

CHARACTERIZATION OF SUBSIDENCE OVER
MULTIPLE LIFT LONGWALL PANELS

FINAL TECHNICAL REPORT
AS OF
30 SEPTEMBER 1982

Donald W. Gentry
Collin L. Stewart

MINE SUBSIDENCE ENGINEERING COMPANY
6590 South Ridgeview Drive
Morrison, Colorado 80564

DATE PUBLISHED - SEPTEMBER 1982
Prepared Under
Contract No. - U.S. D.O.E. DE-AC22-80PC-30118

US DEPARTMENT OF ENERGY
Assistant Secretary for Energy Technology
Division of Fossil Fuel Extraction
Mining Research and Development

TABLE OF CONTENTS

	Page
<u>TABLE OF CONTENTS</u>	ii
<u>LIST OF TABLES</u>	iv
<u>LIST OF FIGURES</u>	v
<u>ABSTRACT</u>	vi
<u>EXECUTIVE SUMMARY</u>	vii
<u>INTRODUCTION</u>	1
<u>SCOPE OF WORK</u>	4
<u>Task 1 - Secure Site</u>	5
<u>Task 2 - Instrumentation Plan</u>	5
<u>Task 3 - Installation</u>	5
<u>Task 4 - Removal</u>	6
<u>Task 5 - Reporting</u>	6
<u>MONUMENT CONSTRUCTION IN ALPINE AREAS</u>	7
<u>Site Access</u>	7
<u>Forest Service Permits</u>	11
<u>Cultural Resources Survey</u>	11
<u>Monument Construction</u>	14
Survey Control Monuments.....	14
Subsidence Monitoring Points.....	15
<u>Monument Removal</u>	21
<u>SURVEYING</u>	23
<u>Equipment</u>	23
<u>Techniques</u>	23
Control Survey.....	24
Subsidence Monitoring Survey.....	24
Monitoring Schedule.....	24
<u>RESULTS</u>	27
<u>DISCUSSION</u>	28
<u>Control Net</u>	28
<u>Subsidence Monitoring Net</u>	29
<u>Monument Construction in Alpine Terrain</u>	31

TABLE OF CONTENTS (continued)

<u>CONCLUSIONS</u>	Page 33
<u>APPENDIX A - FOREST SERVICE PERMITTING FORMS</u>	34
<u>APPENDIX B - ENVIRONMENTAL ASSESSMENT</u>	48
<u>APPENDIX C - CULTURAL RESOURCES SURVEY</u>	75
<u>APPENDIX D - CONTROL SURVEY RESULTS</u>	103
<u>APPENDIX E - BASELINE SURVEY FIELD DATA</u>	116
<u>APPENDIX F - MSE RESPONSES TO DOE REVIEW OF DRAFT FINAL REPORT</u>	122

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
1	Approximate Helicopter Hours ¹	9
2	Special Use Permitting Flow Chart. (U.S. Forest Service)	12
3	Proposed Subsidence Monitoring Schedule	26

LIST OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
1	Site Location Map	2
2	Subsidence Monitoring Area Location Map	8
3	Control Survey Monument Locations	16
4	Control Survey Monument Construction.	17
5	General Layout of the Subsidence Monitoring Net	19
6	Subsidence Monitoring Point Fabrication Details.	20

ABSTRACT

This report presents the methodology and procedures utilized in installing and removing a surface subsidence monitoring net in remote, rugged, alpine terrain. Work on this project was performed by Mine Subsidence Engineering Company (MSE) and funded by the Department of Energy (DOE).

The original contract (73-month duration) called for the installation and monitoring of a surface subsidence net suitable for the characterization of subsidence over multiple lift longwall panels. However, because of DOE contract modifications, actual project work involved only the installation, baseline surveys, and subsequent removal of the subsidence monitoring net during the 24-month contract period. These activities are described herein, as well as the required permitting process. This report describes a successful methodology for permitting, installing and removing a surface subsidence monitoring net under conditions typical of those faced by many operators in the western U.S.

This work was performed above Mid-Continent Resources' L.S. Wood No. 3 Mine, in Coal Basin, Pitkin and Gunnison Counties, Colorado, approximately five miles west of the town of Redstone.

EXECUTIVE SUMMARY

Measuring, characterizing and understanding the various aspects of surface subsidence phenomena resulting from underground mining activities have received considerable attention in recent years -- and for good reason. On September 24, 1980, Mine Subsidence Engineering Company (MSE) entered into a contract with the Department of Energy (DOE) to perform work on a project titled: Characterization of Subsidence over Multiple Lift Longwall Panels. The objective of this study was to develop techniques for measuring and analyzing the response of strata to the mining of a thick coal seam by the longwall method incorporating multiple lifts. Specifically, MSE was required to:

- Secure a suitable site,
- Develop an instrumentation monitoring plan,
- Install a subsidence monitoring net,
- Monitor the subsidence net in accordance with a pre-determined schedule set forth in the RFP,
- Provide the necessary subsidence data to DOE in a format which could be used in subsequent modeling activities, and
- Report on the activities and results of the project.

The site selected for the project was Mid-Continent Resources' L.S. Wood No. 3 Mine, in Coal Basin, Pitkin and Gunnison Counties, Colorado, approximately 5 miles west of the town of Redstone. The median surface elevation at the site was 11,500 ft above sea level. Overburden at the site averaged 2800 ft. Total seam height planned for extraction in two longwall lifts was 19-21 ft. The following features made this subsidence project particularly unique:

- A coal mining methodology never before performed in North America
- Remote, rugged, alpine terrain
- Dipping coal seam
- Extreme depth
- Effects of virgin vs. previously mined ground on subsidence
- Depth of cover to mining height ratios (d/h) never before monitored and/or reported on in the literature or contained in any predictive modeling activities.

Had this project been completed, the data obtained would have contributed greatly to the mining-related surface subsidence data base - - both domestically and world-wide.

In accordance with the scope of work set forth in the request for proposal, MSE designed a subsidence net capable of providing both centerline and transverse profiles with respect to one complete set of upper and lower lift longwall panels and at least one adjacent lift. The net had to be sufficient to define the final subsidence trough that would result from mining each individual lift as well as the final, cumulative subsidence trough resulting from extraction of all three lifts. Specifically, the monitoring net designed was capable of determining:

- Maximum subsidence over the longwall panels from mining each lift
- Horizontal movement of the ground surface from mining each lift
- Subsidence development profiles along panel centerlines for each lift
- Strain profiles across each panel from the panel centerline to the point of zero subsidence for each lift
- Determination of the angle of draw for each lift.

The subsidence monitoring net was designed with monitoring points spaced a maximum of 200 ft apart. This yielded a monitoring point spacing:

Overburden depth ratio of 0.07. Subsidence monitoring net design was constrained by surface topography, vegetative cover as well as local and Federal (Forest Service) regulations.

For this project it was essential that subsidence monuments be simple, easy to fabricate in the field, transportable by helicopter, and easy to install. Monument construction and installation procedures are discussed in this document.

The surface subsidence monitoring net was installed during the summer of 1981 and initial baseline surveys of the monuments performed. Mining of the multiple lift longwall panels had not started prior to net installation.

Although DOE discussed possible project cancellation with MSE personnel on an unofficial basis as early as January 1982, official notification of project cancellation was received by MSE on April 14, 1982. The project was cancelled before the actual response of the net to actively subsiding ground could be determined. In accordance with the contract modification pertaining to project cancellation, funding was not provided to perform the following:

- Reduction of surveying data
- Generation of appropriate maps, plans and profiles
- Final baseline survey to validate monitoring point stability over the winter months.

MSE was directed to remove the subsidence monitoring net in accordance with the provisions specified in the Forest Service Special Use Permits.

As a result of these events, this report describes the approach and procedures associated with permitting, installing and removing a surface subsidence monitoring net in remote, rugged, alpine terrain utilizing specially designed monuments. This project demonstrated that a subsidence

monitoring net can be successfully installed and removed from a remote, high alpine environment - - conditions often faced by many coal operators in the western U.S.

INTRODUCTION

This report presents a summary of work performed by Mine Subsidence Engineering Company (MSE) for the Department of Energy (DOE) under contract number DE-AC22-80PC30118. The project was titled: Characterization of Subsidence over Multiple Lift Longwall Panels.

This report represents the Final Technical Report for this project. It incorporates the editorial review comments contained in a DOE letter dated September 16, 1982. A copy of the review letter and specific MSE responses to the general remarks and conclusions contained in the review letter are presented in Appendix F attached to this report.

The work was performed over a 24 month period commencing September 24, 1980, and ending September 30, 1982. The original object of the project was to monitor subsidence resulting from mining of upper and lower lifts on two adjacent longwall panels over a 73 month period. However, because of a DOE contract modification, actual project work involved the installation of the monitoring net, baseline surveys and removal of the monitoring net.

This study involved the installation and removal of a subsidence monitoring net in remote, rugged, alpine terrain. The median elevation of the surface area was 11,500 ft with elevations varying between 11,000 ft and 11,700 ft. The area was also characterized by severe weather patterns. Field work was limited to the period from the middle of June through the middle of September when the area was relatively clear of snow. Winter snow cover averaged between 10 and 20 ft in depth.

The study also involved contact and coordination with the U.S. National Forest Service personnel and permitting requirements.

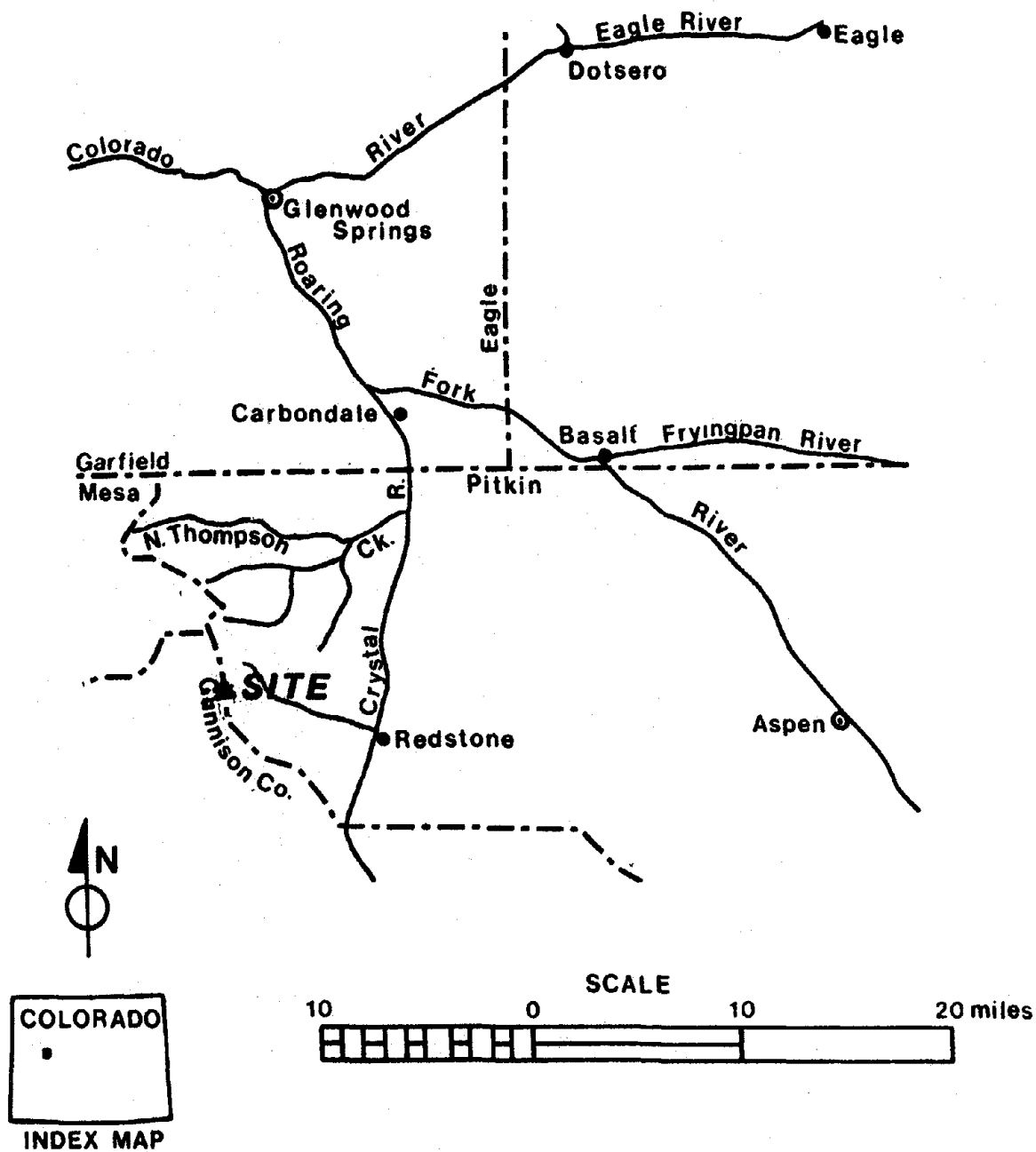


FIGURE 1. SITE LOCATION MAP

This study generally reflects a successful methodology for permitting, installing and recovering a subsidence monitoring net under conditions typical of those faced by operators in the western United States.

SCOPE OF WORK

The revised scope of work for this project was defined in Amendment/Modification No. A003 to DOE contract number DE-AC22-80PC30118, Requisition/Purchase Request number 22-82-PC30118.002. A summary of the Work Statement is presented herein.

Objective

MSE was responsible for developing techniques to measure and analyze the response of strata to the mining of a thick coal seam by the longwall method with multiple lifts.

Deliverables

MSE was responsible for preparing a Monthly Project Status Report, Semi-Annual Technical Progress Reports and a Final Technical Report.

At the direction of DOE, the Final Technical Report was to be a narrative outlining monument installation and surveying procedures. Funding was not provided for the reduction of the surveying data and the generation of appropriate maps, plans and profiles.

Requirements

The revised scope of work was subdivided into five tasks:

1. Secure site
2. Develop an Instrumentation Plan
3. Install the monitoring net
4. Remove the monitoring net
5. Reporting as required by DOE

Task 1 - Secure Site

MSE was responsible for securing access from Mid-Continent Resources, Inc., to monitor subsidence above the multiple lift long-wall mining operation planned for the L.S. Wood No. 3 Mine in Coal Basin, Colorado. In addition, MSE had to secure the required Forest Service Special Use Permits from the West Sopris District of the White River National Forest and the Paonia District of the Gunnison National Forest.

Task 2 - Instrumentation Plan

MSE was responsible for preparing a plan for DOE approval fully documenting the proposed installation and monitoring procedures to be utilized.

The plan was to incorporate a net designed to obtain center line and transverse profiles of the subsidence troughs resulting from mining of at least one complete upper and lower lift sequence and one adjacent lift. The net was to be designed to permit a description of the final subsidence trough over each panel. Data from the net work was to be sufficient to formulate an elementary prediction model.

The plan was to include details of monument layout and construction. A tentative monitoring schedule was to be included.

Task 3 - Installation

MSE was to install the monitoring net approved by DOE.

Task 4 - Removal

MSE was to remove the monitoring net as required by the Forest Service Special Use Permits.

Task 5 - Reporting

MSE was to perform all required reporting specified by DOE.

MONUMENT CONSTRUCTION IN ALPINE AREAS

The subsidence monitoring area is shown on Figure 2. The subsidence monitoring site over the multiple lift longwall panels was a very remote and mountainous area. The area contained both high alpine meadow and partially forested environments. Elevations in the monitoring area varied from approximately 11,000 ft to 11,700 ft (Figure 2). The overburden section above the coal seam was approximately 2100 ft to 2800 ft in thickness.

Site Access

There were no existing roads into the monitoring area. The construction of access roads to the area was prohibited by county and U.S. Forest Service regulations. The study area could only be accessed by foot, or helicopter.

Because of its extremely high elevation and severe winter weather, the monitoring area was inaccessible during the winter. Weather and snow cover prohibited field work from the middle of September through the middle of June. All field construction and surveying had to be completed in the summer months after the snow cover had melted and before the first major snow storm in the fall.

The use of helicopter transport was required to perform all phases of site access: reconnaissance, permitting (archaeologic survey), control survey, net layout, monument construction, monitoring, net removal. Table 1 summarizes the approximate number of helicopter hours required for various aspects of the project.

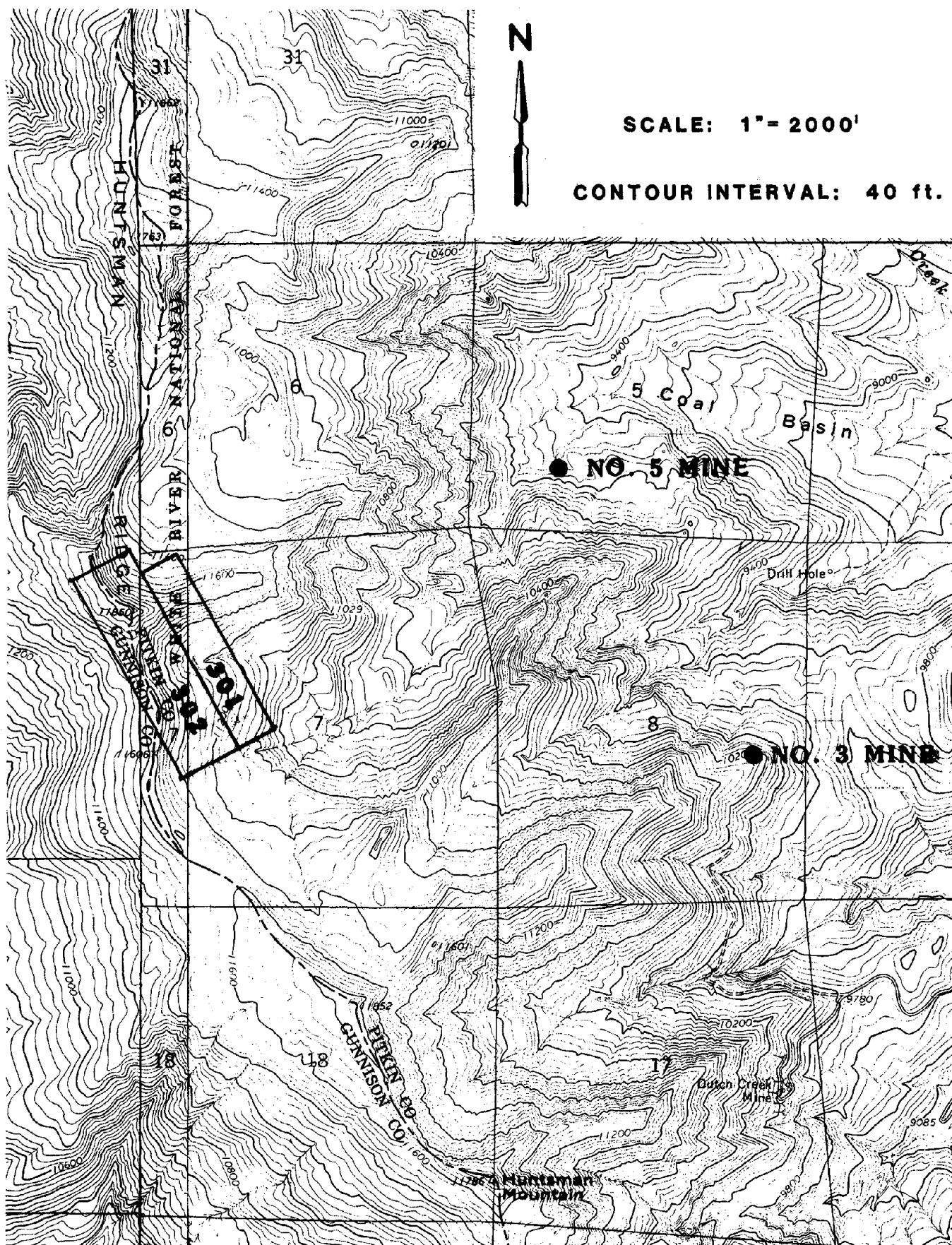


FIGURE 2. SUBSIDENCE MONITORING AREA LOCATION MAP

TABLE 1
APPROXIMATE HELICOPTER HOURS¹

Activity	Helicopter Hours
<u>Site Reconnaissance</u>	4.0
General lay of the topography and vegetative cover with respect to the underground workings. Initial selection of survey control point locations. Initial selection of helicopter landing zones	
<u>Permitting²</u>	
Site visits and orientation for Forest Service personnel. Archaeologic survey	3.0
<u>Control Monument Construction</u>	12.5
Mobilization. Construct five concrete control monuments (see Figure 3 for locations, Figure 4 for construction details)	
<u>Control Survey</u>	7.0
Closed traverse survey tied into mine control net	
<u>Monitoring Net Layout</u>	19.5
Survey in locations for subsidence monitoring points	
<u>Monitoring Net Construction</u>	30.0
Mobilization. Construct 43 points (see Figure 6 for construction details)	

TABLE 1 Continued
APPROXIMATE HELICOPTER HOURS¹

Activity	Helicopter Hours
<u>Monitoring Net Survey</u>	15.0
Sideshots from control point stations	
<u>Removal</u>	90.0
Remove all 43 monitoring points. Reclamation. Final site visits by Forest Service personnel	

NOTES:

1. These times represent estimated times based on our experience. They represent estimates based on a staging area (with fuel available) approximately 5 miles from the site area. These figures do consider decreased lift capability for the helicopter because of the elevation of the site area. Finally, these times represent helicopter times for a 7-man installation/construction crew and a 4-man surveying crew.
2. Increased time requirement because initial archaeological survey disclosed a significant Ute Indian camping area which required detailed mapping.

Forest Service Permits

The monitoring area was within the jurisdiction of the West Sopris District of the White River National Forest and the Paonia District of the Gunnison National Forest. Therefore, Special Use Permits were required prior to the installation of control and monitoring points.

The procedure for obtaining the permit and finally being released from the permit at the end of the project involved six steps:

1. Application
2. Environmental Assessment
3. Cultural Resources Survey
4. Permit
5. Reclamation
6. Release

These are summarized along with pertinent remarks and notes in Table 2. Examples of the various forms and reports are presented in Appendices: A (Application, Statement of Need, Permit, Release), B (Environmental Assessment - MSE Draft) and C (Cultural Resources Survey).

Cultural Resources Survey

A condition for granting the Special Use Permit involved the performance of a Cultural Resources Survey by an archaeologist approved by the Forest Service. This survey had to be performed to insure that monument construction would not damage any archaeological sites.

Specifically, the survey was performed along the subsidence monitoring lines, at the five locations for the survey control points and

TABLE 2
SPECIAL USE PERMITTING FLOW CHART
(U.S. Forest Service)

Activity Number	Description	Responsibility
1.0	<u>Application</u> Forest Service Form FS-2700-3 (1178) Note: Should include a map	Applicant
2.0	<u>Statement of Need</u> (Optional Forest Service Requirement) Contains the following items: a. Description of project and its location b. Relationship of the project to existing operations or systems c. Necessity for project d. Anticipated future expansion e. Alternatives to project f. Need for National Forest lands g. Other ownership and agencies involved	Applicant
3.0	<u>Environmental Assessment</u> (Reference: Federal Register, Vol. 44 No. 147, Monday July 30, 1979 p. 44732) Addresses the following items: a. Purpose and need b. Affected environment c. Alternatives d. Effects of implementation	Forest Service w/optional appli- cant assistance
4.0	<u>Cultural Resources Survey</u>	Applicant

TABLE 2 Continued
SPECIAL USE PERMITTING FLOW CHART

Activity Number	Description	Responsibility
5.0	<u>Permit</u> Forest Service Form 2700-4 (7/71)	Forest Service
6.0	<u>Reclamation</u> Stipulations appended to the Special Use Permit	Applicant
7.0	<u>Release</u> Forest Service Form FS-2700-3a (11-78)	Applicant/ Forest Service

at eight helicopter landing pads. This survey was performed in June 1981 and involved 1.5 mandays.

As a result of this survey a significant archaeological site was discovered in the area of one of the survey control points. This had several consequences. First the control point and attendant helicopter pad had to be moved. Secondly, a detailed map of the site had to be prepared by the archaeologist.

Snow cover precluded complete mapping of the site until late June. At that time the mapping was completed. This detailed site mapping involved 1.5 mandays.

In planning for and installing a subsidence monitoring net on Federal land, an operator should be prepared for the possibility of a Cultural Resources Survey. In this case, a survey of approximately 9000 ft of monitoring line, five survey control point locations, eight helicopter landing pads and detailed mapping of a significant site involved 3 mandays of archaeologist effort. Typical archaeological reports are presented in Appendix C.

Monument Construction

Two types of monuments were constructed in the site area: survey control monuments and subsidence monitoring points.

Survey Control Monuments

No survey control existed in the subsidence monitoring area because of its remote location. It was therefore necessary to bring coordinate and elevation control into the monitoring area from Mid-Continent's mine survey control net. One of Mid-Continent's triangulation stations

was located so that extending survey control into the project area could be accomplished with several long shots. The control survey was used to establish permanent surveying monuments adjacent to, but outside of, the monitoring area. These control survey monuments were established in locations outside of any area that would have been undermined during the duration of the project. A total of five control survey monuments were constructed at the locations shown on Figure 3. This configuration allowed for a closed traverse control survey to reduce surveying error.

The construction of the survey control monuments is illustrated on Figure 4. These monuments were constructed of concrete, with rock bolt reinforcing rods. Monuments were 12 inches in diameter and 4 to 5 ft in height.

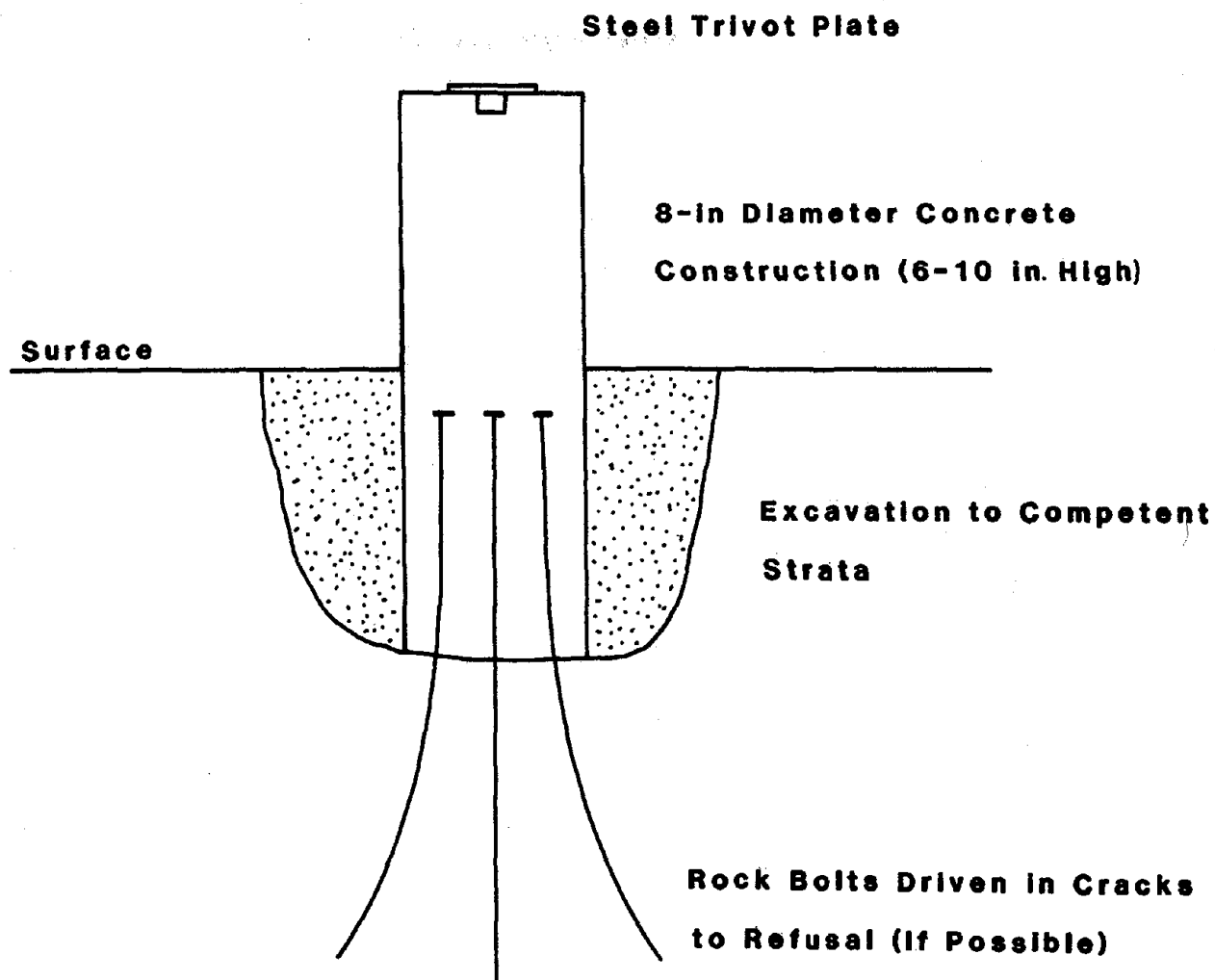
The typical construction sequence involved the following steps:

1. The monument locations was cleared of all loose rock and debris down to bedrock.
2. Two to four rock bolts (6-ft lengths) were driven to refusal with a 12-lb sledge hammer into joints and fractures in the rock
3. A concrete forming tube was placed around the rock bolts
4. Concrete was mixed in a mixing trough and poured into the form
5. A trivet plate, designed to mate with a Wild trivet was set into the top of the wet concrete
6. The concrete was allowed to cure a minimum of 96 hours prior to any surveying

Subsidence Monitoring Points

Mine Subsidence Engineering Company installed a network of 43

FIGURE 3. CONTROL SURVEY MONUMENT LOCATIONS



Not to Scale

**FIGURE 4. CONTROL SURVEY CONCRETE TYPE
MONUMENT CONSTRUCTION**

subsidence monitoring points over two adjacent longwall areas. This network included three lines of points perpendicular to panel centerlines and a partial line of points over each panel centerline. Figure 5 illustrates the general layout of the monitoring net and its relationship to the underground workings.

Each monitoring point was fabricated of 1- and 2-ft lengths of EW drill rod (1.375-in diameter). A bottom 1-ft section had a hardened steel drive point welded on. A 0.25-in thick steel plate, drilled with holes to mate with a Wild trivet, was welded to a drill rod coupling. This was installed on top of the drill rod subsidence point once installation was completed. Details of subsidence monitoring point construction are illustrated on Figure 6.

The installation sequence for monitoring points in soil areas generally involved the following:

1. A drive head was attached to the top coupling
2. The point was initially driven by two individuals with a fence post driver. Plumb of the monument was frequently checked with a "pill box" level. As needed, 1-ft or 2-ft sections of drill rod were added
3. The fence post driver was used until approximately 10 to 20 blows were required to drive the point 1 inch
4. A Pionjar gasoline powered hammer-drill was then used to further drive the point. This hammer-drill was used until refusal. Refusal was judged as 10 to 20 blows per inch of drive
5. The drive head was removed and the top trivet plate was installed

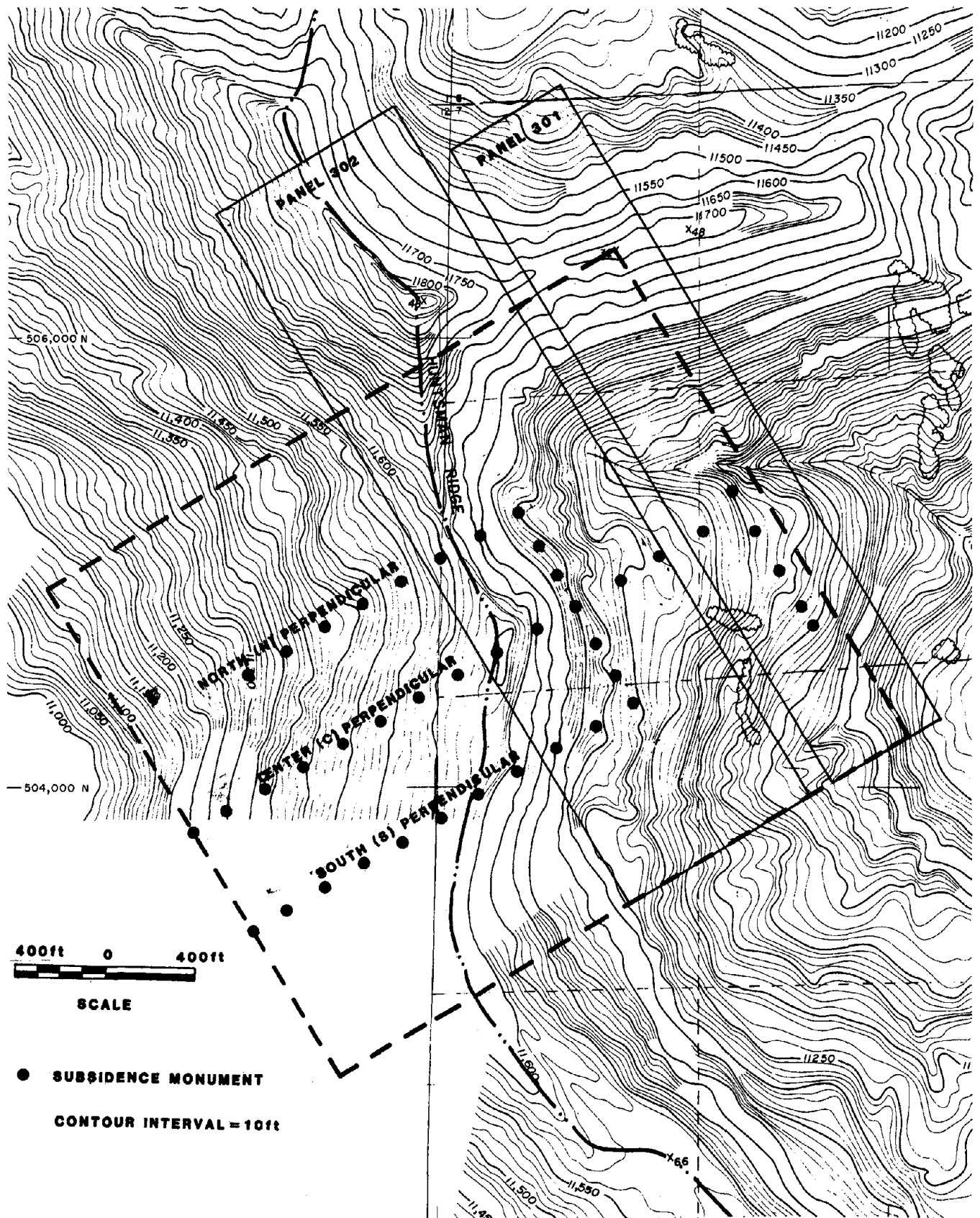
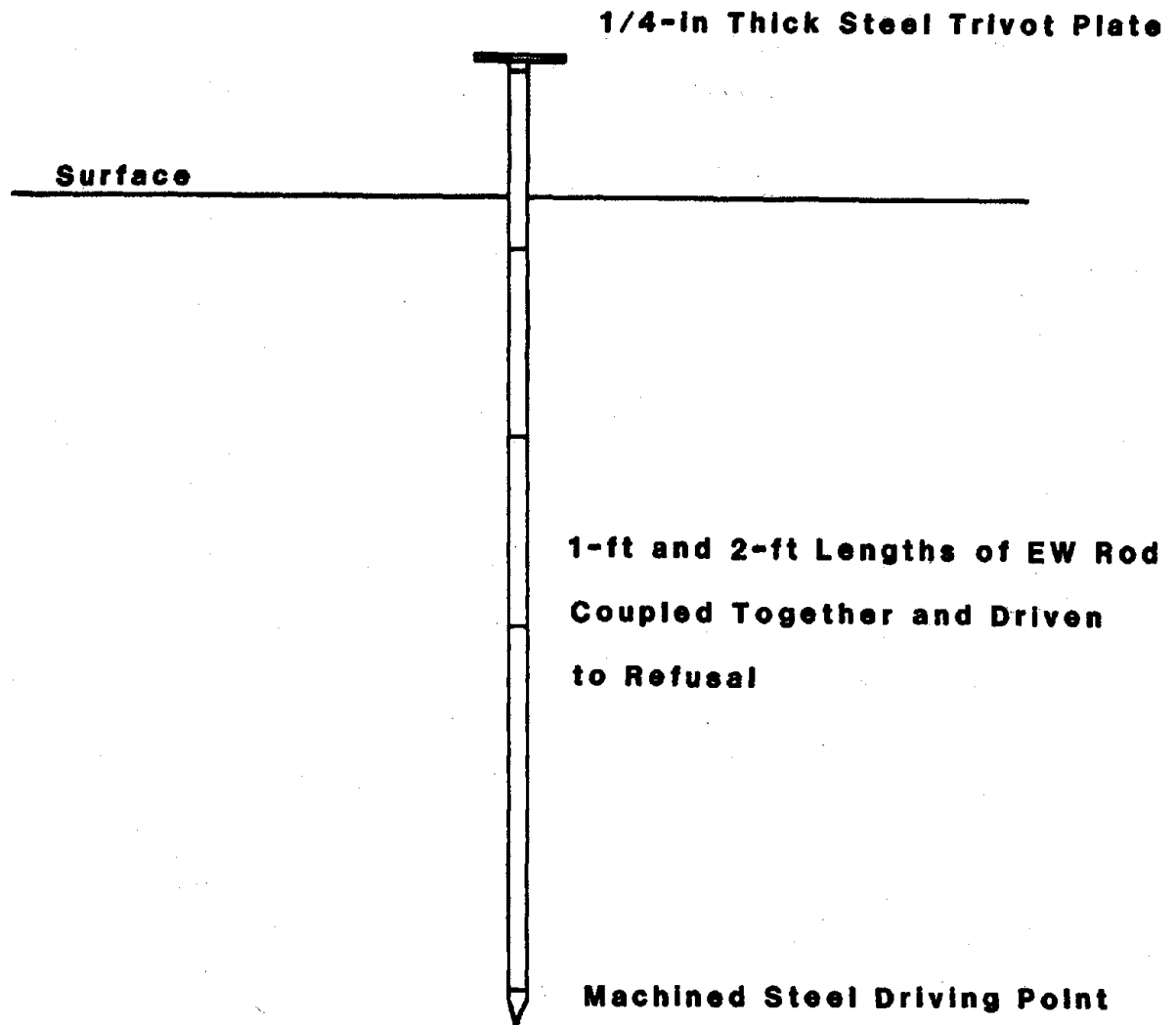


FIGURE 5. GENERAL LAYOUT OF THE SUBSIDENCE MONITORING NET



Not to Scale

**FIGURE 6. SUBSIDENCE MONITORING POINT
FABRICATION DETAILS**

6. All couplings and the top trivet plate were tightened with 36-in pipe wrenches
7. Plumb of the monument was checked with a "pill box" level.

In general, monuments were installed to depths of 5 to 7 ft before refusal. The deepest monument was installed to a depth of about 12 ft. All monuments were installed to a height of from 1 to 2 ft above the ground.

Where bedrock lay at or near the surface, the monument installation procedures were modified as follows:

1. The drill feature of the Pionjar hammer-drill was used to drill a 1.5-in diameter hole 2 ft into the rock
2. A monitoring point was then resin-grouted into the hole

This type of construction was required on four of the 43 points installed in the monitoring net.

Construction of either the soil or the bedrock monitoring points required a two-man crew. The average installation times for each point was between 15 and 20 minutes.

Installation of the concrete control points required a minimum crew of two individuals. Average construction time was 2 hours. It should be noted that this construction time is based on all construction operations being performed manually.

Monument Removal

The conditions of the Forest Service Special Use Permits required that all installed survey control points and subsidence monitoring points were to be removed at the end of the project.

The survey control points were not removed. The mine operator wanted to incorporate the survey control points into his control net. Responsibility for these monuments was transferred to the mine operator.

Subsidence monitoring points were designed with ease of removal as a prerequisite. Actual removal of the monitoring points consisted of jacking them out of the ground with a "bumper" type of jack. Because of the installation and removal procedure, the ground was not disturbed and site reclamation was not required. Removal of the monitoring points required about one-half manhour of time.

SURVEYING

This section briefly discusses the equipment and techniques utilized in surveying the control net and the monitoring points. The monitoring schedule that was proposed is also presented.

Equipment

The selection of surveying equipment was dictated by the site and the required accuracy specified in the Statement of Work. The Statement of Work specified that Third Order, Class II accuracy was required for surveys performed on the monitoring net. The long distances of traverse legs for the control survey required a distance measuring device with a range of at least 2 miles.

All measurements of the vertical and horizontal angles were made with a Wild T-2 Theodolite. This instrument has an accuracy of 1 sec of arc.

The slope distances between survey control monuments were measured with a TOPCON DMC-2 electronic distance measuring device (EDM). Slope distance measurements when surveying the subsidence monitoring points were made with a Wild DI-3S. Both instruments have an accuracy greater than 0.05 ft per 1000 ft.

Techniques

Slightly different surveying techniques were utilized for the control survey and the baseline survey of the subsidence monitoring points.

Control Survey

The control survey was performed to an accuracy equivalent to a Second Order, Class II survey. All internal angles were measured with the theodolite in the erect and inverted aspect. Six sets of inverted and erect internal angles were measured at each traverse station. A closed traverse was utilized to allow for internal angle triangulation and elevation closure to provide further accuracy.

The initial control survey required a four-man crew 1.5 days.

Subsidence Monitoring Survey

Surveys of the subsidence monitoring net were required to be within Third Order, Class II accuracy limits. The only surveys performed on the net prior to its removal were the baseline surveys performed immediately after the net was installed in August 1981.

Side shots from a survey control point to each survey monitoring point were utilized as the surveying technique for the surveys of the subsidence monitoring points. Vertical and horizontal angles were measured with the theodolite in both the erect and inverted aspects. At least two complete surveys, done on different days, were performed for each monitoring point. Preliminary data reduction indicates that this provided accuracy within the Third Order, Class II requirement.

Monitoring Schedule

Because of the scheduling of the project cancellation, no monitoring of the subsidence net was performed. This section briefly describes the monitoring schedule that was proposed for the subsidence net.

It was anticipated that the severe winter climate and residual snow cover would restrict monitoring of the subsidence net to the time period between June 15 and September 15. It was anticipated that the entire subsidence net would be surveyed each time to insure that all surface movement was recorded. All surveys were to be coordinated with mining activity to insure that the greatest amount of information was recorded.

The proposed monitoring schedule is presented in Table 3. This monitoring schedule would have resulted in surveying of active subsidence over Panel 301L three times, Panel 302 four times and Panel 302L three times in addition to the initial and final subsidence surveys.

Based on the baseline surveys, a minimum crew size of three individuals would have been required for a monitoring survey. This would have included an instrument man and two rod men. Surveying time would have been between 1.5 and 2 days. Had it been necessary to re-establish survey control into the area, it is anticipated that this would have required an additional 1 to 1.5 days with the three-man crew.

TABLE 3
PROPOSED SUBSIDENCE MONITORING SCHEDULE

Lift	1981	1982	1983	1984	1985	1986
301 L	I	II	II	AAA	FFF	F
302	I	AA	AA	FFF	FFF	F
302 L	I	II	II	III	AAA	F

L - Denotes Lower Lift Panel

I - Initial Survey

A - Active Survey

F - Final Survey

RESULTS

The only results obtained during the survey were the coordinates and elevations of the control points and field survey data for the baseline survey of the monitoring points.

The results from the control survey are tabulated in Appendix D.

The field survey data from the baseline survey of the monitoring net are tabulated in Appendix E.

DISCUSSION

This section addresses the layout and design rationale for the survey control net and the subsidence monitoring net. The constraints imposed by topography, vegetative cover and local and Federal (Forest Service) regulations are described. The unique aspects of monument construction in alpine terrain are discussed.

Control Net

The design rationale and layout of the control net were dictated by the mine plan, topography, the proposed surveying procedures and the locations of existing points within the mine's triangulation net.

It was desired to construct the minimum number of points necessary to provide for a closed traverse control survey. At least one point in the control net had to be located outside the area of possible influence of any mining in the five mines within Coal Basin. Selected control points would be positioned so as to serve as instrument stations for monitoring the subsidence net. These instrument stations/control points had to be located where snow cover would be minimal or nonexistent by the middle of June. All control points had to be located such that helicopter landing areas were near by. Finally, all control point locations and attendant helicopter landing zones had to be free of any "cultural resources".

The procedure for establishing the control net involved the following steps:

1. Selection of possible sites on a topographic map based on the existing mine control points, mine layout and surface topography

2. A site reconnaissance utilizing the helicopter and the archaeologist
3. Test set up with the theodolite to insure lines of sight
4. Construction of concrete control points
5. Control survey

The layout of the control installed as a portion of this study was shown on Figure 3. Results from the control survey are presented in Appendix D.

Subsidence Monitoring Net

The design rationale and layout of the subsidence monitoring net were dictated by the Scope of Work, the mine plan, the surface topography, vegetative cover and conditions established by the Forest Service Special Use Permits (ie, extensive cutting of trees was not allowed and monuments had to be removed at the end of the project).

The Scope of Work specified that the net be designed to provide both center line and transverse profiles with respect to one complete set of upper and lower lift panels and at least one adjacent lift. The net had to be sufficient to define the final subsidence trough that would result from mining each individual lift as well as the final, cumulative subsidence trough resulting from extraction of all three lifts. Data from the net had to be sufficient to formulate an elementary subsidence prediction model.

Specifically the monitoring net was designed to determine:

1. Maximum subsidence over the longwall panels from mining each lift
2. Horizontal movement of the ground surface from mining each lift

3. Subsidence development profiles along panel centerlines for each lift
4. Subsidence profiles across each panel from the panel centerline to the point of zero subsidence for each lift
5. Strain profiles across each panel from the panel centerline to the point of zero subsidence for each lift
6. Determination of the angle of draw for each lift

In addition to these data it was anticipated that additional information addressing the following points would have been obtained:

1. The effects of dipping seams on subsidence
2. The effects of topography on subsidence
3. The effects of geology on subsidence
4. The effects of virgin vs. previously mined ground on subsidence
5. The effects of depth and mining geometry on subsidence
6. The visible effects of subsidence on the ground surface for this given environment

The subsidence monitoring net was designed with monitoring points spaced a maximum of 200 ft apart. This yielded a ratio of monitoring point spacing : overburden depth ($h = 2800$ ft) of 0.07. This compares with the $0.1h$ to $0.15h$ maximum spacing recommended by the British National Coal Board.

Perpendicular (traverse) subsidence lines were extended out from the panel ribside for a distance of 1250 ft. This distance was determined from the depth of the seam (2800 ft), the projected angle of draw (24°) and the pitch of the seam (12°).

Lines of monuments were positioned along the centerline of lower lift Panel 301L and the centerline of the upper lift and lower lift

pair, Panels 302 and 302L. Topography and vegetative cover controlled the exact location and length of each centerline segment.

The Panel 301L centerline segment was 700 ft long (5 monuments). This short length was dictated by steep topography and dense tree cover. The centerline segment for Panels 302 and 302L was 1000 ft long (7 monuments). The location of this line was controlled by steep topography.

Three perpendicular subsidence lines were installed in addition to the two centerline segments. The principal control on the location of these lines was the desire to place them at the start, end and half-way points of the 302/302L centerline segment. These three lines were denoted the north, center and south perpendiculars. All three perpendiculars were extended out 1800 ft from the 302/302L centerline segment. These lines consisted of 7, 14 and 10 monuments for perpendiculars north, center and south, respectively.

Only the center perpendicular was extended to the Panel 301L centerline. The other two were constrained by topography and dense tree cover.

The original plan also included rough leveling points installed along certain segments of the perpendicular lines. The points were to be installed on 50-ft centers. They were to be utilized to better define the angle of draw. However, the project was cancelled before this work was performed.

The general layout of the monitoring net was shown on Figure 5.

Monument Constuction in Alpine Terrain

This project involved construction on a subsidence monitoring net in remote, high alpine terrain. The project indicated that several factors are key parameters in this type of subsidence monitoring.

These are:

1. helicopter support
2. simple monument construction
3. Placement of instrument stations to reduce surveying time

Experience gained on the project was that simple monument construction is essential. Monuments must be easy to fabricate, transport and install. MSE believes that the monuments utilized in this work satisfied these requirements. MSE was unable to validate monument stability through surveying because of the project cancellation. However, observations during the removal process indicated that the monuments most probably were stable.

The strategic placements of instrument stations to maximize the number of points that would be surveyed from a particular instrument set up should be a factor in the design of a subsidence monitoring net in alpine terrain. Care should be exercised in locating these instrument stations in areas prone to lightning strikes. One of the control points installed by MSE was struck by lightning and the top 1 ft of the concrete monument blown off. Approximately 1.5 mandays were required to rebuild and re-survey this point.

Our experience shows that approximately 21 manhours and one helicopter hour were required for the installation of each monitoring point. These figures do include the time and effort required for the initial reconnaissance, permitting, cultural resources survey, establishing survey control, net layout, installation and baseline survey. If all factors except actual installation time are ignored, then approximately one manhour and 1/4 helicopter hour were required per monitoring point.

CONCLUSIONS

This project demonstrated that a subsidence monitoring net can be successfully installed and removed from a remote, high alpine environment. The study showed that pre-planning with respect to instrument station locations was a critical factor in reducing installation and monitoring time.

It is also critical to closely coordinate activities with the appropriate regulatory agencies to avoid unnecessary and costly delays. Simple monument construction is necessary to reduce installation costs.

The project was cancelled before the actual response of the net to actively subsiding ground could be determined. Also, no funding was allowed for a final baseline survey to validate monitoring point stability. Future work should be concentrated in these areas.

APPENDIX A
FOREST SERVICE PERMITTING FORMS

United States Department of Agriculture
Forest Service**SPECIAL USE APPLICATION AND REPORT**
(Reference FSM 2712)

This report is authorized by the Organic Act of June 4, 1897 for the purpose of evaluating the proposed use and no permit may be issued unless this form is completed or the information it requires has been made a part of the record in some other manner.

FOREST SERVICE USE ONLY	a. Record no. (1-2)	b. Region (3-4)	c. Forest (5-6)
	7 0	0 2	0 4
	d. District (7-8)	e. User number (9-12)	f. Kind of use (13-15)
	0 8	- - - -	6 1 2
	g. State (16-17)	h. County (18-20)	i. Cord No. (21)
	0 8	GUNN 0 5 1	1

PART I - APPLICATION (To be completed by applicant)

Application is hereby made for a permit to use National Forest land as indicated below:

1. Description of land: (Attach MAP or PLAT)

A parcel of land in sections 6 and 7, T.10S., R.89W. and sections 1 and 12, T.10S., R.90W., as shown on the attached map.

2. Purpose of use.

Installation and monitoring of approximately 54 surveying monuments for the purpose of measuring surface subsidence due to underground coal mining. The work is being done under DOE contract #DE-AC22-80PC30118.

3. Land Area applied for (For Rights-of-Way show length and width and convert to acres; for other uses show acres)

Length in: (Miles) or X Width (Feet) = (Acres)

4. Improvements**a. Description**

NONE. Monuments to be removed upon project completion except where they will be used by Mid-Continent Resources, Inc. for their subsidence monitoring requirements. All monuments will be removed when they are no longer required for subsidence monitoring.

b. Plans attached ☒ Yes ☐ No. If "NO" show date plans will be furnished

c. Estimated cost	d. Construction will begin within	e. Construction will be completed within
\$ 30,000.000	6 (Months)	12 (Months)

Date of Application	Applicant's name and signature	Applicant's address
January 16, 1981	Department of Energy, Carbondale Mining Technology Center Collin L. Stewart, Partner Mine Subsidence Engineering Company	P.O. Box 2587 Carbondale, ILL 62901 Mine Subsidence Engineering Company P.O. Box 746 Carbondale, CO 81623
		(ZIP Code)

Previous edition of this form is obsolete

(OVER)

FS-2700-3 (11/78)

PART II. REPORT ON APPLICATION (To be completed by Forest Officer)

1. General description of the area and adaptability for the proposed use. Outline area on separate Map Sheet if needed to clarify proposed use. (Use Field Map Sheet Form 3400-20, if needed)

R89W., T10S., Sec. 7 and R90W., T10S., Sec. 12. See attached maps. The land under consideration for this project is well adapted for the proposed use.

2. If previously under permit indicates:

a. N/A b. _____ c. _____
(Name of Permittee) (Date of Permit) (Date Closed)

3. Describe any encumbrances on the land, such as withdrawals, power projects, easements, rights-of-way, mining claims, leases, etc. Show on map provided or on Form 3400-20.

Mid-Continent Coal Lease #C-125457. This project is being done in conjunction with this lease by the Department of Energy.

4. State approximate amount and kinds of timber to be cut, recommended stumpage prices, method of scaling; include recommendation on disposal of merchantable timber (a) to permittee at current damage appraisal or (b) to others than permittee under regular timber sale procedure.

There is no merchantable timber involved. Site clearing between monitoring sites will involve only oakbrush which will be lopped and scattered.

5. Is the proposed use in conformity with the Multiple Use Plan?

Environmental Analysis prepared?

Environmental Impact statement prepared? (P.L. 91-190)

Does it conform with the District Land Adjustment Plan?

(NOTE: If "NO" is checked in answer to any of the above questions, explain under No. 6 below)

☒ Yes

☒ Yes (Attach)

N/A ☐ Yes (Attach)

N/A ☐ Yes

☐ No

☐ No

☐ No

☐ No

6. Recommendations, including any factors which might affect the granting of the permit or future use of the land.

Monuments to be removed at conclusion of project or as they are no longer needed.

7. List conditions which should be made a part of this permit (See FSM 2730)

B8, R2-E-1, R-2-D-1, D-2, D-3, D-7, F-24, R2-X2, X-6. In addition, a letter stating that archaeological clearance must be obtained before work on the ground begins and that helicopter access will be granted from May 1 - August 31.

8. Fee recommendation (Describe here or on computation sheet attached)

This is a free use permit as it is issued to another Federal Agency. (FSM 2710.12a)

9. Name and Address of Permittee exactly as it should be shown on the permit:

Department of Energy

RR#2

Universal Match Road

Cartersville, ILL

62918

(Zip Code)

RECOMMEND:	Approval? ☒	DATE	SIGNATURE	TITLE
	Disapproval? ☐	7/29/81	Michael K. Ward	Forester
	Approved? ☒	DATE	SIGNATURE	TITLE
	Disapproved? ☐	7/29/81	J. L. Elch	D.R.

*Delete One

GPO 234-700

United States Department of Agriculture
Forest Service

REQUEST FOR TERMINATION OF AND APPLICATION FOR SPECIAL USE PERMIT
(Ref: FSM 2716)

This report is authorized by the Organic Act of June 4, 1897 for the purpose of evaluating the requested actions and no permit may be issued unless this form is completed.

PART I - REQUEST FOR TERMINATION (To be completed by Permittee)

TO: FOREST SUPERVISOR Gunnison NATIONAL FOREST

I (WE), THE UNDERSIGNED PERMITTEE(S) UNDER THAT CERTAIN SPECIAL USE PERMIT, DATED July 29, 1981,

AUTHORIZING ME (US) TO install and operate approximately fifty-four monuments for monitoring surface subsidence caused by underground coal mining. HAVE

~~CONVEYED ALL OR PART, RIGHT, TITLE, AND INTEREST IN AND TO THE IMPROVEMENTS LOCATED ON THE PARCEL COVERED BY SAID PERMIT~~ removed all improvements located by MSE on the parcel covered by said permit

OR

~~ENTERED INTO A CONTRACT FOR THE SALE OF THE IMPROVEMENTS LOCATED ON THE PARCEL COVERED BY SAID PERMIT BUT HAVE~~

~~RETAINED TITLE TO SAID IMPROVEMENTS UNTIL COMPLETION OF PAYMENTS UNDER SAID CONTRACT WITH:~~

(NAME OR NAMES)

(ADDRESS)

ACCORDINGLY, I (WE) REQUEST THAT SAID SPECIAL USE PERMIT BE TERMINATED. THE REMAINING BALANCE OF ANY FEES PREVIOUSLY PAID SHOULD BE CREDITED TO THE APPLICANT NAMED BELOW.

DATE: 8 August, 1982

Collin L. Stewart - MSE
Robert W. Stephenson - Pres. Mgr.
(SIGNATURES OF ALL PERMITTEES LISTED ON PERMIT)

*STRIKE OUT INAPPLICABLE ALTERNATIVES

PART II - APPLICATION (To be completed by Applicant)

APPLICATION IS HEREBY MADE FOR A SPECIAL USE PERMIT TO COVER THE SAME PARCEL OF LAND COVERED BY THE PERMIT REFERRED TO IN THE ABOVE REQUEST, AND FOR THE SAME PURPOSE OF SAID PERMIT, SUBJECT, HOWEVER, TO SUCH NEW CONDITIONS AND STIPULATIONS AS THE CIRCUMSTANCES MAY WARRANT.

I (WE) ACKNOWLEDGE THAT WHEN A NEW PERMIT IS ISSUED, A TRANSFER FEE OF \$ _____ IS CHARGED. IT WILL BE INCLUDED IN THE INITIAL PAYMENT FOR THE NEW PERMIT.

DATE: _____, 19____.

(TYPE IN NAMES OF PROPOSED PERMITTEES)

BY _____

(SIGNATURE)

(ADDRESS)

(Over)

FS-2700-3a (8/81)

United States Department of Agriculture Forest Service SPECIAL USE PERMIT Act of June 4, 1897 This permit is revocable and nontransferable (Ref. FSM 2710)	a. Record no. (1-2)	b. Region (3-4)	c. Forest (5-6)
	70	02	04
	d. District (7-8)	e. User number (9-12)	f. Kind of use (13-15)
	08	----	612
	g. State (16-17)	h. County (18-20)	i. Card no. (21)
	08	051	1

Permission is hereby granted to Department of Energy, Carbondale Mining Technology

NR Center, P.O. Box 2587, Carbondale, ILL 62901

hereinafter called the permittee, to use subject to the conditions set out below, the following described lands or improvements:

A parcel of land in Sections 6 and 7, T10S., R89W., and Sections 1 and 12, T10S., R90W., as shown on attached map.

This permit covers 81 acres and/or N/A miles and is issued for the purpose of:

1. Construction or occupancy and use under this permit shall begin within 6 months, and construction, if any, shall be completed within 12 months, from the date of the permit. This use shall be actually exercised at least 365 days each year, unless otherwise authorized in writing.

2. In consideration for this use, the permittee shall pay to the Forest Service, U.S. Department of Agriculture, the sum of — Dollars (\$ —) for the period from N/A 19 , to N/A 19 , and thereafter annually on N/A Dollars (\$):

Provided, however, Charges for this use may be made or readjusted whenever necessary to place the charges on a basis commensurate with the value of use authorized by this permit.

3. This permit is accepted subject to the conditions set forth herein, and to conditions 18 to 27 attached hereto and made a part of this permit.

PERMITTEE	NAME OF PERMITTEE	SIGNATURE OF AUTHORIZED OFFICER	DATE
		<i>Wm. F. [Signature]</i>	7/4/51
ISSUING OFFICER	NAME AND SIGNATURE	TITLE	DATE
	<i>L. [Signature]</i>	<i>District Ranger</i>	7/24/51

(CONTINUED ON REVERSE)

2700-4 (7/71)

4. Development plans; layout plans; construction, reconstruction, or alteration of improvements; or revision of layout or construction plans for this area must be approved in advance and in writing by the forest supervisor. Trees or shrubbery on the permitted area may be removed or destroyed only after the forest officer in charge has approved, and has marked or otherwise designated that which may be removed or destroyed. Timber cut or destroyed will be paid for by the permittee as follows: Merchantable timber at appraised value; young-growth timber below merchantable size at current damage appraisal value; *provided* that the Forest Service reserves the right to dispose of the merchantable timber to others than the permittee at no stumpage cost to the permittee. Trees, shrubs, and other plants may be planted in such manner and in such places about the premises as may be approved by the forest officer in charge.

5. The permittee shall maintain the improvements and premises to standards of repair, orderliness, neatness, sanitation, and safety acceptable to the forest officer in charge.

6. This permit is subject to all valid claims.

7. The permittee, in exercising the privileges granted by this permit, shall comply with the regulations of the Department of Agriculture and all Federal, State, county, and municipal laws, ordinances, or regulations which are applicable to the area or operations covered by this permit.

8. The permittee shall take all reasonable precautions to prevent and suppress forest fires. No material shall be disposed of by burning in open fires during the closed season established by law or regulation without a written permit from the forest officer in charge or his authorized agent.

9. The permittee shall exercise diligence in protecting from damage the land and property of the United States covered by and used in connection with this permit, and shall pay the United States for any damage resulting from negligence or from the violation of the terms of this permit or of any law or regulation applicable to the National Forests by the permittee, or by any agents or employees of the permittee acting within the scope of their agency or employment.

10. The permittee shall fully repair all damage, other than ordinary wear and tear, to national forest roads and trails caused by the permittee in the exercise of the privilege granted by this permit.

11. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this agreement or to any benefit that may arise herefrom unless it is made with a corporation for its general benefit.

12. Upon abandonment, termination, revocation, or cancellation of this permit, the permittee shall remove within a reasonable time all structures and improvements except those owned by the United States, and shall restore the site, unless otherwise agreed upon in writing or in this permit. If the permittee fails to remove all such structures or improvements within a reasonable period, they shall become the property of the United States, but that will not relieve the permittee of liability for the cost of their removal and restoration of the site.

13. This permit is not transferable. If the permittee through voluntary sale or transfer, or through enforcement of contract, foreclosure, tax sale, or other valid legal proceeding shall cease to be the owner of the physical improvements other than those owned by the United States situated on the land described in this permit and is unable to furnish adequate proof of ability to redeem or otherwise reestablish title to said improvements, this permit shall be subject to cancellation. But if the person to whom title to said improvements shall have been transferred in either manner provided is qualified as a permittee and is willing that his future occupancy of the premises shall be subject to such new conditions and stipulations as existing or prospective circumstances may warrant, his continued occupancy of the premises may be authorized by permit to him if, in the opinion of the issuing officer or his successor, issuance of a permit is desirable and in the public interest.

14. In case of change of address, the permittee shall immediately notify the forest supervisor.

15. The temporary use and occupancy of the premises and improvements herein described may be sublet by the permittee to third parties only with the prior written approval of the forest supervisor but the permittee shall continue to be responsible for compliance with all conditions of this permit by persons to whom such premises may be sublet.

16. This permit may be terminated upon breach of any of the conditions herein or at the discretion of the regional forester or the Chief, Forest Service.

17. In the event of any conflict between any of the preceding printed clauses or any provisions thereof and any of the following clauses or any provisions thereof, the following clauses will control

18. Indemnification of United States

The permittee shall indemnify the United States against any liability for damage to life or property arising from the occupancy or use of National Forest lands under this permit.

19. Permit Termination

"Unless sooner terminated or revoked, this permit shall expire and become void on 12/31/86, but a new permit to occupy and use the same National Forest land may be granted provided the permittee shall have notified the Forest Supervisor not less than three months prior to said date that a new permit is desired, and the permittee is willing that his future occupancy of the premises shall be subject to such conditions and stipulations as existing or prospective circumstances may warrant and if, in the opinion of the issuing officer or his successor, issuance of a permit is desirable and in the public interest."

20. Refuse Disposal

The permittee shall dispose of all brush, refuse, debris and unused timber at such times and in such manner as may be required by the District Ranger.

21. Water Pollution

No waste or byproducts shall be discharged if it contains any substances in concentrations which will result in substantial harm to fish and wildlife, or to human water supplies.

Storage facilities for materials capable of causing water pollution, if accidentally discharged, shall be located so as to prevent any spillage into waters, or channels leading into water, that would result in substantial harm to fish and wildlife or to human water supplies.

22. Esthetics

The permittee shall protect the scenic esthetic values of the area under this permit, and the adjacent land, as far as possible with the authorized use, during construction, operation, and maintenance of the improvements.

23. Erosion Control

The permittee shall be responsible for the prevention and control of soil erosion and gullying on the area covered by this permit and lands adjacent thereto, and shall provide preventive measures as required by specifications attached to and made a part of this permit.

24. Fire Prevention and Suppression

The permittee shall do everything reasonable within its power and shall require its employees, contractors, and employees of contractors to do everything reasonable within their power, both independently and upon request of the Forest Service to prevent and suppress fires on or near the lands to be occupied under this permit.

25. Archeological-Paleontological Discoveries

"The permittee shall immediately bring to the attention of the District Ranger any and all antiquities or other objects of historic or scientific interest including, but not limited to, historic or prehistoric ruins, fossils, or artifacts discovered as the result of operations under this permit, and shall leave such discoveries intact until authorized to proceed by the District Ranger. Protective and/or mitigative measures specified by the Forest Service shall be the responsibility of the permittee."

26. Mineral, Oil, Gas Rights Granted

This permit is subject to the rights and privileges granted in mineral, oil, or gas leases covering this land which have been issued by an authorized agency of the United States, and this permit does not authorize the prevention or obstruction of the reasonable exercise of the rights and privileges granted by said mineral, oil, or gas leases.

STATEMENT OF NEED

1. Description of project and its location.

The proposed project involves monitoring of mining-induced surface subsidence above two multiple lift longwall panels at Mid-Continent Resources, Inc.'s Mine No. 3. Specifically, the proposed project involves the design, installation and monitoring of a surface subsidence data collection system. The work is being done under a Department of Energy Contract #DE-AC22-80PC30118.

The proposed project site is located in the Coal Basin area near Redstone, Colorado, in sections 6 and 7, T.10S., R.89W. and sections 1 and 12, T.10S., R.90W., as shown on the attached map.

2. Describe the relationship of the project to existing operations or systems.

The project is related to underground coal mining operations at Mid-Continent Resources, Inc.'s No. 3 Mine. The project will determine the magnitude and distribution of surface subsidence effects that may result from the underground extraction of the coal seam.

The surface subsidence monitoring will not have any adverse effects on any existing surface features or the surface environment.

3. Necessity for the project.

This study has been initiated by the Department of Energy (DOE) as a part of the Nation's energy program to study mining conditions and associated subsidence characteristics in coal fields throughout the United States.

As the national energy base shifts from oil to coal, vast areas of the United States will be subjected to greater underground mining activity. Increased interest has therefore been generated in the extraction of thick coal seams located in the western United States.

Recent environmental legislation by both Federal and state governments has placed severe restrictions on mining impacts to the surface environment. One major constraint on the extraction of thick and steeply dipping seams by longwall techniques has therefore been a fear of the consequences of the associated surface subsidence.

At the present time, adequate methods for predicting the characteristics of subsidence and the impact of subsidence on the surface environment are not well developed for mining environments in the United States. In many European countries, notably the United Kingdom, the area of subsidence prediction has been developed on an empirical basis using extensive subsidence data bases collected over a long period of time. These empirical capabilities are routinely utilized by mine planners to minimize the surface impacts of underground mining.

This study has been initiated as a portion of the DOE's program to collect subsidence data for the development of empirical subsidence prediction models for U.S. mining conditions. This study is unique. It is specifically designed to collect subsidence data from the multiple lift longwall mining of a thick coal seam (25 ft thick) under deep overburden cover (2500 ft thick) in a mining environment that typifies coal fields in the Rocky Mountain region of the western

United States. It should be noted that the multiple lift longwall mining operation at the No. 3 Mine is the only one of its kind in the United States. It represents a demonstration of a mining method that has not previously been used in the United States.

4. Anticipated future expansion.

None.

5. Alternatives to the project.

No alternatives exist except a no action alternative. Mid-Continent Resources, Inc. is the only mining company utilizing multiple lift longwall mining in the United States. The project is being funded by the Department of Energy to test the feasibility of this type of mining for thick coal seams with U.S. mining conditions and health and safety regulatory constraints.

6. Need for National Forest lands.

The ground surface lies partly within the Gunnison-Uncompahgre-Grand Mesa National Forest. The National Forest land is needed to install surveying points for the subsidence monitoring program.

7. Other ownerships and agencies involved.

Sopris District - White River National Forest



Collin L. Stewart, Partner
Mine Subsidence Engineering Company

January 16, 1981

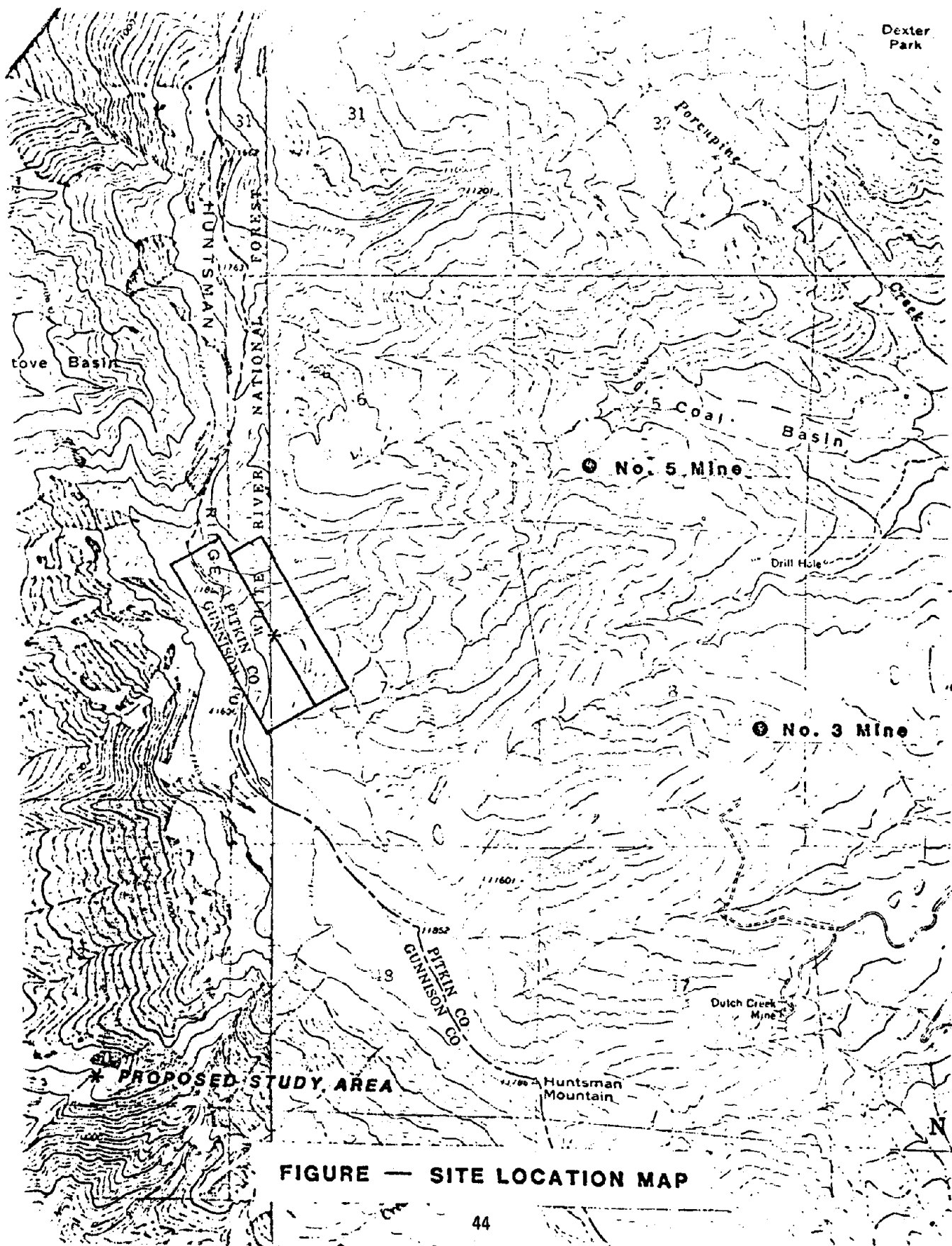


FIGURE — SITE LOCATION MAP

United States Department of Agriculture
Forest Service**SPECIAL USE APPLICATION AND REPORT**
(Reference FSM 2712)

This report is authorized by the Organic Act of June 4, 1897 for the purpose of evaluating the proposed use and no permit may be issued unless this form is completed or the information it requires has been made a part of the record in some other manner.

FOREST SERVICE USE ONLY	a. Record no. (1-2)	b. Region (3-4)	c. Forest (5-6)
	70	--	--
	d. District (7-8)	e. User number (9-12)	f. Kind of use (13-15)
	--	--	--
	g. State (16-17)	h. County (18-20)	i. Card No. (21)
	--	--	1

PART I - APPLICATION (To be completed by applicant)

Application is hereby made for a permit to use National Forest land as indicated below:

1. Description of land (Attach MAP or PLAT)

A parcel of land in sections 6 and 7, T.10S., R.89W. and sections 1 and 12, T.10S., R.90W., as shown on the attached map.

2. Purpose of use.

Installation and monitoring of approximately 54 surveying monuments for the purpose of measuring surface subsidence due to underground coal mining. The work is being done under DOE contract #DE-AC22-80PC30118.

3. Land Area applied for (For Rights-of-Way show length and width and convert to acres; for other uses show acres)

Length in: $\frac{\text{(Miles)}}{\text{(Feet)}}$ or $\frac{\text{(Feet)}}{\text{(Feet)}}$ X Width $\frac{\text{(Feet)}}{\text{(Feet)}}$ = $\frac{\text{(Acres)}}{\text{(Acres)}}$

4. Improvements**a. Description**

NONE. Monuments to be removed upon project completion except where they will be used by Mid-Continent Resources, Inc. for their subsidence monitoring requirements. All monuments will be removed when they are no longer required for subsidence monitoring.

b. Plans attached ☒ Yes ☐ No. If "NO" show date plans will be furnished

c. Estimated cost	d. Construction will begin within	e. Construction will be completed within
\$ 30,000.000	6	12
	(Months)	(Months)
Date of Application	Applicant's name and signature	Applicant's address
January 16, 1981	Collin L. Stewart, Partner Mine Subsidence Engineering Company	Mine Subsidence Engineering Company P.O. Box 746 Carbondale, CO 81623
		(ZIP Code)

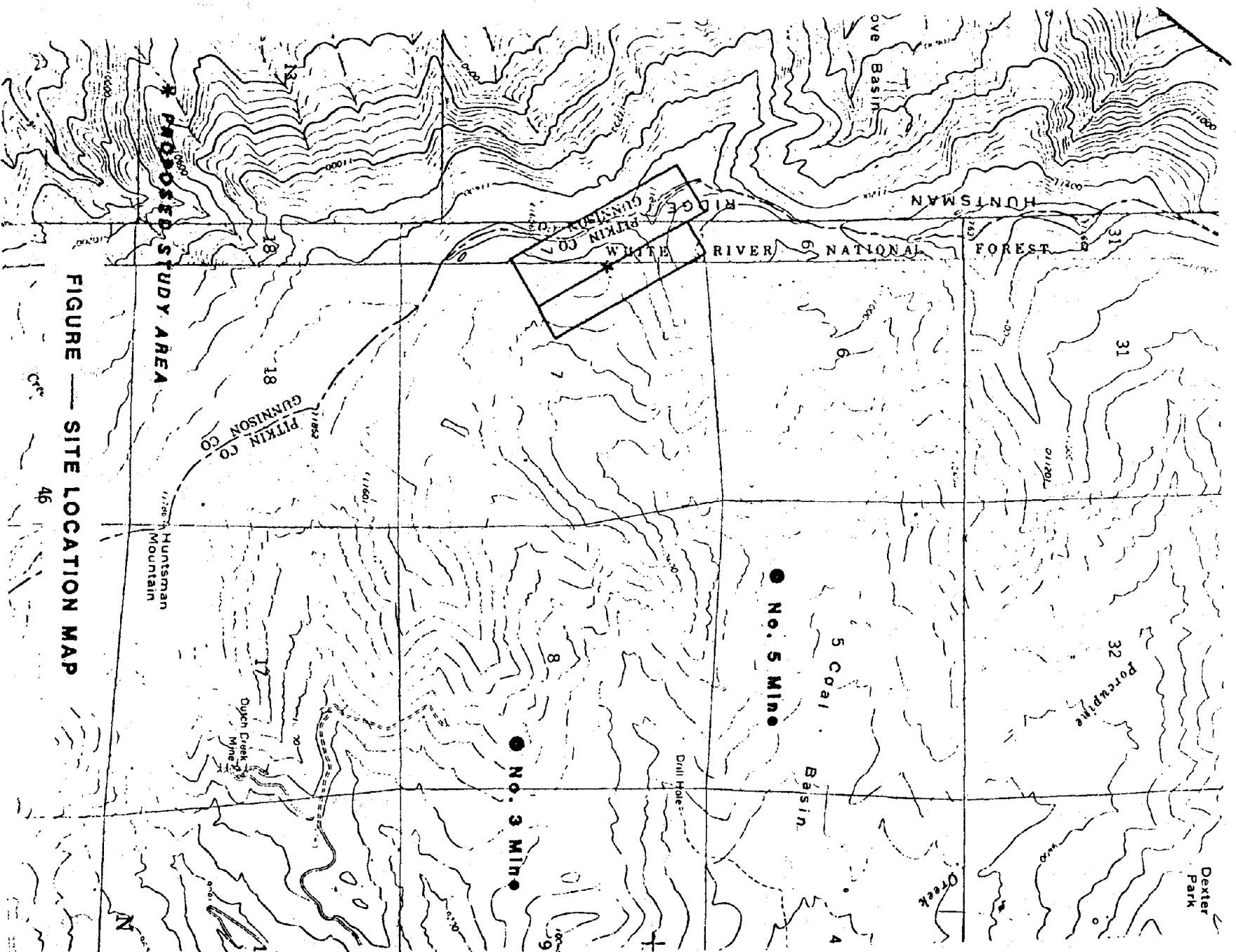


FIGURE — SITE LOCATION MAP

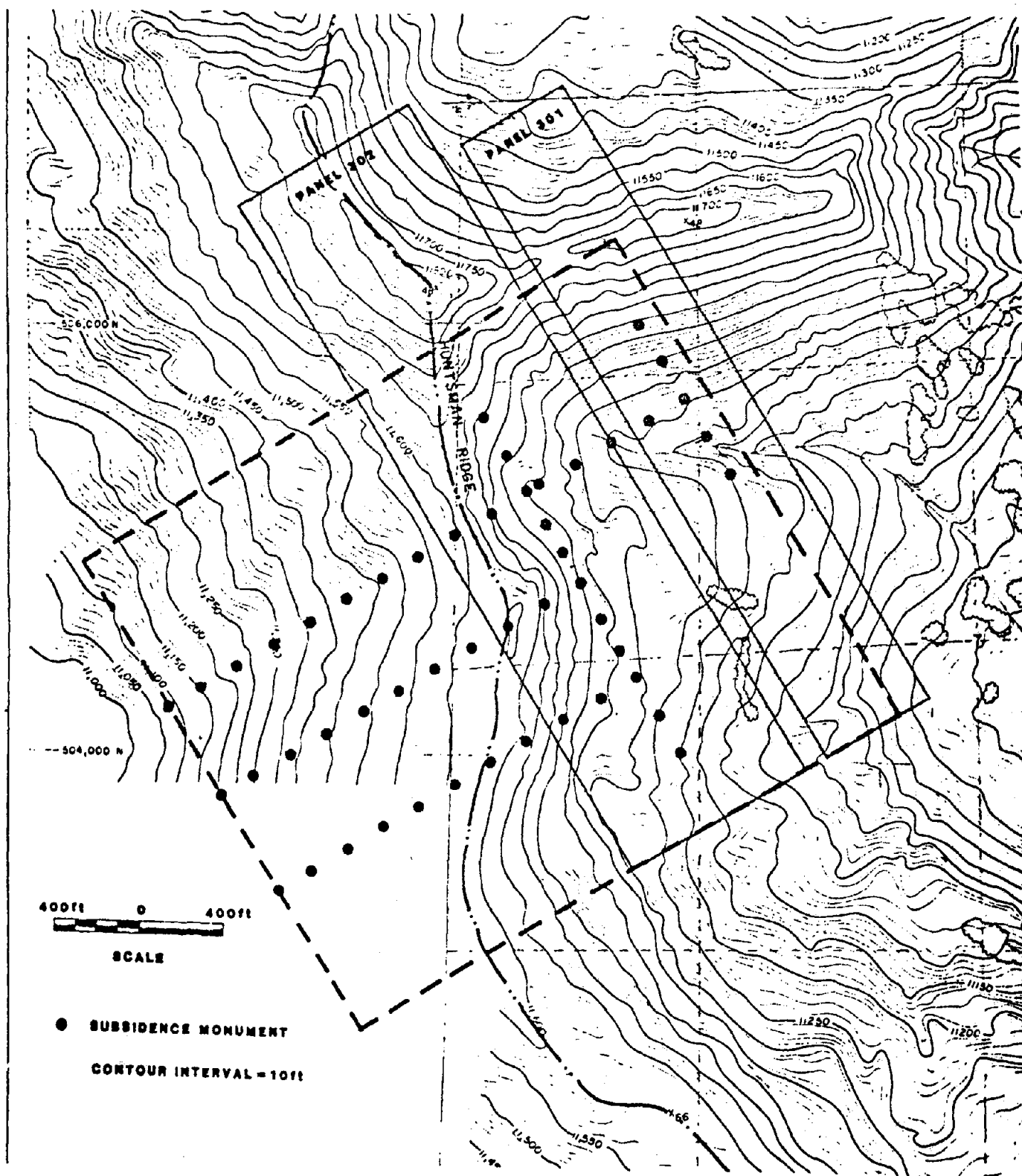


FIGURE LAYOUT OF SUBSIDENCE MONITORING NET

APPENDIX B
ENVIRONMENTAL ASSESSMENT

reference." (40 CFR 1508.13). (See Section 213 of FSM 1909.15, The NEPA Process Handbook.)

The FONSI shall be included as an integral part of the decision notice.

Responsible officials " . . . shall make the finding of no significant impact available for public review (including State and areawide clearinghouses) for 30 days before the agency makes its final determination whether to prepare an environmental impact statement and before the action may begin when:

"(i) The proposed action is, or is closely similar to, one which normally requires the preparation of an environmental impact statement.

"(ii) The nature of the proposed action is one without precedent." (40 CFR 1501.4).

In these two situations, the decision notice, and its integral FONSI, shall be made available for a 30-day public review period prior to implementation of the plan, policy, program or project.

1852.3—Format. Environmental assessments and environmental impact statements should generally conform to the following outline. The outline follows the sequence of steps in the environmental analysis (FSM 1951). Sections of the outline may be combined or rearranged in the interest of clarity and brevity.

EA or EIS Outline

1. Cover Sheet (optional for EA)
 2. Summary (optional for EA).
 3. Table of Contents (optional for EA).
 4. Introduction.
 5. Affected Environment.
 6. Evaluation Criteria.
 7. Alternatives Considered.
 8. Effects of Implementation.
 9. Evaluation of Alternatives.
 10. Identification of the Forest Service Preferred Alternative.
 11. Consultation With Others.
 12. Index (optional for EA).
 13. Appendix (optional for EA).
- (a) list of preparers.
- (b) list of Federal, State and local agencies to whom the the EIS or EA is being sent.
- (c) substantive review comments or summaries (final EIS only).

1852.4—Contents. Writers of environmental assessments or environmental impact statements should be concerned with content, clarity and brevity.

Writers " . . . shall incorporate material into an environmental impact statement (or environmental assessment) by reference when the effect will be to cut down on bulk without impeding agency and public review of the action. The incorporated material shall be cited in the statement (or assessment) and its content briefly described. No material may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for comment. Material based on proprietary data which is itself not available

for review and comment shall not be incorporated by reference." (40 CFR 1502.21).

Material incorporated by reference is considered reasonably available when:

(a) It is an environmental impact statement that has been filed with the Council or EPA, or

(b) It is a book or other publication generally available in technical libraries, or

(c) It may be obtained (at the usual cost of furnishing such information) from the person listed on the cover sheet as the source of further information.

In final environmental impact statements, the material listed in items 4 through 10 in FSM 1952.3 shall normally not exceed 150 pages (and preferably shorter) or 300 pages for proposals of unusual scope or complexity.

Responsible officials " . . . shall insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements (and environmental assessments). They shall identify and methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement (or assessment)." (40 CFR 1502.24).

"The draft statement must fulfill and satisfy to the fullest extent possible the requirements established for final statements." (40 CFR 1502.9).

1. Cover sheet. (optional for EA). See section 231, FSM 1909.15, The NEPA Process Handbook, for a sample cover sheet. The cover sheet shall not exceed one page. It shall include:

- "(a) A list of the responsible agencies including the lead agency and any cooperating agencies.
- "(b) The title of the proposed action that is the subject of the statement, together with the State(s) and County(ies) (or other jurisdiction if applicable) where the action is located.
- "(c) The name, address, and telephone number of the person at the agency who can supply further information.
- "(d) A designation of the statement as a draft, final, or draft or final supplement.
- "(e) A one-paragraph abstract of the statement.
- "(f) The date by which comments must be received." (40 CFR 1502.11). (Draft EIS only).
- "(g) The name of the responsible official."

2. Summary. (Optional for EA). The responsible official will determine the need for an environmental assessment summary. It is desirable for lengthy and detailed environmental assessments.

"Each environmental impact statement contain a summary which adequately and accurately summarizes the statement. The summary shall stress the major conclusions, areas of controversy (including issues raised by agencies and the public), and the issues to be resolved (including the choice among

alternatives). The summary will normally not exceed 15 pages. (40 CFR 1502.12).

If a summary is distributed as a separate document, it must:

(a) State how the complete EIS or EA can be obtained or reviewed.

(b) Have a cover sheet attached.

3. Table of contents. (Optional for EA). Self-explanatory.

4. Introduction (purpose of and need for action). The introduction briefly describes the nature of the decision to be made. A map showing the general location of the plan or project should be included. Major issues and concerns identified as a result of "scoping" and other essential background information are presented only if important to understanding the decision.

"The statement (or assessment) shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives to the proposed action." (40 CFR 1502.15).

Statements must (and assessments may) " . . . list all Federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. If it is uncertain whether a Federal permit, license, or other entitlement is necessary, the draft environmental impact statement shall and (assessment may) so indicate. " . . .

5. Affected environment. This section is based on the situation analysis and " . . . shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement." (40 CFR 1502.15).

This description should include major factors affecting and affected by the decision—not just those which are within the control of the Forest Service.

6. Evaluation criteria. This section describes the evaluation criteria which were used to evaluate alternatives. The sources of these criteria should be shown. (Also see FSM 1951.3)

7. Alternatives considered. This section is usually in two parts: The first briefly describes the process used in formulating the alternatives; and the second describes each alternative including mitigation measures, management and monitoring requirements, as appropriate.

The alternatives described must include:

(a) " . . . alternatives which were eliminated from detailed study and a brief discussion of the reasons for their having been eliminated.

(b) " . . . reasonable alternatives not within the jurisdiction of the lead agency.

(c) " . . . the alternative of no action . . . " (40 CFR 1502.14).

The detail of description should be similar for all alternatives.

8. Effects of implementation. This section describes consequences of implementing each alternative in term of outputs, costs and environmental changes. Objectivity is important. Significant differences of opinion about the kind, amount or duration of effects should be discussed. (See FSM 1951.6).

The description should (commensurate with the importance of the issue):

(a) Identify the assumptions used in estimating the effects of implementation.

(b) Make use of appropriate analyses, data and information. Cite sources used instead of including lengthy analyses in EA's or EIS's.

(c) Express expected environmental changes in quantitative or qualitative terms as applicable, and as necessary to indicate relative differences between the alternative in terms of significance, duration and magnitude of the changes.

(d) Indicate the expected outputs, in terms of goods, services and uses that will result from implementing each alternative. Express the outputs in Service-wide standard terminology. See FSI 1309.11, Management Information Handbook. Use RPA program planning time periods.

(e) Indicate estimated Forest Service expenditures for implementing each alternative. Other public and private expenditures may be shown, as appropriate.

(f) Discuss significant changes (effects) in physical, biological, economic and social components of the environment associated with implementation of each alternative. This includes direct, indirect, cumulative and unavoidable effects, long- and short-term relationships and irreversible and irretrievable resource commitments. It is not mandatory to use separate headings for these items.

"The agency shall make every effort to disclose and discuss at appropriate points in the draft statement all major points of view on the environmental impacts of the alternatives including the proposed action." (40 CFR 1502.9a)

If analyses of economic efficiency (benefit/cost, etc.) have been made, show the results of the analyses here.

"When an agency is evaluating significant adverse effects on the human environment

in an environmental impact statement (or assessment) and there are gaps in relevant information or scientific uncertainty, the agency shall always make clear that such information is lacking or that uncertainty exists.

"If the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement (or assessment)." (40 CFR 1502.22).

"If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g., the means for obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the action to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst-case analysis and an indication of the probability or improbability of its occurrence." (40 CFR 1502.22b).

9. Evaluation of alternatives. This section discusses how the alternatives compare with each other in terms of the evaluation criteria. This provides the basis for identification of a preferred alternative. (Also see FSM 1951.8.)

"Statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned)." (40 CFR 1508.2d).

10. Identification of the Forest Service preferred alternative. This section identifies the preferred alternative and the rationale for preference. If the preferred alternative has not been identified, this should be clearly stated. (Also see FSM 1951.8).

"When a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision." (40 CFR 1502.23).

11. Consultation with others. Document the methods used to obtain public participation and list the agencies and groups consulted during scoping and other steps in the analysis. Individuals may be listed when appropriate. This discussion should relate to substantive information received and used and not

be directed solely to responses and rebuttals.

"Final environmental impact statements shall respond to comments. The agency shall discuss at appropriate points in the final statement any responsible opposing view which was not adequately discussed in the draft statement and shall indicate the agency's response to the issues raised." (40 CFR 1502.9).

This section of a final EIS should describe how the substantive information contained in the review comments (that are included in the appendix) was used, or not used, in the preparation of the final EIS.

Final environmental impact statements should identify changes in the draft EIS content as a result of substantive review comments. Possible changes are to modify the proposed action; formulate, analyze and evaluate alternatives not previously considered; supplement, improve, or modify analyses, or make factual corrections. In addition, it may be desirable to explain why some comments did not warrant changes in the draft EIS content.

12. Index (optional in E-1). Environmental impact statements must include an index. The purpose of an index is to make the information in the EIS or EA fully available to the reader without delay. See Chapter 300, FSI 1909.15, The NEPA Process Handbook.

13. Appendix. "The appendix shall:

"(a) Consist of material prepared in connection with an Environmental Impact Statement (or assessment) (as distinct from material which is not so prepared and which is incorporated by reference).

"(b) Normally consist of material which substantiates any analysis fundamental to the impact statement (or assessment).

"(c) Normally be analytic and relevant to the decision to be made.

"(d) Be circulated with the environmental impact statement (or assessment) or be readily available on request." (40 CFR 1502.16).

"(e) The EIS appendix shall, and the EA appendix may, "list the names, together with their qualifications (expertise, experience, professional disciplines), of the persons who were primarily responsible for preparing the environmental impact statement or significant background papers, including basic components of the statement. Where possible the persons who are responsible for a particular analysis, including analyses in background papers, shall be identified. Normally the list will not exceed two pages." (40 CFR 1502.17).

Copies of all substantive comments received on a draft EIS should be included in the appendix of the final EIS. If response has been exceptionally voluminous, it may be summarized. Copies, or summaries of all substantive comments should be included in the

**DRAFT ENVIRONMENTAL ASSESSMENT FOR A
DEPARTMENT OF ENERGY
SUBSIDENCE MONITORING PROGRAM
COAL BASIN AREA
GUNNISON AND PITKIN COUNTIES, COLORADO**

December 12, 1980

**Prepared by:
Mine Subsidence Engineering Co.
Collin L. Stewart, Partner
60 Clearwater Dr
Carbondale, Colorado 81623
Telephone: (303) 963-1936**

TABLE OF CONTENTS

TABLE OF CONTENTS.....	ii
LIST OF FIGURES.....	iii
1.0 INTRODUCTION.....	1
1.1 Background Information.....	1
1.2 Purpose for Proposed Action.....	1
1.3 Geographical Area.....	2
1.4 Program Objectives.....	2
1.5 Issues and Concerns.....	4
2.0 AFFECTED ENVIRONMENT.....	4
3.0 EVALUATION CRITERIA.....	6
4.0 ALTERNATIVES CONSIDERED.....	6
4.1 Alternative A - Aerial Photogrammetry.....	6
4.2 Alternative B - Conventional Survey with Road Construction.....	7
4.3 Alternative C - Conventional Survey with Helicopter Access.....	8
5.0 EFFECTS OF IMPLEMENTATION.....	9
5.1 Effects of Alternative A.....	9
5.2 Effects of Alternative B.....	9
5.3 Effects of Alternative C.....	10
6.0 EVALUATION OF ALTERNATIVES.....	10
6.1 Criterion 1: Project Objectives are Best Satisfied.....	10
6.2 Criterion 2: Issues and Concerns are Best Mitigated.....	10
6.3 Criterion 3: Least Cost.....	10
7.0 IDENTIFICATION OF PREFERRED ALTERNATIVE.....	10
8.0 APPENDIX A - Preliminary Archaeological Report.....	A-1

LIST OF FIGURES

Figure 1. Site Location Map.....	3
Figure 2. Affected Environment - Subsidence Monitoring Area.....	5

1.0 INTRODUCTION

1.1 Background Information

Mine Subsidence Engineering Company has been contracted by the Department of Energy to monitor mining-induced surface subsidence above two multiple lift longwall panels at Mid-Continent Resources, Inc. Mine No. 3. Mine Subsidence Engineering Company has specifically contracted to design, install and monitor a subsidence data collection system and to summarize the resulting subsidence data.

Mine Subsidence Engineering Company is applying for a Special Use Permit to allow the construction and monitoring of a subsidence data collection system on National Forest land.

1.2 Purpose for Proposed Action

This study has been initiated by the Department of Energy (DOE) as a part of the Nation's energy program to study mining conditions and associated subsidence characteristics in coal fields throughout the United States.

As the national energy base shifts from oil to coal, vast areas of the United States will be subjected to greater underground mining activity. Increased interest has therefore been generated in the extraction of thick coal seams located in the western United States.

Recent environmental legislation by both the Federal and state governments has placed severe restrictions on mining impacts to the surface environment. One major constraint on the extraction of thick and steeply dipping seams by longwall techniques has therefore been a fear of the consequences of the associated surface subsidence.

At the present time, adequate methods for predicting the characteristics of subsidence and the impact of subsidence on the

surface environment are not well developed for mining environments in the United States. In many European countries, notably the United Kingdom, the area of subsidence prediction has been developed on an empirical basis using extensive subsidence data bases collected over a long period of time. These empirical capabilities are routinely utilized by mine planners to minimize the surface impacts of underground mining.

This study has been initiated as a portion of the DOE's program to collect subsidence data for the development of empirical subsidence prediction models for U.S. mining conditions. This study is unique. It is specifically designed to collect subsidence data from the multiple lift longwall mining of a thick coal seam (25 ft thick) under deep overburden cover (2500 ft thick) in a mining environment that typifies coal fields in the Rocky Mountain region of the western United States.

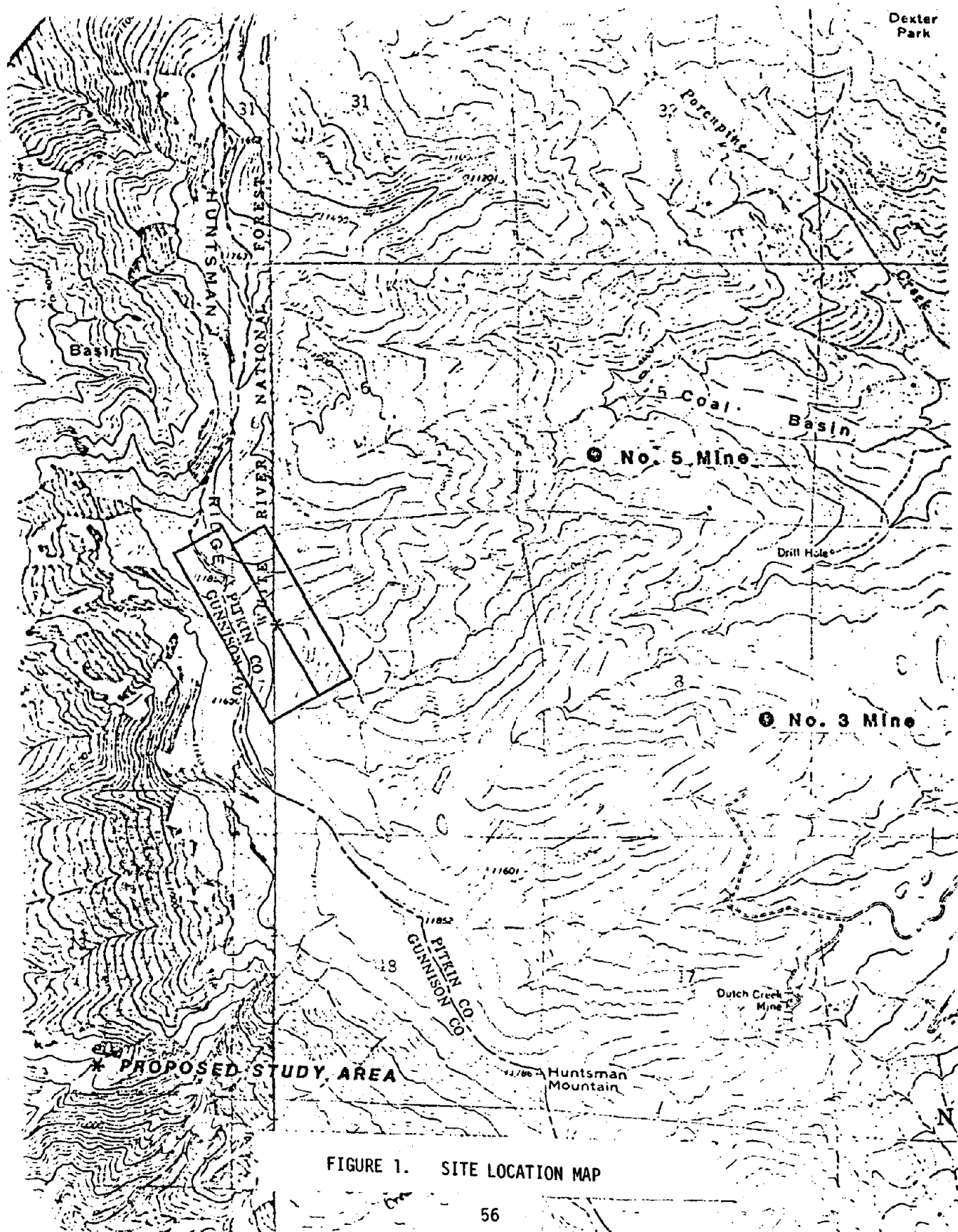
The subsidence data collection system proposed by Mine Subsidence Engineering Company consists of surveying monuments installed in a systematic manner along the ground surface above Mine No. 3. A portion of this ground surface area lies within National Forest lands.

1.3 Geographical Area

The subsidence monitoring site is located in the Coal Basin area near Redstone, Colorado, in Pitkin and Gunnison counties (Figure 1).

1.4 Program Objectives

The following program objectives have been identified:



- 1.4.1 Collect vertical and horizontal subsidence data along the ground surface above the DOE multiple lift demonstration longwall panels 301 and 302
- 1.4.2 Collect the subsidence data within accuracy limits of Third order, Class II surveying
- 1.4.3 Monitor sufficient ground surface area to define the angle of draw
- 1.4.4 Provide at least two surveys of the ground surface for each lift extracted

1.5 Issues and Concerns

The following issues and concerns have been identified:

- 1.5.1 Minimize impact on the surface environment
- 1.5.2 Minimize impact on existing grazing operations

2.0 AFFECTED ENVIRONMENT

The proposed subsidence monitoring area is located along Huntsman Ridge in the Coal Basin area, Pitkin and Gunnison counties, Colorado (Figure 2).

The proposed subsidence monitoring area is located in a very remote and rugged mountainous area. Elevations in the monitoring area vary from approximately 11,000 ft to 12,000 ft.

The proposed monitoring area is partially forested with mature and overmature spruce and fir. Because of the elevation, the trees are not well developed.

Area access is via an existing Mid-Continent drill road and by foot. The drill road extends to within approximately two miles of the

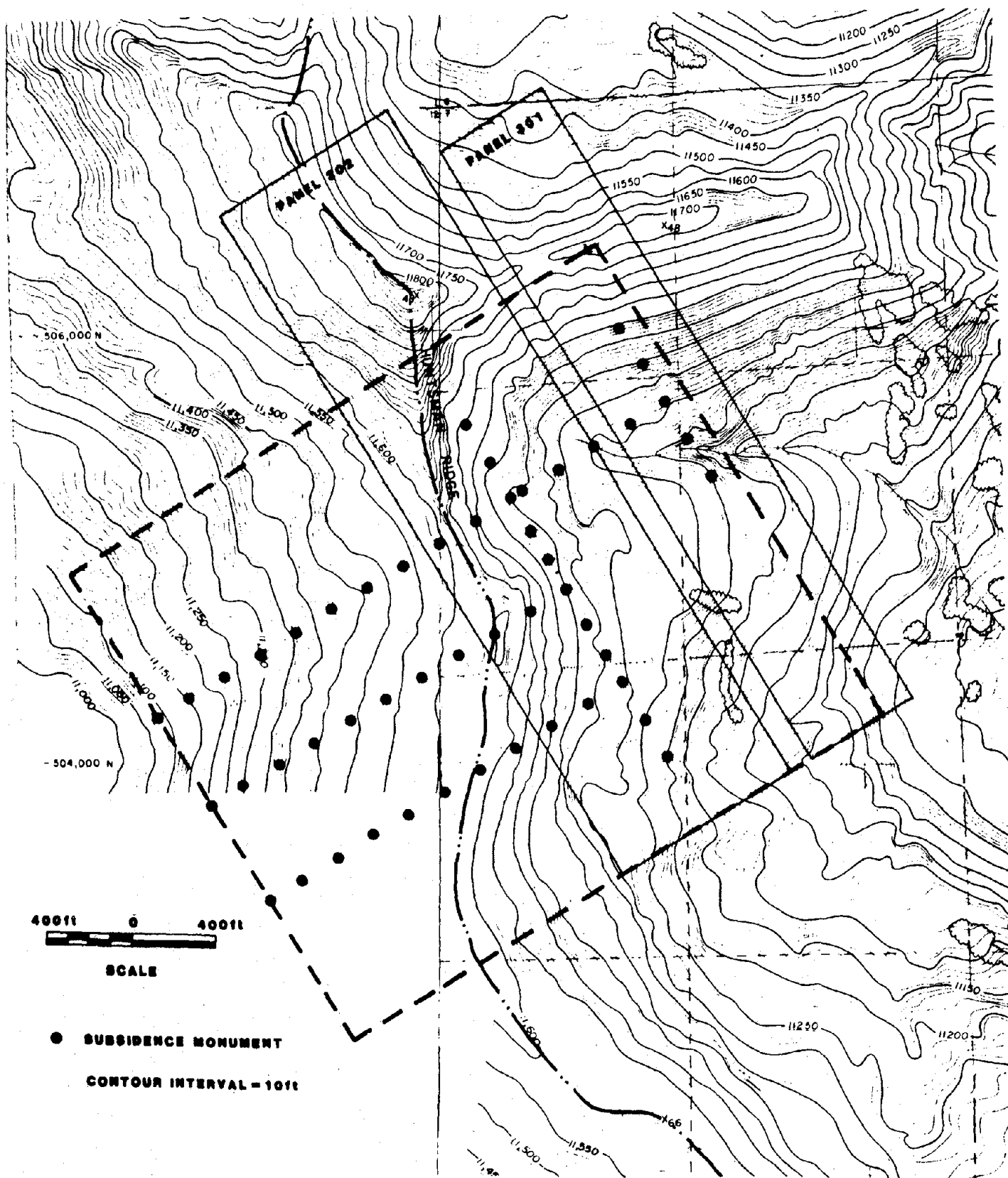


FIGURE 2. AFFECTED ENVIRONMENT - SUBSIDENCE MONITORING AREA

proposed monitoring area. It is planned that helicopters will be used to provide access to the area for survey monument construction and subsequent monitoring.

Current land use is restricted to sheep grazing in the summertime. One permittee presently has use of the area.

An ongoing cultural survey has revealed no significant sites within the proposed monitoring area (See Appendix A for the Preliminary Archaeological Report). An approved, on-site survey will be filed with National Forest personnel prior to the start of any survey monument construction.

3.0 EVALUATION CRITERIA

The evaluation criteria used to select the preferred alternative were:

- 3.1 Program objectives are best satisfied
- 3.2 Issues and concerns are best mitigated
- 3.3 Least cost

4.0 ALTERNATIVES CONSIDERED

The following alternatives were developed in response to the issues, objectives and evaluation criteria:

- 4.1 Alternative A - Aerial Photogrammetry. This alternative includes the following actions and mitigation measures:
 - 4.1.1 Archaeological survey of all ground points where survey monuments will be installed. See Appendix A for Preliminary Archaeological Report.

- 4.1.2 Helicopter access into and out of the site area for all monument construction and surveying
- 4.1.3 Installation of a survey control net
- 4.1.4 Installation of aerial photogrammetry surface control points
- 4.1.5 Installation of surface subsidence/strain monitoring points. These points must be highly visible in aerial photographs
- 4.1.6 Flight missions to obtain aerial photogrammetry one to two times each summer
- 4.1.7 Ground survey of aerial photogrammetry surface control points after each flight mission
- 4.1.8 Ground survey of surface subsidence/strain monitoring points during first two flights to test validity of aerial photogrammetry concept
- 4.1.9 Cutting of trees will be minimized to those that have to be removed to establish surveying monuments and surveying sight lines
- 4.1.10 Removal of all surveying monuments once subsidence monitoring is completed
- 4.2 Alternative B - Conventional Survey with Road Construction. This alternative includes the following actions and mitigation measures:
 - 4.2.1 Construct a road into Huntsman Ridge from the existing U.S. Steel drill road on the west side of the ridge
 - 4.2.2 Archaeological survey of all locations where monuments and roads will be located. See Appendix A for the Preliminary Archaeological Report

- 4.2.3 Helicopter access into and out of the site area for some of the initial work on the survey control net
- 4.2.4 Installation of a survey control net
- 4.2.5 Installation of surface subsidence/strain monitoring points
- 4.2.6 Cutting of trees will be minimized to those that have to be removed to establish surveying monuments and surveying sight lines
- 4.2.7 Ground surveys of surface subsidence/strain monitoring points one to two times each summer
- 4.2.8 Removal of all surveying monuments and restoration of the access road once subsidence monitoring is completed

4.3 Alternative C - Conventional Surveying with Helicopter Access.

This alternative includes the following actions and mitigation measures:

- 4.3.1 Archaeological survey of all locations where surveying monuments will be installed. See Appendix A for Preliminary Archaeological Report
- 4.3.2 Helicopter access into and out of the site area for all monument construction and surveying work
- 4.3.3 Installation of a survey control net
- 4.3.4 Installation of surface subsidence/strain monitoring points
- 4.3.5 Cutting of trees will be minimized to those that have to be removed to establish surveying monuments and surveying sight lines

- 4.3.6 Ground survey of surface subsidence/strain monitoring points one to two times each summer
- 4.3.7 Removal of all surveying monuments once subsidence monitoring is completed

5.0 EFFECTS OF IMPLEMENTATION

5.1 Effects of Alternative A.

- 5.1.1 This is unproven technology in mountainous terrain.
There is a possibility that the subsidence data required by the DOE contract would not be obtained within the required accuracy limits
- 5.1.2 Because of the geometry of underground mining, aerial photogrammetry control monuments would have to be surveyed prior to each airphoto flight mission to insure proper surveying control
- 5.1.3 Subsidence/strain monuments would have to be large enough and distinct enough to be easily visible in aerial photographs
- 5.1.4 Impact on grazing operations would be minimal
- 5.1.5 There would be no lasting impact on the environment
- 5.1.6 Each air photo flight mission will cost approximately \$50,000

5.2 Effects of Alternative B.

- 5.2.1 Approximately three miles of new pioneer road would have to be constructed

- 5.2.2 The pioneer road would have to be reclaimed at the end of the subsidence monitoring program
- 5.2.3 Demonstrated methodology for obtaining both vertical and horizontal subsidence deformation data within Third order, Class II accuracy limits
- 5.2.4 Impact on grazing operations would be minimal
- 5.2.5 Environmental impact should be small

5.3 Effects of Alternative C.

- 5.3.1 Least cost of three alternatives
- 5.3.2 Demonstrated methodology for obtaining both vertical and horizontal subsidence deformation data within Third order, Class II accuracy limits
- 5.3.3 Least environmental impact
- 5.3.4 Impact on grazing operation would be minimal

6.0 EVALUATION OF ALTERNATIVES

6.1 Criterion 1: Project objectives are best satisfied.

Alternatives B and C represent proved methodology for securing the project objectives. Alternative A is an unproven method.

6.2 Criterion 2: Issues and concerns are best mitigated.

Alternatives A and C are considered equal.

6.3 Criterion 3: Least cost.

Alternative C has the least cost.

7.0 IDENTIFICATION OF PREFERRED ALTERNATIVE

Alternative C is selected as the preferred alternative because it was the only alternative that satisfactorily met all three evaluation

criteria. Alternative A was not selected because it represents unproven technology, and still required a large amount of on the ground surveying in addition to the costly air photo flight missions. Alternative B was not selected because it involved the largest environmental impact. Alternative B was also more expensive than Alternative A.

APPENDIX A
PRELIMINARY ARCHAEOLOGICAL REPORT

Prepared by:
Grand River Institute
Grand Junction, Colorado

**Cultural Resources Inventory Preliminary Report
on
A Proposed Subsidence Monitoring Net along Huntsman Ridge
in
The White River and Gunnison National Forests**

**Prepared Under Contract
between
Grand River Institute and Mine Subsidence Engineering Co.**

**GRI/CRI Report No. 8066
21 November 1980**

**U.S. Department of Agriculture
Forest Service
Sopris District, White River National Forest
Paonia District, Gunnison National Forest
Pitkin and Gunnison Counties, Colorado**

Introduction

On 27 September 1980 Grand River Institute was authorized by Mine Subsidence Engineering Company to conduct a cultural resources inventory of the impact area of a proposed subsidence monitoring net located along Huntsman Ridge in both the Gunnison and White River National Forests. The project area is located in:

T.10S., R.90W., 6th P.M.

Section 1	E $\frac{1}{2}$	(Gunnison National Forest,
Section 12	E $\frac{1}{2}$	Gunnison County)

T.10S., R.89W., 6th P.M.

Section 6	W $\frac{1}{2}$	(White River National Forest,
Section 7	W $\frac{1}{2}$	Pitkin County)

Special Use Permits from both Forest Districts concerned have been obtained, but early snows have precluded the actual pedestrian survey. It is our intention to perform this survey as soon as the ground is clear and to then complete a detailed archaeological report for the project area. This report will be submitted to the appropriate federal agencies for approval prior to any construction work by Mine Subsidence Engineering Co.

Known Cultural Resources

Because of its high elevation (> 11,000 feet) and harsh, extended winters, it is doubtful that the study area was occupied/utilized prehistorically except on a seasonal basis, perhaps for hunting or as an access route. Historically, the area has been used for summer grazing of livestock (primarily sheep). A search of the Colorado Archaeological Site Inventory, the Colorado Inventory of Historic Sites, and nominations pending or on the National Register, however, produced no known archaeological and/or historical/architectural resources in the project area (see Files Search documentation, attached). A survey of other lands along Huntsman Ridge

proposed for coal development by Mid-Continent Resources was performed by Grand River Institute personnel in October 1979, but this inventory revealed no archaeological or historical resources (see GRI/CRI Report Nos. 7962(a) and 7962(b), on file at the Paonia and Sopris Forest District Offices). Therefore, while it is possible that significant cultural materials from both the Prehistoric and Historic periods are present in the study area, indications are that it is unlikely. If any are encountered, however, during the pedestrian survey, they might prove valuable in their contribution to the rather meager high altitude archaeology data base.

Studies concerning the regional prehistory include:

- 1) Hibbets et al.'s (1979) work in the coal-producing areas of west central Colorado and Reed and Scott's (1980) work in the Gunnison and Uncompahgre Resource Areas, which identified manifestations of Archaic, Fremont, and Ute cultures;
- 2) Baker et al.'s (1980) work on the Mt. Emmons project which produced evidence of occupation as early as 8000 B.C. (Paleo-Indian);
- 3) Buckles' (1971) work on the Uncompahgre which identified 12 phases of the 'Uncompahgre Complex' dating from 5000 B.C. to A.D. 1880;
- 4) reports of excavations and surveys in northeastern Utah and northwestern Colorado by Wormington (1955), Wormington and Lister (1956), and Breternitz (1965 and 1970), which establish cultural materials from Paleo-Indian, Archaic, Fremont, Anasazi, Ute, and Historic Euro-American peoples in the region; and
- 5) Jesse D. Jennings' "Prehistory of Utah and the Eastern Great Basin" (Jennings 1978), which describes cultural materials from the Desert Archaic, Anasazi, Fremont, Shoshoni, and Navajo.

This body of literature suggests that West Central Colorado was influenced by regional variations of the Desert Archaic (Uncompahgre Complex), the Fremont, and the Ute, and that these people may have been present in or near the study area.

References

- Baker, Steven G.; Black, Kevin D.; Horvath, Steven M.; Kvamme, Kenneth L.; Mode, Wm., N.; Schroedl, Alan; and Sullenberger, Martha A.
1980 Baseline Cultural Resource Surveys and Evaluations in Primary Impact Areas of the Mount Emmons Project: 1978 and 1979 Field Seasons. (Heritage Resource Study Series for the Mount Emmons Project of Amax, Inc., Gunnison County, Colorado, Vol. 1). Report prepared by Centuries Research Inc., Montrose.
- Breternitz, David A.
1965 Archaeological survey in Dinosaur National Monument, Colorado-Utah, 1963. Report submitted to National Park Service, Midwest Region, Omaha.

1970 Archaeological Excavations in Dinosaur National Monument, Colorado-Utah, 1964-1965. University of Colorado Studies, Series in Anthropology, No. 17, Boulder.
- Buckles, William G.
1971 The Uncompahgre Complex: Historic Ute Archaeology and Prehistoric Archaeology on the Uncompahgre Plateau in West Central Colorado. Ph.D. dissertation, Department of Anthropology, University of Colorado. University Microfilms, Ann Arbor.
- Conner, Carl E. and Langdon, Diana L.
1979 Cultural resources inventory report of a proposed mining access road in White River National Forest, GRI/CRI Report No. 7962(a), and Cultural resources inventory report of five proposed drill hole locations and related access roads in Gunnison National Forest, GRI/CRI Report No. 7962(b). Reports prepared for Mid-Continent Resources, Inc. Grand River Institute, Grand Junction.
- Hibbets, Barry N.; Grady, James; Halasi, Judith A.; and Huse, Hannah
1979 Final report of an archaeological survey of the west central Colorado coal leases: Volume 1 -- settlement analysis. Report prepared for the Bureau of Land Management, Grand Junction District Office. Archaeological Associates, Inc., Boulder.

Jennings, Jesse D.

1978 Prehistory of Utah and the Eastern Great Basin. University of Utah Anthropological Papers, No. 98, Salt Lake City.

Reed, Alan D. and Scott, Douglas D.

1980 The archaeological resources of the Uncompahgre and Gunnison resource areas, West Central Colorado. Report prepared by the Bureau of Land Management, Montrose.

Wormington, H. M.

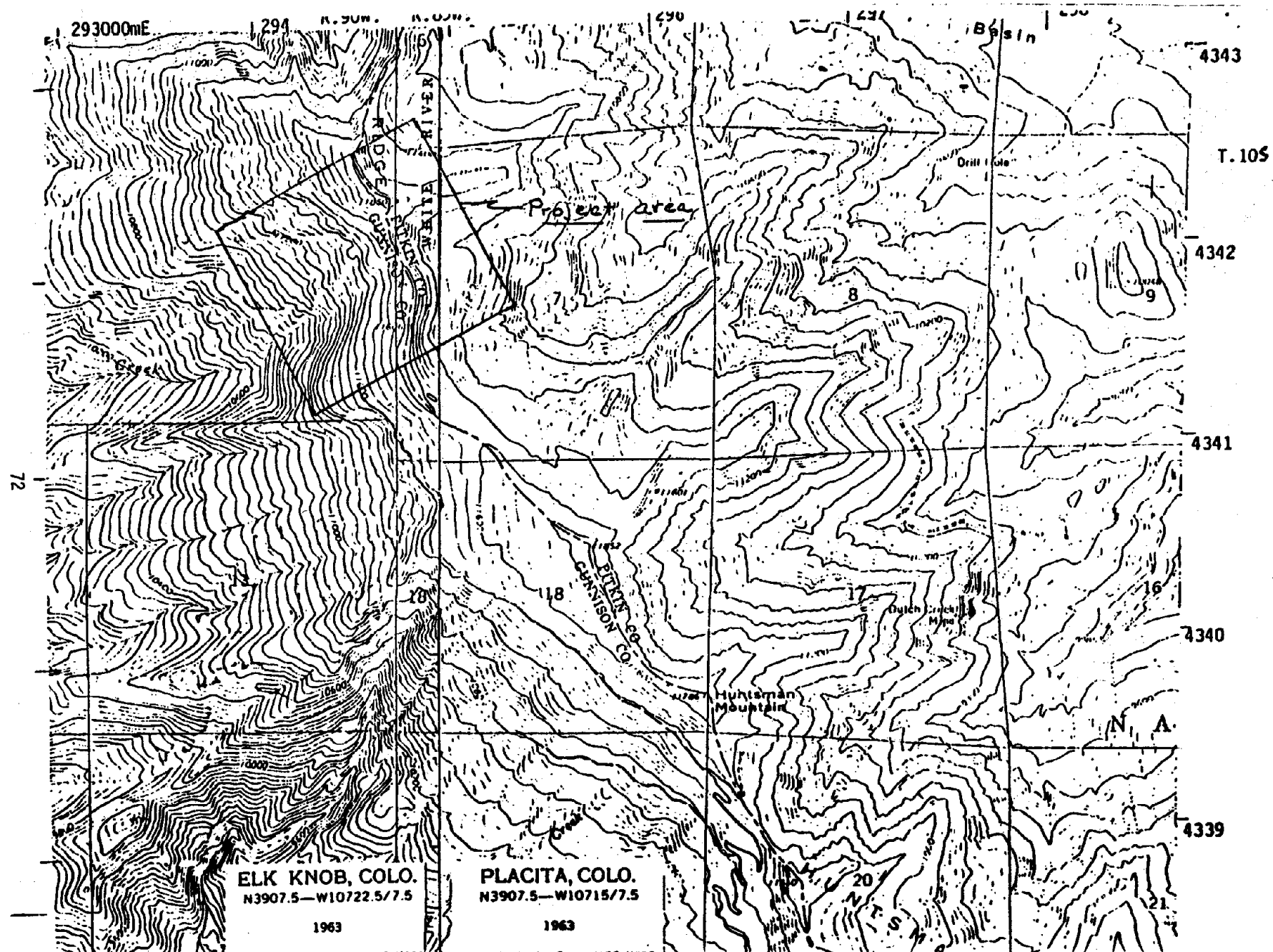
1955 A Reappraisal of the Fremont Culture with a Summary of the Archaeology of the Northern Periphery. Denver Museum of Natural History Proceedings, No. 1.

Wormington, H. M. and Lister, Robert H.

1956 Archaeological Investigations on the Uncompahgre Plateau in Western Colorado. Denver Museum of Natural History Proceedings, No. 2.

Attachments

- 1. Map showing project area.**
- 2. Copy of request for files search.**
- 3. Copy of response to files search request.**



SITE FILE SEARCH REQUEST



1300 Broadway
Denver, CO 80203
303-839-3391, 2.3

township	range	sections							
1 0 S	18 9 W	16	17						
1 0 S	19 0 W	11	12						

FOR EXAMPLE AND

FOR COUNTY ABBREVIATIONS SEE OTHER SIDE

THIS REQUEST WILL NOT BE HONORED UNLESS ALL INFORMATION BELOW IS COMPLETED

AUTHORIZED SIGNATURE: Carl E. Conner DATE: 9/29/80

NAME: Carl E. Conner TITLE: Administrative Director
print or type

ORGANIZATION: Grand River Institute DIVISION: _____

ADDRESS: 1030 Colorado Avenue
number/street or P.O. Box

Grand Junction Colorado 81501
city state ZIP

LEAD GOVERNMENT AGENCY: U.S. Forest Service

PROJECT TITLE AND NUMBER: Subsidence Monitoring, Huntsman Ridge

YOUR REFERENCE NUMBER (purchase order, etc.) GRI/CRI No. 8066

REASON FOR REQUEST: Cultural resources inventory for Mine Subsidence Engineering Co.

REMARKS: _____

PLEASE PHOTOCOPY THIS FORM FOR YOUR FUTURE USE

MAIL TO: OFFICE OF THE STATE ARCHAEOLOGIST, 1300 BROADWAY, DENVER, COLORADO 80203

ATTN: SITE FILE INVENTORY



COLORADO HISTORICAL SOCIETY

The Colorado Heritage Center 1300 Broadway Denver, Colorado 80203

CO	T	R	S
PT	10S	89W	6,7
GN	10S	90W	1,12

Date Received 02 October 1980

Date Responded 07 October 1980

At your request this office has conducted a search of the Colorado Archaeological Site Inventory and the Colorado Inventory of Historic Sites, as well as nominations pending or on the National Register of Historic Places.

The result of this file search is indicated below:

- (x) There are no known (x) Archaeological and/or (x) Historical/Architectural resources in the impact area of the proposed undertaking.
- *() Information regarding previously documented resources in these areas is attached. These resources have not been evaluated for inclusion in the National Register. However, they must be considered to be Eligible for inclusion in the National Register until a formal determination has been completed.
- *() Information regarding cultural resources pending nomination to or on the National Register of Historic Places in the proposed project area is attached.

Our files are incomplete in this area as the vast majority of Colorado has not been inventoried. There is always the possibility that as yet unidentified Cultural Resources exist within the proposed impact area.

Therefore, the federal agency is required to conduct a professional survey to Identify any Eligible Cultural Resources in the proposed project area.

We anticipate consultation with this office regarding the Effect of the proposed project on any Eligible resource in accordance with the Advisory Council Procedures for the Preservation and Protection of Historic and Cultural Resources (36 CFR 800).

Please provide this office with the results of the survey for our review of professional adequacy and compliance.

Arthur C. Townsend
State Historic Preservation Officer

Howard J. Pomerantz
Acting State Archaeologist

*Information regarding significant archaeological resources is excluded from the Freedom of Information Act. Therefore, legal locations of these resources must not be included for public distribution.

APPENDIX C
CULTURAL RESOURCES SURVEY

**Cultural Resources Inventory Report
on
A Proposed Subsidence Monitoring Net and Related Control Stations
Along Huntsman Ridge
in
Gunnison National Forest**

**Prepared Under Contract
between
Mine Subsidence Engineering Company and Grand River Institute**

**GRI/CRI Report No. 8066
9 July 1981**

**United States Department of Agriculture
Forest Service
Paonia Ranger District
Gunnison National Forest
Gunnison County, Colorado**

A cultural resources inventory of a mine subsidence monitoring net and a related control station proposed for emplacement along Huntsman Ridge on lands administered by the National Forest was conducted by Grand River Institute personnel at the request of Mine Subsidence Engineering Company of Carbondale, Colorado. The study area is located in T.10S., R.89W., Sections 6 and 7, and T.10S., R.90W., Sections 1 and 12, 6th P.M. A search of the Colorado Archaeological Site Inventory, the Colorado Inventory of Historic Sites, and nominations pending or on the National Register produced no known archaeological and/or historical/architectural resources in the vicinity of the proposed project. A 100-percent pedestrian survey of the study area performed by Carl E. Conner (Project Archaeologist) and Danni L. Langdon on 1 and 25 June 1981 identified archaeological site 5PT293 in a saddle area of Huntsman Ridge approximately 500 feet south of the northernmost survey control station. The site was mapped and photographed and will be avoided by Mine Subsidence Engineering Company activities. An isolated find, 5GN1570, was also identified in the study area but it too will be avoided. A determination of no adverse effect is recommended.

Carl E. Conner 7/9/81
Carl E. Conner Date
Project Archaeologist

Clifton M. Wignall 7/9/81
Clifton M. Wignall Date
Principal Investigator

Table of Contents

	Page no.
INTRODUCTION	1
LOCATION OF STUDY AREA	1
ENVIRONMENTAL OVERVIEW	3
Topography/Geology/Soils	3
Modern Climate and Biota	4
General Environmental Assessment	4
KNOWN CULTURAL RESOURCES	5
RESEARCH RATIONALE	6
FIELD METHOD	6
SURVEY RESULTS AND RECOMMENDATIONS	6
REFERENCES	8
Appendix A (Documentation of Files Search)	9
Appendix B (OSAC Site and Isolated Find Forms)	12
 FIGURE 1. Project area map	 2

INTRODUCTION

A cultural resources inventory of a mine subsidence monitoring net and a related survey control station proposed for emplacement within the Gunnison and White River National Forests was conducted 1 and 25 June 1981 for Mine Subsidence Engineering Company at the request of the U.S. Department of Agriculture Forest Service. The survey was effected in compliance with Executive Order 11593, the National Environmental Policy Act of 1969, and the National Historic Preservation Act of 1966. Fieldwork was performed by Carl E. Conner (Project Archaeologist) and Danni L. Langdon of Grand River Institute.

LOCATION OF STUDY AREA

The locations of the proposed mine subsidence monitoring net and the related survey control station occurring within the Forest Service Boundary are described as follows (see Figure 1):

Monitoring net:

T.10S., R.89W., Section 7, W $\frac{1}{2}$, and
T.10S., R.90W., Section 12, E $\frac{1}{2}$, 6th P.M.

Control station #2:

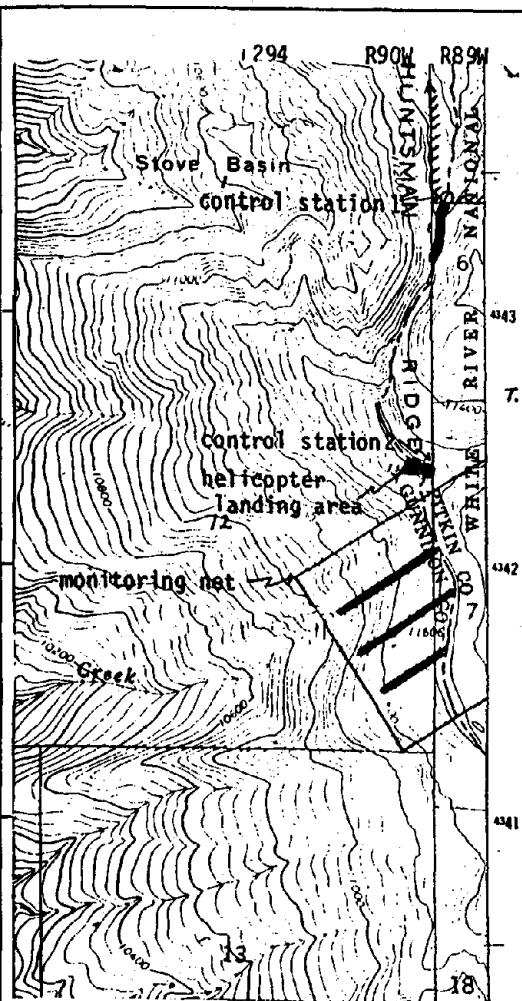
T.10S., R.90W., Section 12, NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$, 6th P.M.

A second survey control station (#1) was originally staked on Forest Service land but, because of its proximity to archaeological site 5PT293, it was moved 400-500 feet north (up the ridge) onto Mid-Continent property. Its relocated position is described as follows (see Figure 1):

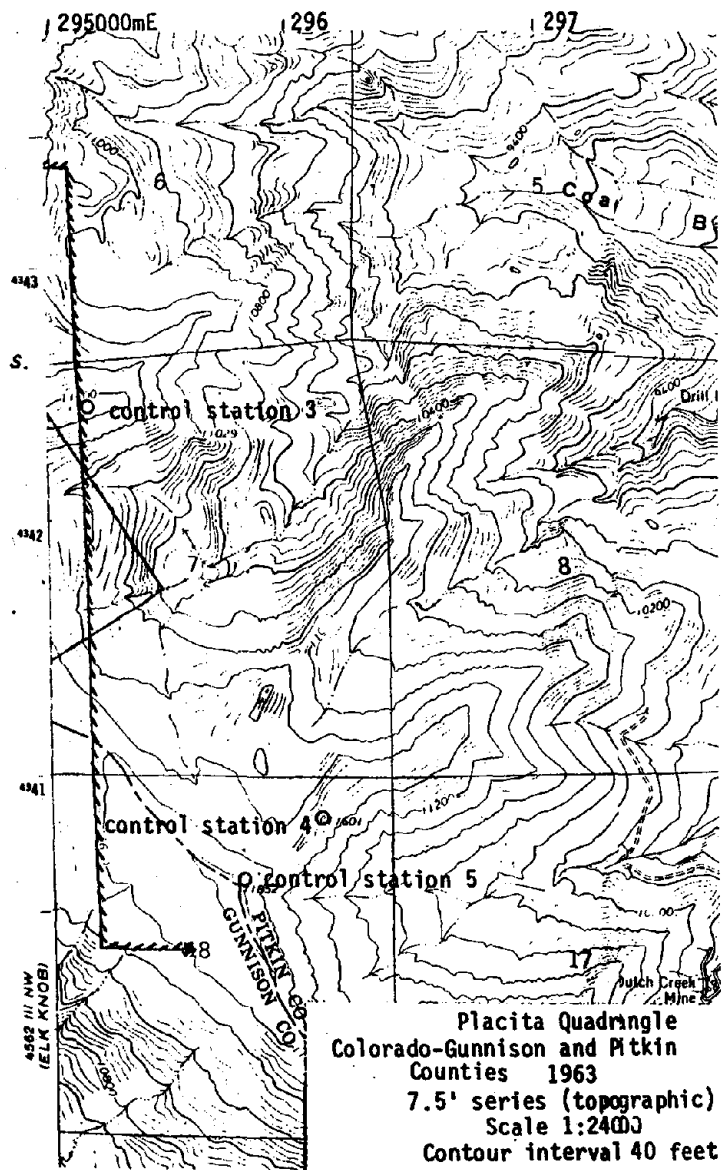
Control station #1:

T.10S., R.89W., Section 6, SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$, 6th P.M.

Three other control stations were inspected on 1 June 1981 but their actual locations were subsequently determined to be on lands owned by



Elk Knob Quadrangle
 Colorado-Gunnison and Pitkin Counties
 1963
 7.5' series (topographic)
 Scale 1:24000
 Contour interval 40 feet



Placita Quadrangle
 Colorado-Gunnison and Pitkin Counties
 1963
 7.5' series (topographic)
 Scale 1:24000
 Contour interval 40 feet

Cultural resources inventory report on a proposed subsidence monitoring net and related control stations along Huntsman Ridge in Gunnison National Forest. Private land (Mtl-Continent) is shown thusly (////). Areas surveyed for cultural resources are highlighted in yellow.

Mid-Continent Coal Company. Locations of these stations are described as follows (see Figure 1):

Control station #3:

T.10S., R.89W., Section 7, NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$, 6th P.M.

Control station #4:

T.10S., R.89W., Section 18, SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$, 6th P.M.

Control station #5:

T.10S., R.89W., Section 18, C SW $\frac{1}{4}$ NE $\frac{1}{4}$, 6th P.M.

Access to the study area is gained by traveling south from Carbon-dale, Colorado on Highway 133 to the coke ovens at Coal Creek (opposite Redstone). The study area lies to the west along Huntsman Ridge, which demarcates the upper boundary of the Coal Creek drainage.

ENVIRONMENTAL OVERVIEW

Topography/Geology/Soils

The study area lies atop Huntsman Ridge, within an elevation range of 11,000 to 11,800 feet. Slope on the east side of the ridge is generally quite steep, up to 66%; slope on the west side is gentler, 20-30%. The headwaters of several creeks occur just below the top of the ridge -- those flowing to the west are tributary to Clear Fork, while those draining to the east empty into Coal Creek and the Crystal River.

Underlying the study area is the Upper Cretaceous age Mesa Verde formation, which consists of sandstone, shale and, of course, coal deposits. (The proposed monitoring net is being emplaced to monitor possible ground subsidence resulting from the extensive coal mining operations of Mid-Continent Coal Company.) These deposits yield soils which are tan, sandy, and contain much broken rock debris. Soil depth is estimated at 2-15cm along the top of Huntsman Ridge, somewhat greater on the treed slopes below.

Modern Climate and Biota

The climate of the study area is characterized by long, cold winters and short, cool summers. Average annual temperature is around 30° F. Annual precipitation averages between 25 to 45 inches, with more than two-thirds falling as snow. Much of the ridge was still under snow on 1 June of this year, but only small patches remained by the 25th. The optimum growing season for native plants is 1 July to 15 August.

The upper elevations of the study area are vegetated with tufted alpine grasses, forbs, and scattered spruce and fir. Lower slopes exhibit dense stands of evergreen, scattered shrubs, and grasses. Near springs and creeks, sedges and shrubs are found in greater abundance. Ground cover is approximately 30-50%.

Faunal sign indicated use of the Huntsman Ridge area by elk and mule deer. Other mammal species known to utilize this habitat are snowshoe hare, marmot, weasel, pika, mountain lion, and coyote. The area is also grazed by domestic sheep.

General Environmental Assessment

Because of its rather harsh, extended winters, it is likely that the study area would have been attractive to prehistoric peoples only during the summer months. At this time of year, temperatures are tolerable, water is readily available from snow melt, and there is a plethora of edible berries and plants at lower elevations. Also, during the summer, wildlife migrate to the upper slopes to graze; elk were seen within 300 feet of the study area at the time of survey.

Aside from slab sandstone, no lithic source materials were observed in the study area. However, the Crystal River (~ 4 miles east) provides many cobbles of various materials, while chert nodules may be found in outcrops of the Morrison Formation (~ 3 miles east).

KNOWN CULTURAL RESOURCES

A search of the Colorado Archaeological Site Inventory, the Colorado Inventory of Historic Sites, and nominations pending or on the National Register of Historic Places, produced no known archaeological and/or historical/architectural resources in the impact area of the proposed monitoring net/control station (see Appendix A for documentation of files search). A survey of adjacent Forest Service lands along Huntsman Ridge conducted by Grand River Institute for Mid-Continent Resources, Inc. in 1979 revealed no cultural resources (Conner and Langdon 1979).

Regionally, studies have been conducted by Hibbets et al. (1979), Nickens et al. (1980), and Gooding (in progress). As part of their archaeological survey of the west-central Colorado coal leases, Hibbets et al. surveyed two transects within 20 miles of our study area -- Transect 9B, 5039 acres in T.12S., R.91W., and Transect 9A, 1440 acres in T.13S., R.92W. The first yielded a prehistoric site density of .0006/acre, the second a density of .0007/acre.

Nickens et al. performed a Class II inventory of the Glenwood Springs Resource Area, within 20 miles of our study area. They predict that the higher altitudes (spruce-fir, aspen, and mountain grassland strata) will generally yield less than 5% of the area's cultural resources and that these will likely be limited activity and short-term camping sites.

A high-altitude excavation at Vail Pass by the Colorado Department of Highways (Gooding, in progress) produced cultural materials dating from 7320 to 200 years B.P. Cultural horizons represented include Early Archaic, McKean Technocomplex, Late Plains Archaic, Woodland, Upper Republican, and Late Prehistoric.

Other studies concerning the regional prehistory include Reed and Scott's (1980) work in the Gunnison and Uncompahgre Resource Areas, which identifies manifestations of Archaic, Fremont, and Ute cultures; Baker

et al.'s (1980) work on the Mount Emmons project which produced evidence of occupation as early as 8000 B.C. (Paleo-Indian); and Buckles' (1971) work on the Uncompahgre which identified twelve phases of the 'Uncompahgre Complex' dating from 5000 B.C. to A.D. 1880. This body of literature suggests that west central Colorado was influenced by regional variations of the Desert Archaic (Uncompahgre Complex), the Fremont, and the Ute, and that these people may have been present in or near the study area.

RESEARCH RATIONALE

Because there is so little known about both the archaeology of this geographic area and that of high altitudes in general, the search for archaeological sites in this region is scientifically imperative for the development of a comprehensive data base for western Colorado.

FIELD METHOD

A Class III inventory of the proposed monitoring net was made by walking each of the three lines (see Figure 1) in a zigzag pattern which extended 50 feet to either side of the flagged centerline. Survey control stations were inspected in a spiral pattern to a diameter of 50 feet. Where necessary, helicopter landing areas were surveyed in parallel transects spaced at 10-foot intervals. Suspect areas within 50-100 feet of the areas just described were also intensively inspected. Approximately 8.5 acres were surveyed for cultural resources.

SURVEY RESULTS AND RECOMMENDATIONS

With the exception of one isolated find, the proposed monitoring net area was found to be free of cultural materials. The isolated find (5GN1570) consisted of a grey chert interior flake and a unifacial mano fragment of diorite. Descriptions of these artifacts and their location can be found in Appendix B (OSAC Site and Isolated Find Forms). The

isolated find will be avoided by Mine Subsidence Engineering Company's activities.

An archaeological site, 5PT293, was identified in a saddle of Huntsman Ridge approximately 500 feet south of the present location of Control Station #1. (This site was found during inspection of the original location of Station #1 approximately 400-500 feet south of the station's present location. The station was subsequently moved to its present location on Mid-Continent property to avoid the resource.) Covering an area of ~7200 sq. meters, the site consists of a scatter of 30 chipped and ground stone artifacts of various materials, including chert, chalcedony, obsidian, and sandstone. Tools present include scrapers, knives, and grinding/milling stones, indicating use of the site as a seasonal campsite. No features or chronologically diagnostic artifacts were observed. The site was mapped and photographed; no collection was made. (See Appendix B for OSAC site form and photographs.)

Evidence of subsurface cultural deposits has been revealed in several places by sheet wash, and it was felt that a trowel or shovel test was unnecessary to verify the presence of such. Because of the probability that these cultural deposits will yield additional information important to the prehistoric use of high altitude sites in Colorado and because the site appears to possess integrity of location and association (36CFR60.6d), it is considered potentially eligible to the National Register of Historic Places. A final determination of eligibility must await test excavation.

It is recommended that such a determination be made as soon as possible. By moving Control Station #1 north (up the ridge) 400-500 feet onto private land, Mine Subsidence Engineering Company has avoided site 5PT293, thus mitigating any direct adverse effects; however, because the presence of the site is now known to a number of people and pedestrian traffic in the area is expected to increase, the site will undoubtedly suffer secondary adverse affects.

REFERENCES

- Baker, Steven G.; Black, Kevin D; Horvath, Steven M.; Kvamme, Kenneth L.; Mode, William N.; Schroedl, Alan; and Sullenberger, Martha A.
1980 Baseline cultural resource surveys and evaluation in primary impact areas of the Mount Emmons project: 1978 and 1979 field seasons. Heritage Resource Study Series for the Mount Emmons Project of Amax, Inc. Gunnison County, Colorado, Vol. I. Centuries Research, Inc., Montrose.
- Buckles, William G.
1971 The Uncompahgre Complex: Historic Ute Archaeology and Prehistoric Archaeology on the Uncompahgre Plateau in West Central Colorado. Ph.D. dissertation, Department of Anthropology, University of Colorado. University Microfilms, Ann Arbor.
- Conner, Carl E. and Langdon, Danni L.
1979 Cultural resources inventory report of 5 proposed drill hole locations and related access roads in Gunnison National Forest. Report prepared for Mid-Continent Resources, Inc. and submitted to the Gunnison National Forest. GRI/CRI Report No. 7962. Grand River Institute, Grand Junction.
- Gooding, John
In progress The archaeological excavation of Vail Pass Camp. State of Colorado Department of Highways Project No. 1 70-2 (19).
- Hibbets, Barry N.; Grady, James; Halasi, Judith A.; and Huse, Hannah
1979 Final report of an archaeological survey of the west central Colorado coal leases: Volume 1 - settlement analysis. Report prepared for the Bureau of Land Management, Grand Junction District Office. Archaeological Associates, Inc., Boulder.
- Nickens, Paul R.; Burgess, Robert J.; Kvamme, Kenneth L.; Reed, Alan D.; and Tucker, Gordon C., Jr.
1980 Class II Cultural resource inventory of the Glenwood Springs Resource Area, Grand Junction District, Colorado (DRAFT). Report submitted to the Bureau of Land Management, Grand Junction District. Nickens and Associates, Montrose.
- Reed, Alan D. and Scott, Douglas D.
1980 The archaeological resources of the Uncompahgre and Gunnison resource areas, West Central Colorado. Report prepared by the Bureau of Land Management, Montrose.
- U.S.G.S. topographic maps, 7.5' series
1963 "Elk Knob, Colorado"
1963 "Placita, Colorado"

Appendix A
(Documentation of Files Search)

Project No. GRI364



**COLORADO
HISTORICAL
SOCIETY**

CO	T	R	S
PT	10S	89W	6,7
GN	10S	90W	1,12

The Colorado Heritage Center 1300 Broadway Denver, Colorado 80203

Date Received 02 October 1980

Date Responded 07 October 1980

At your request this office has conducted a search of the Colorado Archaeological Site Inventory and the Colorado Inventory of Historic Sites, as well as nominations pending or on the National Register of Historic Places.

The result of this file search is indicated below:

- (x) There are no known (X) Archaeological and/or (X) Historical/Architectural resources in the impact area of the proposed undertaking.
- *() Information regarding previously documented resources in these areas is attached. These resources have not been evaluated for inclusion in the National Register. However, they must be considered to be Eligible for inclusion in the National Register until a formal determination has been completed.
- *() Information regarding cultural resources pending nomination to or on the National Register of Historic Places in the proposed project area is attached.

Our files are incomplete in this area as the vast majority of Colorado has not been inventoried. There is always the possibility that as yet unidentified Cultural Resources exist within the proposed impact area.

Therefore, the federal agency is required to conduct a professional survey to Identify any Eligible Cultural Resources in the proposed project area.

We anticipate consultation with this office regarding the Effect of the proposed project on any Eligible resource in accordance with the Advisory Council Procedures for the Preservation and Protection of Historic and Cultural Resources (36 CFR 800).

Please provide this office with the results of the survey for our review of professional adequacy and compliance.

Arthur C. Townsend
State Historic Preservation Officer

Howard J. Pomerantz
Acting State Archaeologist

*Information regarding significant archaeological resources is excluded from the Freedom of Information Act. Therefore, legal locations of these resources must not be included for public distribution.

Form No. 011 rev 06/80
File Search Request

OFFICE OF THE STATE ARCHAEOLOGIST

SITE FILE SEARCH REQUEST



1300 Broadway
Denver, CO 80203
303-439-3391, 2, 3

county	township	range	sections									
P, T	1, 0, S	18, 9, W	16	17								
G, N	1, 0, S	19, 0, W	11	12								

FOR EXAMPLE AND

FOR COUNTY ABBREVIATIONS SEE OTHER SIDE

THIS REQUEST WILL NOT BE HONORED UNLESS ALL INFORMATION BELOW IS COMPLETED

AUTHORIZED SIGNATURE: Carl E. Conner DATE: 9/29/80

NAME: Carl E. Conner TITLE: Administrative Director
print or type

ORGANIZATION: Grand River Institute DIVISION: _____

ADDRESS: 1030 Colorado Avenue
number/street or P.O. Box

Grand Junction Colorado 81501
city state ZIP

LEAD GOVERNMENT AGENCY: U.S. Forest Service

PROJECT TITLE AND NUMBER: Subsidence Monitoring, Huntsman Ridge

YOUR REFERENCE NUMBER (purchase order, etc.) GRI/CRI No. 8066

REASON FOR REQUEST: Cultural resources inventory for Mine Subsidence Engineering Co.

REMARKS: _____

PLEASE PHOTOCOPY THIS FORM FOR YOUR FUTURE USE

MAIL TO: OFFICE OF THE STATE ARCHAEOLOGIST, 1300 BROADWAY, DENVER, COLORADO 80203
ATTN: SITE FILE INVENTORY

Appendix B
(OSAC Site and Isolated Find Forms)



INVENTORY RECORD

IMPORTANT: COMPLETE THIS SHEET FOR EACH
RESOURCE PLUS EITHER AN ARCHAEOLOGICAL OR
HISTORICAL/ARCHITECTURAL COMPONENT FORM.

NOT FOR FIELD USE	
___	DET. ELIG.
___	DET. NOT ELIG.
___	NOMINATED
___	LISTED, DATE

I. IDENTIFICATION: 1)Resource No. 5PT293 2)Temp. No. 8066-1

3)Resource Name Huntsman Ridge Site 4)Project Name Mine Subsidence Eng. Co./
Mid-Continent Coal Mine

5)Category: Arch. Site X, Hist./Archit. Structure , Hist./Archit. District .

6)(For Arch. site)In a District:yes no X;Name

II. LOCATION: 7)Township 10S.; Range 89W.; W₂ of W₂ of NW 1/4 of SW 1/4 of
Section 6; P.M. 6th. 8)County Pitkin and Gunnison

9)USGS QUAD Elk Knob, Colorado; 7.5 x 15; Date 1963 Attach photocopy
portion of Quad. Clearly show site. 10)Other maps

11)Dimensions 120 (N-S) x 60 (E-W) m 12)Area 7200 sq.m(+4047=) 1.8 acres

13)UTM Reference: (One UTM centered on resource may be given for resource under 10 acres.)

A. 1, 3, 2, 9, 4, 7, 6, 5 mE; 4, 3, 4, 2, 9, 8, 0 mN. B. mE; mN.

C. mE; mN. D. mE; mN.

14)Address Huntsman Ridge Lot Block Addition
Potentially eligible

III. MANAGEMENT DATA: 15)Field Assessment: Eligible Not Eligible Need Data X

16)Owner/Address USFS - White River and Gunnison

17)Gov't Involvement: County State Federal X Private : Agency USFS

18)Disturbance: none light X moderate heavy total ; Explain Sheep grazing: some
amateur collecting.

19)Threats to Resource: Water Erosion X Wind Erosion X Animal Activity X Neglect Vandalism
Recreation Construction ; Comments

20)Management Recommendations Avoid until collected and subsurface tested

V. REFERENCE: 21)State/Fed. Permit Nos. 80-CO-106

22)Photo Nos. 8066-1-#9-20, 8066-2-#0A-9A, on file at Grand River Institute

23)Report Title GRI/CRI No. 8066 - Mine Subsidence Monitoring Net above Mid-Continent

24)Recorder Carl E. Conner, Danni L. Langdon 25)Recording Date 6/25/81 Mine

26)Recorder Affiliation Grand River Institute 27)Phone No. 245-7868

V. SKETCH MAP: Map all features and show the boundaries of the resources. Show all major topographic features, permanent modern features, and vegetation zones as appropriate. Give names of features, streets and addresses if known. Provide scale, key and direction.

scale:

key:

See attached map.



true _____

mag. _____

28) Location/Access:

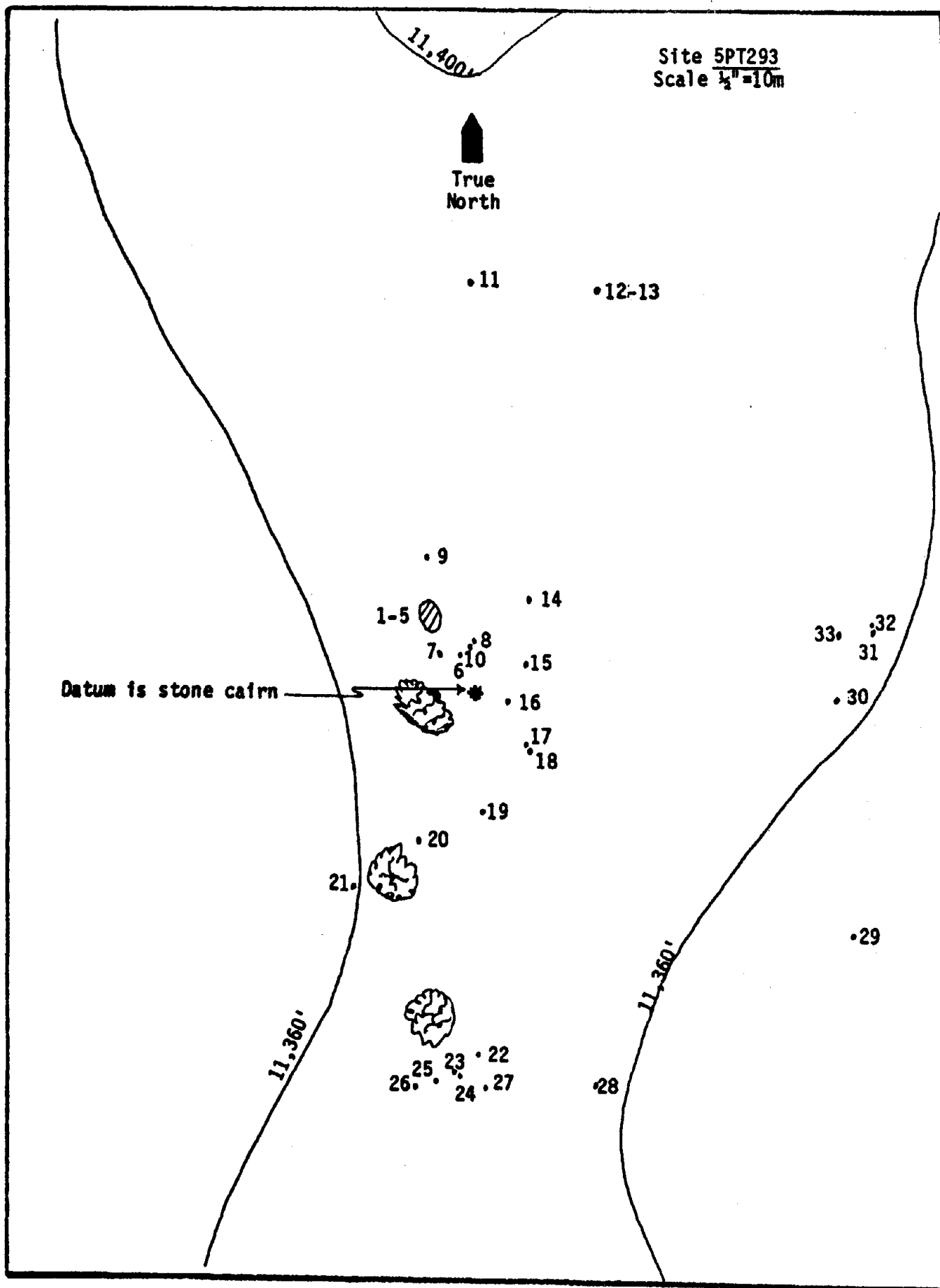
Access is gained by traveling south from Carbondale on Highway 133 to the coke ovens at Coal Creek (opposite Redstone). The site lies to the west in a saddle atop Huntsman Ridge.

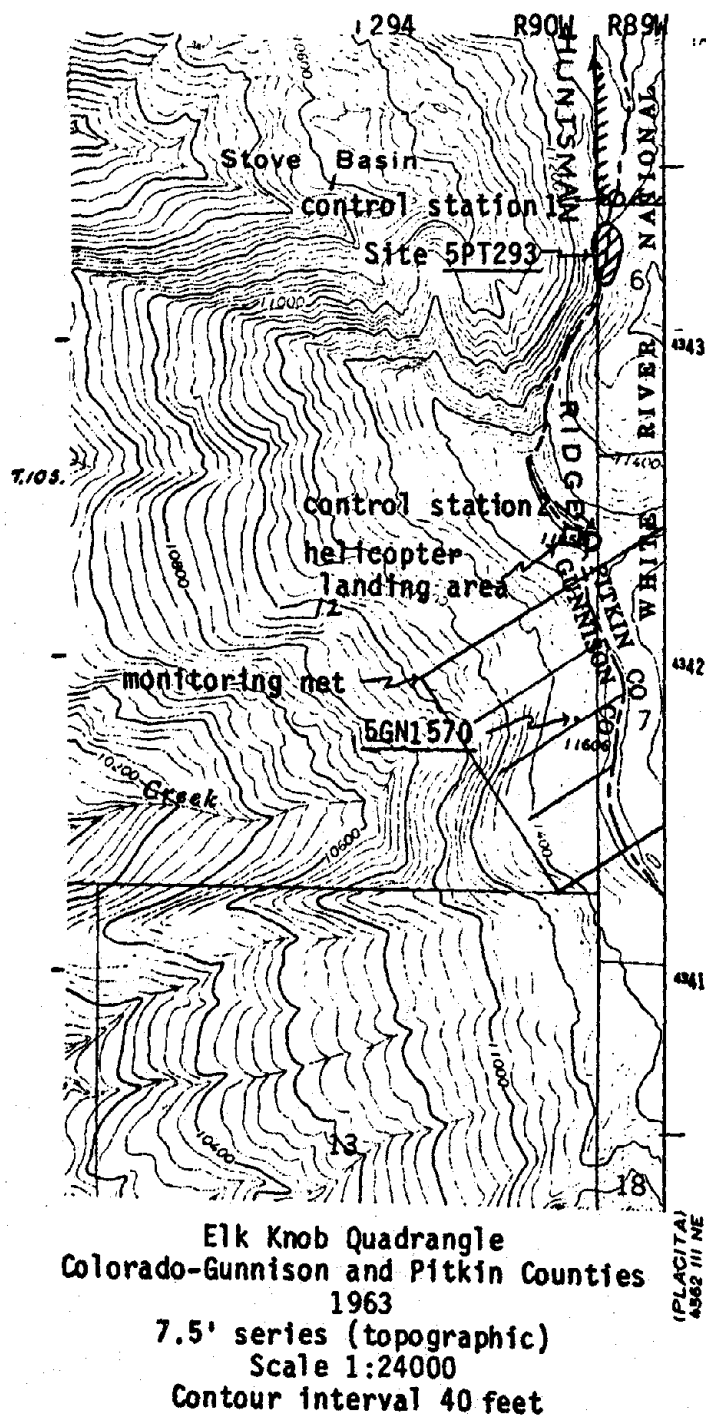
29) Boundary Description:

Visible surface cultural materials.

30) Boundary Justification:

Visible site periphery.





USGS 7.5' topographic map showing locations of archaeological site 5PT293 and isolated find 5GN1570 in relationship to proposed mine subsidence net.



ARCHAEOLOGICAL COMPONENT FORM

IMPORTANT: USE IN CONJUNCTION WITH THE GREEN INVENTORY RECORD
FORM FOR RECORDING PREHISTORIC OR HISTORIC ARCHAEOLOGICAL SITES

1) Resource No. 5PT293 2) Temp. No. 8066-1 3) Name Huntsman Ridge Site

I. ARCHAEOLOGICAL DATA: 4) Site Type Open campsite.

5) Description/Features Dispersed scatter of chipped and ground stone artifacts lying
within saddle of Huntsman Ridge. No diagnostic artifacts or features observed.
Saddle provides access between Coal and Stove Basins.

6) Cultural Material

#	Type	Size (cm)			Material
1	Unifacial Edge	L= 2.2	W= 1.4	T= 0.2	Banded black chert
2	Flake	1.8	1.3	0.2	Grey-brown chert
3	Flake	2.0	1.2	0.3	Grey obsidian
4	Flake	0.9	0.6	0.1	Grey-green chert

(Continued on attached sheet)

7) Cultural Affiliation Unknown Date BC
AD

8) Dating Criteria None

9) Site Depth Unknown (bedrock exposed); based on cut/bank auger shovel other

10) Activities inferred from site features Tool manufacture, vegetal and faunal food
preparation: camping.

11) Research potential/significance May be likely to yield information important in
the prehistory of western Colorado, particularly that of high altitudes.

12) Known Collections/Excavations/Publications None

13) Informants: Name/Address None

II. ENVIRONMENTAL DATA: 14) Topography Saddle atop Huntsman Ridge, between Stove Basin and Coal Basin.

15) Elev. 11370 ft. (x .3048=) 3466 m 16) X-Grade: site 5 Surrounding 5-40

17) Aspect E/W 18) Soil: color (Munsell) tan

depth undetermined character rocky, mountain soil

19) Nearest water: name headwaters of Second Creek; Int. Perm. X Fos. ; elev. 3292 m,

dist. 760 m, direc. W/NW; Nearest permanent water Same

elev. m, dist. m, direc. ; Other

20) Veg. on site Alpine grasses, dwarf spruce and fir.

21) Surrounding veg. Same, more spruce & fir.

III. ADMINISTRATIVE DATA: 22) Completed: record X collect map X test part. exca.

total excav. stabilized other

23) Protection: none X marked fenced patrolled access controlled other

24) Surface Collected: yes no X % collected 0; sampling technique: none grab
random transect other , describe No collection

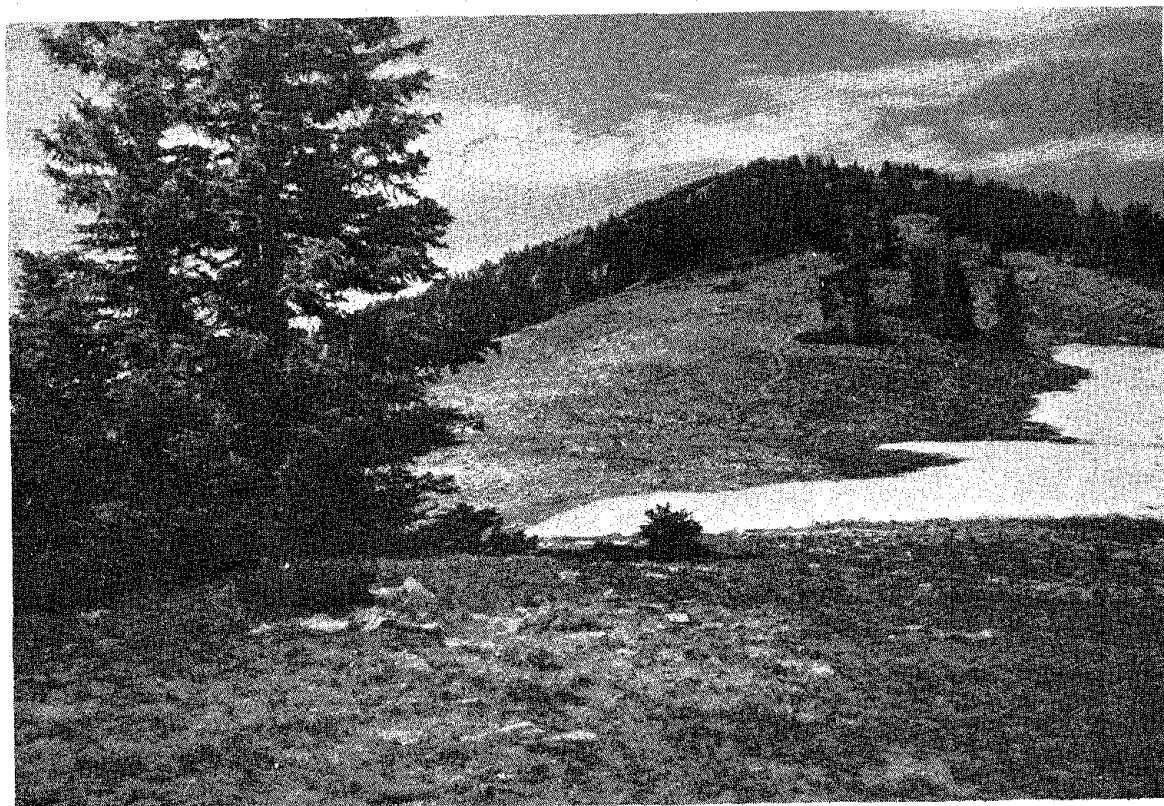
25) Artifact Storage at Not applicable.

26) Recorder Carl E. Conner, Danni L. Langdon 27) Date(s) 6 / 25 / 81

IV. ADDITIONAL INFORMATION:

Continuation of I.6) Cultural Material:

#	Type	Size (cm)			Material
		L=	W=	T=	
5	Biface	2.0	1.8	0.3	Black obsidian
6	Metate fragment	12.0	11.0	3.0	Red sandstone
7	Flake	4.0	3.0	0.4	White chert
8	Bifacial edge	3.2	2.1	0.3	Black chert
9	Flake	2.0	1.2	0.2	Pink chalcedony
10	Flake (unifacially worked)	1.7	1.5	0.2	Red chert
11	Scraper	5.0	4.1	0.8	Caramel chert
12	Biface	2.5+	1.8	0.2	Red/black chert
13	Core	5.0	4.3	3.8	White chert
14	Ground stone fragment	6.0	3.5	3.0	Red sandstone
15	Flake	2.8	2.0	0.2	White chert
16	Metate fragment	14.0	10.0	5.6	Red sandstone
17	Metate fragment	12.0	11.0	2.5	Red sandstone
18	Flake	3.1	2.3	0.4	Grey chert
19	Flake	1.8	1.8	0.2	Caramel chert
20	Flake	1.3	0.8	0.1	Grey chert
21	Distolateral scraper	4.8	3.4	1.2	Grey chert
22	End scraper	5.8	5.0	0.8	Red quartzite
23	Flake	3.8	2.3	0.3	White quartzite
24	Flake	1.5	1.2	0.2	White chert
25	Flake	3.6	3.0	0.3	White quartzite
26	Biface fragment	1.8	1.6	0.3	White chalcedony
27	Metate fragment	12.0	6.0	4.5	Red sandstone
28	Flake	4.8	2.0	0.6	Brown chert
29	Flake	4.1	2.9	0.4	Grey chert
30	Flake (bifacial edge)	2.6	1.8	0.3	Red chert
31	Flake	2.8	1.8	0.3	Red chert
32	Biface fragment	2.5	2.0	0.3	Red chert
33	Chunk	5.6	1.8	0.8	Caramel chert



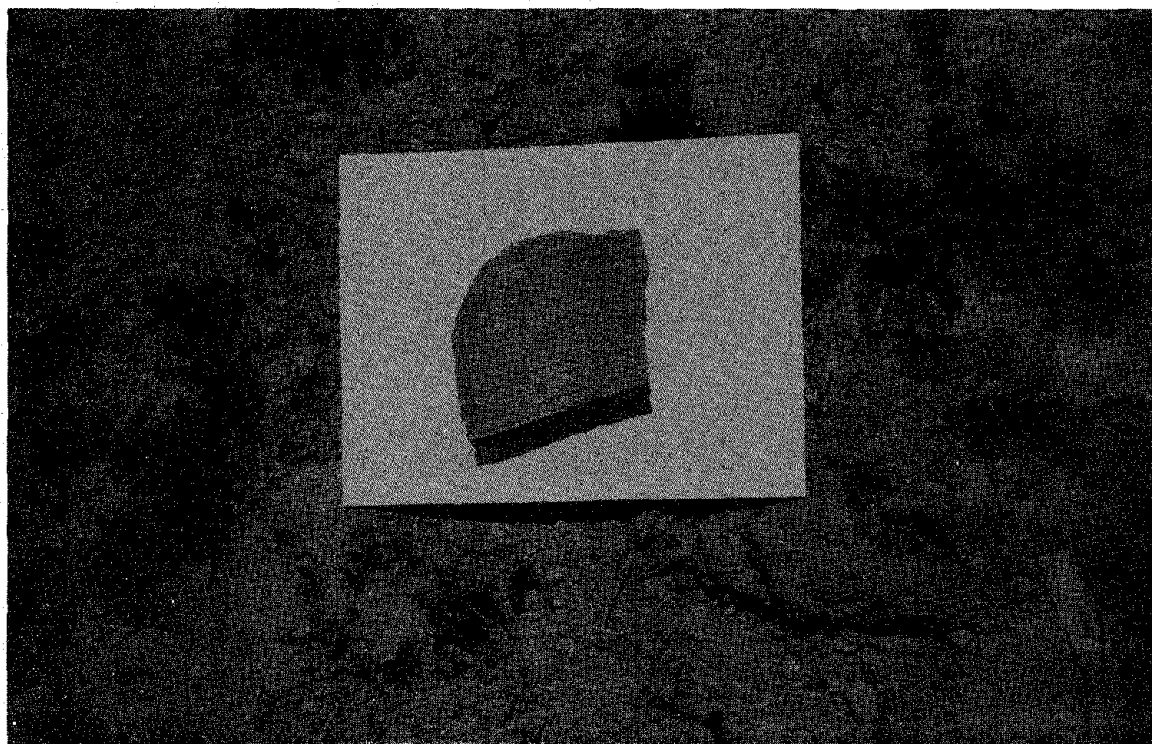
Site No: 5PT293

Photo No: 8066-2-5A

View: North

Date: 6/25/81

Comment: Overall view of site, taken from southern boundary. Cairn (left of center) is datum.



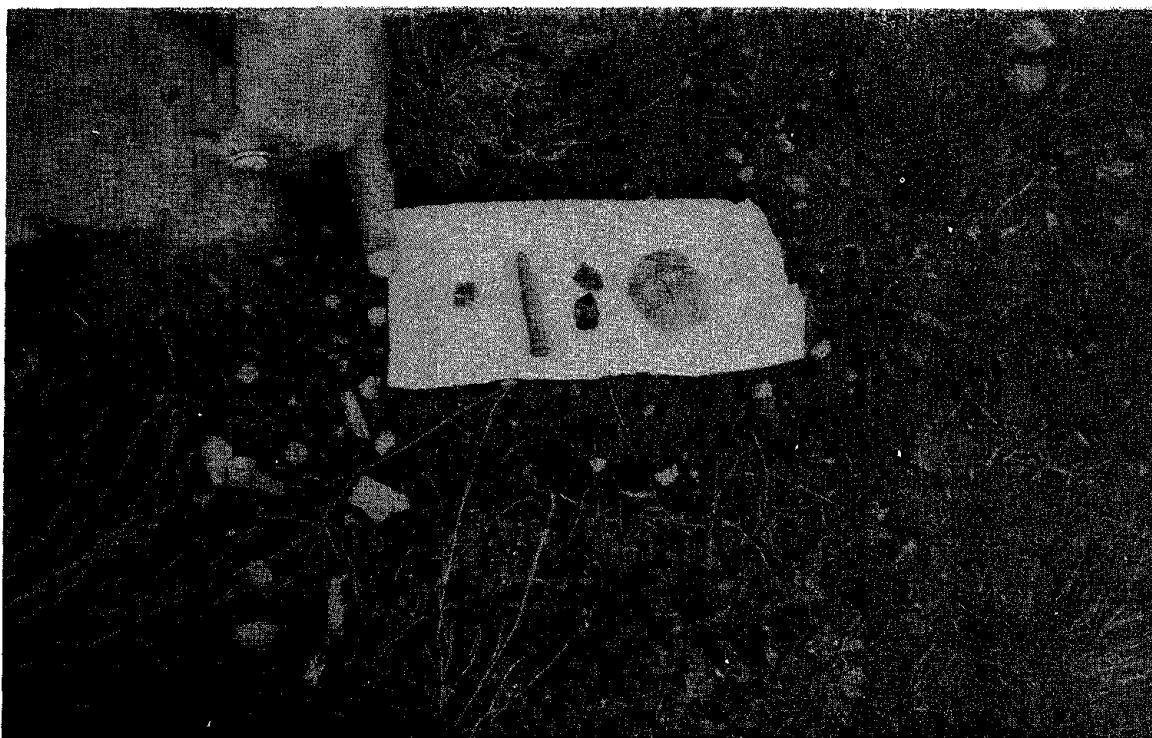
Site No: 5PT293

Photo No: 8066-2-3A

View: Down

Date: 6/25/81

Comment: Artifact #17, metate fragment. Note pecked and ground surface.



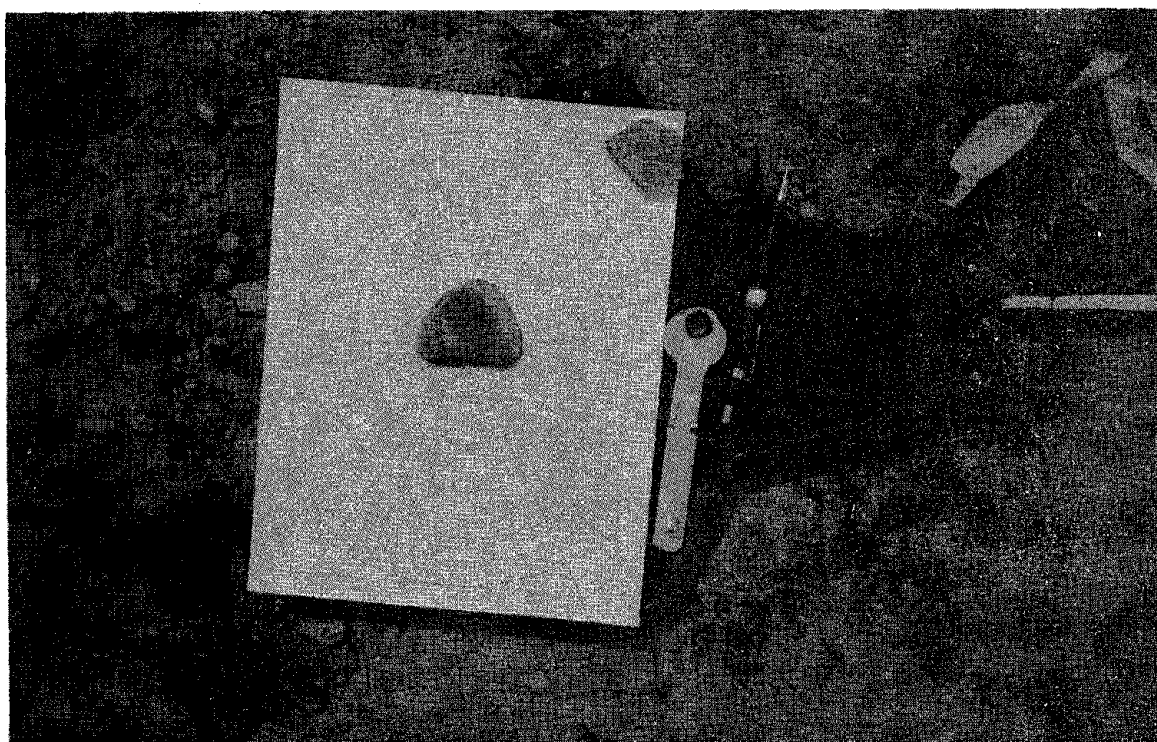
Site No: 5PT293

Photo No: 8066-1-16

View: Down

Date: 6/1/81

Comment: Artifacts #3,1,5, and 11. Cartridge shows scale.



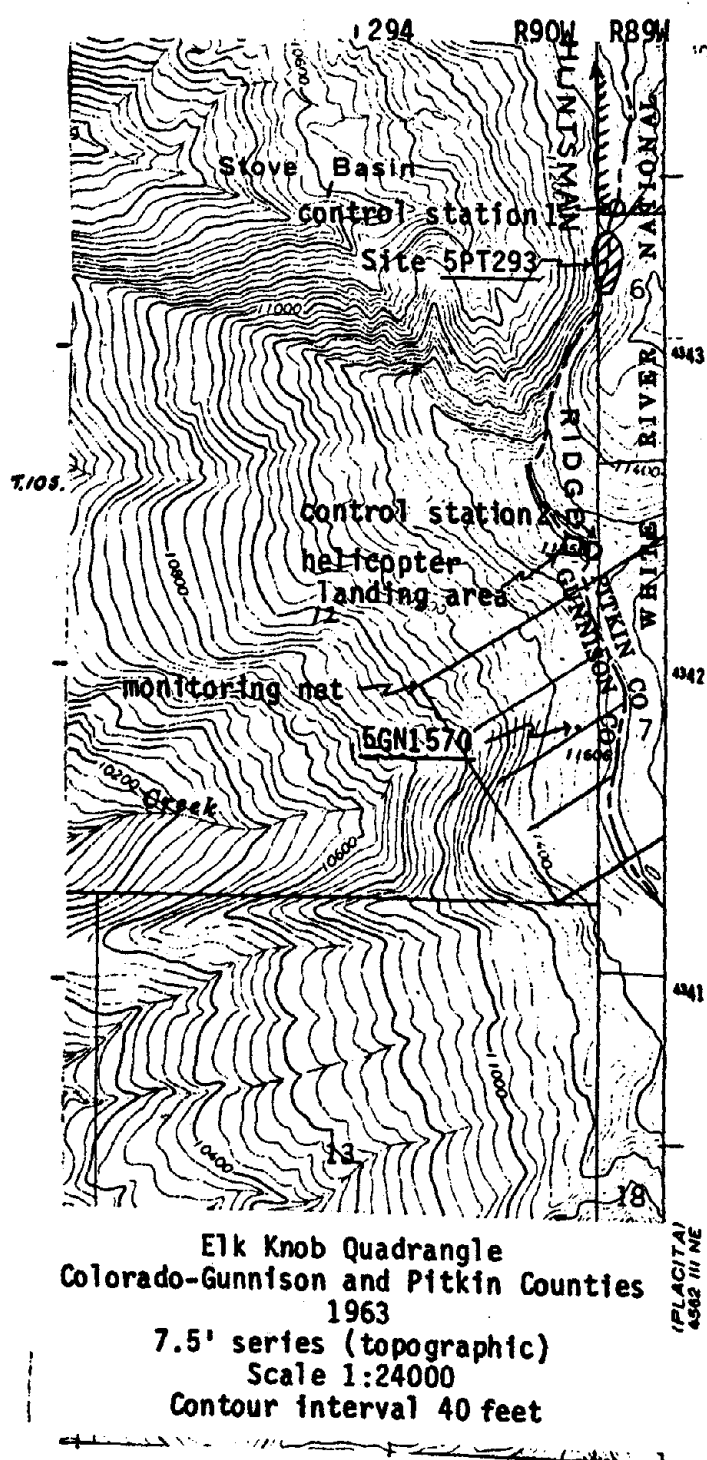
Site No: 5PT293

Photo No: 8066-2-4A

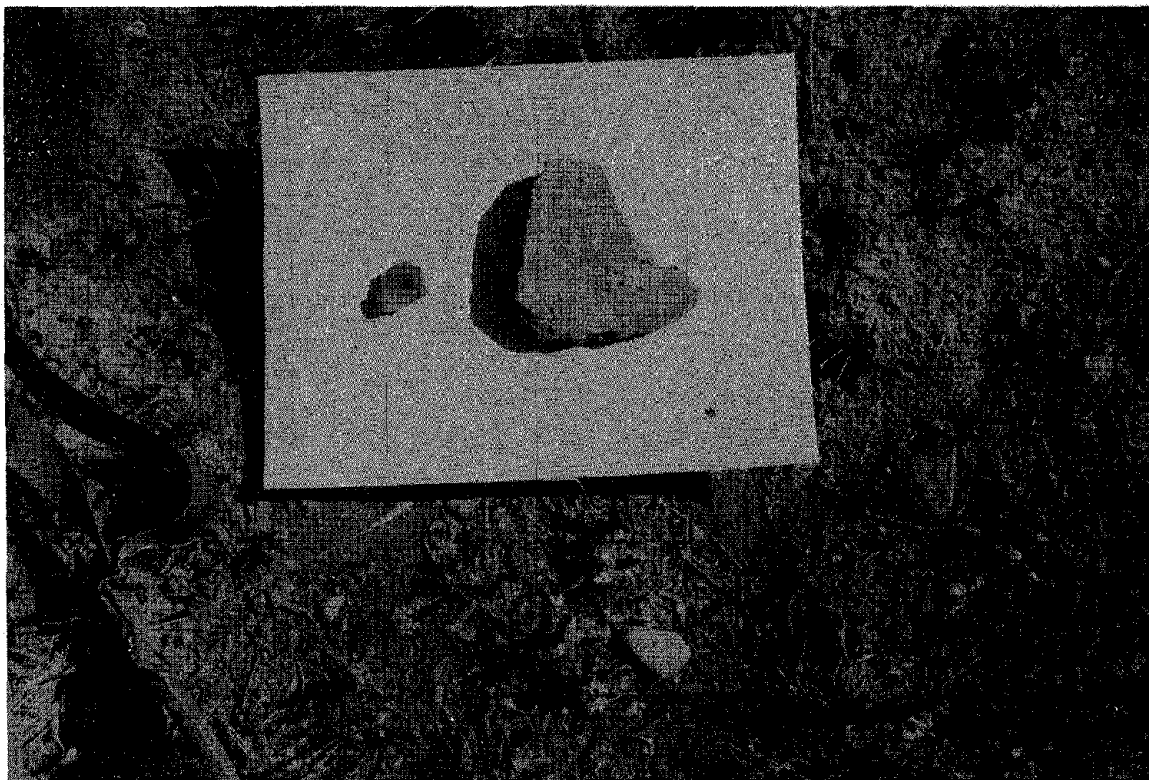
View: Down

Date: 6/25/81

Comment: Artifact #22, red quartzite scraper.



USGS 7.5' topographic map showing locations of archaeological site 5PT293 and isolated find 5GN1570 in relationship to proposed mine subsidence net.



Site No: 5GN1570

Photo No: 8066-2-00

View: Down

Date: 6/25/81

Comment: Isolated Find -- chert flake and mano fragment.

APPENDIX D
CONTROL SURVEY RESULTS

ENGINEERING ASSOCIATES, INC.
Suite 207 Village Plaza
GLENWOOD SPRINGS, COLORADO 81601
(303) 945-8576

JOB LINE MEASURE
SHEET NO 7 OF
CALCULATED BY GP DATE JUNE 18
CHECKED BY DATE
SCALE 1"=19.00'

STATION	NORTHING	EASTING	ELEVATION
4 MINE	6534.71	13683.23	10171.30
WOODPILE	11767.45	11813.35	9804.04
TP#1-	11202.99	2339.54	11844.57
TP#2-	14975.26	520.24	11842.22
TP#3-	20486.81	681.07	11445.92
TP#4-	17301.21	1630.55	11723.44
TP#5-	11994.59	4905.48	11591.03

ENGINEERING ASSOCIATES, INC.
Suite 207 Village Plaza
GLENWOOD SPRINGS, COLORADO 81601
(303) 945-8676

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

LIST OF EQUIPMENT

1- WILD T-2
WILD TRIBRACHS
RETRO RAY PRISMS
TRI PODS

TOPCON DMC-2 EDM
AZIMUTH BASE (LIERZ?)

MISC. HAND TOOLS

ATMOSPHERIC CORRECTION FROM BOOK 133 Pg. 849
TEMP 55° ELEV 9804.04 WOODPILE

CHARTS @ APPROX. 85 FPM

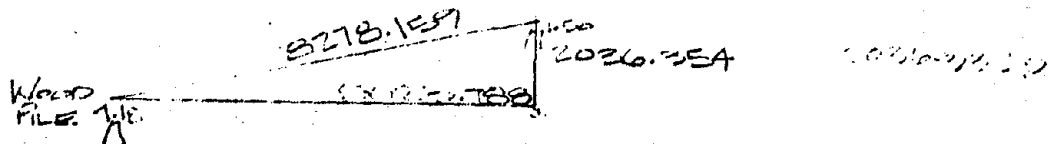
MEASURED SD 1715.79
6561.665
ACTUAL MEAS. SD 8277.455

$$8277.455 \times (25 \times 10^{-9}) = .704$$

$$8277.455 + .704 = \text{TOTAL SD} = 8278.159$$

$$m) \angle = 75^\circ 45' 34.5''$$

$$\text{TOTAL HD} = 8023.788$$



$$\begin{aligned} 9804.01 &= \text{WOOD PILE} \\ + 4.18 &= \text{HI @ WOOD PILE} \\ 9808.22 &= \text{ELEV OF INSTRUMENT} \\ + 2036.354 & \\ \hline 11844.574 &= \text{ELEV OF PRISM} \\ - 1.50 &= \text{HI @ TP \#1} \\ \hline 11843.074 & \end{aligned}$$

Correction for refraction & curvature

$$.021 (M^2)$$

M = distance in thousands of feet

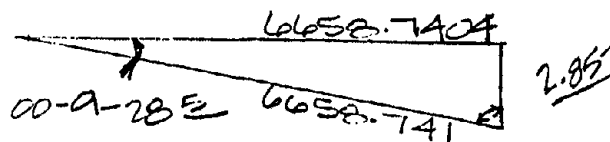
TP #1 ELEV 11844.424

$$(8023^2) \cdot 0.021 = 1.35'$$

ATMOSPHERIC CORRECTION FROM BOOK, 133 Pg. 1142
TEMP 55° ELEV 11843.074 TP #1
HI 44N .91 HI PRISM 1.35
CHARTS @ approx. 100

$$\begin{array}{r} \text{MEASURED SD } 96.41 \\ 6561.665 \\ \hline 6658.075 \end{array}$$

$$\begin{aligned} 6658.075 \times (100 \times 10^{-6}) &= .666 \\ 6658.075 + .666 &= 6658.741 = \text{TOTAL SD} \\ m) \angle &= 90-01-28.5 \\ \text{TOTAL HD} &= 6658.740 \end{aligned}$$



$$\begin{aligned} \sin \frac{\theta}{2} \quad \sin 00-01-28.5 (6658.741) &= \frac{0}{1} \\ 2.851 &= 2 \end{aligned}$$

$$\sqrt{(6658.741^2) - (6658.740^2)} = 2.828$$

$$m) = 2.843$$

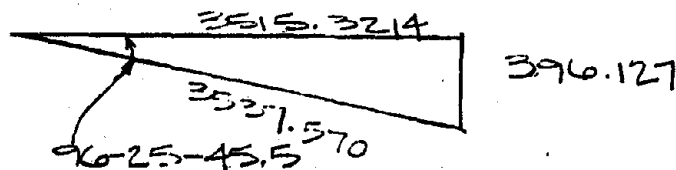
$$\begin{array}{r} 11843.074 \\ + 0.910 \\ \hline 11843.984 \\ - 2.843 \\ \hline 11841.141 \\ - 1.35 \\ \hline 11839.7910 \end{array}$$

$$6.658^2 (.021) = .93$$

ENGINEERING ASSOCIATES, INC.
 Suite 207 Village Plaza
 GLENWOOD SPRINGS, COLORADO 81601
 (303) 945-8676

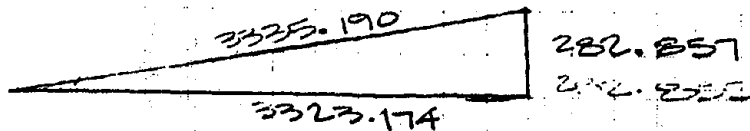
SHEET NO. 3 OF _____
 CALCULATED BY GP DATE JUNE 16
 CHECKED BY _____ DATE _____
 SCALE 1829.001

HI GUN .92 HI PRISM 1.35
 ELEV TP#2 11839.791
 MEASURED SD = 3537.570
 m 2x 96-25-45.5
 HD 3515.3214



11839.791
 + .92
 11840.711
 - 396.127
 11444.584
 - 1.35
 11443.234 ELEV TP#3

HI GUN 0.92' HI PRISM 0.95'
 ELEV TP#3 11443.234
 MEASURED SD 3335.190
 m 2x 25°08'05.2"
 HD 3323.174



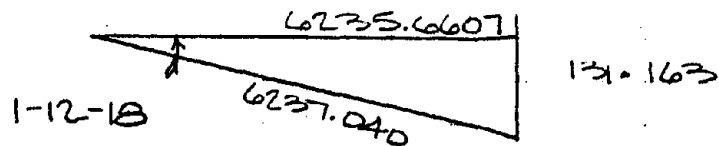
11443.234
 + 0.92
 11444.154
 + 282.856
 11727.010

11727.010
 - 0.95
 11726.060 ELEV TP#4

ENGINEERING ASSOCIATES, INC.
 Suite 207 Village Plaza
 GLENWOOD SPRINGS, COLORADO 81601
 (303) 945-8676

JOB LINE SUBSIDENCE
 SHEET NO. 4 OF _____
 CALCULATED BY GP DATE JUNE 16
 CHECKED BY _____ DATE _____
 SCALE _____

HI GUN .92 HI PRISM 1.35
 ELEV TP#4 11726.060
 MEASURED SD 62357.040
 MZ) 91-12-18
 HD 62355.6607



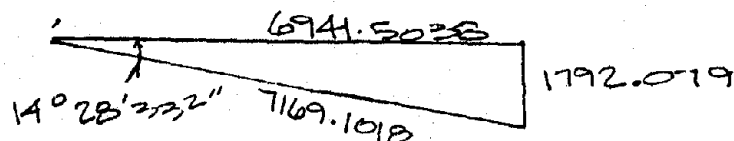
11726.060
 + 0.92
 11726.98
 - 131.163
 11595.817
 - 1.35
 11594.467 ELEV TP#5

ATMOSPHERIC CORRECTION from ~~Point 133P~~ 30
TEMP 60.0 ± ELEV 11594.467 TP#4
HI GUN .91' HI PRISM 4.61'
CHARTS @ approx. 100.

$$\begin{array}{r} \text{MEASURED SD } 606.720 \\ \underline{6561.665} \\ \text{ACTUAL MEASURED SD } 7168.385 \end{array}$$

$$7168.385 \times (00 \times 10^{-6}) = .7168$$

$$\begin{array}{l} 7168.385 + .7168 = \text{TOTAL SD} = 7169.1018 \\ m \angle = 104-28-33.2 \\ \text{TOTAL HD} = 6941.5038 \end{array}$$



$$\begin{array}{r} 11594.467 \\ + .91 \\ \hline 11595.377 \\ - 1792.019 \\ \hline 9803.298 \\ - 1.61 \\ \hline 9798.488 \end{array}$$

$$\begin{array}{r} 9804.04 \\ \underline{1798.688} \\ 5.35 \end{array}$$

WOODPILE	9804.04	
TP#1	11843.074	+ 1.35
TP#2	11839.791	+ .93
TP#3	11443.234	+ .26
TP#4	11726.060	+ .23
TP#5	11594.467	+ .82
WOODPILE	9798.688	+ 1.01

$$.021(8.023^2) = 1.35$$

$$\begin{array}{r} 11843.074 \\ + 1.35 \\ \hline 11844.424 \end{array} \quad \begin{array}{l} \text{refraction correction} \\ \text{TP\#1} \end{array}$$

$$.021(6.659^2) = \frac{.93}{2.28}$$

$$\begin{array}{r} 11839.791 \\ + 2.28 \\ \hline 11842.071 \end{array} \quad \begin{array}{l} \text{refraction correction} \\ \text{TP\#2} \end{array}$$

$$.021(3.515^2) = \frac{.26}{2.54}$$

$$\begin{array}{r} 11443.234 \\ + 2.54 \\ \hline 11445.774 \end{array} \quad \begin{array}{l} \text{refraction correction} \\ \text{TP\#3} \end{array}$$

$$.021(3.323^2) = \frac{.23}{2.77}$$

$$\begin{array}{r} 11726.060 \\ + 2.77 \\ \hline 11728.830 \end{array} \quad \begin{array}{l} \text{refraction correction} \\ \text{TP\#4} \end{array}$$

$$.021(6.236^2) = \frac{.82}{3.59}$$

$$\begin{array}{r} 11594.467 \\ + 3.59 \\ \hline 11598.067 \end{array} \quad \begin{array}{l} \text{refraction correction} \\ \text{TP\#5} \end{array}$$

$$.021(6.942^2) = \frac{1.01}{4.60}$$

$$\begin{array}{r} 9798.688 \\ + 4.60 \\ \hline 9803.288 \end{array} \quad \begin{array}{l} \text{WOODPILE CHECK} \\ \text{9804.04} \\ \hline 0.752 \end{array} \quad \begin{array}{l} \text{RECORD} \\ \text{11} \end{array}$$

• 15 per station

ENGINEERING ASSOCIATES, INC.
Suite 207 Village Plaza
GLENWOOD SPRINGS, COLORADO 81601
(303) 945-8676

SHEET NO. 7 OF
CALCULATED BY GP DATE JUNE 18
CHECKED BY DATE
SCALE 1329.001

STATION	NORTHING	EASTING	ELEVATION
4 MINE	6534.71	13683.23	10171.80
WOODPILE	11767.45	11843.35	9804.04
TP#1-	11202.99	3839.54	11844.57
TP#2-	16175.26	520.04	11842.22
TP#3-	20486.81	684.07	11445.92
TP#4-	17301.21	1630.55	11723.44
TP#5-	11994.59	4905.48	11591.03

POINT	QUAD	BEARING	DISTANCE	ZENITH	NORTHING	EASTING
-------	------	---------	----------	--------	----------	---------

42	SE 19 22 19.7				11767.450	11843.350
83	AR 105 20 17.5	8278.159	75 45 34.5			
84	AR 244 7 52.7	6658.741	90 1 28.5			
85	AR 212 34 35.8	3515.377	90 0 0.0			
86	AR 340 46 46.8	3323.222				
87	AR 164 52 0.3	6235.771				
88	AR 123 33 18.2	7169.102	104 28 33.2			
	SE 88 7 29.6				11767.450	11843.350

0 0 1.0 ANGLE ERROR

0 0 0.2 ANGLE CORRECTION

H. CLOSURE

SE 86 47 6.6 0.412 CLOSING LINE
34698.402 DIST TRAVERSED
84278 PRECISION

COMPASS ADJUSTMENT

POINT	QUAD	BEARING	DISTANCE	ZENITH	NORTHING	EASTING
-------	------	---------	----------	--------	----------	---------

42	SW 85 57 57.3	8023.694			11767.450	11843.350 TP WOODPILE
83	NW 29 54 7.8	6658.697			11202.985	3839.536 TP #1
84	NE 2 40 28.2	3515.377			16975.262	520.039 TP #2
85	SE 16 32 50.0	3323.235			20486.810	684.073 TP #3
86	SE 31 40 49.6	6235.813			17301.205	1630.549 TP #4
87	SE 88 7 29.5	6941.586			11994.588	4905.481 TP #5
88					11767.450	11843.350

TRANSIT ADJUSTMENT

POINT	QUAD	BEARING	DISTANCE	ZENITH	NORTHING	EASTING
-------	------	---------	----------	--------	----------	---------

42					11767.450	11.843
----	--	--	--	--	-----------	--------

TRANSIT ADJUSTMENT

POINT	QUAD	BEARING	DISTANCE	ZENITH	NORTHING	EASTING
-------	------	---------	----------	--------	----------	---------

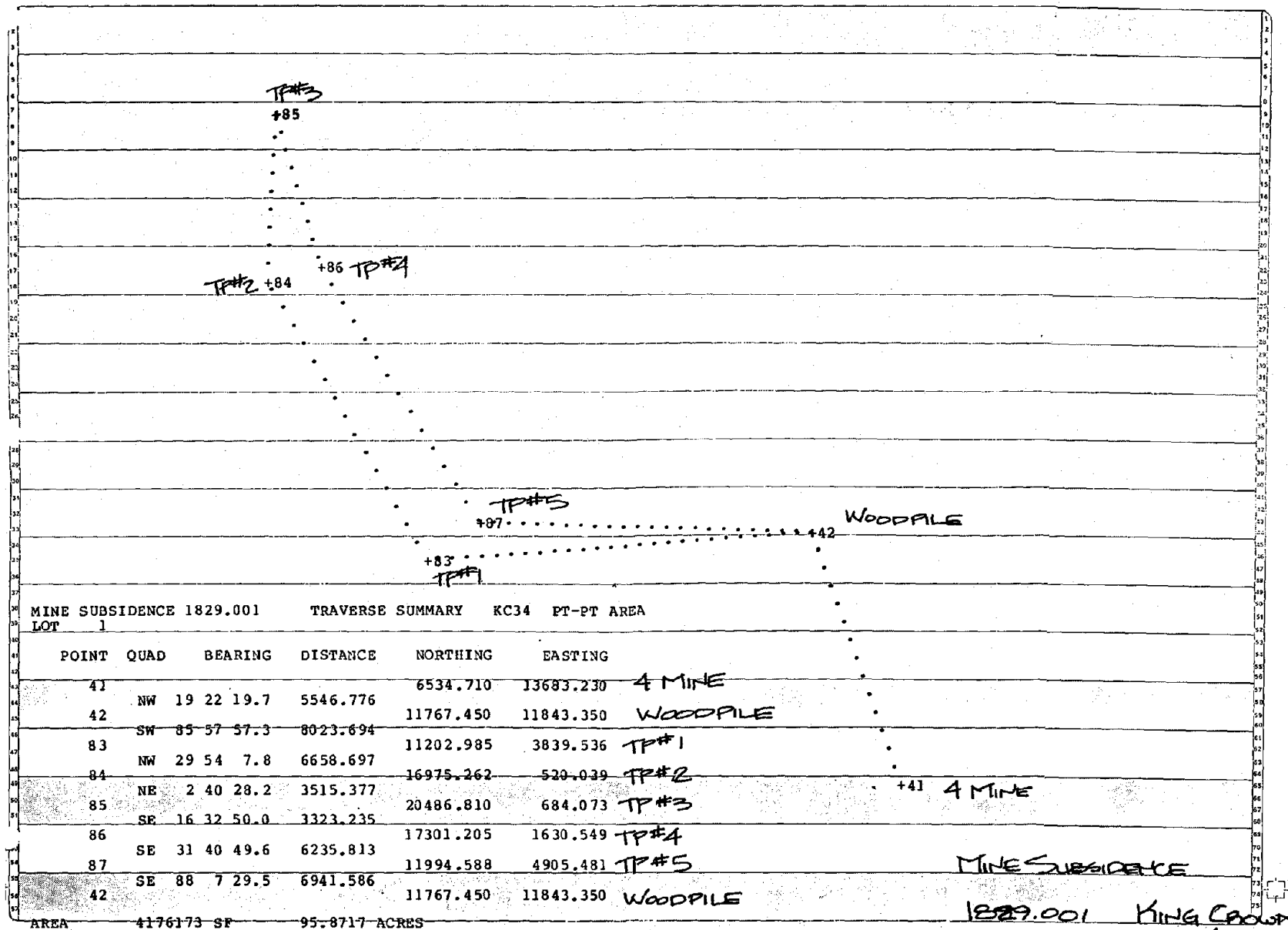
POINT	QUAD	BEARING	DISTANCE	ZENITH	NORTHING	EASTING
-------	------	---------	----------	--------	----------	---------

START

42					11767.450	11.843
----	--	--	--	--	-----------	--------

E * A

42					11767.450	11843.350
----	--	--	--	--	-----------	-----------



CLAYCOMB ENGINEERING ASSOCIATES, INC.



June 18, 1981

Mine Subsidence Engineering Co.
6590 South Ridgeview Drive
Morrison, Colorado 80465

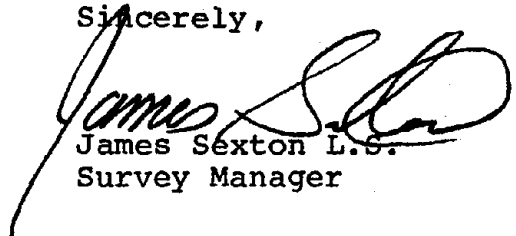
Attn: Robert P. King M.S.

Dear Bob:

Enclosed is the survey control data you requested of
the Huntsman Ridge Area.

It has been a pleasure working with you, and we look
forward to assisting you in the future.

Sincerely,


James Sexton L.S.
Survey Manager

JS/sh

Enclosures

APPENDIX E
BASELINE SURVEY FIELD DATA

TABLE E-1
 BASELINE SURVEY FIELD DATA
 PANEL 101 CENTERLINE

Monument Number	Survey Date	Backsite Monument	Angle (deg)	Horizontal Angle (deg)	Vertical Angle (deg)	Slope Distance (ft)
100+00	8/20/81	TP-3	343°27'10"	162°38'02"	117°29'12"	1289.95'
102+00	8/20/81	TP-3	343°27'10"	161°02'39"	114°18'49"	1404.22'
104+00	8/20/81	TP-3	343°27'10"	159°43'04"	111°48'27"	1586.43'
106+00	8/20/81	TP-3	343°27'10"	158°16'59"	110°25'12"	1779.89'
107+00	8/20/81	TP-3	343°27'10"	158°11'53"	109°58'12"	1871.77'

TABLE E-2
BASELINE SURVEY FIELD DATA
PANEL 302 CENTERLINE

Monument Number	Survey Date	Backsite Monument	Angle (deg)	Horizontal Angle (deg)	Vertical Angle (deg)	Slope Distance (ft)
200+00	8/19/81	TP-3	343°27'10"	208°22'20"	109°24'20"	1205.11'
201+00	8/19/81	TP-3	343°27'10"	204°13'20"	109°44'38"	1264.14'
202+00	8/19/81	TP-3	343°27'10"	200°26'32"	109°08'24"	1321.39'
204+00	8/19/81	TP-3	343°27'10"	193°50'42"	106°56'53"	1442.23'
206+00	8/19/81	TP-3	343°27'10"	188°28'31"	105°57'27"	1587.44'
208+00	8/19/81	TP-3	343°27'10"	184°01'54"	104°54'01"	1742.03'
210+00	8/19/81	TP-3	343°27'10"	180°25'22"	104°09'56"	1908.21'

TABLE E-3
BASELINE SURVEY FIELD DATA
SOUTH PERPENDICULAR

Monument Number	Survey Date	Backsite Monument	Angle (deg)	Horizontal Angle (deg)	Vertical Angle (deg)	Slope Distance (ft)
S00+00	8/24/81	TP-3	343°27'10"	185°22'50"	102°23'43"	2011.63'
S02+00	8/24/81	TP-3	343°27'10"	189°45'19"	99°44'12"	2119.71'
S04+00	8/24/81	TP-3	343°27'10"	193°35'37"	97°00'47"	2244.89'
S06+00	8/24/81	TP-3	343°27'10"	196°57'18"	94°30'09"	2382.19'
S08+00	8/25/81	TP-3	02°40'28"	173°09'31"	96°22'07"	2079.03'
S10+00	8/25/81	TP-3	02°40'28"	177°59'46"	96°48'01"	2173.24'
S12+00	8/25/81	TP-3	02°40'28"	182°19'48"	97°05'46"	2282.28'
S14+00	8/25/81	TP-3	02°40'28"	186°15'26"	97°32'31"	2399.76'
S16+00	8/25/81	TP-3	02°40'28"	189°45'00"	98°21'47"	2536.90'
S18+00	8/25/81	TP-3	02°40'28"	193°00'43"	98°41'51"	2668.59'

TABLE E-4
BASELINE SURVEY FIELD DATA
CENTER PERPENDICULAR

Monument Number	Survey Date	Backsite Monument	Angle (deg)	Horizontal Angle (deg)	Vertical Angle (deg)	Slope Distance (ft)
C00+00	8/21/81	TP-3	343°27'10"	166°31'39"	114°41'34"	1348.08'
C02+00	8/21/81	TP-3	343°27'10"	174°54'29"	110°22'26"	1389.41'
C04+00	8/28/81	TP-3	343°27'10"	182°12'15"	107°44'43"	1475.07'
C06+00	8/21/81	TP-3	343°27'10"	188°29'05"	105°57'35"	1587.45'
C08+00	8/21/81	TP-3	343°27'10"	193°44'55"	102°33'13"	1703.51'
C10+00	8/21/81	TP-3	343°27'10"	198°13'41"	97°42'20"	1829.84'
C12+00	8/21/81	TP-3	343°27'10"	201°53'43"	93°15'41"	1970.97'
C14+00	8/25/81	TP-3	02°40'28"	172°21'11"	97°38'37"	1633.95'
C16+00	8/25/81	TP-3	02°40'28"	178°53'51"	98°32'26"	1732.54'
C18+00	8/25/81	TP-3	02°40'28"	183°49'43"	99°26'00"	1835.98'
C20+00	8/25/81	TP-3	02°40'28"	189°16'58"	100°12'00"	1991.21'
C22+00	8/25/81	TP-3	02°40'28"	193°21'32"	100°47'53"	2120.28'
C24+00	8/25/81	TP-3	02°40'28"	196°47'44"	101°16'33"	2271.47'
C26+00	8/25/81	TP-3	02°40'28"	201°03'57"	102°50'02"	2441.45'

TABLE E-5
BASELINE SURVEY FIELD DATA
NORTH PERPENDICULAR

Monument Number	Survey Date	Backsite Monument	Angle (deg)	Horizontal Angle (deg)	Vertical Angle (deg)	Slope Distance (ft)
N00+00	8/25/81	TP-3	02°40'28"	152°28'12"	114°48'26"	1074.66'
N02+00	8/25/81	TP-3	02°40'28"	163°47'16"	110°27'22"	1078.13'
N04+00	8/25/81	TP-3	02°40'28"	173°53'08"	103°21'43"	1106.88'
N06+00	8/25/81	TP-3	02°40'28"	183°44'27"	103°37'11"	1234.39'
N08+00	8/25/81	TP-3	02°40'28"	190°22'10"	104°57'11"	1354.89'
N10+00	N O T S U R V E Y E D					
N12+00	N O T S U R V E Y E D					
N14+00	N O T S U R V E Y E D					

APPENDIX F
MSE RESPONSES TO DOE REVIEW
OF DRAFT FINAL REPORT

This appendix summarizes the specific MSE responses to the review comments contained in the DOE letter dated September 16, 1982. A copy of the letter is also included.

Letter Section I. General Remarks:

Comment
Number

MSE Response

I.1

Over a period of several months, MSE tried to get DOE approval and funding for a more detailed Final Report. The final instructions to MSE as regarded the final report were that it was to be strictly narrative in content utilizing only figures and calculated results presented in previous MSE reports to DOE. The report was to summarize what work was performed. No new figures were to be prepared. These instructions were an outgrowth of an MSE letter to DOE dated June 1, 1982, proposing a final draft report outline.

The DOE, TPM, removed all items from the proposed outline that would require extra time in terms of calculations and drafting. A copy of the original proposed outline with the DOE deletions is included in this appendix. MSE believes that within the limitations imposed by DOE we have prepared a narrative report explaining exactly what was done and how it was accomplished. This was our charge from DOE.

Comment
Number

MSE Responses

- I.2 MSE should have included these items in our draft report. As was stated in the cover letter included with the report this material was "not included to reduce copying costs. Both the drawings and appendices consist of material submitted to DOE during the course of this project". (MSE letter to R. W. Stephan dated August 20, 1982).
- I.3 As with comment I.1, no specifics were given as to the "limited coverage". As MSE reviewed the comments contained in the DOE letter it became obvious that the various DOE reviewers were not well versed in the Scope of Work for this project. MSE again believes that we have provided a document that provides a narrative account of what was done during the project. MSE tried on numerous occasions to convince DOE to allow the company to perform a final survey prior to the removal of the monitoring net. MSE stated that information on the stability of these relatively easy to install monuments would be invaluable to western mine operators. However, this request was denied and MSE was directed to generate a narrative report on what work was performed.
- I.4 The monitoring of the subsidence net during winter was impossible because of the deep snow depths (10 ft or more) and the avalanche danger. The proposed monitoring schedule presented in Table 3 (p.26) is a copy of the

monitoring schedule approved by DOE in the MSE instrumentation plan. MSE also indicated in the original technical proposal (p.5) that monitoring would be impossible during most parts of the year. Therefore no plans were made, nor funding provided, for monitoring of the net during those periods of the year when snow cover was in excess of 3 ft. Apparently the reviewers were unaware of these various references to this fact dating back all the way to the original technical proposal submitted to DOE prior to the awarding of the Contract to MSE.

I.5 See comment I.4 for a response to the lack of monitoring during the winter months. It should be noted that the Work Statement in the contract restricted the project to monitoring only "Surface response "(Section 3.1 in the Contract Work Statement). "Subsurface and mine level response" measurements were outside the Scope of Work for the project. Apparently the reviewers were not familiar with the Scope of Work for this project.

I.6 A comparison of various methods for monument installation was not within the Scope of Work for this project. It was definitely not within the scope of MSE direction to generate a narrative report on what was done during the project. MSE believes that Table 1 (p.9) and the verbal presentation on page 31 adequately provide an "indepth" discussion of the use of the helicopter on this project.

Comment
Number

MSE Response

I.7 MSE believes that the report adequately addresses "the establishment of a surface subsidence network in in alpine area". If the reviewers would provide specific questions within the Scope of Work, MSE will be glad to incorporate the appropriate data into this report. A detailed discussion of the "value and practicability of the helicopter" was clearly outside the Scope of Work for the project.

I.8 A section on monument removal was added to the test.

II. Editorial Review and Comments

Cover Page - Included in Final Report

Disclaimer - Included in Final Report

Title Page - Included in Final Report

Table of Contents - Added pagination

Table of Contents - Added subsection on Survey Control Monuments

Introduction - Added Executive Summary

p 1, Para.3, Line 2 - Changed text

p 1, Line 1 - Not sure exactly where this comment was referring.

Left text unchanged

p 2 - Figure 1 - Included in Final Report

p 5-7 - Task description - In the absence of more definitive comments this section was left unchanged. The wording in this section is derived directly from the contract documents

p 7, Para. 1, Line 1,2 - Combined into one paragraph
p 7, Line 3, Line 2 - Made suggested change in text
p 7, Line 4, Line 1 - Made suggested change in text
p 8 - Figure 2 - Included in Final Draft
p 31, Para. 2, Line 1 - Made suggested change in text
p 31, Para. 2, Line 3 - Made required change in text
p 33 - All Appendices were included in the Final Report

III. Conclusions

MSE agrees that a wealth of information of direct interest to western coal operators could have been made available in this report, particularly in the area of monument stability under severe alpine weather conditions. However, descopeing of the project yielded a report that was to be strictly narrative in nature describing only what work was done on the project.

To the specific areas listed in the Conclusions section of the review letter MSE offers the following responses:

1. Information on Regulatory Requirement:

MSE believes this is outside of the original and revised Scope of Work for the project. However, we believe this facet of the project is more than adequately covered in the following portions of the report:

Table 2 - Special Use Permitting

Flow Chart (p.12)

Forest Service Permits (p.11)

Cultural Resources Survey (p.11)

Appendix A - Forest Service Permitting Forms

Appendix B - Environmental Assessment

Appendix C - Cultural Resources Survey

Should DOE care to respond with specific comments, MSE will incorporate the required information into the Final Report.

2. The relationship and practicality of helicopter use for property survey(s), monument installations and removal, monitoring survey, problems encountered, cost data and comparisons with other survey techniques: This project was designed simply to monitor subsidence resulting from longwall mining utilizing multiple lifts. It was not structured as a comparison of various monitoring methods and techniques. The helicopter support utilized on this project was simply a tool. Detailed comparisons of helicopter requirements were not part of the Scope of Work. MSE does believe that the information presented in our report would allow a knowledgeable western coal operator to evaluate the feasibility and cost cost effectiveness of utilizing helicopter support in their subsidence monitoring program.
3. Summary: MSE believes that the company has prepared a report that adequately presents, in narrative form, exactly what work was performed during the project. We also believe that we have summarized general information on permitting requirements and helicopter usage that could be of use to western coal operators. MSE believes that many of the reviewers were unaware of the original Scope of Work and the final Scope of Work as

well as the directive to generate a narrative report.

Because of this lack, many of the general remarks are not germane to the project Scope of Work. It should be stressed that the original Scope of Work involved the installation of a monitoring net to measure surface response. The final Scope of Work involved the installation of a monitoring net to measure surface response. The final Scope of Work removed the monitoring requirement. The project was not designed to evaluate the effectiveness of helicopter support. Nor was it designed to monitor reclamation requirements after removing the monitoring net. In summary, MSE would be more than happy to respond to any specific reviewer comments. However, project constraints do not allow MSE to elaborate on general questions or areas outside of the Scope of Work.



MINE SUBSIDENCE ENGINEERING CO.

DONALD W. GENTRY, Ph.D.

ROBERT P. KING, M.S.

COLLIN L. STEWART, M.S.

June 1, 1982

Dorothy Noga, Contract Specialist
Acquisition & Assistance Division
U.S. Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, PA 15236

SUBJECT: Revised Optional Form 60
(Contract No. DE-AC22-80PC30118)

Dear Ms. Noga:

As you requested in your letter dated April 28, 1982, Mine Subsidence Engineering Company (MSECo) has prepared a revised Optional Form 60 to reflect the reduced Scope of Work for Contract No. DE-AC22-80PC30118.

In developing the revised cost estimate MSECo assumed that the required final report would address specific items. These items are outlined, in general terms, in Attachment 1.0, Proposed Outline for Final Report, DOE Contract No. DE-AC22-80PC30118.

Implicit in this proposed outline is a final survey of the monitoring points prior to their removal. MSECo strongly believes this final survey will provide data on the stability this particular type of monitoring point under extremely severe weather conditions. *

The results of the final survey will establish the stability of these relatively inexpensive, easy to install monitoring points. We believe that a final report containing this information will be of value to mining companies in the western United States, particularly in dealing with the various regulatory agencies.

If this final survey is not performed MSECo can only generate a narrative report of what we did. This will have little value to the mining industry.

I would like to stress that the additional cost for this final survey is minimal. We will simply survey a point prior to removing it.

MSECo requires a go-no go decision on the enclosed Optional Form 60 as soon as possible. Our firm has rearranged a rather crowded summer schedule to accommodate DOE's change in plans. We have contracted for a helicopter for the period from July 7, 1982, through July 28, 1982. If we miss this July window, we will not be able to accomplish removal of the net before September 1982. Because of the 2 to 3 week lead times on securing the equipment, supplies and consultants required for removal of the

* Delete from
Final report as
per DOE
directions.

8890 SOUTH RIDGEVIEW DRIVE • MORRISON, COLORADO 80465 • TELEPHONE (303) 697-5592



MINE SUBSIDENCE ENGINEERING CO.

Page 2
Ms Noga
1 JUN 82

monitoring net, MSECo requires the go - no go decision on the revised Optional Form 60 by June 15, 1982. With the exception of the helicopter, MSECo will not make any arrangements for the required equipment and supplies without written authorization from DOE.

Your attention to this matter as soon as possible is greatly appreciated. Should you have any questions on the revised Optional Form 60 or proposed project scheduling, please contact me at (303) 963-0115.

We are retrieving the project books from the accountant and should have the requested breakdown of incurred costs by cost element to you the week of June 7.

Sincerely yours,

MINE SUBSIDENCE ENGINEERING COMPANY

Collin L. Stewart
Partner

encl.
attachment

CLS/vs



MINE SUBSIDENCE ENGINEERING CO.

PROPOSED OUTLINE FOR FINAL REPORT
DOE CONTRACT NO. DE-AC22-80PC30118

1.0 INTRODUCTION

2.0 SCOPE OF WORK

3.0 MONUMENT CONSTRUCTION IN ALPINE AREAS

3.1 Site Access

3.2 Forest Service Permits

3.3 Cultural Resources Survey

3.4 Monument Construction

3.4.1 Survey Control Points

3.4.2 Subsidence Monitoring Points

4.0 SURVEYING

4.1 Equipment

4.2 Techniques

4.3 Schedule

5.0 RESULTS

5.1 Control Survey

5.2 Baseline Survey

~~5.3 Final Survey *~~

~~5.4 Profiles *~~

6.0 DISCUSSION

6.1 Control Net

6.1.1 Design Rationale

6.1.2 Layout

6.2 Monitoring Net

6.2.1 Design Rationale

6.2.1.1 Mine Layout

6.2.1.2 Topography

6.2.1.3 Monitoring Considerations

6.3 Monument Construction in Alpine Terrain

~~6.4 Monument Stability Under Extremely Severe Weather Conditions *~~

7.0 CONCLUSIONS

** Delete these items as per directions from DOE*



Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, Pennsylvania 15236

September 16, 1982

Mr. Collin L. Stewart
Mine Subsidence Engineering Company
6590 South Ridgeview Drive
Morrison, Colorado 20465

Dear Mr. Stewart:

The Draft Final Report for the project "Characterization of Subsidence Over Multiple Lift Longwall Panels," Contract No. DE-AC22-80PC30118 has been reviewed by R. W. Stephan and J. S. Jaspal of Pittsburgh Mining Technology Center, M. A. Harthill Office of Coal Mining, Germantown, Maryland, and Dr. N. Styler, Mining Engineer, University of Pittsburgh. Comments by the reviewers are as follows:

I. General Remarks

1. Although the contract was descoped and the level of activity (tasks) was greatly reduced, the quality of the draft Final Report should have been of a higher technical level and quality.
2. The DOE Guidelines for Processing Technical Reports were not observed, i.e., the absence of a cover page, title page, contract title and number, etc.
3. The establishment of a subsidence monitoring network in an alpine terrain is of interest to Western coal mine operators. However, a meaningful report was lost by the limited coverage given in the report.
4. The site surface is open to field work only three months of the year. The subsidence movements were to be monitored on the ground surface before, during and after mining of the panels. What plans or techniques did MSE have to conduct this survey and monitoring during the continuous LWM operations during the year?

A description of the technique or plan would have been a good contribution to the report.

5. Since underground longwall mining is continuing during the winter months, what methods or techniques were to be used to measure surface, subsurface and mine level response to coal extraction?
6. Perhaps, this was the first time a helicopter was used for the installation of control and monitoring points for surface subsidence. More indepth comments on helicopter use and cost comparison and manpower requirements for other methods for monument installation and monitoring would have been of considerable value.

7. Discussion of results should have been expanded to include the establishment of a surface subsidence network in an alpine area. Also the value and practicability of the helicopter to survey the area, use in installation of/ and removal of control and monitoring points.

8. Mention should have been given to the ease or difficulty of monument removal. Also, reclamation, seeding, etc.

II. Editorial Review and Comments

Cover Page - Missing

Disclaimer - Back cover page missing

Title Page - Missing

Table of Contents, Tables and Figures - no pagination (i, ii, iii . . .)

Table of Contents - Section identification/numbering missing. Also under monument construction (p. 15), omitted subsection, Survey Control Monuments."

Introduction - should have had an "Executive Summary"

p1, Para. 3, Line 2 - Delete - work was originally intended . . . add . . . The objective of the project was to monitor

p1, Line 1 - Should have included the original Scope of Work. Then introduce the fact that the contract was descoped, thus limiting the scope of work.

p2 - Figure 1 - site location, missing

p5-7 - Task description. Poorly presented.

p7, Para.1, Line 1,2 - Combine as one paragraph.

p7, Para. 3, Line 2 - Would delete - "Impossible because of "--add--prohibited by county,

p7, Line 4, Line 1 - Would rewrite first part of the sentence. "The use of the helicopter transport was required . . ."

p8 - Figure 2 - site location map, missing.

p31, Para. 2, Line 1 - would write beginning of the sentence --
"Experience gained on the project . . ."

p31, Para. 2, Line 3 - Delete we use - MSE -

p33 - Appendix A - Forestry Permit Form, missing

Appendix B - Environmental Assessment, missing

Appendix C - Cultural Survey Results, missing

Appendix D - Control Survey Results, missing

Appendix E - Baseline Survey Field Data, missing

III. Conclusions

The opportunity to report the results of experience gained for the installation of a subsidence net in an alpine setting has been lost. Although the project was descoped, due to Federal funding cuts, a wealth of information of direct interest to Western coal operators could have been made available in this report. Information on regulatory requirement, the relationship and practicality of helicopter use for property survey(s), monument installations and removal, monitoring survey, problems encountered, cost data and comparisons with other survey techniques could have been presented.

Overall, the Draft Final Report complies with contract requirements. Approval of the Draft Final Report is given provided that the Guidelines for Processing Technical Reports are followed. The Final Report (5 copies) is to be sent to DOE/PMTC, Bruceton, Pennsylvania.



Robert W. Stephan
Project Manager
Mine Planning Branch

Attachments

cc: RAvellanet, W.O.
MHarthill, W.O.
1)CAGoode 2)WDMayercheck
3)Files
RWStephan

