MINE SUBSIDENCE INVESTIGATION

Dearmin/Swink Property
420.58 Acres in Section 21,
Township 1 North, Range 68 West,
Weld County, Colorado

Prepared For:

SOUTHERN LAND COMPANY

1225 17th Street, Suite 2420
Denver, Colorado 80202

WESTERN ENVIRONMENT AND ECOLOGY, INC.

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1225 17th Street, Suite 2420
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Project Number 778-002-01

December 15, 2018

Greg D. Sherman, P.G.
President

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1.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of mine subsidence investigations completed on and adjacent to the Dearmin/Swank Property, consisting of 420.58 acres in Section 21, Township 1 North, Range 68 West, Weld County, Colorado, Western Environment and Ecology, Inc. (Western Environment) presents the following:

- The average "theoretical" surface strains calculated for the Dearmin/Swank property are:

Boulder Valley Mine 0.127%

Columbine Mine 0.206%

Eagle Mine 0.213%

- The depth to the top of the "main" seam ranged from:

278 feet for the Boulder Valley Mine

192* feet for the Upper Seam of the Columbine Mine

415 feet for the Eagle Mine

Using these conclusions, the following general subsidence related recommendations for development are presented:

- Areas shown on Figure 2 and 6 as occurring outside of the **0% strain line** have no mine subsidence related development restrictions.
- The theoretical "worst case" strains identified for the project will allow construction of buildings or building segments equal to or less than;

154 feet for the Boulder Valley Mine

98 feet for the Columbine Mine, Upper Seam

93 feet for the Eagle Mine

- Structures should be limited to two stories or less and be constructed using wood or metal framing.
- Larger structures may be built if additional studies, including drilling, are conducted.

* **Depth inferred from seam elevations noted on original mine map.**

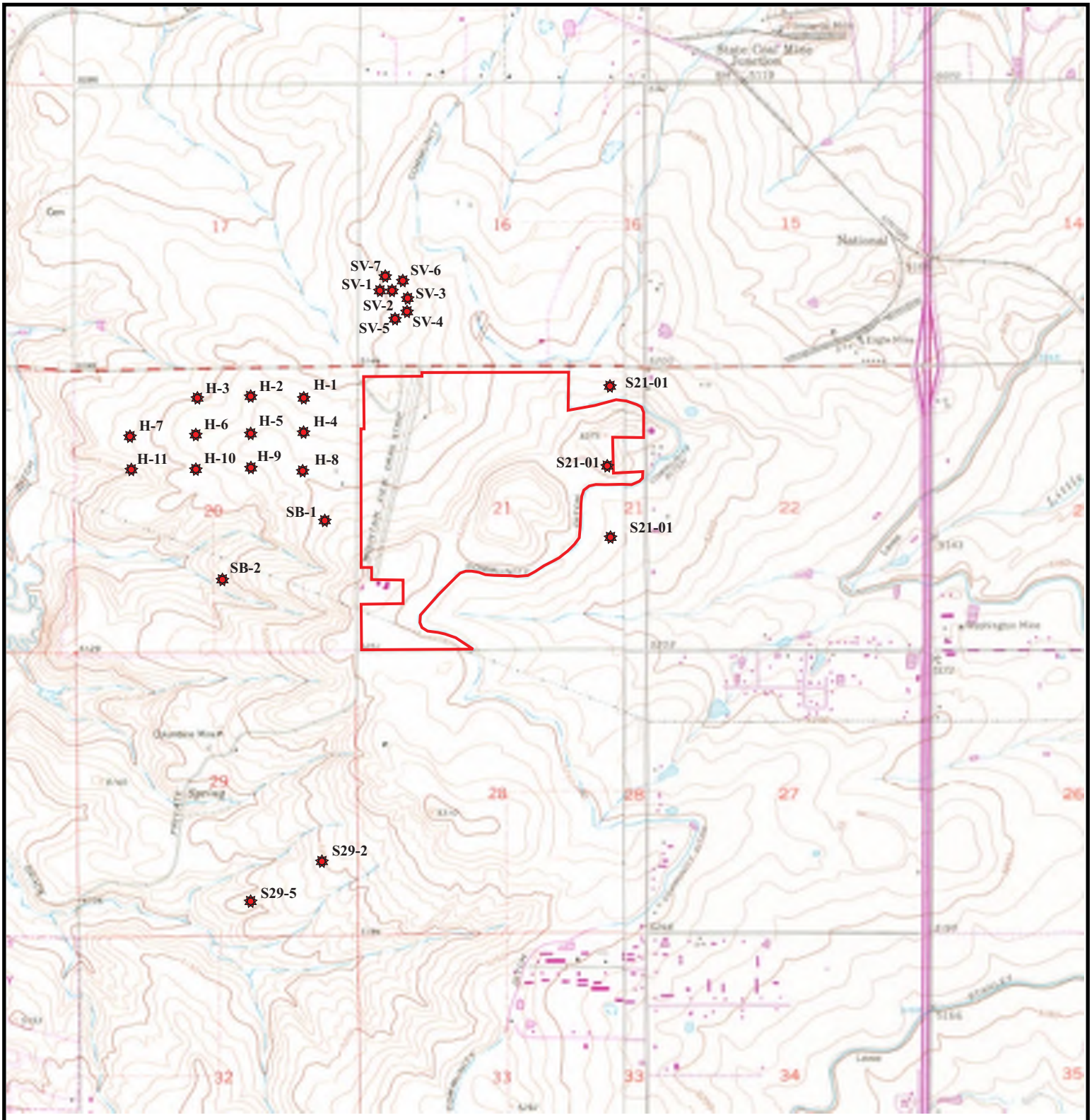
2.0 INTRODUCTION

Western Environment was retained by Ms. Heidi Majerik of the Southern Land Company to conduct a mine subsidence investigation of 420.58 acres in Section 21, Township 1 North, Range 68 West, Weld County, Colorado (Figure 1).

The purpose of this investigation is to evaluate the subsidence potential of the Boulder Valley, Columbine and Eagle Mines, and evaluate "theoretical" surface strains from a "worst case" subsidence event. Additionally, recommendations for subsidence resistant development procedures and techniques are given. In a September 7th, 2018 letter to Hannah Hippely. Community Development Director for the Town of Erie , Jill Carlson of the Colorado Geological Survey, recommended that the Town **"require that a subsidence hazard investigation be perform as a part of the preliminary plat application."** This subsidence investigation meets that requirement.

Western Environment has completed several mine subsidence investigations on and adjacent to the Dearmin/Swank Property. These reports are entitled: ***Mine Subsidence Investigation: Horst Property, April 4, 2000 (Project # 167-003-01)***; ***Mine Subsidence Investigation, Proposed Erie High School Site, May 10, 2003 (Project Number 256-002-01); Preliminary Mine Subsidence Investigation East 1/2 of Section 21, Township 1 North, Range 68 West, Weld County, Colorado, dated July 19, 2006 (Project Number 82-022-01); Preliminary Mine Subsidence Investigation, Pratt Property, Section 29, Township 1 North, Range 68 West , dated November 16, 2006 (Project Number 445-001-01) and Mine Subsidence Investigation Erie Estates Subdivision, dated May 29, 2008 (Project Number 233-005-05)***.

Data acquired during these investigations evaluated "theoretical" subsidence induced surface strains and made recommendations regarding development of the projects. These investigations were submitted to the Colorado Geological Survey and therefore are public information. The results and recommendations contained within this report are intended for use as an aid in planning and design. This report should accompany the annexation request submitted to the Town of Erie. The Town will then forward the report to the Colorado Geological Survey review and comment. This process will aid in assuring a more predictable and thus economic development process.



USGS Erie and Frederick Quadrangles, 7.5 Minute Series, 1979

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Figure 1 - Property Location Map
Showing Hole Locations
Dearmin/Swank Property
Section 21, Township 1 North, Range 68 West
Weld County, Colorado

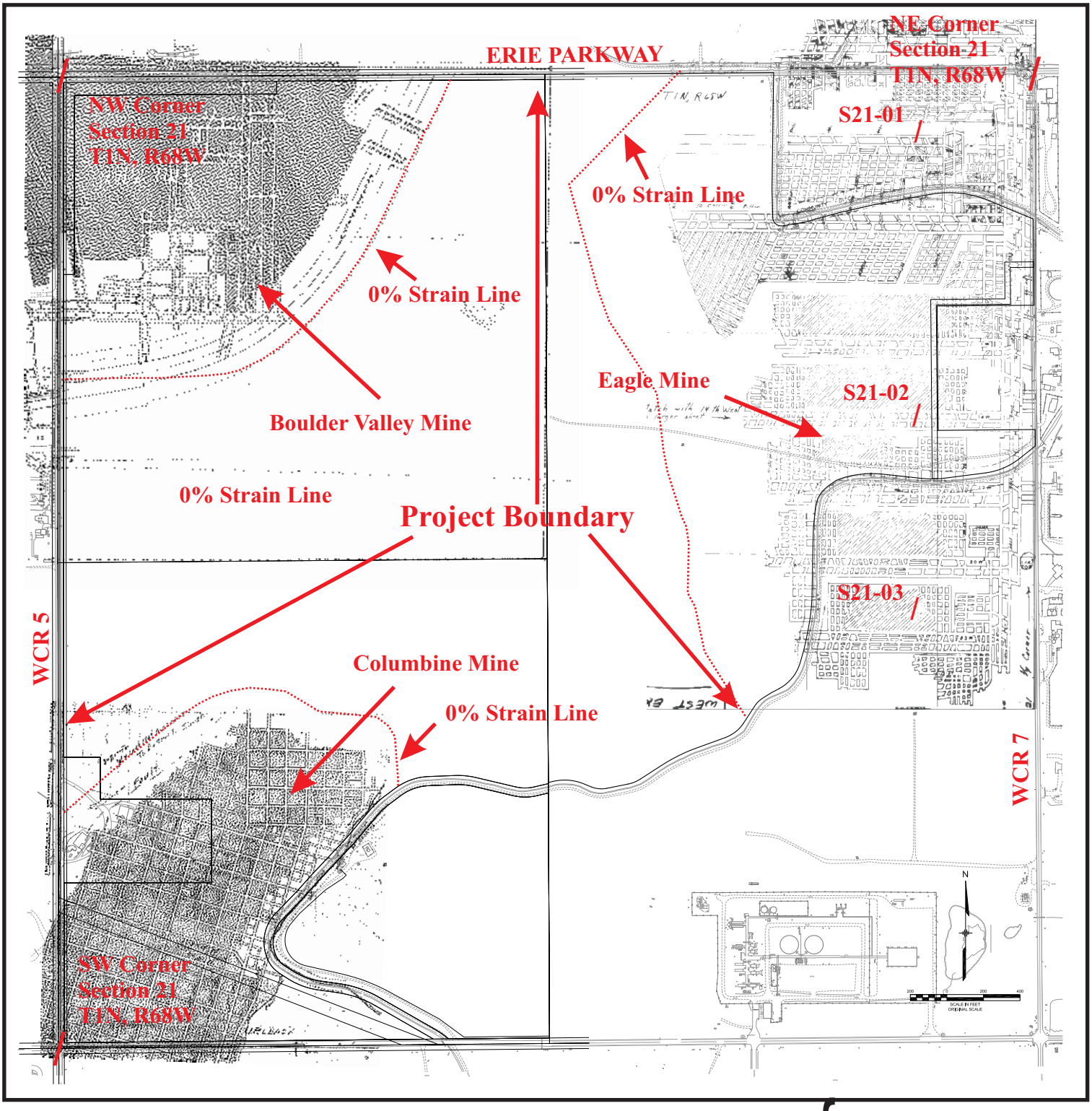
3.0 SITE CHARACTERISTICS

This Mine Subsidence Assessment was conducted for approximately 420.58 acres within Section 21, Township 1 North, Range 68 West, unincorporated Weld County, Colorado (Figure 1). According to the Weld County Assessor's Office, the property is currently zoned for agricultural use. With the exception of petroleum production wells and ancillary equipment, no buildings are present on the site. The Community Ditch forms a portion of the northern boundary and the entire southern boundary.

The site is located southwest of the intersection of Erie Parkway and Weld County Road 7 (Figure 2). Surrounding properties include agricultural land to the north, west, and southeast. The Encana Oil & Gas natural gas production facility is located directly to the south, and rural commercial properties, including two dairy farms and a RV storage lot occur to the east along Weld County Road 7. Erie High School is located to the north of the property with single family residential developments to the northwest and west. Several large regional landfills are located south and southwest of the project.

The elevation of the property ranges of 5,210 to 5,290 feet (USGS, Erie and Frederick 7.5 Minute Quadrangles, 1979). The center of the site is elevated, with slopes to the north and northwest. Topography of the southern end of the site is sloped to the southeast. The National Resource Conservation Service (NRCS) indicates that site soils are predominately Colby, Nunn and Weld loams with Wiley-Colby complex and Cascajo gravelly sandy loam overlaying the Cretaceous Age Laramie Formation (Tweto, 1979).

The abandoned coal mines that underlies the project are referenced in the files of the Colorado Geological Survey as the Boulder Valley, Columbine and Eagle Mines. A detailed description of the mine is presented in Section 4.0.



Western environment and ecology, inc. 2217 West Powers Avenue Littleton, Colorado 80120	**Figure 2 - Site Map Dearmin/Swank Property** **Section 21,** **Township 1 North, Range 68 West,** **Weld County, Colorado**

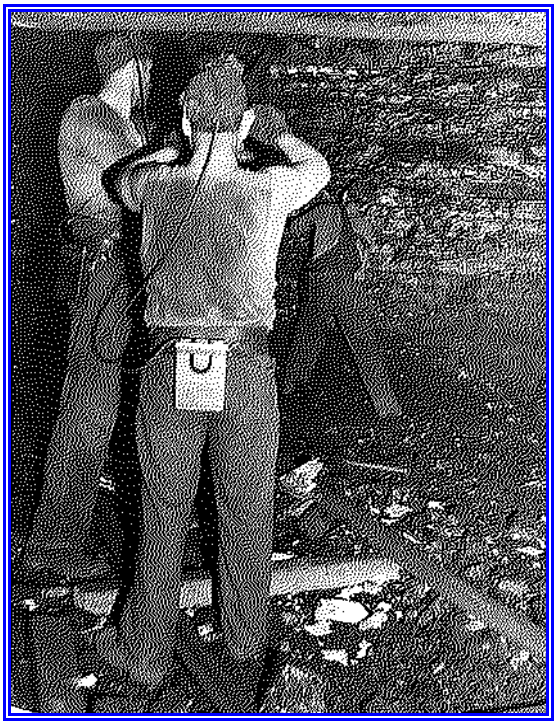
4.0 COAL MINE DESCRIPTIONS

The eastern portion of the site is undermined by the **Eagle Mine** (Figure 2). Records on file with the Colorado Division of Mines (CDM) show that production began in 1939. The mine was officially closed in 1978 after producing 7,953,469 tons. Entry to the mine was gained via a 370 foot deep shaft located approximately 4,000 feet east of the subject property. The Eagle Mine began production as a modified room and pillar mine using the Pillar Retreat method of mining. However, during the late 1940's and early 1950's a shortwall mining method, employing a Continuous Miner, was introduced. This equipment radically changed coal mining after its wide spread use in the early 1950's substantially increasing production and safety. This mine was one of the largest and last of the mines operating the Boulder/Weld Field. The mine was forced to close when fire required the flooding of the mining operation in 1978.

The **Boulder Valley Mine** (Figure 2) opened in 1910. During the 46 years the mine was in production it changed its name from the Andrew to the Boulder Valley #1 then the State before finally the Boulder Valley (New) Mine. The mine was officially closed in May of 1946 after producing 3,518,912 tons. Entry to the mine was gained through a 330 foot deep hoisting shaft located in Section 20, 400 feet west of the Dearmin/Swank project. The air shaft occurred approximately 220 feet southwest of the main shaft also in Section 20. This mine likewise operated as a modified room and pillar mine using the Pillar Retreat method of extraction. However, it closed before utilizing the Continuous Miner.

The third mine which operated below the property is the **Columbine Mine** (Figure 2). Records from the Colorado Division of Mines and the Colorado Geologic Survey show the "Columbine" Mine began operation in 1920 and continued until 1946. The Columbine Mine is an extremely complex multi level mine and was also among the largest in the Boulder/Weld Coal Field producing 7, 216,286 tons. Entry to the mine was gained via a 300 foot deep, two compartment production shaft located over 5000 feet south of the Dearmin/Swank property, beneath the currently operating Denver Regional Landfill South. The Columbine mine maps indicate that three levels of mining, Lower, Middle and Upper Seams occurred. However, research performed by Western Environment has determined that only the Upper Seam was mined beneath Section 21. The Columbine Mine operation was also classified as a modified room and pillar mine utilizing the Pillar Retreat method during the early years of operation. Haulage ways were ten feet wide and were separated by 30 foot wide "chain pillars". Rooms had approximate widths of fifteen feet and lengths of 200 feet.

The Columbine Mine stands out from the other large mines in the district in that it was one of the first to utilize the Continuous Mining machine. Review of the original mine map of the Columbine Mine (Figure 2) indicates that from approximately 1940 through 1946, when the mine closed, a Continuous Mining operation was occurring beneath the Dearmin/Swank Property. Western Environment has determined that coal extraction rates increased from 60-70% in the older (Pillar Retreat) mines, to 70-80% or greater in the mines operating after introduction of the Continuous Miner.



Workers in Columbine Mine using Pillar Retreat Methods. Photo from the Denver Public Library, Western History Collection

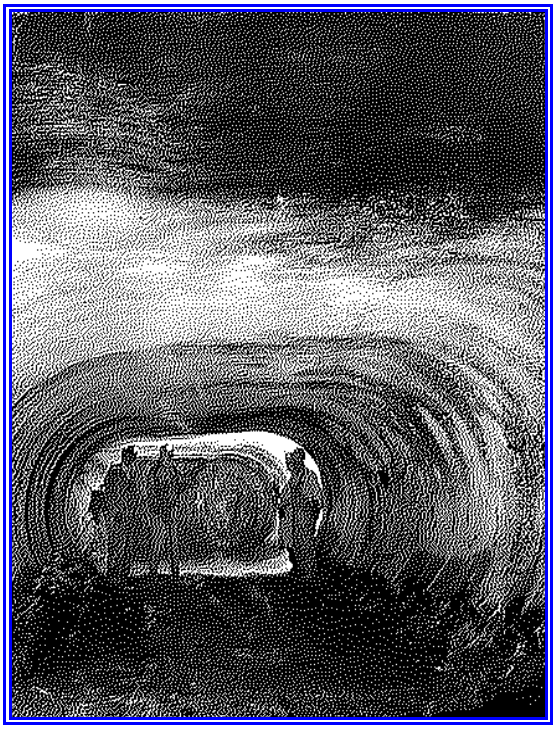
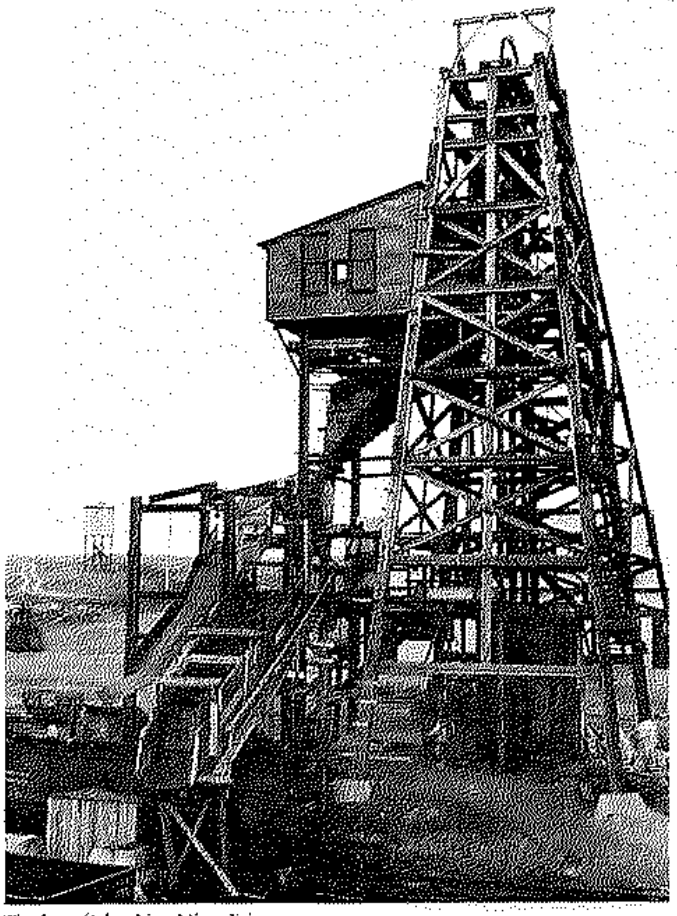


Photo of Room Mined Using Continuous Miner

The Columbine Mine and it's owner, Josephine Roche, have an important role in Colorado history. The "Columbine Mine Massacre" occurred in 1927 when striking coal miners were attacked by Colorado State Police. The strike was a nationwide work stoppage called by the Industrial Workers of the World. The company town of Serene, located on Section 29, one half mile to the south, was the site of the Columbine Mine. Strikers had been conducting morning rallies at Serene for two weeks because the Columbine was one of the few coal mines in the state to remain in operation using management and non-striking employees. On November 21, 1927, five hundred miners, some accompanied by their wives and children, arrived at the north gate just before dawn. The miners were surprised to see men dressed in civilian clothes and armed with automatic weapons. After verbal alterations escalated into violence, six miners lay dead or dying. Ms. Josephine Roche, who gained control of Rocky Mountain Fuel Company upon the death of her father, had instituted a labor policy that allowed the Columbine Mine to be the first United Mine Workers mine in Colorado. She was highly regarded by the miners, obtaining a loan to make sure the striking miners were paid during work stoppage. Later, Ms. Roche was named Assistant Secretary of the Treasury by Franklin Roosevelt during his first term as President.



Tipple at Columbine Mine, Erie
ROCKY MOUNTAIN FUEL CO. OPERATED COLUMBINE MINE FROM 1920 UNTIL IT WAS CLOSED IN 1946. THE MINE WAS LOCATED SOUTH OF ERIE AND THE MINE CAMP OF SERENE WAS CLOSE BY FOR HOUSING FOR THE MINERS. 7,346,275 TONS OF COAL WERE PRODUCED AT THE MINE.
Photo from Louisville Public Library and Louisville Historical Museum

5.0 DRILLING PROCEDURES

Twenty five rotary holes (Figure 1), drilled on and adjacent to the Dearmine/Swank property, were used for this assessment. All of the borings were completed under the supervision of Western Environment. Truck mounted mud drill rotary drills were selected for the studies. All holes were both lithologically and geophysically logged. Lithologic strip logs were taken of cutting samples at five foot intervals. Geophysical logs consisting of natural gamma, spontaneous potential (SP), resistance and three arm caliper were run holes intercepting the mine workings

The caliper tool was calibrated prior to each use to graphically show the diameter of the hole. The full extension of the arms would indicate a cavity of at least greater than 18 inches. The drill will normally make a 5.125 hole. Therefore, a significantly larger or smaller hole could indicate mining activity.

After drilling and logging, each hole required plugging in a manner which would not allow water to enter the workings. On all holes, a simple cement plug was set from 2 to 15 feet with the remaining footage of the hole being filled with Colorado State Mined Land Reclamation Board approved abandonment fluid which is designed to inhibit fluid penetration. Native soil was then replaced from 2 feet to the surface.

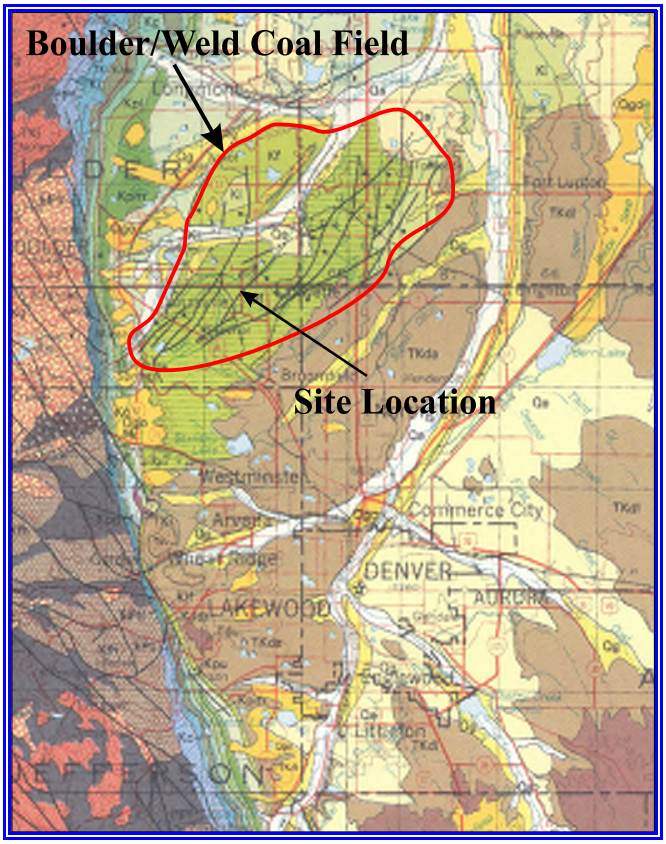
Caliper Tool

MGX Digital Logger

6.0 REGIONAL GEOLOGY

6.1 Outcropping Units

Outcropping units within and surrounding the Erie area are the Pierre Shale, the Fox Hills Sandstone, the Laramie Formation and Quaternary gravels and soils (Figure 3).



Boulder/Weld Coal Field

The Pierre Shale is a lead gray to brown and black shale of marine origin. Total thickness in the area is greater than 7,000 feet (Blair 1951), with the majority of the formation made up of shale. Near the top of the Pierre Shale it becomes increasingly sandy and contains beds of fine sandstones and siltstones as it grades into the Fox Hills Sandstone.

The Fox Hills Sandstone is a massive to crossbedded sandstone. It was deposited in a beach and/or delta-front environment and comfortably overlies the Pierre Shale. The lower two-thirds of the formation is a fine to coarse grained, bluff colored sandstone which weathers to a light tan to tan color. The Fox Hills Sandstone contains numerous iron colored calcareous concretions, ranging in size from fractions of an inch to several feet. The upper one-third of the Fox Hills Sandstone is a fine to medium grained, light grey to pale yellow in color, crossbedded sandstone. The total thickness of the formation near this location is about 140 feet as measured in the NW 1/4 of Section 28, T1S, R70W. Thickness varies from 60 feet near Ralston Creek (Van Horn, 1957) to 250 feet near Baseline Reservoir.

The Laramie Formation, which directly underlies the site is predominantly a fresh water deltaic sequence, consisting of clays, sands, silts and coals (Figure 4). The lower portion is approximately 100 feet thick and is composed of sandstones, sandy shales, claystones, and coal beds. These coals have been economically mined in the past. The upper unit has a thickness of approximately 600 feet and is made up of mostly clay shales, very fine sandy shales, and

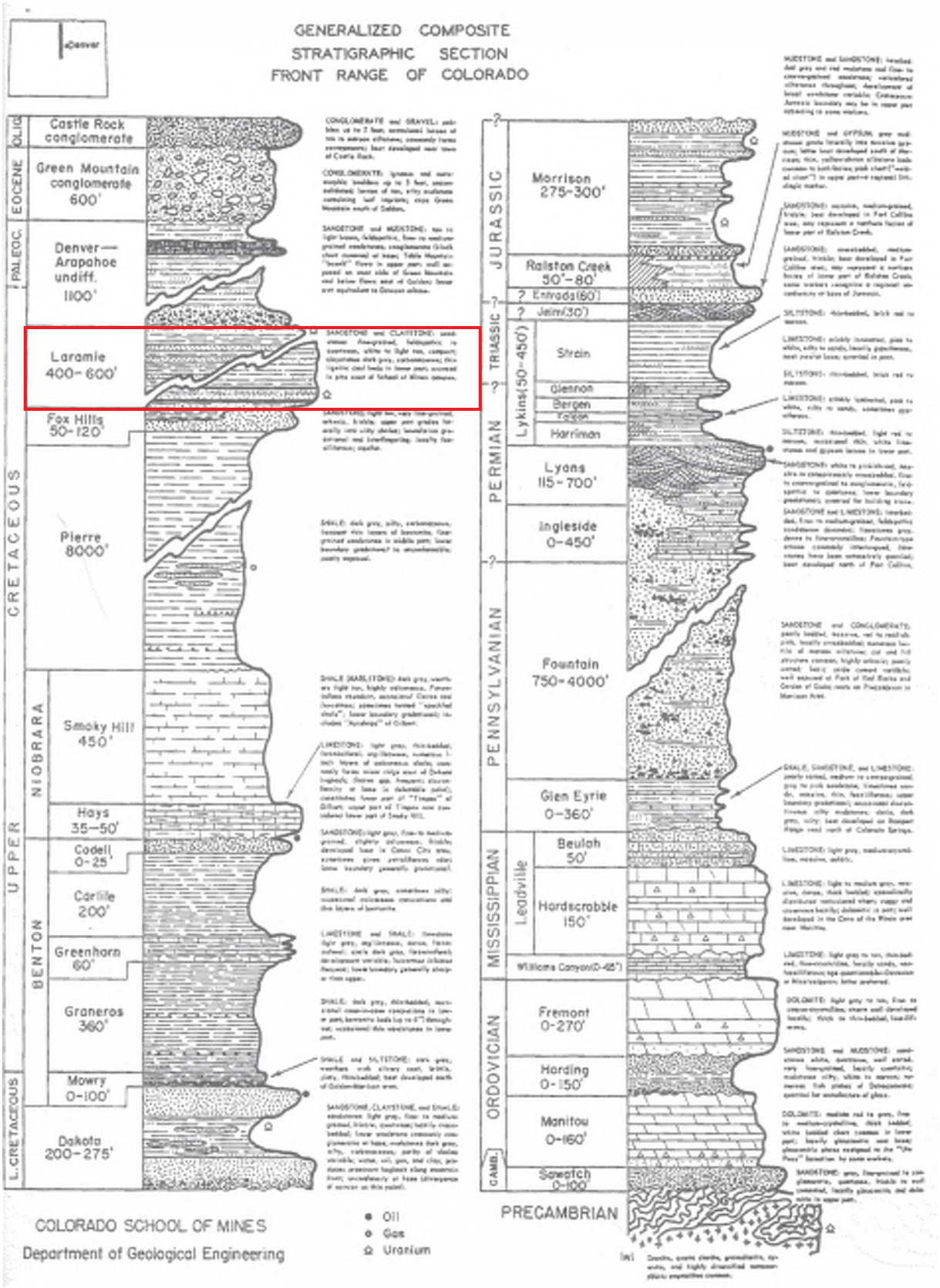


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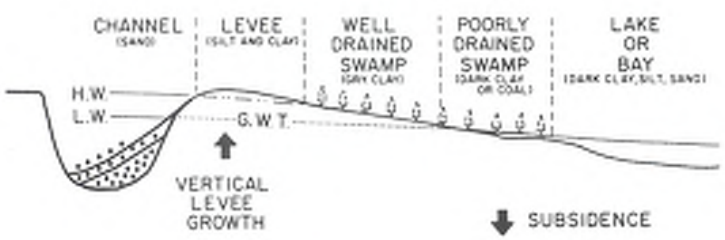
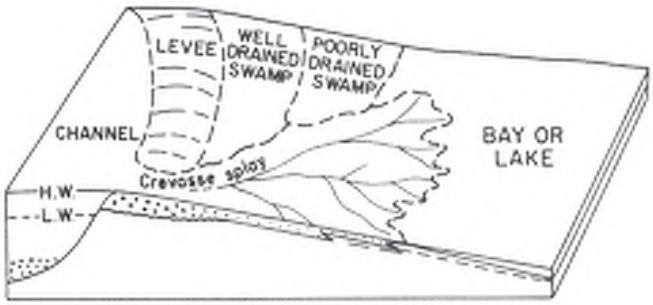
Figure 3- Generalized Stratigraphic Section
Dearmin/Swank Property
Section 21, Township 1 North, Range 68 West
Weld County, Colorado

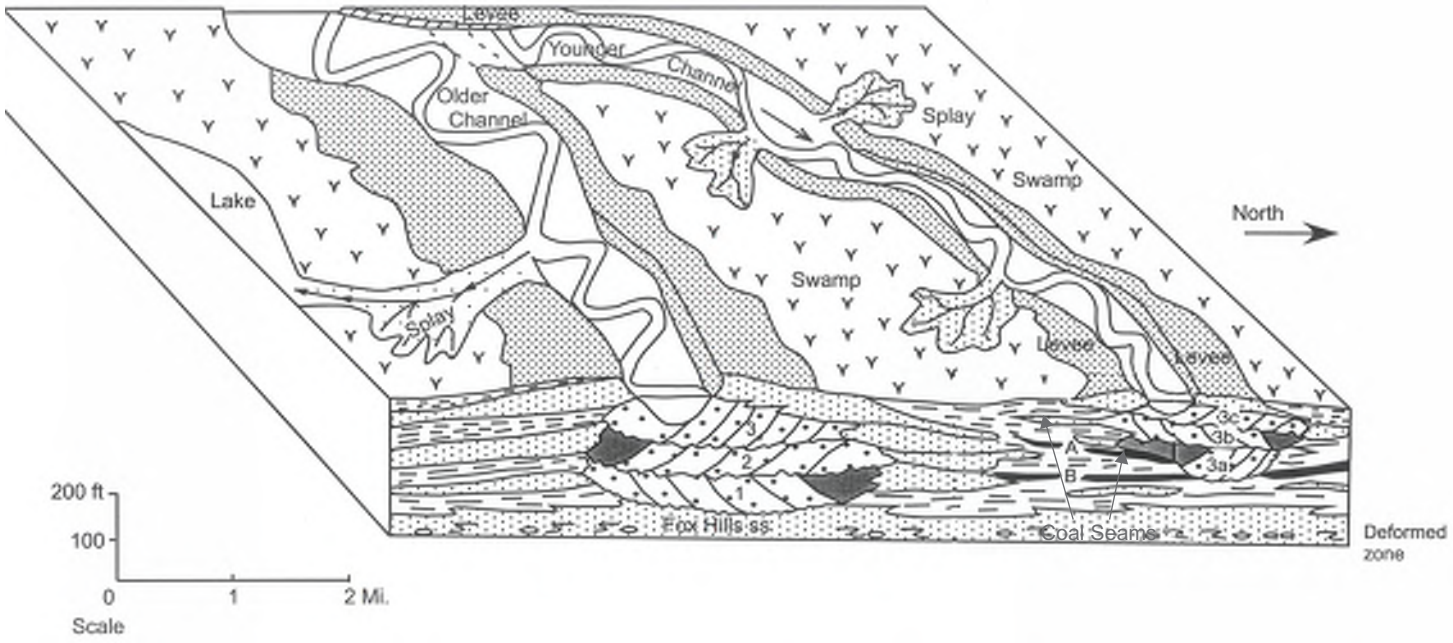


Channel and channel margin environments for lithologies in Laramie Formation.



LARAMIE ENVIRONMENTS OF DEPOSITION

Relationship of channel margin environments to crevasse splay deltas.



Figures from: A Guide to the uppermost Cretaceous stratigraphy, central Front Range Colorado, deltaic sedimentation, growth faulting and early Lamide vertical Movement
Weimer, R.J. 1973

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Figure 4 - Generalized Stratigraphic Model
Laramie Formation
Dearmin/Swank Property
Section 21, Township 1 North, Range 68 West
Weld County, Colorado

lenticular beds of sandstone. The shales are largely carbonaceous and in places becomes lignitic. The Laramie Formation lies comfortably on the Fox Hills Sandstone.

6.2 Structure

The proposed subdivision lies on the western edge of the Denver-Julesberg Basin against the Front Range Uplift. This basin contains up to 13,000 feet of sediments derived from the ancestral Rockies which laid to the west. Three kinds of faulting occur in this portion of the basin. A basement-controlled late Cretaceous Laramide faulting is the most prevalent and is the result of deformation associated with uplift. The second has been described by Davis and Weimer (1976) as growth-faulting as a result of differential loading of the deltaic sequence at the time of deposition. The third type, recently identified, is low angle reverse faults.

Growth faulting is the major structural feature seen in the area. A zone is present with dominant faults trending in a northeasterly direction. This system is ten miles wide and thirty miles long. These faults are high-angle, normal structures near the surface, but seismic work has shown that they tend to flatten and die out at depth. Work by Davis and Weimer (1976) shows that these listric normal faults do not continue below the Hygiene Member of the Pierre Shale. Antithetic faults resulting from tension then form horst and grabens. This effect had resulted in the increased thickness of sediments in the graben areas. The Fox Hills Sandstone has been reported to have a thickness near a growth fault of 484 feet (Spencer, 1961). The Laramie Formation also has increased thickness in these zones and this is believed to be the reason for the increased thickness of the coal seams in the Boulder-Weld coal field.

Recently investigators have recognized low angle reverse faults in the Boulder-Weld area. Kittleson (2009) describes the Longmont Detachment and identifies the Romero Fault as the footwall to the Detachment. These detachments are analogous to landslides, on a vastly larger scale, and occur in rocks exhibiting incomplete lithification. The footwalls to these detachments are low angle reverse faults seen on several projects near the subject site.

7.0 SITE GEOLOGY

Four distinct units were encountered during drilling on the Dearmin/Swank Property. Geologically, the most recent unit, of Pleistocene to Holocene Age, is a silty sandy soil occurring in isolated locations from 0 to 30 feet in depth. This unit appears to be aeolian (wind deposited) in origin. Western Environment's experience with the geo-technical properties of the unit has shown that, although high swell potentials are unlikely, collapsing upon saturation can occur.

The next oldest geologic unit encountered was the Verdos Alluvium, consisting of gravelly sand with cobbles. The Verdos Alluvium, of middle Pleistocene Age, was penetrated during the completion of boring S21-02. This alluvial deposit extended from 0 to 40 feet at this location and occurs only as isolated hilltop erosional remnants.

Below the soil and/or alluvial deposits was the interbedded clays, silts, fine-grained sands, and coals of the Cretaceous Age Laramie Formation. This formation occurred from approximately 30 to 40 feet beneath the surface. The average depth of the "main" coal seams ranged from to 454 feet. The average thickness of the main coal seams varied from 5.0 to 10.0 feet. The third significant geologic unit penetrated was the fine-grained quartzose sands of the Fox Hills Formation. The contact between the Laramie and the Fox Hills occurred at 445 feet in boring S21-01 and 355 in feet boring SV-1.

Cuttings Samples

8.0 DESCRIPTION OF HOLES

The description of rotary holes drilled on the project and adjacent projects are from the drill cuttings taken every five feet, and interpretation of geophysical logs for each boring. **H** indicates borings advanced on the Horst Property, **SB** indicates borings on the Erie Estates Property, **SV** indicates borings drilled on the Erie High School project, **S29** borings were completed on Section 29 and **S21** denotes the holes on Section 21.

Horst Property

H-1 A light brown arenaceous soil occurred from 0 to 20 feet. Light gray to brown claystone was penetrated from 20 to 60 feet. A light gray claystone was encountered from 60 to 275 feet. The "A" seam was encountered from 145 to 150 feet. The "main" seam interval was encountered from 280 to 285 feet. Circulation was lost at 275 feet. A 6 inch caliper deflection occurred at 280 feet. Total depth of the boring was 340 feet. Collapse was complete with no open voids.

H-2 A light brown arenaceous soil occurred from 0 to 30 feet. Brown to gray claystone was penetrated from 30 to 320 feet. The "A" seam was encountered from 120 to 125 feet. The "main" seam occurred from 290 to 295 feet. No mine workings were penetrated. Total depth of the boring was 340 feet.

H-3 A light brown arenaceous soil occurred from 0 to 10 feet. Light gray to brown claystone was penetrated from 10 to 80 feet. A light gray claystone was encountered from 80 to 265 feet,. The "A" seam was encountered from 145 to 150 feet. The "main" seam interval occurred from 240 to 245 feet. Circulation was lost at 265 feet. Maximum caliper deflection of 7.2 inches occurred at 249 feet. Total depth of the boring was 300 feet. Collapse was complete with no open voids.

H-4 A light brown arenaceous soil occurred from 0 to 20 feet. Light gray to brown claystone was penetrated from 20 to 95 feet. A light to medium gray claystone

with carbonaceous stringers was encountered from 95 to 315 feet. The "A" seam was encountered from 160 to 165 feet. The "main" seam interval occurred from 305 to 315 feet. Circulation was lost at 315 feet. Maximum caliper deflection of 6.0 inches occurred at 310 feet. Total depth of the boring was 340 feet. Collapse was complete with no open voids.

H-5 A light brown arenaceous soil occurred from 0 to 15 feet. Light gray to brown claystone was penetrated from 15 to 70 feet. A light gray claystone was encountered from 70 to 270 feet,. The "A" seam was encountered from 120 to 125 feet. The "main" seam interval occurred from 285 to 290 feet. Circulation was lost at 275 feet. Maximum caliper deflection of 11 inches occurred at 284 feet. Total depth of the boring was 300 feet. Collapse was complete with no open voids.

H-6 A light brown arenaceous soil occurred from 0 to 15 feet. Light gray to brown claystone was penetrated from 15 to 80 feet. A light gray claystone was encountered from 80 to 270 feet. The "A" seam was encountered from 105 to 110 feet. The "main" seam interval occurred from 235 to 240 feet. Circulation was lost at 230 feet. Maximum caliper deflection of 11 inches occurred at 238 feet. Total depth of the boring was 300 feet. Collapse was complete with no open voids.

H-7 A light brown arenaceous soil occurred frm 0 to 15 feet. Light gray to brown claystone was penetrated from 15 to 75 feet. A light gray claystone was encountered from 75 to 150 feet. A light gray sandstone was drilled from 155 to 230 feet. No coal seams were penetrated. No mine workings were encountered. Total depth of the boring was 230 feet.

H-8 A light brown arenaceous soil occurred from 0 to 20 feet. Light gray to brown claystone was penetrated from 20 to 70 feet. A light to medium gray claystone

was encountered from 80 to 260 feet. The "A" seam was encountered from 165 to 170 feet. Circulation was not lost. No mine workings were encountered. Total depth of the boring was 260 feet.

H-9 A light brown arenaceous soil occurred from 0 to 15 feet. Light gray claystone was penetrated from 15 to 50 feet. A medium gray claystone was encountered from 50 to 325 feet. The "main" seam was encountered from 230 to 237 feet. No mine workings were penetrated. Total depth of the boring was 340 feet.

H-10 A light brown arenaceous soil occurred from 0 to 15 feet. Light gray to brown claystone was penetrated from 15 to 70 feet. A medium gray claystone was encountered from 70 to 200 feet. The "A" seam was encountered from 130 to 135 feet. Circulation was lost at 200 feet. The "main" seam interval occurred from 235 to 240 feet. A maximum caliper deflection of 6 inches occurred at 223 feet. Total depth of the boring was 280 feet. Collapse was complete with no open voids.

H-11 A light brown arenaceous soil occurred from 0 to 20 feet. Light gray to brown claystone was penetrated from 20 to 100 feet. A medium gray claystone was encountered from 100 to 340 feet. No mine workings were penetrated. Total depth of the boring was 340 feet.

Erie Estate Property

SB-1 Light brown silty sandy clay was penetrated from 0 to10 feet. From 10 to 45 feet sandy to silty brown grading to gray claystone was encountered. From 45 to 50 feet an oxidized coal seam (clinker) was present. From 50 to 130 feet medium gray claystone occurred. Light gray very fine grained quartzose sandstone was penetrated from 130 to 135 feet. From 135 to 243 feet medium gray claystone with minor carbonaceous intervals was drilled. From 243 to 285 feet interbedded

coal and claystone was penetrated. Circulation was lost a 285 feet. From 285 feet to 330 feet claystone was encountered. The Upper Columbine "main" seam interval was drilled from 330 to 337 feet. Collapse was complete with no open voids. Total depth of the hole was 340 feet.

SB-2 Light brown silty sandy clay was penetrated from 0 to10 feet. From 10 to 33 feet brown grading to gray claystone was encountered. From 33 to36 feet carbonaceous claystone was present. From 36 to 101 feet medium gray claystone occurred. Carbonaceous claystone was penetrated from 101 to 106 feet. From 106 to 220 feet, interbedded claystone with carbonaceous layers were encountered. Circulation was lost at 220 feet. From 220 feet to 245 feet, drilling progress indicated undisturbed bedrock was present. From 245 to 275 feet fractured rock was penetrated. Drilling progress from 280 285 feet indicated in-place bedrock. Western Environment interprets that the Upper Columbine "main" seam was penetrated from 245 to 252 feet. The Lower Columbine "main" seam was interpreted to occur from 275 to 280 feet. Due to "Block Caving" at 215 feet no caliper log could be run.

Erie High School

SV-1 Light brown argillaceous soil was penetrated from 0 to 10 feet. From 10 to 40 feet medium brown claystone was drilled. Medium brown to medium gray claystone was penetrated from 40 to 60 feet. From 60 to 145 feet medium gray claystone was found. Medium gray carbonaceous claystone was drilled from 145 to 155 feet. Medium gray claystone was found from 155 to 260 feet. From 260 to 295 feet carbonaceous claystone was penetrated. Vitreous coal was drilled from 295 to 305 feet. Medium gray claystone was found from 305 to 355 feet. The Fox Hills Sandstone was penetrated from 355 to 360 feet. The total depth of the boring was 360 feet. No mine workings were encountered.

SV-2 From 0 to 5 feet light brown argillaceous soil with claystone was drilled. From 5 to 40 feet medium brown to medium gray claystone was found. Medium gray claystone was drilled from 40 to 65 feet. Medium gray carbonaceous claystone was penetrated from 65 to 70 feet. Medium gray to brown claystone was found from 70 to 100 feet. Medium gray claystone with carbonaceous intervals was drilled from 100 to 160 feet. Vitreous coal was found from 160 to 165 feet. Medium gray claystone with slight carbonaceous intervals was drilled from 165 to 190 feet. From 190 to 300 feet medium gray claystone was found. Circulation was lost at 300 feet. No samples were obtained from 300 to 340 feet. The maximum caliper deflection was 9.70 inches at 292 feet. The "main" seam interval was encountered from 292 to 298 feet. The total depth of the boring was 340 feet. Collapse was complete with no open voids.

SV-3 From 0 to 5 feet light brown argillaceous soil was penetrated. Medium brown to medium gray claystone was drilled from 5 to 50 feet. Medium gray claystone was penetrated from 50 to 115 feet. From 115 to 120 feet carbonaceous claystone was drilled. From 120 to 165 feet medium gray claystone was found. Medium gray carbonaceous claystone was drilled from 165 to 170 feet. From 170 to 175 feet medium gray claystone was penetrated. Vitreous coal and dark gray claystone was found from 175 to 180 feet. Medium gray claystone was drilled from 180 to 300 feet. Circulation was lost at 300 feet. From 300 to 340 feet no samples were obtained. The maximum caliper deflection was 12.6 inches at 301 feet. The "main" seam interval was encountered from 298 to 304 feet. The total depth of the boring was 340 feet. Collapse was complete with no open voids.

SV-4 Light brown argillaceous soil was found from 0 to 10 feet. Light gray claystone was drilled from 10 to 40 feet. From 40 to 50 feet medium brown claystone was found. From 50 to 55 feet medium gray claystone was drilled. Light gray claystone was penetrated from 55 to 120 feet. Medium gray claystone was found from 120 to 165 feet. Vitreous coal was drilled from 165 to 170 feet. Medium gray claystone with carbonaceous intervals was found from 170 to 300 feet. Circulation was lost at 300 feet. No samples were obtained from 300 to 320 feet.

The maximum caliper deflection was 14.5 inches at 298 feet. The "main" seam interval was encountered from 297 to 300 feet. The total depth of the boring was 320 feet. Collapse was complete with no open voids.

SV-5 Light brown argillaceous soil was found from 0 to 10 feet. From 10 to 135 feet light to medium gray claystone was drilled. Dark gray claystone was penetrated from 135 to 160 feet. Dark gray carbonaceous claystone was found from 160 to 165 feet. Medium gray claystone was found from 165 to 205 feet. From 205 to 220 feet dark gray carbonaceous claystone was penetrated. Medium gray claystone was found from 220 to 240 feet. From 240 to 275 medium gray claystone with sandstone was drilled. Dark gray carbonaceous claystone was found from 275 to 290 feet. Circulation was lost at 290 feet. No samples were retrieved from 290 to 320 feet. The maximum caliper deflection was 6.2 inches at 293 feet. The "main" seam interval was encountered from 292 to 298 feet. The total depth of the boring was 320 feet. Collapse was complete with no open voids.

SV-6 Light brown argillaceous soil was penetrated from 0 to 5 feet. From 5 to 40 feet light gray claystone was found. From 40 to 50 feet dark gray carbonaceous claystone was drilled. Light gray claystone was found from 50 to 80 feet. Dark gray claystone was penetrated from 80 to 90 feet. From 90 to 115 feet light gray fine-grained quartzose sandstone was drilled. From 115 to 175 light to medium gray claystone was found. From 175 to 185 feet dark gray claystone was found. Light to medium gray claystone was penetrated from 185 to 275 feet. From 275 to 280 feet light gray fine-grained quartzose was penetrated. Medium gray claystone was drilled from 280 to 300 feet. From 300 to 310 feet vitreous coal was drilled. Medium gray claystone with slight vitreous coal was found from 310 to 315 feet. From 3 15 to 340 feet dark gray claystone was drilled. The total depth of the boring was 340 feet. No mine workings were encountered.

SV-7 Light brown argillaceous soil was drilled from 0 to 10 feet. From 10 to 80 feet light to medium gray claystone was penetrated. From 80 to 90 feet light gray fine-grained quartzose sandstone was drilled. Light to medium gray claystone was penetrated from 90 to 125 feet. Dark gray claystone was found from 125 to 130 feet. Light gray claystone was drilled from 130 to 180 feet. Light gray fine-grained quartzose sandstone was drilled from 180 to 185 feet. From 185 to 260 feet light to medium gray claystone was drilled. Dark gray claystone was penetrated from 260 to 265 feet. Light gray fine-grained quartzose sandstone was found from 265 to 270 feet. Medium gray claystone was drilled from 270 to 285 feet. Circulation was lost at 285 feet. No samples were obtained from 285 to 320 feet. The maximum caliper deflection was 5.5 inches at 290 feet. The top of the mined interval was at 290 feet. The total depth of the boring was 320 feet. Collapse was complete with no open voids.

Section 21

S21-01 From 0 to 10 feet, fine to medium grained silty sand was drilled. From 10 to 35 feet, silty, sandy clay was encountered. Mottled to gray to dark gray claystone with interbedded sandstone and coal lenses of the Laramie Formation was penetrated from 35 to 445 feet. The Eagle “main” seam was drilled from 392 to 400 feet. Light gray to gray fine grained quartzose sandstone of the Fox Hills Formation was encountered from 445 to 460 feet. Circulation was not lost. No mine workings were encountered. Total depth of the boring was 460 feet.

S21-02 From 0 to 10 feet, fine to medium grained silty sand was drilled. Silty sand with gravel and cobble was penetrated from 10 to 40 feet. Casing was set in this boring from 0 to 30 feet. Mottled to gray to dark gray claystone with interbedded sandstone and coal lenses of the Laramie Formation was penetrated from 40 to 460 feet. The Eagle “main” seam was encountered at 454 feet. Circulation was lost at 458 feet. Maximum caliper deflection was 15.0 inches at 456.3 feet. Collapse was complete with no open voids. Total depth of the boring was 480 feet.

S21-03 From 0 to 10 feet, fine to medium grained silty sand was drilled. From 10 to 40 feet, silty, sandy clay was encountered. Mottled to gray to dark gray claystone with interbedded sandstone and coal lenses of the Laramie Formation was penetrated from 35 to 408 feet. Circulation was lost at 408 feet. The Eagle "main" seam was drilled from 400 to 410 feet. Maximum caliper deflection was 13.8 inches at 407.8 feet. Collapse was complete with no open voids. Total depth of the boring was 440 feet.

Section 29

S29-2 Sandy clay soil occurred from 0 to 10 feet. Brown to iron stained claystone was drilled from 10 to 35 feet. From 35 feet to 295 feet, light gray to dark gray claystone was penetrated. Circulation was lost at 295 feet. The Columbine "main" seam occurred from 307 to 315 feet. Maximum caliper deflection of 7.8 inches at 309.8 feet was observed. Total depth of the hole was 320 feet. Collapse was complete, with no open voids.

S29-5 Sandy clay soil occurred from 0 to 15 feet. Light brown to gray to dark gray claystone with interbedded coal was drilled from 15 to 360 feet. Circulation was not lost. The Columbine "main" seam was penetrated from 267 to 275 feet. Negative caliper deflection was observed at this location. Collapse was complete with no open voids.

9.0 DISCUSSION OF SUBSIDENCE PREDICTION METHODS

Piggot and Eynon (1977) states that "subsidence will not propagate to the ground surface over room and pillar workings where the overburden to extraction thickness ratio (H/h) exceeds 10." Additionally, Piggot and Eynon indicate that "Caving of the roof above a mine can continue until the extraction and collapse area is filled with broken and bulked rock or caving reaches the surface." Using a bulking factor of 40% as referenced in Piggot and Eynon (1977) and applying a safety factor of 1.5, caving will not propagate more than 90 feet above the mine. These assessments results in the conclusion that no significant effects of subsidence occurs when a mine is greater than 90 feet in depth.

However, in a paper presented at the 1985 Conference on Coal Mine Subsidence in the Rocky Mountain Region, Sherman (1986) inventoried structural damage to over 100 buildings in the Louisville and Lafayette area constructed before mining. The results of this study were used to confirm, if not the validity, the conservatism of using the British National Coal Boards (NCB) Graphical Strain Profiling Method of subsidence prediction for projects in the Boulder/Weld Coal Field. Subsequently, the study also determined that "no two-story brick buildings built prior to mining survived through the late 1920's." This investigation together with other studies (Amuedo and Ivey, 1975) and (Myers, 1975), and reports of damage to buildings and roads in local newspapers (Denver Post, 1969) and (Louisville Times, 1978) indicate that surface subsidence as a result of coal mining has occurred throughout the Boulder/Weld area at mining depths greater 400 feet.

The subsidence prediction method employed by Western Environment, the NCB Graphical Strain Prediction method, was developed for long wall mining methods. It is our opinion that the pillar retreat method and certainly the shortwall method used in the Boulder Valley, Columbine and Eagles Mines, more closely resembles the long wall method in recovery percentage and surface subsidence (Oravecz, 1977) and (Sherman, 1986) then the classical room and pillar method evaluated by Piggot and Eynon (1977).

However, the use of the Piggot and Eynon (1977) research regarding collapse and bulking is valid when mining techniques or mine geometry is similar to room and pillar extraction methods. Additionally, Western Environment would agree that following the immediate post-extraction collapse of mines that utilize the pillar retreat method, additional subsidence would more closely resemble room failure and likely not propagate to the surface when a bedrock thicknesses are in excess of 90 feet.

10.0 STRAIN ANALYSIS

The strain analysis performed for this study is adapted from the United Kingdom National Coal Board's graphical strain profiling system. This method of strain prediction was developed for on-going long wall mining operations. To make the method applicable to abandoned room and pillar mines, several modifications and assumptions were made.

The first modification is to define the thickness of the void space. The standard method is to use the actual mined thickness of coal. However, the drill holes completed on the referenced projects show collapse to be complete. Therefore, to proceed with a "worst case" theoretical analysis, the following assumption was made: any increase in hole diameter greater than 50% (9 inches for 5 1/8 inch boring) will be treated as an open void. The amount of "theoretical" void for all holes intercepting the mine within the Boulder Valley, Columbine Mine and Eagle Mines was then averaged. Due to hole collapse in SB-2, Western Environment chose to utilize 5.0 feet of "theoretical" void which represents 2 times the maximum theoretical void (2.5') identified on adjacent projects. The following Tables provides the average depth and theoretical void thickness.

Table 1. Depth to top of mined interval /theoretical void, Boulder Valley Mine

Boring	Depth to Top of Mined Interval	Theoretical Void (Feet)
Horst 1	280	0.0
Horst 2	290	NM
Horst 3	240	0.0
Horst 4	305	0.0
Horst 5	284	2.0
Horst 6	238	2.0
Horst 7	No Coal	No Coal
Horst 8	No Coal	No Coal
Horst 9	230	NM
Horst 10	235	0.0
Horst 11	No Coal	No Coal
SV-1	295	NM
SV-2	292	2.0
	Continued on next page	

Boring	Depth to Top of Mined Interval	Theoretical Void (Feet)
SV-3	298	2.5
SV-4	297	2.0
SV-5	292	0.0
SV-6	296	NM
SV-7	290	0.0
AVERAGE	**278**	**0.95**

Table 2. Depth to top of mined interval / theoretical void, Columbine Mine

Boring	Depth to Top of Mined Interval	Theoretical Void (Feet)
S29-2	307	0.0
S29-5	267	0.0
SB1	300	0.0
SB2	245	5.0
AVERAGE	**279***	**1.25**

* Note Borings penetrated Columbine Mine Middle Seam, depth used for strain analysis **192 feet** from mine map elevations

Table 3. Depth to top of mined interval / theoretical void, Eagle Mine

Boring	Depth to Top of Mined Interval	Theoretical Void (Feet)
S21-01	392	NM
S21-02	454	3.1
S21-03	400	1.3
AVERAGE	**415**	**2.2**

NM - Not Mined and No Coal values were not used in theoretical void analysis

The width of the extraction is critical to the analysis. Several options are available to use in the analysis. They include distance between drill holes, actual width (length) of the workings, or arbitrary values to produce the maximum amount of subsidence. Western Environment chose to use the actual width (length) of the workings shown on the individual mine maps, which is approximately:

150 feet for the Boulder Valley Mine

100 feet for the Upper Seam of the Columbine Mine

250 feet for the Eagle Mine

The reader is here encouraged to review both the United Kingdom National Coal Board's Subsidence Handbook, and the previous studies for the mechanics of the process. By using this information, the maximum "worst case" theoretical horizontal strains would be:

Boulder Valley Mine 0.127%

Columbine Mine 0.206%

Eagle Mine 0.213%

These "theoretical worst case" strains are sufficient to cause "appreciable " damage to structures or foundation segments (Figure 5):

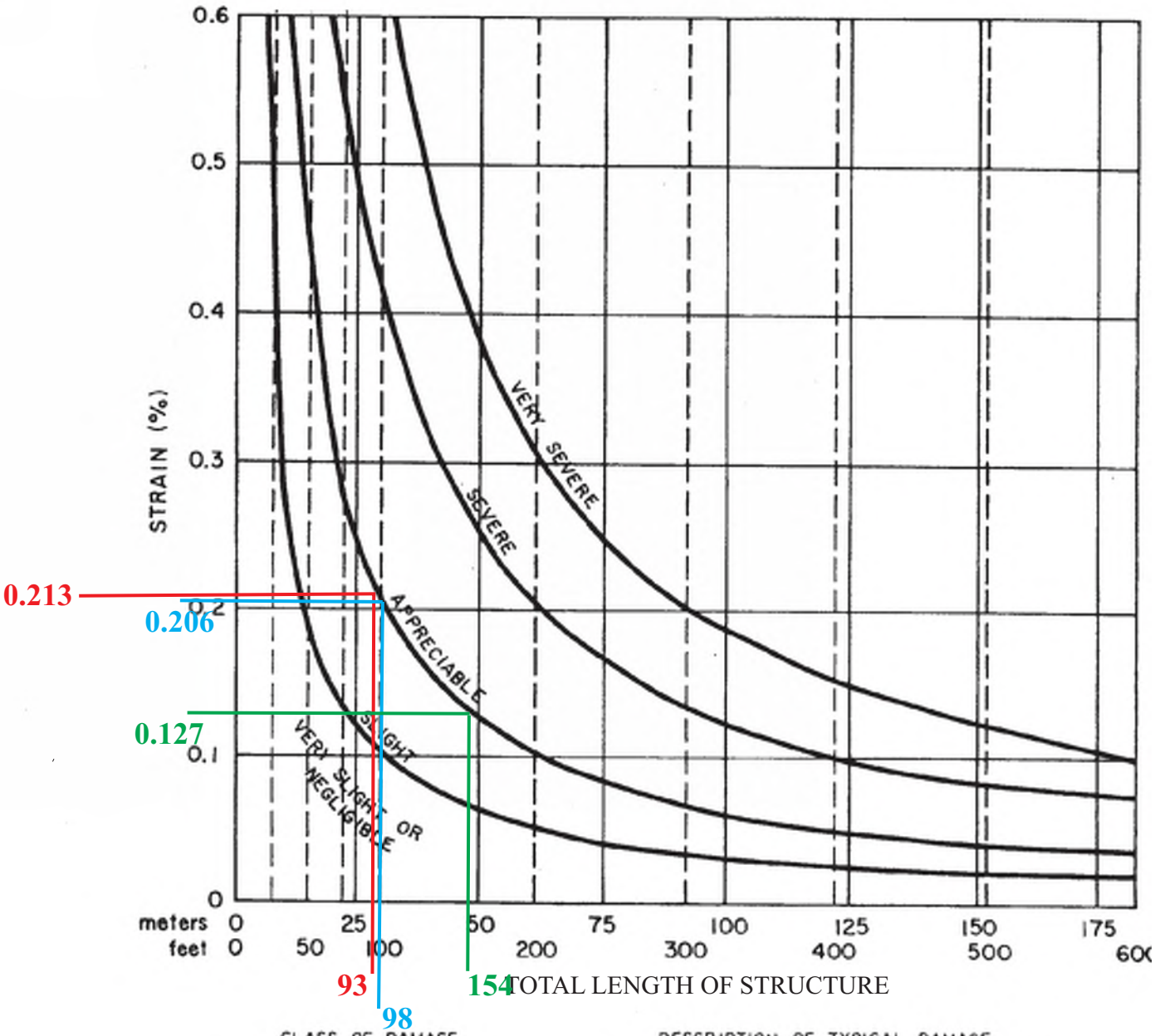
Greater than 154 feet for the Boulder Valley Mine

Greater than 98 feet for the Columbine Mine, Upper Seam

Greater than 93 feet for the Eagle Mine

The areas of the proposed development affected by these structure length restrictions are shown on Figure 6. Portions of the project outside of the 0% strain line shown on Figure 6 have no subsidence related development restrictions. The strains calculated for the Dearmin/Swank project will allow for construction of buildings with a foundation length of **154 feet** or less within the Boulder Valley Subsidence Zone: **98 feet** or less within the Columbine Subsidence Zone, and **93 feet** or less in the Eagle Subsidence Zone. These size structure would be exposed to **less than appreciable** damage in a "worst" case subsidence event.

With the "inherent and unreconcilable uncertainties" associated with abandoned mine subsidence prediction, conservatism must be incorporated in proposed development. Therefore, we recommend that construction of buildings greater than **Subsidence Zone length restrictions,** requires additional building specific investigations, including drilling, that would confirm collapse is complete.



CLASS OF DAMAGE	DESCRIPTION OF TYPICAL DAMAGE
VERY SLIGHT OR NEGLIGIBLE	SLIGHT CRACKS SHOWING IN WALLS AND CEILINGS INSIDE BUILDINGS, BUT NOT VISIBLE ON OUTSIDE.
SLIGHT	SLIGHT CRACKS SHOWING INSIDE THE BUILDING. DOORS AND WINDOWS WILL NOT CLOSE.
APPRECIABLE	SLIGHT CRACKS SHOWING BOTH OUTSIDE AND INSIDE BUILDING. DOORS AND WINDOWS WILL NOT CLOSE. DRAINS, SEWERS, AND GAS PIPES FRACTURE.
SEVERE	DRAINS, SEWERS, AND GAS PIPES FRACTURE. OPEN FRACTURES THROUGH WALLS OF BUILDING. WINDOW AND DOOR FRAMES DISTORTED. FLOORS NOTICEABLY SLOPING, WALLS LEANING OR BULGING NOTICEABLY. SOME LOSS OF BEARING OF BEAMS ON WALLS. PORTICOES AND FLOORS BUCKLE.
VERY SEVERE	WORSE THAN ABOVE AND REQUIRING PARTIAL OR COMPLETE REBUILDING. ROOF AND FLOOR BEAMS LOSE BEARING AND WALLS LEAN BADLY AND NEED EXTERNAL SUPPORT. WINDOWS BROKEN AND DISTORTED. SEVERE SLOPES, BUCKLING AND BULGING OF ROOFS AND WALLS OCCUR.

(FROM N.C.B.)

EAGLE

COLUMBINE

BOULDER V.

WESTERN ENVIRONMENT AND ECOLOGY, INC.
2217 West Powers Avenue
Littleton, Colorado 80120

Figure 5 - Strain Percent to Length of Structure
Dearmin/Swank Property Section 21, Township 1 North, Range 68 West, Weld County, Colorado

10/3/2018

0 600’

Western environment and ecology, inc.
2217 West Powers Avenue
Littleton, Colorado 80120

Figure 6 - Conceptual Master Plan
Dearmin/Swank Property
Section 21,
Township 1 North, Range 68 West,
Weld County, Colorado

11.0 CLOSURE

The recommendations provided herein were developed from the information obtained from field exploration which reflect subsurface conditions only at the specific locations, at the particular times designated. Subsurface conditions at other locations and times may differ from conditions occurring at these locations. The nature and extent of any variations between the drill holes may not become evident until or during the course of construction. If variations then appear, it may be necessary to re-evaluate the recommendations of this report after performing on-site observations during the excavation period and noting the characteristics of any variations.

This report was prepared by a Professional Geologist, not an engineer, and should not be construed as, or substituted for, engineering. This report is intended to inform geotechnical and structural engineers working on building design of the potential earth forces that could develop at the site, and to assist the client in determining whether to acquire and build on the site in question.

Our professional services have been performed, our findings, and our recommendations prepared in, accordance with generally accepted geological principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

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APPENDICES

Appendix A

Architectural Techniques to Reduce Subsidence

ARCHITECTURAL TECHNIQUES TO REDUCE STRUCTURAL DAMAGE DUE TO SUBSIDENCE

Numerous papers have been written concerning building techniques designed to accommodate strain associated with subsidence (NTIS 1979). Presented below are some very basic strain reduction techniques which could be incorporated into structures located in these areas.

A structure of simple box form, designed to act as a unit, is best suited to resist the effects of mining subsidence. The smaller the plan of the building, the less likelihood there is of damage, and therefore, attached structures should be avoided. Where it is desired to retain the attached plan, this can be achieved by building units with adequate gaps between them to permit movement. Semi-detached buildings are preferable to detached. Outbuildings should not be attached structurally to the main building; they should be able to move independently.

The gaps between the structural units should be kept free from obstructions and should extend through the foundations; they should be sufficient to prevent adjacent units from coming into contact when the ground is deformed by subsidence. A gap of at least four inches is suggested for two-story buildings. Suitable gaps should be provided in all boundary walls especially when they abut a structure.

If required, areas between units should be paved with a flexible material, such as asphalt, incapable of offering any appreciable resistance to horizontal compression. Solid concrete paving should not be used.

Openings are a source of weakness in walls and should be kept as small as other considerations permit. Windows and doors are best arranged with substantial widths of brickwork around them so that the wall, wether reinforced or not, may be as strong as possible. Arched lintels should not be used. Corner windows, bay windows, and other similar projections weaken the structure, door openings have more serious weakening effects than windows and are best located in the shorter sides of buildings. If in the longer sided, they should be installed in the middle rather than at the ends of the building. Front and back doors should not be arranged closely side by side.

Floors and flat roofs should be fastened to all walls and not merely to those which carry joists and rafters. Plasterboard or fiberboard should be used for ceilings. To ensure continued effective drainage if the building has been tilted by subsidence, the gradients of gutters should be kept higher than normal.

For complete protection against damage due to subsidence, a building would have to be able to resist the effects of vertical and horizontal differential movements. Protection against most damage by differential horizontal movements is comparatively simple and may be obtained by building the structure on a lightly reinforced concrete base slab which is bedded on granular material. The base slab ties the walls together and the flat underside forms slip surface. The total tensile strength of the slab in the direction of either principal axis should be adequate to resists a force equal to the product of half the weight of the structure on the slab and the coefficient of friction between the slab and granular material. Before placing the reinforcement and concrete in the base slab, the granular material in the sub-grade should be covered with a layer of stout waterproof paper (to form a slip plane). The provision of a reinforced base slab, combined with the recommendations already made, should be sufficient to prevent damage except where differential vertical movement occur.

The resistance of the walls to flexure may be increased by the introduction of steel reinforcement in any brickwork. The additional cost of such reinforcement is justifiable only in structures certain to be subjected to severe differential vertical movements, such as those near the boundaries of mine workings. Horizontal reinforcement may be used in brick walls of any thickness, but vertical reinforcement can only be used in wall 9 inches thick or more. Special care is necessary where steel reinforcement is to be used in conjunction with brickwork; the metal will not be protected from corrosion in the same way as rods in well made concrete. Lime mortar should be used in brickwork. Damp-proof courses should be of the bituminous type.

The weakest mortar consistent with the normal load-carrying requirements of the walls should be used. This will allow the walls to adjust themselves to moderate changes of curvature of the ground without serious cracking. If the ground on which the structures are built is of a yielding nature, the conditions will be more favorable than if it is yielding since abrupt changes of curvature are less likely.

APPENDIX B

Lithologic and Geophysical Logs

HOLE NUMBER: Horst 1	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/10/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
5	SAND, light brown
10	SAND, light brown
15	SAND, light brown
20	SAND, light brown
25	CLAYSTONE, light brown to gray
30	CLAYSTONE, light brown to gray
35	CLAYSTONE, light brown to gray
40	CLAYSTONE, light brown to gray
45	CLAYSTONE, light brown to gray
50	CLAYSTONE, light brown to gray, traces of COAL
55	CLAYSTONE, light brown to gray
60	CLAYSTONE, light brown to gray
65	CLAYSTONE, light gray
70	CLAYSTONE, light gray
75	CLAYSTONE, light gray
80	CLAYSTONE, light gray, with traces of COAL
85	CLAYSTONE, light gray
90	CLAYSTONE, light gray
95	CLAYSTONE, light gray
100	CLAYSTONE, light gray
105	CLAYSTONE, light gray
110	CLAYSTONE, light gray
115	CLAYSTONE, light gray
120	CLAYSTONE, light gray
125	CLAYSTONE, light gray, with traces of COAL
130	CLAYSTONE, light gray
135	CLAYSTONE, light gray
140	CLAYSTONE, light gray
145	CLAYSTONE, light gray
150	CLAYSTONE, light gray
155	CLAYSTONE, light gray
160	CLAYSTONE, light gray
165	CLAYSTONE, light gray
170	CLAYSTONE, light gray, with traces of COAL
175	CLAYSTONE, light gray
180	CLAYSTONE, light gray
185	CLAYSTONE, light gray
190	CLAYSTONE, light gray
195	CLAYSTONE, light gray
200	CLAYSTONE, light gray, with traces of COAL

HOLE NUMBER: Horst 1	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/10/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, light gray, with traces of COAL
210	CLAYSTONE, light gray
215	CLAYSTONE, light gray
220	CLAYSTONE, light gray
225	CLAYSTONE, light gray
230	CLAYSTONE, light gray
235	CLAYSTONE, light gray
240	CLAYSTONE, light gray
245	CLAYSTONE, light gray
250	CLAYSTONE, light gray
255	CLAYSTONE, light gray
260	CLAYSTONE, light gray
265	CLAYSTONE, light gray
270	CLAYSTONE, light gray
275	CLAYSTONE, light gray
280	LOST CIRCULATION, NO SAMPLES MAIN SEAM
285	LOST CIRCULATION, NO SAMPLES
290	LOST CIRCULATION, NO SAMPLES
295	LOST CIRCULATION, NO SAMPLES
300	LOST CIRCULATION, NO SAMPLES
305	LOST CIRCULATION, NO SAMPLES
310	LOST CIRCULATION, NO SAMPLES
315	LOST CIRCULATION, NO SAMPLES
320	LOST CIRCULATION, NO SAMPLES
325	LOST CIRCULATION, NO SAMPLES
330	LOST CIRCULATION, NO SAMPLES
335	LOST CIRCULATION, NO SAMPLES
340	TOTAL DEPTH 340'
345	NO CALIPER DEFLECTION
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 2	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/1000	BIT SIZE: 5 1/8"	DRILLED WITH: AIR MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND, light brown
10	SAND, light brown
15	SAND, light brown
20	SAND, light brown
25	SAND, light brown
30	SAND, light brown
35	CLAYSTONE, brown to gray
40	COAL
45	CLAYSTONE, medium gray
50	CLAYSTONE, medium gray
55	CLAYSTONE, medium gray
60	CLAYSTONE, medium gray
65	CLAYSTONE, light gray
70	CLAYSTONE, light gray
75	CLAYSTONE, light gray
80	CLAYSTONE, light gray
85	CLAYSTONE, light gray
90	CLAYSTONE, medium gray
95	CLAYSTONE, medium gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray, with traces of COAL "A" SEAM
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray
170	CLAYSTONE, medium gray
175	CLAYSTONE, medium gray
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray, with traces of COAL
190	CLAYSTONE, medium gray
195	CLAYSTONE, medium gray
200	CLAYSTONE, light gray

HOLE NUMBER: Horst 2	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/10/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray
220	CLAYSTONE, medium gray, with traces of COAL
225	CLAYSTONE, medium gray
230	CLAYSTONE, medium gray
235	CLAYSTONE, medium gray, with traces of COAL
240	CLAYSTONE, medium gray
245	CLAYSTONE, light gray
250	CLAYSTONE, light gray
255	CLAYSTONE, light gray
260	CLAYSTONE, light gray
265	CLAYSTONE, light gray
270	CLAYSTONE, light gray
275	CLAYSTONE, light gray
280	CLAYSTONE, light gray
285	CLAYSTONE, medium gray
290	CLAYSTONE, medium gray , with traces of COAL MAIN SEAM
295	CLAYSTONE, medium gray
300	CLAYSTONE, medium gray
305	CLAYSTONE, medium gray
310	CLAYSTONE, medium gray / COAL
315	CLAYSTONE, medium gray / COAL
320	CLAYSTONE, medium gray
325	SANDSTONE, light gray to white
330	SANDSTONE, light gray to white
335	SANDSTONE, light gray to white
340	SANDSTONE, light gray to white
345	TOTAL DEPTH 340'
350	NO CALIPER DEFLECTION
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 3	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bidom Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 360'
DATE: 2/1100	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND, light brown
10	SAND, light brown
15	CLAYSTONE, light brown to gray
20	CLAYSTONE, light brown to gray
25	CLAYSTONE, light brown to gray
30	CLAYSTONE, light brown to gray
35	CLAYSTONE, light brown to gray
40	CLAYSTONE, light brown to gray
45	CLAYSTONE, light brown to gray
50	CLAYSTONE, light brown to gray
55	CLAYSTONE, light brown to gray
60	CLAYSTONE, light brown to gray
65	CLAYSTONE, light brown to gray
70	CLAYSTONE, light brown to gray
75	CLAYSTONE, light brown to gray
80	CLAYSTONE, light brown to gray
85	CLAYSTONE, light gray
90	CLAYSTONE, light gray, with traces of COAL
95	CLAYSTONE, light gray
100	CLAYSTONE, light gray
105	CLAYSTONE, medium gray
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray, with traces of COAL "A" SEAM
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, light gray
170	CLAYSTONE, light gray
175	CLAYSTONE, light gray
180	CLAYSTONE, light gray
185	CLAYSTONE, light gray
190	CLAYSTONE, light gray
195	CLAYSTONE, light gray
200	CLAYSTONE, light gray

HOLE NUMBER: Horst 3	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 300'
DATE: 2/10/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray, with traces of COAL
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray
220	CLAYSTONE, medium gray
225	CLAYSTONE, medium gray
230	CLAYSTONE, medium gray
235	CLAYSTONE, medium gray
240	CLAYSTONE, medium gray, with traces of COAL MAIN SEAM
245	CLAYSTONE, medium gray
250	CLAYSTONE, medium gray
255	CLAYSTONE, medium gray
260	CLAYSTONE, medium gray
265	LOST CIRCULATION, NO SAMPLES
270	LOST CIRCULATION, NO SAMPLES
275	LOST CIRCULATION, NO SAMPLES
280	LOST CIRCULATION, NO SAMPLES
285	LOST CIRCULATION, NO SAMPLES
290	LOST CIRCULATION, NO SAMPLES
295	LOST CIRCULATION, NO SAMPLES
300	LOST CIRCULATION, NO SAMPLES
305	TOTAL DEPTH 300'
310	MAXIMUM CALIPER DEFLECTION 7.2" AT 249'
315	
320	
325	
330	
335	
340	
345	
350	
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360	
365	
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375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 4	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Eidson Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR ___ MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND, brown
10	SAND, brown
15	SAND, brown
20	SAND, brown
25	CLAYSTONE, brown to light brown- gray
30	CLAYSTONE, brown to light brown- gray
35	CLAYSTONE, brown to light brown- gray
40	CLAYSTONE, brown to light brown- gray
45	CLAYSTONE, brown to light brown- gray
50	CLAYSTONE, brown to light brown- gray
55	CLAYSTONE, brown to light brown- gray
60	CLAYSTONE, brown to light brown- gray
65	CLAYSTONE, brown to light brown- gray
70	CLAYSTONE, brown to light brown- gray
75	CLAYSTONE, brown to light brown- gray
80	CLAYSTONE, brown to light brown- gray
85	CLAYSTONE, brown to light brown- gray
90	CLAYSTONE, brown to light brown- gray
95	CLAYSTONE, brown to light brown- gray
100	CLAYSTONE, light gray
105	CLAYSTONE, light gray
110	CLAYSTONE, light gray
115	CLAYSTONE, light gray
120	CLAYSTONE, light gray
125	CLAYSTONE, light gray
130	CLAYSTONE, light gray
135	CLAYSTONE, light gray
140	CLAYSTONE, light gray
145	CLAYSTONE, light gray
150	CLAYSTONE, light gray
155	CLAYSTONE, light gray
160	CLAYSTONE, light gray, with traces of COAL "A" SEAM
165	CLAYSTONE, light gray
170	CLAYSTONE, light gray
175	CLAYSTONE, light gray
180	CLAYSTONE, light gray
185	CLAYSTONE, light gray
190	CLAYSTONE, light gray, with traces of COAL
195	CLAYSTONE, light gray
200	CLAYSTONE, light gray

HOLE NUMBER: Horst 4	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/900	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium to light gray
210	CLAYSTONE, medium to light gray
215	CLAYSTONE, medium to light gray
220	CLAYSTONE, medium to light gray
225	CLAYSTONE, medium to light gray
230	CLAYSTONE, medium to light gray
235	CLAYSTONE, medium to light gray
240	CLAYSTONE, medium to light gray
245	CLAYSTONE, medium to light gray
250	CLAYSTONE, medium to light gray
255	CLAYSTONE, medium to light gray
260	CLAYSTONE, medium to light gray
265	CLAYSTONE, medium to light gray
270	CLAYSTONE, medium to light gray
275	CLAYSTONE, medium to light gray
280	CLAYSTONE, medium to light gray
285	CLAYSTONE, medium to light gray
290	CLAYSTONE, medium to light gray
295	CLAYSTONE, medium to light gray
300	CLAYSTONE, medium to light gray
305	CLAYSTONE, medium to light gray
310	CLAYSTONE, medium to light gray
315	LOST CIRCULATION, NO SAMPLES MAIN SEAM
320	LOST CIRCULATION, NO SAMPLES
325	LOST CIRCULATION, NO SAMPLES
330	LOST CIRCULATION, NO SAMPLES
335	LOST CIRCULATION, NO SAMPLES
340	LOST CIRCULATION, NO SAMPLES
345	TOTAL DEPTH 340'
350	NO CALIPER DEFLECTION
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 5	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 300'
DATE: 2/1100	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
5	SAND, light brown
10	SAND, light brown
15	SAND, light brown
20	CLAYSTONE, brown to light gray
25	CLAYSTONE, brown to light gray
30	CLAYSTONE, brown to light gray
35	CLAYSTONE, brown to light gray
40	CLAYSTONE, brown to light gray
45	CLAYSTONE, brown to light gray
50	CLAYSTONE, brown to light gray
55	CLAYSTONE, brown to light gray
60	CLAYSTONE, brown to light gray
65	CLAYSTONE, brown to light gray
70	CLAYSTONE, brown to light gray
75	CLAYSTONE, light gray
80	CLAYSTONE, light gray
85	CLAYSTONE, light gray
90	CLAYSTONE, light gray
95	CLAYSTONE, light gray
100	CLAYSTONE, light gray
105	CLAYSTONE, light gray
110	CLAYSTONE, light gray
115	CLAYSTONE, light gray
120	CLAYSTONE, light gray, with traces of COAL "A" SEAM
125	CLAYSTONE, light gray
130	CLAYSTONE, light gray
135	CLAYSTONE, light gray, with traces of COAL
140	CLAYSTONE, light gray
145	CLAYSTONE, light gray
150	CLAYSTONE, light gray
155	CLAYSTONE, light gray
160	CLAYSTONE, light gray
165	CLAYSTONE, light gray
170	CLAYSTONE, light gray
175	CLAYSTONE, light gray
180	CLAYSTONE, light gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray
195	CLAYSTONE, medium gray
200	CLAYSTONE, medium gray

HOLE NUMBER: Horst 5	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 300'
DATE: 2/11/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray
220	CLAYSTONE, medium gray, with traces of COAL
225	CLAYSTONE, medium gray, with traces of COAL
230	CLAYSTONE, medium gray
235	CLAYSTONE, medium gray
240	CLAYSTONE, medium gray
245	CLAYSTONE, medium gray
250	CLAYSTONE, medium gray
255	CLAYSTONE, medium gray
260	CLAYSTONE, medium gray
265	CLAYSTONE, medium gray
270	CLAYSTONE, medium gray
275	LOST CIRCULATION, NO SAMPLES
280	LOST CIRCULATION, NO SAMPLES
285	LOST CIRCULATION, NO SAMPLES MAIN SEAM
290	LOST CIRCULATION, NO SAMPLES
295	LOST CIRCULATION, NO SAMPLES
300	LOST CIRCULATION, NO SAMPLES
305	TOTAL DEPTH 307
310	MAXIMUM CALIPER DEFLECTION 11 INCHES AT 284 FEET
315	
320	
325	
330	
335	
340	
345	
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 6	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling'	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 360'
DATE: 2/11/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
5	SAND, brown
10	SAND, brown
15	SAND, brown
20	CLAYSTONE, gray
25	CLAYSTONE, gray
30	CLAYSTONE, gray
35	CLAYSTONE, gray
40	CLAYSTONE, gray
45	CLAYSTONE, gray
50	CLAYSTONE, gray
55	CLAYSTONE, gray
60	CLAYSTONE, gray
65	CLAYSTONE, medium gray
70	CLAYSTONE, medium gray
75	CLAYSTONE, medium gray
80	CLAYSTONE, medium gray
85	CLAYSTONE, medium gray
90	CLAYSTONE, medium gray
95	CLAYSTONE, medium gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray, with traces of COAL "A" SEAM
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray, with traces of COAL
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray, with traces of COAL
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray
170	CLAYSTONE, medium gray
175	CLAYSTONE, medium gray
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray, with traces of COAL
195	CLAYSTONE, medium gray
200	CLAYSTONE, medium gray

HOLE NUMBER: Horst 6	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 300'
DATE: 2/11/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray, with traces of COAL
220	CLAYSTONE, medium gray
225	CLAYSTONE, medium gray
230	LOST CIRCULATION, NO SAMPLES
235	LOST CIRCULATION, NO SAMPLES MAIN SEAM
240	LOST CIRCULATION, NO SAMPLES
245	LOST CIRCULATION, NO SAMPLES
250	LOST CIRCULATION, NO SAMPLES
255	LOST CIRCULATION, NO SAMPLES
260	LOST CIRCULATION, NO SAMPLES
265	LOST CIRCULATION, NO SAMPLES
270	LOST CIRCULATION, NO SAMPLES
275	LOST CIRCULATION, NO SAMPLES
280	LOST CIRCULATION, NO SAMPLES
285	LOST CIRCULATION, NO SAMPLES
290	LOST CIRCULATION, NO SAMPLES
295	LOST CIRCULATION, NO SAMPLES
300	TOTAL DEPTH 300'
305	MAXIMUM CALIPER DEFLECTION 11 INCHES AT 238 FEET
310	
315	
320	
325	
330	
335	
340	
345	
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 7	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Hideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 230'
DATE: 2/10/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND, brown
10	SAND, brown
15	SAND, brown
20	CLAYSTONE, brown to gray
25	CLAYSTONE, brown to gray
30	CLAYSTONE, brown to gray
35	CLAYSTONE, brown to gray
40	CLAYSTONE, brown to gray
45	CLAYSTONE, brown to gray
50	CLAYSTONE, brown to gray
55	CLAYSTONE, brown to gray
60	CLAYSTONE, brown to gray
65	CLAYSTONE, brown to gray
70	CLAYSTONE, brown to gray
75	CLAYSTONE, brown to gray
80	CLAYSTONE, light gray
85	CLAYSTONE, light gray
90	CLAYSTONE, light gray
95	CLAYSTONE, light gray
100	CLAYSTONE, light gray
105	CLAYSTONE, light gray
110	CLAYSTONE, light gray
115	CLAYSTONE, light gray
120	CLAYSTONE, light gray
125	SANDSTONE, light gray
130	SANDSTONE, light gray
135	SANDSTONE, light gray
140	SANDSTONE, light gray
145	SANDSTONE, light gray
150	SANDSTONE, light gray
155	CLAYSTONE / SANDSTONE, light gray
160	CLAYSTONE / SANDSTONE, light gray
165	CLAYSTONE / SANDSTONE, light gray
170	CLAYSTONE / SANDSTONE, light gray
175	CLAYSTONE / SANDSTONE, light gray
180	CLAYSTONE / SANDSTONE, light gray
185	CLAYSTONE / SANDSTONE, light gray
190	CLAYSTONE / SANDSTONE, light gray
195	CLAYSTONE / SANDSTONE, light gray
200	CLAYSTONE / SANDSTONE, light gray

HOLE NUMBER: Horst 7	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 230'
DATE: 2/11/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, light gray
210	CLAYSTONE, light gray
215	CLAYSTONE, light gray
220	CLAYSTONE, light gray
225	CLAYSTONE, light gray
230	CLAYSTONE, light gray
235	TOTAL DEPTH 230' BROKE BIT, COULD NOT PENETRATE
240	NO CALIPER DEFLECTION
245	
250	
255	
260	
265	
270	
275	
280	
285	
290	
295	
300	
305	
310	
315	
320	
325	
330	
335	
340	
345	
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 8	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 260'
DATE: 2/8/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND, light brown
10	SAND, light brown
15	SAND, light brown
20	SAND, light brown
25	CLAYSTONE, light brown to gray
30	CLAYSTONE, light brown to gray
35	CLAYSTONE, light brown to gray
40	CLAYSTONE, light brown to gray
45	CLAYSTONE, light brown to gray
50	CLAYSTONE, light brown to gray
55	CLAYSTONE, light brown to gray
60	CLAYSTONE, light brown to gray
65	CLAYSTONE, light brown to gray
70	CLAYSTONE, light brown to gray
75	CLAYSTONE, medium gray
80	CLAYSTONE, medium gray
85	CLAYSTONE, medium gray
90	CLAYSTONE, medium gray
95	CLAYSTONE, medium gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray, with traces of COAL
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray, with traces of COAL
145	CLAYSTONE, medium gray
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray, with traces of COAL "A" SEAM
170	CLAYSTONE, medium gray
175	CLAYSTONE, medium gray
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray
195	CLAYSTONE, medium gray
200	CLAYSTONE, medium gray

HOLE NUMBER: Horst 8	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 260'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray
220	CLAYSTONE, medium gray
225	CLAYSTONE, medium gray, with COAL
230	CLAYSTONE, medium gray
235	CLAYSTONE, medium gray, with COAL
240	CLAYSTONE, medium gray
245	CLAYSTONE, medium gray
250	CLAYSTONE, medium gray
255	CLAYSTONE, medium gray
260	CLAYSTONE, medium gray
265	TOTAL DEPTH 260'
270	NO CALIPER DEFLECTION
275	
280	
285	
290	
295	
300	
305	
310	
315	
320	
325	
330	
335	
340	
345	
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 9	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD X

DEPTH	SAMPLE DESCRIPTION
5	SAND , brown
10	SAND , brown
15	SAND , brown
20	CLAYSTONE, light gray
25	CLAYSTONE, light gray
30	CLAYSTONE, light gray
35	CLAYSTONE, light gray
40	CLAYSTONE, light gray
45	CLAYSTONE, light gray
50	CLAYSTONE, light gray
55	CLAYSTONE, medium gray
60	CLAYSTONE, medium gray
65	CLAYSTONE, medium gray
70	CLAYSTONE, medium gray
75	CLAYSTONE, medium gray
80	CLAYSTONE, medium gray
85	CLAYSTONE, medium gray
90	CLAYSTONE, medium gray
95	CLAYSTONE, medium gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray
170	CLAYSTONE, medium gray, with traces of COAL
175	CLAYSTONE, medium gray, with traces of COAL
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray
195	CLAYSTONE, medium gray, with traces of COAL
200	CLAYSTONE, medium gray

HOLE NUMBER: Horst 9	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, medium gray
210	CLAYSTONE, medium gray
215	CLAYSTONE, medium gray
220	CLAYSTONE, medium gray
225	CLAYSTONE, medium gray
230	CLAYSTONE, medium gray, with COAL MAIN SEAM
235	CLAYSTONE, medium gray, with COAL
240	CLAYSTONE, medium gray
245	CLAYSTONE, medium gray
250	CLAYSTONE, medium gray
255	CLAYSTONE, medium gray
260	CLAYSTONE, medium gray
265	CLAYSTONE, medium gray
270	CLAYSTONE, medium gray
275	CLAYSTONE, medium gray
280	CLAYSTONE, medium gray
285	CLAYSTONE, medium gray
290	CLAYSTONE, medium gray
295	CLAYSTONE, medium gray
300	CLAYSTONE, medium gray
305	CLAYSTONE, medium gray
310	CLAYSTONE, medium gray
315	CLAYSTONE, medium gray
320	CLAYSTONE, medium gray
325	CLAYSTONE, medium gray
330	CLAYSTONE / SANDSTONE, light gray
335	CLAYSTONE / SANDSTONE, light gray
340	CLAYSTONE / SANDSTONE, light gray
345	TOTAL DEPTH 340'
350	NO CALIPER DEFLECTION
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 10	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 280'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
5	SAND, brown
10	SAND, brown
15	SAND, brown
20	CLAYSTONE, light gray to brown
25	CLAYSTONE, light gray to brown
30	CLAYSTONE, light gray to brown
35	CLAYSTONE, light gray to brown
40	CLAYSTONE, light gray to brown
45	CLAYSTONE, light gray to brown
50	CLAYSTONE, light gray to brown
55	CLAYSTONE, light gray to brown
60	CLAYSTONE, light gray to brown
65	COAL
70	CLAYSTONE, medium gray
75	CLAYSTONE, medium gray
80	CLAYSTONE, medium gray
85	CLAYSTONE, medium gray
90	CLAYSTONE, medium gray
95	CLAYSTONE, medium gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray, with traces of COAL "A" SEAM
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray, with COAL
170	CLAYSTONE, medium gray
175	CLAYSTONE, medium gray
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray
195	CLAYSTONE, medium gray
200	CLAYSTONE, medium gray

HOLE NUMBER: Horst 10	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 280'
DATE: 2/9/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	LOST CIRCULATION, NO SAMPLES
210	LOST CIRCULATION, NO SAMPLES
215	LOST CIRCULATION, NO SAMPLES
220	LOST CIRCULATION, NO SAMPLES
225	LOST CIRCULATION, NO SAMPLES
230	LOST CIRCULATION, NO SAMPLES
235	LOST CIRCULATION, NO SAMPLES MAIN SEAM
240	LOST CIRCULATION, NO SAMPLES
245	LOST CIRCULATION, NO SAMPLES
250	LOST CIRCULATION, NO SAMPLES
255	LOST CIRCULATION, NO SAMPLES
260	LOST CIRCULATION, NO SAMPLES
265	LOST CIRCULATION, NO SAMPLES
270	LOST CIRCULATION, NO SAMPLES
275	LOST CIRCULATION, NO SAMPLES
280	LOST CIRCULATION, NO SAMPLES
285	TOTAL DEPTH 280'
290	NO CALIPER DEFLECTION
295	
300	
305	
310	
315	
320	
325	
330	
335	
340	
345	
350	
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 11	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Hideau Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/8/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
205	CLAYSTONE, dark gray
210	CLAYSTONE, dark gray, with traces of COAL
215	CLAYSTONE, dark gray
220	CLAYSTONE, dark gray
225	CLAYSTONE, dark gray
230	CLAYSTONE, dark gray
235	CLAYSTONE, light gray, with COAL
240	CLAYSTONE, light gray, with COAL
245	CLAYSTONE, light gray
250	CLAYSTONE, light gray
255	CLAYSTONE, light gray
260	CLAYSTONE, light gray
265	CLAYSTONE, light gray
270	CLAYSTONE, light gray
275	CLAYSTONE, light gray
280	CLAYSTONE, light gray
285	CLAYSTONE, light gray
290	CLAYSTONE, light gray
295	CLAYSTONE, light gray
300	CLAYSTONE, light gray
305	CLAYSTONE, light gray
310	CLAYSTONE, light gray
315	CLAYSTONE, light gray
320	CLAYSTONE, light gray
325	CLAYSTONE, light gray, with COAL
330	CLAYSTONE, light gray, with COAL
335	CLAYSTONE, light gray
340	CLAYSTONE, light gray
345	TOTAL DEPTH 340'
350	NO CALIPER DEFLECTION
355	
360	
365	
370	
375	
380	
385	
390	
395	
400	

HOLE NUMBER: Horst 11	LOCATION: Horst Property	STATE: Colorado
DRILLED BY: Bidcan Drilling	LOGGED BY: Eric Sandifer	TOTAL DEPTH: 340'
DATE: 2/8/00	BIT SIZE: 5 1/8"	DRILLED WITH: AIR __ MUD _X_

DEPTH	SAMPLE DESCRIPTION
5	SAND, brown
10	SAND, brown
15	SAND, brown
20	SAND, brown
25	CLAYSTONE, brown to gray
30	CLAYSTONE, brown to gray
35	CLAYSTONE, brown to gray
40	CLAYSTONE, brown to gray
45	CLAYSTONE, brown to gray
50	CLAYSTONE, brown to gray
55	CLAYSTONE, brown to gray
60	CLAYSTONE, brown to gray
65	CLAYSTONE, brown to gray
70	CLAYSTONE, brown to gray
75	CLAYSTONE, brown to gray
80	CLAYSTONE, brown to gray
85	CLAYSTONE, brown to gray
90	CLAYSTONE, brown to gray
95	CLAYSTONE, brown to gray
100	CLAYSTONE, medium gray
105	CLAYSTONE, medium gray
110	CLAYSTONE, medium gray
115	CLAYSTONE, medium gray
120	CLAYSTONE, medium gray
125	CLAYSTONE, medium gray
130	CLAYSTONE, medium gray
135	CLAYSTONE, medium gray
140	CLAYSTONE, medium gray
145	CLAYSTONE, medium gray
150	CLAYSTONE, medium gray
155	CLAYSTONE, medium gray
160	CLAYSTONE, medium gray
165	CLAYSTONE, medium gray
170	CLAYSTONE, medium gray
175	CLAYSTONE, medium gray
180	CLAYSTONE, medium gray
185	CLAYSTONE, medium gray
190	CLAYSTONE, medium gray, with traces of COAL
195	CLAYSTONE, medium gray, with traces of COAL
200	CLAYSTONE, medium gray

Hole Number: **SB1**
Drilled By: Western Environment
Date: 4/29/2008

Location: N40°02.149 W105°01.131
Logged by: D. Greeley
Bit Size: 5.125

State: Colorado
Total Depth: 340 feet
Drilled with: Air/Mud

Depth	Sample Description
0	Sand, silty, light brown
5	Sand, silty, light brown
10	Clay, silty, sandy, brown
15	Clay, silty, sandy, brown
20	Clay, silty, sandy, brown
25	Clay, silty, sandy, gray
30	Clay, silty, sandy, mottled
35	Clay, silty, sandy, tan
40	Claystone, silty, tan
45	Claystone, silty, gray
50	Oxidized coal (clinker), ferrous, red
55	Claystone, silty, gray
60	Claystone, silty, gray
65	Claystone, silty, gray
70	Claystone, silty, gray
75	Claystone, silty, gray
80	Claystone, silty, gray
85	Claystone, silty, gray
90	Claystone, silty, gray
95	Claystone, silty, gray
100	Claystone, silty, gray
110	Claystone, silty, gray
115	Claystone, silty, gray
120	Claystone, silty, gray
125	Claystone, silty, gray
130	Sandstone, gray
135	Claystone, silty, gray
140	Claystone, silty, gray
145	Claystone, silty, gray
150	Claystone, silty, gray

155	Claystone, silty, gray
160	Claystone, silty, gray
165	Claystone, silty, carbonaceous, dark gray
170	Claystone, silty, gray
175	Claystone, silty, gray
180	Claystone, silty, gray
185	Claystone, silty, gray
190	Claystone, silty, gray
195	Claystone, silty, gray
200	Claystone, silty, gray
205	Claystone, silty, gray
210	Claystone, silty, gray
215	Claystone, silty, gray
220	Claystone, silty, gray
225	Claystone, silty, gray
230	Claystone, silty, gray
235	Claystone, silty, gray
240	Claystone, silty, gray
245	Claystone, silty, carbonaceous, dark gray
250	Claystone, silty, gray
255	Coal
260	Claystone, gray
265	Carbonaceous claystone
270	Claystone, gray
275	Coal
280	Claystone, gray
285	No sample
290	No sample
295	No sample
300	No sample
305	No sample
310	No sample SB1

315	No sample
320	No sample
325	No sample
330	No sample
335	No sample
340	No sample Total Depth

Hole Number: **SB2**
Drilled By: Western Environment
Date: 4/30/2008

Location: N40°02.004 W105°01.644
Logged by: D. Greeley
Bit Size: 5.125

State: Colorado
Total Depth: 285 feet
Drilled with: Mud

Depth	Sample Description
0	Sand, silty, light brown
5	Sand, silty, light brown
10	Clay, silty, sandy, mottled
15	Clay, silty, sandy, mottled
20	Clay, silty, sandy, mottled
25	Clay, silty, sandy, mottled
30	Clay, silty, sandy, mottled
35	Clay, silty, sandy, mottled
40	Claystone, silty, mottled
45	Claystone, silty, gray
50	Carbonaceous claystone, dark gray
55	Claystone, silty, gray
60	Claystone, silty, gray
65	Claystone, silty, gray
70	Claystone, silty, gray
75	Claystone, silty, gray
80	Claystone, silty, gray
85	Claystone, silty, gray
90	Claystone, silty, gray
95	Claystone, silty, gray
100	Claystone, silty, gray
110	Carbonaceous claystone, gray
115	Claystone, silty, gray
120	Claystone, silty, gray
125	Claystone, silty, gray
130	Claystone, silty, gray
135	Claystone, silty, gray
140	Claystone, silty, gray
145	Claystone, silty, gray

150	Claystone, silty, gray
155	Claystone, silty, carbonaceous, dark gray
160	Claystone, gray with coal
165	Claystone, silty, carbonaceous, dark gray
170	Claystone, silty, gray
175	Claystone, silty, gray
180	Claystone, silty, gray
185	Claystone, silty, gray
190	Claystone, silty, gray
195	Claystone, silty, carbonaceous, dark gray
200	Claystone, gray with coal
205	Claystone, gray with coal
210	Claystone, silty, gray
215	Claystone, silty, gray
220	No Sample Recovery
225	No Sample Recovery
230	No Sample Recovery
235	No Sample Recovery
240	No Sample Recovery
245	No Sample Recovery
250	No Sample Recovery
255	No Sample Recovery
260	No Sample Recovery
265	No Sample Recovery
270	No Sample Recovery
275	No Sample Recovery
280	No Sample Recovery
285	No Sample Recovery Total Depth
	Circulation lost at 215 feet

BORE LOGS: Mine Subsidence Investigation - Proposed Erie High School Site

HOLE NUMBER: SV-1	**LOCATION**: N40° 2.869'/W105° 1.036'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Rebecca Pierce	**TOTAL DEPTH**: 360'
DATE: 1/30/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR** **MUD** X

DEPTH	SAMPLE DESCRIPTION
5	light brown sandy clay
10	medium brown claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	medium brown to medium gray claystone
50	"
55	"
60	"
65	medium gray claystone
70	"
75	"
80	"
85	"
90	"
95	"
100	"
105	"
110	"
115	"
120	"
125	"
130	"
135	"
140	"
145	"

150	medium gray carbonaceous claystone
155	"
160	medium gray claystone
165	"
170	"
175	"
180	"
185	"
190	"
195	"
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	"
265	dark gray carbonaceous claystone
270	"
275	"
280	"
285	"
290	"
295	vitreous coal Clayton Mine "main" seam
300	"
305	medium gray claystone
310	"
315	"
320	"

325	"
330	"
335	"
340	"
345	"
350	"
355	"
360	Fox Hills Formation, lt gray, very fine grain quartzose sandstone
	TOTAL DEPTH = 360 Feet

HOLE NUMBER: SV-2	**LOCATION**: N40° 2.868'/W105° 0.983'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Rebecca Pierce	**TOTAL DEPTH**: 340'
DATE: 1/29/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR** **MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown sandy clay
10	medium brown to medium gray claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	medium gray claystone
50	"
55	"
60	"
65	"
70	medium gray carbonaceous claystone
75	medium gray to brown claystone
80	"
85	"
90	"
95	"
100	"
105	medium gray claystone with carbonaceous intervals
110	"
115	"
120	"
125	
130	
135	
140	
145	

150	"
155	"
160	"
165	vitreous coal
170	medium gray claystone with carbonaceous intervals
175	"
180	"
185	"
190	"
195	medium gray claystone
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	"
265	"
270	"
275	"
280	"
285	"
290	"
295	"
300	Clayton mine "main" seam interval circulation lost 300'
305	no samples
310	"
315	"
320	"

325	"
330	"
335	"
340	"
	TOTAL DEPTH = 340 Feet

HOLE NUMBER: SV-3	**LOCATION**: N40° 2.850'/W105° 0.937'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Rebecca Pierce	**TOTAL DEPTH**: 340'
DATE: 4/11/02	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR** **MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown sandy clay
10	medium brown to medium gray claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	"
50	"
55	medium gray claystone
60	"
65	"
70	"
75	"
80	"
85	"
90	"
95	"
100	"
105	"
110	"
115	"
120	dark gray carbonaceous claystone
125	medium gray claystone
130	"
135	"
140	"
145	"

150	"
155	"
160	"
165	"
170	medium gray carbonaceous claystone
175	medium gray claystone
180	vitreous coal and dark gray claystone
185	medium gray claystone
190	"
195	"
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	"
265	"
270	"
275	"
280	"
285	"
290	"
295	"
300	Clayton mine "main" seam interval circulation lost 300'
305	no samples
310	"
315	"
320	"

325	"
330	"
335	"
340	"
	TOTAL DEPTH = 340 Feet

HOLE NUMBER: SV-4	**LOCATION**: N40° 2.833'/W105° 0.936'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Adam Lusk	**TOTAL DEPTH**: 320'
DATE: 1/31/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR ____ MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown sandy clay
10	light gray claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	medium brown claystone
50	"
55	medium gray claystone
60	light gray claystone
65	"
70	"
75	"
80	"
85	"
90	"
95	"
100	"
105	"
110	"
115	"
120	"
125	medium gray claystone
130	"
135	"
140	"
145	"
150	"
155	"

160	"
165	"
170	vitreous coal
175	medium gray claystone with carbonaceous intervals
180	"
185	"
190	"
195	"
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	"
265	"
270	"
275	"
280	"
285	"
290	"
295	"
300	Clayton Mine " Main" Seam Interval circulation lost @ 300'
305	no samples
310	"
315	"
320	"
	TOTAL DEPTH = 320 Feet

HOLE NUMBER: SV-5	**LOCATION**: N40° 2.795'/W105° 0.974'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Adam Lusk	**TOTAL DEPTH**: 320'
DATE: 1/31/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR____ MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown medium-grained sand
10	light to medium gray claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	"
50	"
55	"
60	"
65	"
70	"
75	"
80	"
85	"
90	"
95	"
100	"
105	"
110	"
115	"
120	"
125	"
130	"
135	"
140	dark gray claystone
145	"
150	"

155	"

160	"
165	dark gray carbonaceous claystone
170	medium gray claystone
175	"
180	"
185	"
190	"
195	"
200	"
205	"
210	dark gray carbonaceous claystone
215	"
220	"
225	medium gray claystone
230	"
235	"
240	"
245	medium gray claystone with sandstone
250	"
255	"
260	"
265	"
270	"
275	"
280	dark gray carbonaceous claystone
285	"
290	Clayton min "main" seam interval Circulation Lost at 290'
295	no samples
300	"
305	"
310	"
315	"
320	"

	TOTAL DEPTH = 320 Feet

HOLE NUMBER: SV-6	**LOCATION**: N40° 2.895'/W105° 0.294'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Adam Lusk	**TOTAL DEPTH**: 340"
DATE: 3/09/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown medium-grained sand
10	light gray claystone
15	"
20	"
25	"
30	"
35	"
40	dark gray carbonaceous claystone
45	"
50	light gray claystone
55	"
60	"
65	"
70	"
75	"
80	dark gray claystone
85	"
90	light gray fine-grained quartzose sandstone
95	"
100	"
105	"
110	"
115	light to medium gray claystone
120	"
125	"
130	"
135	"
140	"

145	"
150	"
155	"
160	"
165	"
170	"
175	dark gray claystone
180	"
185	light to medium gray claystone
190	"
195	"
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	"
265	"
270	"
275	light gray fine-grained quartzose sandstone
280	medium gray claystone
285	"
290	"
295	"
300	vitreous coal
305	"
310	medium gray claystone with slight vitreous coal

315	dark gray claystone
320	"
325	"

330	"
335	"
340	"
	TOTAL DEPTH = 340 Feet

HOLE NUMBER: SV-7	**LOCATION**: N40° 2.914'/W105° 1.020'	**STATE**: Colorado
DRILLED BY: N.R. Bideau Drilling	**LOGGED BY**: Adam Lusk	**TOTAL DEPTH**: 320"
DATE: 3/09/03	**BIT SIZE**: 5 ½"	**DRILLED WITH: AIR** **MUD X**

DEPTH	SAMPLE DESCRIPTION
5	light brown medium-grained sand
10	light to medium gray claystone
15	"
20	"
25	"
30	"
35	"
40	"
45	"
50	"
55	"
60	"
65	"
70	"
75	"
80	light gray fine-grained quartzose sandstone
85	"
90	light to medium gray claystone
95	"
100	"
105	"
110	"
115	"
120	"
125	dark gray claystone
130	light gray claystone
135	"

140	"
145	"
150	"
155	"
160	"
165	"
170	"
175	"
180	light gray fine-grained quartzose sandstone
185	light to medium gray claystone
190	"
195	"
200	"
205	"
210	"
215	"
220	"
225	"
230	"
235	"
240	"
245	"
250	"
255	"
260	dark gray claystone
265	light gray fine-grained quartzose sandstone
270	medium gray claystone
275	"
280	"
285	Circulation lost at 285'
290	no samples (Top of mined interval)
295	"
300	"
305	"

310	"
315	"
320	"
	TOTAL DEPTH = 320 Feet

Hole Number: **S21-01** Location: N40°02.578 W105°00.079 State: Colorado
Drilled By: Bideau Drilling Logged by: D. Greeley Total Depth: 460 feet
Date: 5/16/2006 Bit Size: 5.125 Drilled with: Mud

Depth	Sample Description
0	Sand, silty, light brown
5	Sand, silty, light brown
10	Clay, silty, sandy, mottled
15	Clay, silty, sandy, mottled
20	Clay, silty, sandy, mottled
25	Clay, silty, sandy, mottled
30	Clay, silty, sandy, mottled
35	Clay, silty, sandy, mottled
40	Claystone, silty, mottled
45	Claystone, silty, mottled
50	Claystone, silty, mottled
55	Claystone, silty, mottled
60	Claystone, silty, mottled
65	Claystone, silty, gray
70	Claystone, silty, gray
75	Claystone, silty, gray
80	Claystone, silty, gray
85	Claystone, silty, gray
90	Claystone, silty, gray
95	Claystone, silty, gray
100	Claystone, silty, gray
110	Claystone, silty, gray
115	Claystone, silty, gray
120	Claystone, silty, gray
125	Claystone, silty, gray
130	Claystone, silty, gray
135	Claystone, silty, gray
140	Claystone, silty, gray
145	Claystone, silty, gray
150	Claystone, silty, gray

155	Claystone, silty, gray
160	Claystone, silty, gray
165	Claystone, silty, gray
170	Claystone, silty, gray
175	Claystone, silty, gray
180	Claystone, silty, gray
185	Claystone, silty, gray
190	Claystone, silty, gray
195	Claystone, silty, gray
200	Claystone, silty, gray
205	Claystone, silty, gray
210	Claystone, silty, gray
215	Claystone, silty, gray
220	Claystone, gray with coal
225	Claystone, carbonaceous, dark gray
230	Claystone, carbonaceous, dark gray
235	Claystone, carbonaceous, dark gray
240	Claystone, gray with coal
245	Claystone, gray with coal
250	Claystone, gray with coal
255	Claystone, gray with coal
260	Claystone, gray with coal
265	Claystone, gray with coal
270	Claystone, gray with coal
275	Claystone, gray with coal
280	Claystone, gray with coal
285	Claystone, gray
290	Claystone, gray
295	Claystone, gray
300	Claystone, gray
305	Claystone, gray
310	Claystone, gray S21-01

315	Claystone, gray
320	Claystone, gray
325	Claystone, gray
330	Claystone, gray
335	Claystone, gray
340	Claystone, gray
345	Claystone, gray
350	Claystone, gray
355	Claystone, gray
360	Claystone, gray
365	Claystone, gray
370	Claystone, gray
375	Claystone, gray
380	Claystone, gray
385	Claystone, gray
390	Claystone, gray
395	Claystone, carbonaceous, dark gray
400	Claystone, carbonaceous, dark gray
405	Coal **Eagle Mine Main Seam**
410	Coal **Eagle Mine Main Seam**
415	Claystone, carbonaceous, gray
420	Claystone, gray
425	Claystone, gray
430	Claystone, gray
435	Claystone, gray
440	Claystone, gray
445	Sandstone, light gray, fine grained, quartzose, Fox Hills Formation
450	Sandstone, light gray, fine grained, quartzose, Fox Hills Formation
455	Sandstone, light gray, fine grained, quartzose, Fox Hills Formation
460	Sandstone, light gray, fine grained, quartzose, Fox Hills Formation Total Depth
	Circulation not lost, no mine workings were encountered. S21-01

Hole Number: **S21-02** Location: N40°02.380 W105°00.079 State: Colorado
Drilled By: Bideau Drilling Logged by: D. Greeley Total Depth: 480 feet
Date: 5/17/2006 Bit Size: 5.125 Drilled with: Mud

Depth	Sample Description
0	Sand, silty, light brown
5	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
10	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
15	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
20	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
25	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
30	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
35	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
40	Sand, silty, gravelly, with cobble, light brown to mottled, Verdos Alluvium
45	Claystone, silty, gray
50	Claystone, silty, gray
55	Claystone, silty, gray
60	Claystone, silty, gray
65	Claystone, silty, gray
70	Claystone, silty, gray
75	Claystone, silty, gray
80	Claystone, silty, gray
85	Claystone, silty, gray
90	Claystone, silty, gray
95	Claystone, silty, gray
100	Claystone, silty, gray
110	Claystone, silty, gray
115	Claystone, silty, gray
120	Claystone, silty, gray
125	Claystone, silty, gray
130	Claystone, silty, gray
135	Claystone, silty, gray
140	Claystone, silty, gray
145	Claystone, silty, gray
150	Claystone, silty, gray
155	Claystone, silty, gray S21-02

160	Claystone, silty, gray
165	Claystone, silty, gray
170	Claystone, silty, gray
175	Claystone, silty, gray
180	Claystone, silty, gray
185	Claystone, silty, gray
190	Claystone, silty, gray
195	Claystone, silty, gray
200	Claystone, silty, gray
205	Claystone, silty, gray
210	Claystone, silty, gray
215	Claystone, silty, gray
220	Claystone, silty, gray
225	Claystone, silty, gray
230	Claystone, silty, gray
235	Claystone, silty, gray
240	Claystone, silty, gray
245	Claystone, silty, gray
250	Claystone, silty, gray
255	Claystone, silty, gray
260	Claystone, silty, gray
265	Claystone, silty, gray
270	Claystone, silty, gray
275	Claystone, silty, gray
280	Claystone, silty, gray
285	Claystone, silty, gray
290	Claystone, silty, gray
295	Claystone, silty, gray
300	Claystone, silty, gray
305	Claystone, silty, gray
310	Claystone, silty, gray
315	Claystone, silty, gray
320	Claystone, silty, gray
325	Claystone, silty, gray S21-02

330	Claystone, gray with coal
335	Claystone, silty, gray
340	Claystone, silty, gray
345	Claystone, silty, gray
350	Claystone, silty, gray
355	Claystone, silty, gray
360	Claystone, silty, gray
365	Claystone, silty, gray
370	Claystone, silty, gray
375	Claystone, silty, gray
380	Claystone, silty, gray
385	Claystone, silty, gray
390	Claystone, silty, gray
395	Claystone, silty, gray
400	Claystone, silty, gray
405	Claystone, silty, gray
410	Claystone, silty, gray
415	Claystone, silty, gray
420	Claystone, silty, gray
425	Claystone, silty, gray
430	Claystone, silty, gray
435	Claystone, silty, gray
440	Claystone, silty, gray
445	Claystone, silty, gray
450	Claystone with coal
455	Claystone with coal
460	Circulation lost at 458
465	No Sample Recovery
470	No Sample Recovery
475	No Sample Recovery
480	No Sample Recovery Total Depth
	Circulation lost at 458 feet, collapse complete with no open voids. Maximum caliper deflection was 15 inches at 456.3 feet. S21-02

Hole Number: **S21-03** | Location: N40°02.174 W105°00.079 | State: Colorado
Drilled By: Bideau Drilling | Logged by: D. Greeley | Total Depth: 440 feet
Date: 5/18/2006 | Bit Size: 5.125 | Drilled with: Mud

Depth	Sample Description
0	Sand, silty, fine to medium grained, light brown
5	Sand, silty, fine to medium grained, light brown
10	Sand, silty, fine to medium grained, light brown
15	Clay, silty, sandy, mottled
20	Clay, silty, sandy, mottled
25	Clay, silty, sandy, mottled
30	Clay, silty, sandy, mottled
35	Clay, silty, sandy, mottled
40	Clay, silty, sandy, mottled
45	Claystone, gray
50	Claystone, gray
55	Claystone, gray
60	Claystone, gray
65	Claystone, tan to mottled
70	Claystone, tan to mottled
75	Claystone, tan to mottled
80	Claystone, tan to mottled
85	Claystone, tan to mottled
90	Claystone, gray
95	Claystone, gray
100	Claystone, gray
110	Claystone, gray
115	Claystone, gray
120	Claystone, gray
125	Claystone, gray
130	Claystone, gray
135	Claystone, gray
140	Claystone, gray
145	Claystone, gray
150	Claystone, gray
155	Claystone, gray

160	Claystone, gray
165	Claystone, gray
170	Claystone, gray
175	Claystone, gray
180	Claystone, gray
185	Claystone, gray
190	Claystone, gray
195	Claystone, gray
200	Claystone, gray
205	Claystone, gray
210	Claystone, gray
215	Claystone, gray
220	Claystone, gray
225	Claystone, gray
230	Claystone, gray
235	Claystone, gray
240	Claystone, gray
245	Claystone, gray
250	Claystone, gray
255	Claystone, gray
260	Claystone, gray
265	Claystone, gray
270	Claystone, gray
275	Claystone, gray
280	Claystone, gray
285	Claystone, gray
290	Claystone, gray
295	Claystone, gray
300	Claystone, gray
305	Claystone, gray
310	Claystone, gray
315	Claystone, gray
320	Claystone, gray
325	Claystone, gray S21-03

330	Claystone, gray
335	Claystone, carbonaceous, dark gray
340	Claystone, carbonaceous, dark gray
345	Claystone, carbonaceous, dark gray
350	Claystone, gray to dark gray with coal
355	Claystone, gray
360	Claystone, gray
365	Claystone, gray
370	Claystone, gray
375	Claystone, gray
380	Claystone, gray
385	Claystone, gray
390	Claystone, carbonaceous, dark gray
395	Claystone, carbonaceous, dark gray with coal
400	Claystone, carbonaceous, dark gray with coal
405	Claystone, carbonaceous, dark gray with coal
410	Circulation lost
415	No Sample Recovery
420	No Sample Recovery
425	No Sample Recovery
430	No Sample Recovery
435	No Sample Recovery
440	No Sample Recovery
	Circulation lost at 408 feet, collapse complete with no open voids. Maximum caliper deflection was 13.8 inches at 408.8 feet. S21-03

Hole Number: **S29-2**
Drilled by: Plains Water Well Service
Date: 11/6/06

Location: N40°01.217 W105°01.198
Logged by: D. Greeley
Bit Size: 6.25 inches

State: Colorado
Total Depth: 320'
Drilled with: Mud

Depth	Sample Description
5	Clay, sandy, light brown to brown
10	Clay, sandy, light brown to brown
15	Claystone, silty, brown
20	Claystone, silty, brown
25	Claystone, silty, gray with rust stains
30	Claystone, silty, gray with rust stains
35	Claystone, silty, gray with rust stains
40	Claystone, silty, gray with rust stains
45	Claystone, dark gray
50	Claystone, dark gray
55	Claystone, dark gray
60	Claystone, dark gray
65	Claystone, dark gray
70	Claystone, dark gray
75	Claystone, dark gray
80	Claystone, dark gray
85	Claystone, dark gray
90	Claystone, dark gray
95	Claystone, dark gray
100	Claystone, dark gray
105	Claystone, dark gray
110	Claystone, dark gray
115	Claystone, dark gray
120	Claystone, dark gray
125	Claystone, dark gray
130	Claystone, dark gray
135	Claystone, dark gray
140	Claystone, dark gray
145	Claystone, dark gray
150	Claystone, dark gray
155	Claystone, dark gray
160	Claystone, dark gray
165	Claystone, dark gray
170	Claystone, dark gray
175	Claystone, dark gray

180	Claystone, dark gray
185	Claystone, dark gray
190	Claystone, dark gray
195	Claystone, dark gray
200	Claystone, dark gray
205	Claystone, dark gray
210	Claystone, dark gray
215	Claystone, dark gray
220	Claystone, dark gray
225	Claystone, carbonaceous, dark gray with coal
230	Claystone, dark gray
235	Claystone, dark gray
240	Claystone, dark gray
245	Claystone, dark gray
250	Claystone, dark gray to black with coal
255	Claystone, gray
260	Claystone, gray
265	Claystone, gray
270	Claystone, gray
275	Claystone, gray
280	Claystone, gray
285	Claystone, gray
290	Claystone, gray
295	Circulation lost, no sample recovery
300	No Recovery
305	No Recovery
310	No Recovery
315	No Recovery
320	No Recovery Total Depth

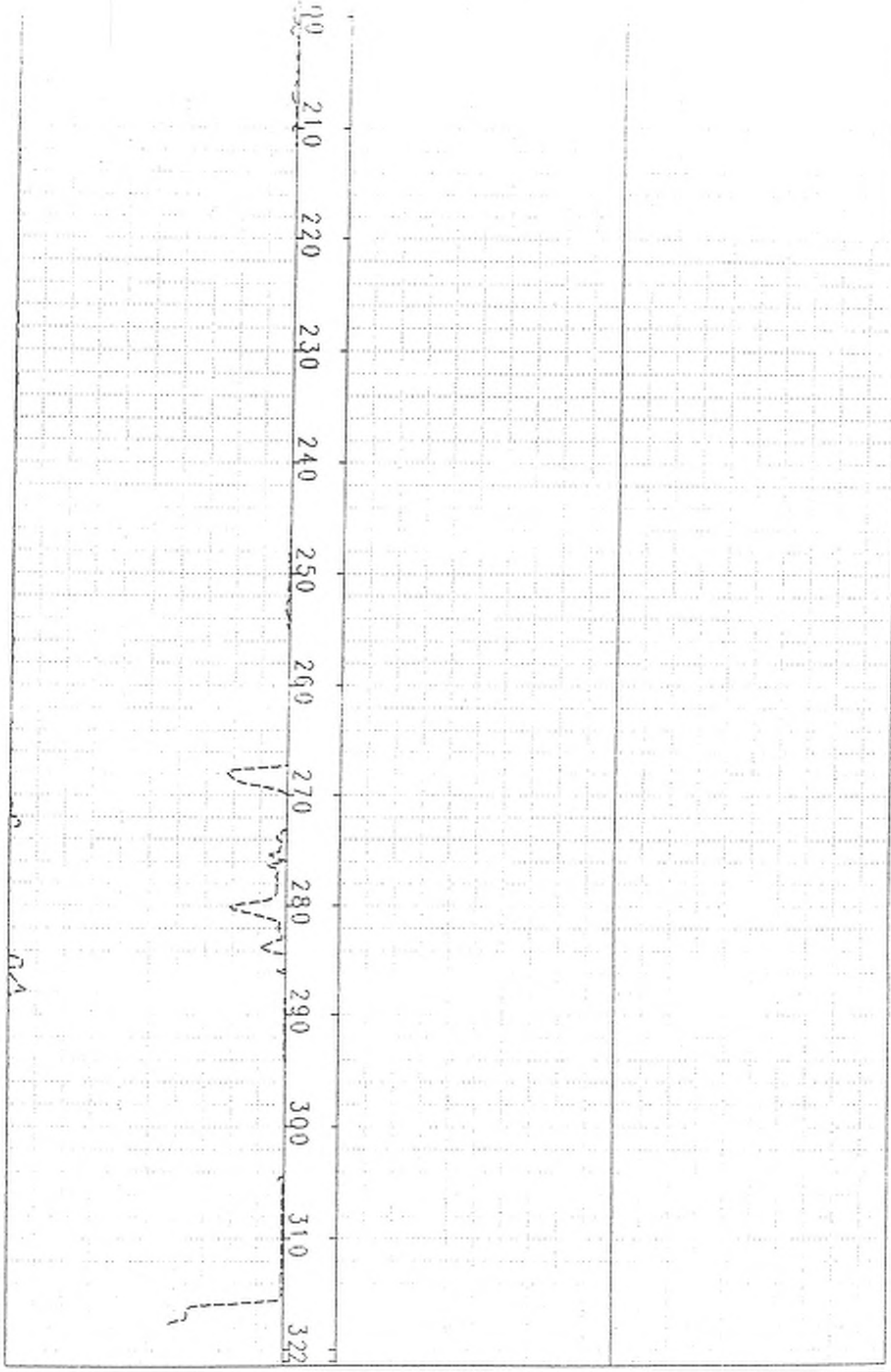
Hole Number: **S29-5**
Drilled by: Plains Water Well Service
Date: 11/7/06

Location: N40°01.052 W105°01.413
Logged by: D. Greeley
Bit Size: 6.25 inches

State: Colorado
Total Depth: 360'
Drilled with: Mud

Depth	Sample Description
5	Clay, sandy, light brown to brown
10	Clay, sandy, light brown to brown
15	Clay, sandy, light brown to brown
20	Claystone, silty, light brown with rust
25	Claystone, silty, light brown with rust
30	Claystone, silty, light brown with rust
35	Claystone, silty, light brown with rust
40	Claystone, silty, light brown with rust
45	Claystone, silty, light brown with rust
50	Claystone, silty, light brown with rust
55	Claystone, silty, light brown with rust
60	Claystone, silty, light brown with rust
65	Claystone, silty, light brown with rust
70	Claystone, dark gray
75	Claystone, dark gray
80	Claystone, dark gray
85	Claystone, dark gray
90	Claystone, dark gray
95	Claystone, dark gray
100	Claystone, dark gray
105	Claystone, dark gray
110	Claystone, dark gray
115	Claystone, dark gray
120	Sandstone lense, gray
125	Claystone, dark gray
130	Claystone, dark gray
135	Claystone, dark gray
140	Claystone, dark gray
145	Claystone, dark gray
150	Claystone, dark gray
155	Claystone, dark gray
160	Claystone, dark gray
165	Claystone, dark gray
170	Claystone, dark gray
175	Claystone, dark gray

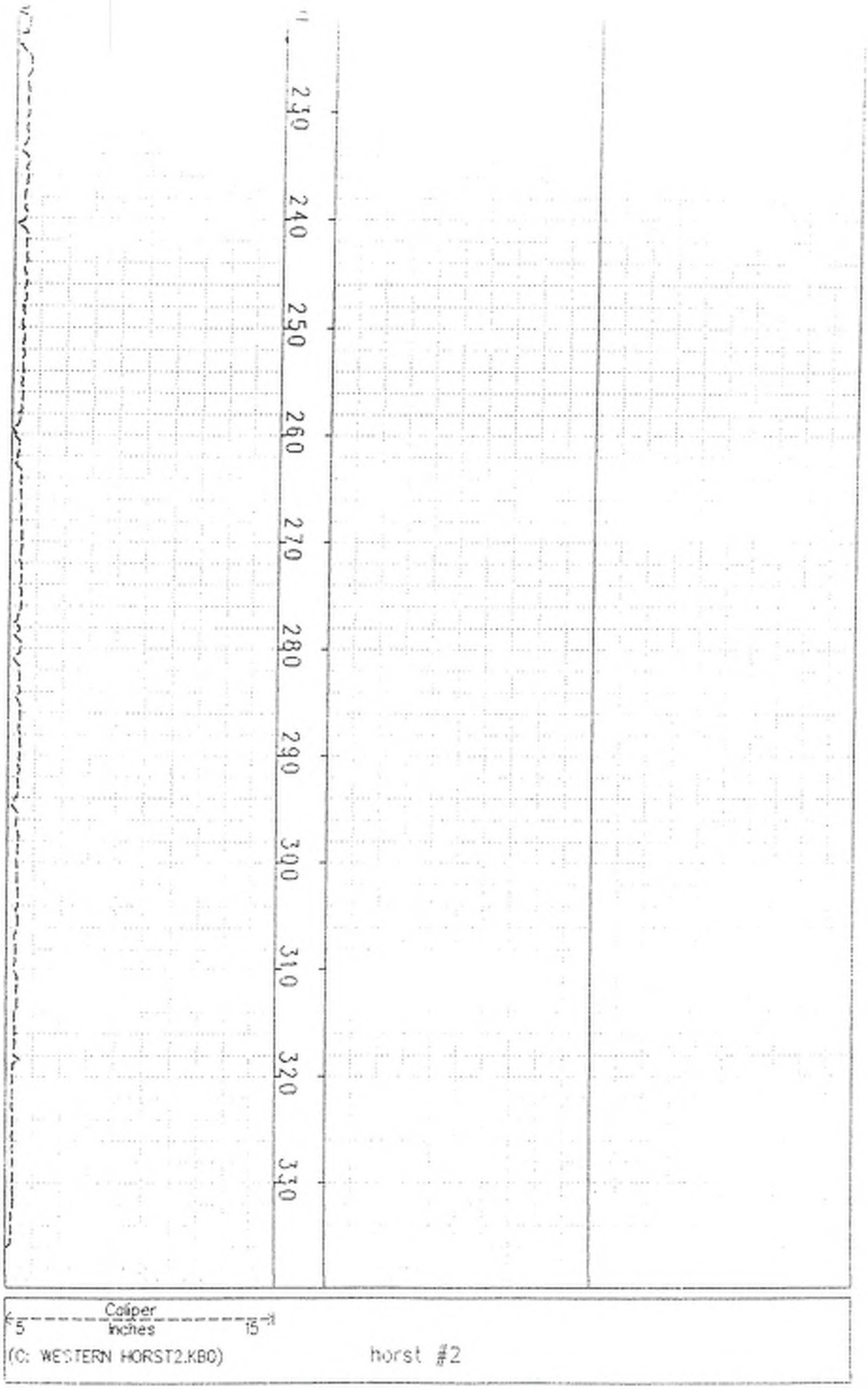
180	Claystone, dark gray	
185	Claystone, dark gray	
190	Claystone, dark gray	
195	Claystone, dark gray	
200	Claystone, dark gray	
205	Claystone, dark gray	
210	Claystone, dark gray, with coal	
215	Claystone, dark gray	
220	Claystone, dark gray	
225	Claystone, carbonaceous, dark gray	
230	Claystone, dark gray	
235	Claystone, dark gray	
240	Claystone, dark gray	
245	Claystone, dark gray	
250	Claystone, dark gray to black with coal	
255	Claystone, gray	
260	Claystone, gray	
265	Claystone, carbonaceous, dark gray, with coal	Columbine Main Seam
270	Claystone, gray	
275	Claystone, gray	
280	Claystone, gray	
285	Claystone, gray	
290	Claystone, gray	
295	Claystone, gray	
300	Claystone, gray	
305	Claystone, gray	
310	Claystone, gray	
315	Claystone, gray	
320	Claystone, gray	
325	Claystone, gray	
330	Claystone, gray	
335	Claystone, gray	
340	Claystone, gray	
345	Claystone, gray	
350	Claystone, gray	
355	Claystone, gray	
360	Claystone, gray	Total Depth

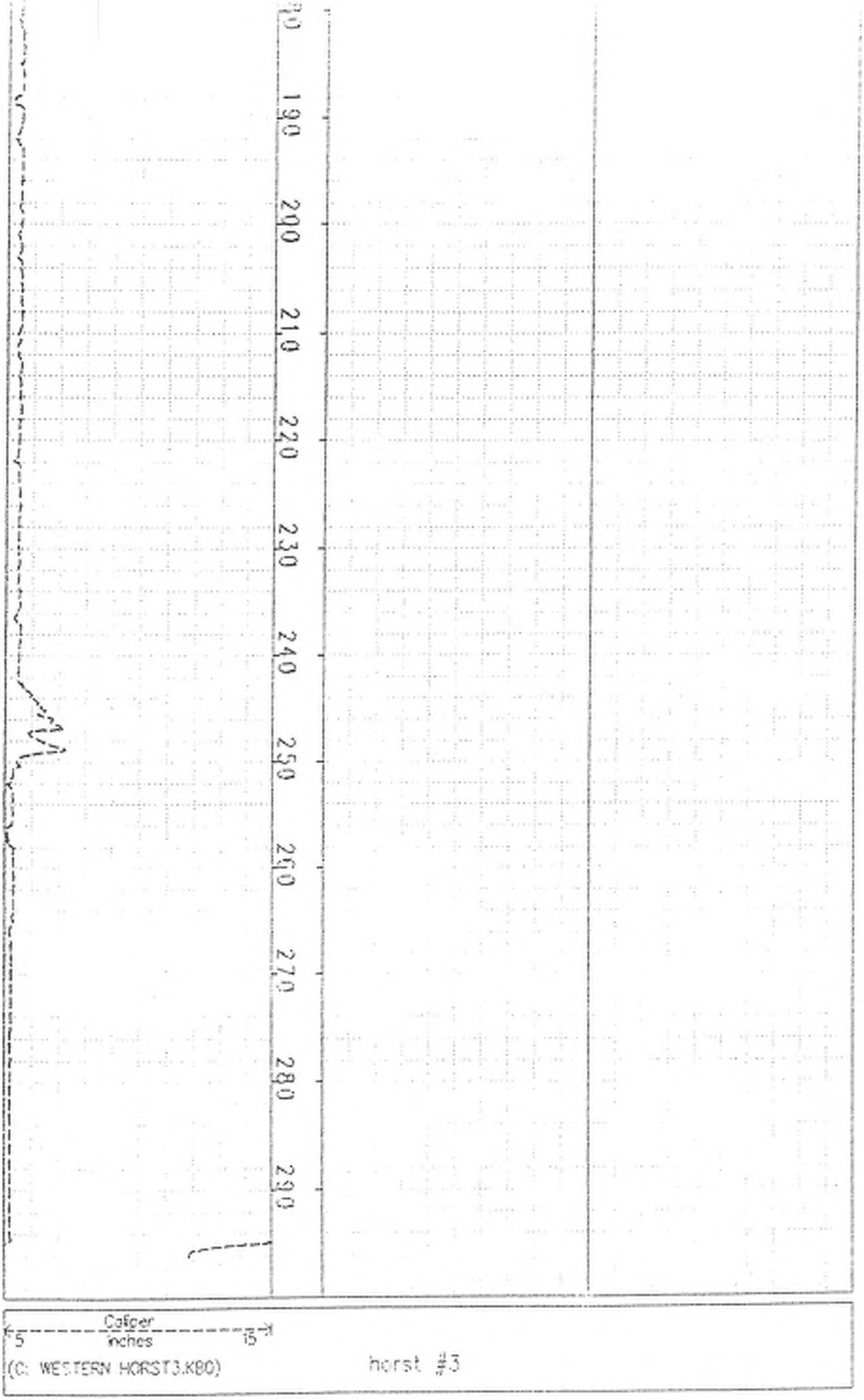


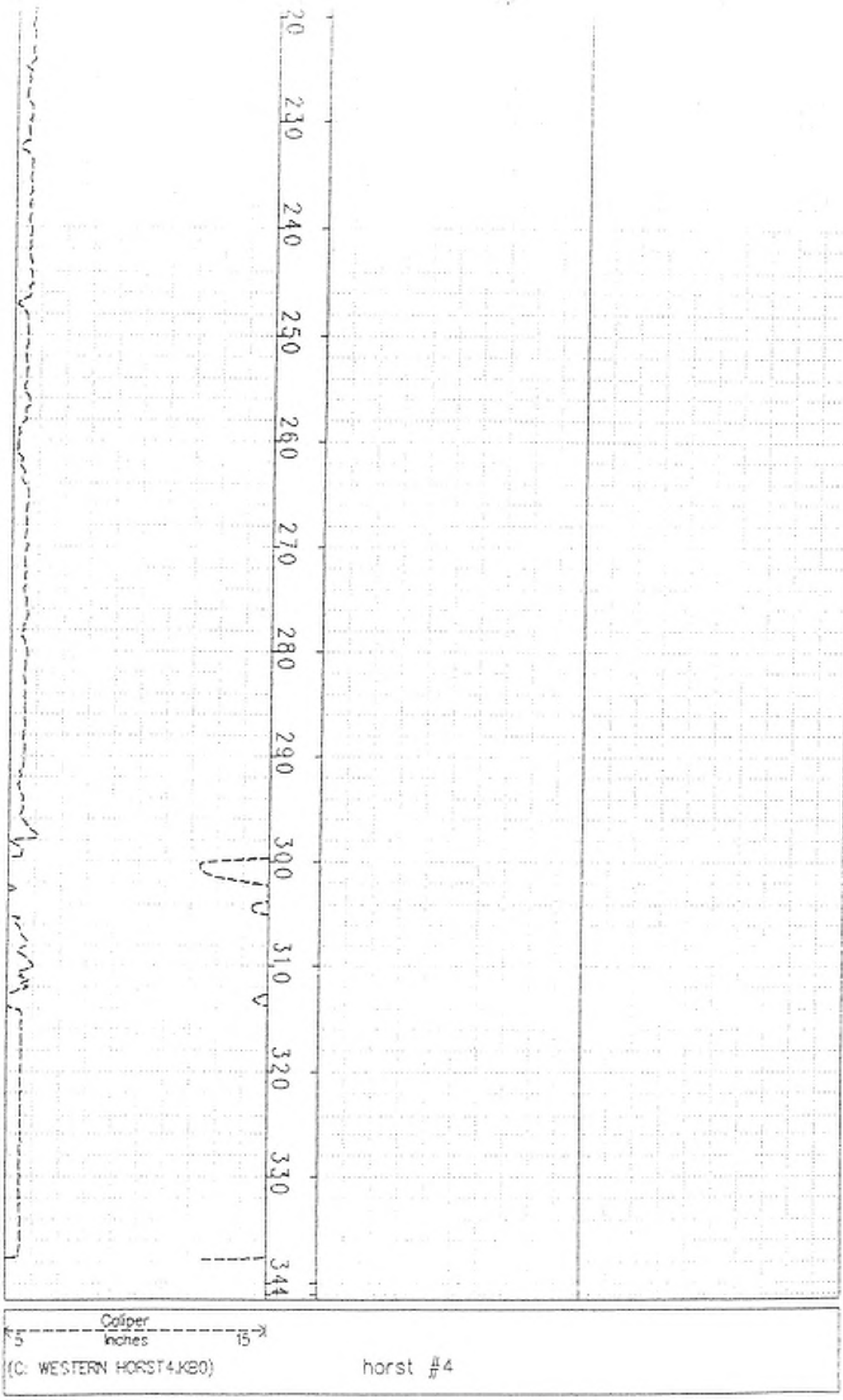
Caliper
5 inches 15

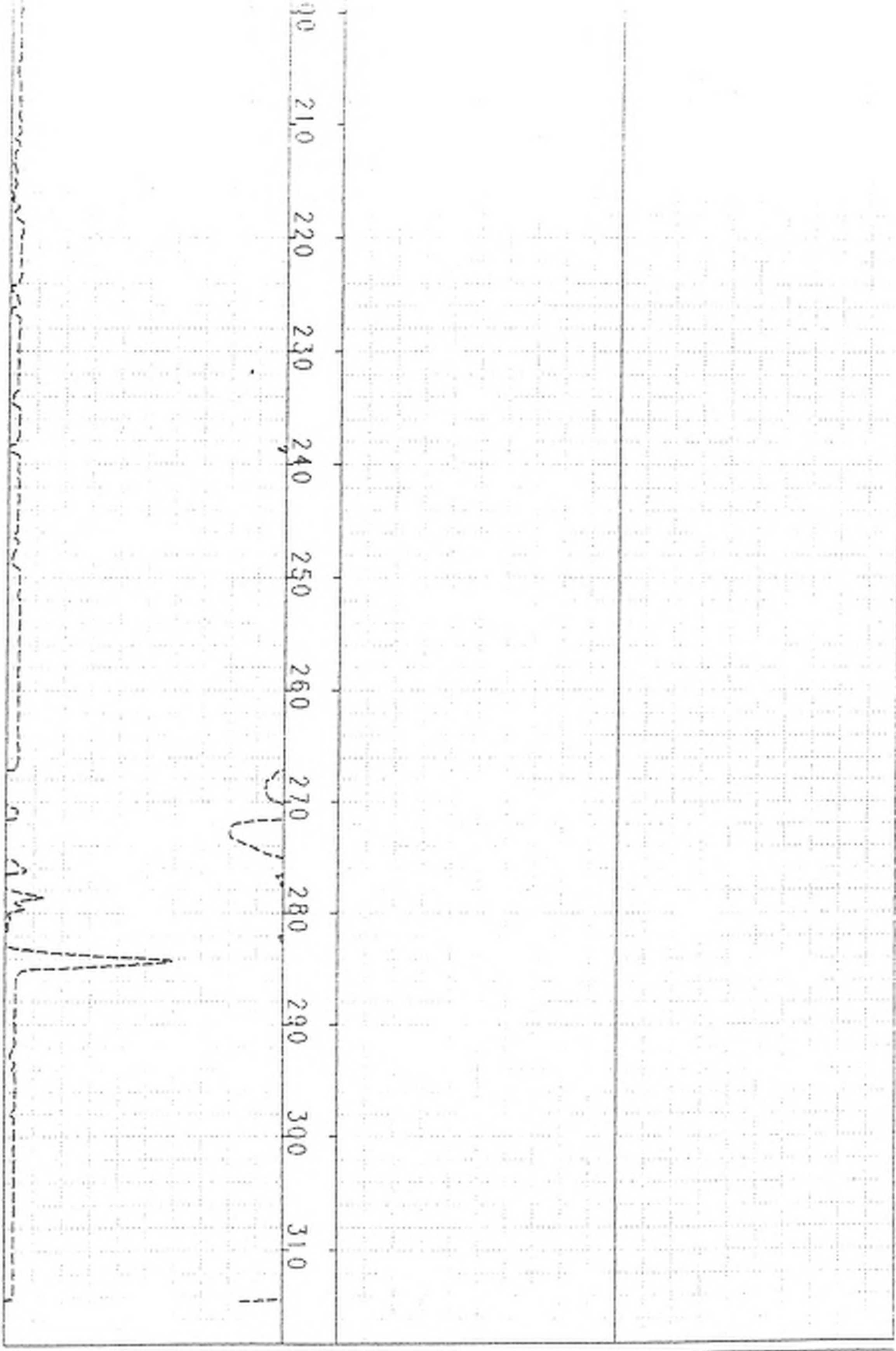
(C: WESTERN HORSTLAA1)

horst #1


230
240
250
260
270
280
290
300
310
320
330
Caliper
Inches
5
15
(C: WESTERN HORST2.KBO)
horst #2

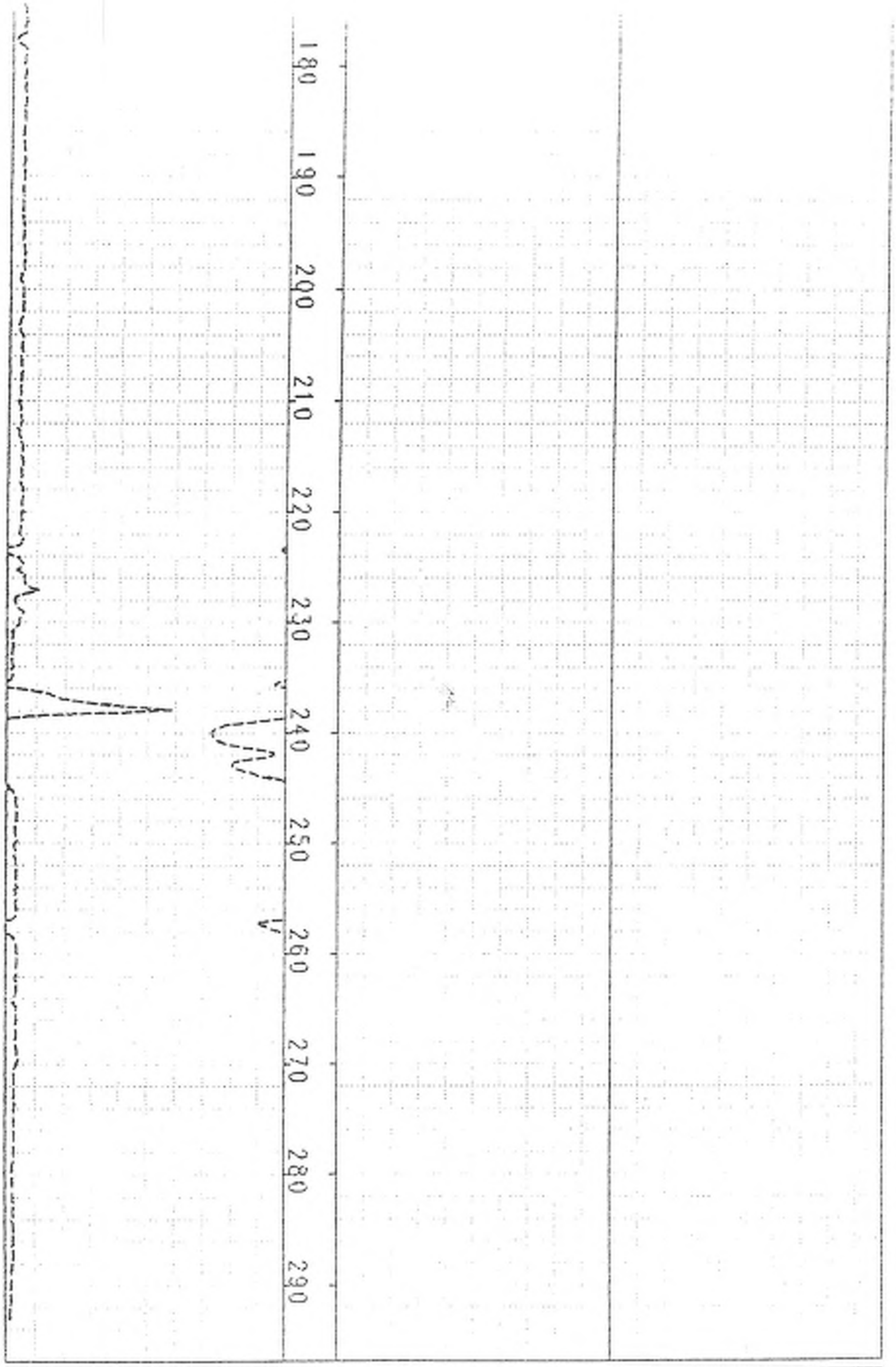

190
200
210
220
230
240
250
260
270
280
290
Caliper
inches
5
15
(C: WESTERN HORST3.K80)
horst #3


230
240
250
260
270
280
290
300
310
320
330
Caliper
5
Inches
15
(C: WESTERN HORST4.KBO)
horst #4



Caliper
5 Inches 15

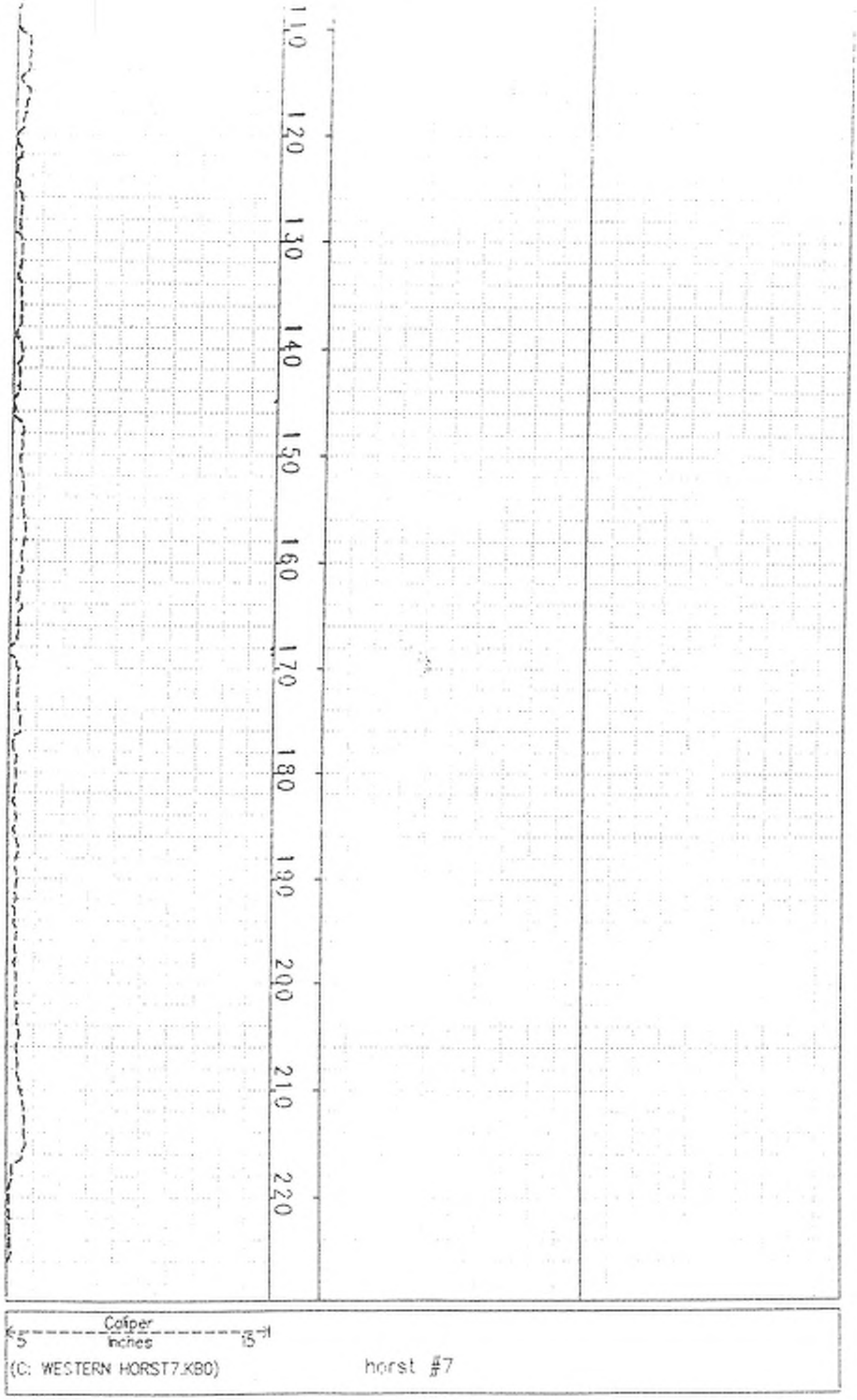
(C: WESTERN HORST5.KB0) horst #5



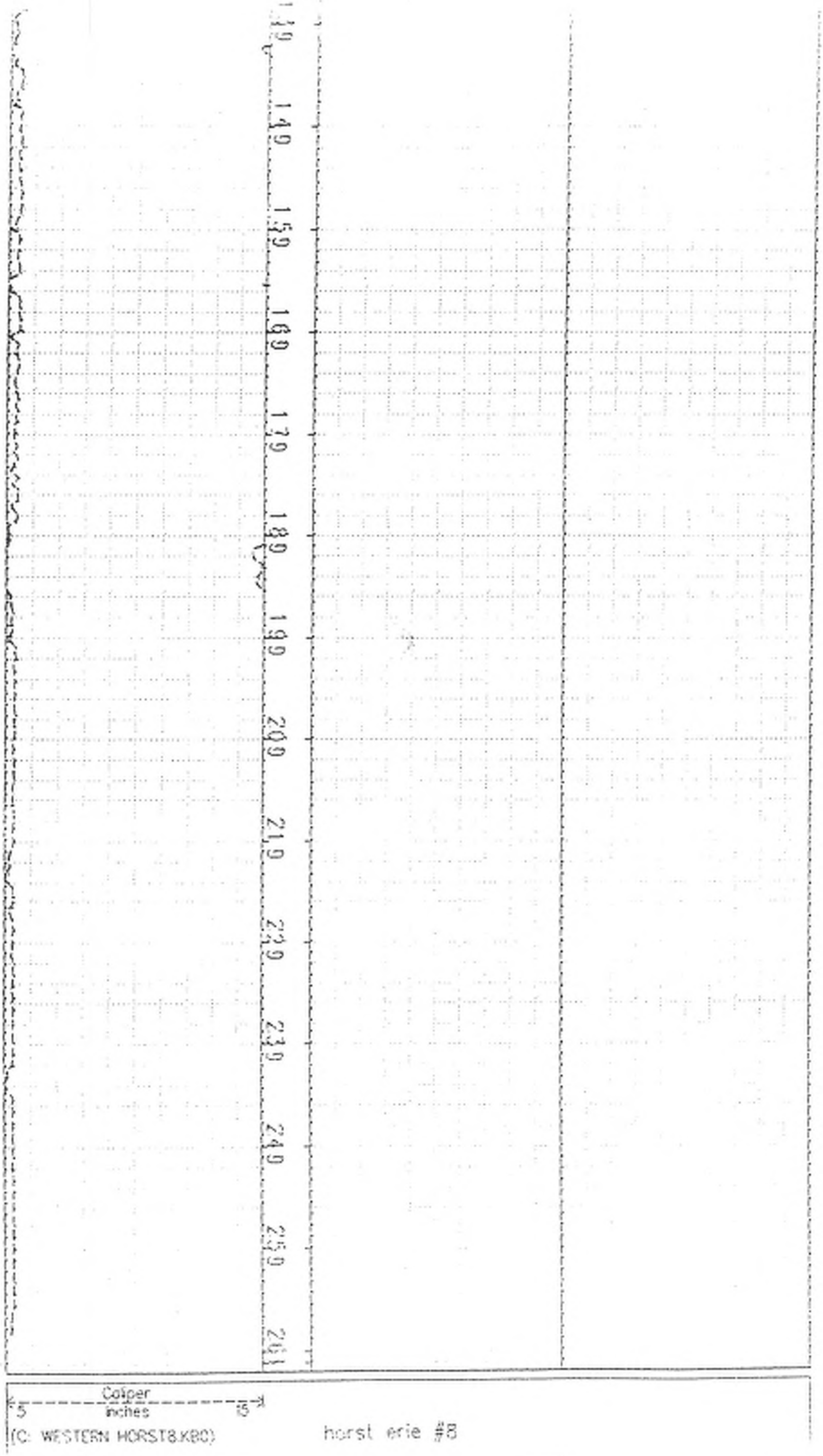
Caliper
5 Inches 15

(C: WESTERN HORST6.KBO)

horst #6



110
120
130
140
150
160
170
180
190
200
210
220
Caliper
Inches
5
15
(C: WESTERN HORST7.KB0)
horst #7


140
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Colper
inches
5
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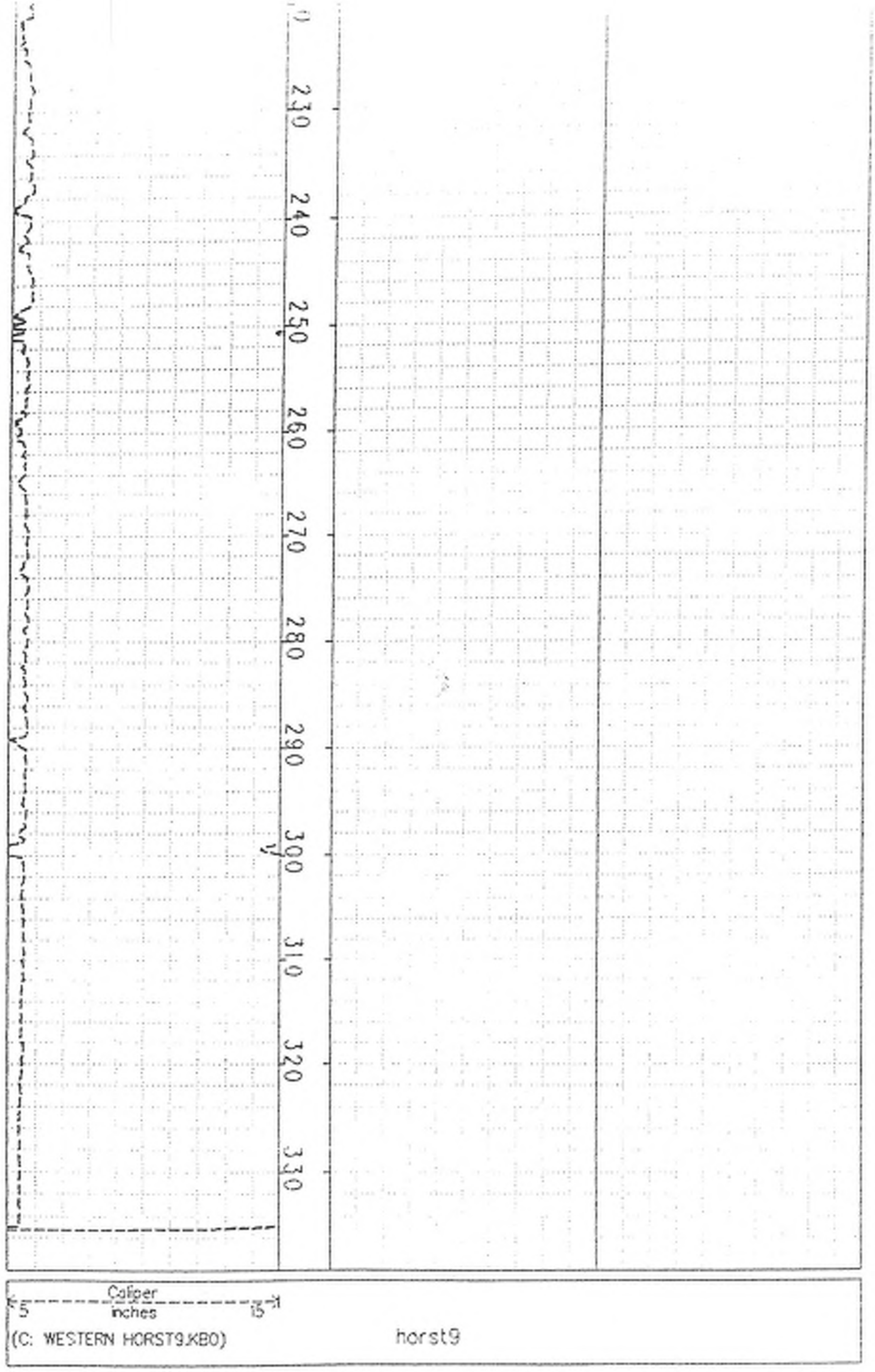
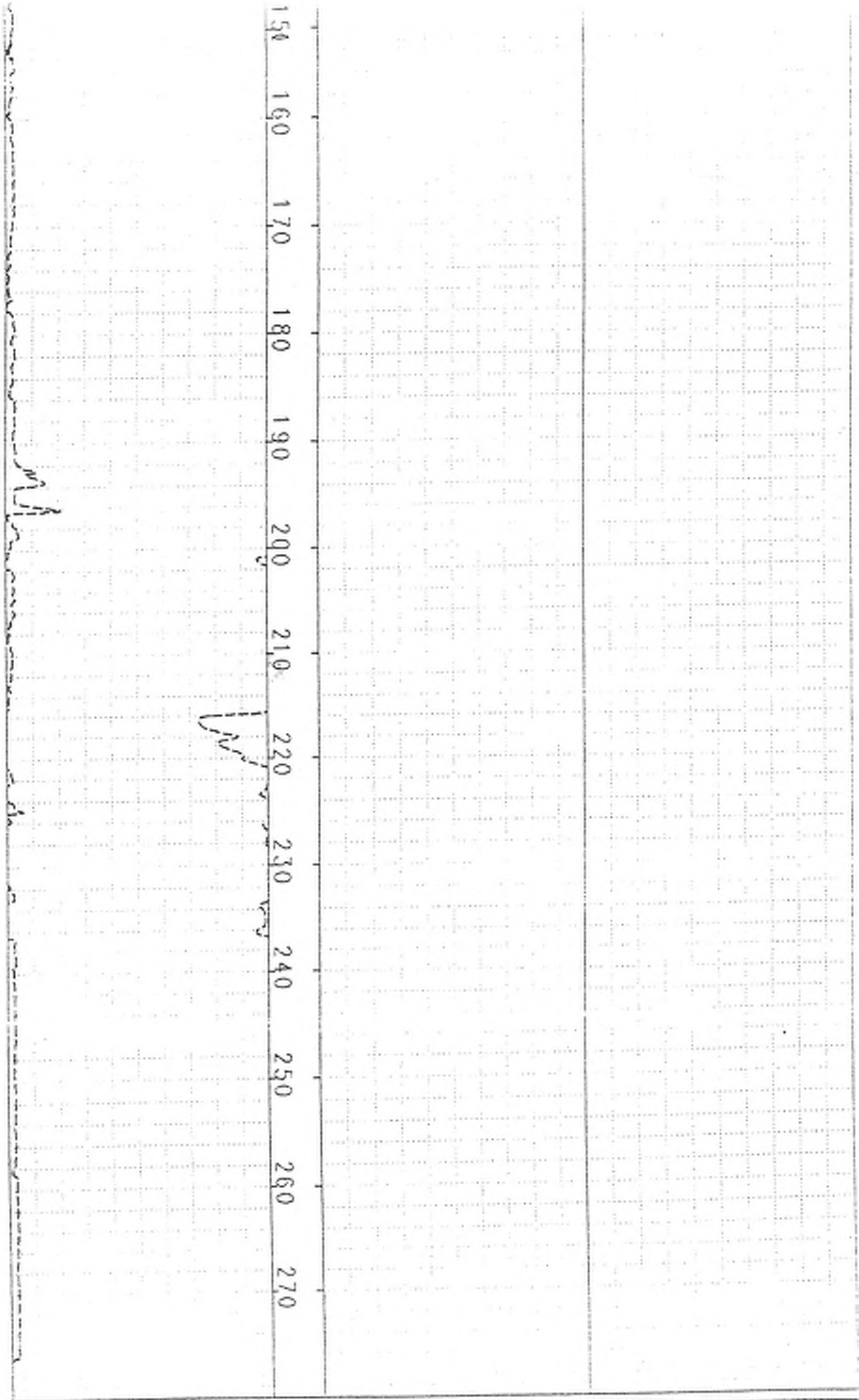
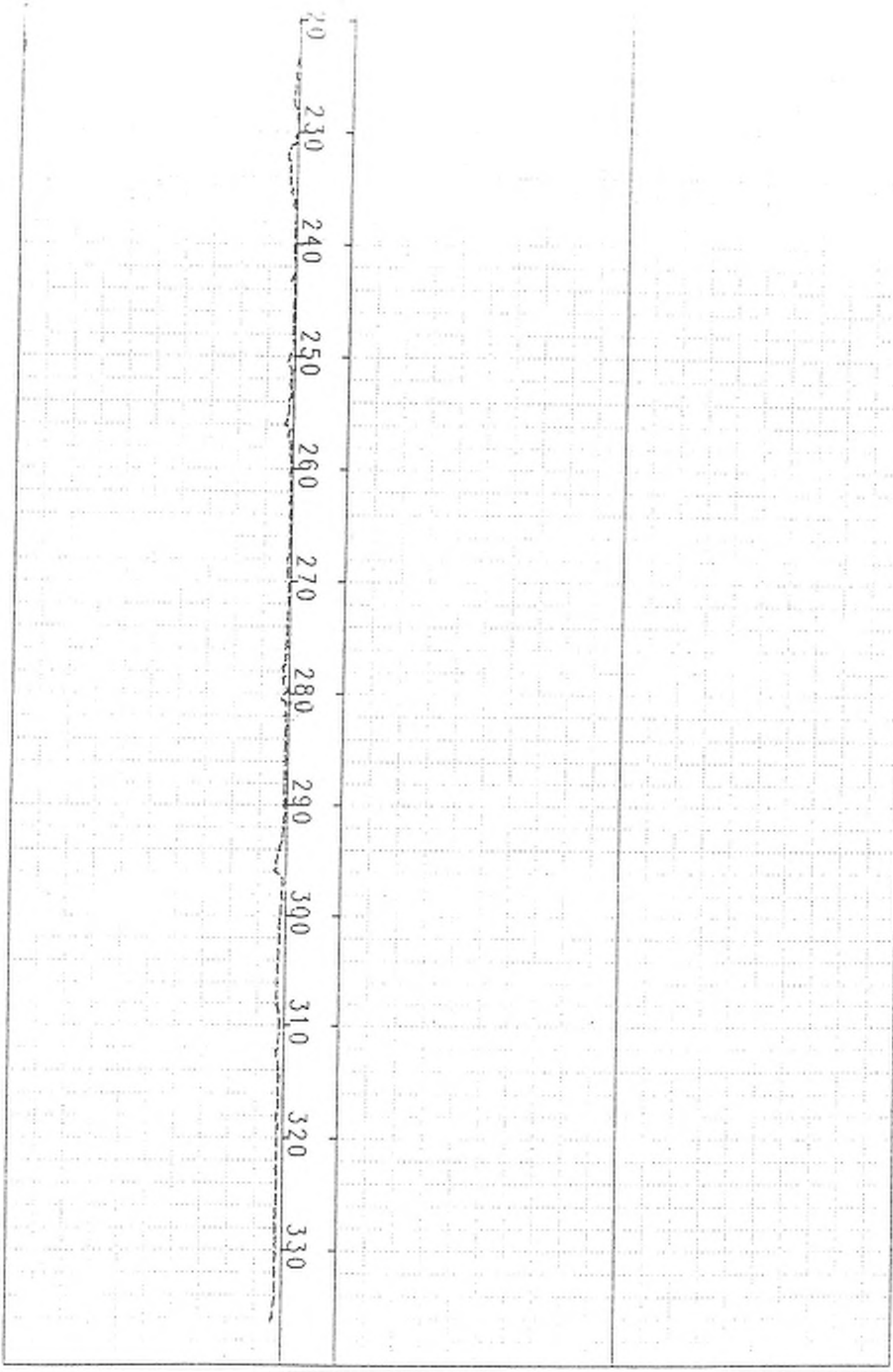
(C: WESTERN HORST8.XBC)
horst erie #8


230
240
250
260
270
280
290
300
310
320
330
Caliper
5
inches
15
(C: WESTERN HORST9.KB0)
horst9



Caliper
5 Inches 15
(C: WESTERN HORST10.KBO) horst #10



Caliper
5 inches 15

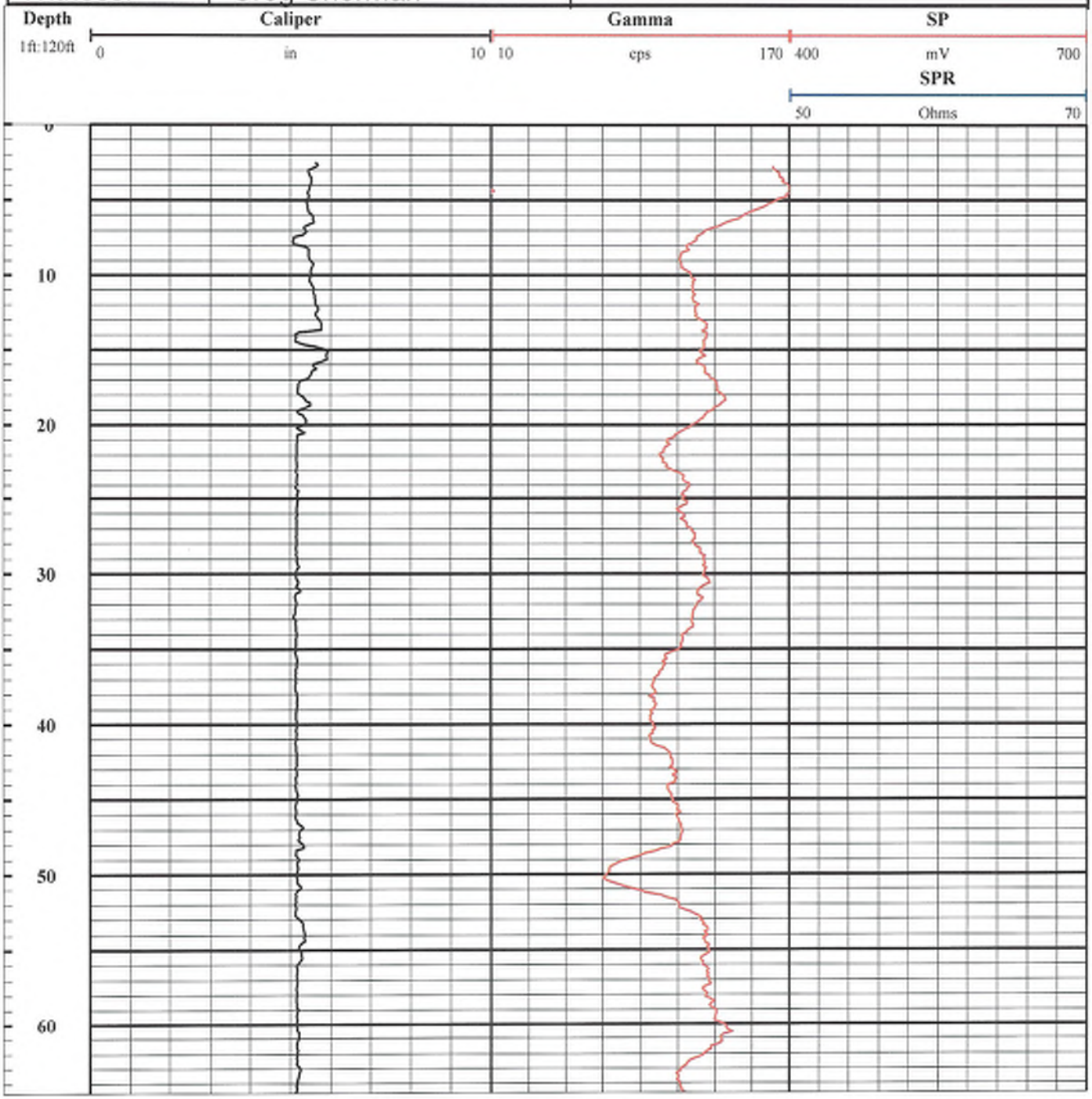
(C: WESTERN HORST11.KBO)

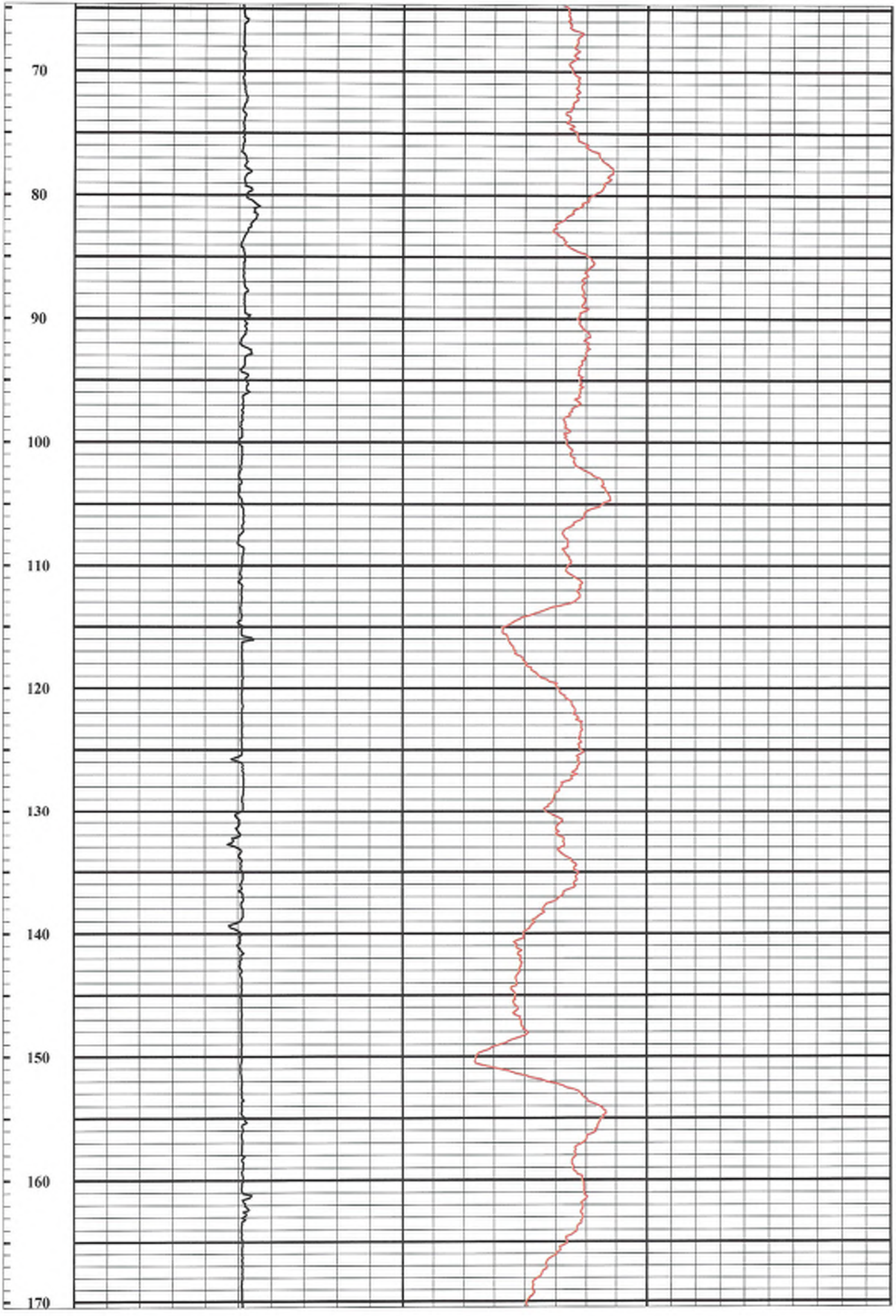
horst #11

	COMPANY: Western Environment and Ecololgy, Inc.
	Location: Southeast 1/4 of Section 20, Twn 1 N, R68W, Erie, CO

Well	SB-1		
Date	29 Apr 2008	BH Fluid	Air
Casing			
File Name	SB-1		
Depth Driller	340		
Depth Logger	334		
Logged by:	Doug Greeley		
Witness:	Greg Sherman		

OTHER SERVICES




70
80
90
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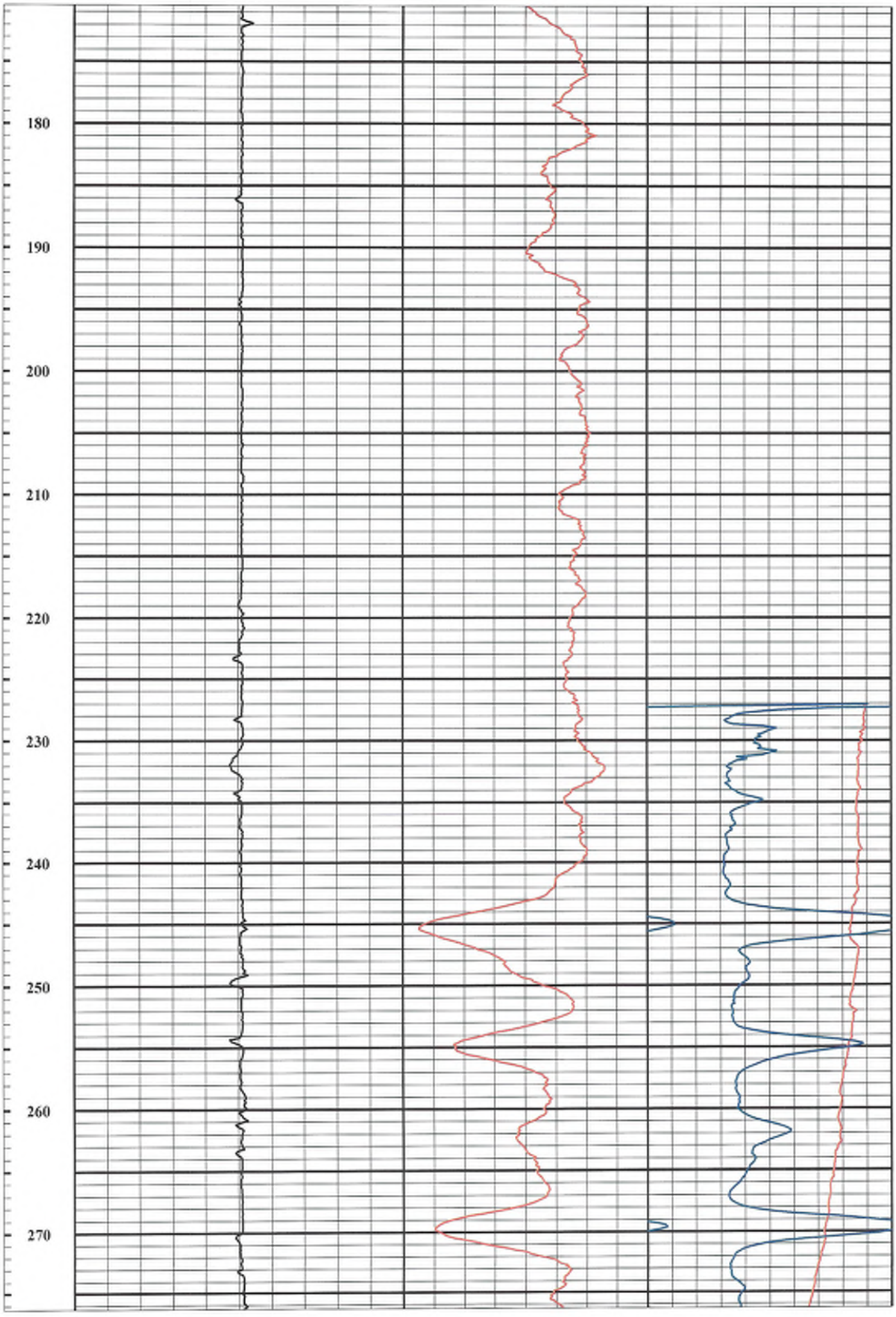
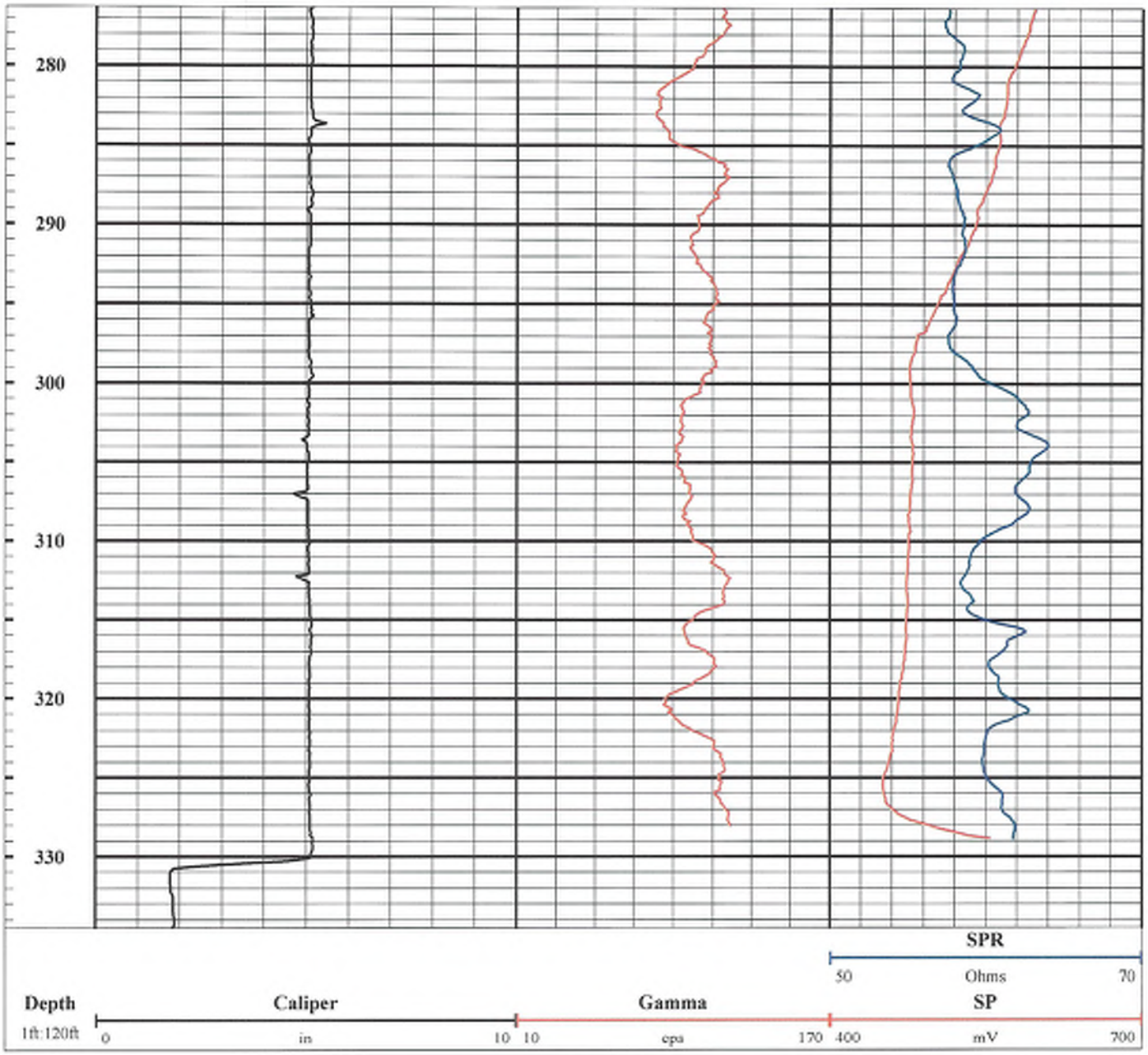
130
140
150
160
170


180
190
200
210
220
230
240
250
260
270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SPR
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Ohms
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Depth
1ft:120ft
Caliper
0
in
10
Gamma
10
cps
170
SP
400
mV
700

	COMPANY: Western Environment and Ecology, Inc.
	Location: Southeast 1/4 of Section 20, Twn 1 N, R68W, Erie, CO

Well	SB-2		
Date	30 Apr. 2008	BH Fluid	Mud
Casing			
File Name	SB-2		
Depth Driller	285		
Depth Logger	211		
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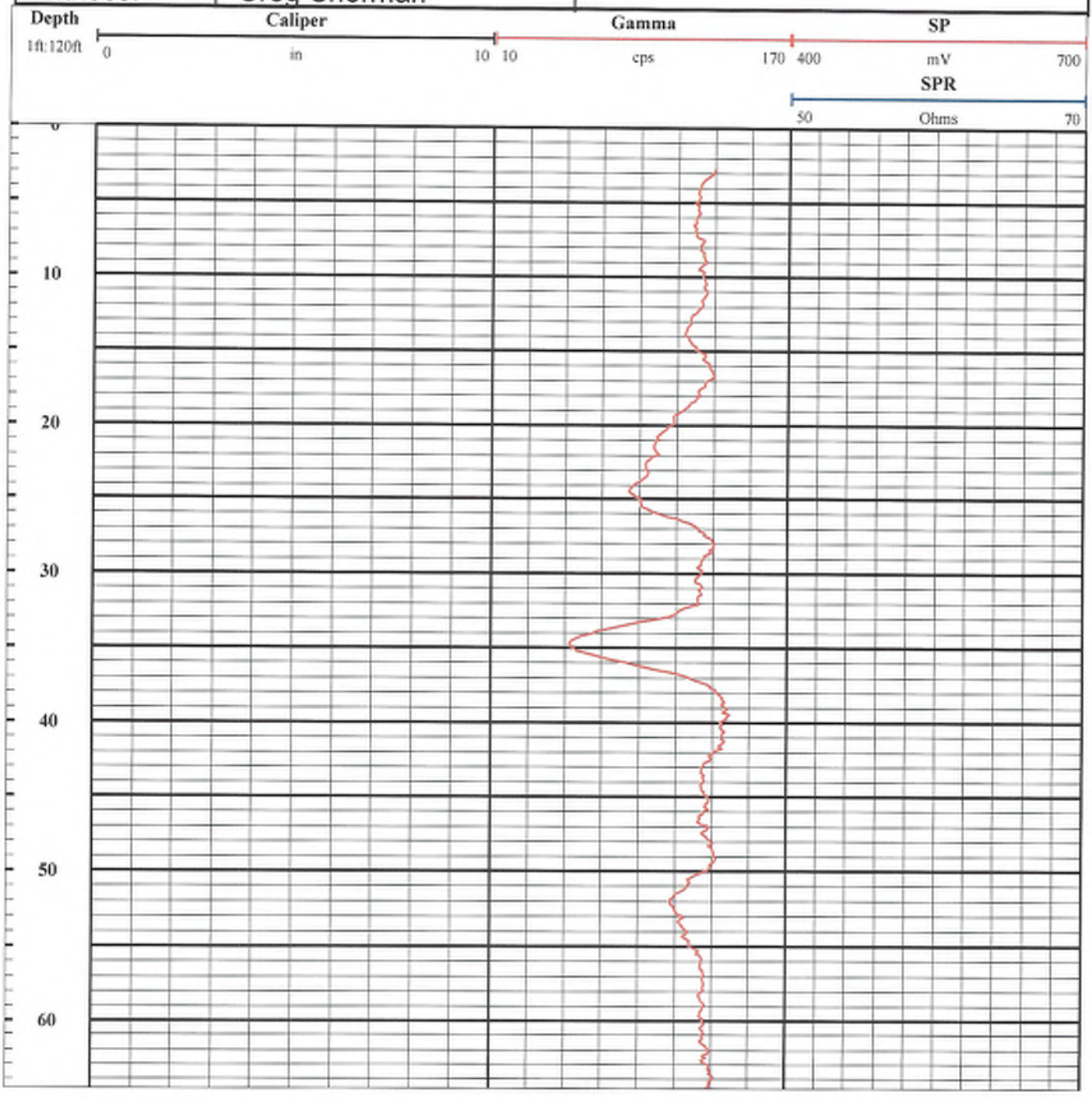
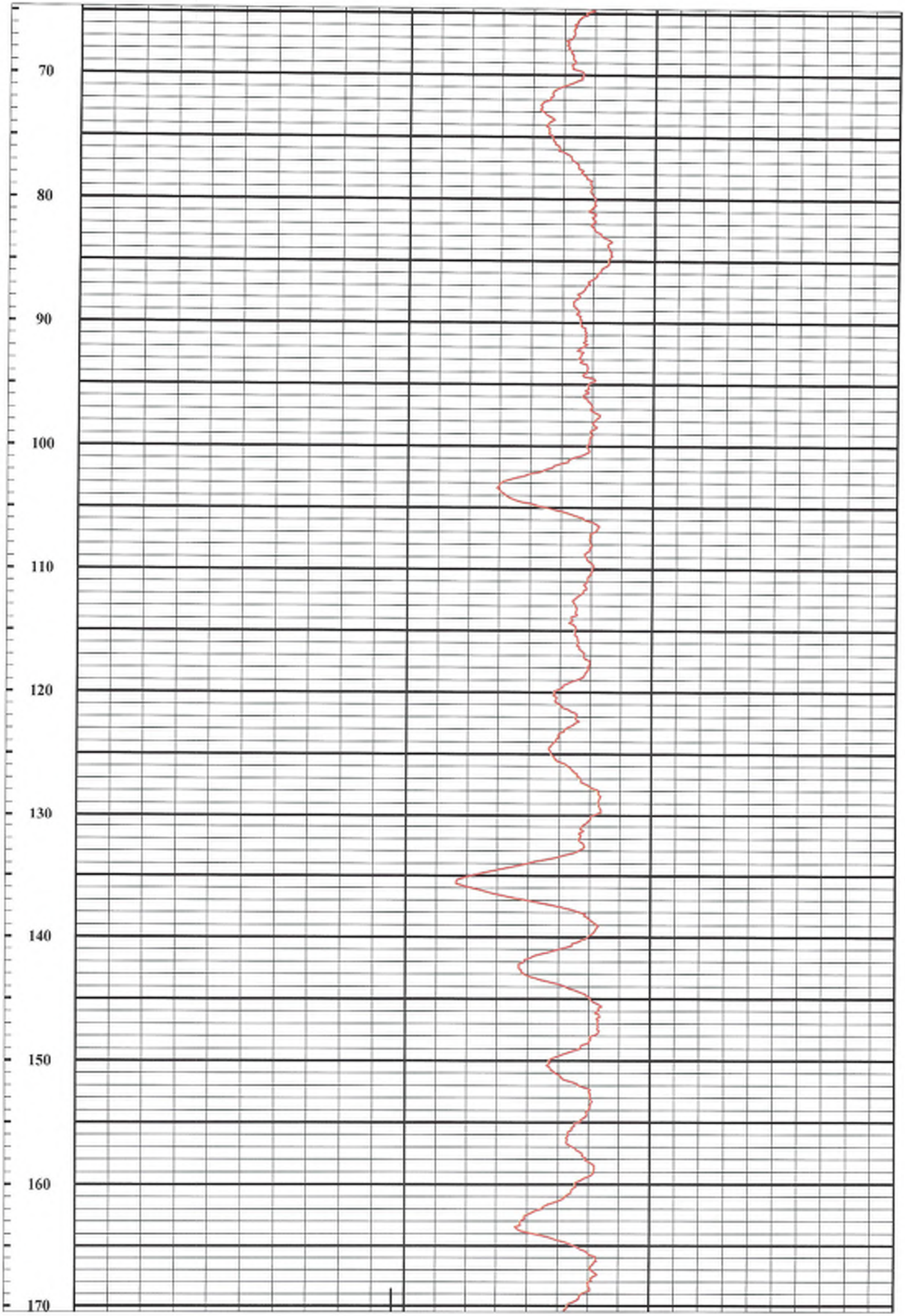
Witness:	Greg Sherman		

OTHER SERVICES

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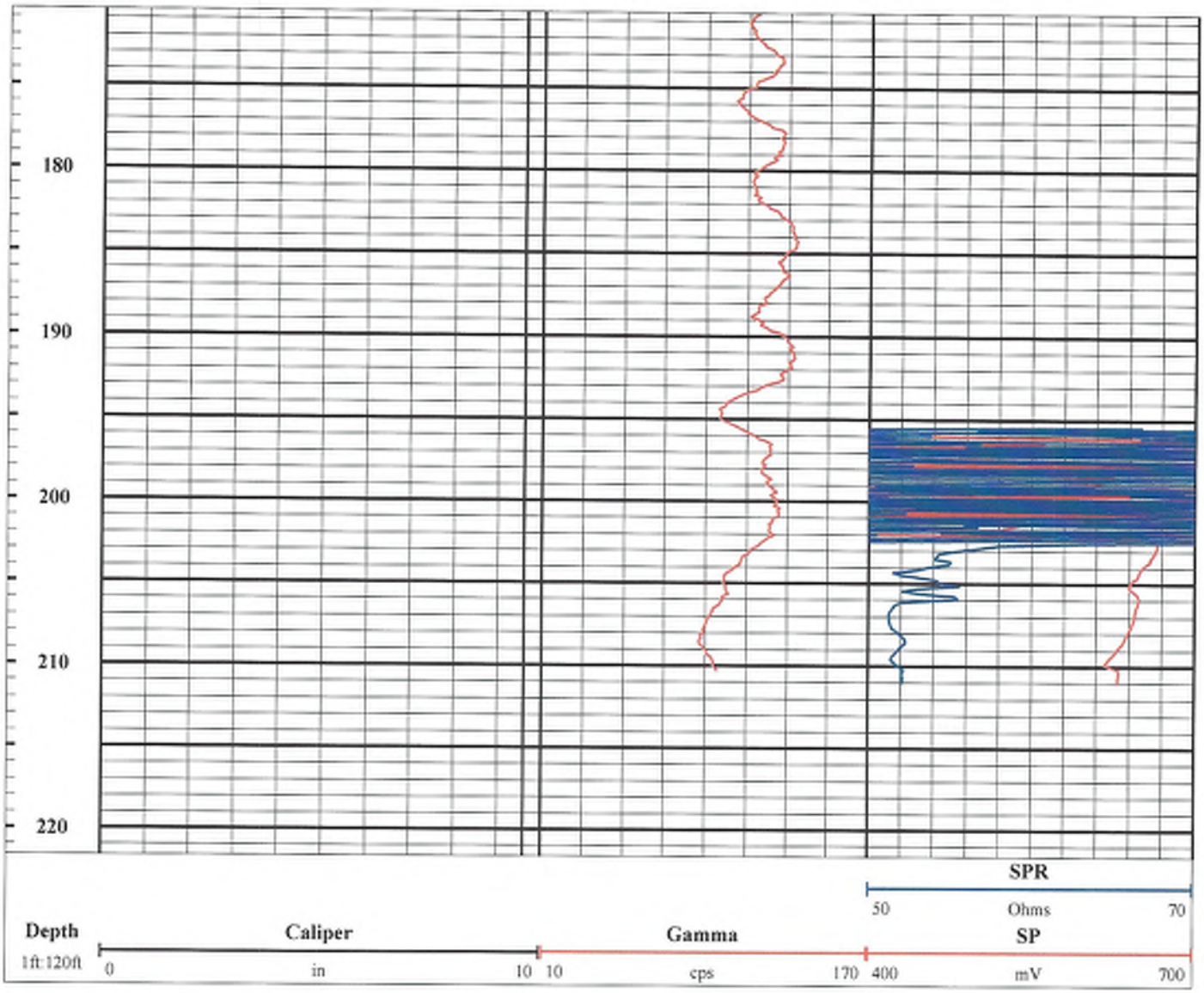
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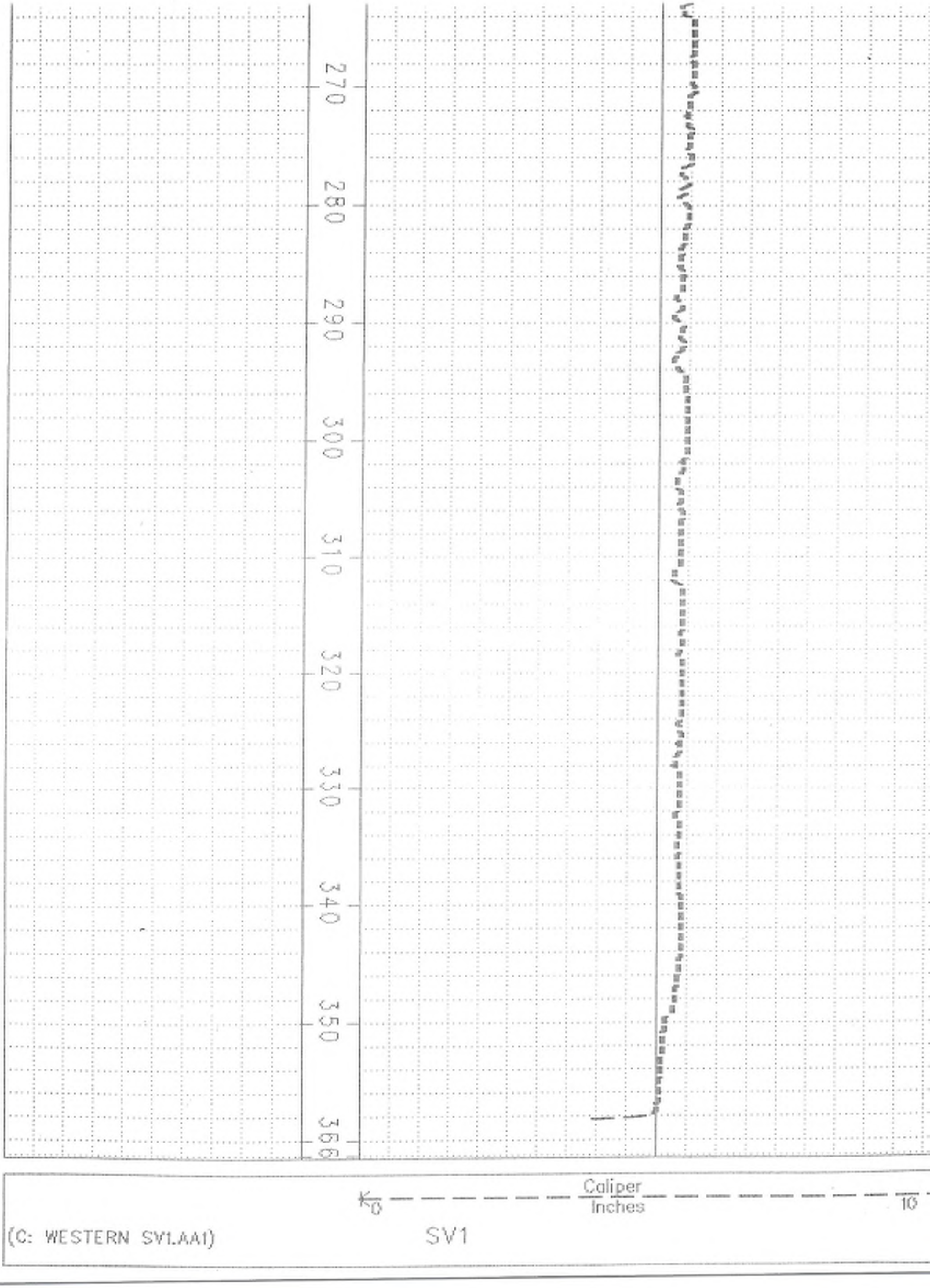
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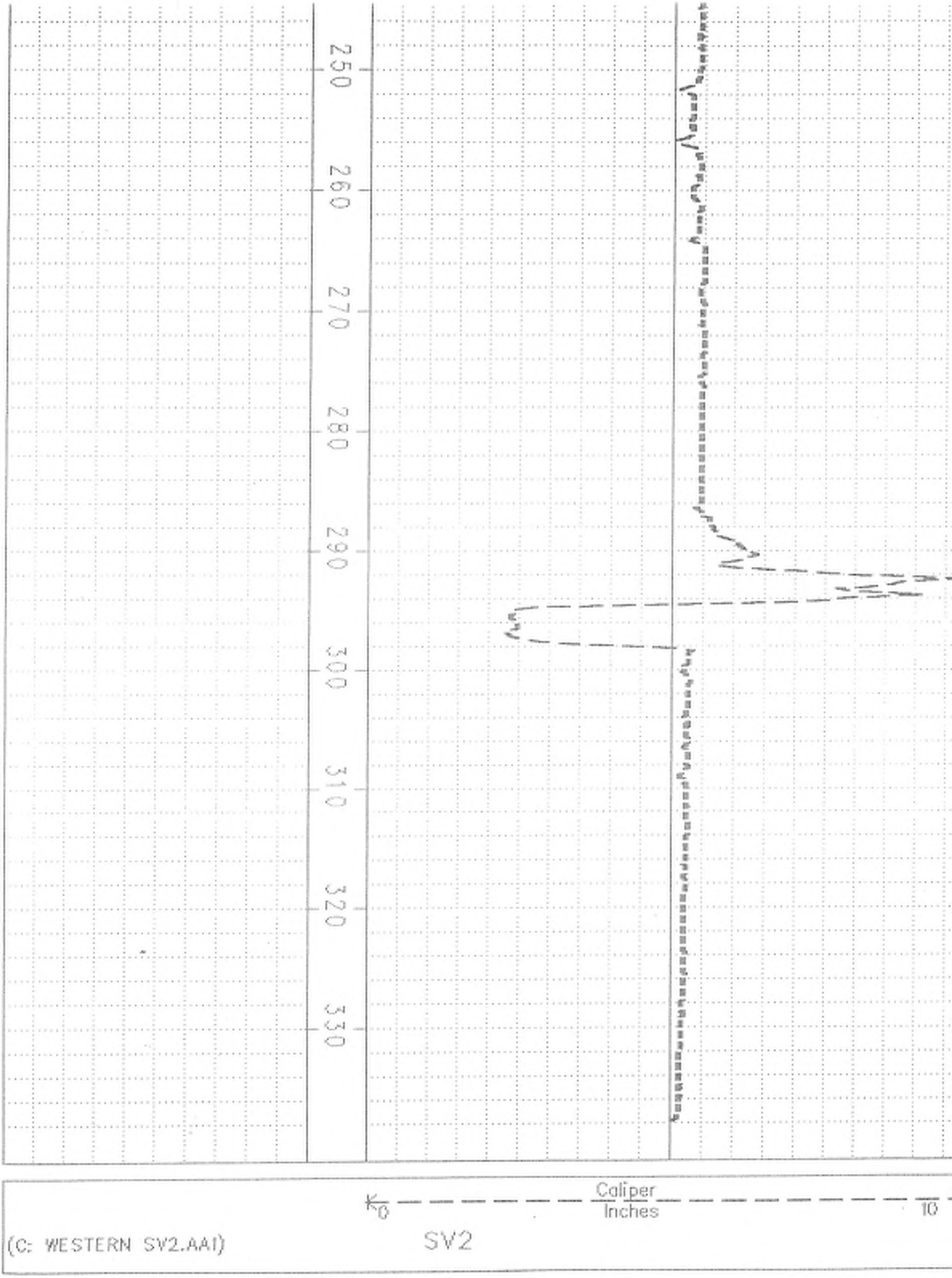
SV1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Caliper
Inches
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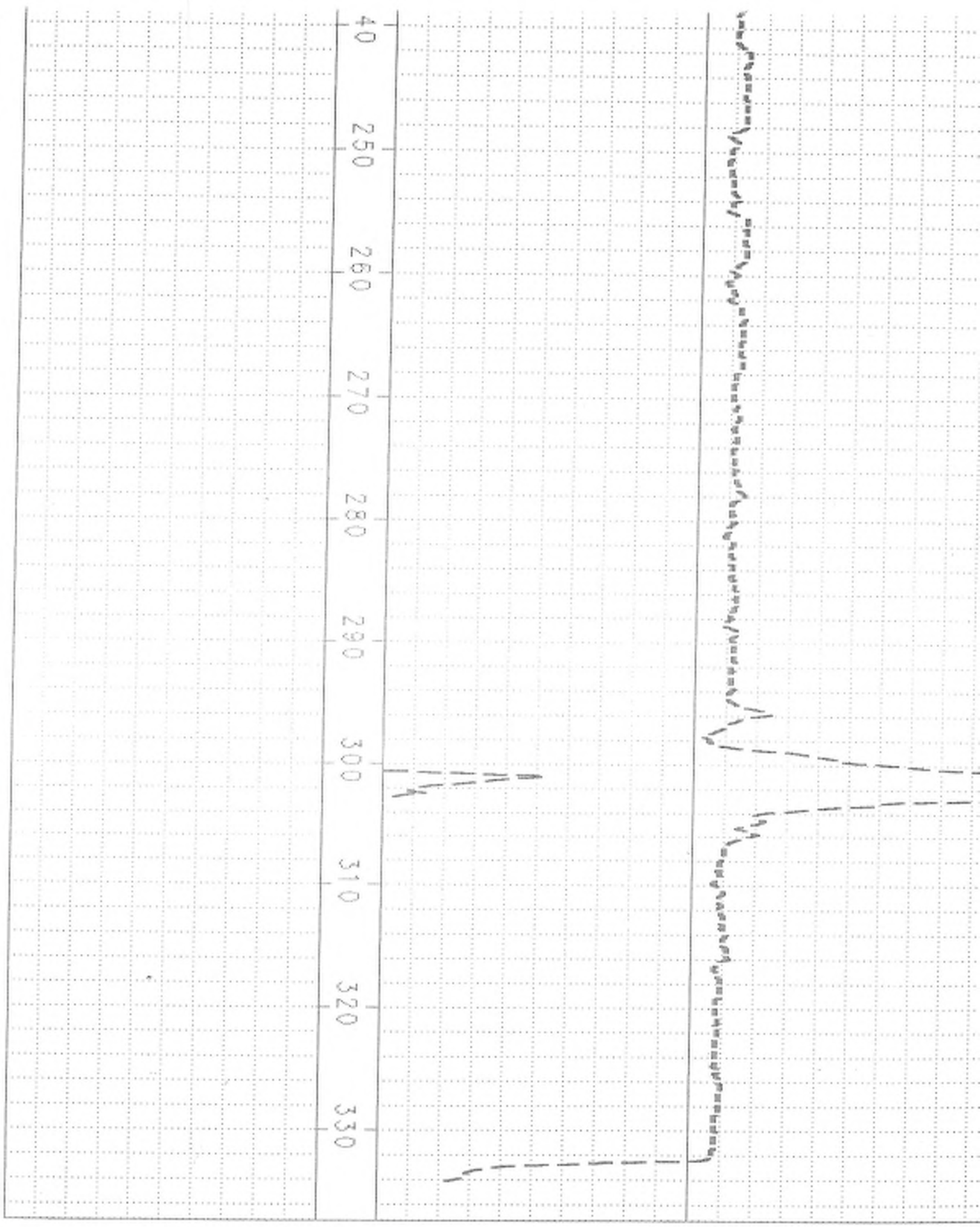
SV2



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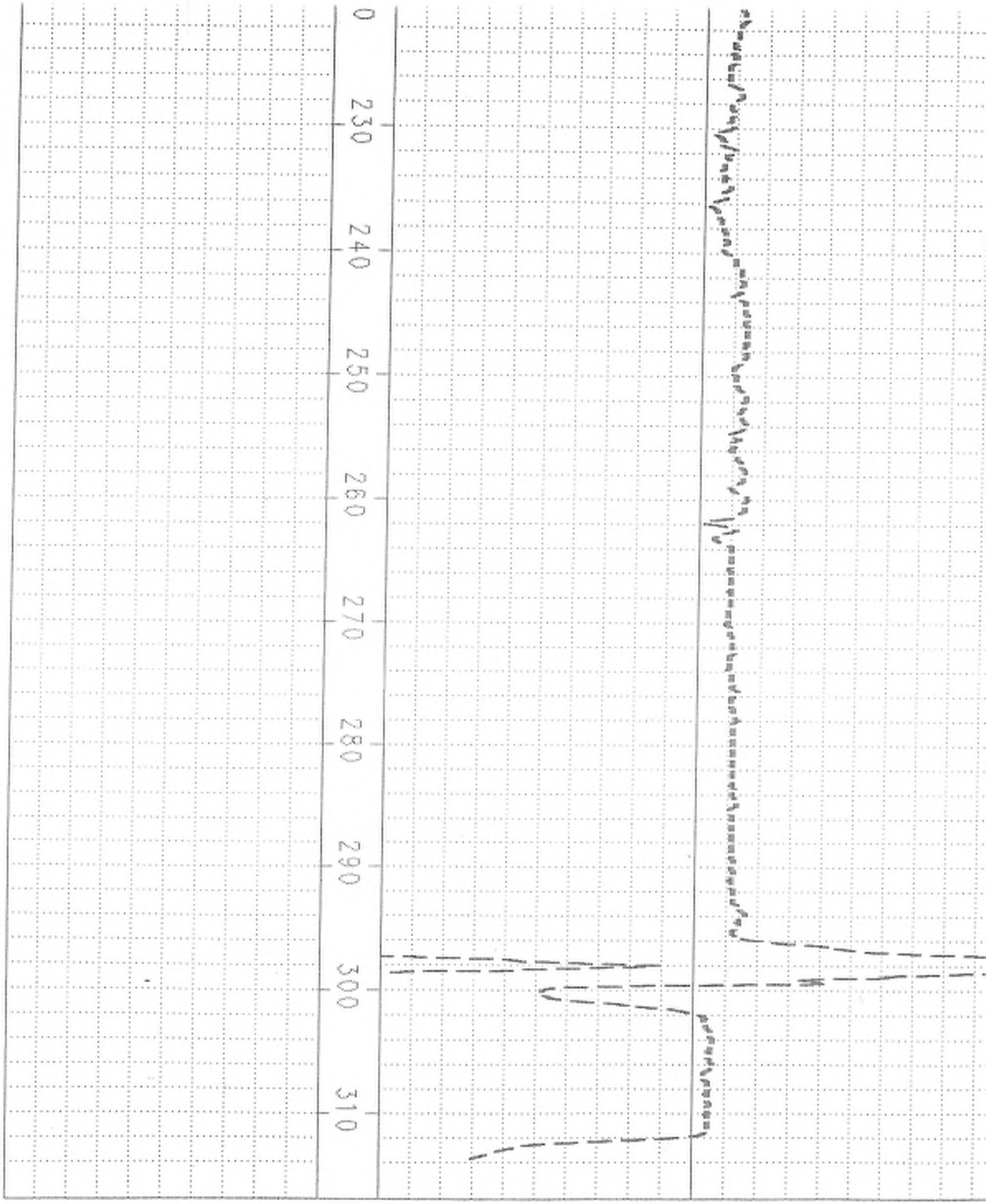

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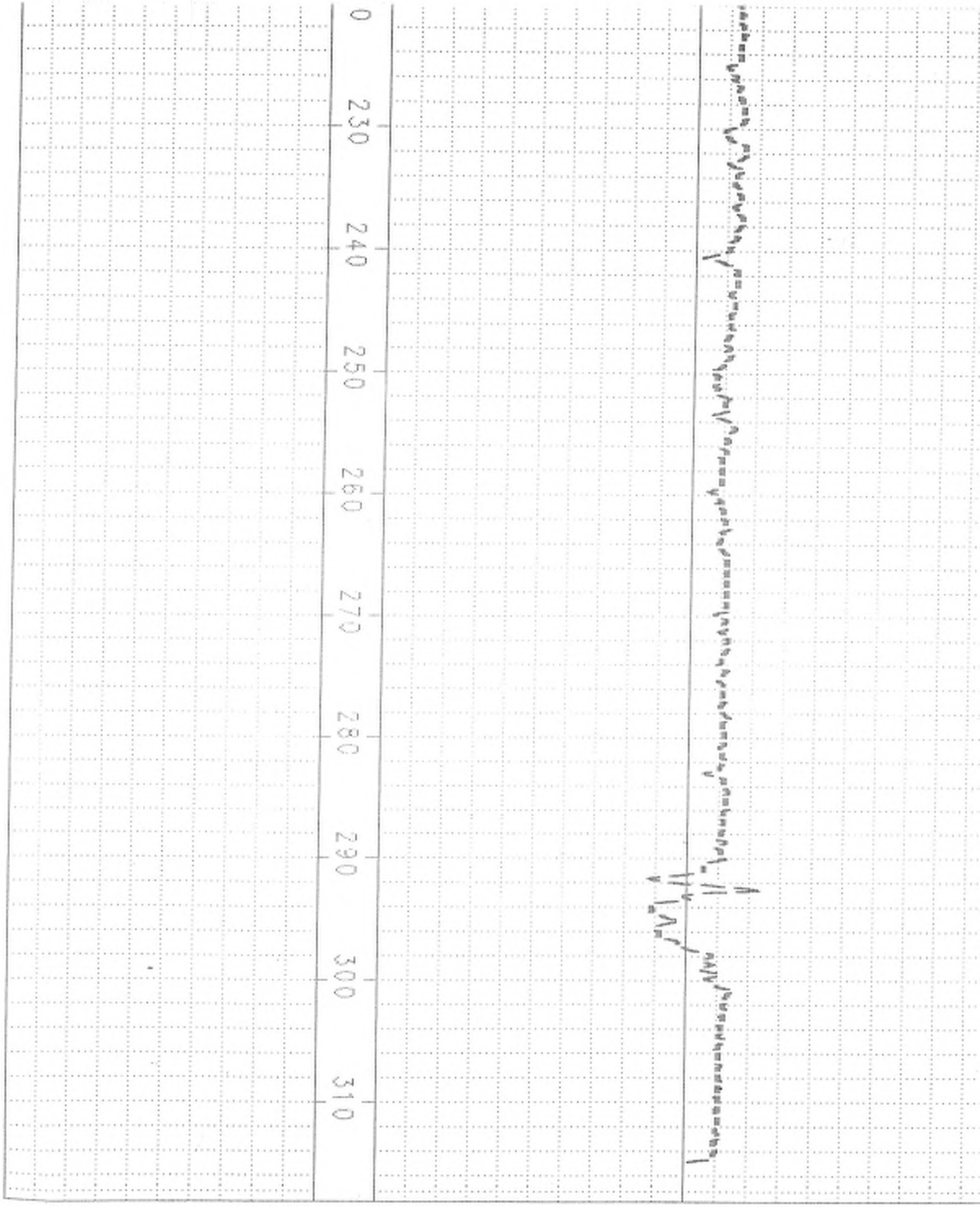

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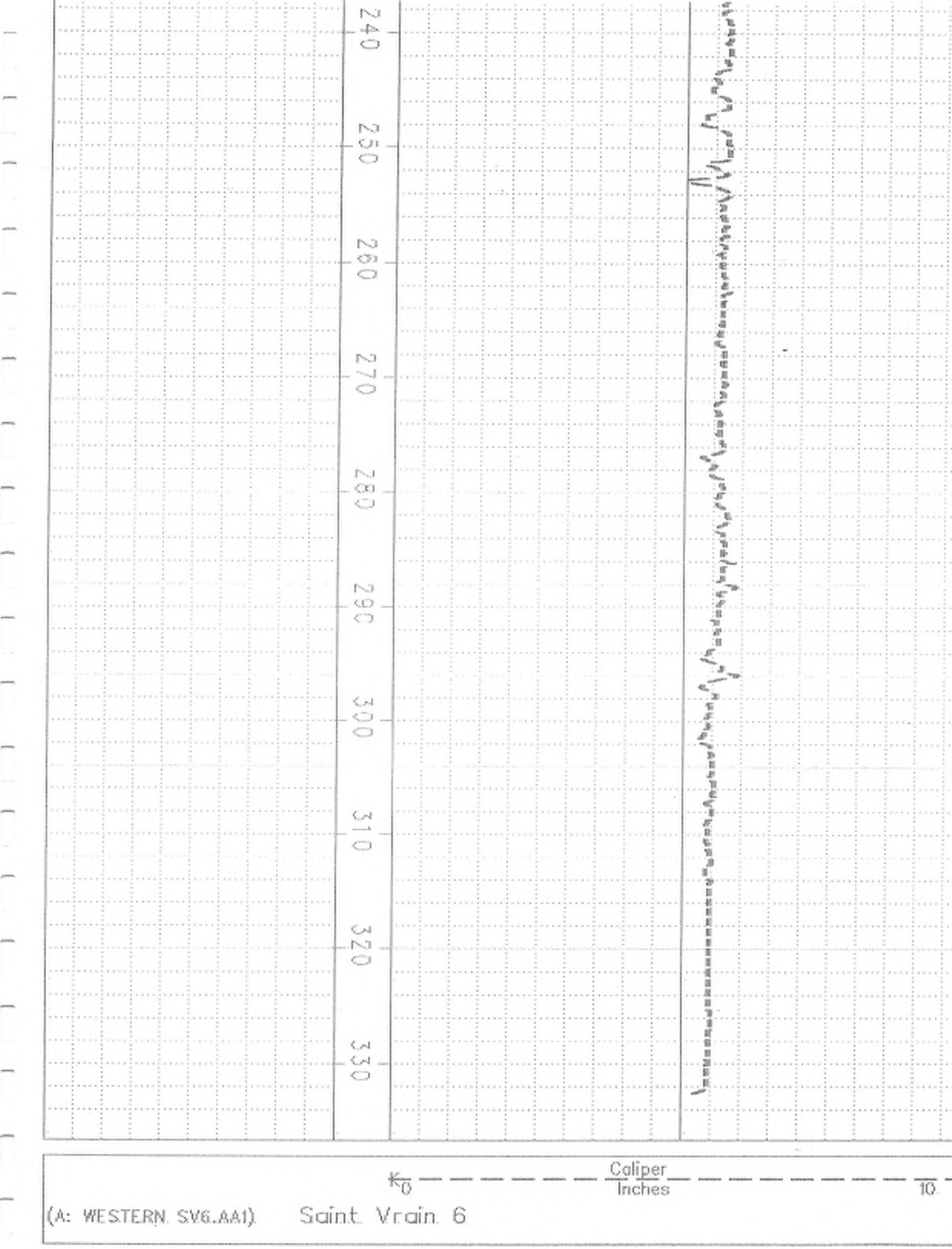
SV5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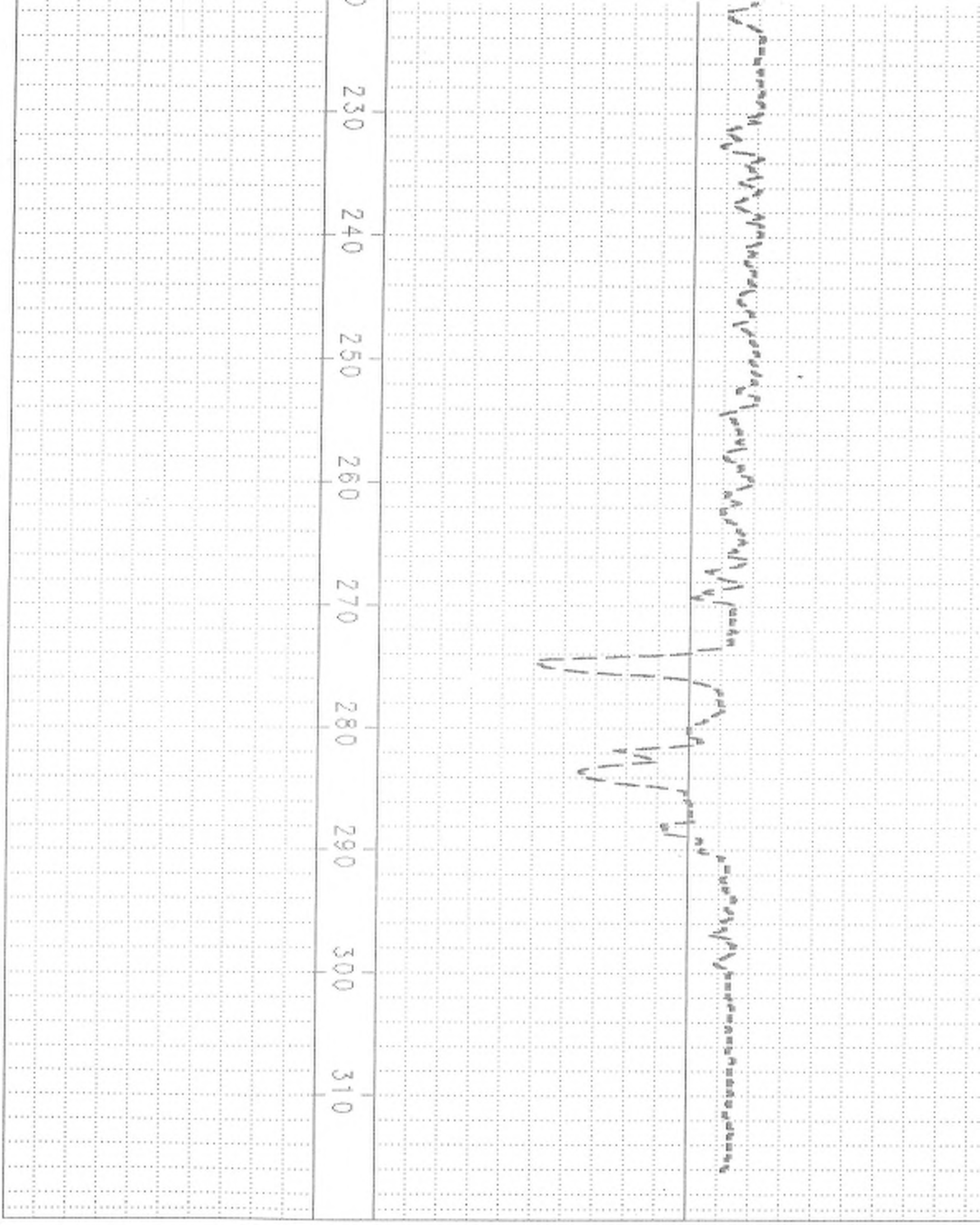
Saint. Vrain. 6



Caliper
Inches
0 10

(A: WESTERN SV77.AA1) Saint Vrain 7

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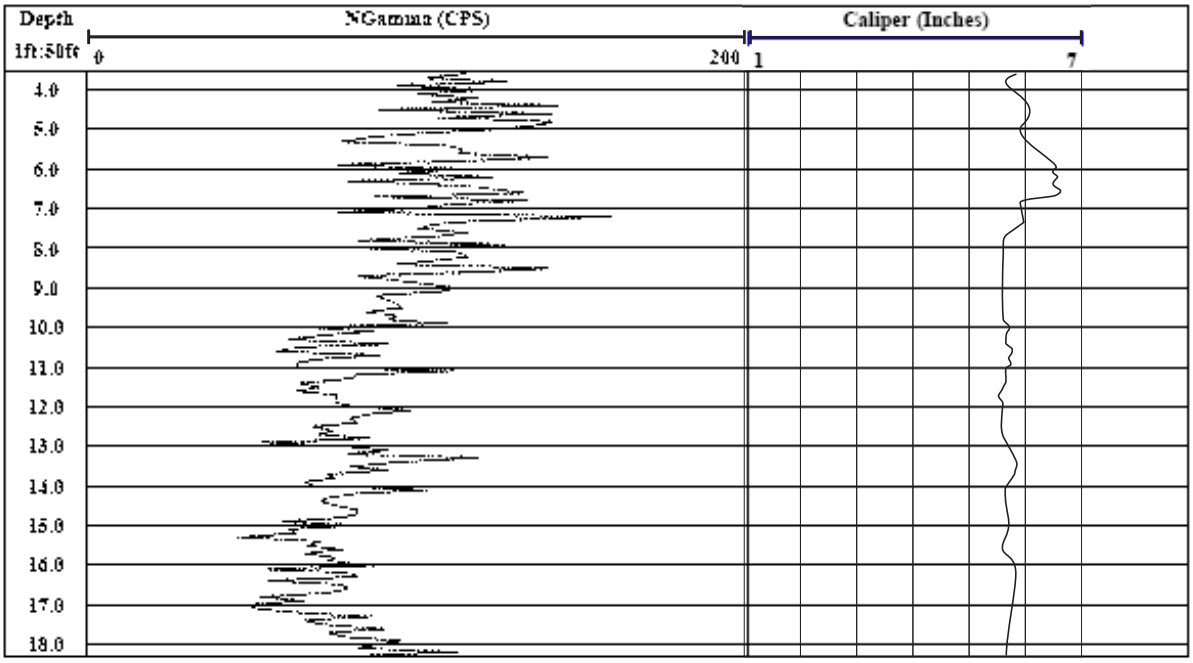
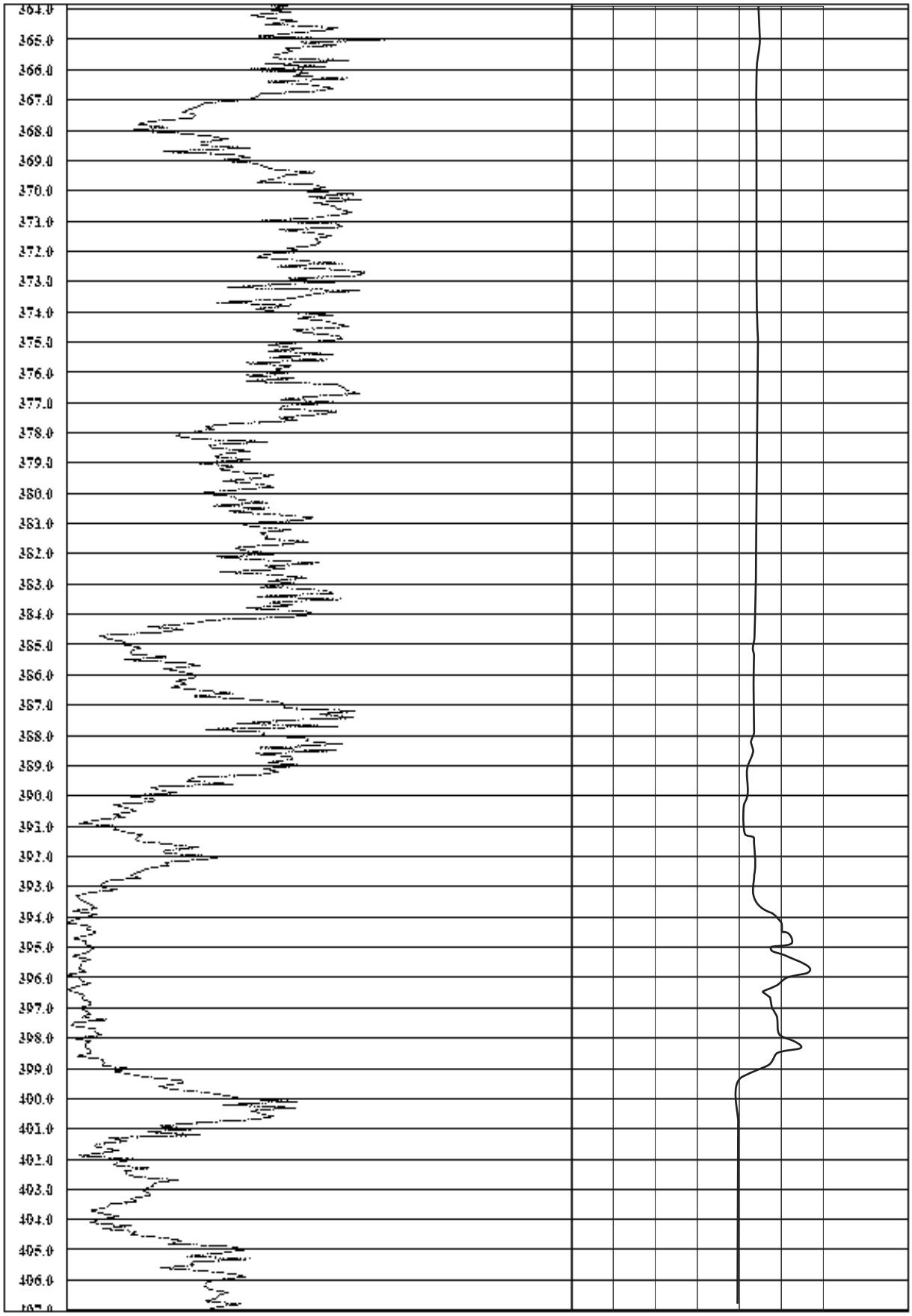
2217 West Powers Avenue
Littleton, Colorado 80120

Well ID -	S21-01
Date Drilled -	May 16, 2006
Depth of Driller -	460 feet
Depth of Logger -	407 feet
Drilling Method -	Mud Rotory
Location of Borehole -	N40°02.578 W105°00.079
Logged By -	D. Greeley
Witnessed By -	B. Partington
Project Number -	82-022-01
Depth to Top of Coal	392 feet
Depth Circulation Lost	Not Lost
Maximum Caliper Deflection / Depth	6.7 inches at 395.6 feet

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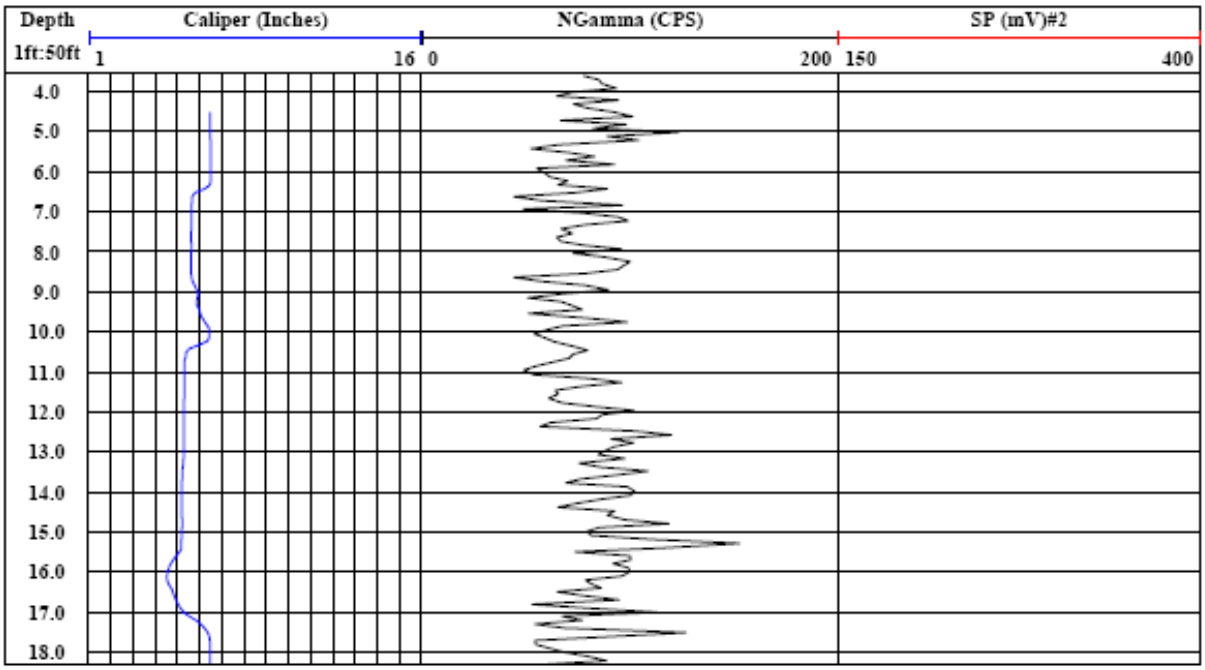
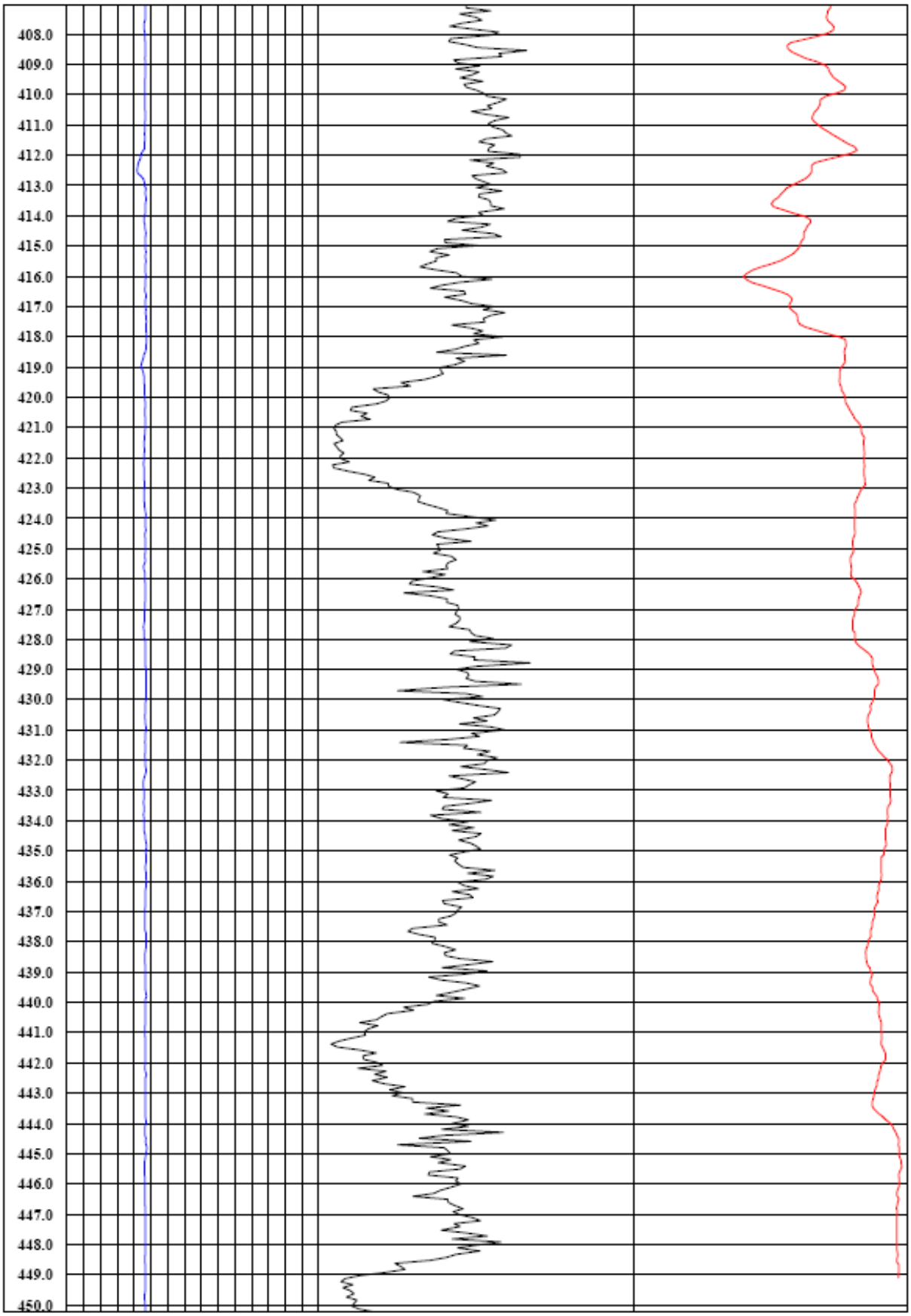
W e s t e r n E n v i r o n m e n t a n d E c o l o g y, i n c.
2217 West Powers Avenue
Littleton, Colorado 80120

Well ID -	S21-02
Date Drilled -	May 17, 2006
Depth of Driller -	480 feet
Depth of Logger -	459 feet
Drilling Method -	Mud Rotory
Location of Borehole -	N40°02.380 W105°00.079
Logged By -	D. Greeley
Witnessed By -	B. Partington
Project Number -	82-022-01
Depth to Top of Coal	454 feet
Depth Circulation Lost	458
Maximum Caliper Deflection / Depth	15 inches at 456.3 feet

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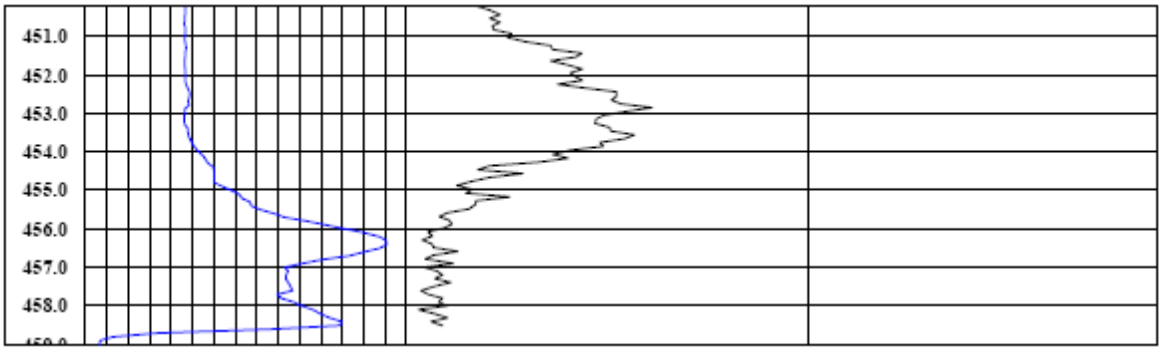
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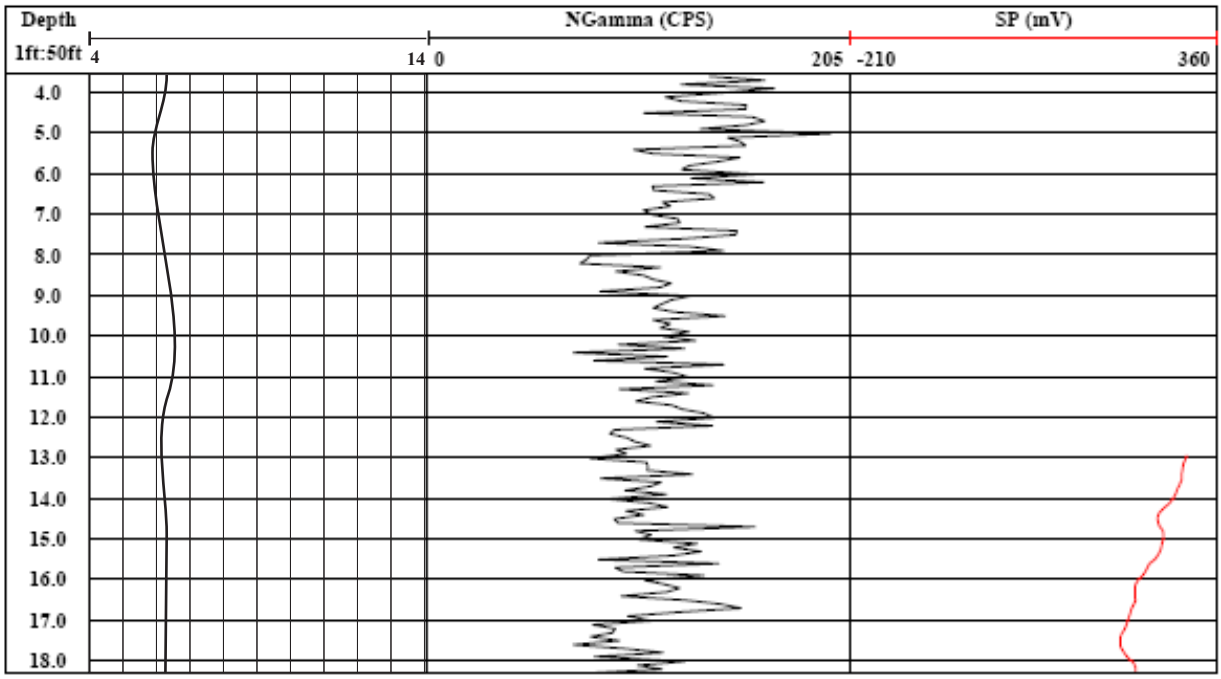
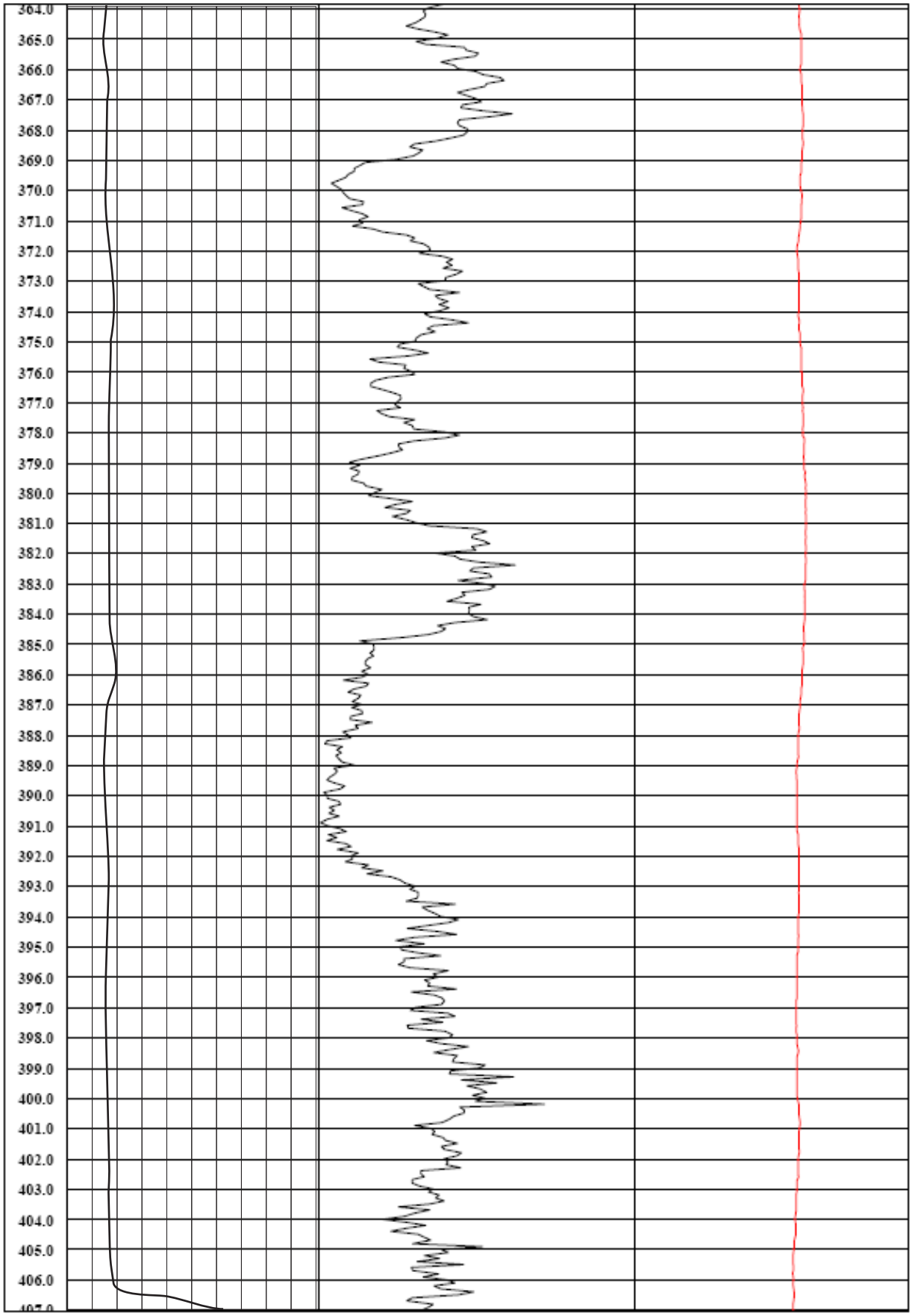
2217 West Powers Avenue
Littleton, Colorado 80120

Well ID -	S21-03
Date Drilled -	May 18, 2006
Depth of Driller -	440 feet
Depth of Logger -	422 feet
Drilling Method -	Mud Rotory
Location of Borehole -	N40°02.174 W105°00.079
Logged By -	D. Greeley
Witnessed By -	B. Partington
Project Number -	82-022-01
Depth to Top of Coal	400 feet
Depth Circulation Lost	408
Maximum Caliper Deflection / Depth	13.8 inches at 408.8 feet

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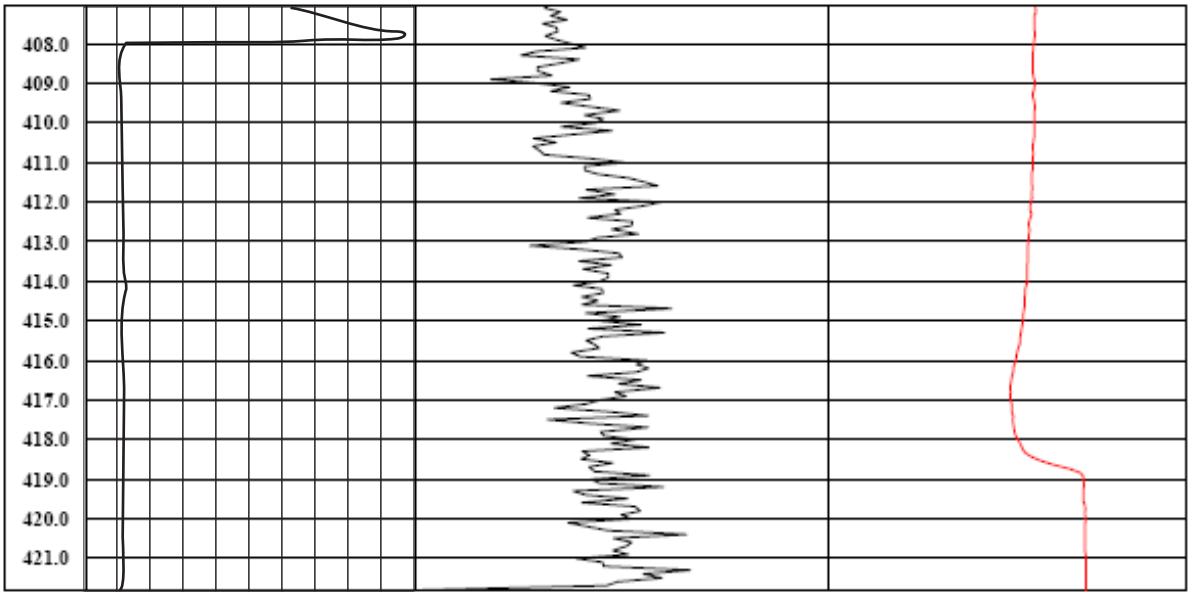
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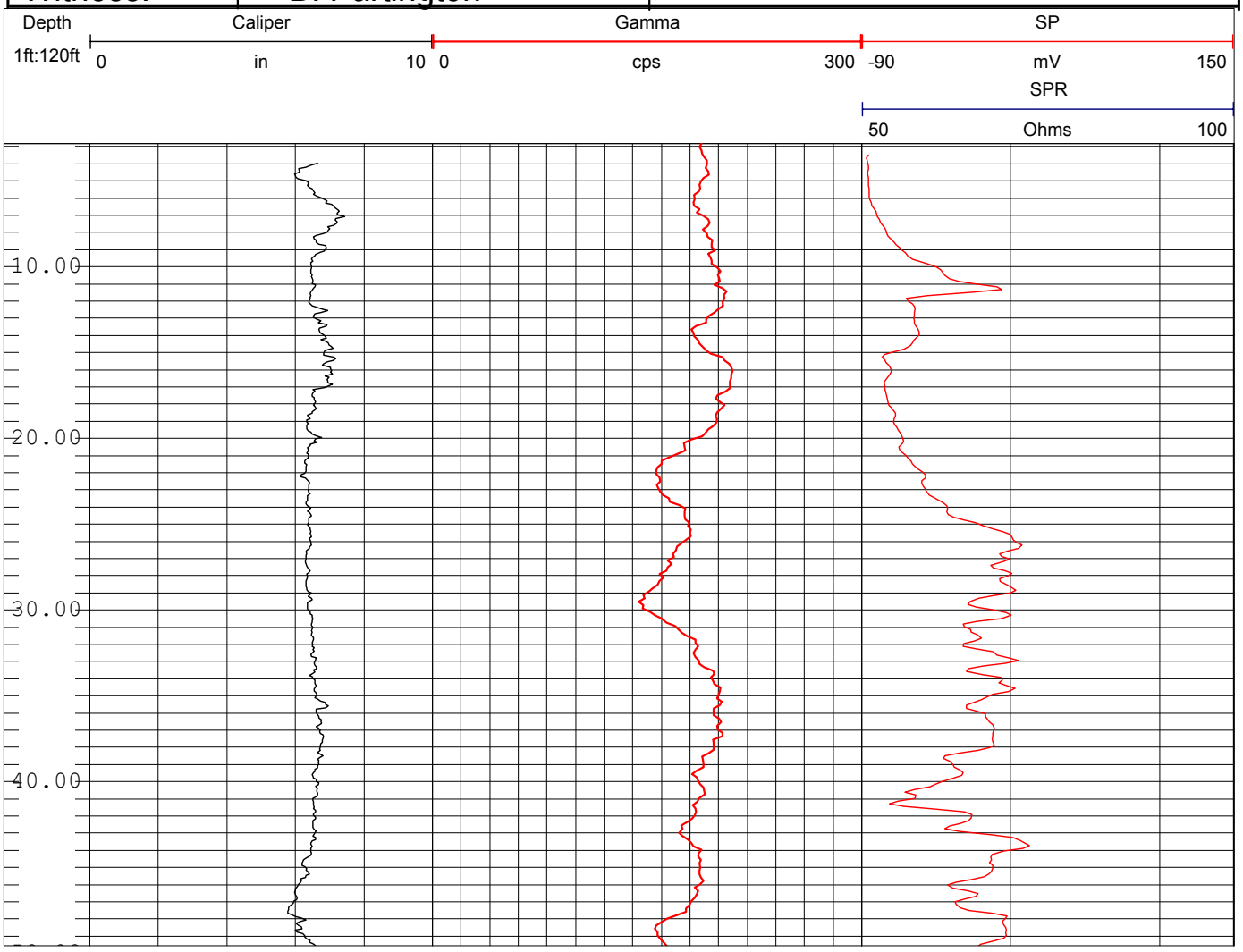
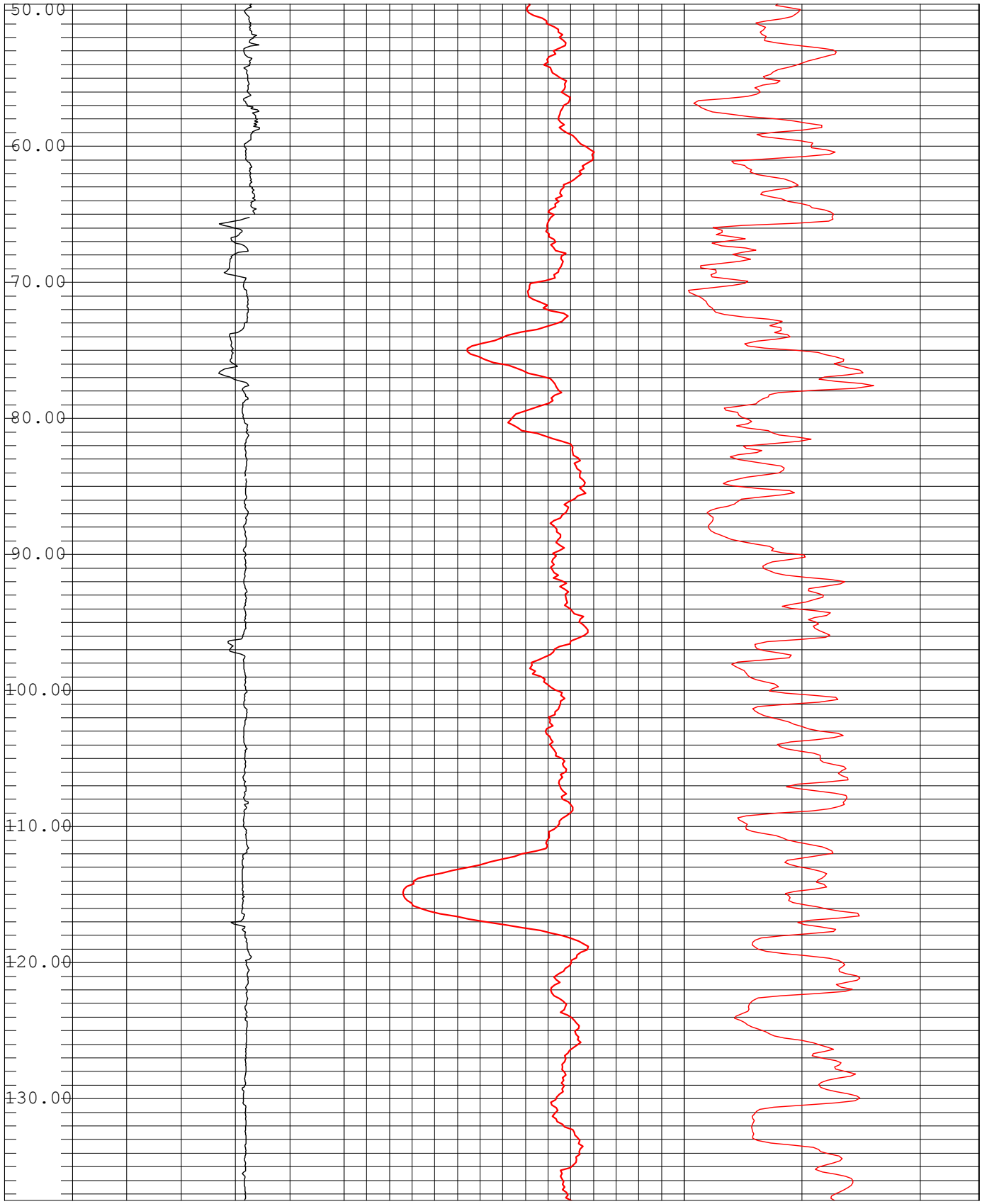
	COMPANY: **WESTERN ENVIRONMENT AND ECOLOGY, INC**
	Location: N40 01.217, W105 01.198

Well	S29-2		
Date	11/6/06	BH Fluid	Mud
Casing	None		
File Name	S29-2		
Depth Driller	320		
Depth Logger	318		
Logged by:	D. Greeley		
Witness:	B. Partington		

OTHER SERVICES

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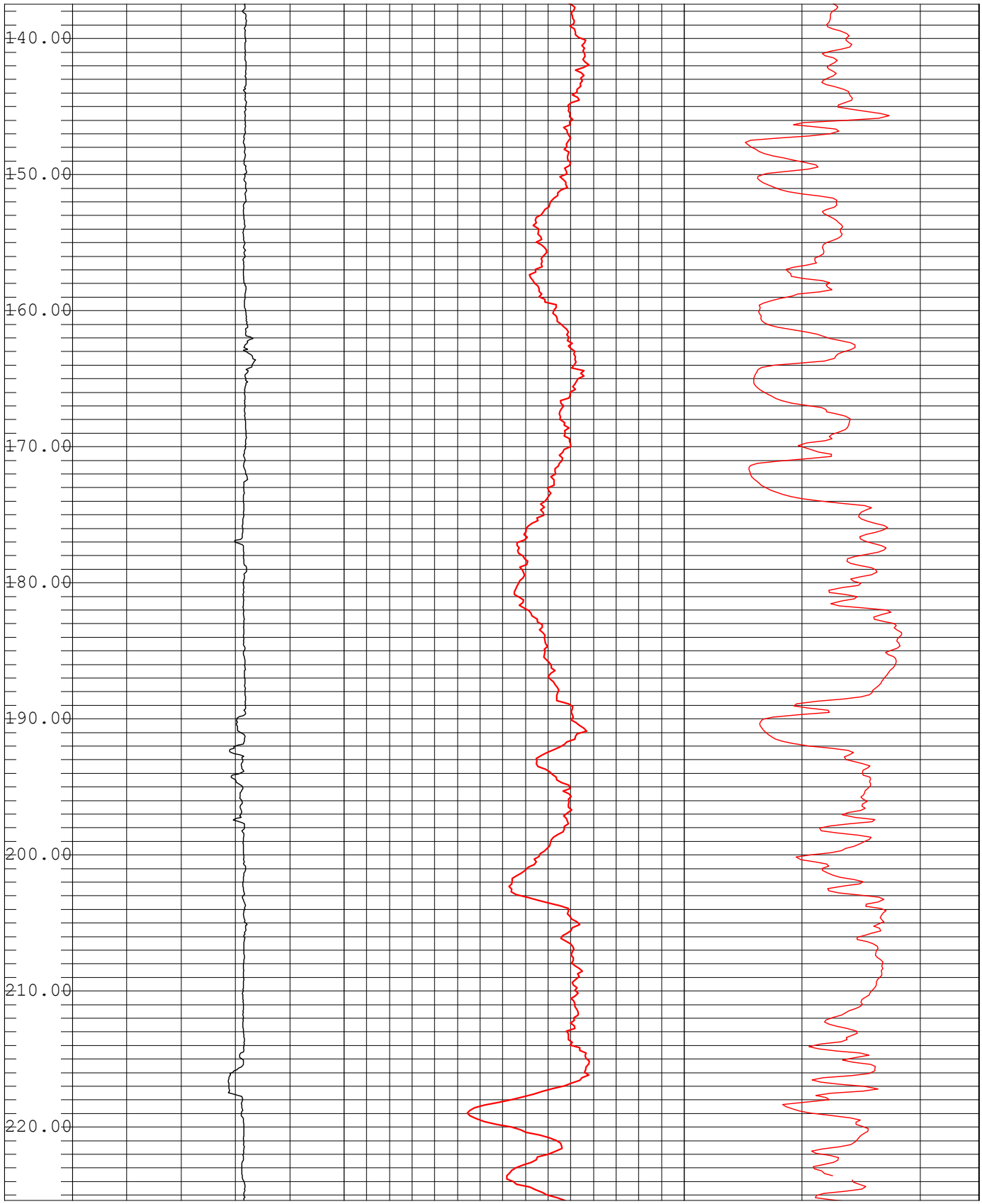
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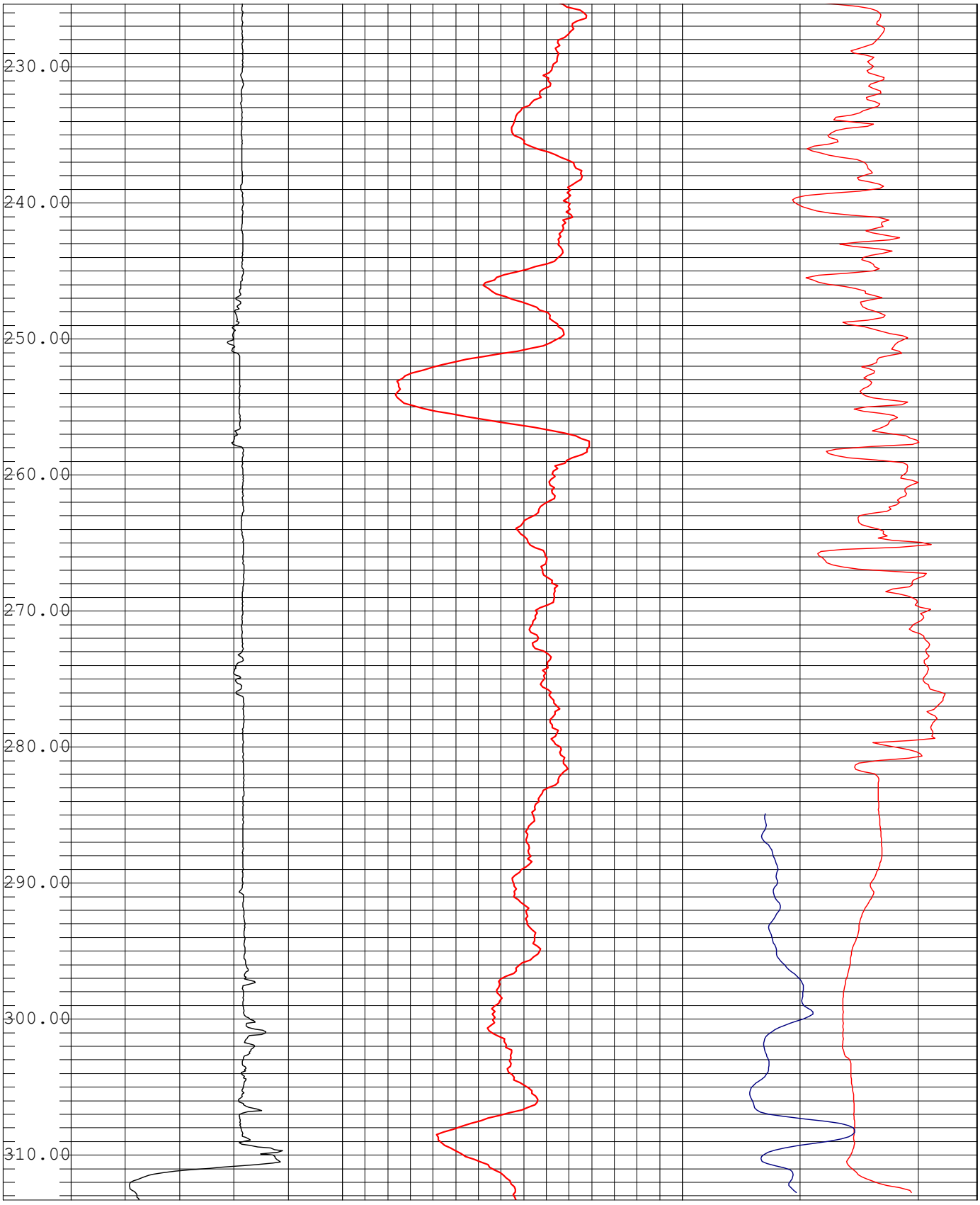
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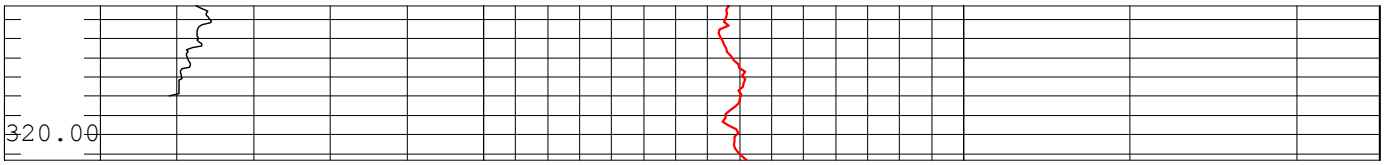
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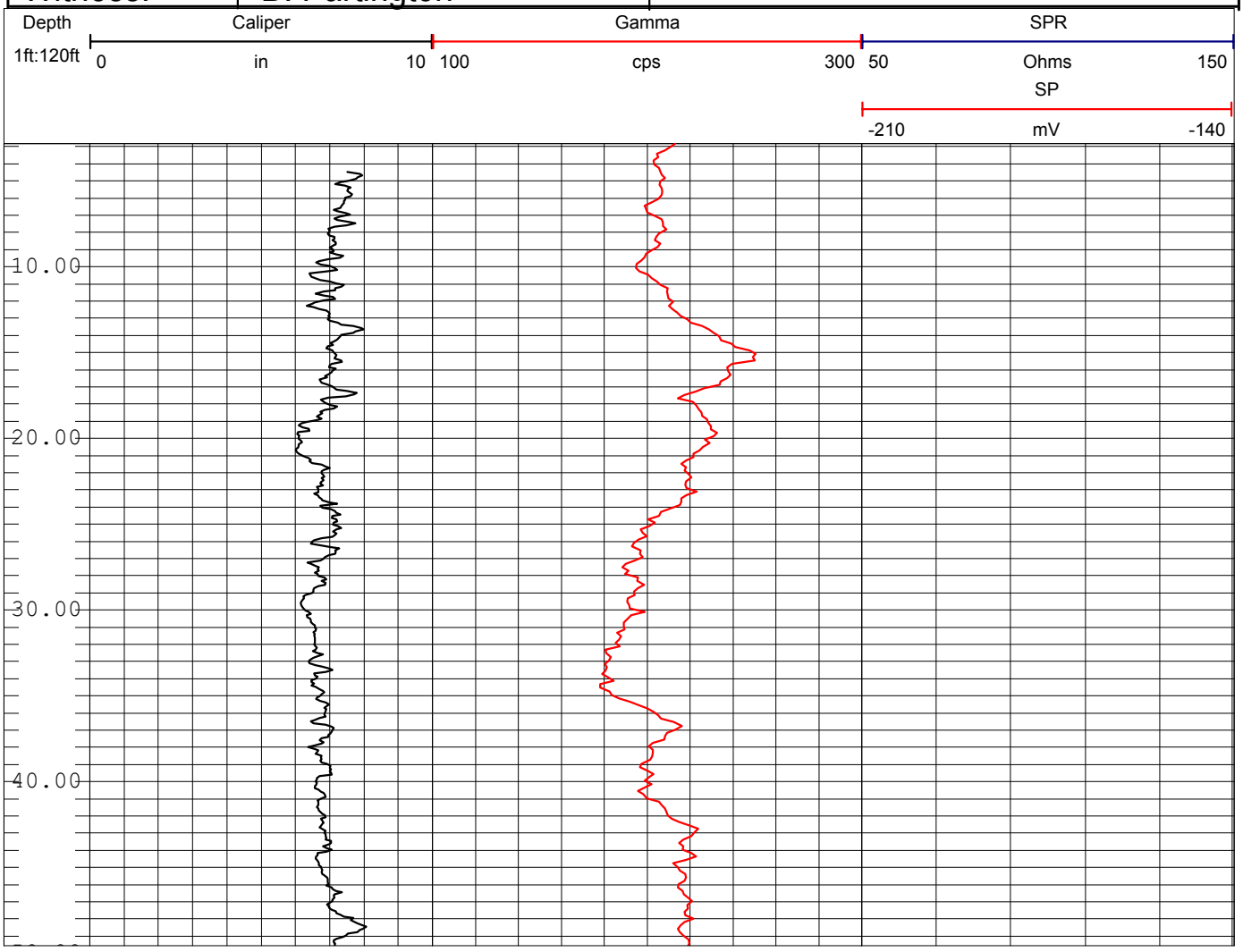
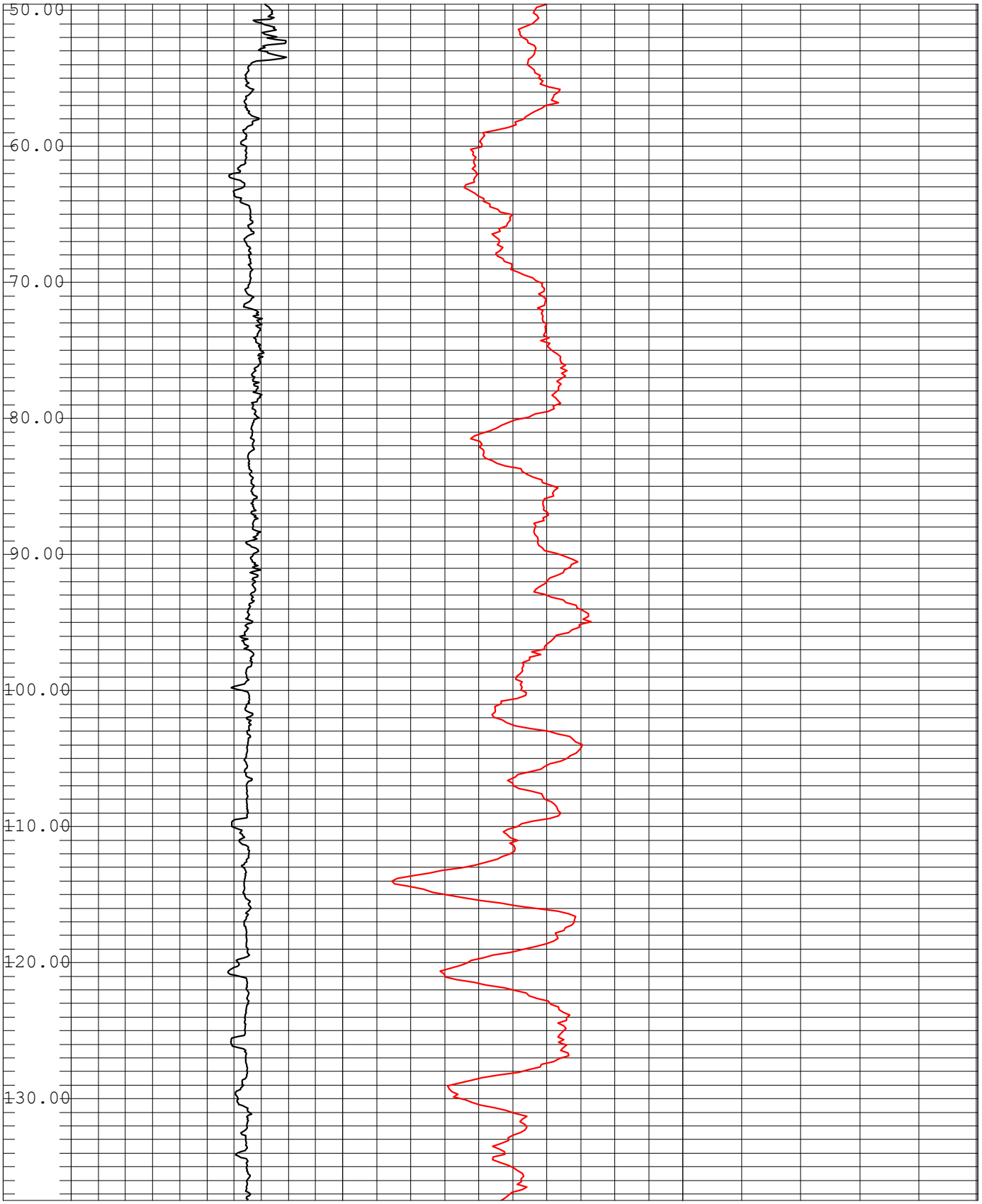
	COMPANY: **WESTERN ENVIRONMENT AND ECOLOGY, INC**
	Location: N40 01.052, W105 01.413

Well	S29-5		
Date	11/7/06	BH Fluid	Mud
Casing	None		
File Name	S29-5		
Depth Driller	380		
Depth Logger	336		
Logged by:	D. Greeley		
Witness:	B. Partington		

OTHER SERVICES

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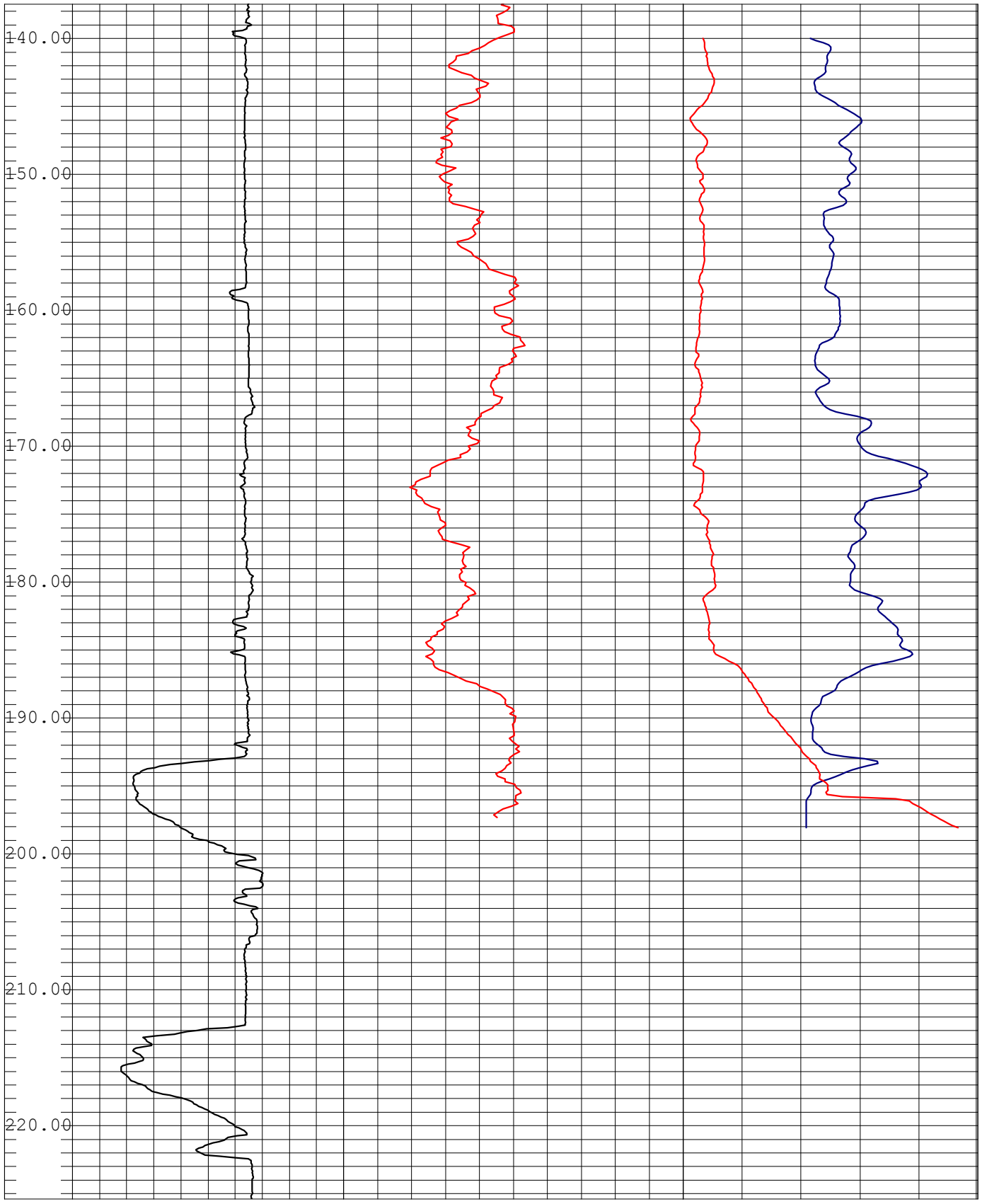
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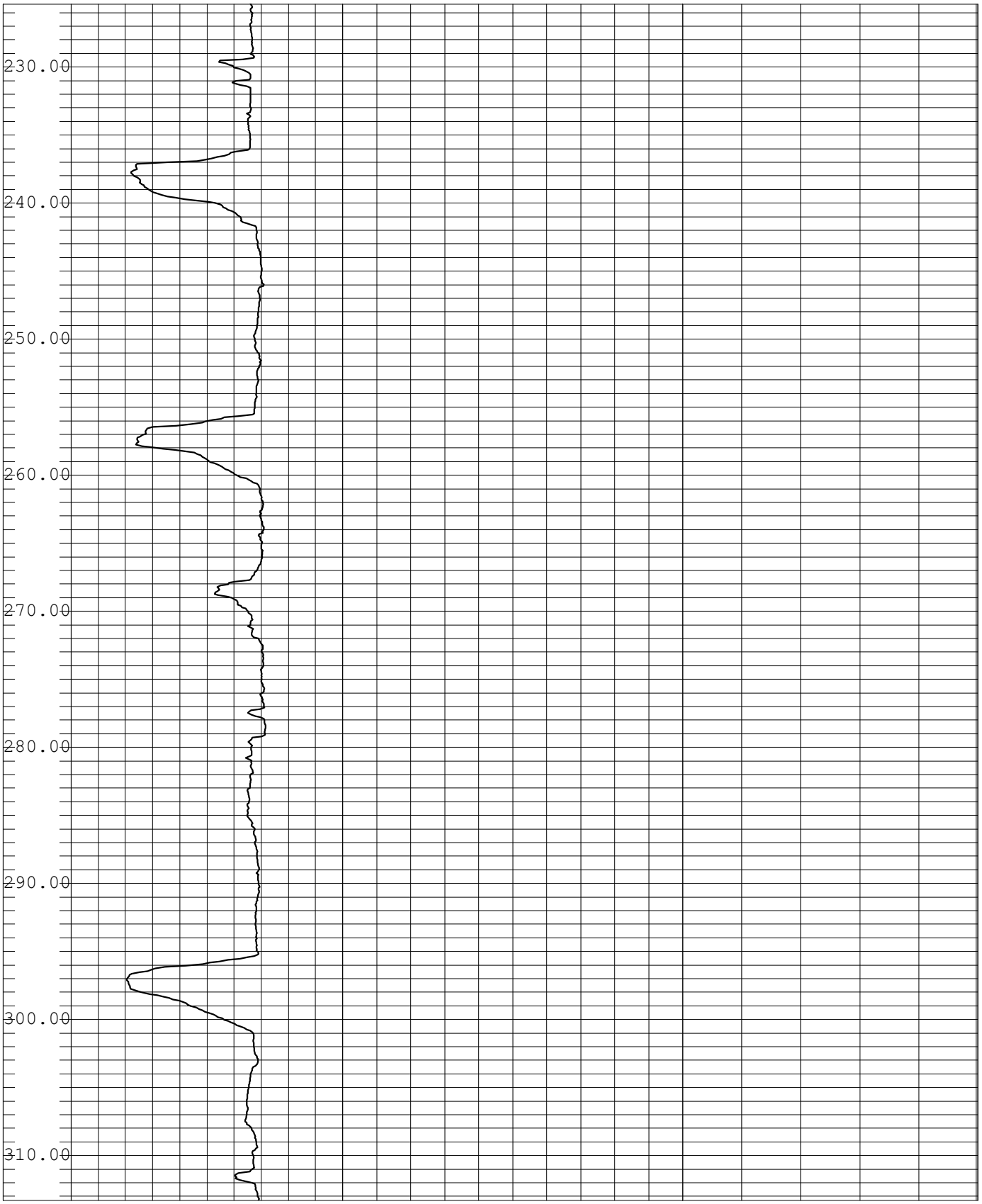
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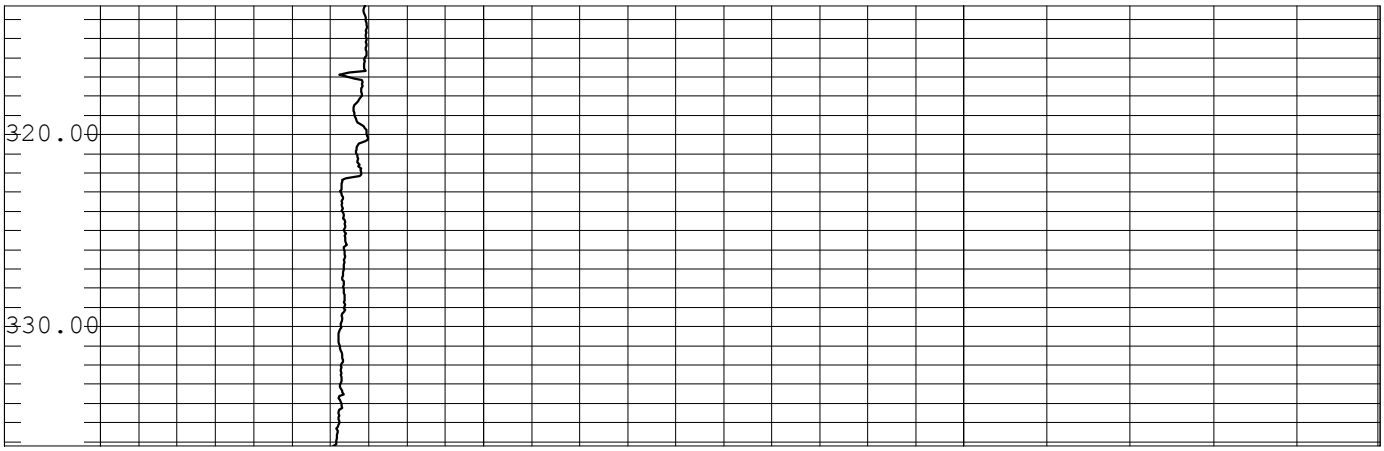
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RESTORATION PLAN

WESTERLY OPEN SPACE – ERIE, COLORADO

REVISED - August 10, 2020

SOUTHERN LAND COMPANY LLC

1225 17TH STREET, SUITE 2420

DENVER, CO 80202

DURAROOT, LLC

4626 CR 65 | KEENESBURG, CO 80643

KELLEY HOUSE | 406.580.0373 | KHOUSE@DURAROOT.COM

CONTENTS

INTRODUCTION

Southern Land Company (SLC) commissioned Duraroot, LLC (Duraroot) to perform a site evaluation at the future Westerly Residential Development in Erie, Colorado, to develop an Open Space Restoration Plan. Open Space dedication consists of an approximate 50-acre parcel of land located south of the future Westerly Development that is designated for future Open Space to compliment the planned community. Land Restoration Plans provide recommendations and procedures for improving and using available resources to improve ecosystem function and community aesthetics. Duraroot proposes the following approach to successfully establish a diverse native plant community that will provide an Open Space area for the enjoyment of the Westerly residents. Duraroot's approach emphasizes the improvement and use of available resources to maximize efficiencies. This Restoration Plan provides specialized re-vegetation technical assistance to improve planting efforts and aid in the successful establishment and/ or conservation of a native vegetation landscape for Open Space dedication associated with the first preliminary plat of the Westerly Development.

SITE DESCRIPTION

The future Westerly Residential Development is located in the W ½ of Section 21, Township 1N, Range 68W, Weld County, Colorado (Figure 1). The area dedicated for Open Space development consists of approximately 50 acres directly south of the subdivision (Figures 2 and 3). The future Open Space area was previously used as dryland crop. During the time of the assessment the land was found to be vegetated, but fallow. The area is comprised of three (3) soil types based on the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soil survey including the:

- Cascajo gravelly sandy loam,
- Wiley-Colby complex, and
- Nunn loam.

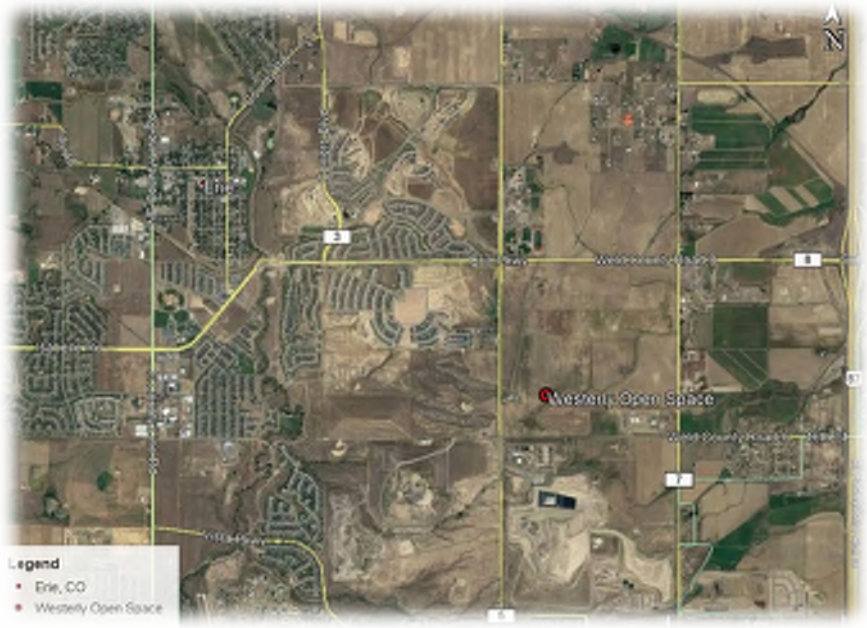

Figure 1. Aerial imagery for the Westerly Open Space relative to Erie, Colorado.

Figure 2. Location of the future Westerly Open Space.

Figure 3. Soil types and sample collection locations for the Westerly Open Space.

SITE ASSESSMENT

Soil physicochemical properties, appropriate re-vegetation species, and re-vegetation methodology comprise a critical component in restoring ecosystem function and long-term sustainability for successful land restoration. Duraroot visited the location on May 21, 2020, to assess current soil and vegetation conditions at the location to assist with restoration planning and Open Space improvement.

During the site assessment Duraroot soil scientists collected soil samples from the three (3) soil types encountered across the location to evaluate the suitability of the on-site material for growth media (Table 1). One (1) composite soil sample was collected from the Cascajo sandy loam and an additional composite soil sample was collected from the Nunn loam to provide soil physicochemical properties representative of these soil types. Because of the larger extent of land covered by the Wiley-Colby complex, two (2) composite soil samples were collected from this soil type (Figure 3). Soil samples were collected using a bucket auger to a depth of 8 inches and submitted to Ward Laboratories, Inc. (Kearney, NE) for laboratory analysis.

Table 1. Location coordinates for the individual Westerly Open Space soil samples.

Sample ID	Latitude	Longitude
Cascajo	40.035299	-105.010571
Wiley-Colby 1	40.033639	-105.012735
Wiley-Colby 2	40.031257	-105.017297
Nunn Loam	40.029960	-105.015210

Soil sample laboratory analysis was conducted to assess soil properties that could impair or limit re-vegetation efforts. Soil samples were analyzed for the following agronomic parameters:

- pH,
- Electrical Conductivity (EC),
- Percent Saturation (%)
- Sodium Adsorption Ratio (SAR),
- Percent Lime ($CaCO_3$),
- Soil Organic Matter (SOM),
- Soil Texture (% sand, silt, and clay), and
- Soil Fertility (plant available N-P-K).

Laboratory analytics were conducted using a saturated paste extract. Laboratory results for the Westerly Open Space are available in Table 2.

In addition to collecting soil samples, Duraroot measured soil compaction to a minimum of 18 inches below ground surface at each sample location using a handheld soil penetrometer capable of identifying compaction zones. It should be noted that penetrometers measure soil strength, which is a surrogate for soil bulk density (compaction). Rather than relying on the accuracy of measurements (PSI) given by the instrument, compaction depths (depth in inches below ground surface to instrument refusal) were identified.

Finally, Duraroot conducted a simple vegetation survey using qualitative assessment methods. Qualitative vegetation assessments were conducted at each location where a soil sample was collected. Qualitative vegetation assessments consisted of visual observations of current vegetation including:

1) List of predominate native and undesirable species observed;
2) Visual estimate of percent vegetative cover (native and undesirable species);
3) Visual estimate of percent bare ground;
4) Visual estimate of percent litter; and,
5) Visual estimate of percent rock.

Qualitative vegetation data will assist in recommended re-vegetation species, seed mix development, and undesirable species management.

SOIL ANALYTICAL RESULTS

Again, laboratory parameters were selected to assess the suitability of in-situ soil resources for re-vegetation and Open Space establishment. Soil analytics included saturated paste pH, electrical conductivity (EC), soluble cations – (Ca, Mg, and Na), sodium adsorption ratio (SAR), soil texture, soil organic matter content (SOM), saturation percentage (%), soil lime ($CaCO_3$) content, and soil macro-nutrient levels (nitrogen-N, phosphorous-P, and potassium-K). Soil analytical data are discussed below and are available in Table 2.

SOIL PH

Soil pH is a measure of acidity and is found by measuring the hydrogen (H+) ion activity (Thorup, 1984). Soil pH is considered one of the most important measurements in the soil and is often called the "master variable" (McBride, 1994). Soil pH affects nutrient availability, ion exchange, dissolution/precipitation of minerals, redox (reduction and oxidation) reactions, adsorption, and other important factors in the soil system, which can influence plant growth and development (Thorup, 1984; McBride, 1994; et al.). Soil pH between 6.0 and 7.5 is generally optimal for most native vegetation species where nutrient availability is concerned. As the pH increases or decreases from this ideal range, the availability of plant nutrients may limit growth.

Soil pH at the future Westerly Open Space ranges from 6.9 to 7.7, with an average soil pH of 7.2. Based on NRCS classification, the soils at the future Westerly Open Space would be classified as neutral (6.6 to 7.3) to slightly alkaline (7.4 to 7.8). Soil pH of the future Westerly Open Space soils is suitable for native species establishment.

SOIL SALINITY

Soil EC is an estimate of soil salinity (Hanson et al., 1999) and is measured by the ECe of the saturated paste extract. At high enough levels, soil salinity can negatively impact plant growth due to osmotic stress (Hanson et al., 1999). This osmotic stress can make it difficult for plants to extract water from the soil (Bohn et al., 1985).

Soil EC at the future Westerly Open Space ranges from 0.32 to 0.35 dS/m, with an average soil EC of 0.34 dS/m. Based on NRCS classification, the soils at the future Westerly Open Space would be classified as nonsaline (< 2.0 dS/m). Soil salinity of the future Westerly Open Space soils is suitable for native species establishment.

Table 2. Soil chemical and physical data for the Westerly Open Space. Parameters shown in red may interfere with re-vegetation success.

Sample ID	Depth	pH	EC	SAR	Percent Saturation	Organic Matter	Lime	Sand	Silt	Clay	Texture	NO3 - N	NO_3 - N	Mehlich-P	NH_4OAC-K
	inches		dS/m		%							ppm	lbs/acre	ppm	
Cascajo	0 to 8	7.1	0.32	0.20	50	2.3	7.4	45	24	31	Sandy Clay Loam	1.7	4.0	38	428
Wiley-Colby 1	0 to 8	7.7	0.33	0.10	59	2.2	5.9	43	23	34	Clay Loam	1.7	4.0	20	283
Wiley-Colby 2	0 to 8	7.7	0.35	0.10	57	2.5	6.7	36	29	35	Clay Loam	6.1	15	49	421
Nunn Loam	0 to 8	6.9	0.35	0.30	54	2.3	10	41	25	34	Clay Loam	2.1	5.0	38	463

Notes:

1. Soil samples were submitted to Ward Laboratories (Kearney, NE) for laboratory analysis.
2. Soil analytical results were established using a saturated paste extract.

SOIL SODICITY

Sodic soils are "non-saline soils containing sufficient exchangeable sodium to adversely affect crop production and soil structure" (Soil Science Society of America, 2010). Elevated exchangeable sodium concentrations in the soil can negatively impact soil structure causing the soil to disperse resulting in hard surface crusts, reduced infiltration rates, and reduced oxygen diffusion rates. The definition and standard for describing sodic soils based on soil chemistry are those soils that have a SAR greater than 13, an EC less than 4.0 dS/m, and pH between 8.5 and 10 (Brady, 1990).

Soil SAR in the future Westerly Open Space soils ranges from 0.10 to 0.30, with an average soil SAR of 1.8. Based on sodic soil classification, the soils at the future Westerly Open Space would be classified as non-sodic (< 13.0). Soil sodicity of the future Westerly Open Space soils is suitable for native species establishment.

SOIL TEXTURE

Soil texture is determined by the relative proportions of sand, silt, and clay particles in a soil. Coarse soil textures (elevated sand content) have limited water retention capabilities and are less reactive, therefore less capable of nutrient retention. Fine soil textures (elevated clay content) provide more surface area and are therefore more reactive. Fine textured soils are more likely to become compacted or dispersed reducing infiltration and aeration, which is necessary for productive plant growth. Soils with fine soil textures are also more likely to retain soil salts due to reduced leaching capabilities. Ideal soil textures for plant growth contain a mixture of the three particle classes and are not dominated by one particular particle size.

Soil texture at the future Westerly Open Space was consistent among all collected soil samples. Soil texture for the future Westerly Open Space was found to consist predominantly of sandy clay loam (SCL) and clay loam (CL), which are considered to be medium textured. Soil texture of the future Westerly Open Space soils is suitable for native species establishment.

SOIL ORGANIC MATTER

SOM consists of plant and animal residue in the soil in various stages of decomposition and gives the A horizon its characteristic dark color (USDA-NRCS, 2015). SOM provides essential nutrients for plant growth. In addition, SOM improves soil structure and soil tilth, infiltration and aeration, and leaching of undesirable constituents. SOM content in the future Westerly Open Space soils ranges from 2.2 to 2.5 percent, with an average SOM of 2.3 percent. SOM of the future Westerly Open Space soils is suitable for native species establishment.

SOIL FERTILITY

Soil fertility is evaluated by measuring the relative amount of plant available soil nutrients. These primarily consist of soil nitrogen (N), phosphorus (P), and potassium (K) levels which make up the soil macro-nutrient component. Macro-nutrients are the soil nutrients that are required by plants in the greatest concentration and are essential for plant function and development.

Soil fertility was fairly consistent across the future Westerly Open Space. Soil N levels in the future Westerly Open Space soils range from 4.0 to 15 pounds per acre, with an average soil N level of 7.0 pounds per acre. Soil N may be deficient for native species establishment on the future Westerly Open Space.

Soil P is often the most limiting soil macro-nutrient in Colorado soils and is extremely important for establishing new plants as it is essential for root development. Soil P levels in the future Westerly Open Space soils range from 20 to 49 ppm, with an average P concentration of 36 ppm. Soil P levels are suitable for native species establishment on the future Westerly Open Space.

Soil K levels are typically found to be adequate in Colorado soils. Soil K levels in the future Westerly Open Space soils range from 283 to 463 ppm, with an average soil K level of 399 ppm. Soil K is suitable for native species establishment on the future Westerly Open Space.

SOIL COMPACTION

Soil compaction was measured at each location a soil sample was collected using a hand-held soil penetrometer. Soil compaction was measured by identifying the depth below ground surface of instrument refusal. Instrument refusal was not observed within the top 12 to 15 inches of soil at any location. Soil compaction was not observed and should not interfere with native species establishment.

VEGETATION SURVEY

Vegetation observations were also recorded during the site assessment. The future Westerly Open Space was previously used for dryland crop. The land has since been left fallow. The location has very high weedy species cover with very little desirable, native plant cover. Table 4 provides a list of species observed across the location.

Several noxious weed species were identified across the location of the future Westerly Open Space. Noxious weeds are defined by the Colorado Department of Agriculture (CDA) as *non-native aggressive invaders that replace native vegetation, reduce agricultural productivity, cause wind and water erosion, and pose an increased threat to communities from wildfire* (CDA[1], 2020).

Noxious species as identified by the CDA consisted of:

- Canada thistle (*Cirsium arvense*)
- Downy brome (*Bromus tectorum*)
- Field bindweed (*Convolvulus arvensis*)
- Common mullein (*Verbascum thapsus*).

Canada thistle is classified as a List B Species. List B Species are species for which Colorado's Commissioner of Agriculture, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, develops and implements state noxious weed management plans designed to stop the continued spread of these species. Downy brome, field bindweed, and common mullein are classified as a List C Species. List C Species are species for which the Commissioner, in consultation with the state noxious weed advisory committee, local governments, and other interested parties, will develop and implement state noxious weed management plans designed to support the efforts of local governing bodies to facilitate more effective integrated weed management on private and public lands (CDA[2], 2020).

Additional undesirable species identified during the vegetation survey include kochia (*Kochia scoparia*), purple mustard (*Chorispora tenella*), ragweed (*Ambrosia artemisiifolia*), and curly dock (*Rumex crispus*). Undesirable species may spread rapidly and out-compete native species for water, light, and soil nutrients. Non-native species also provide little in the way of habitat value or plant community diversity and ecosystem function.

Table 3. Undesirable species observed across the future Westerly Open Space.

Location	Common Name	Scientific Name	Colorado Designation
Cascajo	Downy brome	*Bromus tectorum*	List C
	Purple mustard	*Chorispora tenella*	Undesirable
	Field bindweed	*Convolvulus arvensis*	List C
	Wheat	*Triticum aestivum*	Crop
	Salsify	*Tragopogon porrifolius*	Undesirable
	Tumble mustard	*Sisymbrium altissimum*	Undesirable
	Ragweed	*Ambrosia artemisiifolia*	Undesirable
Wiley-Colby	Field bindweed	*Convolvulus arvensis*	List C
	Canada thistle	*Cirsium arvense*	List B
	Downy brome	*Bromus tectorum*	List C
	Purple mustard	*Chorispora tenella*	Undesirable
	Alyssum	*Alyssum alyssoides*	Undesirable
	Ragweed	*Ambrosia artemisiifolia*	Undesirable
	Curly dock	*Rumex crispus*	Undesirable
Nunn Loam	Canada thistle	*Cirsium arvense*	List B
	Kochia	*Kochia scoparia*	Undesirable
	Downy brome	*Bromus tectorum*	List C
	Curly dock	*Rumex crispus*	Undesirable
	Common mullein	*Verbascum thapsus*	List C

Notes:

1. Plant species were recorded by delineated soil type at the Westerly Open Space.
2. Plant species are listed in order of abundance for each location.
3. Species in red text are identified as Noxious Weed species in the state of Colorado.

The abundant presence of field bindweed, Canada thistle, and Downy brome across the landscape of the future Westerly Open Space will interfere with re-vegetation efforts and native species establishment. Field bindweed is a deep-rooted perennial that spreads from an extensive rootstock and from seed (ACWD, 2020). Most parts of the bindweed roots and rhizomes can produce buds that create new roots and shoots. To successfully manage bindweed, containment and persistence in controlling existing plants are necessary in order to exhaust the root system and deplete the soil seed bank. Canada thistle is a creeping perennial that reproduces from vegetative buds in its root system and from seed (Beck, 2013). It is difficult to control because its extensive root system allows it to recover from control attempts. Canada thistle reduces forage consumption in pastures and rangeland because cattle typically will not graze near infestations. Finally, Downy brome is an annual grass species with an aggressive nature to inhabit native rangeland and disturbed areas and become invasive (Beck, 2012). Downy brome offers little nutritional value to livestock and is highly flammable, altering the timing and occurrence of range fires that negatively impact other desirable species.

To establish a healthy stand of native grasses and forbs, a site-specific Integrated Weed Management Plan (IWMP) should be diligently enforced to manage undesirable species. A site-specific IWMP will address various options for weedy species control including chemical, mechanical, and biological methods. Field bindweed and Canada thistle are extremely difficult species to control and will require time and several methods, including herbicide use and mowing (ACWD, 2020; Beck, 2013).

RESTORATION PLANNING

Duraroot has developed the following comprehensive Restoration Plan for the future Westerly Open Space. The Restoration Plan utilizes collected site data to define step-by-step restoration methodology specific for the future Westerly Open Space including:

1. Integrated weed management options;
2. Seedbed preparation methodology;
3. Proper soil amendments (as-needed);
4. Seeding methodology;
5. Seed mix recommendations including pollinator-friendly species; and
6. Temporary site stabilization.

INTEGRATED WEED MANAGEMENT (2021)

Due to the severity of weedy species encroachment across the location, Duraroot recommends implementing an IWMP immediately to initiate weedy species control. IWMPs address various options for weedy species control including chemical, mechanical, and biological methods. An IWMP will provide the best opportunity to establish a healthy stand of native grasses and forbs for Open Space Restoration. The IWMP should specifically address field bindweed, Canada thistle, and Downy brome cover on-site.

Field bindweed and Canada thistle are difficult species to control and require several methods, including herbicide use and mowing (ACWD, 2020; Beck, 2013). To successfully manage field bindweed and Canada thistle, containment and persistence in controlling existing stands are necessary in order to exhaust the root system and deplete the soil seed bank. These species need to be continually stressed, forcing plants to exhaust root nutrient stores and eventually die.

Weedy species will out-compete planted natives for resources. Additionally, forb planting greatly limits broadleaf herbicide application; therefore, weedy species management needs to be aggressive on the location and weedy species cover needs to be greatly reduced prior to any efforts to establish a desirable native species population. The following IWM practices are recommended to provide the most effective weed control prior to native plant seeding:

2021

1. The entire location should initially be mowed. Mowing will reduce residue cover and improve herbicide efficacy. **Mowing should occur in early spring (late February to early-March)** prior to herbicide application.
2. **Spray the entire location seven (7) to 10 days after mowing with a pre-emergent herbicide** (i.e., Plateau, Oryzalin) prior to germination of the weed seeds. Pre-emergent herbicide will assist in the prevention of new seedling development in the early spring from the available seed bank produced during the previous growing season(s).
3. **Spray the entire location with a selective herbicide mix that is specific for field bindweed and Canada thistle.** Duraroot recommends three (3) herbicide applications during the 2021 growing season. **Spraying should occur:**
    a. in the late spring at pre-flower, bud growth stage;
    b. during the summer growing season; and

c. in the fall prior to seeding. Spraying these species in the fall prior to dormancy will assist in stressing the plants as they prepare to transmit resources to the roots for dormancy and over-wintering.

4. Monitoring should continue on a monthly basis during the 2021 growing season to validate treatment effectiveness and maximize weed management efforts. Hand/ spot spray with the same selective herbicide mix as needed.

Application timing and rates for herbicides should follow the manufacturer's recommendations. All herbicide applications should be approved by property owners prior to application and should be applied by a qualified and certified herbicide applicator. Mowing may be implemented if species begin to flower to prevent seed head production of undesirable species.

PRAIRIE DOGS (2020 – 2021)

Prairie dogs (*Cynomys ludovicianus*) are present on the future Westerly Open Space location and will most likely interfere with native species seeding and restoration efforts. Prairie dog management is limited due to the potential of harming other species in the process. **Any prairie dog management should occur between November 15, 2020, and March 30, 2021, to avoid harming other species on location.** Prairie dog management includes applying rodenticide to control/ reduce populations. Rodenticide use should be conducted by a competent person familiar with the risks of using these products. The location should be monitored every 2 to 4 days during treatment to ensure proper disposal of carcasses to avoid injury to other species. Continued management of prairie dog populations is recommended to preserve seeded vegetation.

SEEDING (FALL 2021 – SPRING 2022)

Seeding should be conducted in the late fall or early spring (between November 15 and April 15) of 2021/ 2022 using a no-till drill seeder capable of direct seed placement into medium textured soils and the seed mix in Table 4. A no-till drill seeder will plant the native grass seed directly into the plant residue after weed management efforts (mowing). Plant residue provides protection of the soil surface from erosion and newly establishing grass seedlings.

A combination drill and packer is desirable. Drill seeding should occur on the contour using a drill equipped with an agitator, double disc opener, wheel press, and depth bands to mix seed and ensure proper seeding depths. **Seed depth is critical.** Seeds should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that the **seed be placed ¼ to ½ inch deep**. The recommended native grass seeding rate of 35 pounds pure live seed (PLS) per acre provides approximately 80 PLS per square foot. **The seed mix should include a mycorrhizal inoculum at the rate of 5.0 pounds per acre.**

Fall dormant seeding is preferred over spring seeding. Dormant seeding is the practice of sowing grass in the winter months when soil temperatures are cold and grass seeds are inactive. Cold season grasses germinate sooner in cold soils and will have more time to develop than seed sown in spring. Dormant seeding also avoids having to prepare the soil when it is still wet and cold in the spring and can result in a head start of several weeks in getting grasses established.

Dormant seeding should take place early enough in winter to avoid the muddy conditions from spring thaw and rains. Studies show that seeding in February, if conditions allow, may result in the greatest success because seed is less susceptible to removal by birds and other animals. Fall dormant seeding also takes advantage of spring snow melt and rains to provide moisture requirements for germination and establishment rather than installing irrigation,

which depends on water availability, water quality, and in some instances may introduce additional weedy species to the site.

A pollinator forb mix has been provided in Table 5. Pollinators are types of insects and animals that help plants reproduce by transporting pollen. Pollinators include numerous species of bees, butterflies, moths, beetles, flies, and birds and bats; they are an integral component of both natural and agricultural ecosystems. The Westerly Open Space Pollinator Habitat will help address the worldwide decline in pollinator habitats by restoring habitat with a variety of plants that attract pollinator species. In addition to insects, pollinator habitat is also beneficial for other wildlife like quail, turkey, and songbirds.

Duraroot recommends seeding forb species separately from native grass seed. Due to the current high weedy species cover across the location, it may be advantageous to seed pollinator species in strips or bands across the location or interspersed islands. This will allow for continued weed management using herbicide, if required. Over time forb species will spread through natural encroachment. If desirable forb cover is not reached in three (3) to five (5) years, the location could be seeded again.

MONITORING AND WEED MANAGEMENT (2022 – 2026)

Following dormant seeding, a new site-specific IWMP should be developed once weedy species can be identified during the first growing season (2022). The site should be periodically mowed prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for native species success. In addition to mowing, herbicides appropriate for the identified weedy species could be spot applied to eradicate any problematic species. Broadleaf herbicide application should be carefully spot applied to avoid any desirable forb species. Do not use herbicides until grasses are grown past the three-leaf stage, because herbicide may hurt the establishing grass seedlings. Application timing and rates for herbicides should follow the manufacturer's recommendations. At a minimum, weed management during the first two (2) seasons following re-vegetation should be diligent to improve establishment of seeded grasses and to prevent weedy species infestation.

The location should be monitored for a minimum of three (3) to five (5) years following seeding to maximize desirable species establishment and cover and to minimize weedy species and prairie dog return. If desirable vegetative cover is not achieved after the first two (2) growing seasons (2022 and 2023), the location may benefit from inter-seeding to improve native species cover.

CONCLUSION

Based on site conditions and available soil physicochemical analytical results Duraroot has developed this Restoration Plan for the future Westerly Open Space. Soil analytical results indicate no limitations to native species establishment pending the proper seedbed preparation and seeding methodology are implemented.

Weedy species cover is very high with the dominant species being field bindweed, Canada thistle, and Downy brome. Each of these species are very difficult to control and will require extended and diligent management. Native species establishment will be unsuccessful unless weedy species are managed properly. Additionally, prairie dogs are abundant on the location. Rodent management will result in improved and sustainable native species cover.

Duraroot, LLC appreciates the opportunity to assist Southern Land Company (SLC) on this endeavor. If you have any questions or comments regarding this Open Space Restoration Plan, please feel free to contact Kelley House, CPSS (khouse@duraroot.com; 406.580.0373).

Best Regards,

Kelley House, CPSS
Senior Soil Scientist
Duraroot, LLC

Table 4. Recommended native grass seed mix for the Westerly Open Space.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Western Wheatgrass	*Pascopyrum smithii*	4.8	12	15%
Mountain Brome	*Bromus marginatus*	3.9	8.0	10%
Basin Wildrye	*Leymus cinereus*	2.7	8.0	10%
Big Bluestem	*Andropogon gerardii*	2.7	8	10%
Green Needlegrass	*Nassella viridula*	2.9	12	15%
Little Bluestem	*Schizachyrium scoparium*	2.0	12	15%
Switchgrass	*Panicum virgatum*	0.90	8.0	10%
Yellow Indiangrass	*Sorghastrum nutans*	2.0	8.0	10%
Quickguard	Sterile Triticale	13	4.0	5%
Total	--	**35**	**80**	**100%**

Notes:

1. Seed mix was developed for soil conditions and future land use at the Westerly Open Space.
2. The recommended seed mix should be seeded in the fall of 2021.
3. The recommended seed mix should include a mycorrhizal inoculum at the rate of 5.0 pounds per acre.

Table 5. Recommended native forb (Pollinator Friendly) seed mix for the Westerly Open Space.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Butterfly Milkweed	*Asclepias tuberosa*	1.3	3.0	10%
Dense Blazing Star	*Liatris spicata*	0.90	3.0	10%
Lewis Flax	*Linum lewisii*	0.77	3.0	10%
Purple Coneflower	*Echinacea purpurea*	1.1	3.0	10%
Purple prairie clover	*Dalea purpureum*	0.62	3.0	10%
Rocky Mountain beeplant	*Cleome serrulata*	1.4	2.0	7%
Rocky Mountain penstemon	*Penstemon strictus*	0.22	3.0	10%
Yarrow	*Achillea millefolium*	0.06	4.0	13%
Showy Milkweed	*Asclepias speciosa*	1.8	3.0	10%
Wild Bergamot	*Monarda fistulosa*	0.10	3.0	10%
Total	--	8.3	30	100%

Notes:

1. Seed mix was developed for soil conditions and future land use at the Westerly Open Space.
2. The recommended seed mix should be seeded in the fall of 2021.
3. Seed mix includes forb species identified as desirable for pollinator species habitat creation in Colorado.

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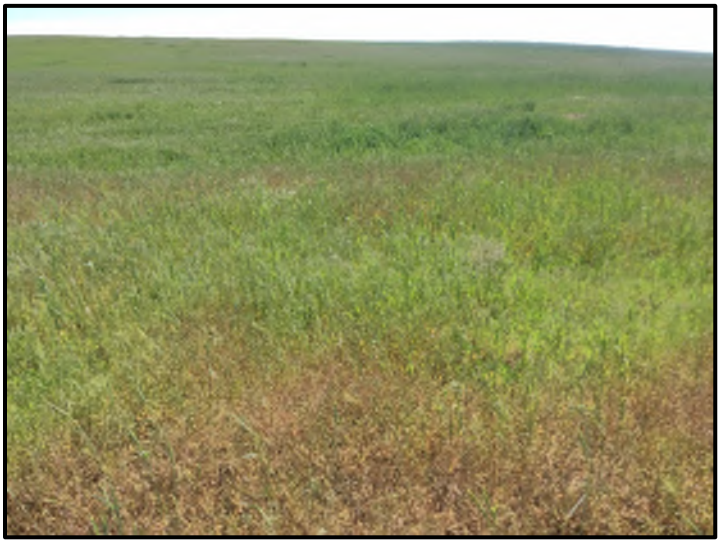

Photo 1. Photo point for the Cascajo soil sample location, May 21, 2020.

Location: N 40.03530 W 105.01057 **Direction: East**

Photo 2. Photo point for the Cascajo soil sample location, May 21, 2020.

Location: N 40.03530 W 105.01057 **Direction: Ground**

Photo 3. Photo point for the Wiley-Colby soil sample location, May 21, 2020.

Location: N 40.03364 W 105.01273 **Direction: East**

Photo 4. Photo point for the Wiley-Colby soil sample location, May 21, 2020.

Location: N 40.03174 W 105.01620 **Direction: North**

Photo 5. Photo point for the Wiley-Colby soil sample location, May 21, 2020.

Location: N 40.03094 W 105.01636 **Direction: North**

Photo 6. Photo point for the Wiley-Colby soil sample location, May 21, 2020.

Location: N 40.03094 W 105.01636 **Direction: Ground**

Photo 7. Photo point for the Nunn Loam soil sample location, May 21, 2020.

Location: N 40.02996 W 105.01521 **Direction: South**

Photo 8. Photo point for the Nunn Loam soil sample location, May 21, 2020.

Location: N 40.02967 W 105.01730 **Direction: East**