

Geologic Hazard Plan
GMT Exploration Company, LLC
Invicta 3-65 28 OGD

GMT Exploration Company, LLC (GMT) is proposing the construction and development of an Oil and Gas Location, Invicta 3-65 28, located in the north half of Section 28 in Township 3 South, Range 65 West, in Adams County, Colorado. Per Colorado Oil and Gas Conservation Commission (COGCC) Rule 304.b.(7).I., a Geologic Hazard Map was developed to identify Geologic Hazards within a one-mile radius of the proposed working pad surface (WPS). Per COGCC Rule 304.c.(21), this Geologic Hazard Plan was developed to describe the hazards and proposed mitigation measures. As defined by the State of Colorado, a Geologic Hazard is defined as a geologic phenomenon which is so adverse to past, current, or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property. The term includes, but is not limited to, avalanches, landslides, rock falls, mudflows, and unstable or potentially unstable slopes, seismic effects, radioactivity, ground subsidence and floods.

The Geologic Hazard Map and Geologic Hazard Plan were prepared by Petrotek Corporation (Petrotek). Petrotek is a Colorado Corporation that is registered to provide engineering and geology services in a variety of states. Petrotek has been retained by GMT via Jost Energy Law, P.C., to provide technical assistance, review and preparation of materials pertaining to GMT's Invicta 3-65 28 OGD application, including the assessment of potential geologic hazards. My name is Errol Lawrence and I am a Senior Geologist at Petrotek. I am a Professional Geologist, meeting the criteria of educational requirements and professional work experience required by C.R.S. 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area, and have identified Geologic Hazards within a one mile radius that could pose a significant risk to the proposed Oil and Gas Operations or Location and may require mitigation.

Site Characteristics

A survey of geologic and natural hazards within one mile of the proposed drilling location or working pad surface (WPS) was conducted for the Oil and Gas Location and surrounding areas.

The attached Exhibit 1 is a map showing identified geologic hazard features that are located within one mile of the proposed Invicta 3-65 28 WPS. The data sources for the Geologic Hazards Features shown on Exhibit 1 are the Colorado Geological Survey and Colorado Oil and Gas Commission GIS Datasets. As the exhibit illustrates, there are identified eolian (windblown) deposits and Cretaceous/Tertiary Formations present throughout the area, which are considered collapsible soils that may pose as an unstable slope or subsidence hazard. The eolian deposits are located throughout the

area surrounding the WPS. Those deposits extend laterally outside of the one-mile area of review radius. Rule 304.b.(7).I requires operators to submit a second map scaled to show the extent of Geologic Hazards that extend beyond a one-mile radius from the WPS. The second map showing the lateral extent of the eolian deposits is included as Exhibit 2. The Cretaceous/Tertiary formations are also present throughout the area surrounding the WPS extending beyond the one-mile area of review radius. Exhibit 2 presents the larger extent of those formations and shows that they extend in excess of 4 miles in all directions from the WPS.

The second identified hazard within the one-mile offset is a historical coal mine. The former mine site was identified in the National Mine Map Repository (NMMR) under the Office of Surface Mining and Reclamation and Enforcement (OSMRE) and is located to the southwest of the pad location. That mine was identified as the Scranton Mine and dated as 1887 in the NMMR database (Map document number 431593). The extent of the mined area shown on Exhibit 1 was derived from the Colorado Geological Survey Historic Coal Mines database. The original map was not available for review. The mine is within what was originally named by Eldridge (1896) as the Scranton district, located in Adams County east of Denver and north of Watkins. Eldridge indicated that mines in the Scranton district worked Denver Formation lignite beds. The Colorado Division of Mines (1978) indicated coal production from the Scranton Mine from 1886 to 1900 in section 28, Township 3 South, Range 65 West. Other sources (Marvine 1874, Eldridge 1896, and Soister 1974) indicate this mine was operating at an earlier date and that there may have been at least two other mines in sec. 16 and 29, T.3S., R.65W. Total recorded production from the mine in section 28 was 35,789 tons (Colorado Division of Mines, 1978). A succession of operators controlled the mine, as follows: R. M. McDowell and Denver R. R. Land & Coal Co., 1886; Denver R. R. Land & Coal Co., 1890; and Colorado Eastern R. R. Coal Co, 1891. Later work includes the Scranton district as part of the Watkins play.

More recent work on coal reserves in the vicinity of the Invicta 3-65 28 WPS was conducted by the CGS (Kirkham 1978, Kirkham and Ladwig 1979, Brand 1979, Brand and Caine 1980, and Brand and Eakins,1980). The Brand and Eakins study included a number of cross-sections, one of which transects north to south across the eastern portion of Section 28, T3S, R65W (shown as Cross-section E-E' on Exhibit 3). The cross sections are comprised largely of coal exploration borings (although the source of the boring data is not clearly indicated). Cross-section E-E', shown on Exhibit 4, indicates a prominent coal seam, identified as the Bennett Bed, that is continuous across Section 28, east of the proposed WPS. The coal bed is between 130 and 170 feet below ground surface and appears to be approximately 25 to 30 feet thick within Section 28. Because the Bennett Bed is the shallowest, thickest and most continuous coal seam shown on the cross section, it is reasonable to assume that this was the unit targeted in the Scranton mine. Note that two separate mined areas are shown on Exhibit 3, one on the south portion of Section 28 and one that extends from the north edge of Section 21 into the south portion of Section 16. Available data indicates the mine area outline is based on mapping from 1887. As previously noted, historical

records indicate mining from the Scranton mine continued until 1900. Therefore, the final aerial extent of underground mine workings is unknown and likely extends further than shown on the Exhibit. Although it is possible that underground coal workings may extend beneath the proposed WPS, there is no direct evidence that indicates that to be the case.

Some hazards are identified with shallow coal beds and historic underground mines. Shallow coal mines may present gas issues in the form of methane from the coal and/or coal mine. In addition, due to the age of the historic mine, all of the mine tunnels may not be adequately mapped. The presence of the coal mines to the north and south of the WPS from the 1887 mapping suggests the possibility of undermined areas between those mines. If there are undermined areas directly beneath the WPS, there may be localized subsidence or shallow gas issues that could pose hazards to drilling operations. These hazards are based on limited data and may not exist beneath the WPS.

The proposed site is not located within the 100-year floodplain, though the 100-year floodplain exists on the border of the one-mile offset from the WPS. No faults or seismicity were identified within the one-mile radius. No potential for avalanches or landslides exist based on the databases and topography of the area. Finally, no radioactive minerals were identified within the one-mile radius.

My review and the attached Exhibits support my conclusion that, based on the results of the geologic hazards survey, collapsible soils and an abandoned mine exist within one mile of the WPS. The Applicant (GMT) has been notified of these hazards and has prepared engineering plans to mitigate the risk of conducting oil and gas drilling and associated operations in an area of known collapsible soils, potential subsidence issues and the possibility of encountering shallow gas associated with the coal and or coal mines. Those mitigation measures are summarized below.

Mitigation Measures

Although there are collapsible soils and potential subsidence and shallow gas issues related to an abandoned underground mine within a one-mile radius of the proposed working pad surface, these geologic features are not anticipated to pose a risk to past, current, or future construction operations or land use at the Oil and Gas Location because of proposed mitigation measures. Standard mitigation measures will be in place including site stabilization, onsite and offsite stormwater controls, water quality Best Management Practices (BMPs), and site inspections following rain or snowmelt events. Additionally, the following measures will be implemented prior to construction, and during the construction and drilling phases:

Pre-Construction Phase

A shallow drilling program will be conducted prior to construction of the WPS to verify that underground mine workings are not present beneath the WPS. As previously described, available data indicate that the coal beds are between 130 and 170 feet below ground within Section 28.

- The drilling program will consist of 4 borings
- The borings will be located at each corner of the proposed WPS.
- Each boring will be drilled to a depth of approximately 200 below ground surface.
- The drilling will be conducted using a truck mounted rig using a hollow stem auger.
- Each boring will be cored from 100 feet to total depth.
- The core will be logged by a geologist
- A geologic report of the findings of the drilling program will be prepared

Construction Phase

The Operator will utilize standard well pad construction techniques to mitigate the risk and impact of collapsible soils in the area.

Topsoil will be removed and stockpiled for use during reclamation of the pad area. The well pad will be over-excavated below the finish grade of the pad, with special attention paid to the areas around the wellhead. Over-excavated areas will be filled in 3" lifts, and compacted with equipment and fresh water to ensure a stable base. The pad will be surfaced with class 6 road base for operations.

During drilling and completion, temporary matting will be used under some equipment to mitigate the potential for compaction.

Drilling Phase

In the area of the Invicta drilling occupation, GMT has identified indicators that vintage, abandoned coal mines could present hazards during the drilling and casing of the surface interval(s). In the event that these hazards are encountered, GMT will implement several measures to ensure the safety of both the environment as well as the personnel involved.

Methane gas tends to migrate freely throughout a homogenous coalbed and therefore presents the issue of drilling into "surface gas" when blowout prevention and well control has not yet been deployed. To mitigate this surface gas issue, GMT would utilize a diverter set up to safely divert surface gas away from the rig floor and out of harm's way. In the event the shallow drilling program (4 borings, each to 200 feet depth) indicates the presence of an abandoned coal mine or related drilling hazards, GMT will submit a plan to address and mitigate those hazards.

Summary

My review and the attached Exhibits support my conclusion that, based on the results of the geologic hazards survey, the only known geologic hazards within one mile of the proposed WPS are collapsible soils and abandoned mines. Although the collapsible soils are present in the immediate vicinity and beneath the WPS, standard stabilization measures will mitigate that hazard. Therefore, the identified collapsible soils do not pose a significant hazard to public health, safety, or property. The abandoned coal mine (if present beneath the WPS) poses potential risks of subsidence, drilling through void space and the occurrence of shallow gas. However, there is no direct evidence that the abandoned coal mine is present beneath the WPS. A pre-construction drilling investigation will be conducted to verify that the abandoned coal mine is not present beneath the proposed WPS location. In the event that the abandoned coal mine is present beneath the WPS, GMT will provide engineering safeguards to mitigate the geologic hazard such that it will not pose a risk to past, current, or future construction or land use operations at the proposed Oil and Gas Location, and will be sufficiently protective of public health, safety, welfare, the environment and wildlife resources despite the existence of a know geologic hazard.

References

- Brand, K. E., 1980. *Geophysical and Lithological Logs from the 1979 Coal Drilling Coring Program, Denver East 1/2° x 1° Quadrangle, Colorado*, Colorado Geological Society, Open File Report 80-01.
- Brand, K. E. and J.M.Caine, 1980. *Geophysical and Lithological Logs from the 1980 Coal Drilling Coring Program, Denver East 1/2° x 1° Quadrangle, Colorado*. Colorado Geological Society, Open File Report 80-09.
- Brand, K. E. and W. Eakins, 1980. *Coal Resources of the Denver East ½° x 1° Quadrangle, Colorado*. Resource Series 13, Department of Natural Resources, Colorado Geological Survey.
- Colorado Division of Mines, 1978. *Coal mine records of Colorado*: Colorado Dept. Natural Resources, Division of Mines, unpublished file information.
- Emmons, S. F., Cross, Whitman, and Eldridge, G. H., 1896. *Geology of the Denver Basin in Colorado*. U.S. Geological Survey Mon. 27, 556 p.
- Kirkham, R.M., 1978. *Location of Drill Holes Used for Coal Evaluation in the Denver and Cheyenne Basins, Colorado*. Colorado Geological Society, Open File Report 78-8, Plate 1.

Kirkham, R.M., and L.R. Ladwig, 1978. *Coal Resources of the Denver and Cheyenne Basins, Colorado*. Resource Series 5, Department of Natural Resources, Colorado Geological Survey.

Marvine, A. R., 1874. in Hayden, F. V., *Annual report of the United States Geological and Geographical Survey of the Territories, embracing Colorado, being a report of the progress of the exploration for the year 1873*, p. 120-121, and pi. 4.

Soister, P.E, 1974. *A preliminary report on a zone containing thick lignite beds, Denver Basin, Colorado*. U.S. Geological Survey open-me rept. 74-27, 64 p

Reference for the Geologic Hazards Map include the following:

Colorado Geological Survey – Collapsible Soils of Colorado – Interactive Web Map
Accessed: 08/09/2023
<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=a6f816b35fb64d3da096e84af661f070>

Floodplain Extent-Colorado Energy & Carbon Management Commission – COGCC
Data Access – GIS Data: Accessed and Downloaded: 08/09/2023
<https://ecmc.state.co.us/data2.html#/downloads>

Colorado Geological Survey – Colorado Historic Coal Mines – Interactive Web Map
Accessed: 08/09/2023
<https://cologeosurvey.maps.arcgis.com/apps/webappviewer/index.html?id=1891e3149eda44af9dc8af81c4dc58a8>

Elevation Contours-U.S. Geological Survey (USGS) The National Map Download (v2.0).
Accessed and Downloaded: 08/09/2023 <https://apps.nationalmap.gov/downloader/#/>

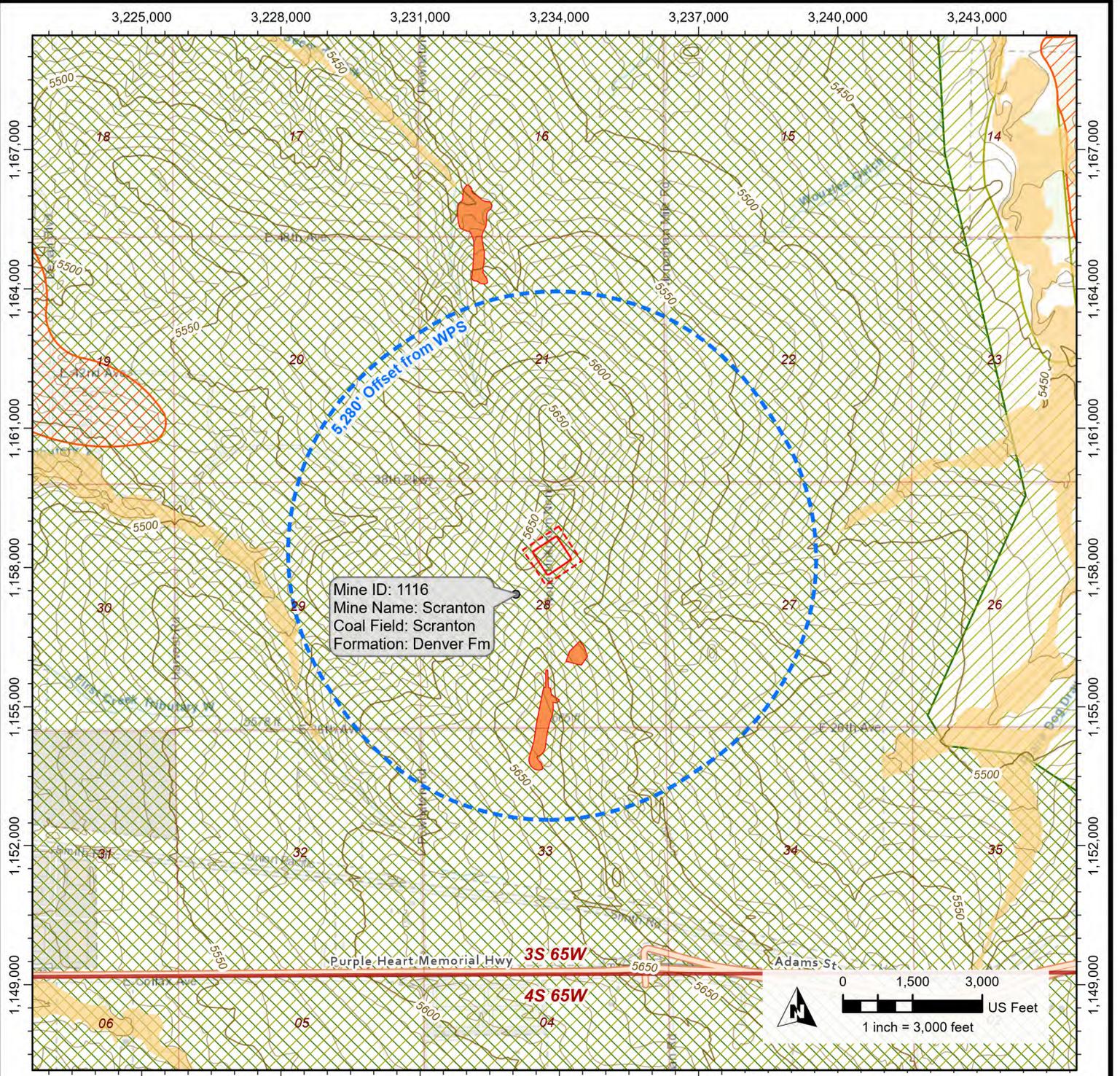
Certification:

I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area, and have identified Geologic Hazards within a one-mile radius that could pose a significant risk to the proposed Oil and Gas Operations or Location and may require mitigation. The operator was notified of the potential geologic hazards and has developed the measures included in this plan to mitigate the risks associated with these geologic hazards. Those mitigation measures are designed to reduce the likelihood that the geologic hazards will threaten public health, safety, welfare, the environment or wildlife resources as related to the proposed Oil and Gas Location and any operations that may occur there..

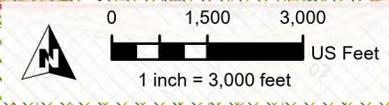
Respectfully:

Handwritten signature in blue ink, appearing to read "Errol Lawrence", followed by the date "9/28/23" written in blue ink.

Errol P. Lawrence, Senior Geologist, PG
Petrotek Engineering Corporation



Mine ID: 1116
 Mine Name: Scranton
 Coal Field: Scranton
 Formation: Denver Fm



Facility

- Oil & Gas Location
- Working Pad Surface

Area of Review

- 5,280' Offset from Working Pad Surface

Elevation Contours (USGS)

- Major Contour (C.I. = 50')
- Minor Contour (C.I. = 10')

Historic Coal Mines

- Historic Coal Mine
- Undermined Area

Floodplain

- 100-Year Floodplain Extent

Collapsible Soils

- EG-14 Eolian (Wind-Blown) Deposits
- EG-14 Dune and Sheet Sand Deposits
- EG-14 Cretaceous and Tertiary Formations

Certification:
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Respectfully,

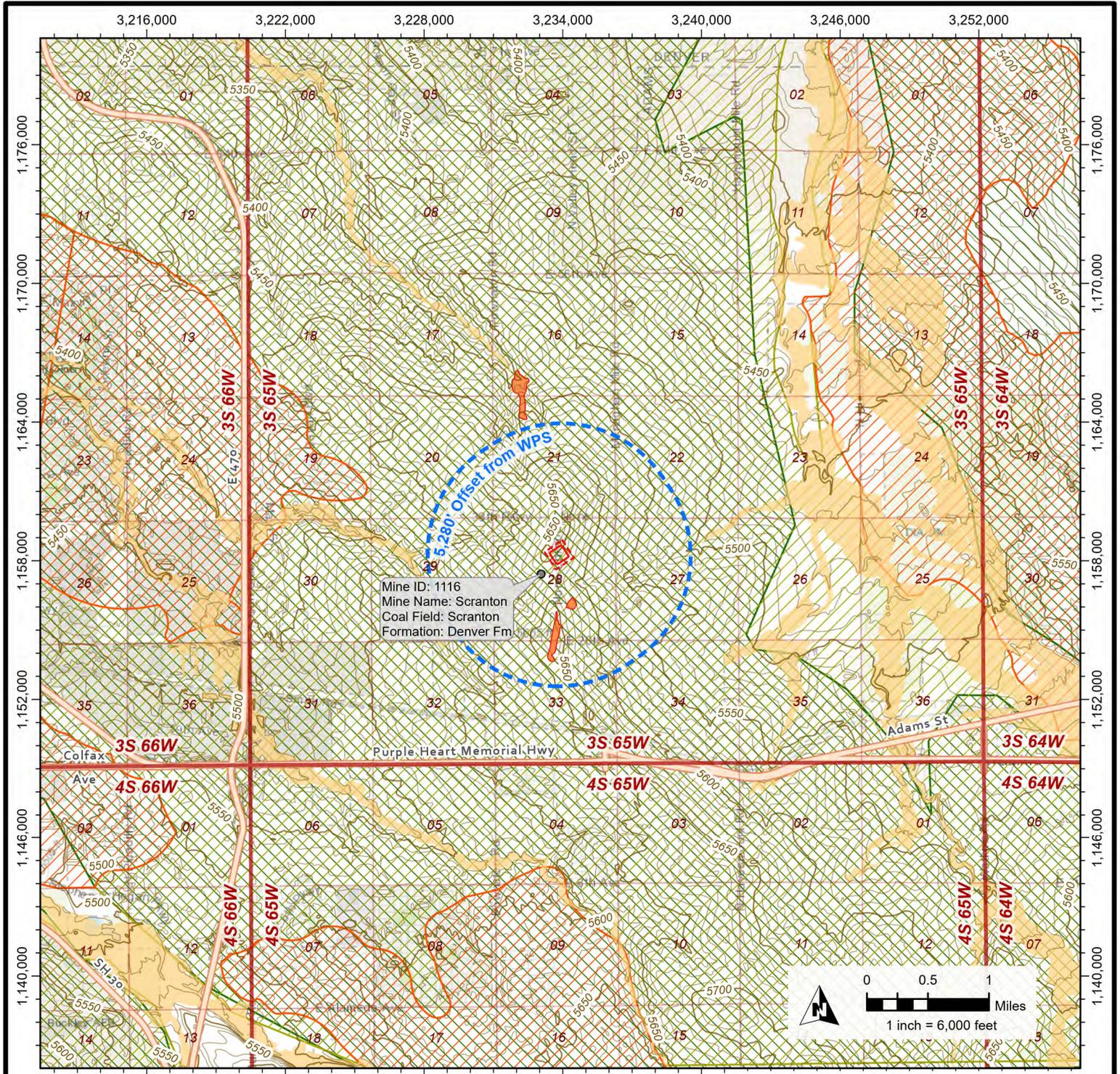
 Errol P. Lawrence, Senior Geologist, PG
 Petrotek Engineering Corporation

GMT
Exploration Company LLC

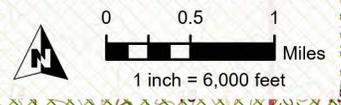
Exhibit 1
Geologic Hazards Map
2023 Geologic Hazards Assessment

Scale: 1:36,000	Date: September 2023
Ex_01_GMT - Geo Hazards V1	By: WEK Checked: DH

Petrotek
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 Littleton, Colorado 80127 USA
 303-290-9414
 www.petrotek.com



Mine ID: 1116
 Mine Name: Scranton
 Coal Field: Scranton
 Formation: Denver Fm



Facility

- Oil & Gas Location
- Working Pad Surface

Area of Review

- 5,280' Offset from Working Pad Surface

Elevation Contours (USGS)

- Major Contour (C.I. = 50')
- Minor Contour (C.I. = 10')

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Respectfully,

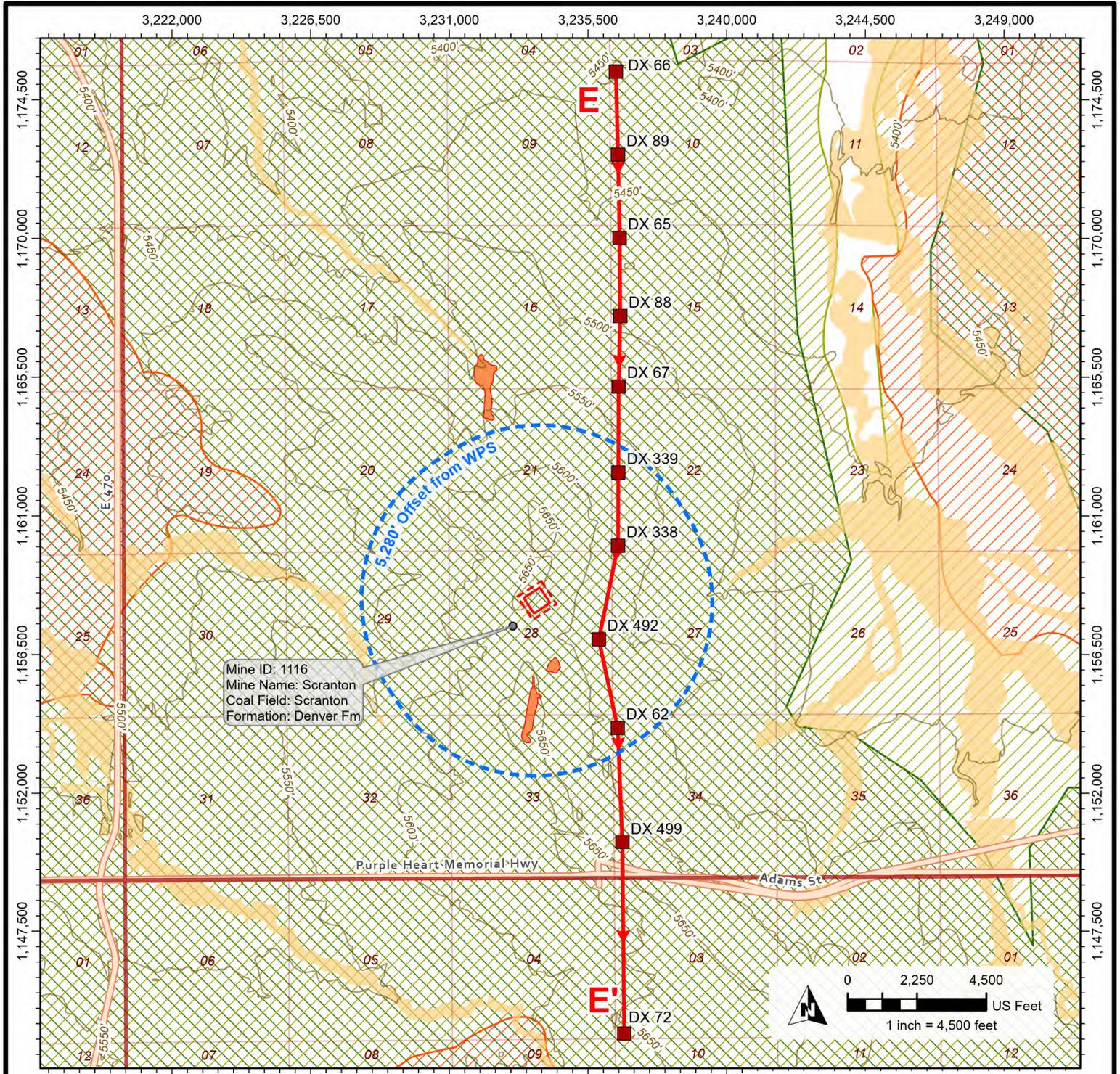
Errol P. Lawrence 9/28/23
 Errol P. Lawrence, Senior Geologist, PG
 Petrotek Engineering Corporation

GMT
Exploration Company LLC

Exhibit 2
Geologic Hazards Map
2023 Geologic Hazards Assessment

Scale: 1:72,000	Date: September 2023
Ex_02_GMT - Geo Hazards V2	By: WEK Checked: DH

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Mine ID: 1116
 Mine Name: Scranton
 Coal Field: Scranton
 Formation: Denver Fm

Facility

- Oil & Gas Location
- Working Pad Surface

Area of Review

- 5,280' Offset from Working Pad Surface

Elevation Contours (USGS)

- Elevation Contour (C.I. = 50')

Historic Coal Mines

- Historic Coal Mine
- Undermined Area

Cross Section

- Mineral Exploration Hole
- Cross Section Line (E-E')

Floodplain

- 100-Year Floodplain Extent

Collapsible Soils

- EG-14 Eolian (Wind-Blown) Deposits
- EG-14 Dune and Sheet Sand Deposits
- EG-14 Cretaceous and Tertiary Formations

Certification:
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Respectfully,

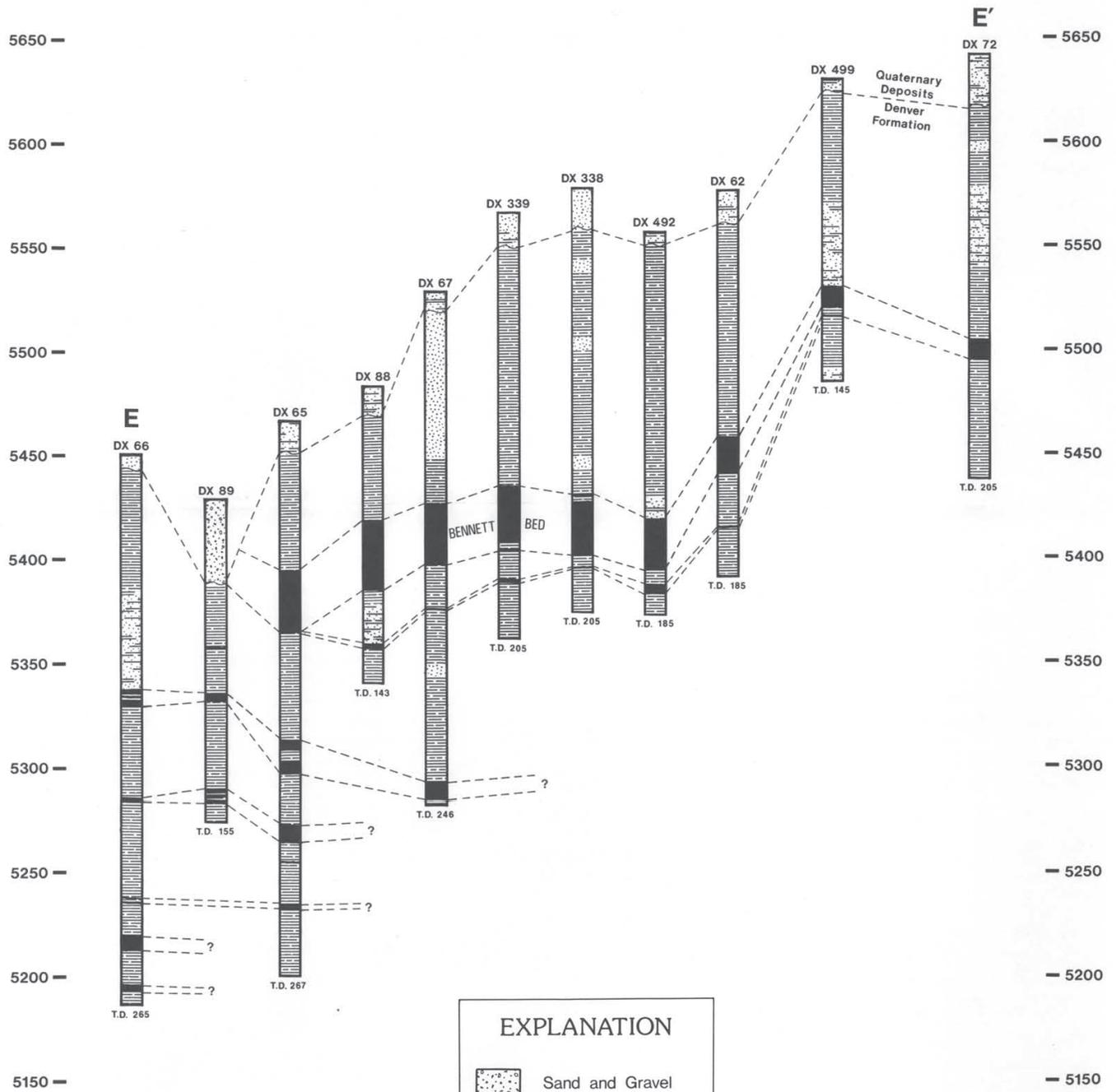
 9/28/23
 Errol P. Lawrence, Senior Geologist, PG
 Petrotek Engineering Corporation

GMT
Exploration Company LLC

Exhibit 3
Geologic Hazards Map and Cross Section E-E'
2023 Geologic Hazards Assessment

Scale: 1:54,000	Date: September 2023
Ex_03_GMT - XS E-E'	By: WEK Checked: DH

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EXPLANATION

	Sand and Gravel
	Sand or Sandstone
	Sandy Siltstone or Silty Sandstone
	Siltstone
	Claystone
	Coal or Lignite

Horizontal Scale 1 : 50,000
 Vertical Scale 1 : 600
 Vertical Exaggeration 1 : 83.3

Drafted by
 M. V. Persichetti

Certification:

I certify that I am a Professional Geologist, having met the educational requirements and professional work experience required by C.R.S. 23-41-208(b). I have reviewed information pertaining to this Oil and Gas Location and the surrounding area, and have identified the following Geologic Hazards within a one-mile radius: collapsible soils and abandoned coal mines.

Respectfully

Errol P. Lawrence, Senior Geologist, PG
 Petrotek Engineering Corporation

Source: Brand, K. E. and W. Eakins, 1980, Coal Resources of the Denver East 1/2° x 1° Quadrangle, Colorado, Resource Series 13, Department of Natural Resources, Colorado Geological Survey.

Exhibit 4
Cross Section E-E'

2023 Geologic Hazards Assessment

Scale: NTS	Date: September 2023
Ex_04_GMT - Cross Sec.pdf	By: WEK Checked: DH

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