--MESA, Beckley, W. Va.; and from the National Technical Information Service, Springfield, Va., PB 264 729/AS.

surface water. When subsidence observations have been carried out and satisfactory calculations of surface tensile strain can be made, any number of seams may be mined by total extraction provided that the maximum cumulative, calculated[4] tensile strain beneath a body for surface water will nowhere exceed 8.75 mm/m (0.875 percent).

3. Where a single seam has already been mined by total extraction in accordance with the provision that for each 1-foot thickness of mineral and rock extracted, a minimum of 60 feet of solid strata cover should exist, no other underlying seam should be mined by total extraction. Where the cover between the two seams is 60 times (or greater) the extractable thickness of the lower seam, such a lower seam should be mined by partial extraction--in accordance with the subsequent guidelines here stipulated--as though the upper seam represented a body of surface water.

4. Where wash or other natural or artificial deposits, which may be highly permeable or which when wet may flow, exist between bedrock and the bed of a body of surface water, these should be excluded from the thickness of solid strata mentioned, except where it has been demonstrated that such wash or other deposits would not be likely to flow when wet and could be considered as impermeable.

5. Where a fault which might connect mine workings with a body of surface water and which has a vertical displacement greater than 10 feet, or an intrusive dike having a width greater than 10 feet, is known to exist or is met with during development, no seam should be totally extracted within 50 feet horizontally on either side of such fault or dike.

Partial Extraction Mining

A partial extraction system is one in which designated pillars are deliberately left unworked for the purpose of giving more or less permanent support to the overlying strata and the land surface. Two such systems are the room-and-pillar first working and the panel-and-pillar system.

Room and Pillar

In the room-and-pillar system of mining about 50 percent of the coal is recovered by two intersecting sets of parallel entries, usually nearly perpendicular to one another. The result is a checkerboardlike array of pillars which systematically support the roof rock. In the following discussion the term "first working" means that the coal is mined by driving the entries, as opposed to "secondary workings" in which the coal left in the pillars is mined to increase recovery.

Minimum Depth of Cover

A minimum thickness of solid strata cover should be left above the coal seam. Both the height and width of the entries and the characteristics of

[4]Calculation procedure is given in the appendix.

the roof beds are significant parameters with respect to expected roof collapse height.

The separate provisions with respect to drifts and tunnels are stipulated because the practicability and cost of supporting and maintaining them would be generally acceptable. In room-and-pillar entries, however, the cost of permanent supports would be exceptionally high and their maintenance would be generally impracticable.

The following guidelines are recommended with respect to a minimum depth of solid strata for room-and-pillar workings.

1. No entry should be driven in any coal seam lying beneath or in the vicinity of any body of surface water where the total thickness of solid strata cover above the seam is less than 5 times the maximum entry width (5s) or 10 times the maximum entry height (10t), whichever is the greater. Where at least one competent bed of sandstone or similar material is present within the solid strata and has a thickness at least 1.75 times the maximum entry width, mining at a lesser cover than 5s or 10t may be considered.

2. In the case of drifts or tunnels beneath or in the vicinity of the body of surface water driven through the strata for the purpose of gaining access to a coal seam, the provision of 10t or 5s should also apply unless drifts or tunnels are permanently supported and are so maintained. In the latter event, however, there should be a minimum solid rock cover of 1.75 times the maximum drift or tunnel width.

Pillar Dimensions for First Workings

The results of observing the behavior of mine pillars underground with respect to stability, of laboratory testing of coal samples, and of theoretical considerations were combined to establish the size of coal pillars needed for safety as functions of coal thickness, depth below surface of the coal seam, and the room width used. In accordance with the results, the following guidelines are proposed with respect to pillar dimensions for room-and-pillar first workings.

1. Where room-and-pillar first working is to be carried out beneath or in the vicinity of any body of surface water and at cover depth greater than the stipulated minimum, the minimum width of pillar should be determined in accordance with tables 1 through 7.[5] An exception is made where specific local data (including relevant and comparable mining experience) exist which demonstrate that a lesser width could be used with safety.

[5]Tables include seams thicknesses of 3, 4, 6, 8, 10, 12, and 14 feet. If other seam thickness data are required, the tabulated value, W, can be obtained by trial and error or numerical methods from the equation $((W+R)/W)^2 1.5D = 1000/\sqrt{H} + 20\ (W/H)^2$, where W, R, H, and D are pillar width, room width, seam thickness, and depth from surface, respectively.

2. Where an upper seam has been mined by room-and-pillar first working in accordance with these guidelines, underlying seams should not be mined--whether by total or partial extraction--except by considering the upper seam as though it were the base of the surface body of water.

3. Where pillar widths are determined in accordance with these provisions, the calculated pillar loading should not exceed the allowable load-bearing capacity of the immediate roof and/or floor beds.

TABLE 1. - Minimum pillar widths for pillar heights of 3 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
100	12	13	14	-	-
150	15	16	16	17	18
200	17	18	19	20	20
250	19	20	21	22	22
300	20	21	22	23	24
350	22	23	24	25	26
400	23	24	25	26	27
450	25	26	27	28	29
500	26	27	28	28	30
550	27	28	29	30	31
600	28	28	30	31	32

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 2. - Minimum pillar widths for pillar heights of 4 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
100	14	15	16	-	-
150	17	18	19	20	21
200	20	21	22	23	24
250	23	24	25	26	27
300	25	26	27	28	29
350	27	28	29	30	31
400	29	30	31	32	33
450	30	31	33	34	35
500	32	33	34	35	36
550	33	34	36	37	38
600	35	36	37	38	39

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 3. - Minimum pillar widths for pillar heights of 6 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
100	17	19	20	-	-
150	22	24	25	26	27
200	26	28	29	30	32
250	30	31	33	34	35
300	33	35	36	37	38
350	36	37	39	40	41
400	39	40	41	43	44
450	41	42	44	45	46
500	43	45	46	47	48
550	45	47	48	49	51
600	47	49	50	51	53

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 4. - Minimum pillar widths for pillar heights of 8 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
100	21	22	24	-	-
150	27	29	30	32	33
200	33	34	36	37	38
250	37	39	40	42	43
300	41	43	44	46	47
350	45	47	48	49	51
400	48	50	51	53	54
450	51	53	55	56	57
500	54	56	57	59	60
550	57	59	60	62	63
600	60	61	63	64	66

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 5. - Minimum pillar widths for pillar heights of 10 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
100	24	26	27	-	-
150	32	34	35	37	38
200	39	40	42	43	45
250	44	46	48	49	51
300	49	51	53	54	56
350	54	56	57	59	60
400	58	60	61	63	64
450	62	64	65	67	68
500	66	67	69	70	72
550	69	71	72	74	75
600	72	74	76	77	79

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 6. - Minimum pillar widths for pillar heights of 12 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
150	37	39	40	42	44
200	45	46	48	50	51
250	51	53	55	57	58
300	57	59	61	63	64
350	63	65	66	68	70
400	68	70	71	73	75
450	73	74	76	78	79
500	77	79	80	82	84
550	81	83	84	86	88
600	85	87	88	90	91
650	88	90	92	94	95
700	92	94	95	97	99
720	93	95	97	98	100

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

TABLE 7. - Minimum pillar widths for pillar heights of 14 feet, feet

Depth, feet	Room width				
	16 feet	18 feet	20 feet	22 feet	24 feet
150	41	43	45	47	48
200	51	53	54	56	58
250	58	60	62	64	66
300	66	67	69	71	73
350	72	74	76	77	79
400	78	80	81	83	85
450	83	85	87	88	90
500	88	90	92	93	95
550	93	95	96	98	100
600	97	99	101	103	104
650	102	103	105	107	108
700	106	107	109	111	113
750	109	111	113	115	116
800	113	115	116	119	120
840	116	118	120	121	123

NOTE.--The figures in this table in no way exclude the application of total extraction mining at the appropriate solid strata cover and seam thickness.

Panel and Pillar

The panel-and-pillar system is defined to be one in which a bedded deposit is totally extracted from panels which are of such width in relation to their depth that the main strata can span any one of them with little deflection. Individual extraction panels are separated by abutment pillars designed to sustain the load of the main strata overlying a group of such panels and pillars. The minerals from the panels may be extracted by longwall mining, or the panels may first be mined by room and pillar and the pillars may subsequently be taken by either continuous or conventional mining methods.

The following guidelines are recommended with respect to panel-and-pillar mining beneath and in the vicinity of bodies of surface water.

1. Where the panel-and-pillar system is to be carried out beneath or in the vicinity of any body of surface water, there should be a minimum solid strata cover thickness of 270 feet or 3p, where p is the width of the panel, whichever is greater.

2. The widths of extraction panels should not exceed one-third the depth of mining, and the widths of pillars between extraction panels should be 15 times their height or one-fifth the depth of mining, whichever is greater.

3. Where more than one seam is to be mined by this system, the panels and pillars in all seams should be superimposed in the vertical direction with the panel widths being determined from the depth to the uppermost seam and the pillar widths being determined by reference to the thickest and/or deepest seam, whichever would give the greater dimension.

4. Where the panel-and-pillar system of mining has been employed in an upper seam, it should not be permissible to mine by total extraction in any underlying seam except by considering the upper one as though it were the base of the surface body of water.

Safety Zones

From observed behavior of rock strata and soil above mined-out regions, a zone is known to exist that will most likely fail if mined, causing flooding of the workings and damage to the surface and to surface structures. From rock mechanics considerations the approximate shape and extent of this zone can be identified. If no risk can be taken, obviously no mining is possible. For many conditions of mining, no damage is likely to occur and mining should be permitted.

Surface Waters

The following guidelines are recommended with respect to safety zones around and beneath bodies of surface water.

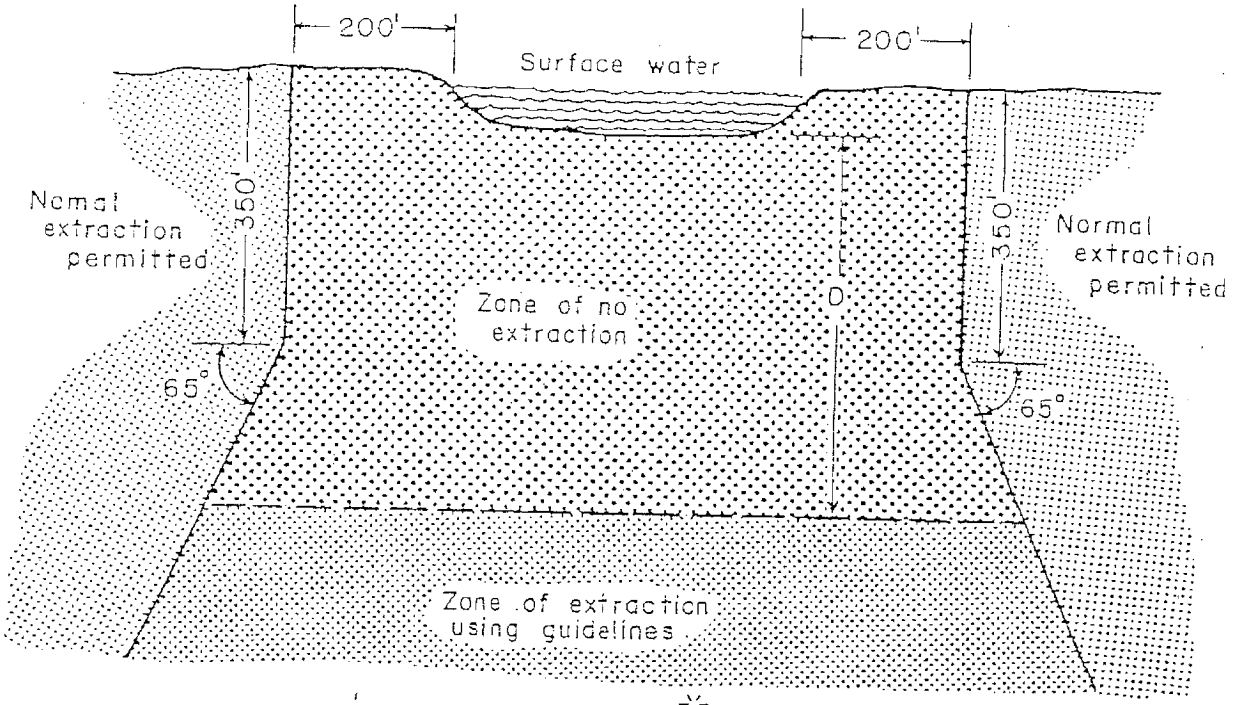
1. Where any body of surface water is present above the potential mine workings, a safety zone around such body of surface water should extend 200 feet horizontally from the high-water mark, or perimeter of the water body, and vertically downward from this point to a depth of 350 feet, then outward at an angle of dip of 65° as shown in figure 1.

2. If mining is considered within such a safety zone, it should be in accordance with the guidelines for mining beneath surface waters.

3. The width of such a safety zone may be increased or decreased if local observations and/or experience justify.

Structures Retaining Water

Since there is always some risk that damage will occur to surface structures by mining, no mining should be done in a safety zone beneath and around



D*

Room and pillar	5s or 10t
Panel	3p or 270 ft
Total extraction	60t

*Whichever is larger

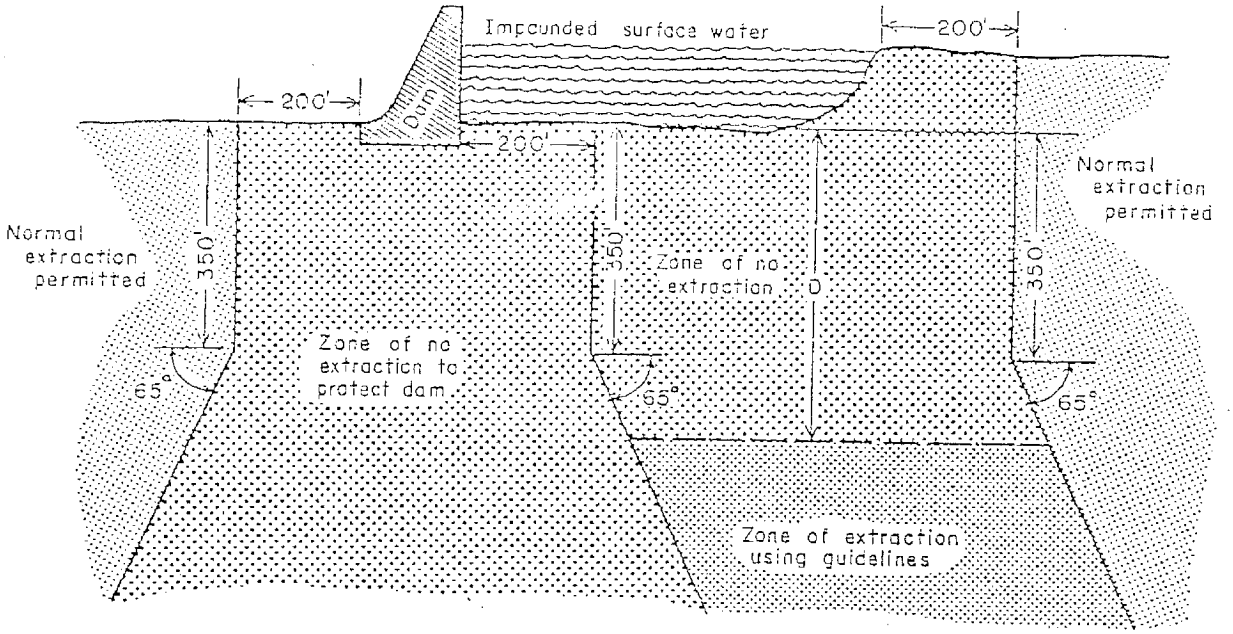
FIGURE 1. - Safety zone beneath body of surface water.

a structure where its failure would cause loss of life, property damage, or damage to water supplies needed for the public welfare. If the consequences of structural failure are not severe, mining may be undertaken.

The following guidelines are recommended with respect to safety zones around and beneath structures the survival of which is important to the public welfare.

1. Where any surface structure is impounding a substantial body of surface water and damage to that structure by mine subsidence effects could lead to a risk of structural failure and prejudice to public safety, no mining should be permitted within the safety zone of such a structure.

2. The perimeter of the structure requiring protection should be established by those responsible for its maintenance and safety. The safety zone around the perimeter of protection should extend outward 200 feet in all directions, then downward for 350 feet, and then outward at a dip of 65° from the horizontal as shown in figure 2. This safety zone is designated as a zone of no extraction. Figure 2 also shows the restriction on mining beneath the impounded water.



0*

Room and pillar	5s or 10t
Panel	3p or 270 ft
Total extraction	60t

*Whichever is larger

FIGURE 2. - Safety zone beneath dam and impounded body of surface water.

3. A greater or lesser distance than that specified in paragraph 2 may be used where local observations and/or experience so indicate.

UNDERGROUND WATERS

Mine Maps

The operator of a coal mine should have in a fireproof repository (located in an area on the surface of the mine chosen by the mine operator to minimize the danger of destruction by fire or other hazard) accurate, up-to-date maps of the mine drawn to scale.

Surface Features

Surface features may be shown directly on the mine map, or on a transparent or translucent sheet, which, when overlain on a map of underground workings, shows true and exact relations of surface features to mine workings and excavations. Surface features to be shown include--

1. Name and address of the mine.
2. Scale and orientation of the map.
3. Boundary lines and names of all surface property owners.

4. Boundary lines of the coal rights pertaining to each mine.
5. All outcrop lines.
6. Topographic features such as hills, ravines, intermittent and permanent streams, bodies of standing waters (with elevations and estimated depths).
7. Location and identification of municipal subdivisions (State, county, townships).
8. Location of all railroads and sidings, highways, and other roads.
9. Location and identification of mine buildings and facilities.
10. Location of all utilities and pipelines.
11. Location and depth of holes drilled for oil, gas, water, or geologic information that penetrate a workable seam.
12. Location of all surface fans.
13. Location of mine openings.
14. The location and description of at least two permanent baseline points coordinated with the underground and surface mine traverses, and the location and description of at least two permanent elevation bench marks used in connection with establishing or referencing mine elevation surveys. Location and description of a permanent bench mark or monument near the main mine opening.

Underground Features

Whether or not combined on the same sheet with surface features, at least one set of maps showing underground features should be composed on the same scale. Pertinent information to be recorded on the mine map should include--

1. Name and address of the mine.
2. Scale and orientation of the map.
3. Boundary lines of coal rights and owner identification.
4. Structure contours and dip of the coalbed being mined at not greater than 10-foot elevation intervals.
5. Location of all drill holes that penetrate the mined bed.
6. All shaft, slope, drift, and tunnel openings and auger- and strip-mined areas of the bed being mined.
7. Location of all ventilation fans.
8. Location and exact extent of adjacent active or abandoned underground workings above, below, or in the same seam. If abandoned workings are known to exist in an area, but exact extent is not known, it should be so indicated.
9. Up-to-date locations of active work areas, worked-out areas, and abandoned areas.
10. Locations of entries and aircourses with direction of airflow indicated by arrow.
11. Location of all escapeways.
12. Location and exact extent of all water pools, water-bearing strata, or fluidlike materials which tend to flow when wet (quicksands, peat, etc.).
13. Location and elevation of any body of water dammed or held back in any portion of the mine.

14. The elevation of tops and bottoms of shafts and slopes, and the floor at the entrance to drift and tunnel openings.
15. The elevation of the floors at intervals of not more than 200 feet in--

    a. At least one entry of each working section and main and cross entries.
    b. The last line of open crosscuts of each working section, and of main and cross entries, before such sections and main and cross entries are abandoned.
    c. Rooms advancing toward or adjacent to property or boundary lines or adjacent mines.

16. The owner, agent, or manager of a mine should take all reasonable steps to determine whether there is any material below the surface which could affect active, or soon to be active, areas in a mine so as to cause danger to miners working in that mine. All facts pertaining to such conditions should be presented to the manager.

Property Boundary Barrier Pillars

To insure that the mining of the coal seam by one company up to the property line does not favor that company over another company that mines later, the following guidelines are recommended.

1. A boundary pillar of unmined coal should be left to the property line; it should be of a width calculated by the equation $Pb = 10 + 2T + 5D$. Pb is the pillar width in feet, 10 is a constant safety factor, T is the thickness of the bed in feet rounded to the next highest integer, and D is the depth of the seam at the property line in 100-foot increments rounded to the next highest integer. This pillar width should be required on both sides of the property line. When mining on one side of the property line has approached closer than would be permitted by this guideline, the advancing working should increase its property boundary barrier pillar requirement so that the cumulative pillar size is equal to 2 Pb. Where faults are known to occur, which could result in a connection between the abandoned and active workings or which could seriously weaken pillar stability and strength, additional pillar widths should be used. This additional width should be based on the experience and judgment of the mine engineer and mine inspector.

2. Boundary barrier pillars should not be altered for increased mineral recovery unless the mining proposal insures inspection and certification that all of the affected workings are free from hazardous accumulations of water, and the proposal has--

    a. Been agreed to by the interested mining companies and superintendents.
    b. Been approved by the mine inspector.
    c. Received approval from the responsible government regulatory agency.
    d. Considered eventual interconnection of the mining operations by either accident or development plan.
    e. Considered the development plans from all affected mining companies.

Abandoned Workings, Abandoned Areas, and Adjacent Mines

Water-filled mine openings, the presence of which is unknown or if known the extent of which is poorly defined, are of major concern to mine operators. The following guidelines are recommended with respect to these problems.

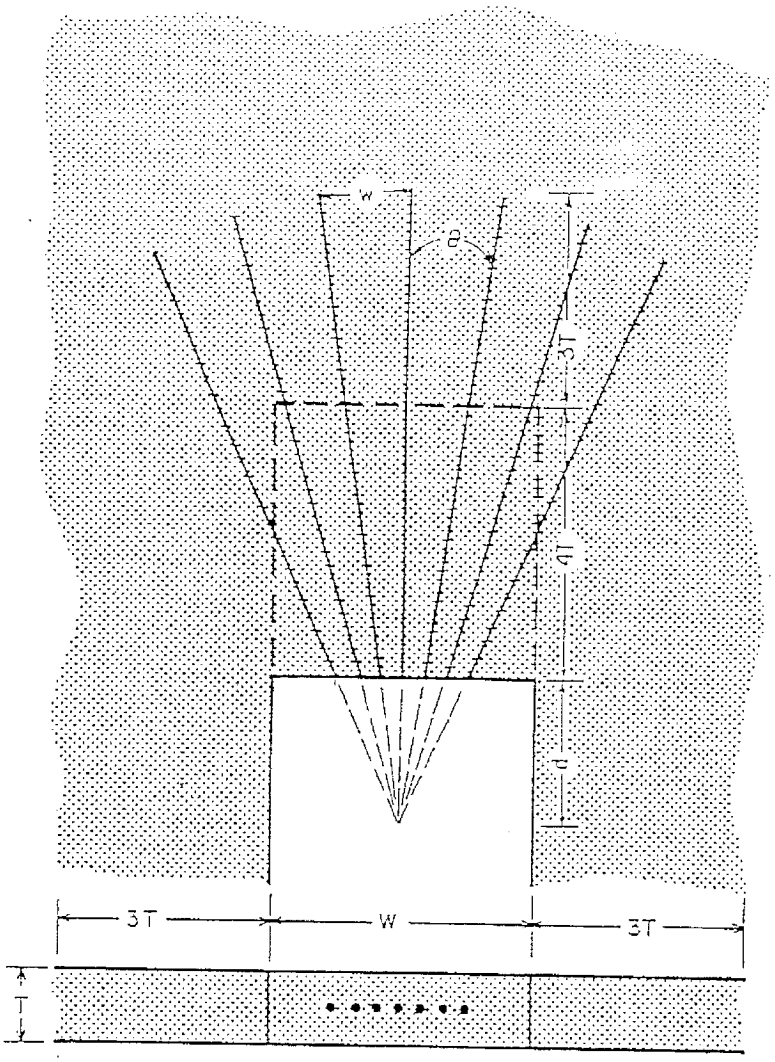
1. No mining should be permitted within 200 feet of any known or suspected abandoned workings (that are part of the present mine and/or other prior mine) which cannot be inspected and certified free of dangerous accumulations of water. When these abandoned workings can be inspected and certified as safe, mining can proceed to within the distance permitted by the Property Boundary Barrier Pillar guidelines, or to within the distance corresponding to a pillar width-to-thickness ratio of 10 to 1, whichever is larger. Where faults are known to occur that could impair the effectiveness of the pillar as a water barrier, additional pillar width may be used as determined by the mine engineer and mine inspector.

2. Locator boreholes should be drilled from the advancing face nearest to the abandoned mine through the 200-foot barrier pillar to determine the location of abandoned workings. The equipment and materials necessary to plug the borehole upon breakthrough must be available to the drill crew. The water head pressure or atmospheric conditions in the abandoned workings should be determined.

3. Unless downhole instrumentation definitely established that no water exists in the abandoned workings, even though pressure or gravity flow does not occur at breakthrough, the workings should be assumed to be flooded. If it is subsequently determined that the abandoned workings are dry, mining may proceed up to the limits of boundary barrier pillar (when approaching the property line) as defined by $Pb = 10 + 2T + 5D$; or normal mining operations should be permitted when the property limits are not a factor to be considered in this development.

4. Water may be drained from abandoned workings through a drift or auger entry, if possible, or from boreholes drilled from the surface. Water also may be drained through the 200-foot barrier pillar to the active workings and pumped to the surface. This latter method is potentially hazardous, however, and should only be used under the direction of knowledgeable and experienced personnel. If permits are necessary to discharge the water on the surface, they will need to be procured.

5. If the abandoned workings are not initially dry or drained of water, an effective safety barrier pillar should be sized by utilizing modeling techniques and unconfined compressive strength tests. For modeling, a factor of safety of 4 should be used in pillar design. Whenever the pressure head is equal to or greater than 5 atmospheres, consideration should be given to draining these workings. The permeability of the unmined barrier pillar should also be determined for consideration of its effect on waterflow and further pillar development. Two proving headings (for ventilation purposes), kept as narrow as possible and protected by boreholes, would be a safe mining plan to utilize for developing the barrier pillar up to the limits determined



Coal thickness = T
Number of holes required = $\frac{W+6T}{w}$ (next whole number)
Hole length = 7 T
Safe advance = 4T
Safety pillar = 3T
Angle θ = ATAN w/(7T+d)
w = width of old headings, if known; if w is unknown, use w = T

FIGURE 3. - Drill pattern for safe advance through coal with unknown inundation hazards.

by this recommended testing procedure. These headings should be limited to 15 feet in width. The mining crew should be alert for signs of pillar instability, excessive water leakage, strong sulfur smell, or other indicators of water, and mining halted or reevaluated as necessary. The permeability of the pillar can be reduced and its strength increased by introduction of grout or other cementing agents.

6. Whenever any working place approaches (1) within 10t or Pb, whichever is greatest, of abandoned areas in the mine as shown by surveys made and certified by a registered engineer or surveyor and the area cannot be inspected, or (2) within 200 feet of any other known abandoned areas of the mine that cannot be inspected and that may contain dangerous accumulations of water or gas, or (3) within 200 feet of known workings of an adjacent mine, a borehole configuration such as that shown in figure 3 should be drilled in advance of the working face of such working place and should be continually maintained in advance of the working face. (NOTE.--In figure 3, w is the width of the smallest old openings, if known. If not known, w is the value of the seam thickness, T).

Oil and Gas Well Pillars

Mining should not come closer to active oil and gas wells than 150 feet in any direction). When these wells are abandoned, however, they can be sealed and the barrier pillar mined through, provided that the seals are tested for leakage prior to mining.

Shaft and Vertical Opening Barrier Pillars

When these abandoned openings can be inspected and certified free of hazardous accumulations of water, they can be mined through as in normal pillar recovery operations.

When mining in the area of any abandoned shafts, raises, or other openings that cannot be inspected and certified free of dangerous accumulations of water, a barrier pillar 300 feet in diameter should be left around the opening, provided that a minimum of 100 feet of solid coal is left around the abandoned opening. Where these openings can be inspected and certified safe, a pillar of width-to-thickness ratio of 10 to 1 should be left around each opening. When mining in the area of abandoned slopes and like openings, the guidelines for mining near abandoned workings should be followed.

Mining Under Abandoned Flooded Workings

Mining under flooded abandoned workings should conform to the 60t and maximum tensile strain rules for total extraction, to the 5s or 10t rules for room-and-pillar extraction, and to the 3p or 270-foot rules for panel-and-pillar extraction.

APPENDIX

In the United Kingdom, numerous examples of total extraction beneath the sea have been examined in which no seawater passed into the mines. The maximum seabed tensile strain for each of these cases was calculated, and the results ranged from 5.0 to 15.0 millimeters per meter (mm/m). On the basis of this analysis, the National Coal Board has adopted a criterion of 10.0 mm/m of calculated maximum tensile strain as governing the minimum depth for total extraction. The expression used in the United Kingdom for calculating maximum tensile strain E_t, is

$$E_t = \frac{K\, S_{max}}{D}.$$

The value of S_{max} with longwall caving is normally taken as 0.90t, and the average value for K as 0.75 in the United Kingdom. Thus, the minimum depth of cover required for safety, D_{min} is

$$D_{min} = 67.5t,$$

where t is the thickness of the coal seam mined. For a limiting tensile strain of 5.0 mm/m, the limiting depth for total extraction would be 135t; for a limiting tensile strain of 15.0 mm/m, the limiting depth would be 45t.

If experience in the United States results in recommended strain values other than those used in the United Kingdom, these values may be used.

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ATTACHMENT 8

PREVENTION OF IMPOUNDMENT LEAKS INTO UNDERGROUND MINES ARCC IMPLEMENTATION PLAN

As a result of four major occurrences since 1996, three in Virginia, and the latest in Martin County, Kentucky, OSM developed an action plan for initiating an effort to assure that impoundment breakthroughs into underground mine works do not occur in the future. To accomplish the objectives spelled out in the OSM action plan the Appalachian Region has established specific tasks focused on identification of high risk impoundments, technical re-evaluation of these structures, correction of identified problems, and oversight of the state programs to ensure that SMCRA requirements related to impoundments are being fully met. These tasks will be accomplished with a maximum level of coordination among the Region's Field Offices, states, and MSHA, in order to ensure consistency and to minimize duplication of effort to the extent possible.

TASK 1. Establish a Regional impoundment technical committee to determine the factors contributing to the Martin County impoundment breakthrough.

TASK 2. Expand the technical committee to include state and MSHA technical representatives. The expanded committee, using their combined expertise along with information gained from the Kentucky and Virginia experiences will:

- Develop criteria that should be considered in reevaluating existing high-risk impoundments over or adjacent to underground mine works.

TASK 3. Develop and implement individual Field Office work plans designed to minimize the potential for future impoundment leaks or breakthroughs into underground mine workings. Each work plan will address the following:

- ***Oversight***
  - Evaluate the state program to determine if state requirements for regulating impoundments are as stringent as those in the Federal regulations at 30 CFR.
  - Evaluate the state's implementation of its program requirements for reviewing and approving coal related impoundments meeting the inventory criteria, including MSHA coordination.
  - Implement corrective action to resolve any deficiencies that are identified in the state program or its implementation.

- Evaluation of Existing Impoundments
  - Ensure the completion of a state inventory that, at a minimum, includes those coal related impoundments that are 20 acre feet in size and within 500 feet of any underground mine workings.

  - Work with the state to prioritize those sites from the inventory in order to ensure the earliest possible review of those impoundments that pose the highest risk.

  - Ensure effective state RA technical reviews of the approved permits for those impoundments identified in the inventory that may pose a threat to health, safety, or environment. Technical reviews should consider the criteria developed by the technical committee in Task 2. The Field Offices will coordinate any requests for technical assistance received from the states.

  - Ensure that appropriate corrective actions are taken where 1/19/01deficiencies in specific permits are identified during the technical review.

General Schedule: Task 1 was initiated on October 16, 2000, and the committee is continuing its efforts to identify factors contributing to the Martin County failure. The committee will now add Task 2 to their objective. All field offices have drafted their work plans and are initiating discussions with their respective states. Work has also begun on inventories in each state. Oversight efforts associated with Task 3 will begin as soon as discussions with states are concluded and work plans are finalized. Technical reviews of high-risk impoundments should begin once the technical committee develops criteria that should be considered in those reviews. A more specific timetable for all implementation activities will be developed as state specific work plans are finalized.