

Gold and electricity

Archaeological survey of Bullendale, Otago

P.G. Petchey

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Cover: Phoenix dynamos, 1996. Partially restored in 1986 to mark the centenary of their commissioning.
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Preface

'Very little is yet really known about electricity'

Mines Inspector commenting in 1887 on the Phoenix Company's new electric dynamos in Skippers Creek and recorded in the Appendices to the Journal of the House of Representatives (C5: 47).

In 1885-86 the Phoenix Company installed two Brush Corporation electric dynamos in Skippers Creek to drive their gold battery nearly 2 miles distant. This was the first time that hydroelectric power had been used in New Zealand to drive such an industrial plant; its use up to then being in small lighting installations. This was no mean feat, as the Phoenix Mine was one of the most remote gold mines in Otago, and road access was never more than a narrow track. All the heavy generating equipment had to be dragged along pack tracks and stream beds. The state of knowledge of electricity at the time was quite basic, and numerous problems were encountered, but the system worked.

The power plant and many of the associated sites have survived, although in a ruinous state, within what is now the Mount Aurum Recreation Reserve administered by the Department of Conservation. The dynamo site was partially restored in 1986 to mark its centenary, while the battery site is still derelict. The original electric motor is sitting a short distance away from the battery beside the old mine shaft.

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ABSTRACT

Bullendale was a small community that existed in the upper reaches of the Right Branch of Skippers Creek, near Arrowtown, Otago, New Zealand, from about 1862 until 1907. Initially called 'The Reefs', it was the home of the local gold miners and their families. In 1866 a total of 13 mining companies were working the local reefs, but by 1889 the whole field was held by the Phoenix Mining Company, owned by George Bullen after whom Bullendale was named. In 1884 the Phoenix Company made the decision to drive their stamper battery using hydroelectric power generated by two dynamos in the Left Branch of Skippers Creek, with a power line running over the intervening Southberg Spur. The equipment started operation in February 1886. It was the first industrial use of hydroelectric power in New Zealand, and there was a great deal of interest in the operation at the time. The mine closed for the last time in 1907, but its remote and rugged situation prevented the removal of much of the heavy equipment. Importantly, the original 1885 dynamos and electric motor were left on site. The centenary of the commissioning of the power plant was celebrated in 1986, and the dynamos were restored to their original positions. In 1996 an archaeological survey was carried out, recording the whole mine system in some detail, and revealing that the original electric motor had survived. This report presents the results of the 1996 survey, with some more recent (2002, 2005) research and observations.

Keywords: Bullendale, Skippers Creek, Shotover River, Otago, New Zealand, gold mining, hydroelectric power

1. Introduction

Bullendale was the name of a small settlement in the headwaters of Skippers Creek, a tributary of the Shotover River, Otago, New Zealand. It existed solely to service several gold mines, of which the Phoenix Mine (later known as the Achilles Mine, after a change in ownership) was the largest and longest lasting. This archaeological survey of Bullendale and the associated gold mines was commissioned by the Department of Conservation in 1996. It was a response to the potential threat that modern gold mining exploration posed to the historic sites in the area in the mid-1990s, as well as the need to formulate a management programme for the historic remains.

Bullendale is located within the Mount Aurum Recreation Reserve near Queenstown (Fig. 1). The general area is being increasingly utilised by the tourism industry, with the main emphasis on rafting, jetboating and bungy jumping on the Shotover River. The Skippers School and the Mount Aurum Homestead have been restored by the Department of Conservation; the former now being used as a small museum of local history. It is therefore an area with growing recreation, tourism and heritage interests.

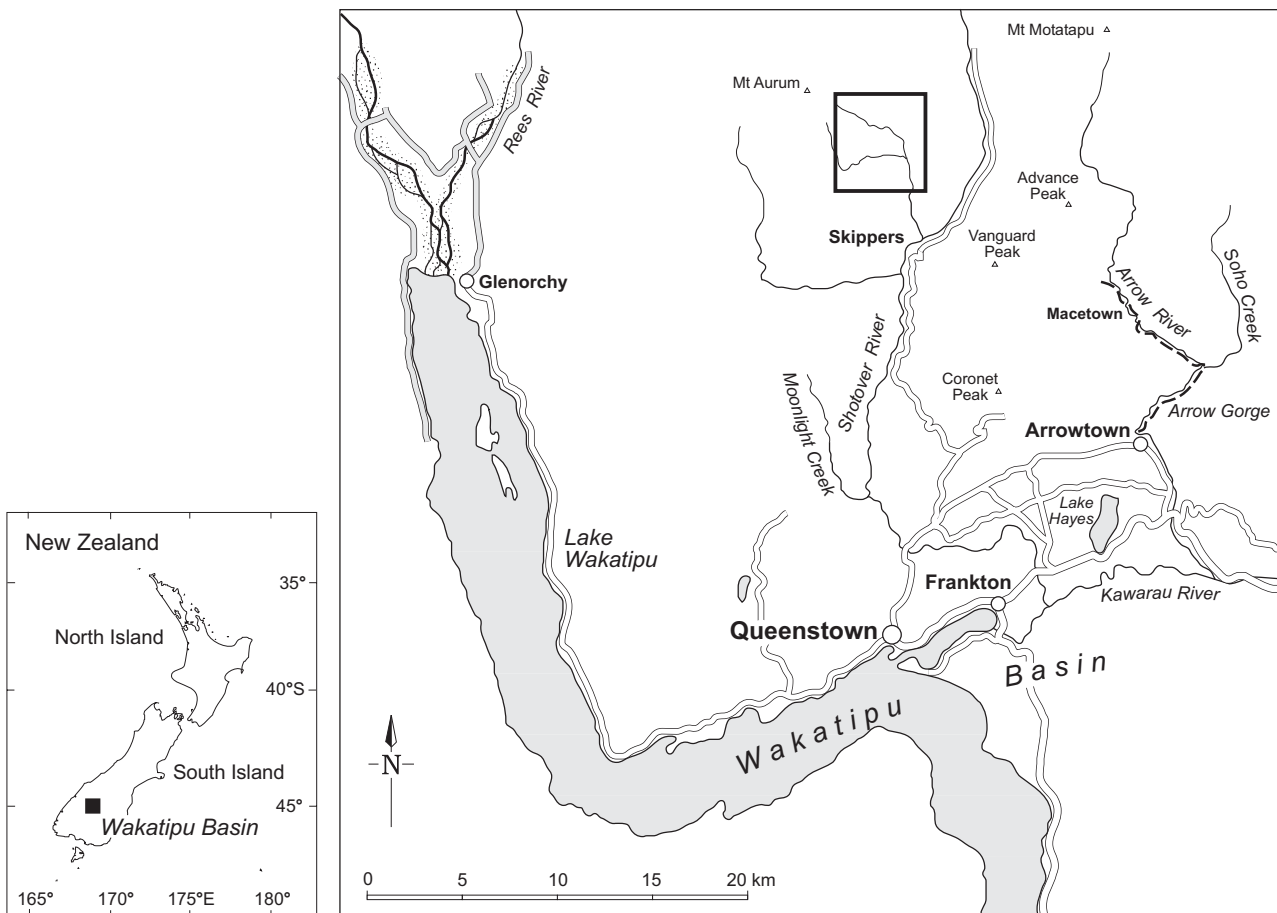


Figure 1. Map showing location of Mt Aurum Recreation Reserve and Bullendale (box—see Fig. 2) and main geographical features of the area.

The Bullendale Mine is significant because of the pioneering of hydroelectricity there in 1886 to power the battery and illuminate the underground workings. This was the first time that hydroelectric power had been used for such an industrial plant in New Zealand, and it attracted a great deal of contemporary interest.

In 1986 the dynamo site was partially reconstructed to commemorate its centenary, the surviving parts of the dynamos being mounted on replicas of the original timber support frames. The 1996 archaeological survey recorded the entire mine complex, including the reconstructed dynamos, derelict battery sites, settlement sites and mine features. In 2002 and 2005, additional visits were made to the area to reinspect some sites and note changes since the 1996 survey. The survival of so much of the overall system, including the major parts of the original dynamos and electric motor, makes this an internationally significant hydroelectric site.

2. Geographical and geological setting

Bullendale is located in the rugged country between the Richardson Mountains and the Harris Mountains in the province of Otago, New Zealand, 27 km north of the popular resort town of Queenstown. The settlement of Bullendale and the Phoenix/Achilles gold mine was situated beside the Right Branch of Skippers Creek, while the power house for the mine was beside the Left Branch of the same creek. Skippers Creek is a tributary of the Shotover River, which was the scene of some very rich gold finds in the early 1860s. The battery site, dynamo site and main geographical features are shown on NZMS 260-E40 Earnslaw (2000 edition).

Access from the Wakatipu Basin to Skippers, 6 km south of Bullendale, is by the tortuous and precipitous Skippers Road, which is itself a historic feature. Beyond Skippers there is only foot access along old farm and pack tracks and up the stream bed to Bullendale.

The highest peak close to Bullendale is Mount Aurum (2245 m), 4 km to the northeast. Between Mount Aurum and the settlement/mine site is Prince of Wales peak (1734 m). At a more local level, the mine workings and settlement site are between and on the flanks of British-American Spur and Southberg Spur, the latter separating the left and right branches of Skippers Creek (Fig. 2). Murdochs Creek runs from the flank of Prince of Wales peak into the Right Branch of Skippers Creek, and was the location of much of the mining activity.

The vegetation in the area is mainly open snow tussock (*Chionochloa rigida*) grassland, but there are a number of large stands of mountain beech (*Nothofagus solandri* var. *cliffortioides*), particularly on the south-facing slopes of Southberg Spur and along Murdochs Creek. Introduced species that were either planted by the goldminers, or have naturalised from such plantings, include poplar trees (*Populus nigra* var. *italica*) on Bakery Flat and Caspers Flat, hawthorn

(*Crataegus monogyna*) around the Phoenix Hotel site and on Caspers Flat, and mint (*Mentha spicata*) on Caspers Flat.

The following geological summary is taken from MacDonell (1992) with the author's permission:

'The Bullendale gold occurrence consists of mineralised quartz lodes within shear zones in the Aspiring Terrane of the Otago (Haast) schist belt. The lithology is characterised by strongly foliated pelitic schist with minor interbedded greenschist. The schist in this area generally dips west at about 40°.

'The Otago schist is an example of a mineralised complex collisional tectonic belt. Mineralisation was initiated during metamorphism of the sedimentary pile during the Mesozoic (225 million years ago). Extensive mineralisation occurred during uplift at all structural levels in shear zones.

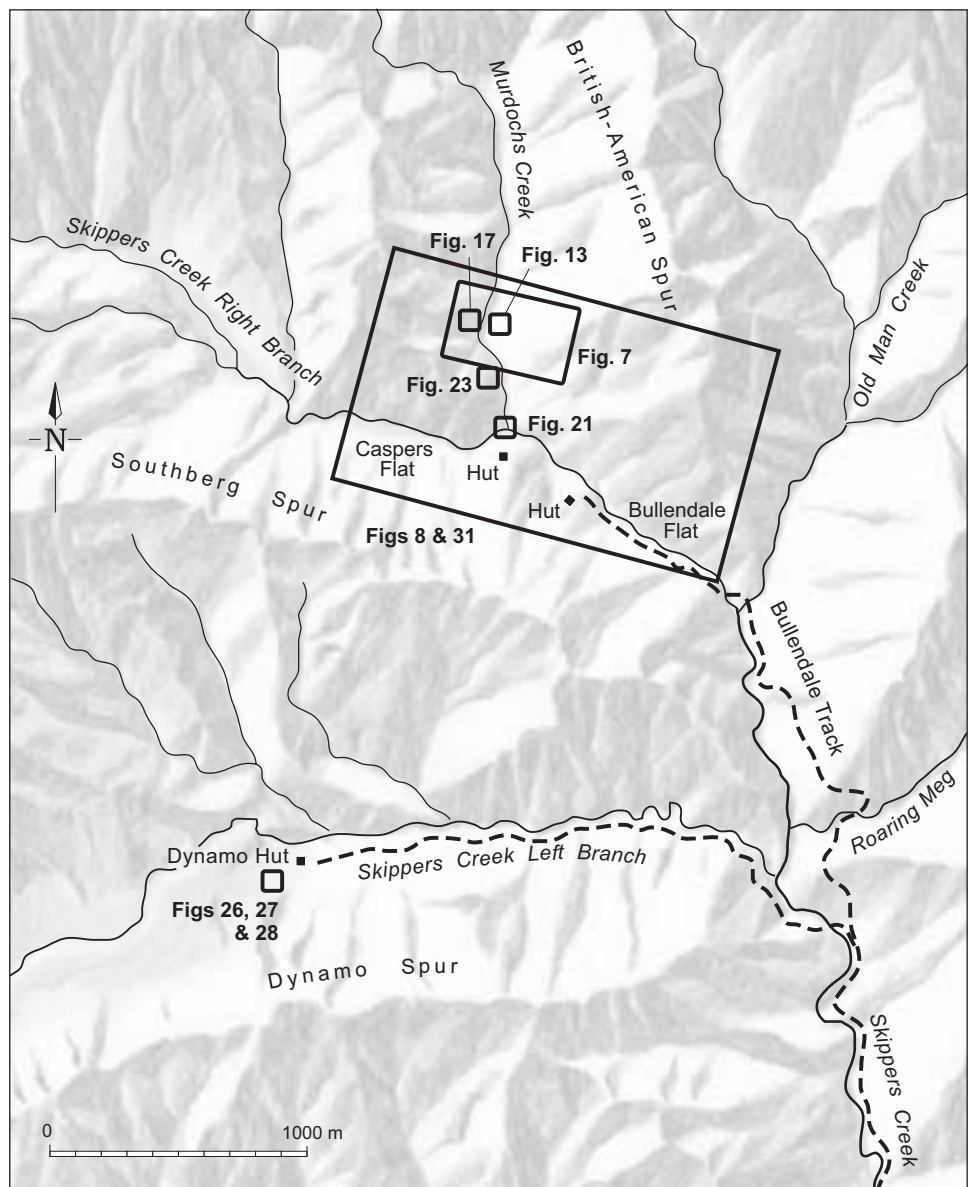


Figure 2. Bullendale, showing main geographical features and location of detailed plans that appear elsewhere in the report.

‘The shear zones at Bullendale are typically 1–3 m wide. On the No. 5 Level of the mine the lode being worked was up to 4 m wide. In the upper levels three sub-parallel lodes were recognised—North, Middle and South Lodes. These three lodes occur within a 30–35 m wide zone of deformation containing brecciated schists traversed in places by a stockwork of quartz veins. The lodes appeared to converge at depth, and at No. 6 Level the North and South Lodes were about 25 m apart (the Middle Lode was not located). The deformation and alteration envelope enclosing the three main lodes is believed to be structurally complex, in which the early miners probably missed some areas of high-grade ore.

‘The lodes are rich in iron-bearing carbonate that weathers to a characteristic orange-brown. The quartz rich material consists of partly silicified brecciated country rock, carbonate-altered quartz veins, and sulphides. The sulphide content of the ore was found to increase with depth. The gold is accompanied by pyrite and arsenopyrite, with trace chalcopyrite. Much of the gold locked up with the pyrite and arsenopyrite would not have been recovered by the gravity and mercury amalgamation processes used in the batteries of the period, and so would have been lost with the tailings.’

The complexity of the lodes and the problem with gold recovery from sulphide ores probably contributed to the eventual failure of the mines.

3. Previous archaeological and historical work at Bullendale

The majority of archaeological sites in the Skippers area were recorded by Neville Ritchie in 1979 as part of the Shotover Survey during the Clutha Valley Development archaeological programme. The Shotover Survey was never formalised into a report, but the sites recorded were entered into the New Zealand Archaeological Association’s Site Recording Scheme.

As the 1986 centenary of the commissioning of the dynamos approached, a more intensive archaeological programme focussed on the powerhouse site. In 1983, Ritchie produced a discussion document that outlined the state of knowledge regarding the dynamos, and considered various alternatives for their partial or total restoration (Ritchie 1983). In 1984 an ‘Electricity Generation Centennial’ committee was established, that made the decision to reconstruct the major elements of the Phoenix Dynamo on site. This work was preceded in 1985 by an archaeological excavation of the site that located evidence of the building that housed the dynamos (Ritchie 1985a: 208–217).

The reconstruction work at the site was undertaken in February 1986 by New Zealand Electricity Department and Lands & Survey Department staff (Dynamo Hut Log Book, Dynamo Hut, Skippers Creek). The main dynamo components were repositioned in their original context on a reconstruction of the timber framework that is known to have been used (see Fig. 3). Figure 4 shows the reconstructed dynamos in 1996.

Figure 3. Phoenix Dynamos, 1886.
Figure reproduced from Appendices to the Journals of the House of Representatives (AJHR).

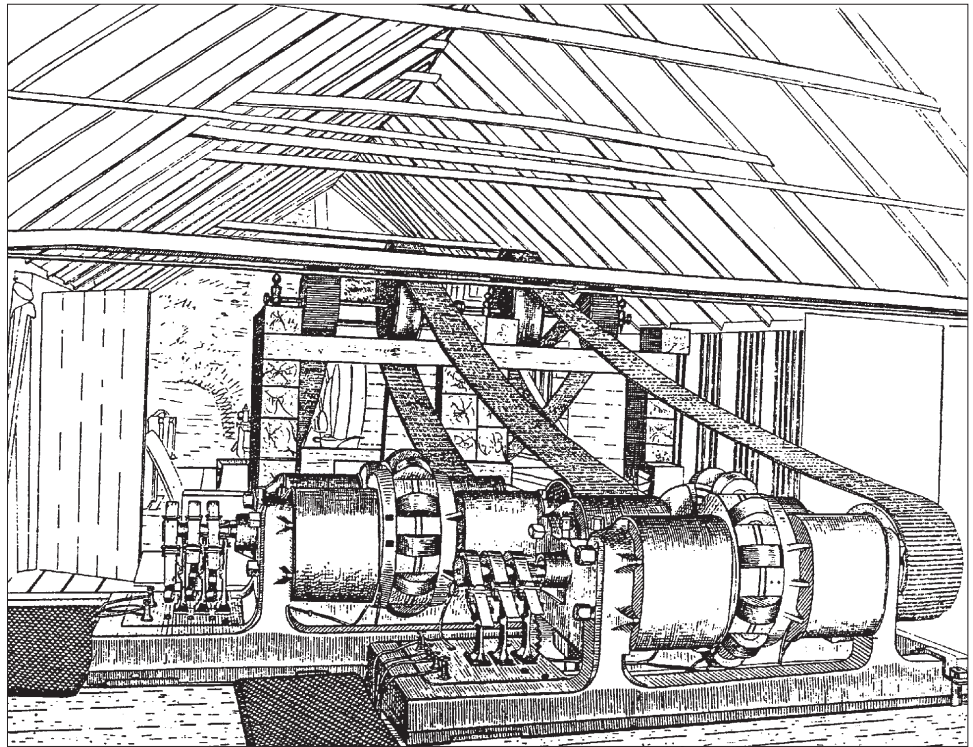
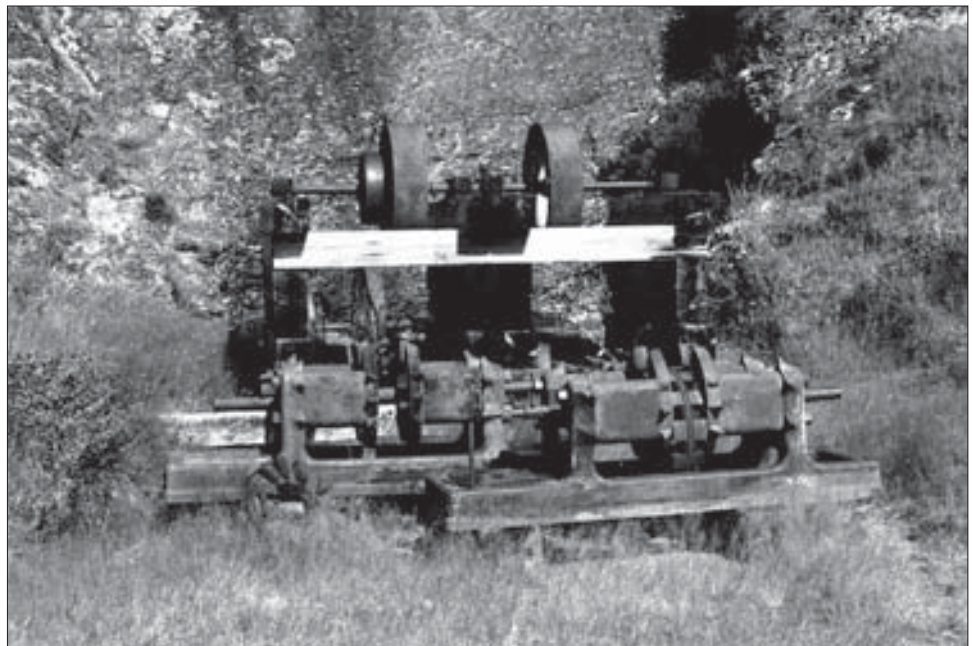


Figure 4. Phoenix Dynamos, 1996. Same perspective as Fig. 3 above. Restoration work was carried out in 1986 to mark the centenary of the commissioning of the dynamos.
Photo: P. Petchey.



Also prepared in time for the centennial of the site in 1986 was Peter Chandler's research on the Bullendale site (Chandler & Hall 1986)¹. This considered in some depth the operating history of the Bullendale mine and dynamo site, the development of electricity as a viable source of motive power and the practicalities of the operation of this pioneering hydroelectric scheme. It remains the most comprehensive account of the history of Bullendale, but did not consider the archaeology of the site. Chandler & Hall (1986) was the main source for the historic overview of the site given below (section 4).

¹ The late Peter Chandler's research notes are held by the Hocken Library Archives, Dunedin. ms 1270.

Also produced in 1986 was Alistair Jeffery's account of the site, prepared for the Ministry of Energy. This was largely a compilation work, based on the annual Mines Department reports. It was not extensively used in the preparation of this archaeological survey, as the original reports were used in preference.

A more recent published work on the history of the area is by De La Mare (1993). It is not as technically detailed as Chandler's work, but provides a good account of the history of the mine and life at Bullendale together with a good historical overview of the Shotover region.

The history and general operation of the Bullendale Mine has thus already been the subject of some intensive research. This report presents only a brief historical summary of the mine, and considers in more detail only those aspects that can now be identified archaeologically.

4. History of the Bullendale mines

This historic overview is taken mainly from Chandler & Hall (1986) and De La Mare (1993), with some details from the contemporary annual Mines Department reports published in the New Zealand Parliament's Appendices to the Journal of the House of Representatives (AJHR).

After the 1861 goldrush to the Tuapeka goldfield following Gabriel Reid's gold discovery in Gabriel's Gully, gold seekers rapidly prospected watercourses throughout Otago. Even the extremely rugged and remote nature of much of the interior failed to dent their optimism. There were a few spectacular finds, such as the 87 lb of gold recovered by Horatio Hartley and Christopher Reilly from the Dunstan Gorge (Dictionary of New Zealand Biography 1990: 178), which spurred on many other, generally less fortunate, hopefuls.

The prospectors reached Skippers Creek by December 1862. Here, the rich alluvial deposits suggested that there was a local source of gold (the proverbial 'Mother Lode'), but no reef was found until floods in July-August 1863 caused a slip which exposed an outcrop of mineralised rock near the head of the Right Branch of Skippers Creek. This was discovered by Jones, Murdoch, Southberg and Olsen (Chandler & Hall 1986: 12) and became known as the 'Scandinavian Reef'. The reef was soon traced for some distance. By 1866, Mining Surveyor Wright listed 13 companies at work on the line, with a further four on the nearby Prince of Wales Reef (AJHR 1866 D14: 3). Most of these companies did very little apart from some minor prospecting, but a few had a more permanent presence.

The Skippers Quartz Mining Co. Ltd was registered in March 1866 to work part of the Scandinavian Reef. Amongst its shareholders was George Francis Bullen, after whom the settlement 'Bullendale' was later named. Bullen was also a shareholder in the Great Scandinavian Quartz Mining Co. Ltd, which was registered on 11 May 1866. This company had its origins in the Scandinavian Prospectors Company of January 1864; this company erected a small 4-stamp battery at their claim. The new company replaced this with a 30-stamp battery at the confluence of

Murdochs and Skippers Creeks. By 1874, the Scandinavian Reef appears to have been renamed the Phoenix Reef, and the company had become the Phoenix Company, owned by the Bullen Brothers (Chandler & Hall 1986: 15, 21).

In June 1866, the British-American Quartz Mining Company Ltd (also known as Perry, Watt and Co.) was formed and gained some immortality through the naming of the British-American Spur. This company built a small stamper battery beside the Right Branch of Skippers Creek (see Fig. 4).

The Otago Quartz Mining Co. Ltd was registered in January 1867, with three of the original discoverers of the Scandinavian Reef as shareholders (Southberg, Murdoch and Olsen) (Chandler & Hall 1986: 17). The company must have been active prior to registration, as it began construction of a 16-stamp battery in Murdochs creek, upstream of the Scandinavian Company's mill, in 1866 (AJHR 1866 D14: 6). This battery is often simply referred to as 'Southberg's Battery'.

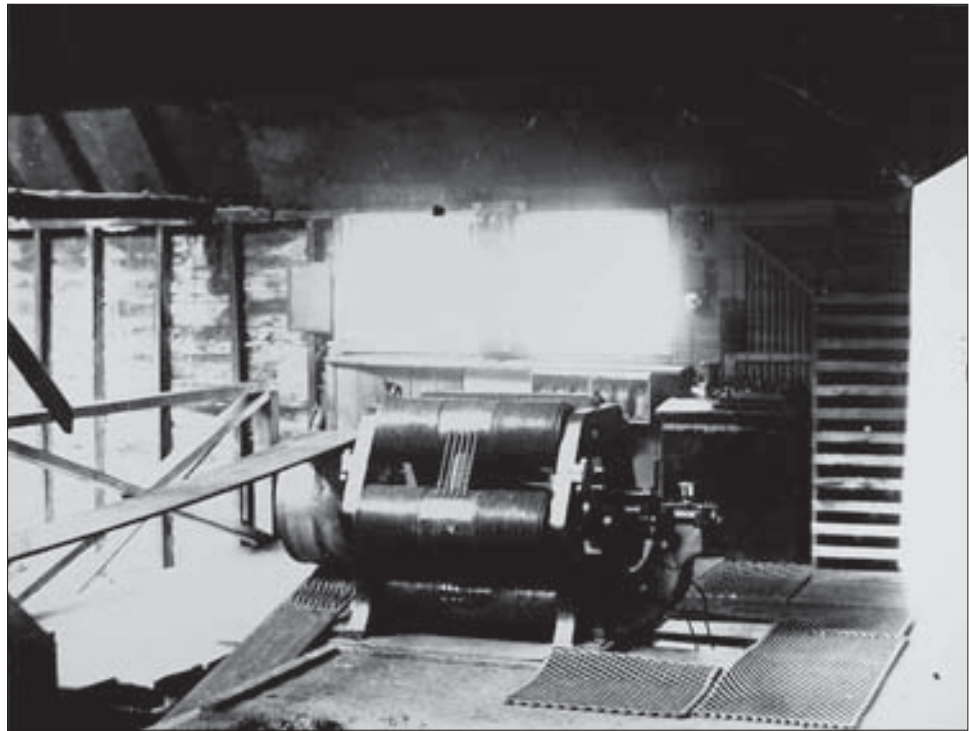
By 1874, only two claims appear to have still been worked with any vigour: the Phoenix (originally the Scandinavian) owned by George Bullen, and Southberg's, worked by the Otago Company (although the British-American Company made periodic appearances in the mines reports until 1886). The Phoenix Mine was let on tribute from 1875 until 1880, when Bullen resumed operations himself, and invested a considerable amount of money in the operation (Chandler & Hall 1986: 23). Good stone was found at depth in 1884 after a new shaft was sunk, following several of years of bad returns (De La Mare 1993: 25). In 1885, Bullen acquired Southberg's ground from the Otago Company. By 1888 he had purchased the British-American ground, and in 1889 he bought the Phoenix Extended Claim, leaving him as the sole owner of the field (Chandler & Hall 1986: 28; De La Mare 1993: 29).

Prior to these purchases, the Phoenix and the Otago Companies had held a shared water right, which created problems in dry periods, as both companies' batteries were water powered. The lack of power prompted Bullen and Fred Evans (the Phoenix Mine manager), advised by Walter Prince, to investigate the use of electric power to drive the battery. A small dynamo was already being used in the field to provide lighting (*Lake Wakatip Mail*, 5 Dec 1884: 2). The site chosen for the generating station was on the other side of Southberg Spur from the mine, in the Left Branch of Skippers Creek. R.E. Fletcher of Dunedin was contracted to supply and install the system (AJHR 1887 C5: 46; Chandler & Hall 1986: 23). Two Anglo-American Brush Corporation Arc dynamos driven by two 6-ft Pelton wheels were installed (Fig. 3), power being transmitted to the mine by a line across the spur. A Brush Corporation Victoria motor (Fig. 5) was installed at the battery house to drive the stampers (AJHR 1887 C5: 46-47). A trial of the system was held on 3 February 1886.

There were numerous problems with the operation of the equipment, and a number of modifications were carried out to improve performance, including the replacement of the cast iron armatures with laminated units². One of the main equipment problems was simply the primitive state of knowledge regarding electricity at the time. Balancing the loads from the generators proved difficult; any imbalance tended to turn one dynamo into a motor and drive it backwards. Additionally, it was found that the combined output of the two dynamos was

² See Chandler & Hall (1986) for a detailed discussion of the dynamo operation.

Figure 5. Brush Corporation electric motor, Bullendale, c. 1886. Photo held by Lakes District Museum, Arrowtown.



considerably less than expected given their individual outputs (AJHR 1887 C5: 47). However, such problems were hardly surprising given the pioneering nature of this installation, and the distance from any source of parts or supplies. The dynamos and the electric motor that they drove are discussed in more detail in section 8 below.

In 1889 some good stone was found in a drive in the ground bought from the Phoenix Extended Company, which produced reasonable returns for 1890-91. However, expenses were still high, profits were correspondingly low, and the good stone had petered out by 1892 (De La Mare 1993: 29). In 1893, Bullen sold the Phoenix Mine to Achilles Goldfields Ltd, although he retained a significant interest in the new company. In 1896 the old battery was rebuilt, and a number of the old stampers were replaced. Electricity was used to power the air compressors, but only provided an alternative power source for the stampers which were instead powered by a Pelton wheel. A new main shaft was dug to access the deep mine workings.

By 1897, the company was in financial strife. It was reconstructed in 1898 as Achilles Gold Mines Ltd. A report by two English engineers—N.C. Morcom and J. Cherry—on the condition of the mine found it to be extremely dilapidated, with the workings requiring re-timbering and the machinery very run down. Some improvements were carried out, including the installation of two new 30-h.p. motors ordered from England.

Despite this, the financial situation remained bad, and the mine closed down in May 1901. With closure of the mine the settlement of Bullendale lost its reason for existence. The Post Office closed in 1902 (New Zealand Gazette 1902).

In 1903 the mine was bought by the Mt Aurum Quartz Mining Co. Ltd (Messrs Robert Lee and party), and work recommenced in 1904. The old deep workings were not pumped out, operations concentrating instead on the British-American Spur section of the reef. An aerial cableway was constructed to convey ore to

the old battery site, where a cyanide plant was possibly installed (Chandler & Hall 1986: 39). However, this operation was not a success, and closed down in 1907 (AJHR 1907 C3: 34). Some small-scale prospecting and mining continued locally—Shore and Sainsbury found some gold to the west of the old mine in 1928 (AJHR 1928 C2: 26). However, the main workings were not re-opened again.

Throughout the life of the mine, which spanned four decades, some good returns were made, with some rich patches of ore found. A total production of 40 000 oz of gold was reported (MacDonell 1992). However, the expenses of operating a large quartz mine in the rugged and remote area, the complexity of the ore body, with rich patches of stone separated by masses of low-value rock, and gold loss as a result of sulphide ores, all reduced the economic viability of the operation. A big problem was always access, with the five miles from Skippers to Bullendale creating enormous problems for the transportation of heavy battery and mining equipment.

4.1 ROAD ACCESS TO BULLENDALE

Throughout its life, the mine remained remote and inaccessible. A pack track into the Shotover from Arthurs Point was established in 1863. Some modifications were made to its route a year later to provide easier grades. However, it was still a particularly hazardous journey into the area. A suspension bridge was built across the Shotover River near Londonderry Creek in 1866, from where the pack track continued up Skippers Creek to Bullendale. It was along this track that the heavy equipment for the mines was hauled.

In 1882 a decision was made to construct a new dray road from Arthurs Point to Skippers. By 1885, the majority of this road was completed, but it was not until October 1886 that the worst section—Pinchers Bluff and the Devils Elbow—was constructed, and May 1890 before the entire road was complete from Arthurs Point to Skippers (De La Mare 1993: 15–16).

However, access to Bullendale was still difficult, as the new road finished at the Skippers Bridge of 1866, which itself had very steep approach grades. A new, higher, bridge was duly designed, but was not completed until May 1900³. By this time it was too late to benefit the Bullendale mine, with all the heavy equipment, including the two Brush dynamos, having been hauled in along the old tracks and creek beds. Even with the completion of the Skippers Bridge, the access to Bullendale from Skippers was still along a narrow pack track, and therefore difficult with any load. The closure of the mine in May 1901 came only two months after the official opening of the new bridge in March. Only the Mt Aurum Quartz Mining Company that reopened the workings on the British-American Spur in 1903 would have benefited from the improved access.

An additional problem for Bullendale, beyond the difficulty of obtaining supplies, was getting sick or injured individuals out for medical attention. Stretchers had to be manhandled along the narrow pack track, which would involve large numbers of men and some considerable time. In response to this, in 1883 the mine manager, Fred Evans, designed a special narrow wagon only 3 ft wide to

³ This being the present Skippers Bridge.

serve as an ambulance along these tracks. This was built at a cost of £45 by the American Carriage Factory in Invercargill, and was housed at Edward Fisher's Store near Skippers Point. It had its first run in 1884, and proved a great success (De La Mare 1993: 36-37). During the present archaeological survey, a very narrow track dray axle was found lying near the Phoenix Battery site.

4.2 BULLENDALE TOWNSHIP

In common with the inhabitants of many remote goldmines, the Bullendale miners, and in many cases their families, lived in a small township that grew up near the mine. This township was never surveyed or formalised⁴. Initially known as 'The Reefs', it became known as 'Bullendale' after the owner of the Phoenix Mine, George Bullen⁵.

The township of Bullendale grew up on the slopes around the battery; in particular, the sunny face of the slip facing the battery building. Details of the exact numbers of people living there are sketchy, as published population figures were often lumped together with nearby settlements such as Skippers. However, some information is available. In 1879 the Warden (after discussing the Phoenix Mine) stated: 'population at present in Skippers Creek: employed in quartz mining, 24; alluvial, 4; women and children, 17: total, 45' (AJHR 1879 H11: 25); while in 1892 the Inspector stated that 60 men were employed about the claim, but did not mention their families (AJHR 1892 C3A: 46). The census data for 1896 and 1901 gave separate figures for Bullendale: 107 males and 37 females in 1896, and 115 males and 74 females five years later (NZ Census 1896, 1901). This appears to indicate that there was a growing population over the life of the mine, although this would have been affected by the varying fortunes of the company. The relatively large number of women present and the establishment of a school (with the teacher's salary paid by the parents) suggests that Bullendale was socially more than a simple miners' camp. Chandler (Chandler & Hall 1986: 14-53) has researched the population of the settlement in some detail, and produced a list of some of the residents and their occupations based on 1899 pay sheets for the mine.

Miller (1949: 121-126) discussed Bullendale, writing at a time when a number of old residents were still alive and could be interviewed. He described a flood in 1878 caused by a slip that temporarily blocked Branch Creek before releasing a large amount of water. This flood destroyed Andrew Southberg's house, the site of which was later used for a new hotel (see section 9.1.6 below).

Most buildings at Bullendale were small huts, generally constructed of corrugated iron on a timber framing, of which two examples remain standing. Figure 6 shows a scatter of some of these buildings on the hillside above the Phoenix Battery. De La Mare (1993: 34) estimated that there may have been as many as 50 such huts and small houses at the peak of mine's activity, after the mid-1880s.

⁴ The 1866 Topographical Map of the area (S.O. 1531) does show two 'Village Reserves' at Bullendale, although many of the known house sites lie outside these areas.

⁵ The name of the Post Office was changed from 'The Reefs' to 'Bullendale' in 1892 (NZ Gazette 1892), but both names are still shown on the current topographical map (NZMS 260-E40 Earnslaw, 2000 edition).

Figure 6. Bullendale, looking up Murdochs Creek. Southberg's Battery is just visible in Murdochs Creek. The cluster of buildings around Bakery Flat is in the distance, while the structures closer to the Phoenix Battery are in the middle ground. The Phoenix Battery itself is not in this view, as it is closer to the photographer.
Photo: Lakes District Museum, Arrowtown.



The remainder of structures can be split into two categories: service buildings and mine buildings. The service buildings consisted of Bullen Hall (with electric lighting, and which also doubled as a school house), a billiard room, the Phoenix Hotel and a combined store, butchery and bakery. The mine structures consisted of the main battery house, the winding house, a mine office and a number of ancillary buildings such as an assay office⁶.

When the mine shut down, Bullendale was virtually abandoned as it stood due to the difficulties of transporting materials out along the pack track. The town apparently stood unchanged until World War I, when shortages of corrugated iron led to the dismantling of many structures. The Phoenix Battery building was set alight in about 1920 by P. Lynch to retrieve ironwork from the roof framing, (NZAA Site Record Form S123/140), while Duncan McNichol of The Branches rebuilt the Ballarat Hut on his run with material taken from Bullendale, including the hall and the manager's house (De La Mare 1993: 41). Once the buildings were shorn of their weather protection, decay would have set in rapidly.

Today, only two small corrugated iron miners' huts still stand on the site, one of which was restored by the Department of Conservation in 1998 (*Otago Daily Times*, 29 May 1998: 3). The sites of other structures are marked only by terraces cut into the hillsides and scatters of iron and artefacts.

⁶ The Dynamo Shed was, of course, some distance from the mine, on the other side of Southberg Spur.

5. The archaeological survey

The fieldwork for this report was undertaken over 5 days in February 1996 by Peter Petchey, accompanied for some of the time by Aaron Braden, Brian Ahern and Kristina Townsend. Access to the site was by foot from the road end at Skippers Cemetery, and a camp was made on Bakery Flat, part of the old settlement site. Mapping was carried out using transparent overlays on aerial photographs. The focus of the survey was on the Bullendale settlement and gold mines, and the fieldwork concentrated on aspects of those features rather than other nearby sites.

Additional visits were also made to Bullendale in 2002 and 2005, when some sites were re-inspected and gradual changes noted.

As could be expected with a mine and isolated community that existed for some forty years, the field remains at Bullendale are extensive and complex, and the site should be considered as an archaeological landscape rather than as a series of discrete sites. However, for the purposes of this report, the complex is described in terms of its discrete functional units:

- The surface remains of gold mining (underground workings were not entered during the survey).
- The battery sites used during the life of the local mines.
- The dynamo site and electrical equipment.
- The settlement of 'Bullendale'.
- The communications infrastructure: roads, tracks and telegraph line.

These sites form a 'system' and thus can best be effectively interpreted as a whole. This system has survived remarkably intact, largely because of the remote nature of the site that has kept at bay much (but not all) of the fossicking and redevelopment that has damaged other historic mining areas⁷. Thus, much of the archaeological evidence is in good condition. Figure 2 gives an overall indication of the layout of the site, and a key to the location of the detailed plans provided in this report.

Some mine workings remain open, or were reopened during prospecting work carried out during the 1990s (Baker 1992). However, for safety reasons no underground workings were entered during this survey, and observations are limited to surface evidence apart from accounts of the accessible adits given in Baker (1992).

Descriptions and specific histories of each site are given below, based (wherever possible) on primary sources, followed by descriptions of the archaeological remains as recorded in February 1996. Note that it is mapping convention that apostrophes are not used in features named on maps. Hence Murdochs Creek rather than Murdoch's Creek. This convention has been followed in this report, except for some of the features shown on plans (such as Southberg's Battery) which do not appear on published topographical maps.

In this report, imperial measurements are quoted directly from original sources, and are used (with metric conversions) when describing all items of machinery and structures that would have been designed and constructed in these units. Metric units are used for other distances and measurements.

⁷ The threat of re-mining that was present during the 1990s has, for the time being, abated.

6. The mine workings

As the Bullendale lodes were worked from 1863 until 1907 by a number of different companies, there is a great deal of surface evidence of mining, despite the fact that the vast majority of the operations were underground. Surface evidence is generally in the form of mullock heaps, adit entrances, shaft mouths and tracks/tramways. Despite only being a small proportion of the actual mine workings, this surface evidence can shed light on the operation of a mine and the transportation of the ore.

Only two contemporary mine plans were located, and one of these was a 1955 copy of an original plan. These plans show the mine in 1897 (the 1955 copy) and 1900 (see Fig. 7), both being very late in the life of the operation. A fire that destroyed the mine manager's house, the company offices and the storerooms in 1897 also destroyed many earlier mine plans (De La Mare 1993: 31), while another fire at the Mines Department in Dunedin possibly destroyed duplicates held there. Even the Achilles Company experienced problems due to the lack of records. For example, an effort was made in 1899 or 1900 to locate a winze that only a few old hands knew of, there being 'no plans of the work available' (quoted, but not referenced, in Jeffery 1986: 14).

The mine workings are discussed below. The workings on British-American Spur are discussed first (including the aerial cableway on the spur), followed by a description of the shaft sites (that were the entrances to the deep underground workings of the mine) found on either side of Murdochs Creek, followed by a description of other surface workings.

In the discussion of the main Phoenix/Achilles Mine, the original names for the various levels and workings are used wherever possible, based on the information from the two known contemporary mine plans. Figure 8 shows the surface features of the mine as recorded in 1996.

6.1 BRITISH-AMERICAN SPUR MINE WORKINGS

British-American Spur was worked during both the earliest and last days of mining at Bullendale. The British-American Company (Perry, Watt and Co.) of 1866 started working on the spur, while between 1904 and 1907 the Mount Aurum Company carried out the last serious mining at Bullendale there. The last detailed Mines Inspector's report in 1906 indicated that at least two levels were being worked, with one drive being 375 ft (114 m) long (AJHR 1906 C6: 60).

The workings on British-American Spur are now the most immediately visible at Bullendale, as they cover the open south-facing flank of the spur that can be seen for some distance, with a particularly good view being from the top of Southberg Spur (Fig. 9). The main area of visible surface working is located between 200 m and 400 m east of the Phoenix Battery site.

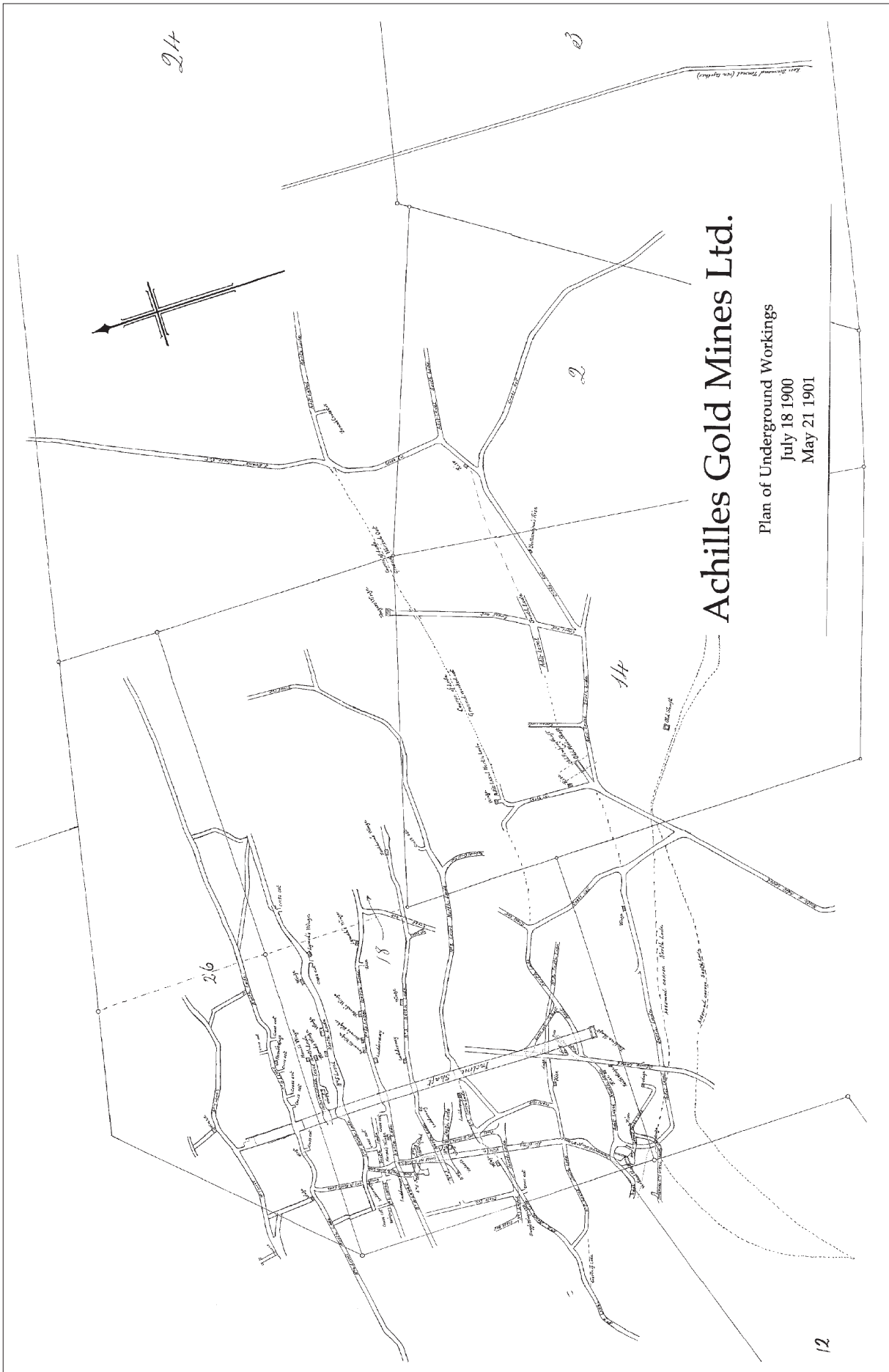


Figure 7. Achilles (Phoenix) Mine, underground workings, 1900. Extract from plan. Plan held by Archives New Zealand, Dunedin Regional Office.

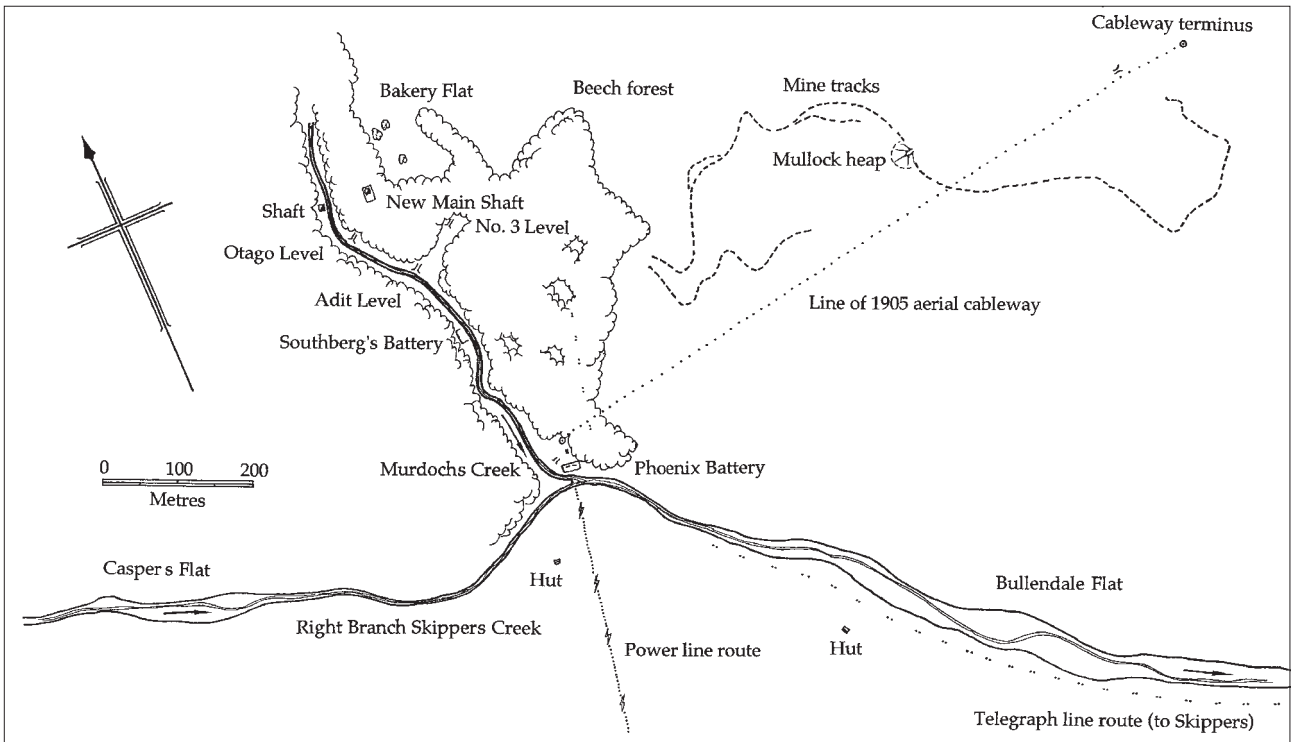


Figure 8. Surface archaeological evidence of goldmines at Bullendale.

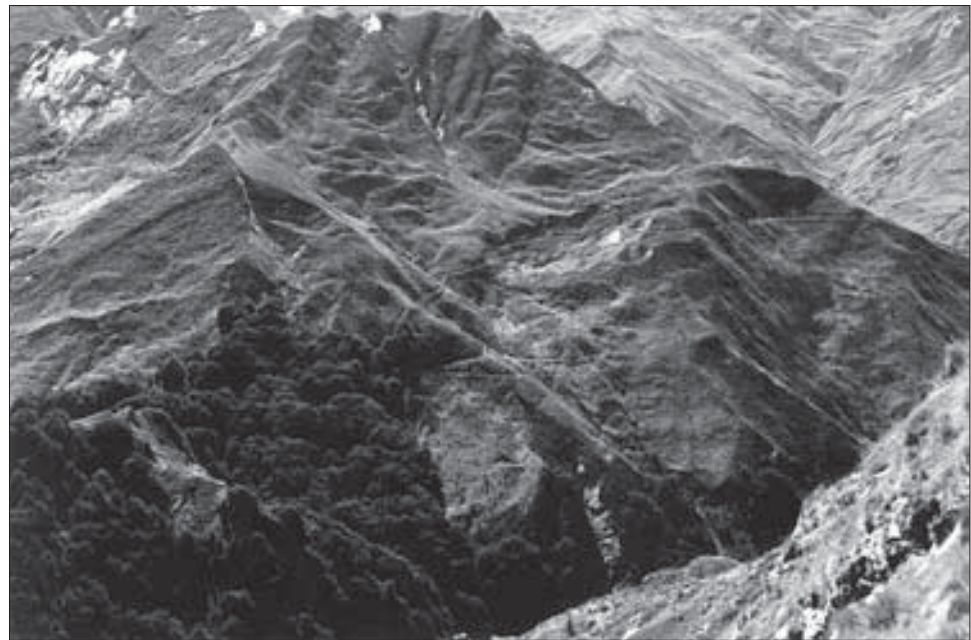


Figure 9. British-American Spur. General view showing gold workings.
Photo: P. Petchey.

The most obvious feature is a high-level benched track that crosses the main south face, and continues around the spur to terminate on the north face close to the terminus of the later aerial cableway (see section 6.2 below). This is probably the tramway shown as 'Perry's Tramway' on the 1866 map of the area (S.O. 1531), and suggests that some of the earliest underground workings are those that were accessible from this line. Below the tramway are a number of other, shorter, benched level and zig-zag tracks that gave access to various mine workings. The line of an aerial cableway built by the Mount Aurum Company in 1904-05 can be found, and this is discussed in detail below (section 6.2).

The actual mine workings have mostly collapsed, and only surface scars and mullock heaps show where adits were located. A short open adit does survive on the north face of the spur, close to the end of Perry's Tramway. A large light-coloured mullock heap outside a collapsed adit on the south face of the spur, at the tramway level, can be clearly seen from some distance, and is shown on Fig. 8. Much of the rest of the worked ground consists of eroded humps and hollows and slipped faces, but little distinct detail survives.

6.2 MOUNT AURUM GOLD MINING COMPANY AERIAL CABLEWAY

The Mount Aurum Gold Mining Company purchased the Phoenix ground and plant in late 1903. They renovated part of the battery (see discussion in section 4), but did not pump out the flooded mine. They instead concentrated on the area of the old workings on British-American spur above the battery, and in 1904-05 installed an aerial cableway to transport ore down the hillside. The system was described in some detail in the contemporary Mines Inspector's report (AJHR 1906 C6: 60):

'To facilitate and cheapen the cost of transporting the quartz from the British-American Mine to the battery, an aerial ropeway on the single-rope system has just been erected. The distance between the two terminal stations is nearly 3000 ft. From the upper terminal the rope rises 270 ft to pass over an intervening ridge, from which point to the lower terminal there is a fall of 790 ft, or a mean grade throughout of 1 in 5.09. The terminals consist of two wheels 9 ft in diameter, the upper wheel being fixed and having a brake attached for regulating the speed. The lower terminal is mounted on wheels and set on rails which have an inclination of 25 degrees, a weighted truck being attached to the terminal to maintain proper tension on the rope. The hauling rope is of Bullivant's patent steel 2.25 inches in circumference, and is supported throughout its length on fourteen standards fixed at the most advantageous points along the line. To the crown of each standard four movable pulleys are mounted, over which the rope passes. Fixed at equal distances along the rope by means of steel clips and hung on hangers, are forty-two buckets, each capable of holding 2 cwt of stone. The loading of the buckets at the upper terminal is performed by one man, who, when the empty bucket arrives, simply disengages it from the hanger, which latter passes round the terminal wheel to where there is exactly under the rope a loaded bucket, which is on a small tram on rails for running to the shoot close by, and this is simply hooked on to the hanger as it passes without stopping the rope. The buckets are made self-tipping at the lower terminal by means of a self-acting catch. It is found that the rope will run satisfactorily 6,000 ft or one complete circuit per hour, and at this speed will deliver 84 cwt per hour or 33 tons 12 cwt per day. The rope runs entirely by gravitation.'

As the mining operation closed down for the winter of 1907 and never reopened, the cableway probably had only about 2 years of use before it was abandoned.