



December 9, 2021

Mr. Zach Trujillo  
Environmental Protection Specialist  
Colorado Division of Reclamation, Mining & Safety  
Department of Natural Resources  
1313 Sherman Street, Room 215  
Denver, CO 80203


**RE: Colowyo Coal Company L.P.**  
**Permit No. C-1981-019**  
**Technical Revision 152 (TR-152)**  
**South Taylor Highwall Mining**

Dear Mr. Trujillo,

Tri-State Generation and Transmission Association Inc. (Tri-State), is the parent company to Axial Basin Coal Company, which is the general partner to Colowyo Coal Company L.P. (Colowyo). Therefore, Tri-State on behalf of Colowyo is submitting technical revision 152 (TR-152) to Permit No. C-1981-019. TR-152 proposes highwall mining of the G7/8 seam in the northeast and southwest portion of the South Taylor Pit.

Included in this technical revision is a change of index sheet to ease incorporation of this technical revision into the permit document, and a public notice for the Division's review. If you should have any additional questions or concerns, please feel free to contact Tony Tennyson at (970) 326-3560 at your convenience.

Sincerely,

DocuSigned by:  
  
D250C711D0BF450...

Chris Gilbreath  
Senior Manager  
Remediation and Reclamation

CG:TT:der

Enclosure

cc: Jennifer Maiolo (BLM-LSFO)  
Tony Tennyson (via email)  
Angela Aalbers (via email)  
File: C. F. 1.1.2.141 - G471-11.3(21)d

## CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONS

Mine Company Name: Colowyo Coal Company

Permit Number: **C-1981-019**

Date: **November 23, 2021**

Revision Description: **TR-152 South Taylor Highwall Mining**

Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
1			No Change
2A			No Change
2B			No Change
2C			No Change
2D			No Change
2E			No Change
3			No Change
4			No Change
4			No Change
5A			No Change
5B			No Change
6			No Change
7			No Change
8	Map 23	Map 23	Map 23 has been updated.
9			No Change
10			No Change
12	South Taylor Lower Wilson - Rule 2, Page 74 (1 page)	South Taylor Lower Wilson - Rule 2, Page 74 (1 page)	Citation to Exhibit 21 in "Disposal of Excess Spoil" was corrected.
12	South Taylor Lower Wilson - Rule 4, Page 7 and 8 (2 pages)	South Taylor Lower Wilson - Rule 4, Page 7 and 8 (2 pages)	Citations to Exhibit 21 in Section 4.09 have been corrected.
12	South Taylor Lower Wilson - Rule 4, Page 14 (1 pages)	South Taylor Lower Wilson - Rule 4, Page 14 (1 pages)	Section 4.23.2(1) has been updated.
13			No Change
14			No Change
15	Table of Contents, Page x (1 page)	Table of Contents, Page x (1 page)	List of Exhibits has been updated.
15	Rule 4, Page 21 (1 pages)	Rule 4, Page 21 (1 pages)	Citation has been added to Section 4.23.2(1).

## CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONS

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Revision Description: **TR-152 South Taylor Highwall Mining**

Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
16			No Change
17			No Change
18A			No Change
18B			No Change
18C			No Change
18D			No Change
19			No Change
20	Exhibit 27, Item 7 All Pages - 19 total	Exhibit 27, Item 7 All Pages - 19 total	Exhibit 27, Item 7 has been updated.
21			No Change
22			No Change

# LIST OF MAPS

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Exhibit 1 Item 11	Names and Address of Surface and Mineral Owners in Permit Revision Area
Exhibit 2	List of Owners and Controllers of Colowyo Mine
Exhibit 6 Item 6	Physiochemical Analyses and Characterization of Overburden in the Project Area Drill Holes 00-03, 00-08, 99-02, 99-04, 99-09, 97-06, 97-09, and 97-15, 83-D3-06, 83-D3-07, 83-D3-10, 83-D3-12, 83-D3-14, and ST-06-08;
Exhibit 7, Item 20	Erosion and Sediment Control Structures
Exhibit 9, Item 5	Narrative Descriptions of NRCS Soil Map Units –Lower Wilson Mine Area
Exhibit 9, Item 6	Narrative Descriptions of Soil Map Units – South Taylor Mine Area
Exhibit 9, Item 7	Soil Inventory Danforth Hills Project Rio Blanco and Moffat Counties
Exhibit 10, Item 5	Vegetation Inventory of the Danforth Hills Project, Rio Blanco County Colorado Harner and Associates, Inc.
Exhibit 13A	South Taylor Reclamation Bond
Exhibit 14, Item 4	Pre-Blast Survey – Structures within ½ Mile of Lower Wilson mining area Tri-State Generation and Transmission Association, Inc (Eight 345 KV Power Pole Foundations) and Routsen Properties (6647 Moffat County Road 51 and 7072 Moffat County Road 51).
Exhibit 14, Item 5	Pre-Blast Survey – Structures within ½ Mile of South Taylor mining area Tri-State Generation and Transmission Association, Inc. (Three 345 KV Power Pole Foundations)
Exhibit 14, Item 6	Pre-Blast Survey – Offering Letters Pre-Blast Structure Locations Drawing
Exhibit 21	South Taylor Excess Spoil Fills Geotechnical Report
Exhibit 23	2013 South Taylor In-Pit Exploratory Drill Holes
Exhibit 23A	2016 South Taylor In-Pit Exploratory Drill Holes
Exhibit 23B	Geotechnical Stability Report for Highwall Mining at the Colowyo Coal Mine

### ***Public Notice of Blasting Schedule***

Colowyo will annually publish a blasting schedule similar to the one set forth in Volume 1, Section 2.05 Figure 1.

### ***Disposal of Excess Spoil***

Colowyo constructed two separate “valley fills” which are called the East Taylor Fill and the West Taylor Fill. These fills were necessary due to the early operation of the South Taylor mining area; overburden needed to be placed into the fills so that sufficient working area could be developed prior to the placement of subsequent overburden into the mined-out areas.

Detailed geotechnical investigations were completed for both the East Taylor Fill and the West Taylor Fill. A report of the investigations can be found in Exhibit 21 Item 1. Construction plans for the fills, addressing the requirements of Rule 4.09, Disposal of Excess Spoil, can also be found in Section 4.09 and Exhibit 21. Locations of the East Taylor Fill and West Taylor Fill can be found in Exhibit 21 and on Map 23.

#### **2.05.4 (1) Reclamation Plan**

The reclamation objective for the South Taylor area is to restore the mined area to a land use capability which will, be equal to or better than that which currently exists. The first objectives of all reclamation practices are to stabilize the soils, maintain hydrologic and vegetation resources, and to restore the approximate original contour of the mined area. Ultimately, the areas being mined will be returned to their approximate original use as rangeland with watersheds having their approximate pre-mining character. In general, the long term appearance and usefulness of the mine plan area will be similar to that which would have been encountered prior to any mining.

The reclamation plan for the existing mining areas provides information relevant to the reclamation of the South Taylor mining area, which can be found in Volume 1, Section 2.05.4. Specific topics requested by the regulations and not incorporated into Volume 1 are included in the following subsections.

#### **2.05.4 (2)(a) Reclamation Timetable**

The sequence for reclamation following the mining process is shown on Map 29. Final reclamation of the South Taylor pit will be delayed, due to the shape, size and depth of the pit; which will result in leaving the majority of the spoil backfilling process until final pit closure. The majority of the spoil will be stacked in the initial boxcut area and associated valley fill areas, allowing adequate space to perform mining operations in a geotechnically safe environment. Although the final reclamation of the South Taylor will be delayed due to the mining operations in the pit, Colowyo is committed to reclamation in accordance with Rule 4.13 and will perform reclamation activities as contemporaneously as practicable with the South Taylor mining operations. With the limitation of areas available for reclamation prior to final pit backfill, Colowyo will reclaim as many areas as allowed by the mine plan as shown on Map 29, prior to final pit closure. The South Taylor pit reached a steady state operation in 2013; where as all spoil material produced in the advancing cut is backfilled into the previously mined areas. In general, it is anticipated that the vast majority of reclamation activities in the South Taylor pit area will begin in the lower elevation areas and progress upslope to the highest elevation areas. This is a matter of practical necessity due to the operational constraints encountered in the area which were also reflected in the hydrological modeling found in Exhibit 7, Item 20. Major departures from this premise will result in the need to revisit the adequacy of the sediment control structures designed and submitted as part of this permit.

# RULE 4 PERFORMANCE STANDARDS

## 4.05.14 – 4.05.18 Various Topics

These sections are addressed in the Volume 1.

### 4.06 TOPSOIL

The topsoil removal, storage, and redistribution plan for the disturbed area associated with the Lower Wilson and South Taylor mining areas will follow the procedures described in Section 4.06 in Volume 1 and as described in Section 2.05.3 (5) and 2.05.4 (2) (d) of this Volume (Volume 12)..

### 4.07 SEALING OF DRILLED HOLES AND UNDERGROUND OPENINGS

Drill holes and underground openings will be sealed in accordance with the procedures outlined in the Section 4.07 in Volume 1.

### 4.08 USE OF EXPLOSIVES

Explosives will be used for blasting in accordance with the procedures and specifications presented in Volume 1, Section 4.08.. Map 26A presents distances to various structures of possible concern surrounding the mining area. Only Section 4.08.2 has changed from Volume 1; see Sections 4.08.1 and 4.08.3 through 4.08.6, in Volume 1.

#### 4.08.2 Pre-Blast Survey

In accordance with Rule 4.08.2(1), pre-blast surveys have been offered to owners of all structures within one-half mile of the permit area. Pre-blast surveys were conducted on residential structures located at 6647 and 7072 Moffat County Road 51, various associated groundwater supply wells, and eleven power pole foundations located along the ridge between Wilson and Taylor Creeks. Copies of the surveys are included in Exhibit 14, Item 4.

### 4.09 DISPOSAL OF EXCESS SPOIL

Spoil removed from the South Taylor pit will be stockpiled as shown on Maps 45 and 20B. Colowyo expects a 20% swell of excavated materials; therefore, part of the material stockpiled in the East and West Taylor Fills will remain at the conclusion of the project as shown on Map 19. Placement will occur as described in previous sections of this volume and in Volume 1.

Design of the two (East Taylor and West Taylor) fills associated with the South Taylor Mine plan are provided in Exhibit 21. The East Taylor Fill will contain approximately 26.6 million yards of temporary out-of-pit spoil and approximately 7.5 million yards of permanent out-of-pit spoil. The West Taylor Fill will contain approximately 10.9 million yards of temporary out-of-pit spoil and approximately 22.6 million yards of permanent out-of-pit spoil. Both fills will be regraded in accordance with the approved post mine topography shown on Map 19. The final configuration of the fills is designed to minimize erosion. This takes into account a number of the components of the other fill piles at the mine, which have proven successful. The final outslope will not exceed 3h:1v.

Fill Name	Temporary Volume	Permanent Volume
East Taylor Fill	26,663,608 Cubic Yards	7,511,137 Cubic Yards
West Taylor Fill	10,993,667 Cubic Yards	22,609,016 Cubic Yards

## RULE 4 PERFORMANCE STANDARDS

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Designed terrace ditches will be constructed at approximately 100 foot vertical increments. Terrace ditches will be backsloped to direct runoff against the face to prevent flows from overflowing the edge of the ditch. These terrace ditches will direct surface runoff perpendicular to the face into a permanent drainage channel designed to pass safely the runoff from a 100 year, 24 hour precipitation event. Terrace ditches are shown on Map 12 and design information is provided in Exhibit 7, Item 20, Parts A and B.

Reclamation, specifically topsoil replacement, seeding etc. will be implemented consistent with the Section 2.05 of the permit.

### CONSTRUCTION PLAN

All available topsoil will be removed and either stockpiled for later use or direct haul replaced to a reclaimed area.

Due to the fact that the valley fill locations are in close proximity to the initial boxcut area means the entire footprint of these fills must be stripped of topsoil. As described in further detail in this submittal under Section 2.05.3(1); “The entire seam sequence from the top overburden through to the bottom G8 seam, which resides in the area of the initial boxcut, will be placed in the valley fill locations; this will allow Colowyo enough spoil room to reach the desired mining depth.”

It is anticipated the valley fill drains and associated lateral drains will be constructed as one project during the first two years of operation in the South Taylor operation for practical purposes and as a necessary step in preparation of the area for full scale mining.

Channels constructed along the outside of the valley fills (perimeter relief drains) will be built immediately after the logical completion of each terrace ditch across the faces of the fills, which obviously cannot be completed until such a time as the fills themselves develop and are constructed to meet PMT compliance. This activity will be logically sequential in that they will be developed from the bottom up.

Colowyo will follow the Shannon & Wilson recommendation for excavation as described in Exhibit 21.

A controlled underdrain in accordance with the Shannon & Wilson recommendations will be placed in the natural drainage bottom from the head to the top of the fill, The harder, available sandstones obtained from the mining operation will be selectively handled and placed in at least a 24 foot wide by 8 foot high configuration to serve as the underdrain before covered by spoil material. The natural spoil sorting which will occur by utilizing the thicker lifts recommended by Shannon & Wilson will be sufficient to protect the drain from clogging above the geotextile fabric.

Lift thicknesses up to 100 feet thick is acceptable and will be utilized to construct the fill. This method of spoil placement also enhances the construction of a free draining layer of spoil material at the base of the fill. Experience at Colowyo provides evidence that the natural sorting process which occurs while dumping in higher lifts is sufficient to create this drain. Inspection and documentation of this natural sorting is recommended and will be conducted by Colowyo. See the Inspection Plan section for additional details.

### INSPECTION PLAN

During construction of the East Taylor and West Taylor Fills, Colowyo will provide the following information in certified reports as required by Rule 4.09.1(11).

## **RULE 4 PERFORMANCE STANDARDS**

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procedures for working around underground mines, surface and groundwater pollution prevention procedures, reduction in fire hazards, backfilling, grading, and PMT requirements for all areas previously permitted.

### **4.23.2(1) Undisturbed Areas of Coal Shall Be Left in Unmined Sections**

As for the rules requirements [Rules 4.23.2(1)(a)-(c)] for leaving undisturbed areas of coal in unmined sections, Colowyo requests a variance from the requirements of this rule for the South Taylor Pit. Colowyo's highly successful highwall mining methods that have been used and will be in the future in the South Taylor Pit, will maximize production and ensure no subsidence occurs. Using this particular method of highwall mining by leaving pillars and barriers allows the seams to be mined below each other and still ensures geologic stability once all seams have been mined out. Please see Exhibit 27, Item 6 and Item 7 in Volume 20 for further discussion on the geotechnical design and operational considerations implemented highwall mining the South Taylor Pit.

### **4.23.2(2) Abandoned or Active Underground Mine Workings**

No abandoned or active underground mine workings have ever existed or currently exist in any of the coal seams in the areas to be highwall mined. Highwall mining will not take place within 500 feet of any abandoned or active underground mining operation.

### **4.23.2(3) Surface Mining Activities and Highwall Mining**

The highwall mining shall follow the surface coal mining activities in a contemporaneous manner consistent with the applicable requirements of Division Rule 4. Due to active pit progressions and sequencing of mining (in addition to meeting the Permit requirements for contemporaneous reclamation), it is required that highwall mining occurs timely if not immediately following conclusion of pit mining activities. Also, as described more fully in 2.06.9(2), the need to backfill, is mandatory for Colowyo in order to build the pit floor from which to work from to mine the successively higher (in the geologic column) coal seam. Hence successful highwall mining is in part dependent upon timely backfill of the pit.

### **4.23.2(4) Prevent Pollution of Surface and Groundwater and to Reduce Fire Hazards**

Ground water in the pit or highwall mining holes will not be problematic since the South Taylor Pit is essentially dry (minor perched aquifers with limited seasonal flows), and is located above the 1<sup>st</sup> regional aquifer (Trout Creek) by a substantial distance. Ground water flow regimes and the negligible impact that Colowyo's surface mining activities have on ground water as a result of mining these target coal seams/rock interburdens are detailed extensively in Section 2.04.7(1). From this extensive body of data and from experiences to date with mining activities, no toxic forming or acid forming water discharge is anticipated from any of the highwall openings. Should toxic forming or acid forming water discharges be encountered, the opening exhibiting the discharge will be backfilled within 72 hours of completion.

Colowyo will backfill each highwall miner entrance hole within 30 days following coal extraction. All highwall miner entrance holes will be further buried by pit backfill during the normal backfill sequence for the pit to remain in compliance with Rules 4.05.1 and 4.05.2. Ground water hydrologic regimes will be re-established in the backfilled pits with no anticipated detrimental effects from the highwall miner holes.

### **4.23.2(5) Holes Need Not Be Plugged**

All highwall miner entrance holes will be backfilled in accordance with the requirements set forth in 4.14.



# LIST OF EXHIBITS

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Exhibit 23, Item 1	Geotechnical Report – Collom Temporary Spoil Pile and Pond
Exhibit 23, Item 2	Addendum to Geotechnical Study for the Collom Temporary Spoil Pile
Exhibit 26, Item 1	Alluvial Groundwater Monitoring Well Information
Exhibit 27, Item 1	Groundwater Monitoring Well Information
Exhibit 27, Item 2	Wilson Reservoir Geotechnical Drilling
Exhibit 27, Item 3	Collom In Pit Drilling
Exhibit 27, Item 5	Collom Facilities Geotechnical Drilling
Exhibit 27, Item 6	Highwall Mining Collom
Exhibit 27, Item 7	Addendum Highwall Mining Collom and South Taylor

## **RULE 4 PERFORMANCE STANDARDS**

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Colowyo does not plan to have concurrent surface or underground mining activities; therefore, the requirements of this Section are not applicable to this permit application.

### **4.23 AUGER AND HIGHWALL MINING**

Colowyo does plan to conduct highwall mining activities; therefore, the requirements of this Section will be revised through the technical revision process prior to initiating any highwall mining in the Collom mining area.

### **4.24 OPERATIONS IN ALLUVIAL VALLEY FLOORS**

### **4.23 AUGER AND HIGHWALL MINING**

#### **4.23.1 Scope**

Highwall mining allows for the recovery of additional coal resources beyond the final pit highwalls and endwalls. Colowyo's has previously effectively highwall mined in the East, Section 16, West, and South Taylor Pits in the past. Colowyo will utilize the vast experience gained from previous highwall mining and implement a highwall mining plan in the Collom Pit. Please see Section 2.06.9 and Map 23B for the seams and areas planned to be highwall mined.

From a surface mining perspective, the Collom Pit delineates the maximum recoverable coal resources permitted by this mining permit for Colowyo to mine. Highwall mining in the Collom Pit will allow for maximum recovery in accordance with Rule 4.23.2(1). Please refer to Sections 2.06.9 in Volume 1 for additional discussion regarding the removal of coal using highwall mining methods.

#### **4.23.2 Performance Standards**

##### **4.23.2(1) Undisturbed Areas of Coal Shall be Left in Unmined Sections**

As for the rules requirements [Rules 4.23.2(1)(a)-(c)] for leaving undisturbed areas of coal in unmined sections, Colowyo requests a variance from the requirements of this rule for the Collom Pit. Colowyo's highly successful highwall mining methods that will be used in the Collom Pit, will maximize production and ensure no subsidence occurs. Using this particular method of highwall mining by leaving pillars and barriers allows the seams to be mined below each other and still ensures geologic stability once all seams have been mined out. Please see Exhibit 27, Item 6 and Item 7 in Volume 20 for further discussion on the geotechnical design and operational considerations implemented highwall mining the Collom Pit.

##### **4.23.2(2) Abandoned or Active Underground Mine Workings**

No abandoned or active underground mine workings have ever existed or currently exist anywhere near the Collom Pit. Therefore, in accordance with Rule 4.23.2(2), no highwall mining activities will occur closer than 500 feet in horizontal distance of any underground mining workings.

##### **4.23.2(3) Contemporaneous Surface and Auger (Highwall) Mining**

Highwall mining will follow the surface coal mining activities in a top-down sequence in the Collom Pit. Highwall mining has to occur as contemporaneous as possible behind surface mining to ensure further advancement of the Collom box cut is not hindered by highwall mining operations. When surface mining opens up a large enough area in the Collom Pit, highwall mining will commence shortly



December 7, 2021

227-43

Mr. Lee Sampson, P.E.  
Senior Mining Engineer  
Colowyo Coal Company  
5731 Highway 13  
Meeker, CO 81641-9124

Re: **Additional/Expanded Highwall Mining Areas, Collom Box Cut and South Taylor Pit, Colowyo Coal Mine, Meeker, Colorado**

Dear Lee:

As you requested on behalf of Colowyo Coal Company (Colowyo), Agapito Associates, Inc. (AAI) has reviewed additional target areas for potential highwall mining (HWM) near the Collom box cut (Collom) and from the South Taylor Pit (South Taylor). AAI previously studied HWM areas for Collom and South Taylor and developed detailed reports for each.<sup>1,2</sup> The additional/expanded targets relative to the previously studied areas are shown in Figure 1.

AAI's previous South Taylor study<sup>1</sup> included mining of the G7 Seam, and where the G7 and G8 Seams come together, their combined thickness (referred to as the G78 Seam). This mining was planned from the low wall (southeast portion) and endwalls (southwest and northeast portions) of the pit. Colowyo is currently considering an additional area not specifically addressed in our previous report, in the northwest and southwest portions of the pit. The original study area and the expanded area for South Taylor are shown in Figure 1.

AAI's previous Collom study<sup>2</sup> included mining of several seams from the low wall and endwalls of the Collom Box Cut. Most of the targets are seam splits that occur close to one another, with little or no parting thickness. For example, the B2/B3 Seam consists of the combined B2 and B3 splits. Mining from the low wall generally included HWM panels mined downdip to the north. This previously studied HWM area in Collom is also shown in Figure 1. Colowyo is currently considering mining in an expanded area not specifically addressed in our previous report, as shown in Figure 1.

AAI reviewed the relevant South Taylor<sup>1</sup> and Collom<sup>2</sup> HWM reports and the updated seam models supplied by Colowyo for the target seams in the additional/expanded areas shown on Figure 1. The

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<sup>1</sup> Agapito Associates, Inc. (2014), "Geotechnical Design and Operational Considerations for Highwall Mining, South Taylor Pit G78 and E/D2 Seams, and West Pit F, E, D2, and C Seams," report to Colowyo Coal Company, April 21, 78 pp.

<sup>2</sup> Agapito Associates, Inc (2019a), "Geotechnical Design and Operational Considerations for Highwall Mining, Collom Box Cut," report to Colowyo Coal Company, November 20, 143 pp.

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**DISCLAIMER:** *This report contains professional opinions based on information provided by the Owner. AAI makes no warranties, either expressed or implied, as to the accuracy or completeness of the information herein. Opinions are based on subjective interpretations of geologic data; other equally valid interpretations may exist. Identification and control of hazardous conditions are the responsibilities of the Owner.*

original studies included compilation of site-specific rock physical properties for both pits, comparison with previous data for other HWM areas of the Colowyo Mine, and detailed analytic and numerical modeling analyses. AAI also reviewed documents related to the filing of the Ground Control addenda for the South Taylor G78 Seam<sup>3</sup> and the Collom B1/B2, C3/C5, D1/D2, and E2 Seams<sup>4</sup> with the Mine Safety and Health Administration (MSHA). The Ground Control addenda referenced different versions of AAI's work for South Taylor<sup>5</sup> and Collom,<sup>6</sup> but the approved design criteria meet or exceed AAI's recommendations.<sup>1,2</sup>

In all, AAI has completed more than 10 HWM studies for Colowyo. Based on our experience on the property over the last 18 years, it is our opinion that the approved design criteria are applicable to the target seams in the additional/expanded areas indicated on Figure 1. The geometric details of the seams in the new areas are slightly different than those discussed in our previous reports,<sup>1,2,6</sup> primarily with regard to planned mining height. These slight differences were not to the extent that would require reevaluation or reconsideration of the design parameters established. A summary of seam characteristics in the current target areas is given in Table 1. Small differences in seam height and/or design cover depth required that the approved web and barrier pillar design curves for the target seams be expanded to include a wider range of these inputs. The updated design curves are shown in Figures 2 through 6. AAI recommends the use of these curves in conjunction with other recommendations from our reports<sup>1,2</sup> to accomplish the mining envisioned for the additional/expanded areas of Figure 1.

**Table 1. Geometric Characteristics of the Target Seams in Additional Areas**

Pit	Parameter	Value (ft)
South Taylor	G78 Cover	30–355
	G78 Thickness	4–9.5
	B2/B3 Cover	90–205
	B2/B3 Thickness	5–8
	B3 to C3 Interburden	20–55
	C3/C5 Cover	170–265
Collom	C3/C5 Thickness	8–10
	C5 to D1 Interburden	30–105
	D1/D2 Cover	30–305
	D1/D2 Thickness	7.5–12.5
	D2 to E2 Interburden	17–55
	E2 Cover	50–355
	E2 Thickness	4.5–7.5

<sup>3</sup> Phillipson, S. E. (2013), "Evaluation of Pillar Stability in the South Taylor Pit, G78 Seams, at Colowyo Coal Co, LP's Colowyo Mine, I.D. 05-02962," MSHA memorandum 13BA142a, September 30, 2 pp.

<sup>4</sup> Lemons, M. L. (2020), "Colowyo Mine ID No. 05-02962 Ground Control Plan Highwall Mining Addendum for: Collom Pit X3/X4, B2/B3, C3/C5, D1/D2, E2, F5/F6, FA/FB, G8/G9 and GB Coal Seams," letter to Colowyo Coal Company, LP, May 14, 44 pp.

<sup>5</sup> Agapito Associates, Inc. (2013), "Highwall Mining Design Curves Based on the ARMPS-HWM Program," letter to Dr. Sandin Phillipson, MSHA Approval and Certification Center, September 27, 16 pp.

<sup>6</sup> Agapito Associates, Inc (2019b), "Geotechnical Design and Operational Considerations for Highwall Mining, Collom Box Cut," report to Colowyo Coal Company, August 5, 143 pp.

Previously, AAI suggested leaving a safety pillar below structures that Colowyo would like to protect from subsidence damage should HWM pillar failure occur. In particular, a transmission line passes through the expanded South Taylor target area. The extent of the safety pillar below a protected structure, where no HWM would occur, can be determined following a method suggested by Peng.<sup>7</sup> This method includes a fixed 30-foot (ft) offset, continues at an outward angle of 45° from vertical through any soil, spoil, or unconsolidated material, and continues at an outward angle of 20° from vertical to the seam of interest (the G78 in the case of South Taylor). For example, the distance around all points of a transmission line support, underlain by 100 ft of spoil and 200 ft of bedrock would be:

$$30 + 100 \tan 45 + 200 \tan 20 = 203 \text{ ft}$$

For areas where the depth to bedrock is unknown and/or difficult to determine, AAI recommends an offset based on a fixed 50-ft offset plus an angle of 25°, resulting in an offset of 190 ft for the above example. This alternative is more conservative for thinner depths to bedrock, but less conservative for thicker depths.

Thank you for the continued opportunity to assist with HWM planning at Colowyo. Please let me know if you have any comments or questions.

Best regards,



Tom Vandergrift  
Vice President and Principal  
[tomvdg@agapito.com](mailto:tomvdg@agapito.com)

TLV:klg

Attachments: Figures 1–6

Transmitted as a PDF via e-mail to [lsampson@tristategt.org](mailto:lsampson@tristategt.org)

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<sup>7</sup> Peng, S. S. (1992), “Surface Subsidence Engineering,” Society for Mining, Metallurgy, and Exploration, Inc., Littleton, Colorado, pp. 78–79.



227-43 Colowyo [F1 HWM SEAM INFORMATION 11-15-21.dwg Layout: F1 Overview]:tv/rjl(4-8-2021)

**Figure 1. HWM Location Map**

Design Depth of Cover, ft	Mining Height, ft												
	4	5	6	7	8	9	10	12	14	16	18	20	22
100	48	60	72	84	96	108	120	144	168	192	216	240	264
140	48	60	72	84	96	108	120	144	168	192	216	240	264
180	56	62	72	84	96	108	120	144	168	192	216	240	264
220	67	72	78	84	96	108	120	144	168	192	216	240	264
260	77	86	92	97	103	109	120	144	168	192	216	240	264
300	85	95	105	113	120	125	132	144	168	192	216	240	264
340	94	105	115	126	135	145	152	164	178	192	216	240	264
380	103	115	127	138	149	160	170	190	204	216	231	245	264
420	111	126	139	151	163	174	186	209	232	252	267	280	293
460	120	136	151	165	178	190	203	229	254	279	303	326	343
500	128	146	162	178	192	207	220	248	277	305	333	360	387
540	137	156	174	191	207	223	238	268	300	332	363	394	425
580	145	166	185	204	222	239	256	288	323	358	393	428	462

Coal strength, psi 900      Mining width, ft 11.50      No. web pillars 19

Pillar widths in italics have width-to-height ratios of 1.0

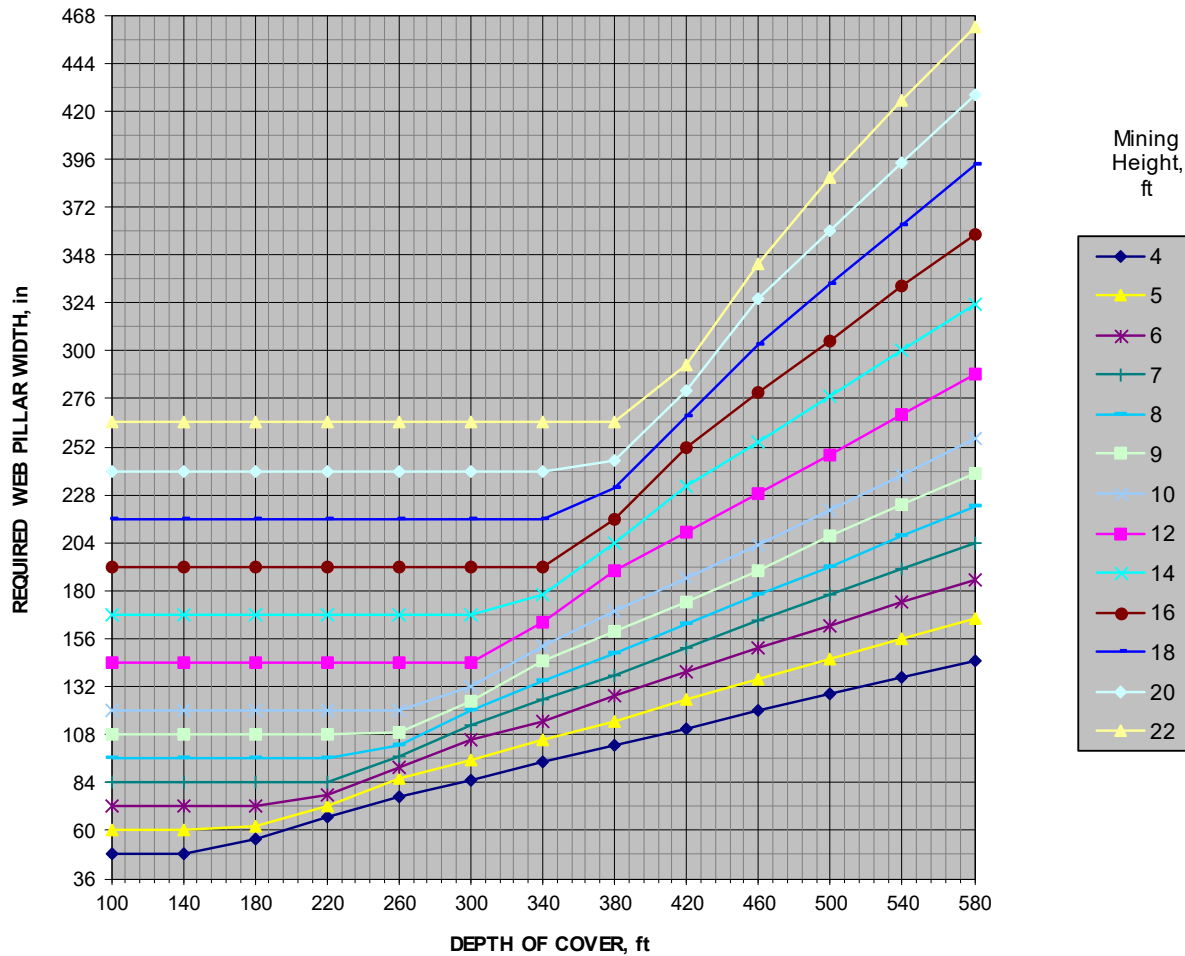


Figure 2a. Web Pillar Design Chart—South Taylor G78 Seam

Design Depth of Cover, ft	Mining Height, ft												
	4	5	6	7	8	9	10	12	14	16	18	20	22
100	7.2	7.8	8.4	9.0	9.4	9.9	10.3	12.0	14.0	16.0	18.0	20.0	22.0
140	10.8	12.0	13.0	13.9	14.7	15.5	16.2	17.5	18.7	19.7	20.7	21.6	22.4
180	14.7	16.4	17.6	18.9	20.2	21.3	22.3	24.3	26.1	27.7	29.2	30.6	32.0
220	16.4	20.0	22.3	24.0	25.6	27.1	28.6	31.2	33.6	35.8	37.9	39.9	41.8
260	18.8	21.1	24.3	28.0	31.1	33.0	34.8	38.1	41.2	44.0	46.7	49.3	51.7
300	21.7	24.4	26.9	29.2	32.4	36.0	40.0	45.1	48.8	52.3	55.6	58.7	61.7
340	24.9	27.8	30.5	33.2	35.7	38.1	40.9	48.0	56.0	60.6	64.5	68.2	71.7
380	28.1	31.4	34.4	37.2	40.0	42.8	45.4	50.4	57.0	64.0	72.0	77.7	81.8
420	31.3	35.0	38.4	41.6	44.5	47.4	50.4	56.0	61.4	66.7	74.0	81.2	88.2
460	34.5	38.7	42.4	45.9	49.2	52.3	55.3	61.7	67.6	73.4	78.9	84.6	92.2
500	37.7	42.3	46.4	50.3	53.9	57.3	60.6	67.3	73.9	80.3	86.4	92.4	98.2
540	40.9	45.9	50.5	54.7	58.6	62.4	65.9	72.9	80.2	87.2	94.0	100.6	107.0
580	44.1	49.5	54.5	59.0	63.3	67.4	71.3	78.5	86.4	94.1	101.5	108.8	115.8
Coal strength, psi		900		Mining width, ft		11.50		No. web pillars		19			
Pillar widths in italics have width-to-height ratios of 1.0													

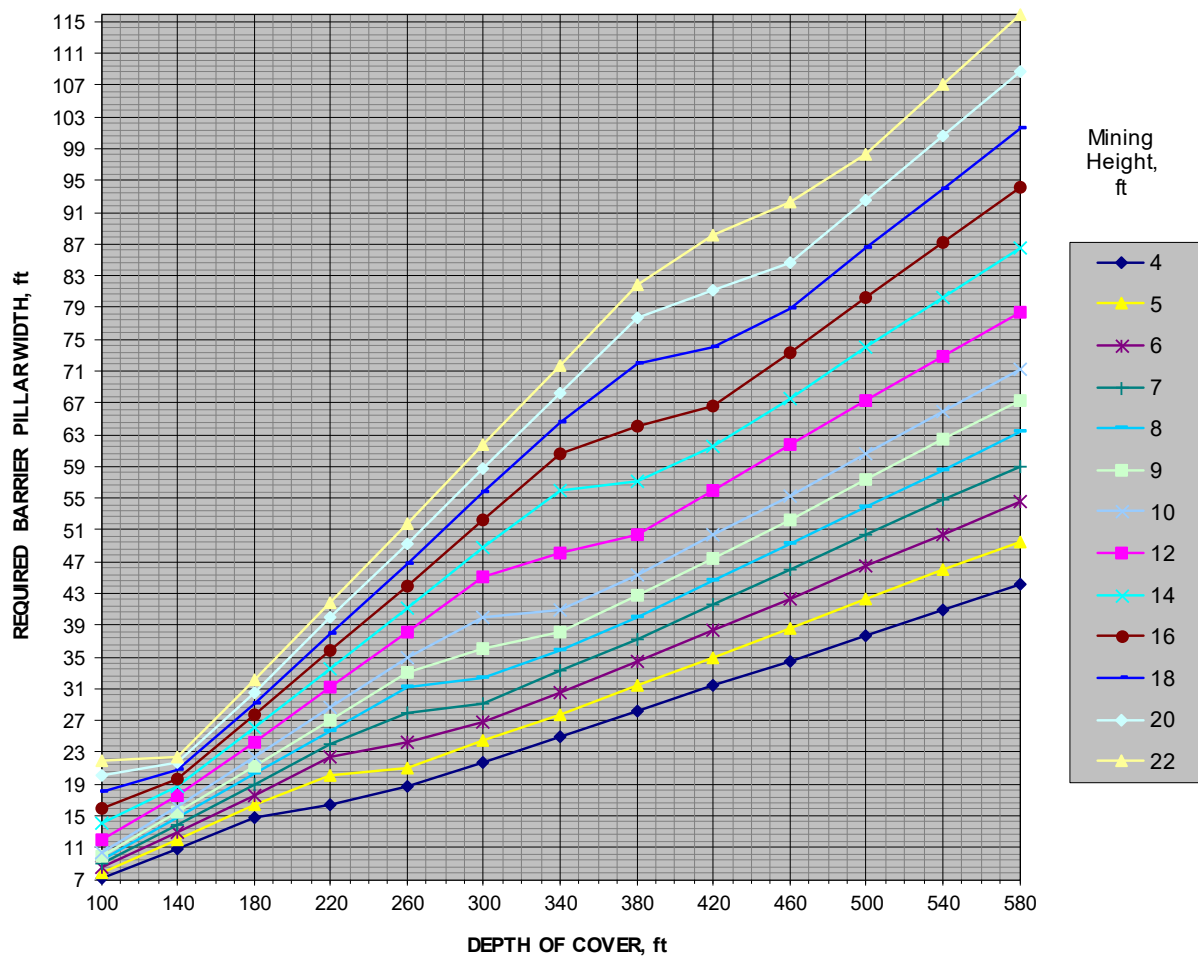


Figure 2b. Barrier Pillar Design Chart—South Taylor G78 Seam



Design Depth of Cover, ft	Mining Height, ft													
	4	5	6	7	8	9	10	12	14	16	18	20	22	
100	73.4	69.1	65.3	61.8	58.8	56.0	53.5	48.9	45.1	41.8	39.0	36.5	34.3	
140	72.6	68.2	64.4	61.0	58.0	55.2	52.7	48.4	44.7	41.5	38.8	36.4	34.3	
180	69.0	66.8	63.6	60.2	57.2	54.5	52.0	47.7	44.1	40.9	38.3	35.9	33.8	
220	65.3	63.2	61.2	59.4	56.4	53.7	51.3	47.0	43.4	40.4	37.7	35.4	33.3	
260	62.0	59.4	57.5	55.9	54.2	52.8	50.6	46.4	42.8	39.8	37.2	34.9	32.9	
300	59.5	56.8	54.4	52.5	50.8	49.6	48.0	45.7	42.2	39.2	36.6	34.4	32.4	
340	57.0	54.2	52.0	49.7	48.0	46.2	45.0	42.8	40.5	38.7	36.1	33.9	32.0	
380	54.6	51.9	49.4	47.4	45.5	43.7	42.2	39.6	37.7	36.2	34.4	33.1	31.5	
420	52.6	49.5	47.1	45.0	43.2	41.6	40.0	37.3	34.9	33.1	31.6	30.5	29.4	
460	50.6	47.5	45.0	42.8	41.0	39.4	37.9	35.2	32.9	30.9	29.2	27.7	26.6	
500	48.9	45.7	43.2	40.9	39.1	37.4	36.0	33.3	31.0	29.0	27.3	25.8	24.4	
540	47.1	44.0	41.4	39.2	37.3	35.6	34.2	31.6	29.3	27.3	25.6	24.1	22.8	
580	45.7	42.4	39.8	37.6	35.7	34.0	32.5	30.1	27.8	25.8	24.1	22.6	21.3	
Coal strength, psi		900		Mining width, ft		11.50		No. web pillars						19

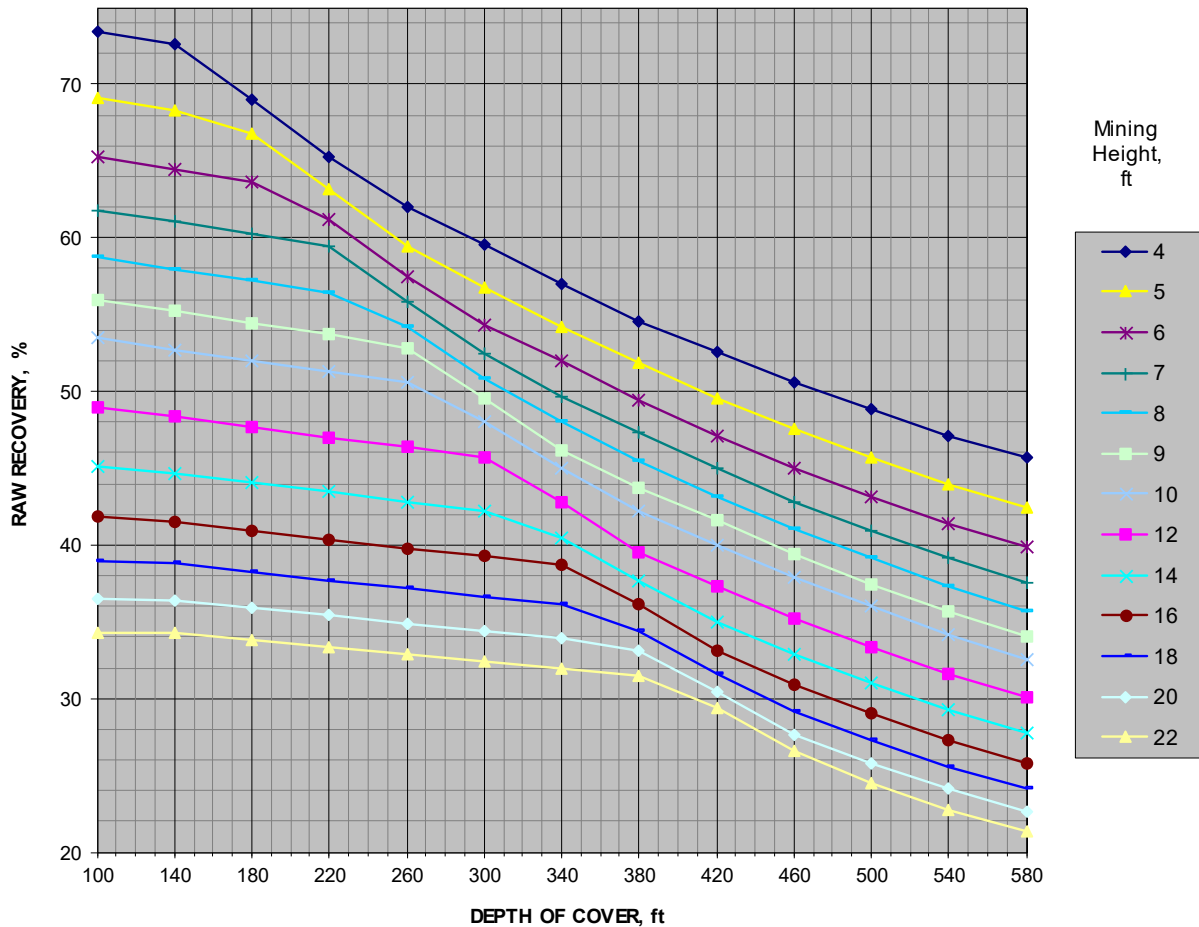


Figure 2c. Raw Recovery—South Taylor G78 Seam

Design Depth of Cover, ft	Mining Height, ft												
	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
110	49	53	58	62	66	70	73	77	81	84	87	91	94
130	55	59	64	68	73	77	81	85	89	93	97	101	104
150	62	66	70	74	79	84	89	93	98	102	106	110	114
170	68	73	78	82	86	91	96	101	106	110	115	120	124
190	74	80	85	90	95	99	104	108	113	119	124	129	134
210	80	86	92	98	103	108	113	118	122	127	132	137	143
230	86	93	99	106	112	117	123	128	133	138	143	148	152
250	91	99	106	113	120	126	132	138	144	149	155	160	165
270	97	105	113	121	128	135	142	148	154	161	166	172	178
290	103	112	120	128	136	144	151	158	165	172	178	185	191
310	108	118	127	136	144	152	160	168	175	183	190	197	204
330	113	124	134	143	152	161	170	178	186	194	202	209	217
350	119	130	140	150	160	170	179	188	196	205	213	221	229

Coal strength, psi 495      Mining width, ft 11.50      No. web pillars 19

Pillar widths in italics have width-to-height ratios of 0.8

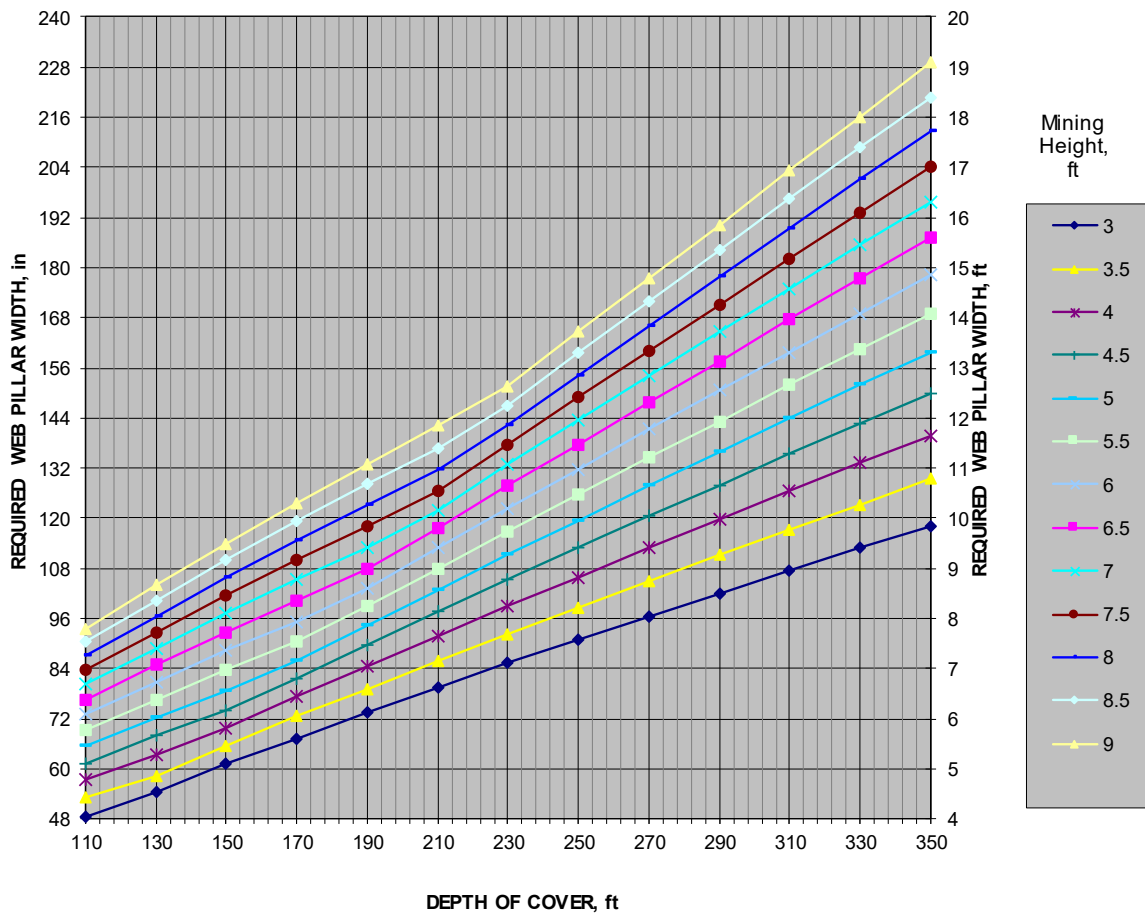


Figure 3a. Web Pillar Design Chart—Collom B2/B3 Seam

Design Depth of Cover, ft	Mining Height, ft												
	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
110	10.0	10.8	11.5	12.2	12.8	13.4	13.9	14.4	14.9	15.4	15.9	16.4	16.8
130	12.0	13.1	14.0	14.8	15.6	16.3	17.1	17.7	18.4	19.0	19.6	20.2	20.7
150	12.0	14.0	16.0	17.5	18.5	19.3	20.2	21.0	21.8	22.6	23.3	24.0	24.7
170	13.8	14.9	16.0	18.0	20.0	22.0	23.4	24.3	25.3	26.2	27.1	27.9	28.7
190	15.6	16.8	18.0	19.1	20.1	22.0	24.0	26.0	28.0	29.8	30.8	31.8	32.8
210	17.4	18.8	20.1	21.4	22.5	23.6	24.7	26.0	28.0	30.0	32.0	34.0	36.0
230	19.3	20.8	22.3	23.6	24.9	26.2	27.4	28.5	29.6	30.7	32.0	34.0	36.0
250	21.1	22.8	24.4	25.9	27.4	28.7	30.1	31.3	32.5	33.7	34.9	36.0	37.0
270	22.9	24.8	26.6	28.2	29.8	31.3	32.7	34.1	35.5	36.8	38.0	39.3	40.4
290	24.7	26.8	28.7	30.5	32.2	33.9	35.4	37.0	38.4	39.8	41.2	42.6	43.9
310	26.6	28.8	30.9	32.8	34.7	36.4	38.1	39.8	41.4	42.9	44.4	45.9	47.3
330	28.4	30.8	33.0	35.1	37.1	39.0	40.8	42.6	44.3	46.0	47.6	49.2	50.7
350	30.2	32.8	35.1	37.4	39.5	41.6	43.5	45.4	47.3	49.0	50.8	52.5	54.1
Coal strength, psi		495		Mining width, ft		11.50				No. web pillars		19	
Pillar widths in italics have width-to-height ratios of 0.8													

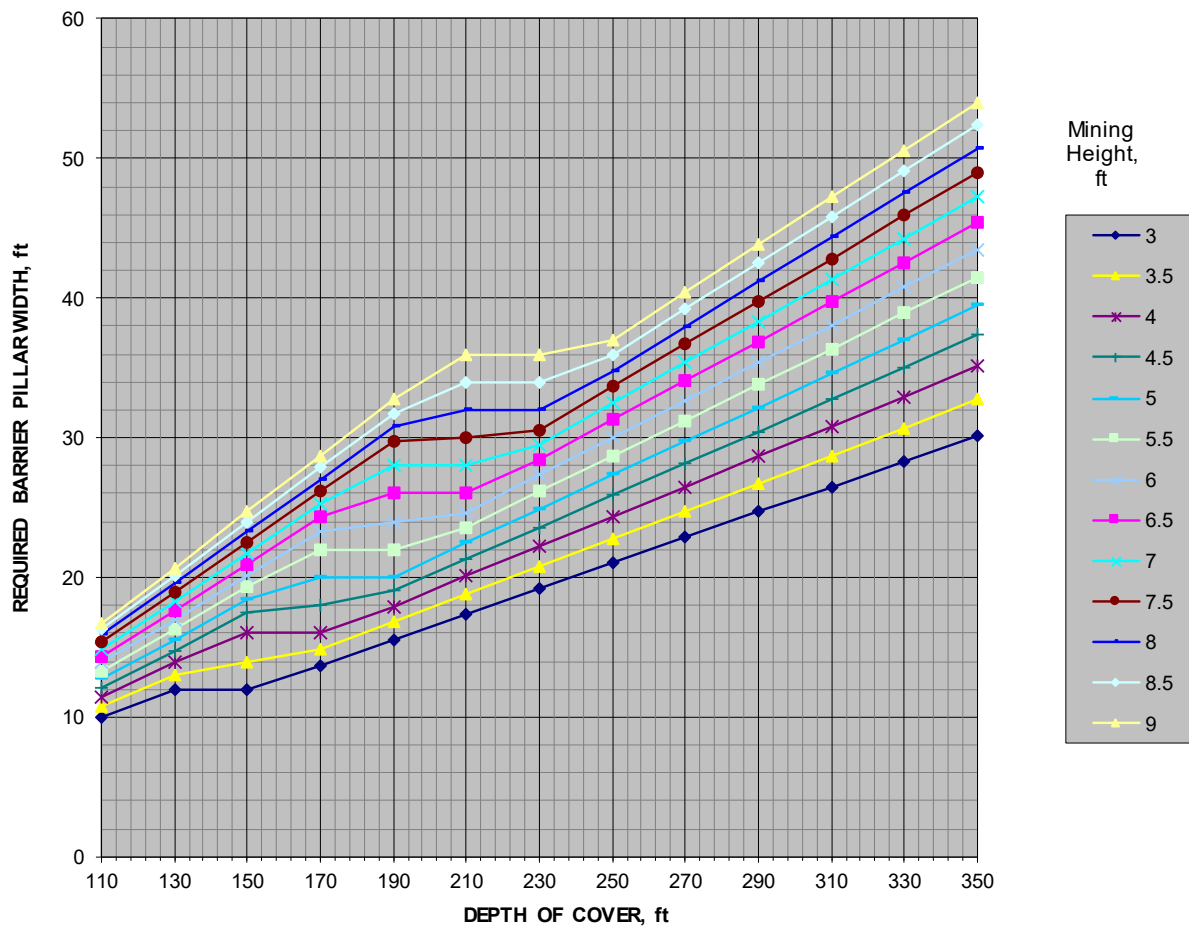


Figure 3b. Barrier Pillar Design Chart—Collom B2/B3 Seam

Design Depth of Cover, ft	Mining Height, ft												
	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
110	72.4	70.8	69.0	67.6	66.2	64.9	64.0	62.8	61.6	60.8	60.0	58.9	58.1
130	69.9	68.3	66.6	65.3	63.7	62.5	61.3	60.2	59.1	58.0	57.0	56.1	55.4
150	67.6	66.0	64.5	63.1	61.6	60.2	58.8	57.8	56.5	55.5	54.6	53.7	52.8
170	65.4	63.8	62.2	60.9	59.6	58.1	56.7	55.5	54.4	53.4	52.4	51.4	50.5
190	63.4	61.6	60.1	58.7	57.4	56.3	54.9	53.9	52.6	51.3	50.3	49.4	48.4
210	61.5	59.7	58.1	56.6	55.3	54.2	53.0	51.9	51.0	49.9	48.8	47.8	46.7
230	59.7	57.8	56.2	54.6	53.2	52.1	50.9	49.9	48.9	48.0	47.1	46.2	45.4
250	58.2	56.2	54.5	52.9	51.4	50.2	49.0	47.9	46.9	46.0	45.1	44.3	43.5
270	56.6	54.6	52.8	51.1	49.7	48.4	47.2	46.1	45.2	44.1	43.3	42.5	41.6
290	55.1	53.0	51.3	49.7	48.2	46.8	45.6	44.5	43.4	42.4	41.6	40.7	39.9
310	53.8	51.6	49.8	48.1	46.7	45.4	44.1	42.9	41.9	40.9	40.0	39.1	38.3
330	52.6	50.3	48.4	46.8	45.3	43.9	42.6	41.5	40.4	39.4	38.5	37.7	36.8
350	51.3	49.1	47.3	45.6	44.0	42.5	41.3	40.1	39.1	38.1	37.2	36.4	35.6

Coal strength, psi 495      Mining width, ft 11.50      No. web pillars 19

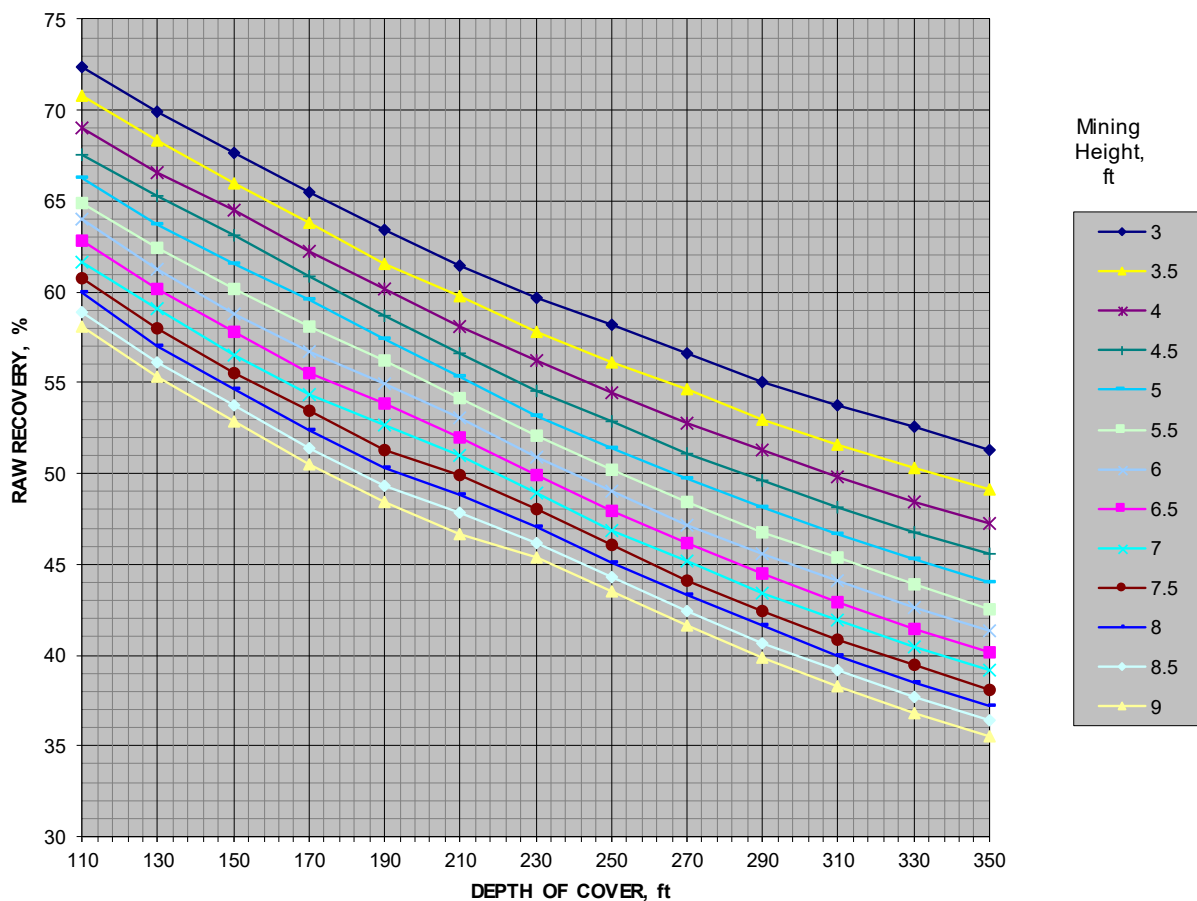


Figure 3c. Raw Recovery—Collom B2/B3 Seam

Design	Mining Height, ft												
Depth of Cover, ft	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11
130	51	54	58	63	68	72	77	82	87	92	96	101	106
160	58	61	64	67	70	73	77	82	87	92	96	101	106
190	64	68	71	75	78	81	85	88	91	94	97	101	106
220	70	74	78	82	85	89	93	96	100	103	107	110	113
250	75	80	84	88	92	97	101	104	108	112	116	120	123
280	81	85	90	95	99	104	108	112	116	121	125	129	133
310	86	91	96	101	106	111	115	120	124	129	133	138	142
340	94	98	102	107	112	117	122	127	132	137	142	146	151
370	101	105	110	115	119	124	129	135	140	145	150	155	160
400	108	113	118	123	128	132	137	142	147	153	158	163	169
430	114	120	126	131	137	142	147	152	156	161	166	172	177
460	121	128	134	140	145	151	156	162	167	172	177	182	187
490	128	135	142	148	154	160	166	172	178	183	189	194	199
Coal strength, psi	900		Mining width, ft			11.50			No. web pillars			19	
Pillar widths in italics have width-to-height ratios of 0.8													

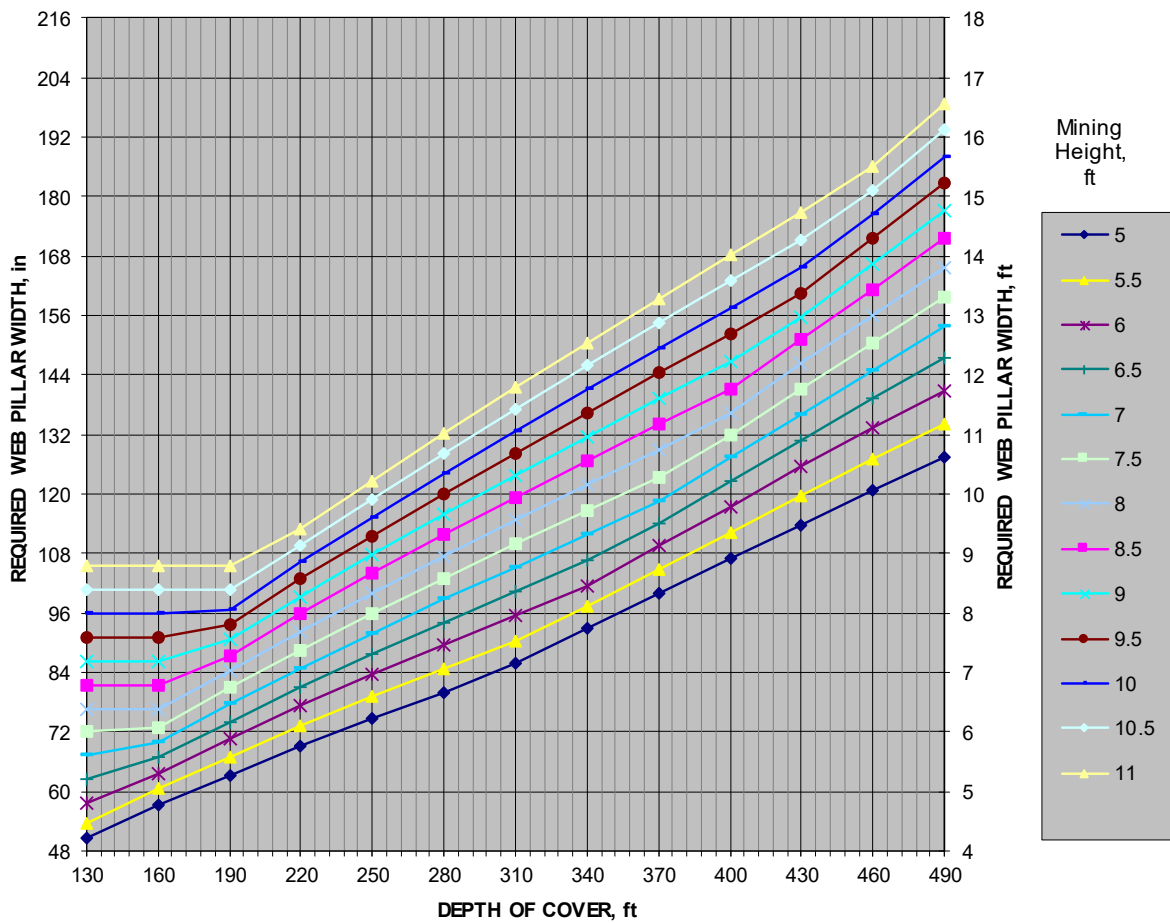


Figure 4a. Web Pillar Design Chart—Collom C3/C5 Seam

Design Depth of Cover, ft	Mining Height, ft													
	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	
130	10.4	10.9	11.3	11.7	12.0	12.4	12.7	13.1	13.4	13.7	14.0	14.4	14.7	
160	13.4	14.0	14.6	15.1	15.6	16.1	16.6	17.1	17.5	17.9	18.3	18.7	19.1	
190	16.5	17.2	17.9	18.6	19.3	19.9	20.5	21.1	21.7	22.2	22.8	23.3	23.8	
220	19.5	20.4	21.3	22.1	22.9	23.7	24.5	25.2	25.9	26.6	27.2	27.9	28.5	
250	20.0	22.0	24.0	25.7	26.6	27.5	28.4	29.3	30.1	30.9	31.7	32.5	33.2	
280	21.5	22.5	24.0	26.0	28.0	30.0	32.0	33.4	34.4	35.3	36.2	37.1	38.0	
310	24.1	25.2	26.3	27.3	28.4	30.0	32.0	34.0	36.0	38.0	40.0	41.8	42.8	
340	26.7	27.9	29.2	30.4	31.5	32.6	33.6	34.7	36.0	38.0	40.0	42.0	44.0	
370	29.3	30.7	32.1	33.4	34.6	35.8	37.0	38.2	39.3	40.3	41.4	42.4	44.0	
400	31.9	33.4	34.9	36.4	37.8	39.1	40.4	41.7	42.9	44.1	45.2	46.4	47.5	
430	34.5	36.2	37.8	39.4	40.9	42.4	43.8	45.2	46.5	47.8	49.1	50.3	51.5	
460	37.1	39.0	40.7	42.4	44.1	45.6	47.2	48.7	50.1	51.5	52.9	54.3	55.6	
490	39.7	41.7	43.6	45.4	47.2	48.9	50.6	52.2	53.7	55.3	56.8	58.2	59.6	
Coal strength, psi	900		Mining width, ft					11.50		No. web pillars				19
Pillar widths in italics have width-to-height ratios of 0.8														

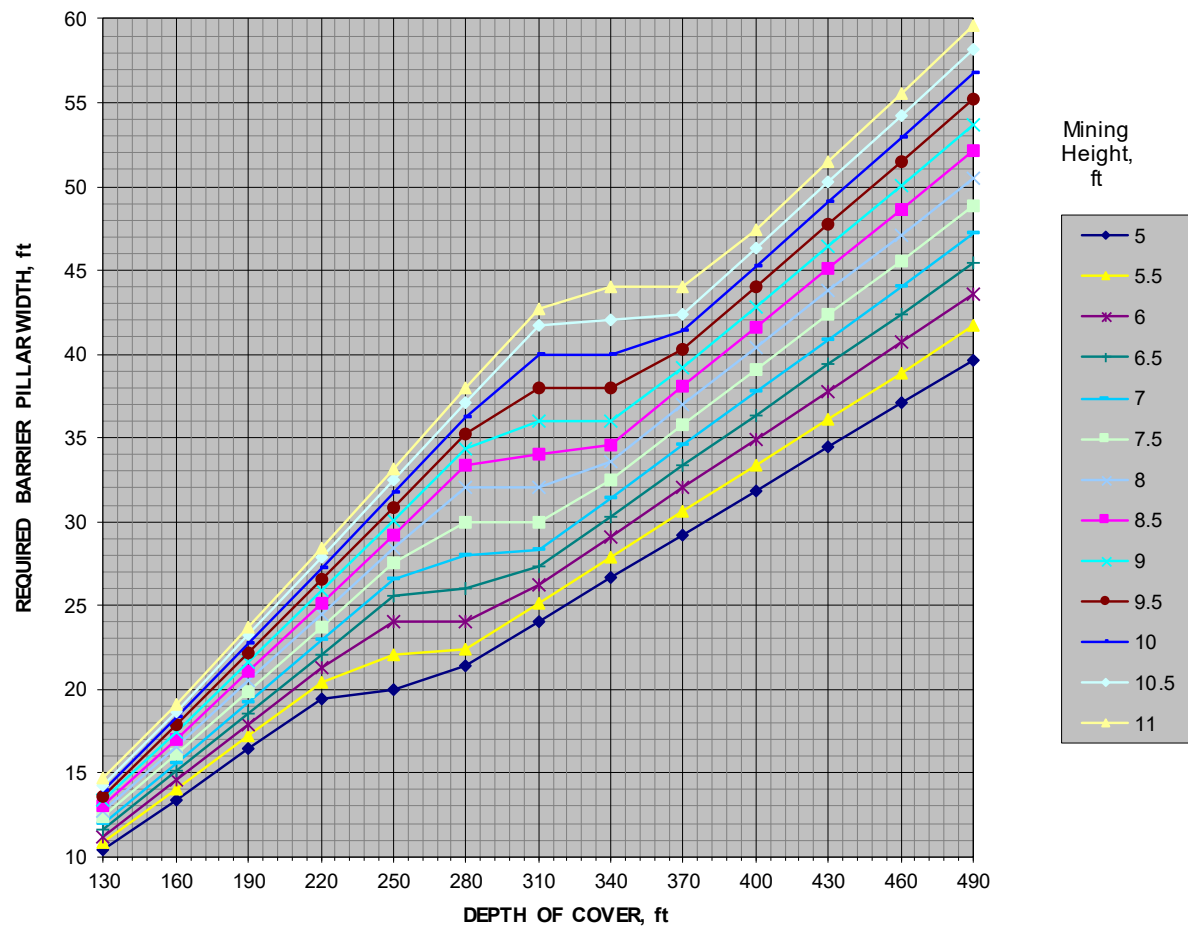


Figure 4b. Barrier Pillar Design Chart—Collom C3/C5 Seam

Design Depth of Cover, ft	Mining Height, ft												
	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11
130	71.6	70.5	69.0	67.4	65.8	64.5	63.1	61.7	60.3	59.1	58.1	56.9	55.8
160	68.6	67.5	66.5	65.5	64.5	63.6	62.4	61.0	59.7	58.4	57.5	56.3	55.2
190	66.1	64.8	63.8	62.6	61.7	60.8	59.7	58.9	58.1	57.4	56.6	55.7	54.5
220	63.8	62.6	61.4	60.2	59.4	58.3	57.2	56.5	55.5	54.8	53.9	53.2	52.6
250	62.4	60.7	59.4	58.2	57.2	55.9	55.0	54.2	53.4	52.5	51.6	50.8	50.2
280	60.6	59.4	58.0	56.6	55.5	54.2	53.1	52.2	51.3	50.3	49.6	48.8	48.1
310	58.9	57.6	56.3	55.1	54.0	52.8	51.8	50.7	49.7	48.7	47.9	46.9	46.2
340	56.7	55.7	54.7	53.5	52.4	51.4	50.4	49.4	48.4	47.4	46.5	45.7	44.8
370	54.9	53.9	52.7	51.6	50.8	49.8	48.8	47.7	46.8	46.0	45.2	44.4	43.6
400	53.1	52.0	50.9	49.9	48.9	48.1	47.2	46.3	45.5	44.5	43.8	43.0	42.2
430	51.7	50.4	49.2	48.2	47.1	46.3	45.4	44.6	43.9	43.2	42.4	41.6	40.9
460	50.1	48.8	47.6	46.6	45.7	44.7	43.9	43.0	42.2	41.5	40.8	40.2	39.5
490	48.7	47.4	46.1	45.1	44.1	43.2	42.3	41.5	40.7	40.0	39.2	38.6	38.0
Coal strength, psi		900		Mining width, ft		11.50				No. web pillars		19	

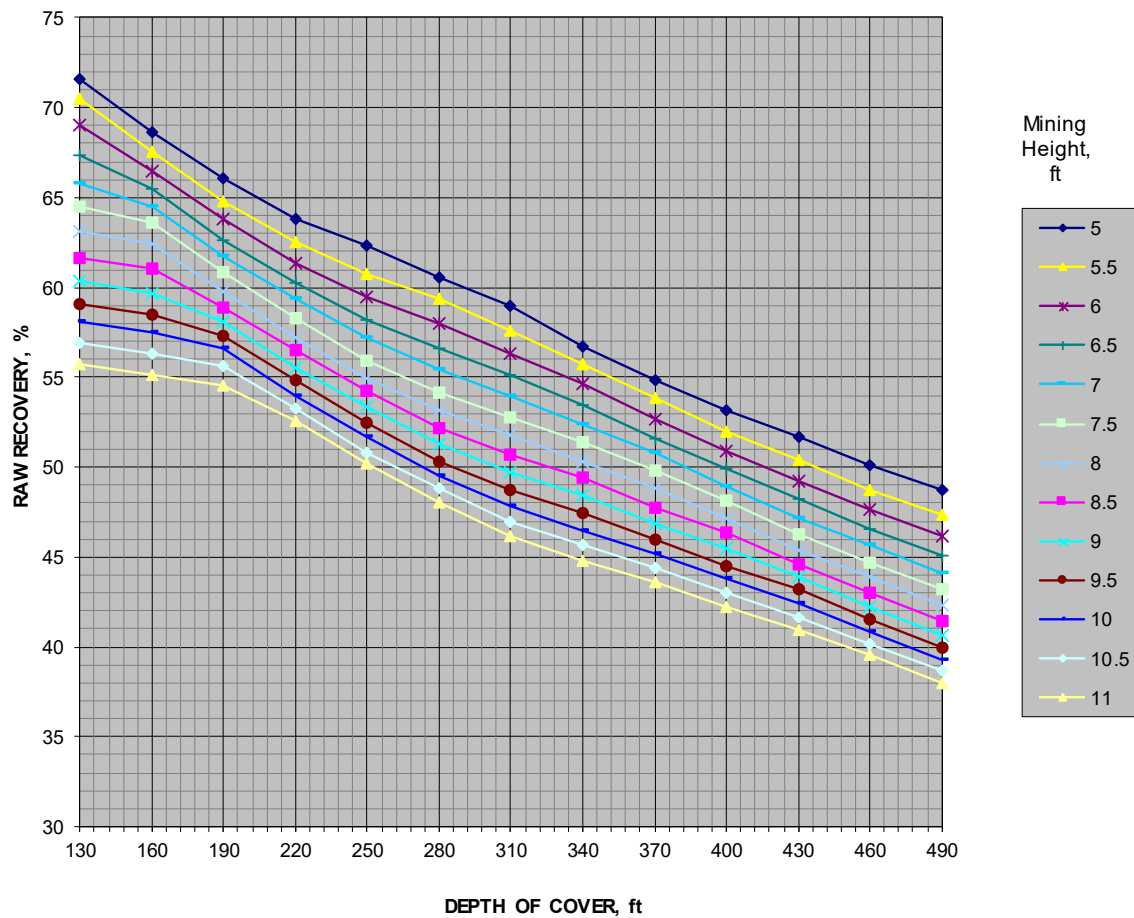


Figure 4c. Raw Recovery—Collom C3/C5 Seam

Design Depth of Cover, ft	Mining Height, ft												
	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
190	83	86	90	93	96	100	103	106	110	113	116	120	125
210	88	92	95	99	103	106	110	113	117	120	124	127	130
230	93	97	101	105	109	113	116	120	124	128	131	135	138
250	98	102	107	111	115	119	123	127	131	135	139	142	146
270	103	107	112	116	121	125	129	134	138	142	146	150	154
290	108	112	117	122	126	131	136	140	144	149	153	157	162
310	112	117	122	127	132	137	142	146	151	156	160	165	169
330	117	122	127	133	138	143	148	153	158	162	167	172	177
350	123	127	132	138	143	148	154	159	164	169	174	179	184
370	129	134	139	143	149	154	160	165	170	176	181	186	191
390	136	141	146	151	156	160	165	171	177	182	188	193	199
410	142	148	153	158	163	168	173	178	183	189	194	200	206
430	149	155	160	166	171	176	181	186	191	196	201	207	213
Coal strength, psi	821												
Mining width, ft	11.50												
No. web pillars	19												

Pillar widths in italics have width-to-height ratios of 0.8

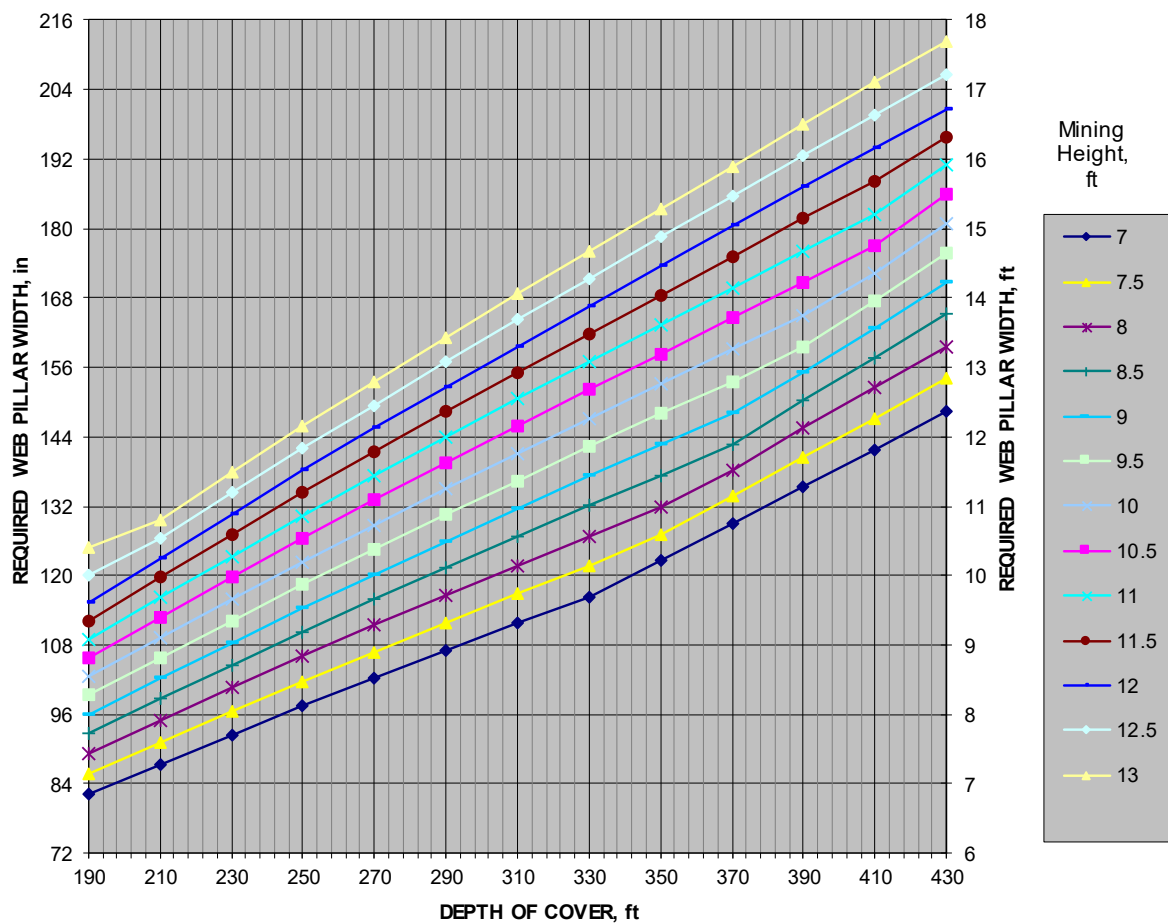


Figure 5a. Web Pillar Design Chart—Collom D1/D2 Seam



Design Depth of Cover, ft	Mining Height, ft												
	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
190	20.5	21.2	21.9	22.5	23.1	23.7	24.3	24.9	25.4	25.9	26.5	27.0	27.5
210	23.1	23.9	24.6	25.4	26.1	26.8	27.4	28.1	28.7	29.3	29.9	30.5	31.1
230	25.7	26.6	27.4	28.2	29.0	29.8	30.6	31.3	32.1	32.8	33.5	34.1	34.8
250	28.0	29.2	30.2	31.1	32.0	32.9	33.8	34.6	35.4	36.2	37.0	37.7	38.5
270	28.0	30.0	32.0	34.0	35.0	36.0	36.9	37.9	38.8	39.6	40.5	41.3	42.2
290	28.0	30.0	32.0	34.0	36.0	38.0	40.0	41.1	42.1	43.1	44.0	45.0	45.9
310	30.0	31.1	32.1	34.0	36.0	38.0	40.0	42.0	44.0	46.0	47.6	48.6	49.6
330	32.3	33.4	34.5	35.5	36.6	38.0	40.0	42.0	44.0	46.0	48.0	50.0	52.0
350	34.5	35.7	36.8	38.0	39.1	40.2	41.2	42.2	44.0	46.0	48.0	50.0	52.0
370	36.7	38.0	39.2	40.4	41.6	42.8	43.9	45.0	46.1	47.1	48.2	50.0	52.0
390	38.9	40.3	41.6	42.9	44.2	45.4	46.6	47.8	48.9	50.1	51.2	52.2	53.3
410	41.1	42.5	44.0	45.4	46.7	48.0	49.3	50.6	51.8	53.0	54.2	55.3	56.4
430	43.3	44.8	46.4	47.8	49.3	50.7	52.0	53.3	54.6	55.9	57.2	58.4	59.6

Coal strength, psi 821      Mining width, ft 11.50      No. web pillars 19

Pillar widths in italics have width-to-height ratios of 0.8

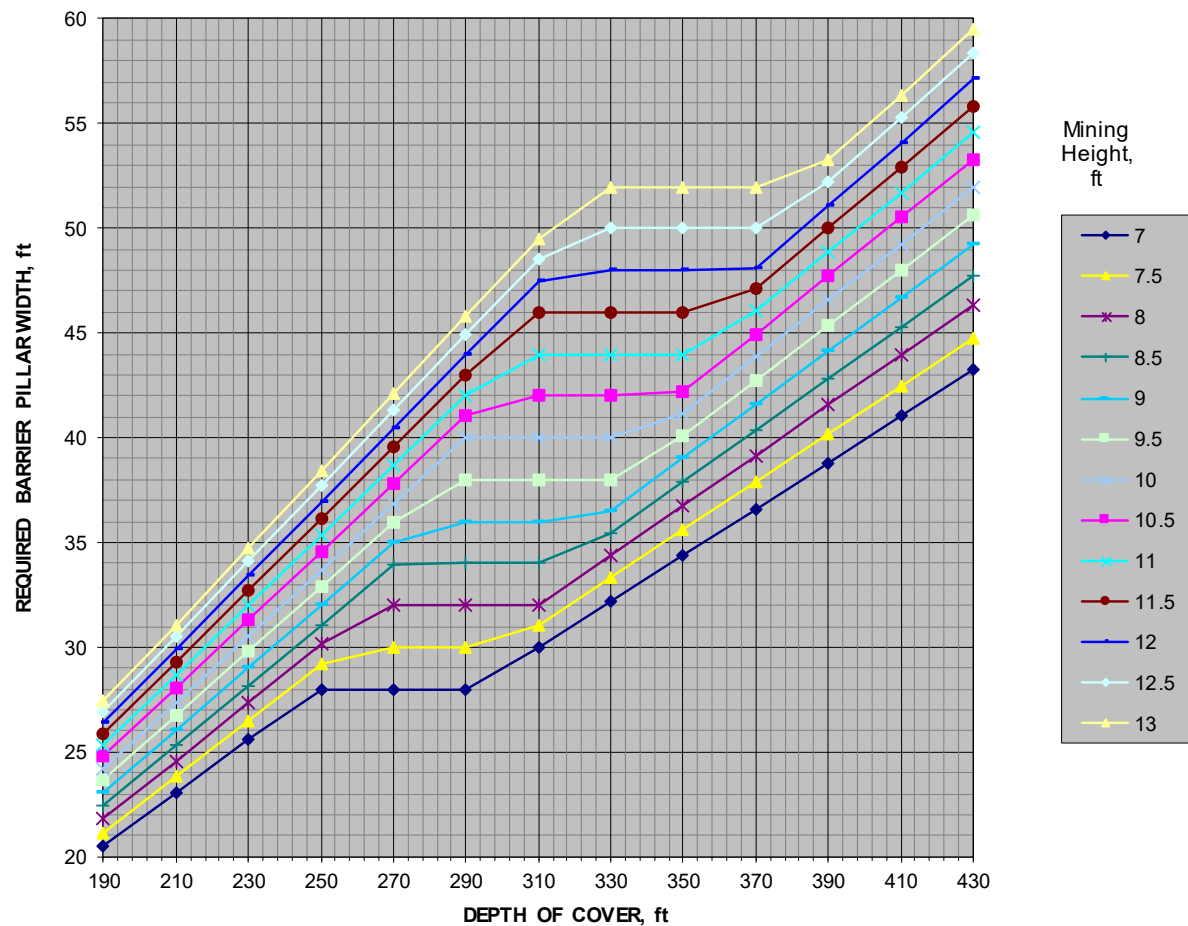


Figure 5b. Barrier Pillar Design Chart—Collom D1/D2 Seam

Design Depth of Cover, ft	Mining Height, ft												
	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13
190	60.2	59.4	58.3	57.5	56.8	55.8	55.1	54.4	53.5	52.9	52.3	51.5	50.5
210	58.6	57.6	56.8	55.8	54.9	54.2	53.3	52.6	51.8	51.2	50.4	49.8	49.3
230	57.1	56.1	55.1	54.2	53.3	52.4	51.8	51.0	50.2	49.4	48.8	48.1	47.6
250	55.7	54.7	53.5	52.6	51.8	51.0	50.2	49.4	48.6	47.9	47.2	46.7	46.0
270	54.6	53.6	52.4	51.4	50.4	49.6	48.8	47.9	47.2	46.5	45.8	45.2	44.6
290	53.6	52.6	51.4	50.3	49.4	48.4	47.4	46.7	46.0	45.2	44.6	43.9	43.2
310	52.6	51.5	50.5	49.5	48.4	47.4	46.5	45.7	44.8	44.0	43.3	42.6	42.0
330	51.4	50.4	49.4	48.3	47.4	46.5	45.6	44.7	43.9	43.2	42.4	41.6	40.9
350	50.1	49.3	48.3	47.3	46.4	45.6	44.7	43.9	43.1	42.3	41.6	40.8	40.1
370	48.8	47.9	47.0	46.3	45.3	44.5	43.6	42.9	42.2	41.4	40.7	40.0	39.4
390	47.5	46.6	45.7	44.9	44.1	43.5	42.8	41.9	41.1	40.5	39.7	39.1	38.4
410	46.4	45.4	44.6	43.8	43.0	42.3	41.6	40.9	40.2	39.5	38.9	38.2	37.5
430	45.2	44.2	43.4	42.5	41.8	41.1	40.5	39.8	39.2	38.6	38.0	37.3	36.7

Coal strength, psi 821      Mining width, ft 11.50      No. web pillars 19

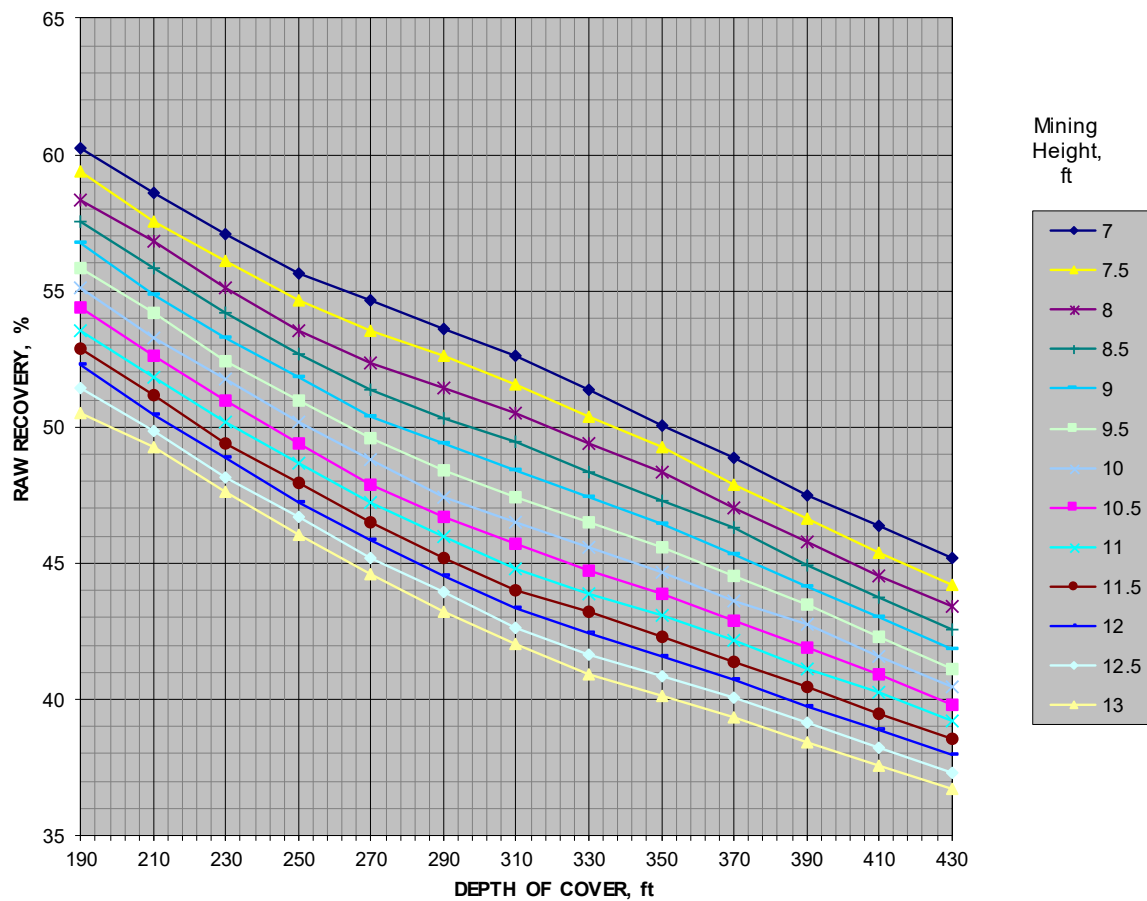


Figure 5c. Raw Recovery—Collom D1/D2 Seam

Design Depth of Cover, ft	Mining Height, ft												
	4	4.33	4.67	5	5.33	5.67	6	6.33	6.67	7	7.33	7.67	8
140	47	49	51	54	56	58	59	61	65	68	71	74	77
170	53	55	58	60	62	64	67	69	71	73	75	77	79
200	58	61	63	66	68	71	73	76	78	81	83	85	87
230	63	66	69	72	74	77	80	83	85	88	90	93	95
260	67	71	74	77	80	83	86	89	92	95	97	100	103
290	74	76	79	82	86	89	92	95	98	101	104	107	110
320	80	83	86	89	92	95	98	101	105	108	111	114	118
350	86	89	93	96	99	102	105	108	111	114	118	121	125
380	92	96	99	103	106	110	113	116	119	122	125	128	132
410	98	102	106	110	114	117	121	124	128	131	134	137	140
440	104	108	112	117	121	125	129	132	136	140	143	147	150
470	109	114	119	123	128	132	136	140	144	148	152	156	160
500	115	120	125	130	135	140	144	148	153	157	161	165	169

Coal strength, psi 900      Mining width, ft 11.50      No. web pillars 19

Pillar widths in italics have width-to-height ratios of 0.8

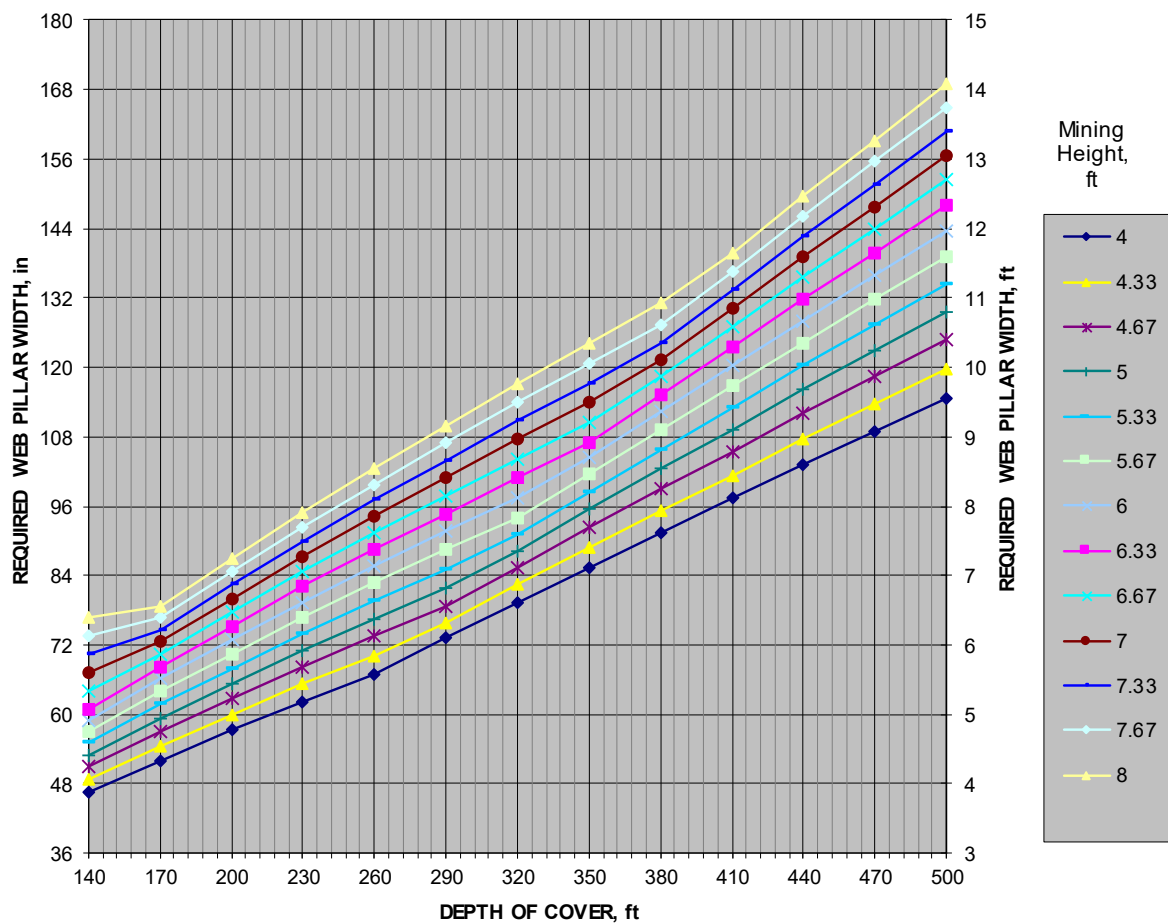


Figure 6a. Web Pillar Design Chart—Collom E2 Seam

Design Depth of Cover, ft	Mining Height, ft												
	4	4.33	4.67	5	5.33	5.67	6	6.33	6.67	7	7.33	7.67	8
140	10.4	10.7	11.1	11.4	11.8	12.1	12.4	12.7	13.0	13.2	13.5	13.8	14.0
170	13.0	13.5	14.0	14.4	14.9	15.3	15.7	16.1	16.5	16.9	17.2	17.6	17.9
200	15.7	16.3	16.9	17.5	18.0	18.6	19.1	19.6	20.0	20.5	21.0	21.4	21.8
230	16.0	17.4	18.7	20.0	21.2	21.8	22.4	23.0	23.6	24.2	24.7	25.3	25.8
260	17.7	18.4	19.1	20.0	21.4	22.7	24.0	25.4	26.7	27.8	28.5	29.1	29.8
290	20.0	20.8	21.6	22.3	23.0	23.7	24.4	25.4	26.7	28.0	29.4	30.7	32.0
320	22.3	23.2	24.1	24.9	25.7	26.5	27.3	28.0	28.7	29.4	30.1	30.7	32.0
350	24.6	25.6	26.6	27.5	28.4	29.3	30.1	31.0	31.8	32.5	33.3	34.0	34.8
380	27.0	28.0	29.1	30.1	31.1	32.1	33.0	33.9	34.8	35.7	36.5	37.4	38.1
410	29.3	30.5	31.6	32.7	33.8	34.9	35.9	36.9	37.9	38.8	39.7	40.7	41.5
440	31.6	32.9	34.2	35.4	36.5	37.7	38.8	39.9	40.9	42.0	43.0	44.0	44.9
470	33.9	35.3	36.7	38.0	39.2	40.5	41.7	42.8	44.0	45.1	46.2	47.3	48.3
500	36.2	37.7	39.2	40.6	41.9	43.3	44.6	45.8	47.1	48.3	49.4	50.6	51.7

Coal strength, psi 900      Mining width, ft 11.50      No. web pillars 19

Pillar widths in italics have width-to-height ratios of 0.8

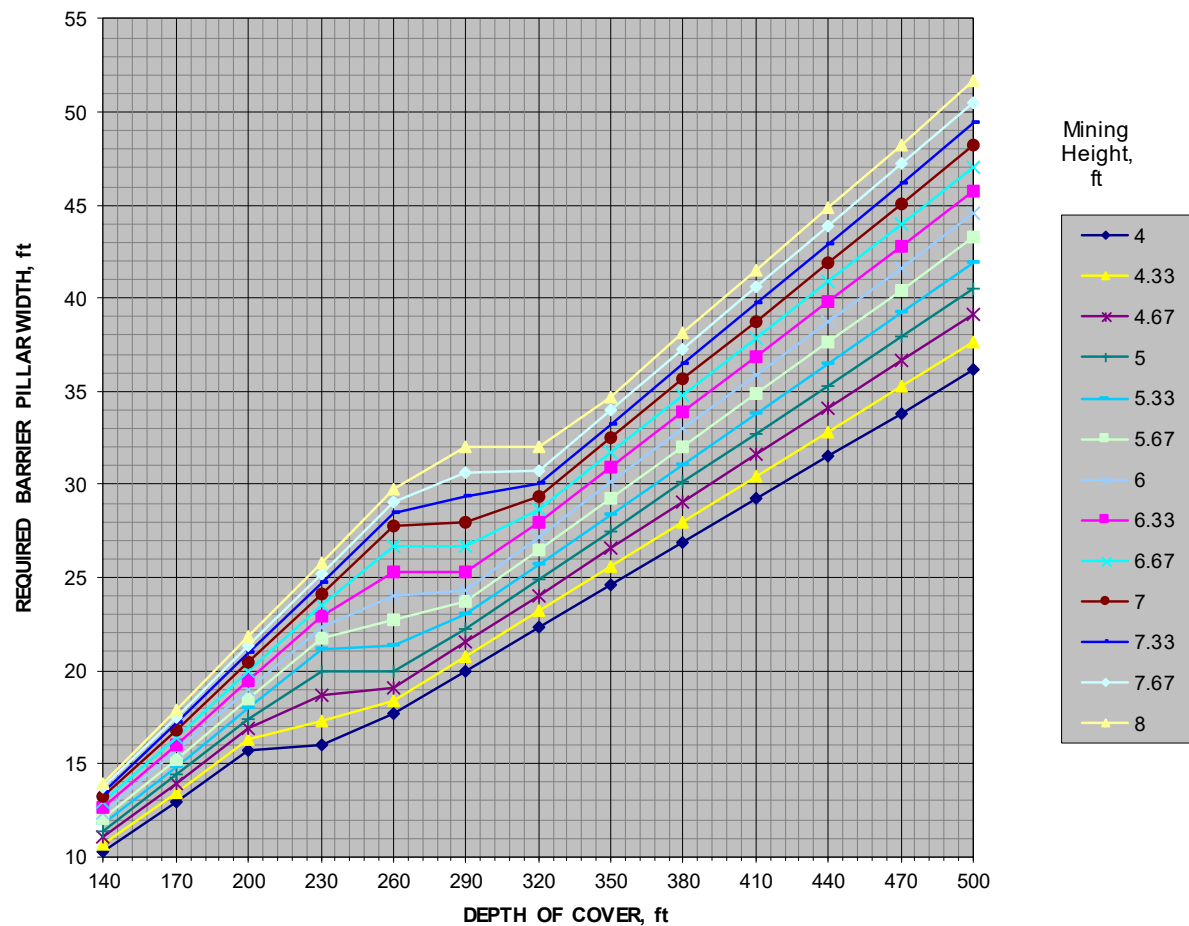


Figure 6b. Barrier Pillar Design Chart—Collom E2 Seam

Design Depth of Cover, ft	Mining Height, ft												
	4	4.33	4.67	5	5.33	5.67	6	6.33	6.67	7	7.33	7.67	8
140	73.1	72.3	71.5	70.4	69.6	68.9	68.5	67.8	66.5	65.6	64.6	63.7	62.9
170	70.4	69.6	68.5	67.8	67.0	66.4	65.4	64.7	64.1	63.5	62.9	62.2	61.7
200	68.1	67.1	66.3	65.3	64.7	63.7	63.1	62.2	61.6	60.7	60.1	59.6	59.0
230	66.5	65.4	64.3	63.2	62.4	61.5	60.7	59.8	59.3	58.4	57.9	57.1	56.6
260	65.0	63.7	62.8	61.8	60.8	59.9	58.9	58.0	57.2	56.3	55.8	55.1	54.4
290	62.6	62.0	61.1	60.2	59.1	58.3	57.5	56.7	55.8	55.0	54.2	53.5	52.7
320	60.7	59.8	58.9	58.1	57.3	56.5	55.8	55.0	54.1	53.4	52.8	52.1	51.2
350	58.9	58.0	57.0	56.2	55.4	54.7	53.9	53.2	52.6	51.9	51.1	50.5	49.7
380	57.1	56.1	55.3	54.3	53.6	52.7	52.0	51.4	50.7	50.1	49.5	48.9	48.2
410	55.5	54.5	53.6	52.6	51.8	51.1	50.3	49.7	48.9	48.3	47.7	47.2	46.6
440	54.0	53.0	52.1	51.0	50.2	49.4	48.6	48.0	47.3	46.6	46.1	45.4	44.9
470	52.7	51.6	50.5	49.7	48.7	48.0	47.2	46.5	45.8	45.1	44.5	43.9	43.3
500	51.3	50.3	49.2	48.3	47.4	46.5	45.8	45.1	44.3	43.7	43.0	42.4	41.9

Coal strength, psi 900      Mining width, ft 11.50      No. web pillars 19

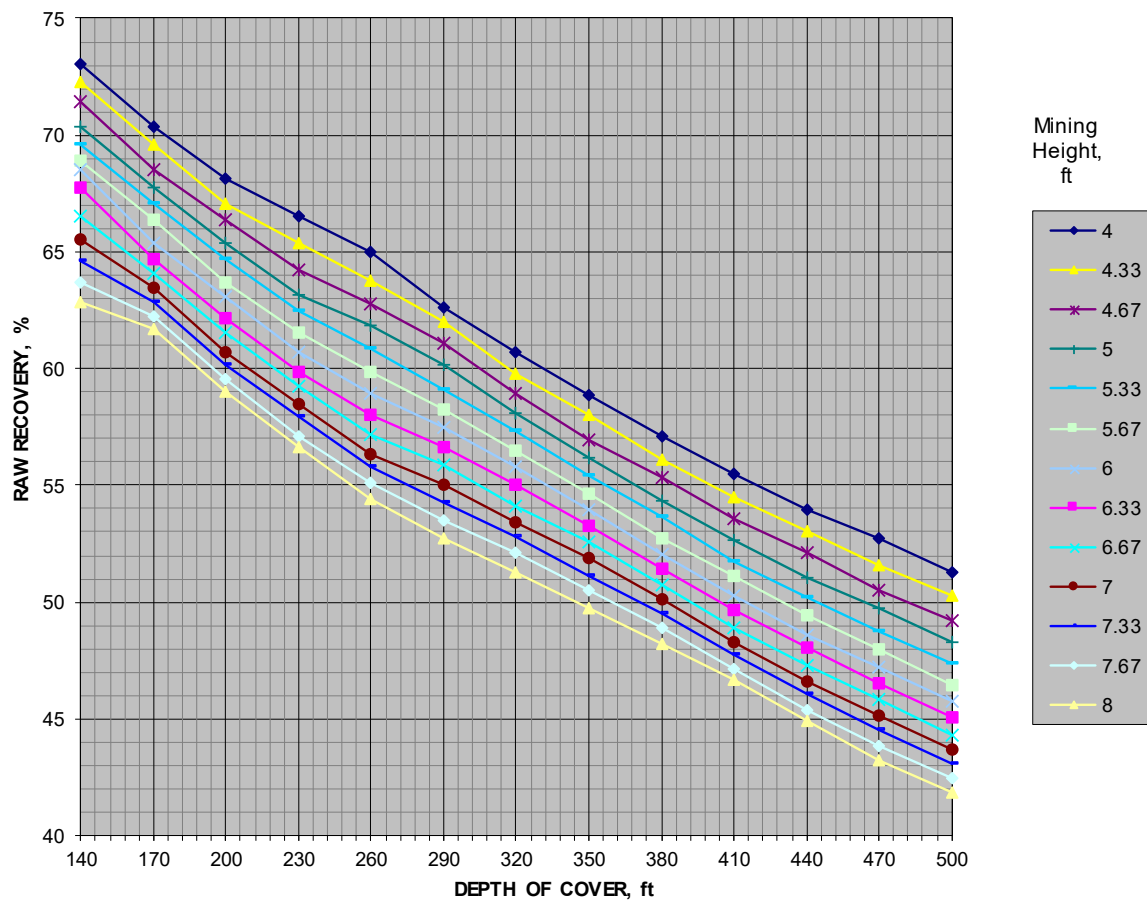


Figure 6c. Raw Recovery—Collom E2 Seam