IR 73-25

February 28, 1973

EVALUATION OF COAL CHANNEL SAMPLES FROM THE NEW LINGAN MINE OF DEVCO

by

T. E. Tibbetts

Fuels Research Centre

CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

MINES BRANCH

OTTAWA

Fuels Research Centre

EVALUATION OF COAL CHANNEL SAMPLES FROM THE NEW LINGAN MINE OF DEVCO

by

T. E. Tibbetts

February, 1973

EVALUATION OF COAL CHANNEL SAMPLES FROM THE NEW LINGAN MINE

by

T. E. Tibbetts*

SUMMARY OF RESULTS

Seventeen channel samples from the new coal mine at Lingan, Nova Scotia were studied to determine any trends in coal quality, particularly the sulphur constituent, as the mine was being developed.

Although the sulphur contents have been found to vary erratically from location to location on four mine slopes, there are some indications that the total sulphur in the area of present partial coal extraction is more stable than on the upper slopes. The sulphur occurs mainly in the pyritic form. The "roof coal", the top 10 inches of the seam, is significantly higher in total mineral matter and sulphur than the remainder of the seam.

*Research Scientist, Fuels Research Centre, Department of Energy, Mines and Resources, Mines Branch, Ottawa, Canada.

INTRODUCTION

The new Lingan mine is situated near the town of New Waterford, Nova Scotia. The mine area lies between the workings of No. 14 colliery on the west and No. 26 colliery on the east. Economical mineable reserves are estimated to be about 35 million tons. The coal is high-volatile A bituminous and of potential metallurgical quality.

Development of the mine started in 1970, and, although production from long walls will not be realized until 1974, some production was obtained in 1972 from partial extraction from a room-and-pillar production section.

Three slopes, Numbers 2, 3 and 4, have been developed from the outcrop and a fourth slope, Number 1, has advanced from a cross-cut from Number 2 Slope about 1600 feet from the outcrop (Figure 1).[1]

In order to follow trends in coal quality as the mine was developed, the Fuels Research Centre has taken channel samples at periodic intervals, while the slopes were being driven, between November, 1970, and August, 1972.

SAMPLES COLLECTED AND RESULTS OF ANALYSES

Seventeen channel samples were taken in the new Lingan mine between November, 1970, and August, 1972, by D. J. O'Brien of the Cape Breton laboratory of the Fuels Research Centre.

Each channel sample was a cut 20 inches wide and 7 inches deep. The earlier samples, Numbers 1 to 10, up to March, 1972, were taken at the driving face across the full seam. The remainder of the samples, Numbers 11 to 17 inclusive, were taken in two parts, (a) roof to 10 inches (where higher sulphur content was suspected) and (b) 10 inches to pavement. The date, location, and seam thickness for each sample was as given in Table 1.

The analyses of coal and ash were conducted at the Fuels Research Centre and are given in Tables 2, 3, and 4.

The ash and sulphur contents are also shown in Figures 2 to 5 which were prepared to illustrate these fundamental components as related to the seam and seam sections.

---

(1) Marsh et al; "Development and Production at the Lingan Mine", presented at a meeting of the Mining Society of Nova Scotia, 25 November, 1972.

The mineral content of the coal from the Lingan mine varies erratically from a low of 3.5 per cent in Channel Sample No. 8 taken on No. 2 Slope to a high of about 12 per cent in Channel Sample No. 14 from No. 1 Slope. Samples 11 and 14 from the No. 1 Slope are relatively high in mineral matter.

The sulphur contents also vary erratically from 1.5 per cent to more than 3 per cent and are highest in samples from No. 1 Slope. Although no definite trends are apparent, the sulphur contents of Samples 15 and 17 of 1.8 per cent and 2.0 per cent respectively indicate that the sulphur content of the seam decreases with depth.

Where the top 10 inches of the seam was sampled separately (Samples 11 and 17) the mineral and sulphur contents of this portion of the seam were higher than for the remainder of the seam, that is, from 10 inches from the roof to the pavement.

In all samples, the sulphur occurs mainly in the pyritic form and constitutes as much as 92.6 per cent of the total sulphur in the top 10 inches of the seam (Channel Sample 17) and as high as 85.6 per cent in the remainder of the seam (Channel Sample 15). Considering the samples (Nos. 15 and 17) taken nearest the present production area, pyritic sulphur constitutes 86.4 per cent and 72.8 per cent respectively of the total seam sulphur. This fact of course is important in the consideration of techniques of beneficiating the coal for metallurgical and environmental reasons and, particularly, of the efficiencies of sulphur removal methods.

The division of the seam for sampling purposes at 10 inches from the mine roof was arbitrarily chosen. Study of more samples to determine the optimum thickness of the mineable seam, from the points of view of coal quality and roof control, should follow.

TABLE 1

Dates of Sampling, Mine Locations, and Seam Thicknesses

Sample No.	Date Sampled	Sampling Location	Distance from Mouth of Portal (ft)	Seam Thickness
1	2.11.70	No. 3 Slope	500	8' 0"
2	18.12.70	No. 3 Slope	566	8' 0"
3	23. 3.71	No. 3 Slope Arch No. 217	937	8' 0"
4	27. 4.71	No. 3 Slope Arch No. 285	1142	7' 4"
5	9. 7.71	No. 3 Slope Arch No. 437	1563	7' 4"
6	30. 8.71	No. 2 Slope Arch No. 141	425	8' 4"
7	13.10.71	No. 2 Slope Arch No. 160	800	7' 7"
8	4.11.71	No. 2 Slope Arch No. 243	1154	7' 4"
9	19. 1.72	No. 4 Slope Arch No. 49	325	7' 6"
10	22. 3.72	No. 4 Slope Arch No. 326	1250	7' 4"
11	31. 5.72	No. 1 Slope Arch No. 50	150	7' 3"
12	30. 5.72	No. 2 Slope Arch No. 548	2024	7' 3"
13	29. 5.72	No. 4 Slope Arch No. 681	2285	7' 4"
14	28. 8.72	No. 1 Slope Arch No. 224	816	6' 8"
15	17. 8.72	No. 2 Slope Arch No. 739	2773	7' 0"
16	24. 8.72	No. 3 Slope Arch No. 436	1559	7' 3"
17	14. 8.72	No. 4 Slope Arch No. 807	2723	7' 3"

TABLE 2

Results of Analyses of Lingan Mine Channel Samples (Dry Basis)

Slope	No. 3 Slope					No. 2 Slope		
Channel Sample No.	1	2	3	4	5	6	7	8
Laboratory No.	3399-70	3468-70	2360-71	2505-71	2654-71	2780-71	2917-71	2995-71
Proximate Analysis								
Ash ..... %	4.6	5.3	3.9	4.4	6.3	4.8	4.0	3.5
Volatile Matter .. %	39.7	39.2	38.5	40.1	37.9	38.2	36.6	37.3
Fixed Carbon..... %	55.7	55.5	57.6	55.5	55.8	57.0	59.4	59.2
Ultimate Analysis								
Carbon ..... %	79.7	80.2	80.6	79.4	78.4	78.8	81.3	81.2
Hydrogen ..... %	5.3	5.4	5.5	5.4	5.1	5.2	5.3	5.2
Sulphur ..... %	3.3	2.8	2.2	2.6	2.0	3.0	1.3	1.6
Nitrogen ..... %	1.6	1.6	1.5	1.6	1.6	1.5	0.8	1.6
Ash ..... %	4.6	5.3	3.9	4.4	6.3	4.8	4.0	3.5
Oxygen ..... %	5.5	4.7	6.3	6.6	6.6	6.7	7.3	6.9
Calorific Value (Dry)..... Btu/lb	14,240	14,470	14,390	14,290	13,930	14,100	14,320	14,520
Calorific Value (DMMF)..... Btu/lb	15,040	15,410	15,070	15,060	15,000	14,930	15,000	15,130
Fusibility of Ash								
Initial .....°F	2180	2010	2050	-	2010	2060	1950	1950
Softening .....°F	2200	2140	2150	-	2160	2120	2240	2150
Hemispherical ....°F	2240	2180	2230	-	2400	2290	2350	2320
Fluid .....°F	2350	2650	2350	-	2700+	2420	2420	2510
Grindability Index	49	50	54	48	49	50	54	54
Swelling Index (ASTM)	7	7	5	$5\frac{1}{2}$	$6\frac{1}{2}$	6	$6\frac{1}{2}$	$5\frac{1}{2}$

- Not Determined.

TABLE 2 (Cont'd)

Results of Analyses of Lingan Mine Channel Samples (Dry Basis)

Slope	No. 4 Slope		No. 1 Slope		No. 2 Slope		No. 4 Slope	
Channel Sample No.*	9	10	11a	11b	12a	12b	13a	13b
Laboratory No.	2183-72	2765-72	3129-72	3130-72	3132-72	3133-72	3135-72	3136-72
Proximate Analysis								
Ash %	3.8	5.2	7.3	7.3	5.7	4.6	5.5	5.0
Volatile Matter %	38.7	39.1	39.2	37.2	39.7	40.0	38.7	37.5
Fixed Carbon %	57.5	58.7	53.5	55.5	54.6	55.4	55.8	57.5
Ultimate Analysis								
Carbon %	80.6	79.0	77.3	77.6	78.3	80.1	79.5	79.6
Hydrogen %	5.3	5.3	5.2	5.2	5.4	5.4	5.4	5.3
Sulphur %	1.9	3.0	4.1	3.0	3.8	2.5	2.8	2.3
Nitrogen %	1.6	1.7	1.6	1.6	1.7	1.7	1.7	1.7
Ash %	3.8	5.2	7.3	7.3	5.7	4.6	5.5	5.0
Oxygen %	6.8	5.8	4.5	5.4	5.2	5.7	5.1	6.1
Calorific Value (Dry) Btu/lb	14,470	14,230	13,910	13,940	14,140	14,340	14,210	14,290
Calorific Value (DMMF) Btu/lb	15,140	15,140	15,190	15,210	15,150	15,140	15,180	15,170
Fusibility of Ash								
Initial °F	2140	2250	2140	1890	2170	2050	2040	1940
Softening °F	2250	2320	2180	1930	2210	2110	2110	2000
Hemispherical °F	2410	2380	2240	2000	2240	2160	2160	2050
Fluid °F	2620	2480	2270	2030	2350	2250	2250	2300
Grindability Index	51	48	44	47	45	48	45	48
Swelling Index (ASTM)	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	5	6	$5\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{1}{2}$

*a = Roof to 10"; b = 10" to pavement.

TABLE 2 (Cont'd)

Results of Analyses of Lingan Mine Channel Samples (Dry Basis)

Slope	No. 1 Slope		No. 2 Slope		No. 3 Slope		No. 4 Slope	
Channel Sample No.*	14a	14b	15a	15b	16a	16b	17a	17b
Laboratory No.	3928-72	3929-72	3932-72	3933-72	3936-72	3937-72	3940-72	3941-72
Proximate Analysis								
Ash ..... %	14.5	11.6	6.8	3.7	4.6	3.8	7.8	7.5
Volatile Matter .. %	36.7	36.0	39.0	37.8	40.0	37.1	39.1	36.2
Fixed Carbon..... %	48.8	52.4	54.2	58.5	55.4	59.1	53.1	56.3
Ultimate Analysis								
Carbon ..... %	68.3	72.8	78.1	81.3	77.6	80.6	75.3	77.0
Hydrogen ..... %	4.8	5.0	5.3	5.4	5.3	5.4	5.1	5.0
Sulphur ..... %	4.3	2.9	3.3	1.6	3.3	1.6	3.8	1.8
Nitrogen ..... %	1.4	1.6	1.5	1.9	1.7	1.8	1.7	1.7
Ash ..... %	14.5	11.6	6.8	3.7	4.6	3.8	7.8	7.5
Oxygen ..... %	6.7	6.1	5.0	6.1	7.5	6.8	6.3	7.0
Calorific Value (Dry)..... Btu/lb	12,680	13,260	14,940	14,520	14,200	14,360	13,740	13,860
Calorific Value (DMMF)..... Btu/lb	15,180	15,250	15,220	15,160	15,010	15,010	15,100	15,130
Fusibility of Ash								
Initial .....°F	1950	2010	2080	1920	2090	1930	2050	2030
Softening .....°F	2020	2140	2290	1970	2230	2080	2080	2080
Hemispherical ....°F	2210	2280	2320	2010	2260	2260	2130	2150
Fluid .....°F	2430	2450	2370	2150	2320	2400	2250	2350
Grindability Index	47	50	46	54	43	50	46	51
Swelling Index (ASTM)	7	5	$5\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	4	5

*a = Roof to 10"; b = 10" to pavement.

TABLE 3

Sulphur and Sulphur Forms of Lingan Coal

Channel Sample No*	Total Sulphur (Air Dry Basis) %	Sulphate Sulphur		Pyritic Sulphur		Organic Sulphur	
		% of Coal	% of Sul.	% of Coal	% of Sul.	% of Coal	% of Sul.
1	3.30	-	-	-	-	-	-
2	2.66	0.01	0.37	1.49	56.02	1.16	43.61
3	2.14	0.10	4.67	1.42	66.36	0.62	28.97
4	2.52	0.11	4.36	1.92	76.19	0.49	19.45
5	1.92	0.03	1.56	1.51	78.64	0.38	19.80
6	2.93	0.03	1.02	2.02	68.94	0.88	30.04
7	1.23	0.00	0.00	0.64	52.03	0.59	47.97
8	1.56	0.03	1.92	1.14	73.08	0.39	25.00
9	1.81	0.01	0.55	1.34	74.03	0.46	25.42
10	2.85	0.08	2.81	2.05	71.92	0.72	25.27
11a	3.97	0.02	0.50	3.06	77.08	0.89	22.42
11b	2.90	0.05	1.72	2.36	81.38	0.49	16.90
12a	3.73	0.27	7.23	2.64	70.78	0.82	21.99
12b	2.50	0.00	0.00	1.47	58.80	1.03	41.20
13a	2.75	0.02	0.73	2.12	77.09	0.61	22.18
13b	2.21	0.01	0.45	1.41	63.80	0.79	35.75
14a	4.25	0.15	3.53	3.45	81.18	0.65	15.29
14b	2.83	0.07	2.47	2.00	70.67	0.76	26.86
15a	3.28	0.06	1.83	3.04	92.68	0.18	5.49
15b	1.53	0.03	1.96	1.31	85.62	0.19	12.42
16a	3.20	0.15	4.69	2.85	89.06	0.20	0.62
16b	1.58	0.05	3.16	1.33	84.17	0.20	12.65
17a	3.64	0.23	6.32	3.37	92.58	0.04	1.10
17b	1.75	0.04	2.28	1.23	70.29	0.48	27.43

*a = roof to 10"; b = 10" to pavement. - Not Determined.

TABLE 4

Ash Analyses of Channel Samples from Lingan Mine

Channel Sample No.*	Ash Constituent - %									
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	CaO	MgO	SO_3	Na_2O	K_2O
1	15.0	12.5	69.5	0.2	0.3	0.7	0.6	0.1	-	0.4
2	-	-	-	-	-	-	-	-	-	-
3	19.9	17.1	60.4	0.3	0.2	1.0	0.4	0.9	0.5	0.4
4	20.9	17.1	59.6	0.7	0.3	1.0	0.3	0.8	0.3	0.7
5	37.1	22.3	35.3	0.6	0.2	0.9	1.0	0.7	0.5	1.8
6	20.4	15.9	59.8	0.5	0.3	0.8	0.4	0.4	0.4	0.4
7	42.0	25.7	27.5	0.9	0.2	1.1	1.2	0.2	0.4	1.5
8	30.0	21.5	45.2	0.6	0.3	1.2	0.9	0.3	0.4	1.0
9	45.6	27.9	12.3	0.7	0.3	5.6	2.1	4.1	2.4	0.9
10	17.2	13.5	66.3	0.4	0.4	0.9	0.5	0.6	0.5	0.6
11a	9.4	7.9	59.6	0.4	0.2	10.4	0.4	11.6	0.3	0.3
11b	19.0	13.2	45.9	0.5	0.1	9.0	0.6	10.8	0.4	0.6
12a	13.2	12.9	71.3	0.3	0.3	0.7	0.2	0.1	0.4	0.2
12b	22.3	15.4	58.8	0.4	0.2	1.1	0.4	0.1	0.6	1.0
13a	22.0	16.2	59.6	0.5	0.3	0.6	0.3	0.1	1.0	0.7
13b	29.2	19.3	48.1	0.5	0.2	0.8	0.8	0.1	1.1	1.0
14a	38.4	17.8	34.0	0.6	0.1	2.7	1.2	2.7	0.4	1.8
14b	43.0	20.2	27.2	0.8	0.1	2.5	1.4	2.4	0.8	2.5
15a	8.9	8.0	55.2	0.3	0.3	11.4	0.5	13.0	0.2	0.4
15b	18.4	13.7	43.7	0.6	0.3	9.0	1.4	10.3	0.5	0.6
16a	10.3	8.9	76.6	0.3	0.3	1.2	0.1	0.9	0.3	0.8
16b	30.3	19.1	43.0	0.7	0.2	2.5	0.9	1.9	0.6	0.4
17a	12.0	10.2	52.8	0.3	0.3	10.2	0.4	12.2	0.4	0.7
17b	40.5	16.0	29.1	0.7	0.2	4.8	1.5	5.1	0.4	2.4

*a = Roof to 10"; b = 10" to pavement. - Not Determined.

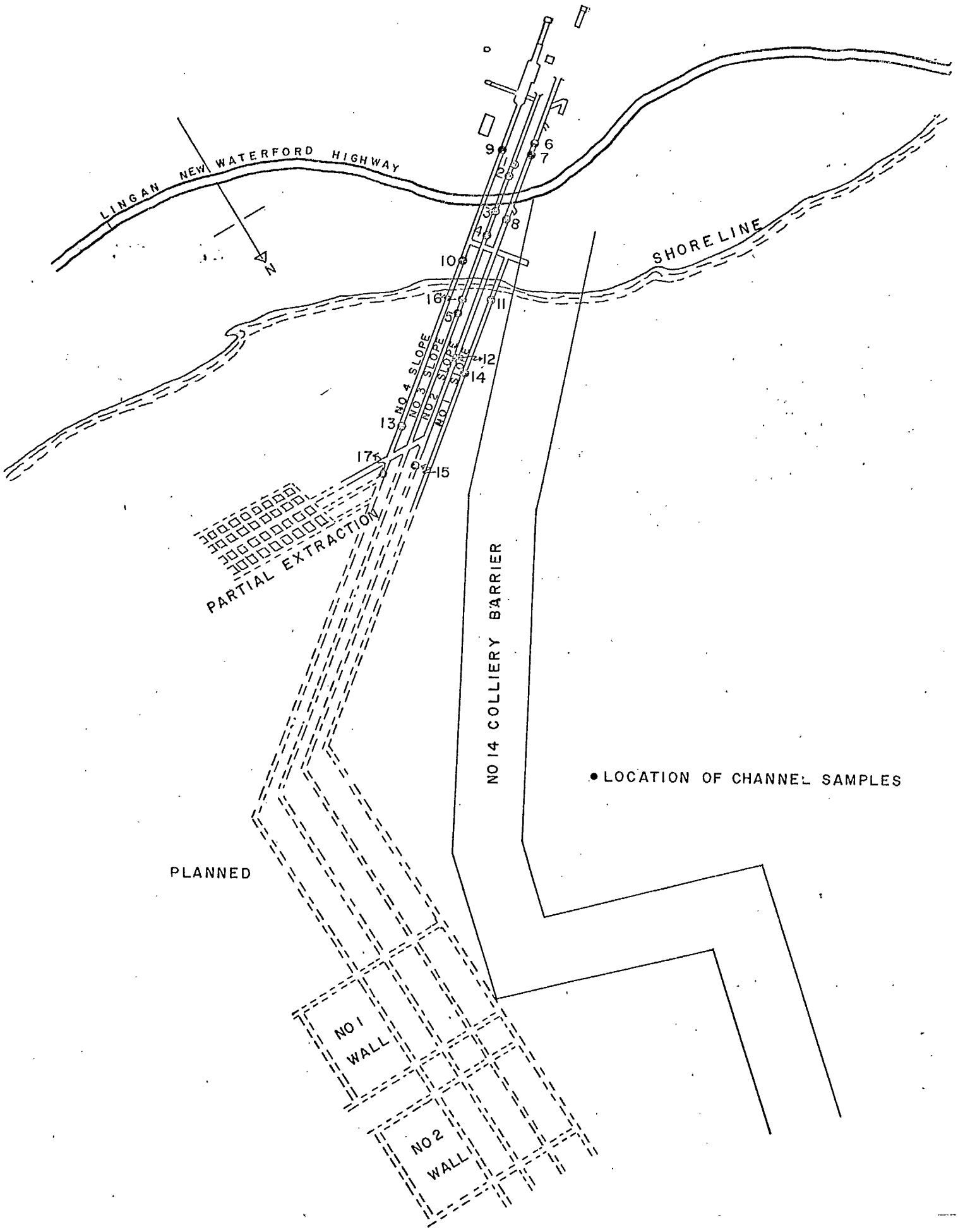
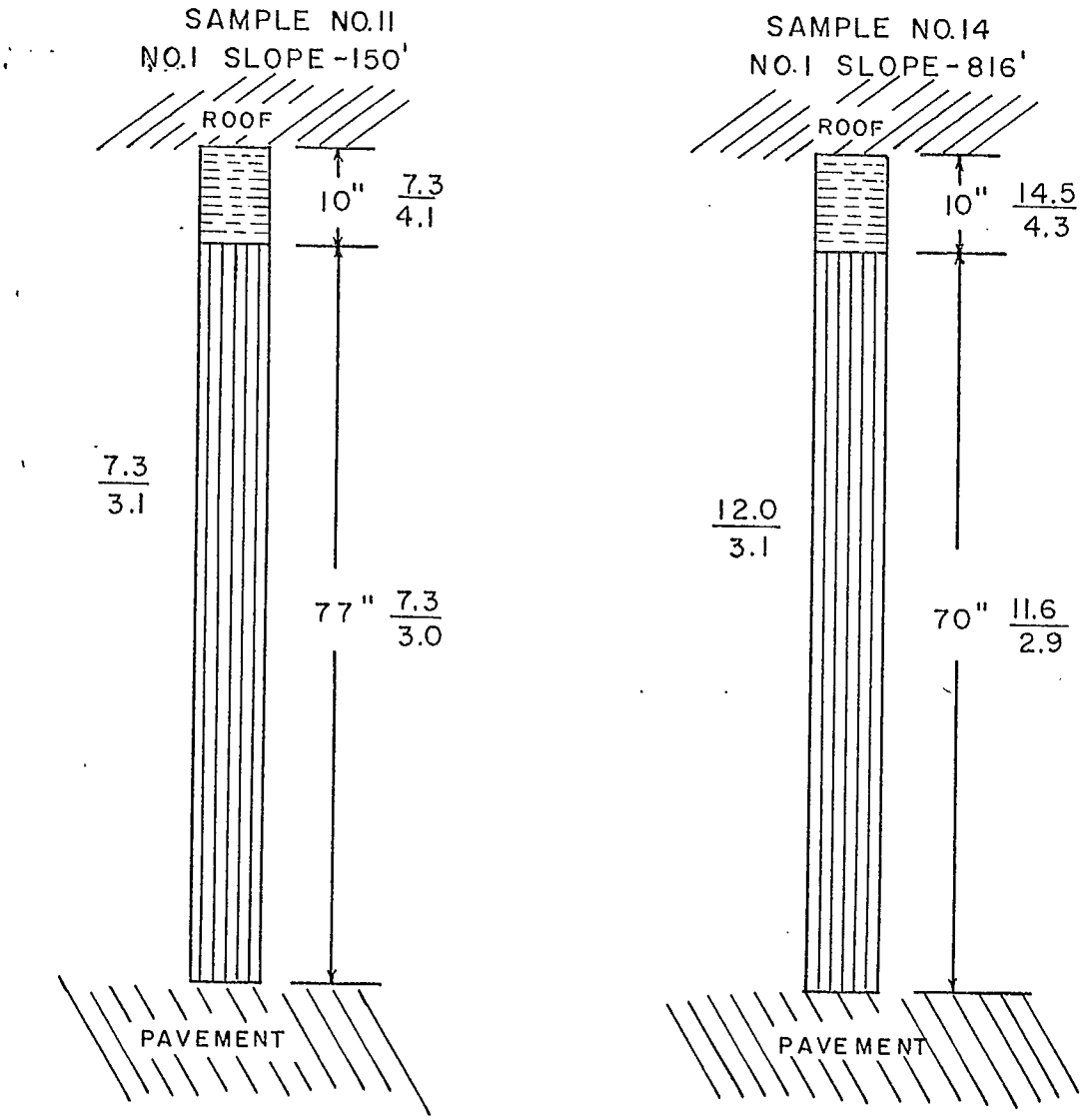


FIGURE 1-SKETCH OF LAYOUT OF LINGAN MINE (NO SCALE)



$$\frac{X.X}{X.X} = \frac{\text{PER CENT ASH}}{\text{PER CENT SULPHUR}}$$

FIGURE 2 - CHANNEL SAMPLES OF COAL SEAM TAKEN AT LINGAN MINE ON NO.1 SLOPE

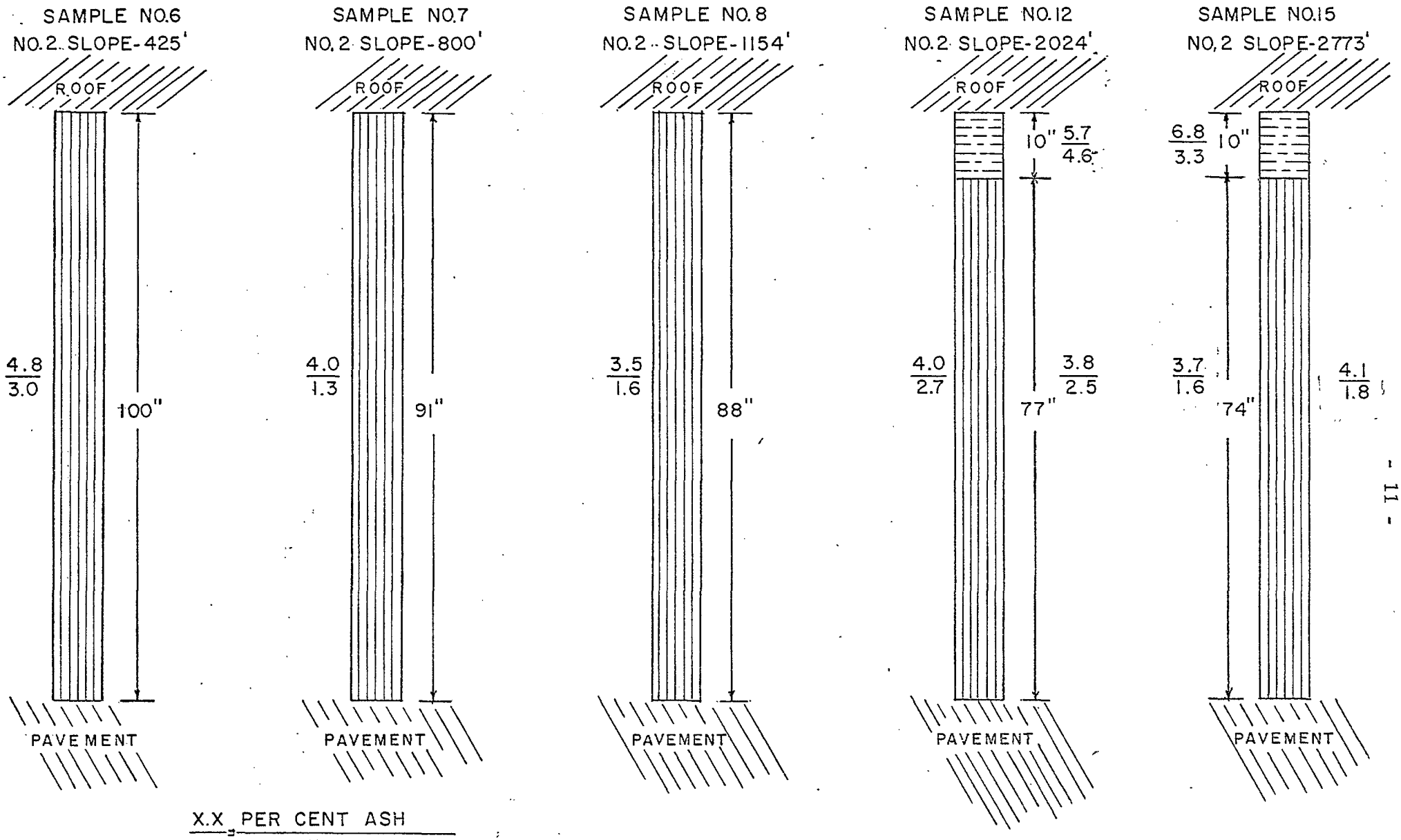
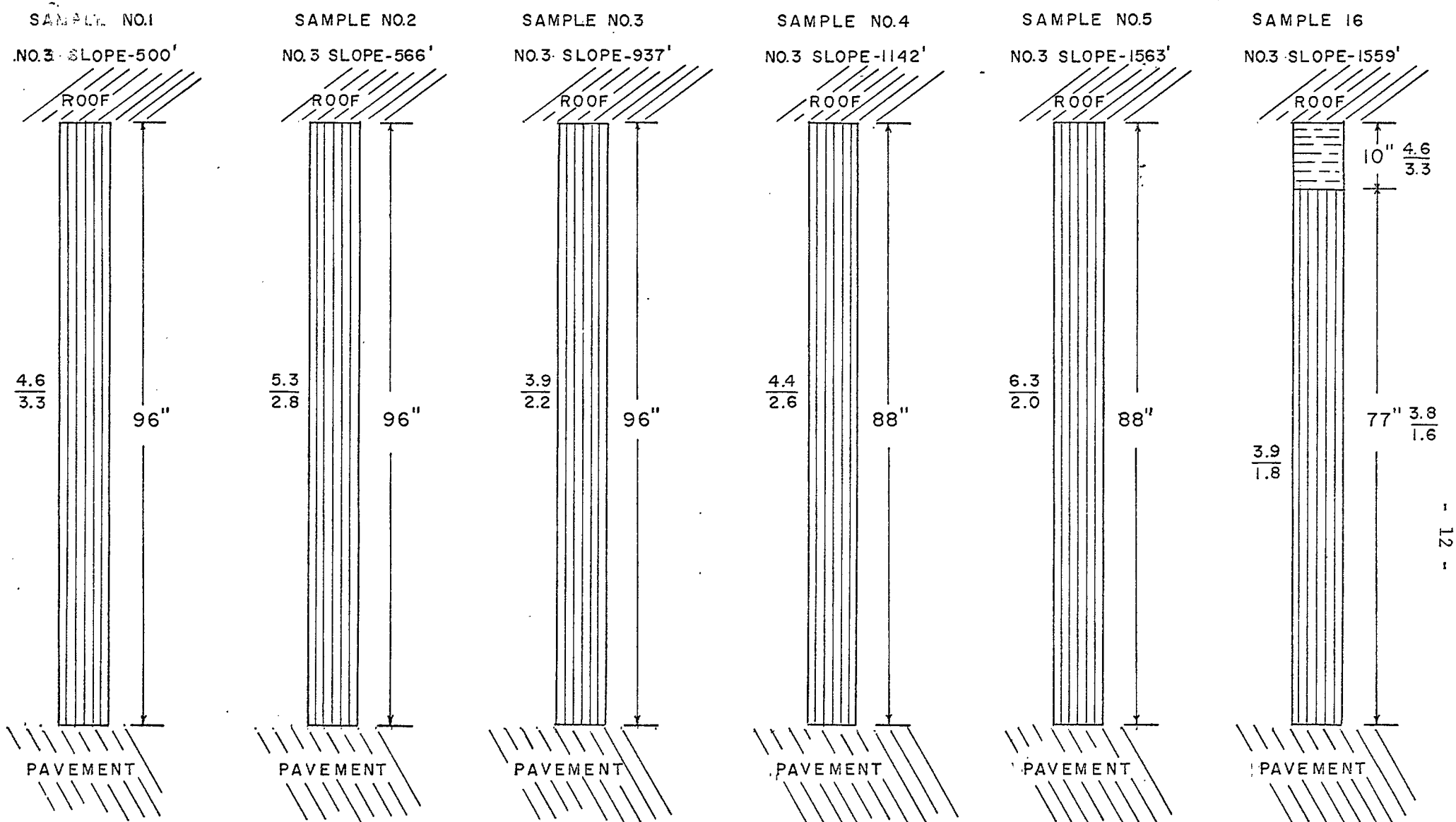
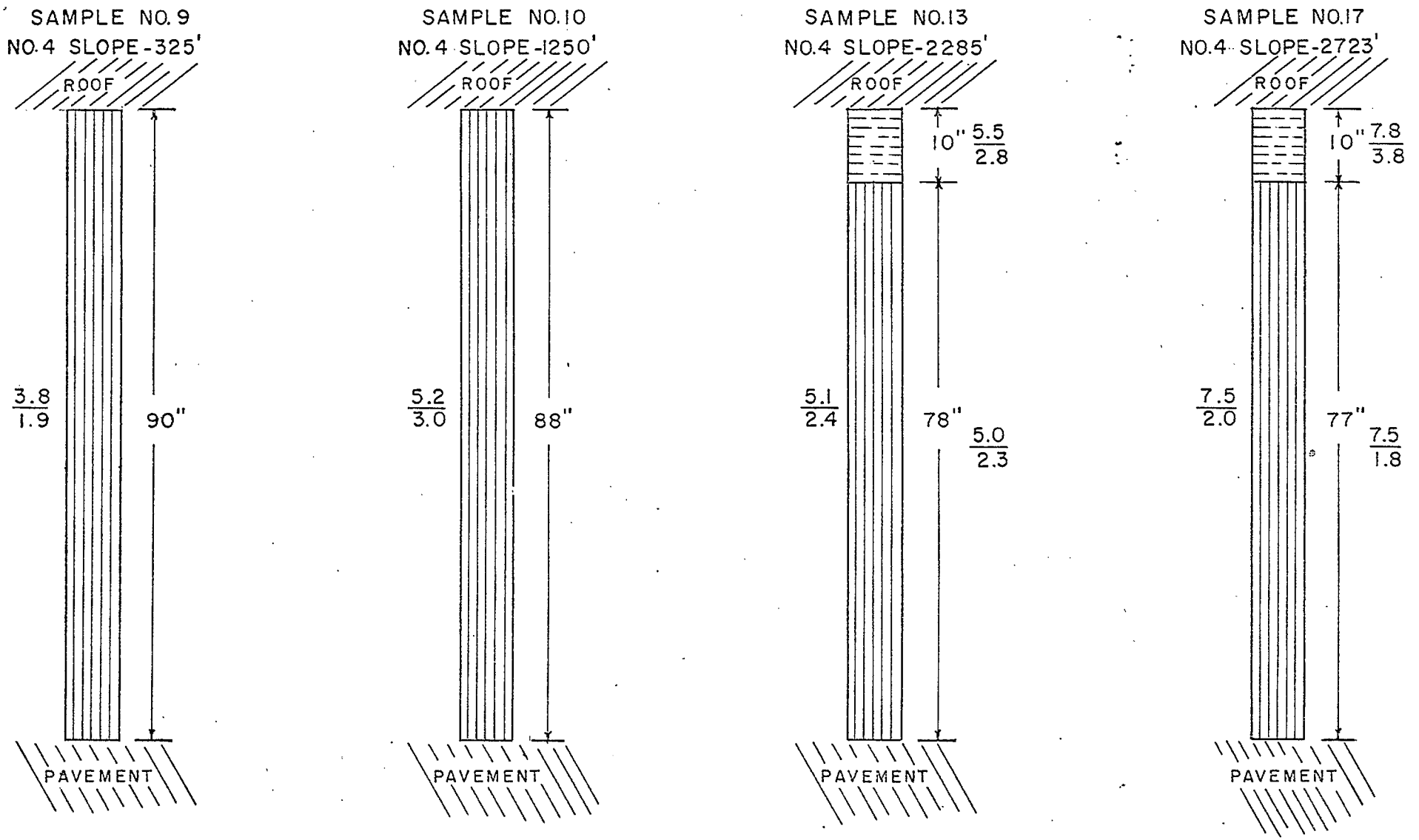


FIGURE 3 - CHANNEL SAMPLES OF COAL SEAM TAKEN AT LINGAN MINE ON NO. 2 SLOPE



$$\frac{X.X}{X.X} = \frac{\text{PER CENT ASH}}{\text{PER CENT SULPHUR}}$$

FIGURE 4 - CHANNEL SAMPLES OF COAL SEAM TAKEN AT LINGAN MINE ON NO.3 SLOPE



$$\frac{\text{X.X PER CENT ASH}}{\text{X.X PER CENT SULPHUR}}$$

FIGURE 5 - CHANNEL SAMPLES OF COAL SEAM TAKEN AT LINGAN MINE NO. 4 SLOPE

ACKNOWLEDGEMENT

Acknowledgement is due to the staff of the Solid Fuels Laboratory for the analyses and to R. W. Taylor, Fuels Research Centre, for the sketches contained in this report.