# Spring 2020 Subsidence and Geologic Field Observations

## Southern Panels Mining Areas

**PREPARED FOR:**
Mountain Coal Company, LLC
West Elk Mine
P.O. Box 591
Somerset, CO 81434


**PREPARED BY:**
Gary D. Witt, P.G., Hydrogeologist/Geological Engineer
Wright Water Engineers, Inc.


Wright Water Engineers, Inc.

September 2020

831-032.911

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September 30, 2020

Mr. Leigh Simmons
Colorado Division of Reclamation, Mining and Safety
1313 Sherman St., Rm. 215
Denver, CO 80203

Re: Spring 2020 Subsidence Monitoring Report Preparation – Mountain Coal Company, LLC.

Dear Mr. Simmons,

The following report entitled *Spring 2020 Subsidence and Geologic Field Observations – Southern Panels Mining Areas*, was prepared by, and under the supervision of, Gary D. Witt, a licensed professional geologist and employee of Wright Water Engineers, Inc.

Sincerely,

WRIGHT WATER ENGINEERS, INC.

By ______________________
Gary D. Witt, P.G., CPG
Vice President
Sr. Hydrogeologist/Geological Engineer

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
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# SPRING 2020 SUBSIDENCE AND GEOLOGIC FIELD OBSERVATIONS SOUTHERN PANELS MINING AREA[1]

## 1.0 BACKGROUND

This subsidence report is the first of two detailed documents on this subject to be generated based on 2020 calendar year observations. These reports of subsidence-related observations associated with the West Elk Mine have occurred annually between 1996 and 2006, and biannually since spring 2007. In accordance with Mountain Coal Company, LLC's (MCC) Colorado Division of Reclamation, Mining and Safety (CDRMS) permit, these subsidence reports are to be submitted by April 30 (for preceding fall monitoring) and September 30 (for preceding spring monitoring).

Prior field observations and experience in the West Elk Mine area over the last twenty-five years[2] (1996 to 2020 inclusive) indicate that subsidence-related features (cracks and bulges) are most visible on roads, well pads, and trails, where the ground is more compact and free of brush. These areas have been, and will continue to be, the focus of the biannual observations to most efficiently obtain subsidence information. Other subsidence features such as rockfalls and landslides are generally observable from overview locations along roads or on well pads and have been, and will continue to be, noted when they occur.

Spring 2020 subsidence observations were performed on May 22, 2020 in the Southern Panels Mining Area with specific focus on the most-recently mined E-seam Longwall Panel (E8) and on the first E-seam Longwall Panel of the Sunset Trail Mining Area (SS1). Traverse names used in the previous reports may not coincide with those used in this report. Pre-mining observations were also made of the area over unmined portions of E-seam Longwall Panel SS1. Observations

[1] The Southern Panels Mining Area includes the E-seam Longwall Panels E1 through E9 originally included in the South of Divide Mining Area, some of which were included in the Dry Fork Mining Area. The Southern Panels Mining Area also includes B-seam Longwall Panels B26 through B29 that underlie E-seam Longwall Panels E1 through E5. The term Southern Panels Mining Area will be used throughout this report to identify what was formerly referred to as the South of Divide and Dry Fork mining areas. The Sunset Trail Mining Area represents four panels located to the south of E-seam Longwall Panel E8 of the Southern Panels Mining Area.

[2] Annual subsidence and geologic hazard reports are maintained at Mountain Coal Company, LLC, and at the Colorado Division of Reclamation, Mining and Safety, and are exhibits to the permit document (Exhibits 60, 60A, 60B, 60C, 60D, and 60E).

associated with E-seam longwall mining of Panels E1 through E6 (mined and subsided more than two years previous) can be found in earlier reports. Observations of the Apache Rocks and Box Canyon B-seam mining areas are covered in reports prior to 2013.

During the spring 2020 field visit, accessible areas within the Southern Panels Mining Area and Sunset Trail Mining Area were visited, examined, and photographed to document subsidence-related features observed since the last field visit and to record newly observed features for future reference (see Maps 1 and 2). Field observations were made from a four-wheel drive vehicle and by foot as needed.

Thirteen photographic observation points have been established and used since 2007 to view and assess changes that may occur as a result of mining. Many of these locations were used for annual comparative purposes even before formal identification with a numeric designation. Beginning with the spring 2013 field visit, nine of these points were removed from the list of observed sites based primarily on their specificity to the terminated B-seam mining activities. Beginning in 2016, these historic photographic observation points have been used without reference to a numbered location and, if used, are called out generically in the text and on Map 1 if there is something important to note at these locations.

## 2.0 GENERAL SUBSIDENCE OBSERVATION AND REPORTING

On May 22, 2020, Wright Water Engineers, Inc. (WWE) observed surface subsidence and geologic field conditions of the Southern Panels Mining Area and Sunset Trail Mining Area (consistent with current Exhibit 60E) for MCC. Actual mining in the area is performed below the surface within the West Elk Mine using longwall mining methods. Similar surface observations have been made annually since 1996 and semi-annually since 2007 to assess potential longwall mining effects on the environment.

Based on field observations from 1996 to spring 2020, the effects of longwall mining above the West Elk Mine have been less than initially projected as reported in Exhibit 60 (Dunrud et al., 1998 rev.) and 60E (WWE, 2012). Rockfalls and/or landslides have generally been observed only sporadically in the Box Canyon mining area since 2006 where the steep, upper reaches of Sylvester Gulch and Box Canyon abut the large geographic feature known as West Flatiron. In the flatter and more rounded topography of the Apache Rocks, Southern Panels, and Sunset Trail mining areas, the rockfall and landslide potential is much smaller. However, subsidence-related tension cracks have occurred in these mining areas, particularly above the active longwall mining face.

E-seam longwall mining in the Southern Panels mining area was initiated on Panel E1 in December 2008 beginning at the east end and progressing westward. All mining in the Southern Panels Mining Area has been planned to progress from the east to west across the panels. As of the time of WWE’s spring 2020 field visit (May 22), mining was complete in E-seam Longwall Panels E1 through E8. Initial mining of the E-seam Longwall Panel SS1 in the Sunset Trail Mining Area was initiated in January 2020 and was approximately 30% complete as of the time of our spring 2020 field visit.

Beginning with the Spring 2011 Subsidence Report, an effort was made to reduce the size of the semi-annual subsidence reports by eliminating much of the regularly included background and historical information (e.g., subsidence projections). For this reason, specific details associated with subsidence projections and field recognition of subsidence and non-subsidence features were eliminated. Since that time, readers have been directed to Sections 1.0 and 2.0, respectively, of the Spring 2011 Subsidence Report and to Exhibits 60 and 60E of the West Elk Mine permit for this information.

Also, in keeping with the goal of a reduction in report size, future reports will focus on the identification and discussion of those observations that reflect an obvious change in the conditions overlying the active portion of the mine and on documenting baseline conditions in areas that have yet to be mined. For this reason, observations from our spring 2020 field visit were focused on areas above E-seam Longwall Panels E7 and E8 in the Southern Panels Mining Area and on E-seam Longwall Panel SS1 of the Sunset Trail Mining Area.

Readers should note that observations are discussed relative to traverses along segments of drill roads providing access to drilling pads containing mine ventilation boreholes (MVBs). Given the dynamic nature of the mining activities (i.e., adding and reclaiming of road segments and MVB pads), future naming of traverses will likely vary from report to report. Efforts will be made, as practical, to keep traverse names the same. Specific nomenclature for observed features will be regularly represented on Map 1 of each report.

## 3.0 SUBSIDENCE MONITORING

MCC has been collecting data from numerous monitoring locations in and around Minnesota Reservoir, Monument Dam, and the general Dry Fork area for many years. Locations of ongoing monitoring by MCC personnel include the U.S. Forest Service (USFS) roads and stock ponds, as well as the Monument Dam and Minnesota Reservoir area. Inspection forms and survey data for these areas are provided in Appendices A, B, and C. Data and discussions associated with ongoing MCC monitoring are provided by MCC and included in this WWE report for convenience.

### 3.1 USFS Roads and Stock Pond Monitoring

As described in previous subsidence reports, observations by MCC personnel of the USFS roads and stock ponds in the vicinity of active mining activities have occurred for many years. Inspection forms from observations conducted during the spring of 2020 are included with this report in Appendix A.

### 3.2 Monument Dam/Minnesota Reservoir Monitoring

MCC has conducted monitoring of the Monument Dam and strategic locations around Minnesota Reservoir since 2006. Data collected from various monitoring locations on the Monument Dam (including Dam Inspection Forms) are provided in Appendix B. In addition, MCC has monitoring and reporting responsibilities for the land survey stations. A summary of both average height and longitudinal displacement data obtained from fall 2019 to spring 2020 is provided in Table 1 of Appendix C.

## 4.0 SPRING 2020 SUBSIDENCE OBSERVATIONS

During WWE's spring 2020 field visit, subsidence-related tension cracks were observed above mined E-seam Longwall Panels E7 and E8 in the Southern Panels Mining Area as accessed by USFS Road 711 (Dry Fork Road) and on MVB pads, particularly where they exist above active mining activities. No subsidence-related tension cracks were observed above the mined portion of E-seam Longwall Panel SS1 of the Sunset Trail Mining Area.

Subsidence features were observed at various locations along the established traverses. The most notable subsidence features were located along the roadway south of MVB E7-12 above mined E-seam Longwall Panel E7, along the roadway north of MVB E6-14 above mined E-seam Longwall Panel E6, along the roadway between MVBs E8-7 and E8-8, and on, or near, the MVB pads for E8-3 and E8-4 above mined E-seam Longwall Panel E8. These locations represent the areas above the most recent mining activity at the time of our field visit. Details associated with the spring 2020 observation of subsidence features can be found in Sections 4.3, 4.5, and 4.6 of this report.

The subsidence features observed and discussed in previous subsidence reports were all revisited and most were noticeably weathered and less discernible. Also, to date, there have been no subsidence-related features observed in alluvium, even above active longwall mining activities.

The following is a detailed discussion of observations associated with Traverses A-A' through G-G' (see Maps 1 and 2). Map 1 shows the outline of E-seam mine workings along with surface topography and other surface features, including the named traverses. Map 2 shows the same area and detail as Map 1 (minus traverses) along with recently active, or potentially active, landslide and rockfall areas as delineated from aerial photo research and field observations. Also on Map 1, note that a designation similar to E6-1/2/3 indicates one MVB pad containing three drill holes. The surface and termination points of each drill hole are shown by small and large filled green circles, respectively, that are connected by green lines. A single large filled green circle is representative of a vertical drill hole.

Some of the numerous photographs obtained during the spring 2020 field visit have been included as figures in the following text. Where these images have notable differences from previous photographs, the older image has been included for comparison purposes. To reduce the overall size of this document, narrative text and photographs are excluded for traverses where no noticeable change was observed.

### 4.1 Traverse A-A'

This traverse overlies portions of mined E-seam Longwall Panels E1 through E6. Traverse A-A' originates just south of Monument Dam (and Minnesota Reservoir) and proceeds in a southeasterly direction along Dry Fork Road a distance of approximately 3.0 miles. The western end of this traverse is adjacent to Minnesota Reservoir and outside the proposed E-seam mining influences of Longwall Panels E1 through E9 or Longwall Panels E10 through E12. The eastern end of this traverse is at the upper flume on the Dry Fork of Minnesota Creek.

Traverse A-A' is included in this report to provide context for other traverses that originate along this traverse and travel southward across the Southern Panels and Sunset Trail mining areas (see Maps 1 and 2).

No subsidence-related features were observed along this Traverse A-A' during our spring 2020 field visit.

### 4.2 Traverse B-B'

Traverse B-B′ begins where the Deer Creek drainage meets the Dry Fork Road (Traverse A-A′). It continues southward up the Deer Creek Road past two manufactured stock watering troughs (fed by a nearby spring) a distance of approximately 0.75 mile to a ‘T’ intersection with another road south of the headgate entries of unmined E-seam Longwall Panel E7 (see Map 1). Two additional stock ponds (P74 and P93) with earthen embankments are located lower in the drainage. Both of these ponds are also fed by nearby springs. This traverse is located above the E-South Mains and the western ends of mined E-seam Longwall Panels E3, E4, E5, and E6.

No subsidence-related features were observed along this traverse during the spring 2020 field visit.

Baseline observations were also made during WWE’s spring 2020 field visit of the area between B′ and Lick Creek including above unmined E-seam Longwall Panel E14 (see Map 1). The area traversed beyond B′ is represented on Map 1 by an orange dashed line.

## 4.3 Traverse C-C’

Traverse C-C′ originates in the Deer Creek drainage adjacent to the lower stock pond (P74) and proceeds eastward, trending north and then south, over mined E-seam Longwall Panels E2, E3, E4, E5, E6, and E7 (see Map 1). E-seam overburden depths along this traverse vary from 450 feet in the Deer Creek drainage to approximately 900 feet over mined E-seam Longwall Panels E4 and E5.

Numerous MVB pads have been historically accessible from this traverse including E3-6, E3-12, E3-17.5, E3-21, E3-25, E4-15, E4-16, E4-17, E4-18, E5-17, and E5-18 over mined E-seam Longwall Panels E3 through E5. Each of these pads has now been reclaimed.

In 2016 and again in 2017, this traverse was extended southward across what is now mined E-seam Longwall Panel E6 and E7 and MVB pads E6-13, E6-14, and E7-12. MVB pad E6-13 has now been plugged and reclaimed.

During the fall 2018 field visit, a series of parallel subsidence cracks was observed in the road north of the MVB E7-12 pad. These cracks have healed and sealed to the point that they are difficult to identify. Parallel subsidence cracks with a N60°W orientation were also observed during the fall 2018 field visit along the road south of the E7-12 MVB pad (Location 1). A follow-up visit was made to this location during our spring 2020 field work and our observations are provided below.

A new subsidence crack with elevation offset was observed during our spring 2019 field visit on the road leading to MVB E6-14 about 1,000 feet south of the pad (Location 2). Details associated with our follow-up visit to this location during our spring 2020 field work are provided below.

### *4.3.1 Location 1*

Two parallel subsidence cracks were observed approximately 300 feet south of the E7-12 MVB pad during WWE’s fall 2018 field work (Figure 1). These cracks had a N60°W orientation and an offset of about 13 feet. Observational evidence at that time (i.e., sharpness of crack edges) suggested that the cracks had not formed at the same time. The northern crack had rounded edges while the southern crack had sharp edges. E-seam overburden thickness at this location is about 800 feet.

Observations made during the spring 2020 field visit were somewhat similar. The northern crack was nearly completely filled while the southern crack still presented with a measurable width and depth. Both cracks showed signs of healing and weathering (Figure 2). Maximum measurements of the southern crack were 6 inches in width and 36 inches in depth.

Figure 1. Southeastward view during the fall 2018 field visit of two parallel subsidence cracks that appeared as a result of recent longwall mining beneath the area. The closer crack showed more rounded edges than the farther crack, suggesting the latter had most recently formed at the time of the observation.

Figure 2. Southeastward view during the spring 2020 field visit of the same area shown in Figure 1.

### *4.3.2 Location 2*

During the spring 2019 field visit, a new subsidence crack was observed approximately 1,000 feet north of the E6-14 MVB pad (Figure 3). This crack had a pronounced elevation offset of 6 inches from north to south and extended completely across the road and beyond (20+ feet in length) in a N70°W orientation. The maximum dimensions were observed to be 24 inches both in width and depth. This location is over the tailgate entries of E-seam Longwall Panel E7 where tensional stresses are somewhat greater. E-seam overburden thickness at this location is about 800 feet.

Observations made during the spring 2020 field visit found that the crack was still evident with signs of weathering (Figure 4). The maximum dimensions observed during the fall 2019 field visit had not changed and neither had the elevation offset of about 6 inches from south to north across the crack.

Figure 3. Northward view during the spring 2019 field visit of a new subsidence crack with 6-inch elevation from north to south observed approximately 1,000 feet north of the MVB E6-14 pad.

Figure 4. Northward view during the spring 2020 field visit of the same subsidence crack shown in Figure 3.

### 4.4 Traverse D-D'

This traverse originates along the south side of the Dry Fork Road (Traverse A-A′) and proceeds southward up Poison Gulch (drainage east of Deer Creek). This traverse crosses mined E-seam Longwall Panels E3, E4, E5, E6, and E7 (see Map 1). The E-seam overburden depth along this traverse varies from less than 700 feet to almost 900 feet. This traverse leads southward from Traverse A-A′, crosses the Dry Fork, and eventually leads to four MVB pads above mined E-seam Longwall Panel E7 (i.e., E7-8, E7-9, E7-10, and E7-11).

During WWE’s fall 2018 field visit, subsidence features on or near the accessible MVB pads over E-seam Longwall Panel E7 were observed as the longwall mining face had passed beneath the area. Starting in spring 2019, these features, along with noted differential settlement cracks, were notably diminished. Observations during the spring 2020 field visit found these features to remain present but they were more difficult to identify.

### 4.5 Traverse E-E'

This traverse begins at Traverse A-A′ and continues southward to an intersection with Traverse F-F′ and then west and south above mined E-seam Longwall Panels E5, E6, E7, and E8 (see Map 1). All MVB pads above mined E-seam Longwall Panels E5 and E6 have now been reclaimed with the exception of MVB E5-11, which is immediately adjacent to the road. Overburden along this traverse varies from about 900 to 1,020 feet.

This traverse provides access to MVBs E7-6 and E7-7 above mined E-seam Longwall Panel E7 and to MVBs E8-5 through E8-8 above mined E-seam Longwall Panel E8. MVB pad E7-5 has now been reclaimed.

The spring 2020 visit to the MVB E7-6 and E7-7 pads found no new subsidence features although the previously observed differential settlement cracks on the E8-5 MVB pad were still present but showed continued signs of weathering. No new subsidence features were observed at the E8-5 MVB pad during WWE’s fall 2019 field visit.

Differential and subsidence cracks observed during the spring and fall 2019 field visits at the E8-6, E8-7, and E8-8 MVB pads could not be located during WWE's spring 2020 visit. As a result, no photographs of these locations are included in this report. However, the parallel series of subsidence cracks located along the road near the fork leading to the E8-7 and E8-8 pads, as observed during the fall 2019 field visit, was visited again, and photographed (Location 3). Details associated with Location 3 are provided below.

#### *4.5.1 Location 3*

Beginning approximately 60 feet west of the fork in the road leading to either the MVB E8-7 or MVB E8-8 pad and continuing eastward is a series of six sets of parallel subsidence cracks that appeared between spring and fall 2019 in response to longwall mining activities that passed beneath the area. These crack sets were comprised of 2 to 4 individual cracks with a general orientation of N10°E and an offset of about 20 to 25 feet from each other. The largest and most continuous of the crack sets was located at the fork. Figures 5 and 7 show these features as observed during WWE's fall 2019 field visit. Figures 6 and 8 are from approximately the same location and with the same orientation. Note the lack of readily identifiable subsidence cracks in just a few months.

Figure 5. Fall 2019 view looking east of subsidence cracks west of the intersection leading to leading to either the MVB E8-7 or E8-8 pads

Figure 6. Spring 2020 view of approximately the same location and orientation as provided in Figure 5.


Figure 8. Northeastward view during fall 2019 of the largest subsidence crack sets located at the fork in the road leading to either MVB E8-7 or E8-8 pads.


Figure 8. Northeastward view during spring 2020 of the same area and orientation as shown in Figure 7.

## 4.6 Traverse F-F'

Traverse F-F′ departs Traverse E-E′ in a southeasterly direction over the east end of mined E-seam Longwall Panels E5, E6, E7, and E8. Most of the MVB pads on the eastern end of mined Longwall Panel E5 and E6 have been reclaimed with the exception of MVB E6-4. This traverse allows access to MVBs E7-1/2, E7-3, and E7-4 over mined E-seam Longwall Panel E7 and to MVB pads E8-1, E8-2, E8-3, and E8-4 over mined E-seam Longwall Panel E8 (see Map 1). The E-seam overburden depth along this traverse is from 1,000 feet to more than 1,200 feet.

During WWE's spring 2019 field visit, subsidence-related features were observed on MVB E8-1 and E8-3 pads. Differential settlement cracks were observed on MVB E8-2, E8-3, and E8-4 pads. Fall 2019 and spring 2020 field visits found that the subsidence crack previously observed on the MVB E8-1 and E8-3 pads had healed and could not be identified. However, the differential settlement cracks on MVB E8-3 were still present and likely exacerbated by the longwall mining that passed beneath the area. These cracks at the edge of the MVB E8-3 pad and road leading toward the MVB E8-4 pad are discussed below as Location 4.

Previously observed differential settlement cracks on the MVB E8-4 pad were still present as of WWE's spring 2020 field visit and were exacerbated by the mining activities in the area. These features are discussed in more detail below as Location 5.

### *4.6.1 Location 4*

A pair of subsidence cracks were observed during WWE's spring 2019 field work on the north side of the MVB E8-3 pad and reported in our Spring 2019 Subsidence Report. The two subsidence cracks in this location were difficult to observe during our fall 2019 field visit due to regrading and other activities on the pad associated with the removal of the pump and trailer.

Numerous differential settlement cracks were observed during the fall 2019 field visit along the south side of the road leaving the southwest side of the pad (i.e., areas of greatest fill placement). This road connects this pad with the MVB E8-4 pad. The largest of these cracks measured about 45 feet in length, had a maximum width of 6 inches, and a maximum depth of 18 inches (Figure 9). Observations made during WWE's spring 2020 field visit found these differential settlement cracks were still present as shown in Figure 10. The various dimensions of the largest crack appear to be similar to those observed during our fall 2019 field visit.

Figure 9. Eastward view during the fall 2019 field visit of a relatively continuous differential settlement crack along the south side of the road connecting the MVB E8-3 pad with the MVB E8-4 pad.

Figure 10. Eastward view during the spring 2020 field visit of the same relatively continuous differential settlement crack shown in Figure 9. The length, maximum width, and maximum depth dimensions appeared to be similar to those observed previously.

### *4.6.2 Location 5*

Figure 11 shows the differential settlement cracks first observed on the southwest corner of the MVB E8-4 pad during WWE's spring 2019 field work. A comparison photo obtained during our spring 2020 field visit found that some of the cracks had healed while others had expanded (Figure 12). The largest of the remaining cracks denoted by a black arrow in Figure 12 measured 45 feet in length with a maximum width of 6 inches and a maximum depth of 18 inches. These cracks are represented in the photograph labeled Figure 13. The E-seam overburden thickness at this location is approximately 1,000 feet. There are no other subsidence features associated with this pad.

Figure 11. Eastward view during the spring 2019 field visit of a series of differential settlement cracks (designated by the oval) located on the largest fill portion of MVB E8-4 pad.

Figure 12. Eastward view during the spring 2020 field visit of the same area depicted in Figure 11. Many previous differential settlement cracks had healed since our last visit while others had remained and even widened. The area within the black oval was one of the areas that had widened, as further represented in Figure 13.

Figure 12. Eastward view during the spring 2020 field visit of differential settlement cracks on the southwest portion of the MVB E8-4 pad.

## 4.7 Traverse G-G′

Traverse G-G′ departs Traverse F-F′ in a southerly direction from the east end of mined E-seam Longwall Panel E7 (see Map 1). This traverse continues south over Lick Creek and to the east end of E-seam Longwall Panel SS1 of the Sunset Trail Mining Area. From this location, the traverse splits and continues either west across mined and unmined portions of E-seam Longwall Panel SS1 to several MVB pads (i.e., SS1-1 through SS1-7) or south to a coal exploration pad located east of unmined E-seam Longwall Panel SS3.

Longwall mining of E-seam Longwall Panel SS1 began in January 2020. At the time of WWE's spring 2020 field visit, the longwall face was located between MVB pads SS1-3 and SS1-4.

Two parallel cracks (separated by approximately 3 feet) were observed near the southeast corner of the MVB SS1-1 pad. This feature was confirmed by MCC personnel to be manmade and is discussed below as Location 6. No subsidence, differential settlement, or anthropogenic features were observed on the MVB SS1-2 pad. Observations from MVB SS1-3 found another parallel set of cracks (with similar separation to that observed at MVB SS1-1) with a subsided trough extending from near the middle of the pad to the northern edge (largest fill portion). This feature appeared to be from a poorly backfilled and compacted track-hoe trench. This assumption was confirmed by MCC personnel who reported that material had been excavation from the pad by a track-hoe for purposes of aiding in the reclamation of the mud pits. This feature is discussed in more detail as Location 7.

Observations were made during our spring 2020 field visit to the remaining MVB pads on unmined portions of E-seam Longwall Panel SS1 (i.e., SS1-4 through SS1-7). Aside from additional evidence of 3-foot side backfilled and subsided track-hoe trenches on several pads, there was no evidence of slumps, landslides, or differential settlement cracks at these locations.

### *4.7.1 Location 6*

A pair of parallel cracks were observed during WWE's spring 2020 field work on the southeast portion of the MVB SS1-1 pad (Figure 13). The separation between the cracks was a consistent 3 feet with an orientation that was nearly due north to south. The easternmost crack extended approximately 30 feet in length with maximum width dimensions of 3 inches and maximum depth dimensions of 5 inches. The westernmost crack was about 57 feet in length with maximum width and depth dimensions of 2 inches and 3 inches, respectively.

The amount of fill material placed during pad construction was relatively small and on the western portion of the pad. The observations of cracks on the southeast portion of this pad led to an initial assumption that the cracks may be the result of settlement of backfill placed over the mud pit or a trench associated with the mud pit as used in the drilling process for the methane drainage borehole into the target E-seam coal. Later observations of parallel cracks on multiple MVB pads over mined and unmined E-seam Longwall Panel SS1 demonstrated that similarly observed features were not longwall mining related but rather the edge of a poorly compacted and subsiding track-hoe trench used in the reclamation of the mud pits. Further evidence that the Location 6 cracks are due to a poorly compacted and subsiding track-hoe trench is the depressed nature of the trough between the two cracks, as visible in Figure 13.

Figure 13. Northward view during the spring 2020 field visit of a parallel set of cracks on the southeast portion of the MVB SS1-1 pad.

#### *4.7.2 Location 7*

A 3-foot-wide trough of approximately 27 feet in length was observed on the MVB SS1-3 pad during WWE's spring 2020 field visit (Figures 14 and 15). This feature originates near the middle of the pad and continues to the northern edge. The elevation difference between the edges and middle of the settlement trough is as much as 8 inches. This feature is similar to that described at MVB SS1-1 (Location 6) and similar in appearance to features observed on the remainder of the

MVB pads west of this location above unmined E-seam Longwall Panel SS1. The consistency in width confirms an anthropogenic origin. The appearance of these settlement features necessitated their inclusion in this report even though they are not the result of longwall mining in the area.

Figure 14. Northeastward view of the MVB SS1-3 pad with a 3-foot-wide settlement trough extending from near the middle of the pad to the northern edge.

Figure 15. Northern view of the same settlement trough shown in Figure 14. This feature has the same width and consistent linear features to those on other pads over unmined E-seam Longwall Panel SS1.

## 5.0 CONCLUSIONS

1. The conceptual B- and E-seam mining model presented in the Exhibit 60 series of the mining permit has been verified by annual field observations in the various West Elk Mine mining areas. With the use of longwall mining methods where the uniform downwarping of the overburden rocks and unconsolidated material act as laterally constrained plates, cracks in zones under tensile stress narrow with depth, and close at the neutral surface. Below the neutral surface, the materials are therefore in compression. This has an important bearing on the hydrologic consequences of longwall mining. Any groundwater or surface water in contact with a given subsidence crack is prevented from traveling downward beyond the neutral surface of the deformed plate. Annual field observations from 1996 to spring 2020, inclusive, verify this conceptual model in bedrock and surficial material (colluvium, alluvium, mudflow, and debris flow deposits) where the overburden is laterally constrained.

2. Typically, uniform downwarping occurs in association with longwall mining when there is lateral constraint. Where there are steep slopes and cliffs, there is little lateral support in at least one direction, which causes the associated rocks and unconsolidated materials to deform like unconstrained beams, plates, or cantilevers as the longwall mining faces move beneath them. This lack of lateral constraint allows subsidence cracks to commonly extend completely through sandstones and other brittle units, and groundwater or surface water present near or within these cracks will likely flow through and exit into existing surface drainages. The relatively few cliffs and over-steepened slopes in the Southern Panels Mining Area tend to provide the lateral constraint needed to produce a more uniform down-warping with fewer significant subsidence cracks observable at the surface.

3. To date, there have been no observed or reported water losses associated with the longwall mining activities.

4. Continuous annual observations find substantial weathering of previously-observed subsidence cracks with edges rounding, widths reducing, and depths filling with eroded material. The only exception to these observations has been those cracks in thick, exposed,

brittle sandstone units above previously mined B-seam panels (i.e., Apache Rocks) where rounding of edges and filling of cracks have occurred over time but widths have remained relatively constant.

5. The length of time that tension cracks are expected to be visible before the effects of erosion and deposition, mass wasting, infilling, and revegetation obliterate them (duration of cracks), is a function of their location with respect to the mine geometry and type of material in which the cracks formed. Crack duration in zones of permanent tensile stress, such as above mine boundaries and unmined pillars between longwall panels, commonly last: 1) from one to three years in colluvium, 2) from three to six years in soft, friable sandstone, and 3) many decades in hard, durable sandstone. However, cracks that form in the zone of temporary tensile stress, such as above moving longwall faces, commonly close again when the longwall moves out of their area of influence.

6. Observed mine-induced subsidence effects have been less in the Southern Panels Mining Area than were observed annually in the Box Canyon and Apache Rocks B-seam mining areas dating back to 1996. The more subdued topography and the fewer cliffs and ledges of the Southern Panels Mining Area reduce the potential for rockfall/landslide areas where E-seam mining has been underway since December 2008.

7. Field visits have revealed the healing and sealing capacity of cracks in surficial material by weathering, mass wasting, and crack infilling over time. This is particularly true in the colluvium that covers much of the surface of the Southern Panels Mining Area. The healing and sealing capacity of these materials cause softening and rounding of the crack edges as well as reduction of crack continuity and depth to a point of being nearly imperceptible within a year or two.

8. Mining activities within the Southern Panels Mining Area have caused no reported impacts on surface flow or induced inflows to the underground mine workings even while mining occurred directly beneath Dry Fork. Of similar significance is the lack of observed cracks in alluvial materials.

9. Subsidence-related effects were observed during the spring 2020 field visit at the following locations:

    - above mined E-seam Longwall Panel E7 (i.e., along Traverse C-C′ on the access road south of MVB E7-12 [Location 1] and on the access road south of E6-14 [Location 2])
    - above mined E-seam Longwall Panel E8 (i.e., along Traverse E-E′ at the intersection of roads leading to MVB E8-7 and E8-8 [Location 3]), and
    - above mined E-seam Longwall Panel E8 (i.e., along Traverse F-F′ at MVB pad E8-2 [Location 4] and at MVB pad E8-3 [Location 5]).

All subsidence-related features were within the expected angle of draw for the E-seam and were generally focused in areas of maximum temporary tensile stress, such as above current or recent longwall mining activities.

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# MAPS


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*MOUNTAIN COAL COMPANY WEST ELK MINE*

LOCATIONS OF OBSERVATIONS IN THE SOUTHERN PANELS MINING AREA - MAY 2020

DESIGN GDW
DETAIL TMV
CHECK GDW
DATE 9/25/20
SCALE 1"=1000'

| PROJECT NUMBER | DATE | MAP |
|---|---|---|
| 831-032.911 | 09/25 | 1 |

Plot Date/Time: 09/29/2020, 10:04:20 AM; Z:\PROJECT FILES\72-99\831-032\831-032.911\CAD-GIS\CAD\SPRING 2020\01_DWGS\BASE-2020-SPRING.DWG-SOUTH OF DIVIDE (24X36)


WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
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(303)480-1700 FAX(303)480-1020

*MOUNTAIN COAL COMPANY WEST ELK MINE*

LANDSLIDES AND ROCKFALLS IN THE SOUTHERN PANELS MINING AREA - MAY 2020

DESIGN GDW
DETAIL TMV
CHECK GDW
DATE 9/25/20
SCALE 1"=1000'

| PROJECT NUMBER | DATE | MAP |
|---|---|---|
| 831-032.911 | 09/25 | 2 |

Plot Date/Time: 09/29/2020, 10:04:55 AM; Z:\PROJECT FILES\72-99\831-032\831-032.911\CAD-GIS\CAD\SPRING 2020\01_DWGS\LSRF 2020-SPRING.DWG-SOUTH OF DIVIDE (24X36)

# APPENDIX A

## Forest Service Road and Stock Pond Inspection Forms

# Forest Service Roads
# Inspection Form

Date: 4/30/2020
Time: 10:15
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: LW SS1 25xc in SS1 HG.
Road(s) Being Inspected: Dry Fork

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is the Forest Service road within the projected angle of draw of subsidence? If yes, which road(s): ______ |
| ☐ | ☒ | Are there visible surface cracks on the road? If yes, describe (location, width, length, etc.): ______ |
| ☐ | ☒ | Is there any recent evidence of potential subsidence induced slope failure? If yes, describe: ______ |
| ☐ | ☒ | Are there any other potentially damaging, subsidence induced features on or near the road? If yes, describe: ______ |
| ☐ | ☒ | Is mitigation needed? If yes, list suggestions: ______ |

Notes: Conditions of roads were good overall.

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the public or operations, notify John Poulos or Kathy Welt immediately.

**Forest Service Roads**
**Inspection Form**

Date: 5/29/20
Time: 12:00
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: LW SS1 Approx 24xc in SS1 HG.
Road(s) Being Inspected: Dry Fork and Deer Creek

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is the Forest Service road within the projected angle of draw of subsidence? If yes, which road(s): ____ |
| ☐ | ☒ | Are there visible surface cracks on the road? If yes, describe (location, width, length, etc.): ____ |
| ☐ | ☒ | Is there any recent evidence of potential subsidence induced slope failure? If yes, describe: ____ |
| ☐ | ☒ | Are there any other potentially damaging, subsidence induced features on or near the road? If yes, describe: ____ |
| ☐ | ☒ | Is mitigation needed? If yes, list suggestions: ____ |

Notes:

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the public or operations, notify John Poulos or Kathy Welt immediately.

# Forest Service Roads
# Inspection Form

Date: 6/25/20
Time: 12:00 PM
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: SS1 approx. 22 xc in SS1 HG
Road(s) Being Inspected: Dry Fork and Deer Creek

Yes No

☐ ☒ Is the Forest Service road within the projected angle of draw of subsidence? If yes, which road(s):

___

☐ ☒ Are there visible surface cracks on the road? If yes, describe (location, width, length, etc.):

___

___

___

☐ ☒ Is there any recent evidence of potential subsidence induced slope failure? If yes, describe:

___

☐ ☒ Are there any other potentially damaging, subsidence induced features on or near the road? If yes, describe:

___

☐ ☒ Is mitigation needed? If yes, list suggestions:

___

Notes:

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the public or operations, notify John Poulos or Kathy Welt immediately.

# Stock Pond
# Inspection Form

Date: 4/30/20
Time: 10:30
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: LW SS1 25 xc in SS1 HG
Stock Pond(s) Being Inspected: DF 35

Yes No

☐ ☐ Is the stock pond within twice the projected angle of draw of subsidence? If yes, which pond(s):

______________________________

☐ ☐ Are there visible surface cracks in or near the stock pond? If yes, describe (location, width, length, etc.):

______________________________
______________________________
______________________________

☐ ☐ Is there any evidence of potential subsidence induced water loss? If yes, describe:

______________________________

☐ ☐ Is there water in the pond? If yes, describe:

______________________________

☐ ☐ Is mitigation needed? If yes, list suggestions:

______________________________

Notes:
Unable to access due to muddy road conditions.

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the pond, notify John Poulos or Kathy Welt immediately.

# Stock Pond
# Inspection Form

Date: 5/29/20
Time: 12:30
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: LW551 Approximately 23 xc in 551 HG
Stock Pond(s) Being Inspected: DF 35

| Yes | No | |
|---|---|---|
| ☒ | ☐ | Is the stock pond within twice the projected angle of draw of subsidence? If yes, which pond(s): 860' is 2x Angle of draw Pond DF35 |
| ☐ | ☒ | Are there visible surface cracks in or near the stock pond? If yes, describe (location, width, length, etc.): |
| ☐ | ☒ | Is there any evidence of potential subsidence induced water loss? If yes, describe: |
| ☒ | ☐ | Is there water in the pond? If yes, describe: Pond is at 90% capacity |
| ☐ | ☒ | Is mitigation needed? If yes, list suggestions: |

Notes:
Prior to 5/29/20, this site was unable to be accessed due to road conditions

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the pond, notify John Poulos or Kathy Welt immediately.

# Stock Pond
# Inspection Form

Date: 6/4/20
Time: 10 AM
Name of Inspector: Robert G. Munz
Current Panel and XC Being Mined: LW 551 22-23xc in 551 HG
Stock Pond(s) Being Inspected: DF 35

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is the stock pond within twice the projected angle of draw of subsidence? If yes, which pond(s): |
| ☐ | ☒ | Are there visible surface cracks in or near the stock pond? If yes, describe (location, width, length, etc.): |
| ☐ | ☒ | Is there any evidence of potential subsidence induced water loss? If yes, describe: |
| ☒ | ☐ | Is there water in the pond? If yes, describe: Pond is approximately at 70% capacity |
| ☐ | ☒ | Is mitigation needed? If yes, list suggestions: |

Notes: Pond is no longer within 2x the angle of draw.

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the pond, notify John Poulos or Kathy Welt immediately.

**Stock Pond**
**Inspection Form**

Date: 6/25/20
Time: 11:30 AM
Name of Inspector: Robert Munz
Current Panel and XC Being Mined: LW SS1 approximately 22 xc in SS1 HG
Stock Pond(s) Being Inspected: DF 35 ~~App~~

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is the stock pond within twice the projected angle of draw of subsidence? If yes, which pond(s): ______ |
| ☐ | ☒ | Are there visible surface cracks in or near the stock pond? If yes, describe (location, width, length, etc.): ______ |
| ☐ | ☒ | Is there any evidence of potential subsidence induced water loss? If yes, describe: ______ |
| ☒ | ☐ | Is there water in the pond? If yes, describe: Water level is approximately 50%. |
| ☐ | ☐ | Is mitigation needed? If yes, list suggestions: ______ |

Notes:

Signature of Inspector: [signature]

* If any potential subsidence induced features are observed that could cause harm to the pond, notify John Poulos or Kathy Welt immediately.

# APPENDIX B

## Monument Dam Inspection Forms

# Monument Dam
# Inspection Form

Date: 4/30/2020
Time: 10:00 Am
Name of Inspector: Robert Munz
Current Panel Being Mined: LW551
☐ Weekly Inspection ☒ Monthly Inspection

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is mining within 1 mile of Monument Dam? |
| ☐ | ☒ | Are there visible surface cracks on the dam?<br>If yes, indicate length and size of crack. ______________. |
| ☐ | ☒ | Is there evidence of subsided areas on or around the dam?<br>If yes, indicate where and degree. ______________. |
| ☐ | ☒ | Are there bulges on the dam?<br>If yes, indicate where and degree. ______________. |
| ☐ | ☒ | Are there signs of seeps on the dam?<br>If yes, indicate where and estimated flow.______________. |
| ☐ | ☒ | Are there any other potentially damaging features on the dam?<br>If yes, describe. ______________. |
| ☐ | ☒ | Are there any recent evidences of slope failure on the landside south of the dam (perform visual inspection and data analysis of inclinometers)?<br>If yes, describe. ______________. |

Notes:

Signature of Inspector: [signature]

*Inspections are performed under the direction of John Poulos, P.E.*

If cracks or other potentially damaging features occur, notify John Poulos or Kathy Welt immediately.

# Monument Dam
# Inspection Form

Date: 5/29/20
Time: 11:00
Name of Inspector: Robert Munz
Current Panel Being Mined: LW 551
☐ Weekly Inspection ☒ Monthly Inspection

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is mining within 1 mile of Monument Dam? |
| ☐ | ☒ | Are there visible surface cracks on the dam?<br>If yes, indicate length and size of crack. ________. |
| ☐ | ☒ | Is there evidence of subsided areas on or around the dam?<br>If yes, indicate where and degree. ________. |
| ☐ | ☒ | Are there bulges on the dam?<br>If yes, indicate where and degree. ________. |
| ☐ | ☒ | Are there signs of seeps on the dam?<br>If yes, indicate where and estimated flow.________. |
| ☐ | ☒ | Are there any other potentially damaging features on the dam?<br>If yes, describe. ________. |
| ☐ | ☒ | Are there any recent evidences of slope failure on the landside south of the dam (perform visual inspection and data analysis of inclinometers)?<br>If yes, describe. ________. |

Notes:

Signature of Inspector: [signature]

*Inspections are performed under the direction of John Poulos, P.E.*

If cracks or other potentially damaging features occur, notify John Poulos or Kathy Welt immediately.

# Monument Dam
# Inspection Form

Date: 6/25/20
Time: 12:30PM
Name of Inspector: Robert Munz
Current Panel Being Mined: 551 Panel
☐ Weekly Inspection ☒ Monthly Inspection

| Yes | No | |
|---|---|---|
| ☐ | ☒ | Is mining within 1 mile of Monument Dam? |
| ☐ | ☒ | Are there visible surface cracks on the dam?<br>If yes, indicate length and size of crack. ____________________. |
| ☐ | ☒ | Is there evidence of subsided areas on or around the dam?<br>If yes, indicate where and degree. ____________________. |
| ☐ | ☒ | Are there bulges on the dam?<br>If yes, indicate where and degree. ____________________. |
| ☐ | ☒ | Are there signs of seeps on the dam?<br>If yes, indicate where and estimated flow.____________________. |
| ☐ | ☒ | Are there any other potentially damaging features on the dam?<br>If yes, describe. ____________________. |
| ☐ | ☒ | Are there any recent evidences of slope failure on the landside south of the dam (perform visual inspection and data analysis of inclinometers)?<br>If yes, describe. ____________________. |

Notes:

Signature of Inspector: [signature]

*Inspections are performed under the direction of John Poulos, P.E.*

If cracks or other potentially damaging features occur, notify John Poulos or Kathy Welt immediately.

# APPENDIX C

## Monument Dam Monitoring Data

**Spring 2020 Semi- Annual Subsidence Report**
**Appendix C**
**Table 1**
**Monument Dam Survey Data**

| | | Fall 2019 to Spring 2020 Easting Displacement (X) | Fall 2019 to Spring 2020 Northing Displacement (Y) | Fall 2019 to Spring 2020 Elevation Displacement (Z) |
|---|---|---|---|---|
| | Survey Points | Displacement (ft) * | Displacement (ft) * | Displacement (ft) * |
| Monument Dam | 6001 | ** Reset | ** Reset | ** Reset |
| | 6003 | -0.03 | 0.12 | 0.08 |
| | 6004 | 0.22 | -0.37 | 0.02 |
| | 6005 | ** Reset | ** Reset | ** Reset |
| | 6006 | -0.14 | -0.45 | -0.15 |
| | 6007 | -0.13 | -0.16 | -0.09 |
| | 6008 | -0.04 | -0.14 | -0.09 |
| | 6009 | -0.09 | -0.16 | -0.02 |
| | 6010 | -0.04 | -0.10 | -0.16 |
| | 6011 | -0.12 | -0.15 | -0.05 |
| | 6012 | -0.34 | -1.30 | -0.09 |
| Hillside south of road past Monument Dam | 7000 | 0.01 | -0.06 | -0.06 |
| | 7001 | -0.17 | -0.18 | 0.00 |
| | 7002 | -0.05 | -0.19 | -0.10 |
| | 7003 | ** Reset | ** Reset | ** Reset |
| | 7004 | -0.06 | -0.19 | -0.24 |
| | 7005 | -0.15 | -0.11 | -0.07 |
| | 7006 | -0.12 | -0.08 | -0.03 |
| | 7007 | -0.15 | -0.13 | -0.20 |
| | 7008 | -0.23 | -0.15 | -0.10 |
| | 7009 | -0.11 | -0.17 | -0.33 |
| | 7010 | -0.06 | -0.13 | -0.15 |
| | 7011 | -0.14 | -0.01 | -0.06 |
| | 7012 | -0.27 | 0.13 | -0.22 |
| | 7013 | ** Reset | ** Reset | ** Reset |
| | 7014 | ** Reset | ** Reset | ** Reset |
| | 7015 | ** Reset | ** Reset | ** Reset |
| | 7016 | ** Reset | ** Reset | ** Reset |
| | 7017 | ** Reset | ** Reset | ** Reset |
| | 7018 | ** Reset | ** Reset | ** Reset |
| | 7019 | 0.00 | -0.07 | -0.03 |
| | 7020 | 0.02 | -0.13 | 0.11 |
| | 7021 | ** Reset | ** Reset | ** Reset |
| | 7022 | ** Reset | ** Reset | ** Reset |
| | 7023 | ** Reset | ** Reset | ** Reset |
| | 7024 | ** Reset | ** Reset | ** Reset |
| | 7025 | -0.19 | -0.26 | -0.24 |
| | 6501 | -0.35 | -0.24 | 0.06 |
| | 6502 | ** Reset | ** Reset | ** Reset |
| | 6503 | ** Reset | ** Reset | ** Reset |
| | 6504 | ** Reset | ** Reset | ** Reset |

** Survey monument reset in Spring 2020 due to previous damage, obstruction, ect.

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