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BELLBIRD COLLIERY

The recovery of the No. 1 Tunnel following an underground fire

BY

J. G. BAILEY

INSPECTOR OF COLLIERIES

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The recovery of the No. 1 Tunnel following an underground fire

BY J. G. BAILEY, Inspector of Collieries

On 22nd December, 1963 the No. 1 Tunnel of Bellbird Colliery was sealed because of the occurrence of a serious underground fire. During the subsequent reclamation of the Colliery using self-contained breathing apparatus the fire was re-activated. A mild blast occurred during re-sealing operations. The second attempt at the recovery of the tunnel was successful and the Colliery resumed production on 14th May, 1964.

CONTENTS

	Page
INTRODUCTION	2
POSITION BEFORE THE FIRE	2
THE UNDERGROUND FIRE	3
RECOVERY OPERATION	5
CONCLUSION	14
REFERENCES	15
APPENDIX 1.—Analysis of samples from 9 West during 1963 ..	15
APPENDIX 2.—Analysis of samples of sealed atmosphere taken from transport heading at the surface after the occurrence ..	16
APPENDIX 3.—Analysis of samples of sealed atmosphere taken by the recovery personnel	17
APPENDIX 4.—Report on samples of combustible material and P.V.C. covered signalling cable by the Chief Analyst—Department of Mines	18

INTRODUCTION

Bellbird Colliery is situated in the South Maitland Coalfields, three miles to the South West of Cessnock. Opened in 1912 the Colliery has extensively worked the Greta seam by means of three tunnels driven from the outcrop. The Greta Seam is the only seam of commercial importance in the colliery holding where it has become well known for its quality, thickness and liability to spontaneous combustion.

The seam, which has a conglomerate roof and a clay floor, comprises from 14 to 30 feet of high-grade coal well suited for gas manufacture. An average analysis is as follows:—

Hydroscopic Moisture	..	..	..	2.2 per cent.
Volatile Matter	..	..	..	41.2 per cent.
Fixed Carbon	..	..	..	50.9 per cent.
Ash	..	..	..	4.7 per cent.
Sulphur	..	..	..	1.0 per cent.
Calorific Value	..	..	..	13,500 BTU's/lb.

During the life of the colliery large sections have been sealed due to the occurrence of spontaneous heating.

Inflammable gas has not been occluded from the seam or adjacent strata to any extent during the normal working of the Colliery. However, inflammable gases are detected during the advanced stages of spontaneous heating and in areas sealed for this reason.

On 1st September, 1923 a serious fire occurred at the Colliery, followed by a number of explosions which resulted in the loss of twenty-one lives. It was considered that the fire originated in the southern portion of the section now known as 2 East and was caused by a naked light in some way unknown. ⁽¹⁾

Prior to the recent fire, the output of the Colliery averaged 600 tons per day, and was obtained from the No. 1 Tunnel where 83 men were employed on one production shift.

POSITION BEFORE THE FIRE

The mining operation which provided the entire production at the Colliery consisted of the extraction of pillars located about 1,400 yds. from the tunnel mouth, and adjacent to the main headings. The attached plan shows the location of these workings and the adjacent panels of the Colliery.

The seam at this point is approximately 28 ft. high. The top coal had been previously extracted to the 18 ft.-20 ft. partings in most of the headings except the two main haulage roads. Extensive coal and stone falls existed in the return airways.

The adjacent No. 9 West Panel was worked during the early life of the Colliery and sealed for preservation. After more than 20 years, the area was reopened during 1950 in preparation for the extraction of pillars. After a period of approximately three months, signs of spontaneous heating were detected and smoke was observed less than 48 hours after. The area was immediately sealed. From this time onward, a distinct smell of firestink could be detected outside the seals of this area.

An attempt was made to inspect 9 West Panel on 26th May, 1962 after the restoration of fresh air. Dangerous falls and high concentrations of carbon monoxide made re-sealing necessary. Analyses taken during 1963 form Appendix 1.

This heating was recognised as a potential danger and before pillar extraction proceeded outbye a stowage pack of loose coal, floor dirt and loam, reinforced with old mine timber, was erected against each of these seals. Several of these seals were located under narrow bridges of top coal and a short distance from the end of the pillars so that the effectiveness of the outbye stowage packs was considerably reduced.

Spontaneous heating has also occurred in the No. 4 and No. 6 West Sections. An attempt to recover this area during 1961 resulted in an ignition of inflammable gases on 1st July. None of the workmen present was injured. The section was re-sealed the same day and has remained so to date. (2)

The adjacent No. 3 East Section was also worked during the early life of the Colliery. During a subsequent operation the top coal was removed from the bords and cut-throughs. One instance of spontaneous combustion is known to have occurred in the area, but it was readily isolated by seals within the area. This section was reopened early in 1961 to ascertain the prospects of pillar extraction. Frequent stone falls and adverse conditions generally were responsible for the area being sealed shortly after.

The extraction of pillars along the main headings of No. 1 Tunnel began during 1962 and continued until December, 1963 when all seals enclosing the 9 West Section were no longer accessible. Large falls of roof were encouraged, whenever possible, adjacent to the stowed seals of the 9 West Section with the intention of covering them and subjecting them to pressure to increase their effectiveness.

Firestink was detected along the goaf edge on numerous occasions during November, 1963. Samples of the atmosphere obtained along the goaf edge and in the West return airway did not reveal the presence of carbon monoxide or inflammable gas.

On 13th December, 1963 production at the Colliery ceased for the celebration of the Annual Holidays.

On 19th December, 1963 a sample from the West return airway revealed the presence of 0.0027 per cent. Carbon Monoxide. Officials at the Colliery considered that a heating was developing in the goaf. Brattice was erected in such a way that about 40,000 cubic feet of air per minute was circulated over the goaf with the intention of cooling the heating.

A sample from the West return airway on the 20th December, 1963 indicated that carbon monoxide or combustibles were not present.

On 21st December, 1963 a deputy inspected the goaf edge and return airways and reported nothing unusual at about 10 a.m. During the rest of the day, inspections of the fan drift required by the Coal Mines Regulation Act, 1912, as amended, were carried out. Nothing unusual was detected during the inspection at 4 p.m. At approximately 5.50 p.m. smoke was observed to be issuing from the fan drift.

Great difficulty was experienced in contacting officials and employees, many of whom had to travel considerable distances from holiday resorts.

THE UNDERGROUND FIRE

At approximately 7.30 p.m. an underground inspection was made of the Colliery. Large volumes of brown smoke were observed in the West return airway where 0.15 per cent. carbon monoxide was detected. Brown smoke was also backing out along the No. 6 West Gannon. Practically no smoke was observed in the East return airway. The inspection did not reveal the location of the fire except that it was restricted to the Western side of the goaf. Varying amounts of carbon monoxide above 0.05 per cent. were detected at various locations around the goaf edge.

To seal the area underground required the transport of materials underground for the erection of nine large seals, one of which was in a return airway containing 0.15 per cent. CO and impenetrable smoke which appeared to be increasing. The shortage of labour, added to this, made it necessary to seal the No. 1 Tunnel at the surface.

Work began immediately to erect concrete brick seals in the portal of each tunnel.

The Colliery fan was kept running. The inspection doors of the fan drift were opened to provide fresh air and access to allow workmen to place 10 in. x 2 in. planks across the 16 ft. dia. upcast shaft.

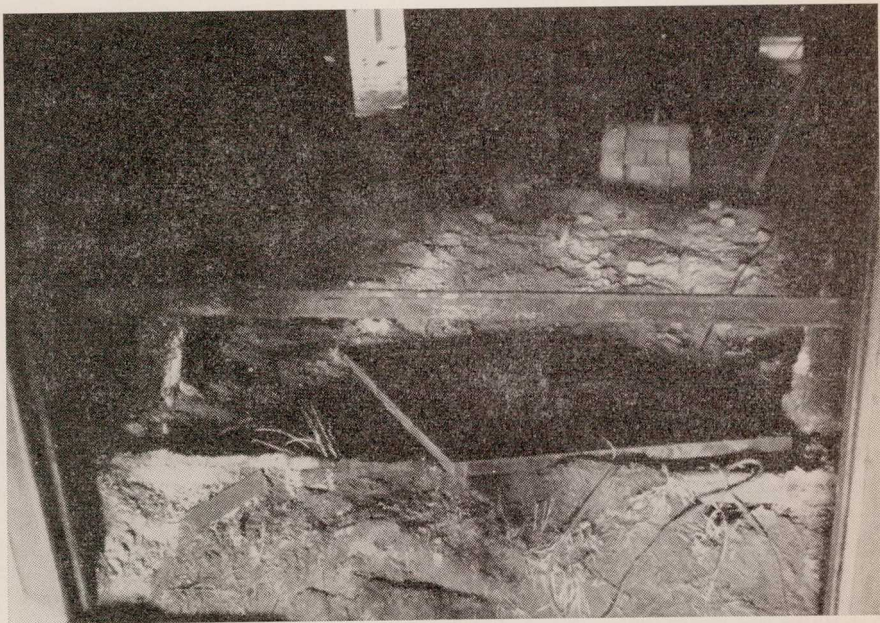
During the night the colour of the smoke, issuing from the fan drift, gradually darkened. At approximately 3 a.m. large flakes of soot were observed and the smoke was distinctly black. A full scale reading of 5 per cent. was recorded on a methanometer testing gas in the collar of the upcast shaft.

The seal in the concrete portal of the transport tunnel was completed at approximately 11 a.m. The seal in the main haulage tunnel required considerable preparation and was not completed until approximately 4 a.m. The final bricks of this seal were set by workmen wearing self-contained breathing apparatus because of the smoke and high concentration of carbon monoxide issuing past the seal killing one canary.

Work then began to complete the seal over the upcast shaft by covering the planks with brattice and applying 6 inches of loam. When this was completed, the fan was stopped. The time was 5 a.m. on 22nd December, 1963.

Except for periodical inspection of the seals, the area remained sealed with the hastily erected single seals until 7 a.m. on 23rd December, 1963 when work began to erect additional seals in the two tunnels and the fan drift. This work was completed on Christmas Day.

Samples of the atmosphere from the sealed openings of the tunnel were regularly obtained and analysed and are shown in Appendix (2).



Seal over upcast shaft. (24th December, 1963.)

RECOVERY OPERATION

Two methods for the recovery of the No. 1 Tunnel of Bellbird Colliery were considered. The first method was to re-open the Colliery and re-circulate fresh air by the normal ventilation system. A large team of workmen would then be used to transport materials into the mine and erect seals around the goaf edge in the least possible time.

This method was not endorsed by the Department of Mines on the grounds that the fire would be quickly re-generated and possibly result in injury to workmen.

The second method which was finally adopted, was the gradual recovery of the Colliery in stages using self-contained breathing apparatus.

The Colliery Management made arrangements to hire "Proto" self-contained breathing apparatus and auxiliary equipment from the South Maitland Mines Rescue Station. A special room was made available at the Colliery for storage and servicing of the equipment.

An appeal to neighbouring collieries to release trained personnel met with a ready response and sufficient volunteers to form three teams of seven were made available. One trainee was employed fully on the maintenance and servicing of equipment.

As a result of a number of experiments conducted on the surface with urethane rigid foam as a sealing medium, it was resolved to use the material wherever practicable. It was realised that the erection of some seals with bricks and mortar would be laborious for workmen in self-contained breathing apparatus, because of the size and awkward location of the seals. It was decided that at these locations, temporary seals, consisting of masonite attached to a substantial wooden frame, would be erected. The spaces between the sheets, and around the edges, would be sprayed with urethane rigid foam. These seals would be replaced later, immediately after the restoration of fresh air, by substantial brick seals adjacent to them.

The first inspection was made of the sealed No. 1 Tunnel on the 24th January, 1964 by members of the South Maitland Mines Rescue Corps, using self-contained breathing apparatus. Entry was made through an air-lock in the transport tunnel and smoke was encountered about 50 yards from the air lock and visibility at some locations was estimated to be about 30 yards. A sample of the sealed atmosphere obtained 350 yards from the air lock, resulted—

CO ₂	6.06
O ₂	1.85
CO	0.053
CH ₄	0.46
H ₂	n/d.
N ₂	91.58
CO/O ₂ Ratio	0.24

After obtaining this sample the inspection party returned to the surface.

The work of reclamation began on 10th February, 1964 by trained personnel, using self-contained breathing apparatus, divided into three teams of seven or eight men depending on the availability of some casual daily recruits. It was arranged that while one team was working in the irrespirable atmosphere, another was acting as a standby at the fresh air base to cover any emergency while the third team was resting and servicing their equipment at the surface. Work began each day at 7 a.m. and normally ceased at 5 p.m. so that, on any one day, two teams spent two periods of two hours performing recovery work and one team spent only one period on recovery work. In this way each team received a "spell" each third day. A six-day week was normally worked.

The first task was the cleaning of coal from the transport road and the erection of timber, where necessary, for a distance of 500 yards. The transport system was then commissioned and used for the carriage of workmen and materials.

Daily samples of the sealed atmosphere were obtained for analysis and the results are shown in Appendix (3).

The first stage of the reclamation consisted of the erection or repair of the following seals, numbered 1 to 18, reference being made to the attached plan.

- Seal No. 1 New brick seal erected 8 in. thick, and then plastered.
- Seal No. 2 Existing brick overcast sprayed with urethane rigid foam.
- Seal No. 3 Existing stopping received slight repairs and sprayed with urethane rigid foam.
- Seal No. 4 New brick seal erected 8 in. thick and sprayed with urethane rigid foam.
- Seal No. 5 Existing stopping repaired and sprayed with urethane rigid foam.
- Seal No. 6 Temporary timber-framed structure covered with masonite and sprayed with urethane rigid foam.
- Seal No. 7 Existing stopping plastered.
- Seal No. 8 New brick seal erected 8 in. thick. The upper five feet of this seal was constructed with vermiculite bricks to reduce effort by reclamation teams.
- Seal No. 9 New brick seal erected 8 in. thick.
- Seals Nos. 10, 11 and 12. Existing stoppings.
- Seals Nos. 13 and 14. Existing stoppings sprayed with urethane rigid foam.
- Seal No. 15 Existing overcast.
- Seal No. 16 Existing air lock—doors plastered.
- Seals Nos. 17 and 18. Existing stoppings.

By means of 32 in. diameter contra rotating fan installed in the portal of the main haulage tunnel, fresh air was restored to the area of the colliery isolated by the seals 1 to 18 on the 20th February, 1964.

A brick seal was immediately erected outbye of the temporary structure at location No. 6. A door was set into the lower section of this seal to form an air lock with the inbye masonite/timber structure and capable of allowing the transport system to pass through it.

The second stage of the reclamation began on 22nd February, 1964. The transport road was cleaned to the return wheel and a number of preliminary inspections made. As the condition of the mining equipment was found to be satisfactory and suitable locations for seals available around the goaf edge, it was decided to erect these seals immediately and dispense with an intermediate stage originally planned.

This second stage consisted of the erection of the following seals lettered A to K, reference being made to the attached plan:—

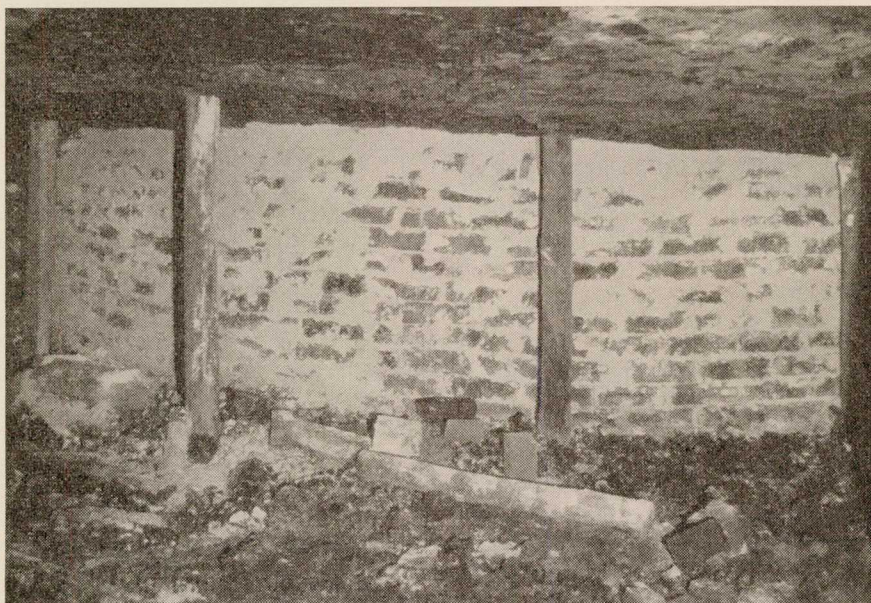
- Seals A, C, D and F. New brick seals 8 in. thick.
- Seal B Existing brick stopping 8 in. thick.
- Seal E New brick seal under existing overcast.

- Seals G, H and I. New seals of masonite and brattice secured to a timber frame and sprayed with urethane rigid foam.
- Seal J Existing brick seal repaired.
- Seal K This seal site was almost inaccessible due to extensive falls of top coal and stone. A stowed pack of stone and fine coal was constructed under a remaining bridge of top coal at this location to relieve the reclamation teams of the arduous task of carrying bricks and mortar to the location.

Photographs of some of these seals form part of this report.

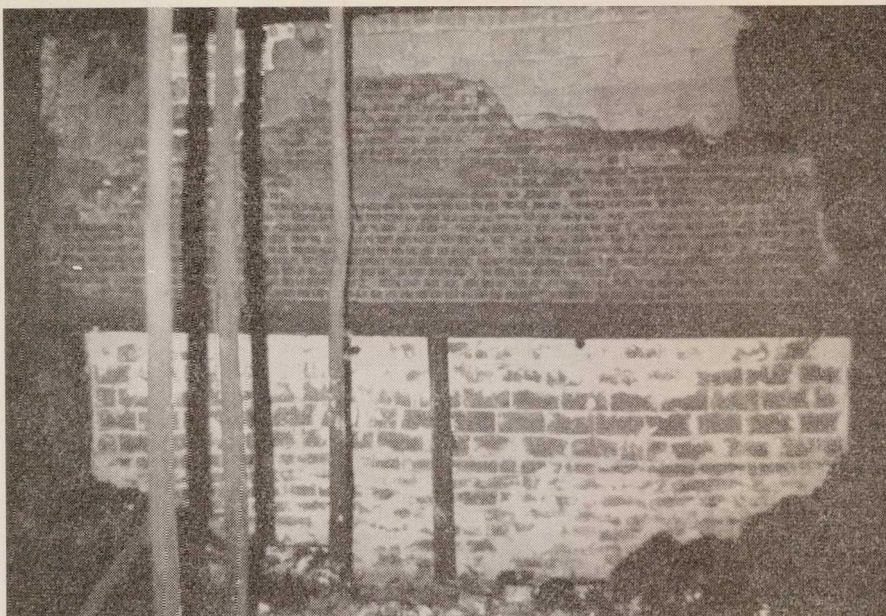
During the second stage, the fan, operating in the main haulage tunnel, was stopped each day when work ceased and the tunnels were sealed.

At 6 a.m. on the 11th March, 1964 the seals 6 and 8, located respectively in the transport tunnel and the haulage tunnel, were breached in addition to the seals in the fan drift, after which ventilation was restored to the colliery by the colliery fan.

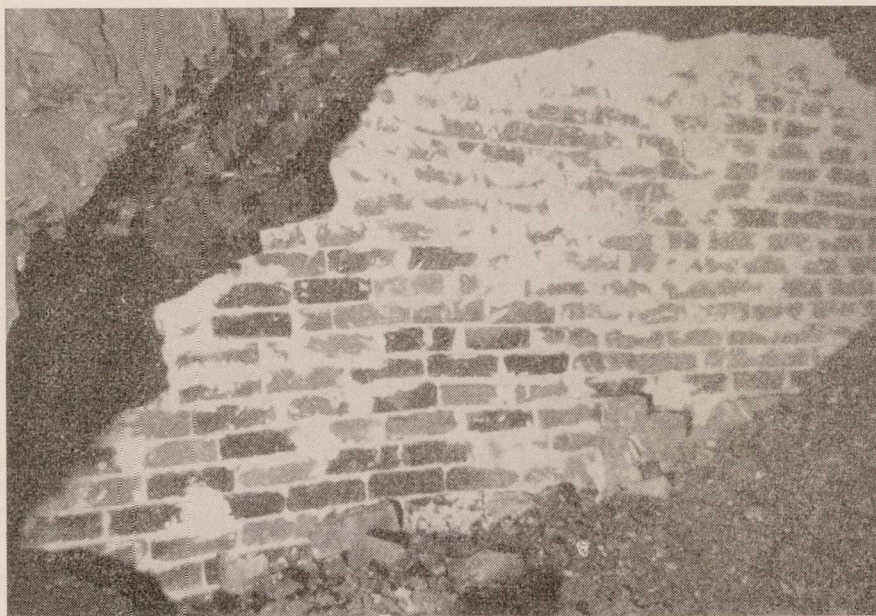


Seal at C. (11th March, 1964)

An inspection after the sealed atmosphere had cleared, revealed that a large fall of top coal had occurred outbye of seal A but the seal appeared to be intact. The temporary masonite seal H was warm over its entire surface and estimated to be about blood temperature. The remaining seals appeared to be satisfactory apart from minor repairs which were immediately attended to. It was observed that the main effect of the fire was located outbye of the seals H and I. Props were found to be charred completely through, trailing cables of mining equipment were burnt; shuttle car tyres appeared charred; coke was found at some rib sides; the floor of the roadways was littered with 18 inches of small coal covered with distillates which had also been deposited on the roof.



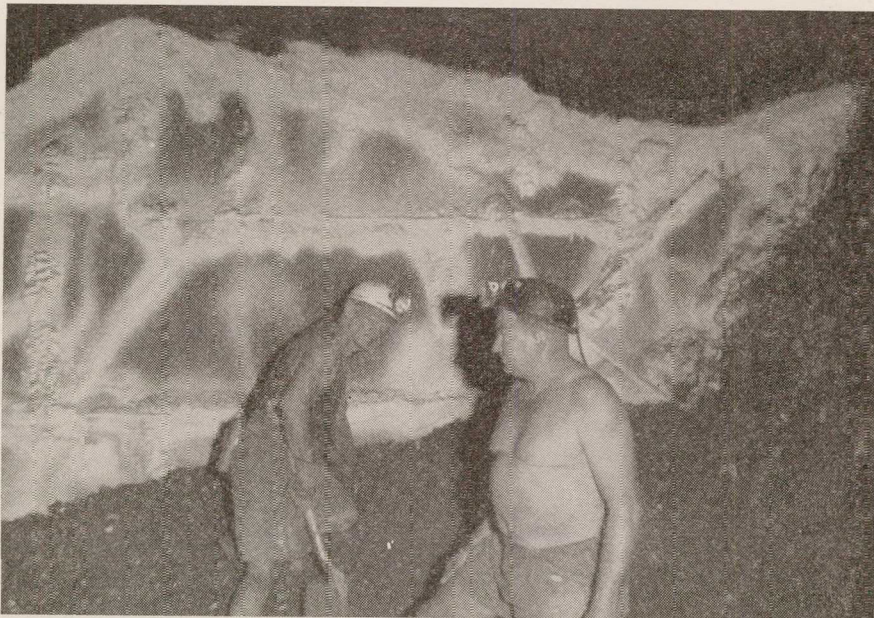
Seal at E under overcast. (11th March, 1964)



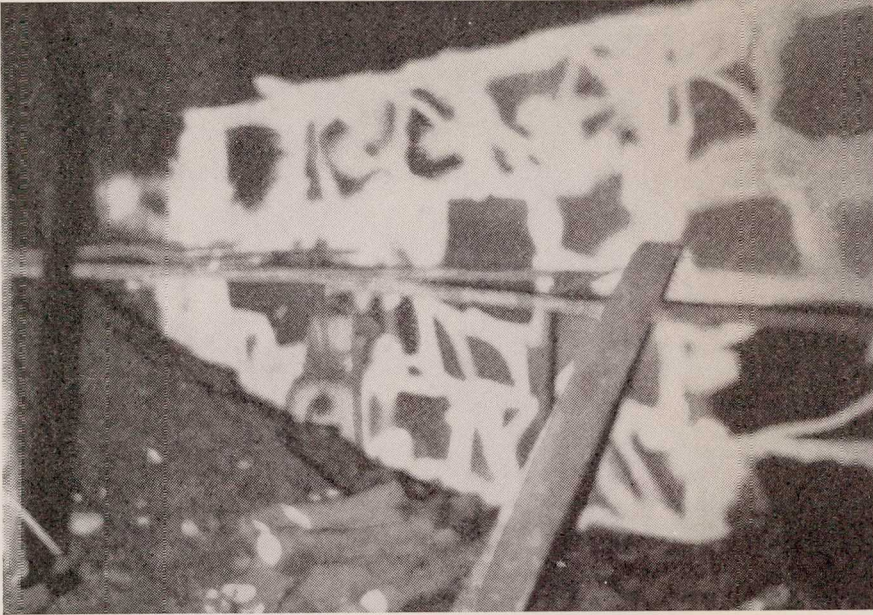
Seal at F. (11th March, 1964)



Seal at G. (11th March, 1964)



Seal at H. 11th March, 1964)



Seal at I. (11th March, 1964)



Seal at J. (11th March, 1964)



Stowage pack at K. (11th March, 1964)

All the reclamation personnel began work to erect a 16 in. brick seal outbye of temporary seal H. This involved the transport of bricks and mortar, the removal of 6 ft. of loose coal to expose the seam floor and the laying of the concrete blocks. When work ceased at 5 p.m. that day, about one-quarter of the bricks necessary for the 12 ft. high seal had been set.

The colliery fan was stopped at 5 p.m. on the 11th March, 1964 and the mine sealed. The fan was re-started at 5 a.m. the following day and, after a pre-inspection, work commenced at 7 a.m.

During the day, the stowed pack at location K was supplemented with additional material and covered with stone dust. This seal was observed to be leaking when completed but was not considered to be excessive. Work also continued with the brick seal at H and when work ceased for the day, was within 2 ft. of the roof. The temporary masonite seal H remained at approximately blood temperature, and during the day a sulphur smell was detected and attributed to the dust in suspension caused by the workmen in this vicinity.

A sample of the sealed atmosphere was drawn from a pipe in Seal B at approximately 10.30 a.m. and resulted—

CO ₂	5.31
O ₂	3.55
CO	0.0012
CH ₄	0.16
H ₂	n/d.
N ₂	90.98

Work ceased at 5 p.m. due to the physical exhaustion of the workmen.

It was decided to keep the fan in operation and carry out frequent inspections of the fan drift. During the day the west return airway had been completely closed off with brattice to provide more ventilation to the region where workmen were engaged. This brattice was left in position when work ceased.

An inspection of the fan drift at 6.15 p.m. revealed conditions to be unchanged. At 7.45 p.m. smoke was found to be issuing from the fan drift. An official attempted to inspect the colliery workings but was stopped by smoke at a point 500 yards down the main haulage tunnel and 200 yards down the transport tunnel. In the absence of the Manager and other senior officials, the colliery fan was stopped at approximately 8 p.m. The fan was re-started at 8.25 p.m.

By 9 p.m. dense volumes of black smoke were issuing from the fan drift. Work was proceeding to lay the 120 concrete blocks required to seal the main haulage tunnel. This completed, it was intended to stop the fan and temporarily seal the remaining openings by closing wooden doors.

At approximately 9.50 p.m. an occurrence took place which can best be described as a windblast. Observers' estimates of the duration of the blast vary between ten and 20 seconds.

The visible effects of the blast were as follows:—

- (a) One workman lifted bodily and carried a short distance, fractured several ribs during his fall. A number of other workmen suffered from a mild shock.
- (b) The portal of the transport tunnel was littered with dust, broken pieces of masonite and timber.
- (c) A small hole appeared on the surface over the transport tunnel road, about 40 yards from the portal.
- (d) The top of the fan drift (the removeable cover) was completely blown off.
- (e) The partly erected seal in the haulage tunnel was blown down.

The ventilation fan was stopped immediately after the blast occurred. The main haulage tunnel mouth was filled with loam, by means of a bulldozer. The undamaged wooden doors in the transport tunnel were closed and bricks erected against them. Planks were placed across the upcast shaft then covered with brattice, galvanised iron and loam.

The re-sealing of the colliery was completed at approximately 12.15 a.m. on 13th March, 1964.

More effective seals were later provided in each of the openings to the tunnel.

An inspection of the tunnel was made on 31st March, 1964 using self-contained breathing apparatus. Damage observed mainly concerned the recently erected brickwork, and was as follows, reference being made to the accompanying plan:—

Seal No. 1	Completely blown down.
Seal No. 2	Overcast appeared intact.
Seal No. 3	Intact.
Seal No. 4	Completely blown down.
Seal No. 5	Old portion intact—new brickwork blown down.
Seal No. 6	Completely blown down.
Seal No. 7	Intact.
Seal No. 8	Portion previously remaining completely blown down.

A subsequent inspection revealed seal No. 9 to be completely blown down and the remaining seals to be intact. The small arrows on the plan indicate the direction of the blast at each seal.

Work began immediately to restore these damaged seals and was completed by the recovery team on 5th April, 1964 organised in the same way as for the previous operation, with the exception that all seals were now in concrete blocks.

Fresh air was restored to the upper section of the No. 1 Tunnel on 6th April, 1964. An inspection of the lower section followed using self-contained breathing apparatus and revealed—

Seals A, B and C.	Intact.
Seal D	Completely blown down.
Seal E	Overcast completely blown down.
Seal F	Intact and covered with soot.
Seal G	Could not be clearly seen, but appeared to be intact.
Seal H	No trace of original masonite/urethane seal. Outbye brick seal visible. Evidence of second fall of 12 in. to 18 in. coal probably due to second fire.

A large heap of top coal at the intersection outbye of the seals G and H was giving off a small quantity of white smoke. It was impossible to hold a piece of coal from the surface of this heap in the hand. Roof conditions generally, in this area showed signs of deterioration with one major fall up into the stone.

The inspection party proceeded no further than this point as it was considered unsafe. The seals J and K were not inspected.

As a result of this inspection, it was decided that the recovery of the mining equipment was now not reasonably practicable. Work commenced to erect 16 in. concrete brick seals at locations D, L, M, N, O and P using self-contained breathing apparatus.

These seals D to P were completed on 4th May, 1964 in addition to a stowed pack against seal A intended to support the top coal above Seal A. Fresh air was restored to the lower section of the Colliery at 1 p.m. the same day after inspections of the East and West return airways had been made.

The following precautions were now observed so that any irregularity might be detected.

- (a) The reclamation corps was divided into three teams and allotted to each eight hour shift. These teams worked under fresh air conditions but maintained self-contained breathing apparatus nearby, ready for use if an emergency developed.
- (b) The team on shift was relieved at the seals so that at no time were the seals unattended.
- (c) The leader of each team was a qualified deputy who inspected all the seals at least once each hour.
- (d) Samples of the atmosphere within the sealed area were obtained each morning and afternoon for analysis (see Appendix 3).
- (e) The fan attendant would inspect the fan drift at the surface at least each hour.

During the week 4th to 8th May, 1964 the reclamation corps erected the Seals A1, B1, C1 and C2 in 8 in. brickwork, as seals A and B were not considered reliable due to the proximity to the goaf. A number of other seals were also plastered.

The reclamation corps ceased work on 8th May, 1964 when the task of preparing the No. 1 Tunnel for production was commenced by the normal colliery employees. Production resumed on 14th May, 1964.

CONCLUSION

The origin of the fire is in doubt. Its rapid development during the afternoon of the 21st December, 1963 suggests that some goaf movement after 10 a.m. that day was responsible for the breaching of a barrier or seals isolating an active heating. If this damage permitted a large quantity of air to pass over the active heating a fire would soon develop. Assuming this to be the case then the 9 West sealed area is the most likely origin, although there is no definite evidence to suggest this. During the time required to seal the colliery the fire would quickly become established and advance across the fallen coal and finally invade the workings.

The development of a heating in the goaf cannot be overlooked. However, from past experience of the occurrence of spontaneous combustion in the Greta Seam, the short period of development from the slight traces encountered up until the last inspection at 10 a.m. on the 21st December, 1963 tends to rule out this possibility to some extent.

The second outbreak of fire appears to have been a reactivation of the original conflagration. Evidence of heated coal was apparent in the vicinity of the temporary seal H and it is likely that a fire could have developed at this point and consumed the temporary seal. It is also likely that a small fall in the goaf area may have resulted in the breaching of two or more temporary seals. These seals were about 25 feet wide and 18 feet high and prone to such damage. The resultant air circuit would easily reactivate the fire.

The windblast effect observed during re-sealing operations on 12th March, 1964 could be accounted for by an ignition of distilled gases or a major goaf fall.

A piece of charred P.V.C. covered signalling cable was obtained in the transport tunnel about six chains from the Seal L and the temperature/time relationship determined to achieve the degree of charring. A sample of carbonaceous material deposited on props in the vicinity of seals, D, L, M, and N was also analysed. These results are shown in Appendix IV.

The ultimate reclamation of the colliery reflects credit on the management and organisation of the recovery operation, and all personnel who participated in the work. The initial failure in no way reflects on the efforts of those concerned, as an element of speculation with regard to the recovery of the equipment existed when the operation began.

REFERENCES

- (1) Department of Mines, N.S.W. *Annual Report*, 1923, Page 59. *Annual Report*, 1924, Page 58.
- (2) Department of Mines, N.S.W. *Bellbird Colliery*. A history of the events leading to an ignition of inflammable gases during the attempted recovery of a district previously sealed because of a spontaneous heating—R. A. Menzies, Inspector of Collieries.

APPENDIX 1

ANALYSIS OF SAMPLES FROM 9 WEST DURING 1963

Date	CO ₂ per cent.	O ₂ per cent.	CO per cent.	H ₂ per cent.	CH ₄ per cent.	N ₂ per cent.	CO/O ₂ ratio	Remarks
								N.B.—Samples were taken at weekly intervals. Sufficient results are given to indicate the general trend.
14-1-63	10.88	3.47	0.52	n/d.	3.06	82.07	2.84	
22-2-63	10.62	2.24	0.28	0.04	2.00	84.82	1.38	
14-3-63	9.79	2.17	0.18	0.05	1.58	86.23	0.87	
10-4-63	10.09	3.13	0.28	0.04	1.29	85.17	1.44	
16-5-63	9.38	3.03	0.46	0.10	1.60	85.43	2.35	
20-6-63	10.52	2.56	0.39	0.06	1.38	85.08	2.00	
18-7-63	10.65	2.99	1.04	0.55	2.55	82.52	5.53	
14-8-63	7.54	1.53	0.06	0.11	1.74	89.02	0.28	
19-9-63	8.93	1.41	0.01	n/d.	0.15	89.50	0.05	
10-10-63	3.26	8.89	0.01	n/d.	0.10	87.74	0.09	Sample pipe became inaccessible.
31-10-64	0.47	19.98	n/d.	n/d.	n/d.	79.55	nil	West return airway samples.
14-11-64	0.53	18.28	n/d.	n/d.	0.03	81.16	nil	West return airway samples.
21-11-64	0.78	18.38	0.01	n/d.	0.07	80.77	0.24	West return airway samples.
4-12-64	1.24	18.84	n/d.	n/d.	n/d.	79.92	nil	West return airway samples.
12-12-64	0.29	20.22	n/d.	n/d.	n/d.	79.49	nil	West return airway samples.

APPENDIX 2

ANALYSIS OF SAMPLES OF SEALED ATMOSPHERE TAKEN FROM TRANSPORT HEADING
AT THE SURFACE AFTER THE OCCURRENCE

Date	CO ₂ Per cent.	O ₂ Per cent.	CO Per cent.	H ₂ Per cent.	CH ₄ Per cent.	N ₂ Per cent.	CO/O ₂ Ratio	Remarks
				Transport Heading				
23-12-63	6.27	4.10	2.03	2.37	3.07	82.16	11.49	
24-12-63	5.66	4.37	1.62	1.42	3.23	83.70	9.16	
27-12-63	5.16	2.73	1.20	0.58	2.87	87.46	5.87	
7-1-64	4.98	1.70	0.46	0.06	0.86	91.94	2.04	
8-1-64	5.01	2.66	0.20	n/d.	0.91	91.22	0.93	
9-1-64	5.28	2.66	0.38	n/d.	0.88	90.80	1.78	
10-1-64	5.53	2.69	0.12	n/d.	0.86	90.80	0.56	
20-1-64	3.12	9.13	0.04	n/d.	0.35	87.36	0.29	High barometric pressure.
21-1-64	1.04	18.25	0.003	n/d.	0.13	80.58	0.08	High barometric pressure.
22-1-64	4.74	6.37	0.05	n/d.	0.39	88.45	0.31	High barometric pressure.
23-1-64	3.65	2.29	0.06	n/d.	0.24	93.76	0.25	
23-1-64	1.32	16.93	0.01	n/d.	0.07	81.68	0.02	High barometric pressure.
31-1-64	0.20	1.49	0.01	n/d.	0.53	91.77	0.05	Recovery operations began 10th February, 1964. Tunnels re- sealed at surface on 12th March, 1964 due to outbreak of fire.
13-3-64	4.83	10.76	1.00	0.06	2.00	81.35	9.27	
16-3-64	6.22	4.96	1.27	0.09	1.90	85.56	7.17	
17-3-64	7.01	3.55	1.00	0.08	1.82	86.54	5.16	
18-3-64	6.66	3.51	1.04	0.08	1.32	87.39	5.30	
19-3-64	6.97	2.38	0.80	0.10	1.08	88.67	3.79	
20-3-64	2.34	14.32	0.18	0.04	0.40	82.72	2.34	High barometric pressure.
23-3-64	7.06	1.67	0.51	0.10	0.69	89.97	2.30	
26-3-64	0.49	20.18	0.01	n/d.	n/d.	79.33	0.11	At 12.30 noon, high barometric pressure.
26-3-64	0.72	19.61	0.01	n/d.	n/d.	79.66	0.42	At 3.30 p.m., high barometric pressure.
27-3-64	0.92	18.71	0.01	n/d.	0.08	80.28	0.31	High barometric pressure.
29-3-64	4.00	3.62	0.11	0.09	0.41	91.77	0.54	
30-3-64	7.02	1.81	0.09	0.06	0.51	90.51	0.41	
31-3-64	6.59	2.42	0.10	0.05	0.45	90.40	0.41	Recovery operations resumed.

APPENDIX 3

ANALYSIS OF SAMPLES OF SEALED ATMOSPHERE TAKEN BY RECOVERY PERSONNEL

Date	CO ₂ per cent.	O ₂ per cent.	CO per cent.	H ₂ per cent.	CH ₄ per cent.	N ₂ per cent.	CO/O ₂ ratio	Remarks	
12-2-64	6.34	2.55	0.001	N O T	0.40	90.71	0.06	Fresh air restored 11th March, 1964. Sample of sealed atmosphere from pipe in seal B.	
20-2-64	5.57	4.80	0.002		0.30	89.33	0.01		
24-2-64	6.00	3.54	0.003		0.19	90.27	0.02		
25-2-64	5.52	4.41	0.003		0.17	89.90	0.02		
26-2-64	5.68	4.83	0.005		0.30	89.19	0.03		
27-2-64	6.19	4.54	0.01		0.23	89.03	0.07		
28-2-64	5.47	5.55	0.01		0.21	88.76	0.05		
2-3-64	5.17	5.56	0.01		0.20	89.06	0.04		
3-3-64	5.20	4.93	0.01		0.22	89.64	0.08		
4-3-64	5.79	4.22	0.01		0.21	89.77	0.07		
5-3-64	5.65	4.64	0.01		0.17	89.47	0.05		
6-3-64	5.77	4.85	0.01		0.18	89.14	0.03		
10-3-64	4.97	7.25	0.001		0.15	87.63	0.08		
11-3-64	6.20	3.44	0.001		0.21	90.15	0.05		
12-3-64	5.31	3.55	0.001		0.16	90.98	0.06		
1-4-64	6.81	1.25	0.07		0.44	91.43	0.31		Insufficient sample to determine CO percentage.
2-4-64	7.18	1.66	0.05		0.46	90.65	0.24		
3-4-64	7.34	1.34	0.04	0.44	90.84	0.17			
6-4-64	7.35	1.11	0.00	0.44	91.10	..			
7-4-64	6.70	1.84	0.01	0.37	91.08	0.05			
8-4-64	7.02	1.83	0.01	0.36	90.78	0.03			
9-4-64	6.67	3.07	0.002	0.35	89.91	0.01			
10-4-64	6.69	3.75	0.001	0.35	89.21	0.01			
11-4-64	6.75	3.85	0.004	0.30	89.10	0.02			
13-4-64	6.72	3.66	0.007	0.31	89.30	0.04			
15-4-64	6.67	3.12	0.006	0.27	89.93	0.03			
16-4-64	6.70	3.57	0.005	0.29	89.43	0.03			
17-4-64	6.89	2.70	0.006	0.31	90.09	0.03			
20-4-64	6.67	3.19	0.002	0.27	89.87	0.01			
21-4-64	6.55	3.54	0.003	0.31	89.60	0.02			
22-4-64	6.90	2.51	0.002	0.29	90.30	0.009			
23-4-64	6.86	2.48	0.001	0.30	90.36	0.004			
24-4-64	7.37	2.59	n/d.	0.29	89.75	nil			
27-4-64	6.71	4.14	0.001	0.30	88.85	0.004			
28-4-64	6.74	4.30	n/d.	0.24	88.72	0.004			
29-4-64	6.49	5.01	n/d.	0.27	88.23	nil			
30-4-64	6.18	5.29	n/d.	0.20	88.33	nil			
1-5-64	5.81	6.34	n/d.	0.21	87.64	nil			
5-5-64	6.98	2.41	0.001	0.27	90.34	0.004			
6-5-64	7.03	2.07	0.001	0.28	90.62	0.005	Fresh air restored 4th May, 1964. From sample pipe in seal M. (Pipe 100 ft. long.)		
7-5-64	6.70	2.76	n/d.	0.28	90.21	nil			
8-5-64	6.56	3.53	n/d.	0.19	89.72	nil			
11-5-64	6.18	4.00	0.002	0.26	89.56	0.01			
12-5-64	6.59	3.71	0.002	0.26	89.44	0.01			
13-5-64	6.26	3.61	0.002	0.21	89.92	0.01			
14-5-64	6.51	2.97	0.003	0.23	90.29	0.02			

APPENDIX 4

REPORT ON SAMPLES OF COMBUSTIBLE MATERIAL AND P.V.C. COVERED SIGNALLING CABLE

by the Chief Analyst—Department of Mines

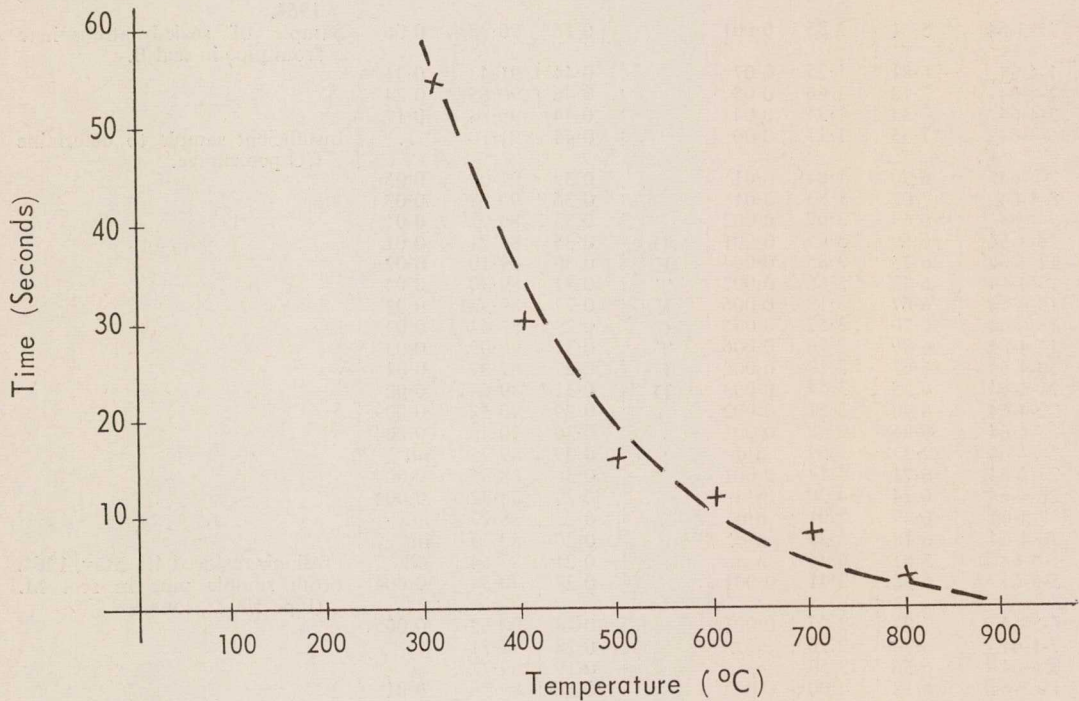
A sample of carbonaceous material obtained from Bellbird Colliery and submitted by Inspector J. Bailey has been examined. The analysis gave—

Combustible Volatile Matter	..	..	..	..	..	..	..	23.4 per cent.
Ash	..	..	..	..	..	..	..	2.8 per cent.

Microscopic examination of the dust revealed some coked particles and acetane extraction produced considerable tarry matter. These results would indicate that some pyrolysis of the coal dust has taken place during the mild explosion reported.

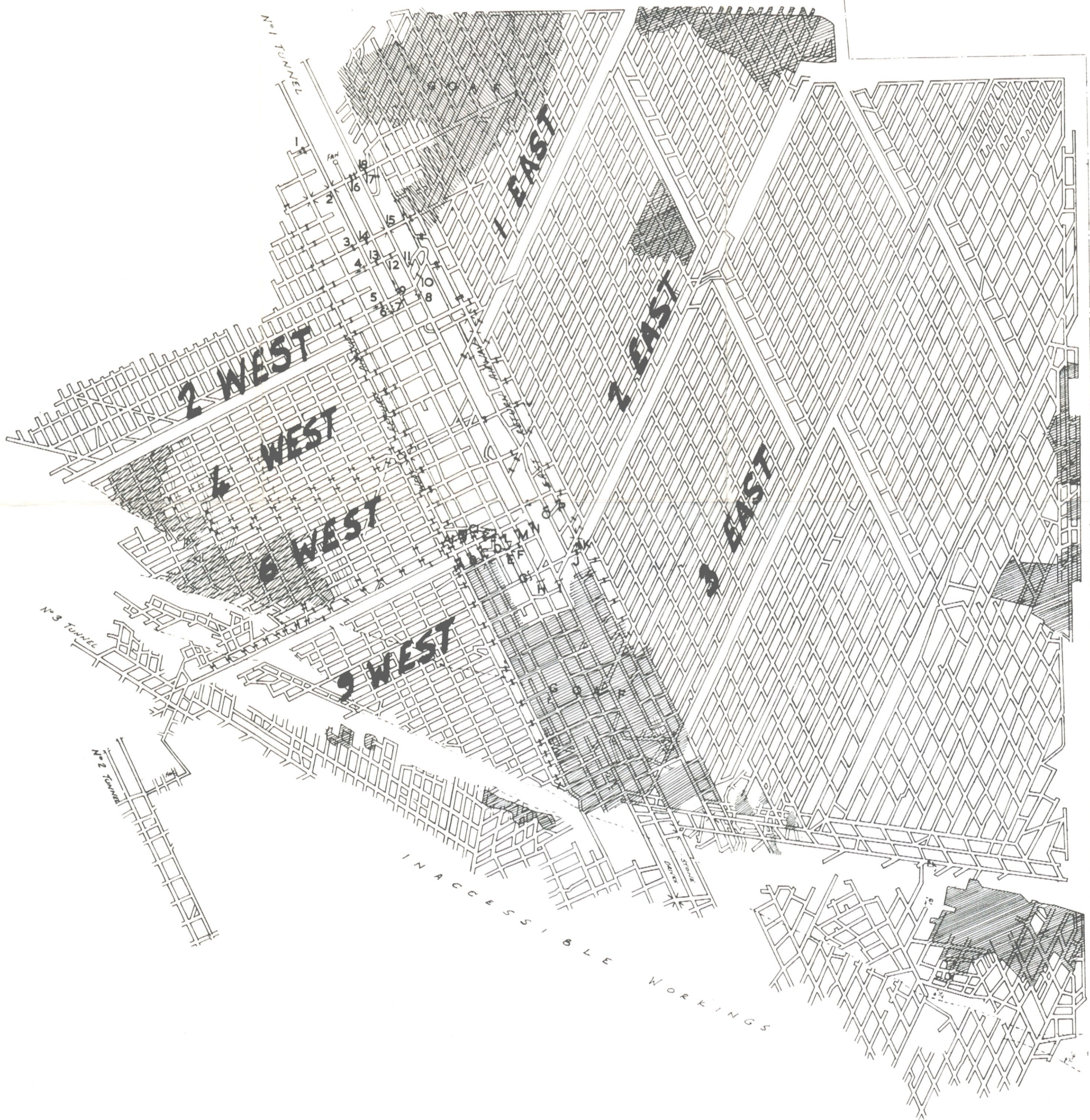
The sample of P.V.C. signalling cable insulation has been heated and the time taken to char the cable to the extent of the burnt cable, measured. A graph of the results is attached. From these results it would be seen that the cable was subjected to a temperature of at least 800° C.

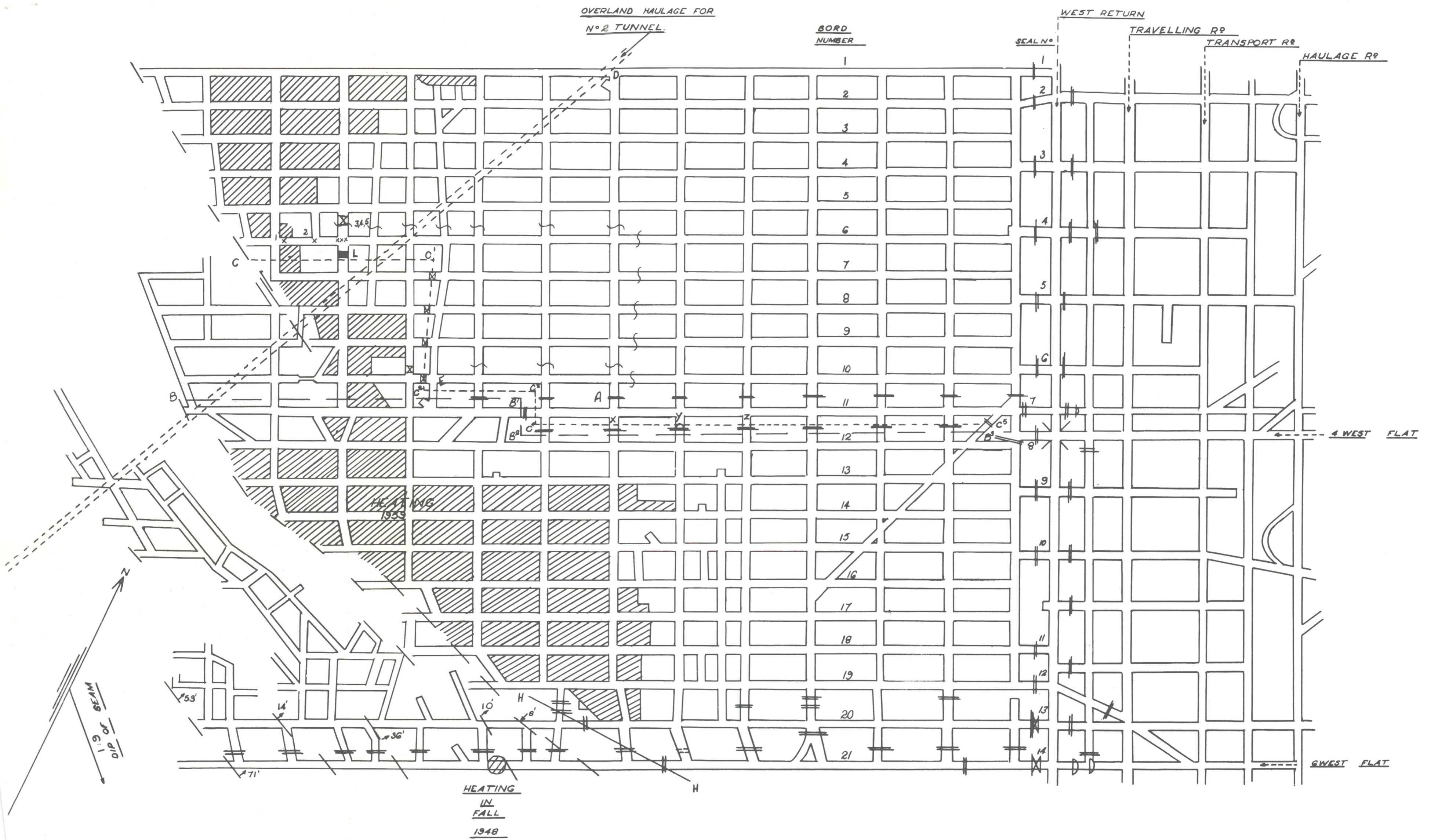
H. DONEGAN, Chief Analyst.



PLAN OF PART OF
BELLBIRD COLLIERY.

SCALE: 4 CHN = 1 INCH





BELLBIRD COLLIERY
N°4 & N°6 WEST SECTIONS N°1 TUNNEL
SCALE: 2 CHAINS = 1 INCH

