WORTH ITS SALT:

A Survey of the Natural and Cultural Heritage of Cheetham Saltworks, Laverton

BY GARY VINES AND BRETT LANE

MELBOURNE'S LIVING MUSEUM
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SYNOPSIS

A study of the Laverton Saltworks of Cheetham Salt Pty Ltd was undertaken in 1989-90 to assess the cultural and natural heritage of the site. A review of relevant literature was carried out followed by field work to record native flora and fauna, Aboriginal archaeology and historic sites. This report contains the findings of the study and presents the information in a series of zoning maps which identify areas of significance in relation to natural and cultural heritage. A major finding of the study is the fundamental relationship between the pumping of seawater through the the saltworks as part of the salt production and the maintenance of a viable wetland habitat for wildlife.

ACKNOWLEDGEMENTS

This study has been carried out with the assistance of a number of people. Staff of the Ministries for Conservation and Environment and Planning and Urban Growth have provided information and advice. Bruce Howard of Cheetham Salt Pty Ltd has given his time to explain the operations at Laverton and provided the map of salt concentrations. Graham Norton from Cheetham Salt Management kindly allowed access to the saltworks for survey and identification of sites..

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1. INTRODUCTION

The Cheetham salt works lies on the lower reaches of Skeleton Creek on the western outskirts of Melbourne, approximately 20 kilometres from the G.P.O. (see Fig 1)

The saltworks was established in the 1920s by Cheetham Salt Pty. Ltd. of Geelong and now covers approximately 826 hectares of freehold land from Aviation Road to the high water mark of Port Phillip Bay and about 90 hectares of un-reserved crown land in the north east of the site leased to Cheetham for the purpose of manufacture of salt. (see Fig 2)

Since early 1988, when it became likely that the site might be sold, representatives of the Ministry for Planning and Environment, MMBW and Department of Conservation Forests and Lands have examined options for the future use of the site. A draft report in September 1988 resulted. (Wood et.al 1988).

The Living Museum of the West has been aware for some time of the important remnant wetland systems which survive in both the saltworks and the Western Region in general. The museum has collaborated with Brett Lane in a study of Wetlands in Melbourne's West (Lane & Wood 1989), and has briefly examined the industrial archaeology of the area in a comprehensive survey of industrial sites. (Vines 1989)

The present study aims to expand on the previous work of the Living Museum in documenting the natural and cultural heritage of Melbourne's Western Region, by carrying out a survey of the fauna, flora and Aboriginal, historic and industrial sites within the saltworks. The study also assesses the significance of and inter-relationship between those sites.

1.1 OBJECTIVES

To identify and survey areas likely to contain sites pertaining to Aboriginal occupation of the site.

To research the history of Aboriginal and European occupation of the site.

To identify historical industrial sites of significance.

To identify areas of specific significance to fauna and flora habitat, particularly in regard to use of the wetlands by birds.

To assess the interaction of the man-made and natural environment, particularly in regard to the creation and maintenance of wetland habitat.

1.2 ORGANIZATION OF THE REPORT

This report presents the results of the investigations under the following headings:

1. Introduction
2. Background History
3. Method
4. Results
5. Discussion
6. Zoning Maps

The section on Background History provides a description of the geology and geomorphology, the Aboriginal and European history of the site and an account of previous studies in the area. Section three provides an account of the approach and methods adopted in the investigation. Section four presents the results of the study, including fauna, flora, aboriginal sites and historic and industrial sites.

The discussion (Section 5) provides a synthesis of this information, examining the relationship between the salt production process and wetland habitat values, the general distibution of Aboriginal sites and the relative significance of the remaining artifacts of Aborigianl and European occupation. The final section (Section 7) includes maps of the site showing areas of significance for nature conservation, archaeology and industrial heritage.

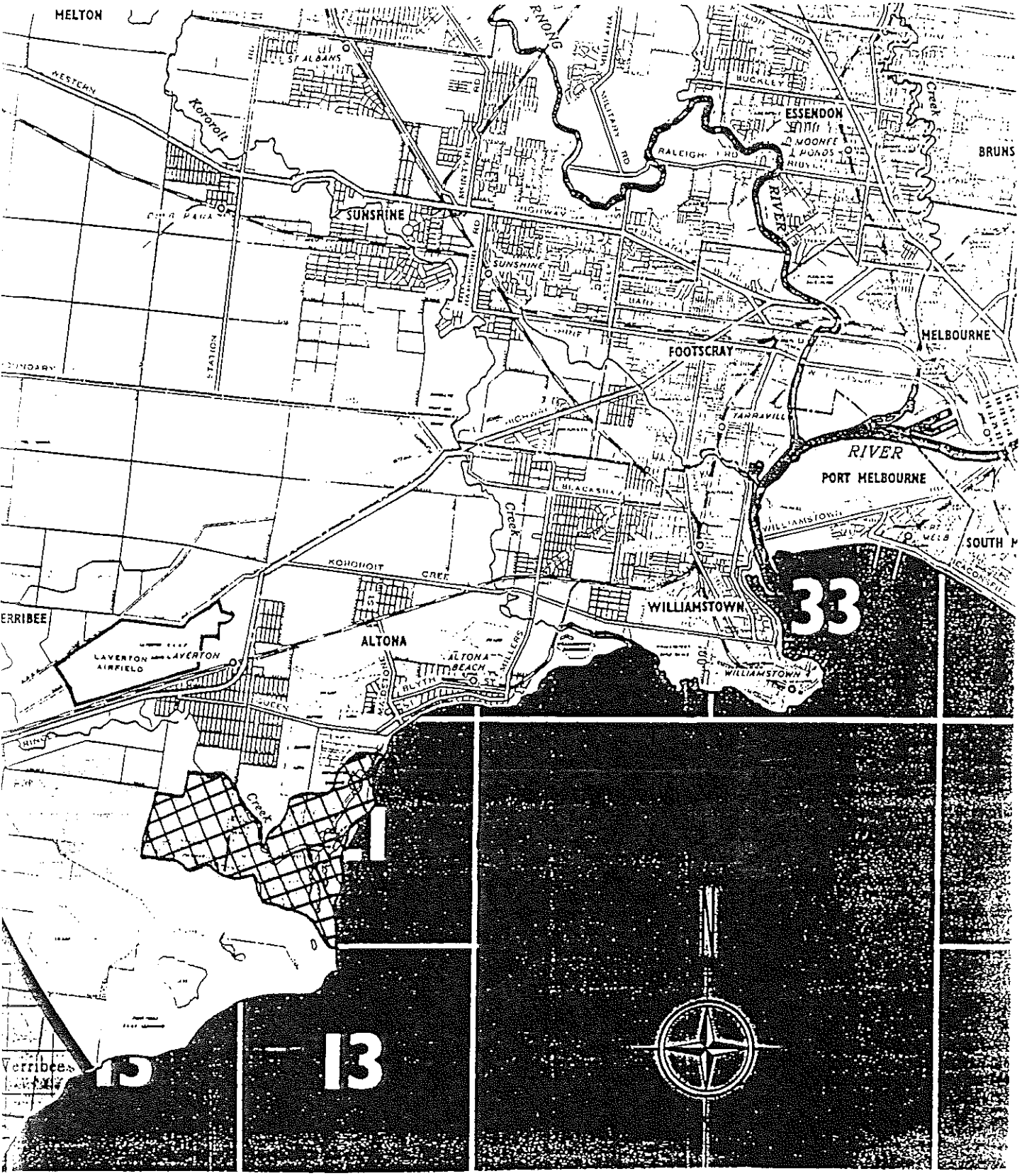


Figure 1. Location of the study area

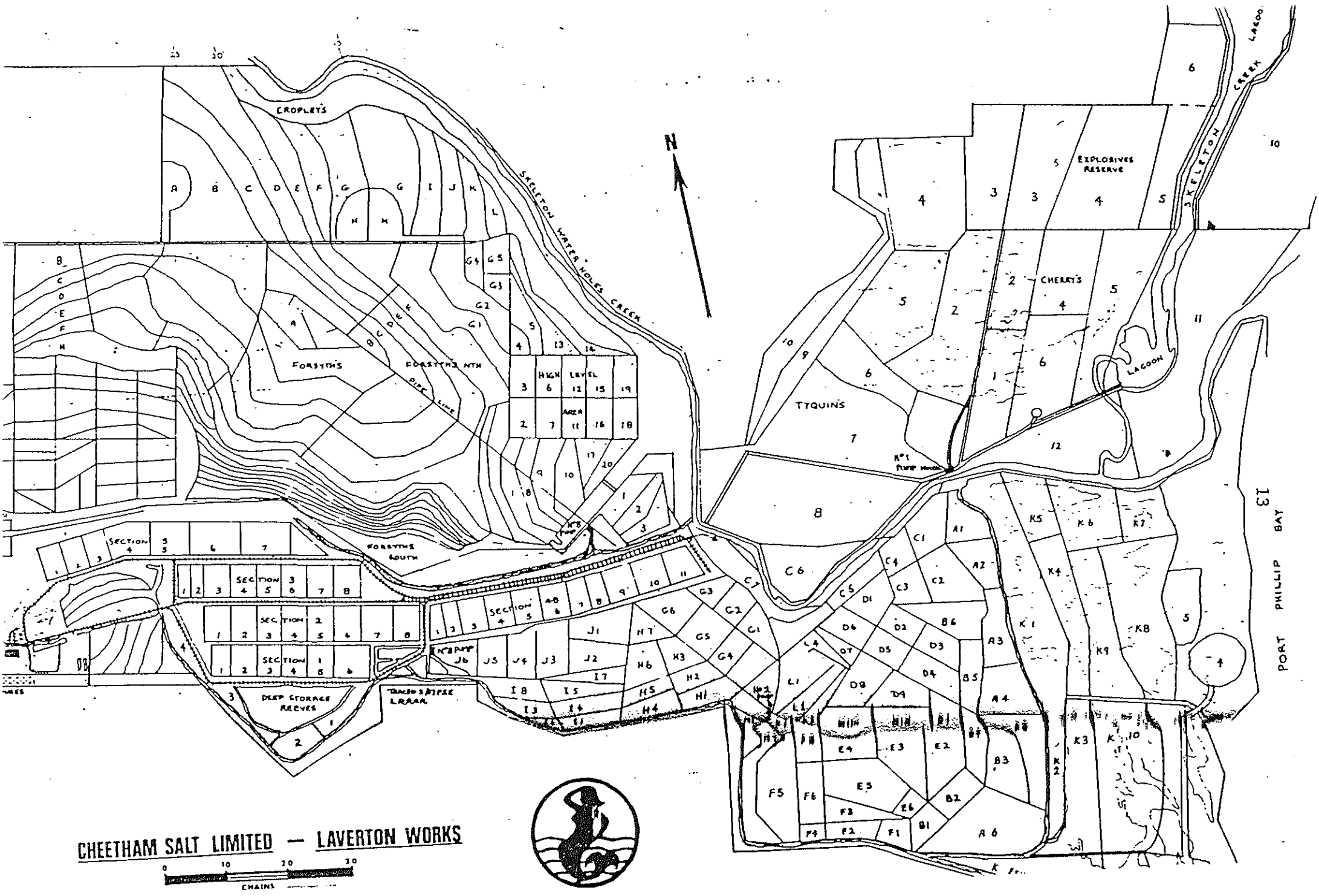


Figure 2. Plan of the study area

2. BACKGROUND HISTORY

2.1 GEOLOGY AND GEOMORPHOLOGY

The underlying geological structure of the study area is composed of the Newer Volcanics from lava flows dated to the late pliocene early pleistocene (about 1 to 4 million years ago. This olivine basalt rock is up to 100 metres deep with some minor interbedded silty sand and baked soils. Overlying this are coastal swamp deposits composed of fine sand, silt, silty clay, often with shell beds in bands. Closer to the coast are raised beach ridges composed of bedded and cross-bedded well sorted sand, shelly sand and minor components of silty or clayey sand. The geology of the study area is shown in Fig 3.

The area of the evaporation pans coincides closely with the coastal swamp deposits which vary in elevation between 1 and 1.5 metres above sea level. These swamp deposits extend to a small lake west of Aviation Road and lie to the east in bands between old beach ridges in an embayment formed by the silting-up of the inlet of Skeleton Creek.

North and south of this tongue of higher ground features a thin veneer of wind-blown silt and clayey silt (loess) over the basalt. Only a small part of this higher ground has been used for evaporators. This is the High Level and Forsyth's area which was constructed since the 1950s.

Also along the coast are active recurving sand spits and relic spits. The active spits extend northwards from the present mouth of Skeleton Creek with a zone of parallel near-shore sand bars. The distal end of the outward spit trends seaward of the general coastal alignment and the recurves are offset landward at angles averaging 30 degrees from the trend. In many instances the recurves have become attached to an earlier formed spit to enclose a lagoon or small tidal inlet. (Rosengren 1986:43)

The main northerly movement of the spits is due to wave action generated by southerly winds, while the offsets of recurves are built by easterlies. The spits are evidence of a predominant south-north movement of sand along the western side of Port Phillip Bay.

Off-shore are a series of narrow sand bars spaced at 40 to 50 metre intervals and occupying a zone averaging 300 metres wide. Landward the terrain has been severely disturbed by excavation for salt pans although remnants of earlier-formed spits can be distinguished. (Rosengren 1986:42)

To the south of Skeleton Creek is an area of lagoons and low sand and shell ridges seaward of the salt works. The floor of the lagoons is basalt buried by silty sand and mud and the ridges are remnants of spits formed in a marine embayment now sealed by the growth of an outer sand ridge system.

The form of the sand ridges is similar to the active spit system north of Skeleton Creek, although some of the lobate forms that extend landward from the main ridge may have been built by storm washover before the growth of the present outer ridge system. The wetland complex occupies a depression in the basalt surface that was breached and flooded by the rising Holocene seas 6,000 to 8,000 years ago. It has been modified since then by the growth of the sandy spits, by washover and by accumulation of lagoonal

muds. The site includes the near-shore sand bar system.

The wetlands system has been greatly altered by drainage and construction of the salt evaporators, but early maps show that a large swamp lay to the south of Skeleton Creek and north of the creek swamps were connected with stream and tidal channels. The outlet of Skeleton Creek appears to have been in part through the hour-glass lake while a channel appears to have connected the wetland system to Trugannina Swamp and Laverton Creek. The present outlet of Laverton Creek appears to be entirely artificial. A wide shallow canal was constructed by the MMBW some time after 1970.

Two sites of geological and geomorphological significance have been recorded in the study area and two others are located nearby. The sites AB2 and AB1 identify the active recurving and relict sand spits as of State and Regional significance respectively. Rosengren remarks:

> The active spits are one of the major coastal bodies of Port Phillip Bay and are an outstanding example of a recurving sand spit system. They comprise a major prograding sector of Port Phillip Bay and are one of the few on the Victorian coast. They are highly mobile and provide opportunity for short-term monitoring of coastal sand movement and for studies in the development of and relationship between, spits and nearshore bars. They are an effective means of protecting this coastal sector from erosion. (Rosengren 1986:42-45)

The relict spits provide an interesting comparison with the active coastal features north of Skeleton Creek. The near-by sites are the sand ridges at Kooringal Golf Club and parallel sand ridges at Point Cook. These are of State and Regional significance respectively and are of interest in the sedimentary history of the bay.

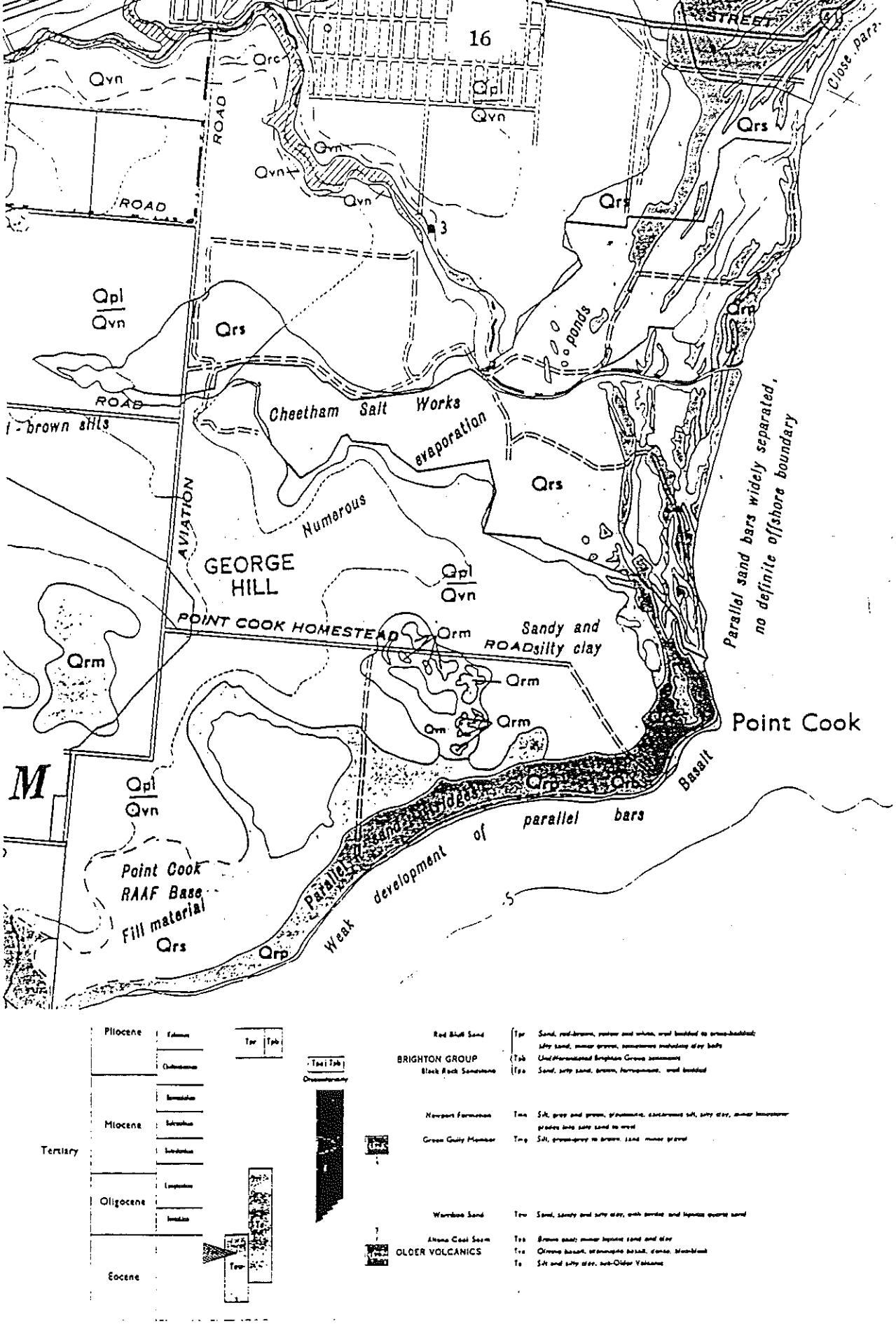


Figure 3. Geology of the study area, From Geological Survey of Victoria, Melbourne Sheet, 1:63,360 sheet SJ=55-1

2.2 ABORIGINAL OCCUPATION

The Aboriginal people who occupied the area of the Cheetham Salt Works were from the Yalukit willam clan of the Bunurong tribe. The Bunurong were predominantly residents of the western side of Port Phillip Bay but appear to have occupied the coastal area as far south as the Werribee River. The Kurung-jang-balluk clan of the Woiwurung people, who were located between the Werribee River and Kororoit Creek, were possibly temporary residents of this coastal strip, sharing the resources in times of plenty. Present day Aboriginal people from the Melbourne suburban area use the name Wurundjeri to identify themselves.

A large campsite of the Yalukit.willam containing many stone artifacts was recorded in Altona some years ago. (Presland 1987:12)

Several other sites have been recorded in the vicinity of the Cheetham saltworks in studies conducted under the aegis of the Victoria Archaeological Survey. Archaeological surveys have covered the coastal area, (Ellander and Weaver) the Werribee planning corridor, (du Cros 1989a) the Werribee plains (du Cros 1989b) and Point Cook Metropolitan Park (Gearing & Hughes 1984). Sites identified include isolated artifacts and artifact scatters located predominantly near the banks of swamps, lakes and watercourses. Several sites have been found along Skeleton Creek outside of the saltworks. Immediately south of the saltworks a number of artifact scatters are located in and around Point Cook Metropolitan Park and a particularly large occupation site exists near the coast at Point Cook itself.

These sites indicate substantial utilization of the area by Aborigines with a focus on the wetland areas of the creeks and lakes. Although several sites are only a short distance from the coast there has been very little evidence of marine exploitation discovered. Tool manufacture and use is evident and some sedentary occupation is probable.

2.3 EUROPEAN SETTLEMENT

European knowledge of the land around Port Phillip Bay began in 1803 when Charles Grimes and James Flemming entered the bay and mapped its shores as well as the tidal reaches of the Maribyrnong, Yarra, Werribee and Little Rivers. The party examined the land near Skeleton Creek noting the swamp and salt water lagoons amidst "a level plain with a few straggling bushes, the face of the ground is one third grass, one third stone and one third earth, mostly newly burnt". (Flemming 1878:22)

The burnt ground speaks of the presence of Aborigines employing fire to promote pasture growth and so attract game. Twenty one years later, Hume and Hovell crossed the district and noted "abundant game and water, the luxuriant growth of grasses and rushes and the general prosperity of the region blacks". (Melb Herald 18-2-1925 p.12 quoting diaries of Hamilton Hume)

In 1836 Captain William Hobson surveyed the locality giving his own name to Hobson's Bay to the east and his Mate's name John M. Cooke to Point Cooke which later lost the terminal "e". (Boys 1935:58)

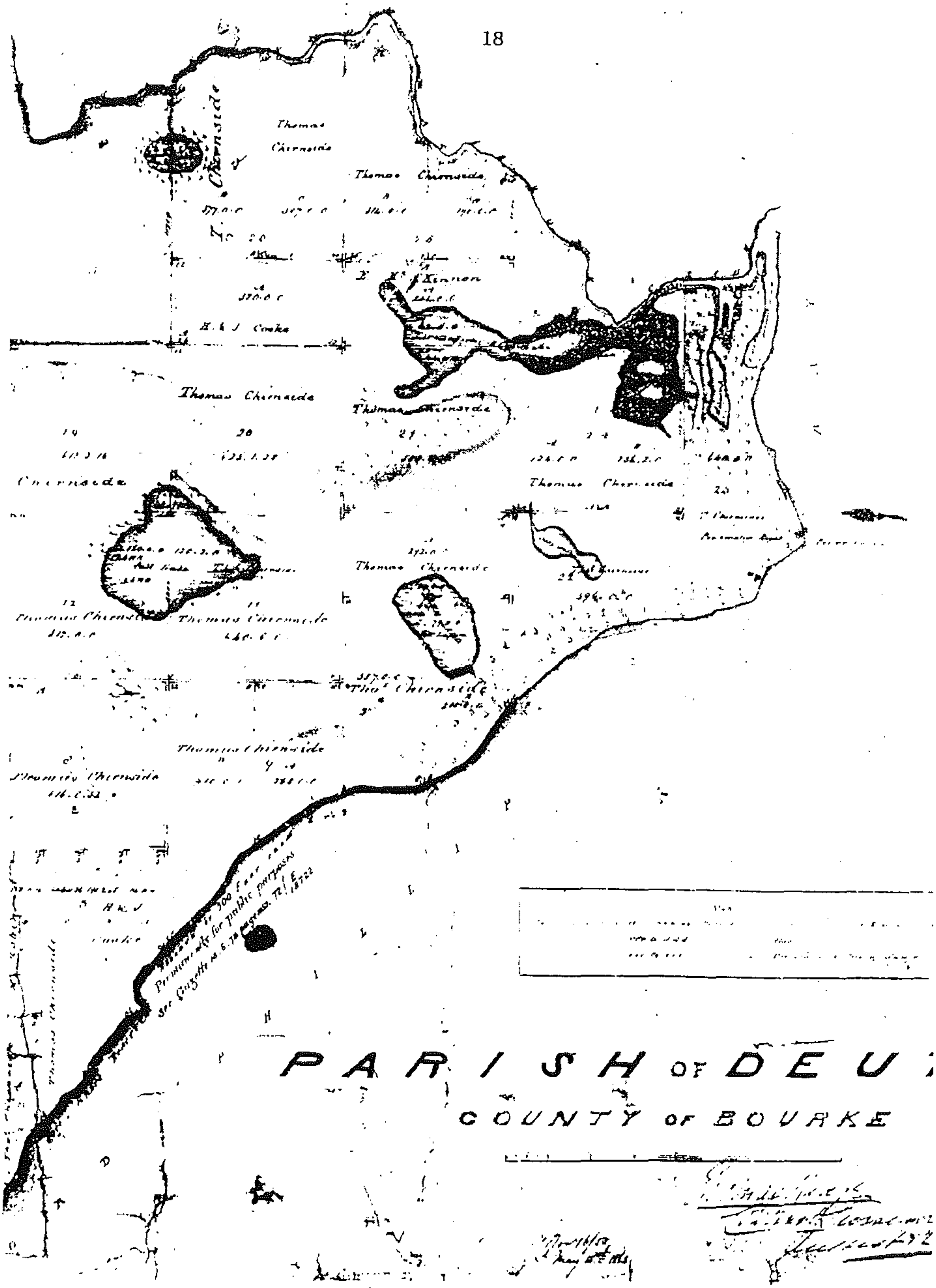


Figure 4. Allotments sold in Parish of Deutgam, 1865.

European settlement of the Laverton-Point Cook area coincided with the arrival of John Batman's Port Phillip Association in 1835. The subsequent claim of a treaty with the Aborigines and distribution of their land among the members of the association saw the land around Skeleton Waterholes Creek (as it was known) allotted to Batman's surveyor, John Helder Wedge. There is no evidence that the area was occupied. The Port Phillip Association's claim was swiftly dissallowed and replaced by an Act of 22 March 1839 which gave settlers the right to occupy Crown Lands for a 10 pound 'squatters' license fee.

Although Robert Hoddle had surveyed a road to Geelong fairly close to the coast in 1839, probably crossing Skeleton Creek at the present ford, there is still no record of settlement until 1842-6 when William L. Quinan appears as a licencee of land for pastoral purposes at Skeleton Waterholes in the Port Phillip Gazette. (Billis & Kenyon)

In 1849 William Drayton Taylor who had owned Noorilim near Murchison, had a pastoral licence for nine lots of land containing 8116 acres in the Parish of Deutgam at "Chain of Ponds". As his claim was under clause 22 of the regulations of March 1844 which specified that land was let to "the present licenced occupier thereof" it is evident that he had been in occupation for some time. However, he failed to renew his lease for 1850. Alexander Irvine appears to have leased the property from 1850 and by March 1852 and January 1854 it was subdivided into standard allotments and put up for auction. Most of the land we are concerned with was sold to Thomas Chirnside at 30/- per acre with one block going to E. McKinnon. This was probably a speculative purchase of a farmer from Djerriwarrah Creek. (See Fig 4)

Chirnside had established himself in the area on freehold land by May 1851 having occupied Learmonth's pre-emptive right on the west of the Werribee River and then extended his holdings. North of Skeleton Creek, Robert Cherry, who had much land in Altona, had a single block of 163 acres at the mouth of the creek. This block appears to have come under the closer settlement act in the 1920s when J.Bunting is recorded as the owner.

In this complex history of land ownership the boundaries of what became the Point Cook Estate are unclear, but it is apparent that all the land south of Skeleton Creek and west of Aviation Road was included in the property. However, the wetlands, described as samphire scrub and lagoons on the parish plan of 1879 appear to have been excised from the allotments only to be purchased later by George Thomas Chirnside in 1897. (under Act 60 No 1456 c5393) Wedge's 1853 plan of the area shows a hut aproximately 500 m. west of the present Skeleton Creek weir. This may well have been a shepherd's hut associated with the early grazing history of property. (Searle 1983:1-5)

The Chirnsides remained owners of the land into the twentieth century although for much of this period they were absentee landlords spending their time between Scotland and Australia, hosting vast social gatherings at Werribee Park and leaving management of the property to younger sons. Farm management was originally limited to sheep grazing.

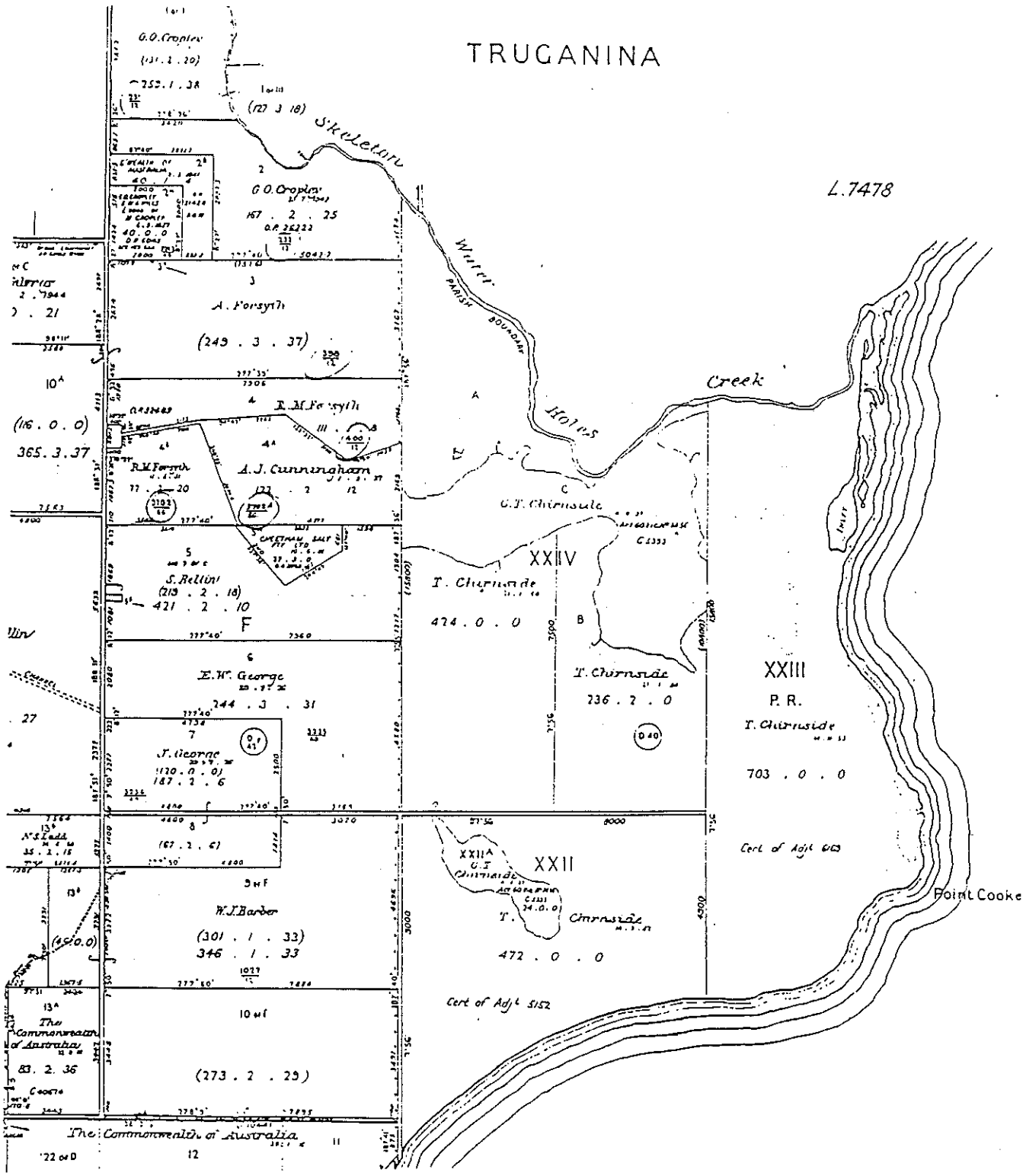


Figure 5. Allotments in Parish of Deutgam, note closer settlement subdivision and early Cheetham Salt purchases, ie. "AJ Cunningham".

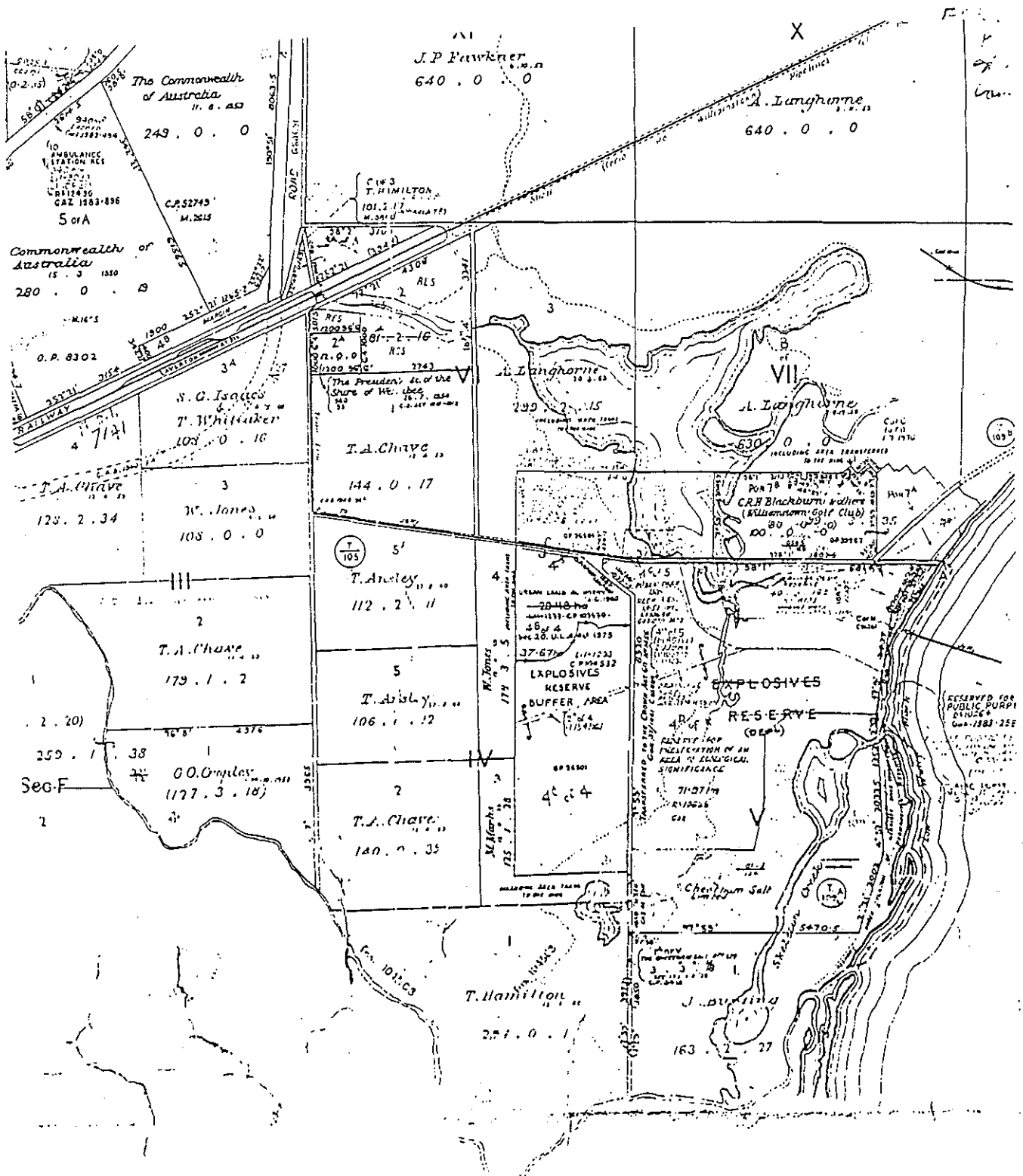


Figure 6. Allotments in Parish of Truganina, note closer settlement subdivision, "Hamilton, Bunting," etc. lots.

During the Chirnside's reign the wetlands along Skeleton Creek were a burden to the property resulting in drowning of stock in winter. Fencing around the creek and swamps was a preoccupation as early as the 1860s (Searle 1983:28). By 1867 the Point Cook property had been reserved for horses, their breeding and racing being the Chirnsides' major pleasure.

Following Thomas Chirnside's death in 1887 the Point Cook land passed to Andrew Chirnside for three years and later to his son George who appears to have neglected much of the property, preferring to let it to tenant farmers. The Chirnsides' connection ended when the property was sold in 1920 to Sydney Dalrymple who worked at the recently established RAAF base and in 1939 a much reduced Point Cook property passed to Mr. M. Hooper.

At this time the Chirnsides' holding was being broken up with much of the estate being purchased by the MMBW for the Sewerage Farm. The Crown Allotments along Aviation Road were re-purchased by the Government for lease or re-sale under the Closer Settlement Act. G.O. Cropley and A and R.M. Forsyth selected the blocks adjacent to the saltworks. North of Skeleton Creek, Closer Settlement resulted in land passing to T. Hamilton and J.Bunting. The area of the swamp was purchased by A.J. Cunningham on behalf of Cheetham Salt in 1927 with later purchases around 1935 creating a re-subdivision and the present boundaries of the Cheetham land being established. (see Figs 5 and 6) The northernmost part of the study area takes in Crown Land leased to Cheetham Salt and a Crown Reserve near the coast. Both areas were once part of the Laverton Explosives Reserve or its buffer zone.

2.4 SALT MAKING TECHNOLOGY

Salt making is one of the most ancient manufacturing processes known. In its most primitive forms (which are still employed in many third world countries) it merely involves gathering raw salt crystals from natural salt pans or mining rock salt from geological deposits and grinding the crystals by hand. Elaboration of this system involves constructing artificial evaporation basins and the manipulation of the flow of brine. or employing other artificial means of evaporation. More sophisticated processes were developed to refine the salt. Refining processes basically involve washing out the impurities and re-crystalizing the salt.

Common salt or sodium chloride (NaCl) occurs in two forms - large natural rock deposits in Europe, Asia and North America and in solution in the oceans of the world. The sea comprises about 2.5 per cent sodium chloride. The uses of salt are as complex as its composition is simple. The basic reaction of the decomposition of salt into its sodium and chlorine components lies at the foundation of the entire modern chemical industry. The first product of the salt-based chemical industry developed in the nineteenth century was alkali or sodium carbonate, used in soap, glass and caustic products. In the twentieth century the emphasis has moved to the chlorine component, now the world's single most important chemical for drugs, plastics, insecticides and solvents. (Crossley 1982)

Salt production by solar evaporation as employed by Cheetham Salt Ltd. requires a large flat area close to the sea. This must be in an area of low rainfall with high temperatures during at least part of the year in order to maintain high evaporation rates.

The Werribee Plains have a rainfall ranging between 450 and 500 mm. per year and evaporation rates of over 1100 mm per year. Winds which increase evaporation in the coastal area are considerably stronger and more frequent in Laverton than elsewhere in the Melbourne area. (McDougal 1987:10-13). A non-porous clay subsoil is necessary to retard leakage of the solution.

Alluvial deltas where streams enter the sea are particularly suitable for salt making, notable examples being in the Camargue area of the Rhone Delta in the south of France and the Ganges and Indus Deltas in the Indian subcontinant.

In Cheshire, England, an area of roughly 400 square kilometers along the Weaver Valley has been exploited for its underground rock salt deposits since Roman times. Salt has been extracted not so much by direct mining (as is more common in other parts of Europe and particularly in Siberia) but by tapping the underground brine streams. Brine was pumped to the surface from countless bores and evaporated in boiling pans fired with coal.

Varying the intensity of the heat and the time taken in the process enables different grades of salt to be produced. Fine grained or "Lump salt" was made by heating the brine to boiling point. This produced dense fine crystals suitable for use in the home, ie. "table salt" and in manufacture of cheese and butter.

Coarse grained salts were produced at lower temperatures but the crystals were more crude and took longer to form. A temperature of 100 degrees Fahrenheit produced a coarse, hard, slow melting crystal considered ideal for fisheries. "Common Salt" used in the chemical industry, pottery and other manufacturing industry was produced when the brine was kept at 160 - 170 degrees Fahrenheit and finally a temperature of 130 - 140 degrees Fahrenheit produced a large-grained flakey salt suitable for the preserving of meat. The manufacture of coarse-grained salts took a considerably longer time, for example, that used in the fishing industry might be "a fortnight forming in the pan". (Didsbury:140-146)

Another technology sometimes employed involved running brine through the "thorn graduation process" employing tall structures containing masses of plant material such as hawthorn. This system, which appears to have originated in Germany, evaporates off part of the water in the brine and was used in New South Wales near the southern coalfields. (Rogers 1984)

The system employed at Laverton combined the solar evaporation common in Mediteranean salt works with a purification process possibly derived from the Cheshire salt works.

2.5 CHEETHAM SALT

a. Establishment

Richard Cheetham was born in Manchester, England in c.1836 and became a manufacturing chemist with some knowledge of the salt gathering industry in Southern Europe. He migrated to Australia in 1862 for health reasons but he quickly saw the possibility of establishing a salt industry on the Victorian coast.

His first attempt at setting up a works for this purpose was at French Island. The venture unfortunately proved a failure and was abandoned but he went on to establish the first successful solar saltworks in Australia. The French Island works has recently been investigated by the Victoria Archaeological Survey.

In 1888 he began construction of a salt production works on the foreshore of Stingray Bay between Limeburner's Point and Point Henry at Geelong on 650 acres of low-lying samphire-scrubland obtained from the Victorian Government under a 21 year lease. A mile long coffer dam was built across the bay with picks, shovels and barrows by men who sometimes worked waist deep at 4 a.m. in winter to take advantage of the low tides.

Richard Cheetham and his associates in the venture had no surveying instruments or detailed engineering knowledge. Drains were dug and filled with water to obtain levels, and this data enabled wooden-lined channels to be constructed with an even fall of one inch over half a mile. Sluice gates to control the flow of water were designed so that the evaporation pans were filled by the incoming tide and the salt-water trapped on the ebb-tide.

In 1890 Geelong Council were inclined to oppose further alteration of the shoreline of Stingray Bay. Cheetham, however, had put in two years of hard work and considerable cost and so appealed to the Council for extensions to the works outside the coffer dam he had already built stating that he had spent "11,000 to 12,000 pounds in reclaiming land which in its original state was not worth sixpence and acre." The expenditure had been mainly on labour for the building of the coffer dam and the salt pans.

A refinery for producing quality salt was the next improvement to be made and Cheetham hoped to employ between 150 and 200 men. However, before he expended further capital he required greater security of tenure, and soon afterwards the Victorian Parliament extended the lease from 21 to 99 years. The company was at that time known as "Richard Cheetham and Company, Victoria Salines".

Financial backing for the company was obtained from Andrew W. Cunningham, retired manager of the Geelong branch of the National Bank. Unable to take an active part, he placed his eldest son Mr. A.H. Cunningham in the business, beginning a long association of the Cunningham family with the salt industry. In 1894 Cheetham Salt Pty. Ltd. was formed from the original partnership. Richard Cheetham died at Ballarat in July 1900 at the age of 64 before the venture he initiated was fully successful. (PRO Defunct Business Files VPRS932/10386)

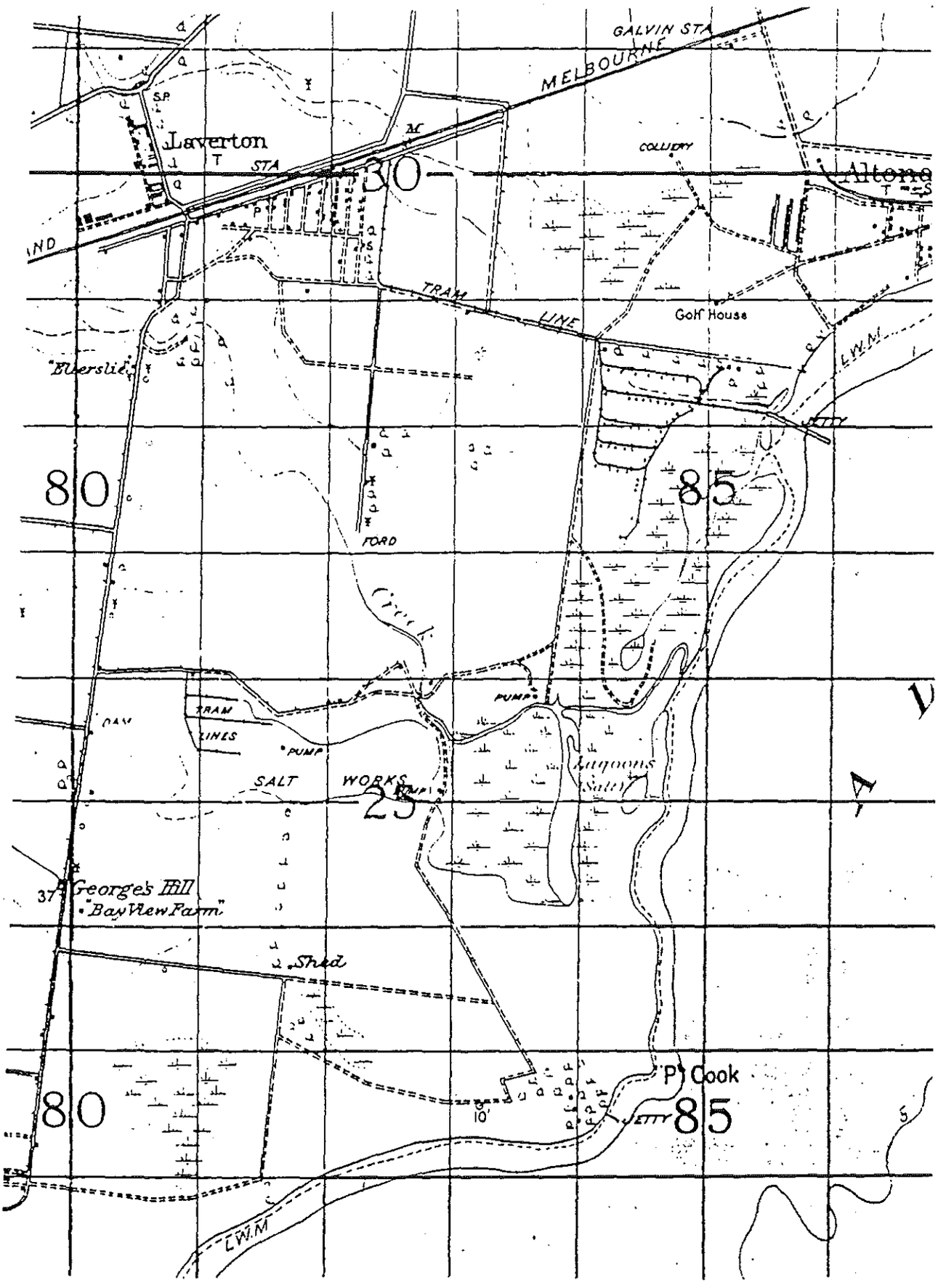


Figure 7. Ordnance Survey Inch to Mile series Melbourne Sheet south j55 1933.

b. Consolidation, 1906-1924

By 1906 the business had become well established. Andrew W. Cunningham's youngest son, Mr. A.J. Cunningham, a trained engineer, joined the company, and after his return from active service in 1918, a new refinery was erected which was opened by the Premier of Victoria at that time, Sir Harry Lawson. Electric power was installed and greater mechanization of salt handling introduced in the form of a portable elevator for the salt stacking process. A great deal of specialized equipment required was built by the Company in its own workshops. Mr. A.H. Cunningham died in 1921 and his younger brother then became managing director. Although some difficulties were met from time to time, the position of the company steadily improved.

c. Expansion, 1924-1953.

In 1924 production at Geelong fell short of demand, and 1,200 acres of land were purchased at Laverton on the shores of Port Phillip Bay. The first harvest was made from this new site in 1926. Only raw salt was produced at Laverton until 1940 when a refinery was erected along with on-site accomodation for the employees and their families. As well as about a dozen houses near the refinery, other buildings were constructed near the pump sites for the men who supervised the brine distribution and two camps were erected for the seasonal employment of large numbers of workers during the harvest. These camps were located near Skeleton Creek on slightly higher ground and comprised canvas and timber huts and possibly an amenities building. Some of these buildings are shown on the 1930 ordinance survey map. (see Fig 7)

In 1950, heavy rainfall during the harvest season caused another short-fall in production and additional land was purchased at Avalon for a third site. The first harvest at Avalon took place in 1953. Cheetham Salt Limited now had three sources of raw salt and two refineries.

d. Cheetham Salt Today.

During the 1970s work at Laverton continued with only small capital outlays, although some rolling stock was refurbished. (L.R. 1974,1978) This period appears to mark the down-turn of the site and the lack of expenditure on maintenance and improvements led to considerable deterioration of the channels and retaining walls of the salt pans.

Late in 1986 the decision was made to discontinue harvesting at Laverton as the salt pans required extensive repairs. The refinery continues to process salt from other sites but it is likely that any future harvest will be discontinued at Laverton. There was no harvest in 1987 or 1988 but harvesting resumed in summer 1990 and may possibly occur in the future year or two. The Victorian Government was at the time of writing, still considering whether to purchase all or part of the Laverton Saltworks for extension of the wetland habitat of Point Cook Metropolitan Park. Cheetham Salt Limited still harvests salt at the Geelong and Avalon sites, processes salt at Geelong and Laverton and has operated other saltworks at Moolap, Linga and Kanagulk in Victoria, Port Augusta, Lochiel, Price, Kangaroo Island, Lake Heart and Edithburg in South Australia and Bowen and Port Alma in Queensland. Their head office is at 10 Moorabool St Geelong.

Cheetham Salt manufacture a variety of grades of salt for industry and domestic use including table salt under the "Mermaid" brand and salt blocks for medicated and trace element livestock licks. The major use of salt produced at Laverton has been in treating animal hides and pickling or curing meat and other foodstuffs. (Cheetham Salt)

2.6 OPERATIONS AT LAVERTON

(Much of this section is based on notes produced by Peter Evans for a LRRSA tour of the Laverton site in 1987, a Cheetham Salt published pamphlet and articles in the Geelong Advertiser on 12.2.1959 and 19.2.1976)

Salt manufacture was carried out at Laverton from 1924 to 1986 using a relatively unchanging method although the layout and arrangement of salt pans was altered and enlarged periodically. The process used is as follows:

a. Evaporation

Sea water which contains approximately 3% of solids in solution consisting mainly of salts of sodium, calcium and magnesium, is pumped to various evaporation systems along Skeleton Creek by the No. 1 pump. This occurs during September and October each year when temperatures suit evaporation. The first evaporation occurs in the lowest, easternmost pans raising the salt content from 3.5 to 9% salts. From here it is allowed to run into the outer condensors where it remains until the density has risen to the point of forcing the calcium sulphate out of solution. When the salt concentration reaches about 19% brine control staff move the liquor, using the No. 2 Pump, on into the gypsum condensors where precipitation takes place. At a concentration of salts between 19 and 25%, calcium sulphate (gypsum) drops out of the solution leaving the salt and water to be pumped off so that the gypsum can be removed. The saturated solution of salt, known as maiden brine, is then pumped, using No 3 Pump, into crystalizing pans walled with timber and having a level compacted floor of washed sand. Close control is essential during the salting period as the maiden brine must be kept at a certain density and depth which means pumping in extra brine as evaporation takes place.

Any remaining liquid, now known as mother liquor, is pumped off and returned to the sea to avoid contamination with chlorides and sulphates of magnesium. The concentrations of salt in each of the salt pans at the works are shown in Fig 8.

b. Harvesting

The crust of salt deposited each season in the crystalizers varies from two to eight inches depending on climatic conditions. Harvesting usually commences in mid to late February. The salt is removed from the pans by a specially adapted tracked vehicle which takes an eight foot wide cut across the pan. It is then loaded into tramway trucks and hauled by diesel locomotive to a "tumbler" near the refinery where trucks are inverted and the salt transfered to a large stack of 20,000 to 30,000 tons. A belt conveyor running on metre gauge track is used to stack the salt. Until 1985 the salt was loaded into side-tipping trucks by power shovel and transported to the refinery where each truck was tipped in turn into a below ground hopper. In 1985 this part of the tramway was replaced with motor trucks.

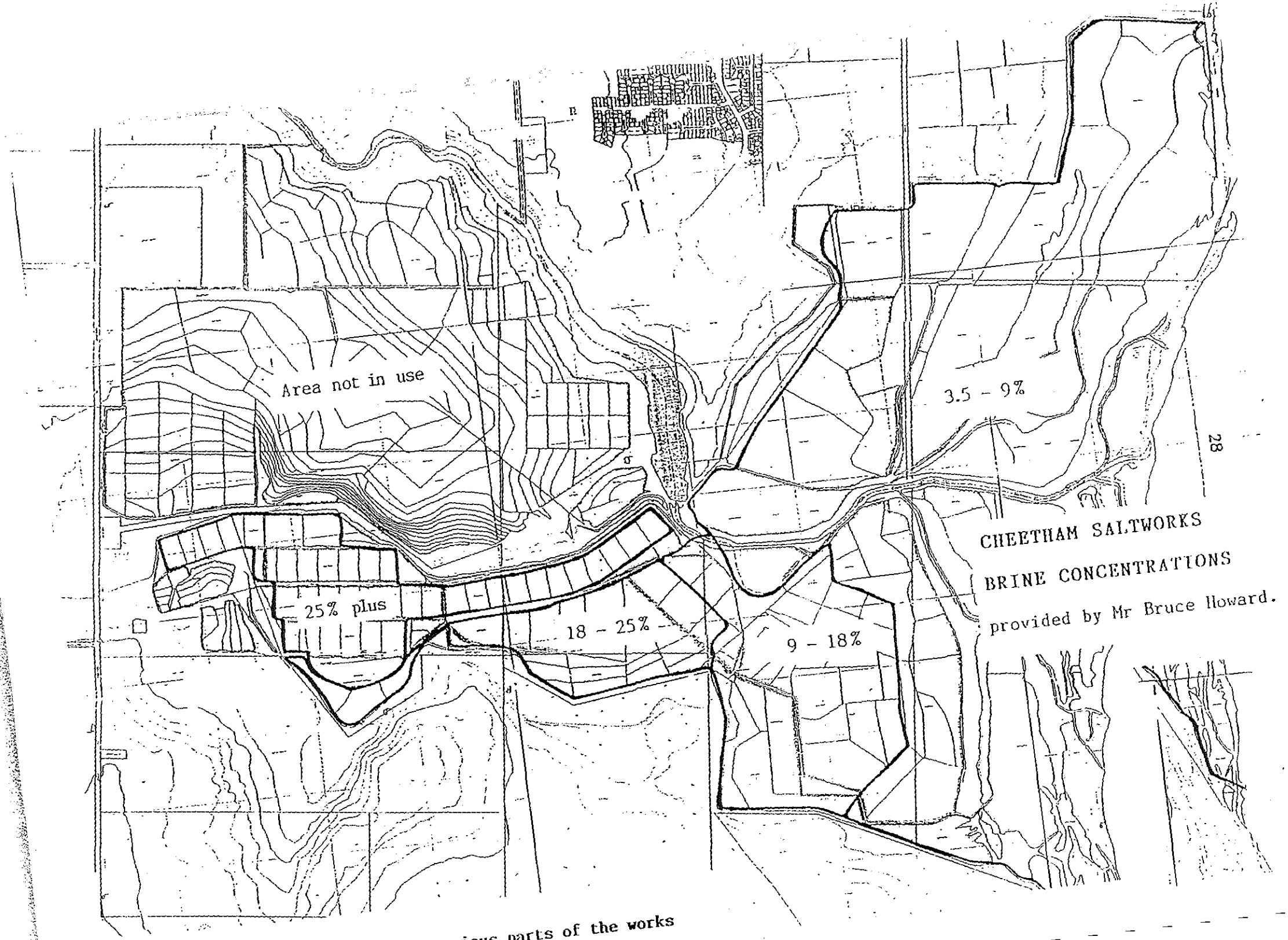


Figure 8. Salt concentrations in various parts of the works

c. The Refining Process

The refinery building is located at the western extreme of the site near Aviation Road. Raw salt crystals, having been partly washed by rainwater on the stacks, is crushed to half an inch or less in size and washed in a concentrated brine solution to remove impurities. The salt is then screened, washed a second time, and dried in a centrifuge. At this stage the cleaned salt contains 2.0 % moisture. It is then transferred by conveyor belt to an oil-fired kiln and heated to 300 degrees Celsius, which in 5 minutes reduces the moisture to 0.05 % and kills any organisms present. Six and a half tons per hour can be processed by this method. The salt is then crushed and sieved to 5 or 6 different grades to suit the customer's requirements; bagged and stacked ready to be dispatched. During the peak of the output season in June/July/August up to 1,000 tons per week leave the Laverton works.

d. The Tramway System

When the Geelong works of Cheetham salt began operation, horse-drawn drays were used to transport salt from the crystalizing pans to the refinery and from the works to the customer. Horse and hand-worked tramways were probably introduced around the turn of the century and by 1902 the company was considering purchasing a Krauss & Co 0-6-0WT locomotive. In 1910 they extended the tramway across a nearby road to a siding on the Geelong-Queenscliff line for dispatching their bagged salt.

Tramways were in use at the Laverton works from its inception and were used for construction and maintenance work as well as salt transport. A line ran from the present terminus of the harvesting tramway near the Skeleton Creek weir to the beachfront to obtain sand for re-flooring the evaporation pans.

The first date for use of locomotive haulage at Laverton is not known, but it is probable that the first motive power was provided by two 0-4-0PM tractors built by W.Day and Sons of Melbourne, or possibly one of the several small petrol locomotives built by Cheetham in their own workshops. The wheels and frames of the Day tractors are now at the Don River Tramway in Tasmania and one of the "Home-made" locomotives still exists at Laverton.

In 1949 the first of the Ruston & Hornsby locomotives was in use at Geelong. Three of these engines were purchased new and a fourth second hand, from the MMBW. Two Motor Rail "Simplex" locomotives were also bought second-hand, one from the S.R.W.S.C. which was used originally for tunneling at Jindavic and a second from the contracting firm of John Howard and Co Ltd. Both Simplex locomotives are out of use and at least two of the Rustons were rebuilt during 1975-6.

Locomotives were transfered between Geelong and Laverton as required until 1982, when the tramway system at Geelong was closed and all rolling-stock concentrated at Laverton. Since harvesting ceased the Laverton tramways have been disused and several sections have been lifted for sale of the rails and sleepers.

However, with the resumption of salt production in 1989-90, the tramway was recommissioned and an additional 12 casual staff were employed for the 1990 harvest. Minimal work was carried out on the track which was still in reasonable condition and new galvanized iron liners were constructed for the bulk salt wagons to replace the old liners which were sent to South Australia. Thirteen sections were harvested and the company have committed themselves to carrying out another and probably final harvest in early 1991. The Ruston and Hornsby locomotives numbers 1,2 and 4 were returned to service but number 3 had a seized main drive and was considered beyond repair. (Evans 1990)

e. Other Rolling Stock

The first rolling stock at Laverton were small side-tipping skips of which many examples can still be seen around the site. When locomotives were introduced larger vehicles could be used which were later fitted with stainless steel hoppers to combat corrosion. One bogie flat wagon which came from the dispatch tramway at Geelong survives at Laverton for general purpose use and there is a large tank car on a four wheel frame.

Cheetham had their own workshops where they constructed 30 special wagons, with removeable galvanized hoppers, for harvesting the salt. They also constructed a rail transportable conveyor system to remove salt from the pans into these wagons.

2.7 PREVIOUS STUDIES

Archaeological surveys

Study of the area near the mouth of Skeleton Creek goes back nearly 70 years with amateur and professional archaeologists paying particular attention to the extensive artifact scatters and camp site deposits at Point Cook and Altona Beach. (Home 1921, Mitchell 1949:113-6). Possibly thousands of stone artifacts had been removed by amateur collectors over the years. The Point Cook site was later recorded by the Victoria Archaeological Survey (Coutts et.al. 1976:39) and a more detailed investigation of the Point Cook Metropolitan Park found an additional two artifact scatters and ten isolated artifacts (Geering and Hughes 1984).

Two other detailed surveys of archaeological sites have been undertaken in the district although neither has looked specifically at the saltworks land. These surveys and other recordings of the Victoria Archaeological Survey have identified a number of sites along the banks of Skeleton Creek south of Laverton township and in the vicinity of Point Cook. The material recorded was principally waste stone flakes of fine grained material such as quartzite and silcrete and some formal stone tool types including backed blades and microlithic points. (du Cros 1989a, Ellander and Weaver 1990)

Historical Studies

Besides contemporary newspaper accounts and a pamphlet published by Cheetham Salt Pty Ltd, the only research on the history of the saltworks has been carried out in connection with the narrow guage tramway by the Light Railway Research Society of Australia. This has concentrated on documenting the construction and operation of the tramway (Evans 1987,1990). Brian Rogers of Woolongong has studied the early history of Cheetham Salt but his material is as yet unpublished. The company records of Cheetham Salt Pty Ltd for the period 1923-1966 have recently been deposited with the Geelong Historical Records Centre where Norm Houghton is cataloguing the material and is currently preparing articles on the company's operations based on these.

Planning Reports

Several planning-oriented reports have been commissioned, primarily by the Ministry for Planning and Environment, Conservation Forests and Lands and Board of Works. These include two coastal plans and a detailed survey of planning options for the saltworks. In each case the natural heritage values of the site have been noted and the importance of protecting the wetland habitat has been stressed. (Altona Coastal Management Plan; Weribee Coastal Management Plan; Lane and Wood 1989; Wood et.al. 1988).

Fauna and flora Studies

Because of their accessibility from Melbourne by both public and private transport, the Laverton Saltworks have been regularly visited by amateur naturalists, especially bird-watchers, for many years. Much of this activity has been informal and little systematic data have been collected and published. No doubt interesting observations exist in bird-watcher's note-books but unless these observations are published they are not accessible to a wider audience.

The first published systematic study of the birdlife of the saltworks was conducted in the early 1950's by the Altona Survey Group, an association of members of the Bird Observers' Club (now the Bird Observers' Club of Australia). The group was led by Mr Roy Wheeler, who, in 1980 (Wheeler 1981), described the establishment of the group as follows:

> "Both BOC (Bird Observers' Club) and RAOU (Royal Australian Ornithologists' Union) members were disappointed when they found that in September 1949 the Red-necked Avocet had nested at the Laverton Saltworks and that in January 1950 the Marsh (Whiskered) Tern had nested at the lignum swamp near Point Cook, and that both nestings had been overlooked. It became apparent to members of both these organisations that a closer watch should be kept of this interesting area. This matter was brought up at a BOC general meeting in February 1950 and in April a preliminary run over the area was made so that ideas could be formulated as to what form the survey could take....
>
> The first team visited the saltworks on June 4th 1950.... A roster was drawn up and weekly visits were to be made to the area and three years was the period suggested. Reports were to be made by the group leaders on species seen, distributions, populations, nesting, food, habits, etc., in fact all aspects of the birdlife of this area. The Silver Gull, which had been nesting at the Saltworks since 1944 was made a special study and plans were made to band the chicks."

Members of the Altona Survey Group conducted surveys of the wetlands of the works and of nearby wetlands immediately to the north, such as Golflinks Swamp (north of Queen Street). Regular reports were published in the journal of the Royal Australasian Ornithologists' Union ("The Emu"). Five publications in the mid 1950's and early 1960's presented the results of the first three years of intensive surveys (Morgan, 1954; Watson, 1955; Wheeler, 1955; Wheeler, 1963; Wheeler and Watson, 1963).

The group existed in a formal sense until 1962 when it combined with other similar interest groups to form the Victorian Ornithological Research Group. While it existed, the group conducted the first large-scale survey work by an interested group of amateurs, the first large-scale bird-banding, and the first life-history study of a bird (the Silver Gull) anywhere in Australia. A history of the Altona Survey Group from 1950 to 1962 is provided by Wheeler (1981).

The Victorian Ornithological Research Group continues to this day to be involved in detailed research on Victoria's birds. Many of the people involved in the Altona Survey Group and the Victorian Ornithological Research Group contributed enormously to the development of ornithology in Victoria and indeed Australia in

the intervening years through their active involvement in these groups. Their enthusiasm also contributed to the rennaissance in the mid 1970's of the Royal Australasian Ornithologists' Union (RAOU) which has since become the most repected and influential ornithological research and conservation body in Australia. Laverton Saltworks and the interest which it generated among Melbourne bird watchers therefore had a fundamental influence on the future course of amateur-based ornithology in Australia.

In the 1960's, Mr Fred Smith, a Melbourne-based amateur ornithologist regularly visited the Laverton Saltworks to observe shorebirds. He published annual summaries of his observations there as well as at other sites in Victoria in the journal and newsletter of the Bird Observer's Club ("The Australian Bird Watcher" and "The Bird Observer"). In recent years he has ceased publishing his records, although he continues to visit the area regularly.

In 1976, a small group of bird banders, led by Dr David Robertson of Melbourne, attempted to start a shorebird banding program at the Laverton Saltworks. This proved unsuccessful because of the difficulty of catching the birds and the group's operations soon moved to the The Spit Fauna Reserve on the southern coast of the MMBW's Werribee Sewage Treatment Complex. In 1978, Dr Clive Minton, a British shorebird bander settled in Melbourne and with David Robertson started the Victorian Wader Study Group, under the umbrella of the Victorian Ornithological Research Group.

The first systematic census of shorebirds on the Victorian coast was organised by the Victorian Wader Study Group by Peter Dann who was a postgraduate student at the Department of Zoology at Melbourne University. The census was conducted in December 1979 and the Laverton Saltworks was included in the count.

Although banding did not work at Laverton, the group concentrating their activities initially at The Spit, the interest generated led to the establishment in 1981 of the Royal Australasian Ornithologists' Union Wader Studies Program. This aimed to investigate the status and distribution of shorebirds throughout Australia.

In February 1981, the first national wader count was organised by the RAOU. Each February and June-July until 1985, the saltworks were systematically surveyed for shorebirds. In 1986, with the end of the Wader Studies Program, the Australasian Wader Studies Group (AWSG), a special interest group within the RAOU which grew out of the RAOU program under the chairmanship of Dr Minton and later Mr Mark Barter, took over the running of shorebird counts on a voluntary basis. Ever since then, the February and June-July counts have continued throughout Port Phillip Bay, including at the Laverton Saltworks.

In 1987, the RAOU organised the first Victorian Wildfowl Count, to determine the numbers and distribution of wildfowl throughout the state. This project was designed to gather information on the summer status of wildfowl in Victoria to assist with the development of effective controls on duck hunting which in the 1980's was growing at an unprecedented rate. In 1988, the Laverton Saltworks were first included in the network of hundreds of count sites in Victoria. These counts continue to this day.

In 1989, a series of counts of all waterbirds were done as part of the current heritage study and these are continuing on a

monthly basis. Data are being collected on changes in waterbird usage of each pan in the saltworks over time to determine the relationship between waterbird habitat usage and quality, and the salt production process. This information will eventually enable appropriate management of the area for waterbirds once salt production ceases.

In 1986, the Victorian Department of Conservation and Environment commenced a study of sites of nature conservation significance in the Melbourne Metropolitan area. These investigations aimed at identifying important sites for the protection of geological, geomorphological, botanical and zoological features in the region. The western region of Melbourne was studied from 1987 to 1990. The Laverton Saltworks were included in this survey, the results of which have been published (geology and geomorphology - Rosengren 1987; botany - McDougall, 1987) or are due to be published shortly (zoology - Beardsell et al. in prep.).

The investigations by the Altona Survey Group in the 1950's as well as the recent work by the RAOU, AWSG and Department of Conservation and Environment have enabled an excellent picture to be constructed of the natural features of the Laverton Saltworks and of the conservation significance of these features in a wider state and national context. Much of what follows is based on the results of these investigations.

3 METHOD

3.1 FLORA AND FAUNA SURVEY

Field Survey

Five visits were made to the saltworks on the following dates: 3rd August, 4th September, 25th October and 30th November 1989, and 28th March 1990. During these visits, a standard route was followed (see Fig 9) incorporating all areas of coastal lagoons and salt evaporation pans up to about 25% salinity, all areas of terrestrial habitat (grassland, dunes, etc.) in the eastern portion of the saltworks and the beaches and creek mouths along the coast.

During these visits, the following information was collected:

- nature and distribution of plant communities;
- records of all sightings and signs of mammals, reptiles and frogs;
- counts of all waterbirds on each lagoon or evaporation pan;
- records of all sightings of other birds.

Each lagoon and evaporation pond on the saltworks was given a number. These are also shown in Figure 9.

Additional Information

Data gathered during the field survey were supplemented by the following unpublished records:

- the Royal Australasian Onithologists Union (RAOU) and Australasian Wader Studies Group (AWSG) wader counts (Feb and June/July 1981 to 1990);
- the RAOU annual wildfowl counts (1988-1990); and
- the Atlas of Victorian Wildlife data base held by the Department of Conservation and Environment Wildlife Management Branch.

As well, the published literature and a number of government reports were reviewed for relevant information on the flora and fauna of the saltworks.

3.2 ABORIGINAL SURVEY

Following initial reconnaissance of the site, examination of aerial photographs from several periods including the most recent available, and a survey of previous archaeological studies, certain locations were identified as having potential for preservation of Aboriginal sites. These locations consist of the small remnants of undisturbed land along Skeleton Creek and on some of the remnant sand ridges from earlier coastlines along the bay. The most likely areas for survival of sites are on relatively undisturbed ground but as more than 90 % of the saltworks land has been drastically modified through construction of salt pans, drains, channels, roads, tramways and buildings, the potential for site preservation is low.

A predictive model for the study area suggests that Aboriginal sites would be found on the banks of Skeleton Creek above the flood prone zone and on the higher ground of the basalt plain adjacent to swamps. (du Cros 1989a, 1989b)

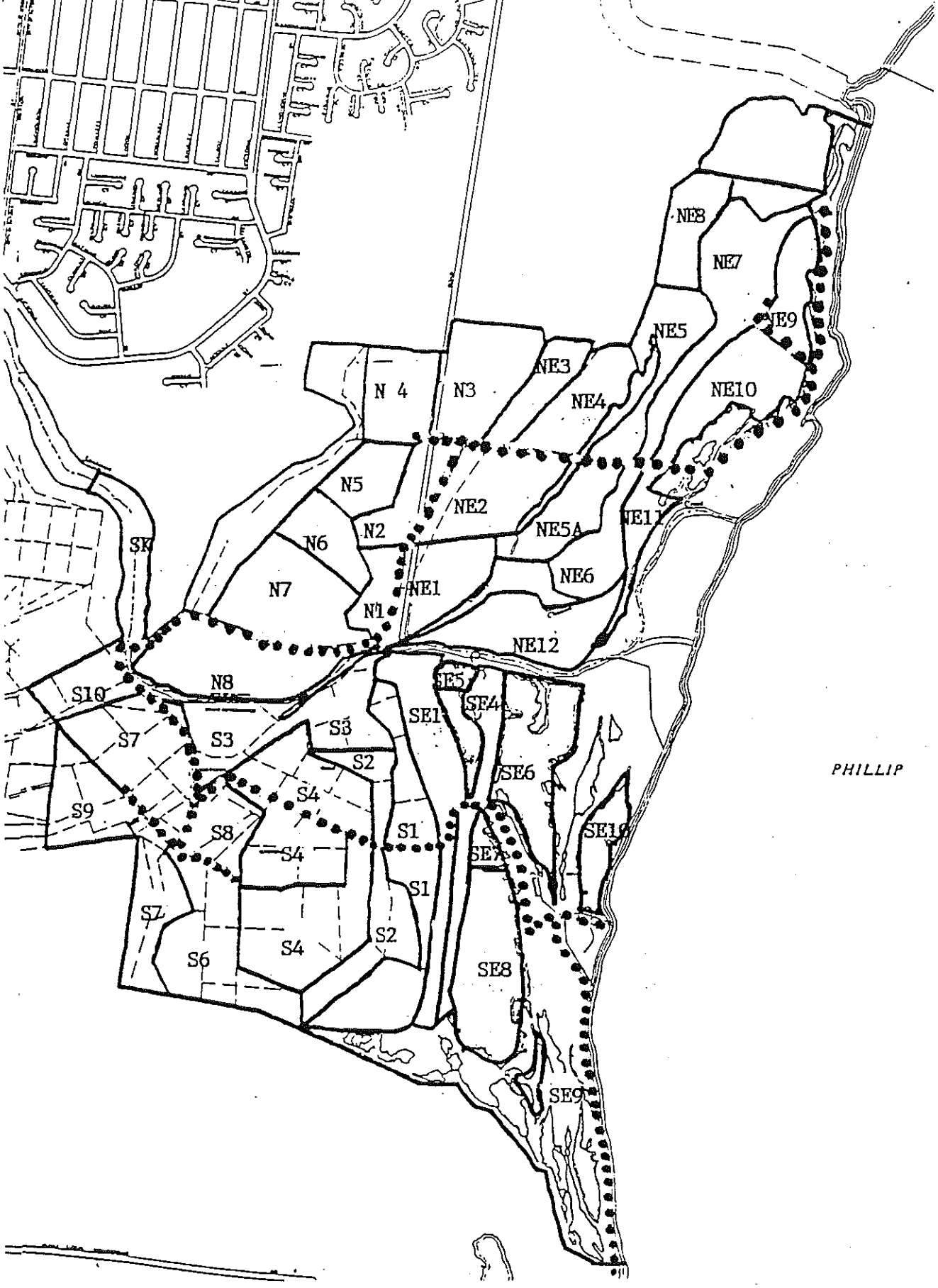


Figure 9. Survey Route for observation of bird numbers and key to pond numbers

NE10 Lagoon number

•••• Route taken during survey

These areas were then surveyed over a total of three days, one day in September 1989 and two in March 1990. Winter and summer survey was carried out in order to assess the effect on site visibility of ground cover and erosion.

Sites were then recorded and photographed and VAS Site Record Cards completed. Information of the type, extent and location of the site were included as well as a description of artifacts and features. It was initially intended that survey areas would be chosen in order to cover representative landform types. There are basically three landforms in the survey area:

1. Delta flats have been formed by the alluvial deposits of the Skeleton Waterholes creek with saltmarshes and remnant swamps. A few small natural shallow lakes and water courses survive in what is predominantly a drastically altered man-made environment of salt pans, drains, channels and raised roadways.

2. Volcanic plains occur adjacent to the delta flats and are generally covered in native and introduced grasses growing in a shallow clay soil. There is a gentle slope towards the creek and bay. As the boundary of the study area generally follows the interface between the alluvial delta and the surrounding higher ground of the basalt, only a small area of this land form occurs in the study area.

3. Coastal sand ridges have been formed at the eastern edge of the site where beach sand is deposited. Much of this land form has been created in the recent past (ie last 150 years) and so is unlikely to contain Aboriginal sites.

Figure 10 shows the location of the area surveyed for Aboriginal sites in relation to the three land forms.

3.3 HISTORICAL AND INDUSTRIAL SURVEY

Historical and industrial features were located in the same way as aboriginal sites. A combination of aerial photo interpretation and on-ground survey were used following a literature search which identified the type of artifacts and features likely to be found. As there have beeen changes in the layout of the site, a comparison was made between aerial photographs from various years, particularly 1951, 1984 and 1987, and maps and plans of various periods in order to identify stages in the development of the site.

Field survey of historic and industrial sites was conducted on five days when sites were mapped and photographed. Historical research and discussions with Mr Bruce Howard facilitated the description of the equipment, its uses and the processes involved.

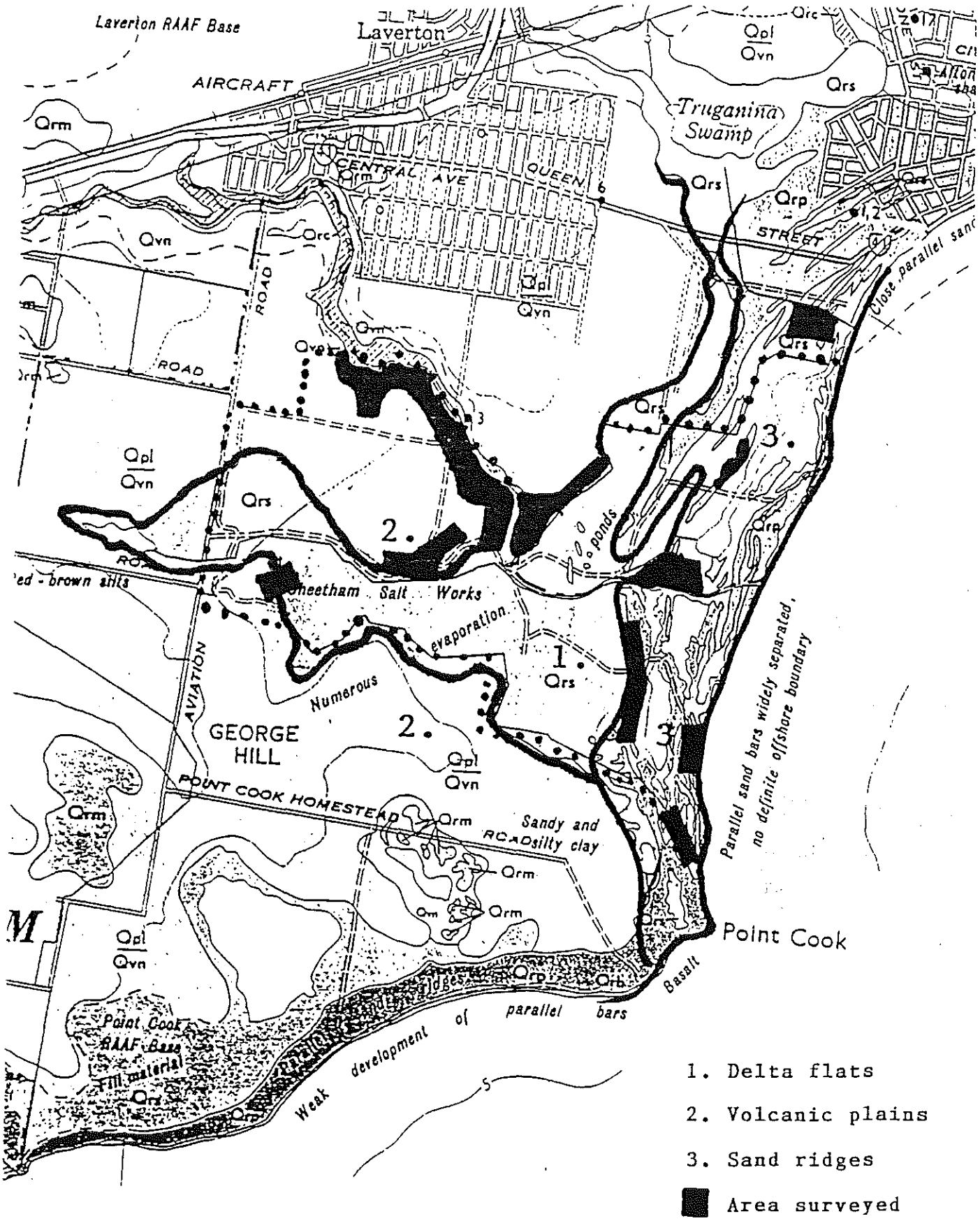


Figure 10. Land Forms and area surveyed
(Basemap = Geological Survey, Melbourne sheet SJ55.)

4 RESULTS

4.1 BIRDS

Some 201 species of bird have been recorded in the Laverton Saltworks (Garnett, et al. 1986) These are listed in Appendix 1. Of these, 102 regularly occur in good numbers. This section of the report summarizes the available information on birds of the saltworks and presents the results of the field surveys. Each major group of birds is dealt with separately under the following headings:

- shorebirds;
- wildfowl;
- large wading birds;
- terns;
- pelican and cormorants;
- other water birds; and
- terrestrial birds.

For each group, the wider significance of the Laverton Saltworks is discussed in terms of its local (Altona region), regional (Port Phillip Bay), state, national and international context. This is followed by a detailed discussion of how the saltworks are used by that group.

The Laverton Saltworks are of international significance for birds (Lane, et al. 1984). The coastal Crown Land south of Skeleton Creek has been listed as a wetland of international importance under the Ramsar Convention and many of the migratory waterbirds which occur in the area are listed on the annexes of the Japan-Australia and China-Australia Migratory Birds Agreements (JAMBA and CAMBA).

Shorebirds (Waders)

Shorebirds (or waders) are the most significant group of birds on the saltworks. Some 34 species of migratory and 13 species of resident shorebirds have been recorded. The migratory species breed in northern Asia and Alaska in June and July, migrating southwards between July and November. The first birds reach the saltworks in late August and numbers continue to rise until most have arrived by the end of November. They depart again from mid-February until most have gone by the end of April. The return migration to the northern hemisphere breeding grounds lasts from mid-February until early June.

Figure 11 shows the relationship between the Laverton Saltworks and other wetlands in the Altona region in terms of the feeding and roosting behaviour of shorebirds.

Shorebirds in the Altona region feed at low tide on intertidal mudflats on the Seaholme foreshore and Williamstown Rifle Range either side of the mouth of Kororoit Creek, on the coast of the saltworks and on the southern coast of the Point Cook Metropolitan Park and RAAF Base. During the high tide period, they move to roost on undisturbed areas of beach, in near-coastal wetlands and in the coastal and saline lagoons of the Laverton Saltworks. The saltworks are by far the most significant high tide habitat for shorebirds in the Altona region. Furthermore, a rich invertebrate fauna in the coastal lagoons and evaporation pans of the saltworks provides a rich supplementary food supply. This enables the birds to continue feeding over the high tide

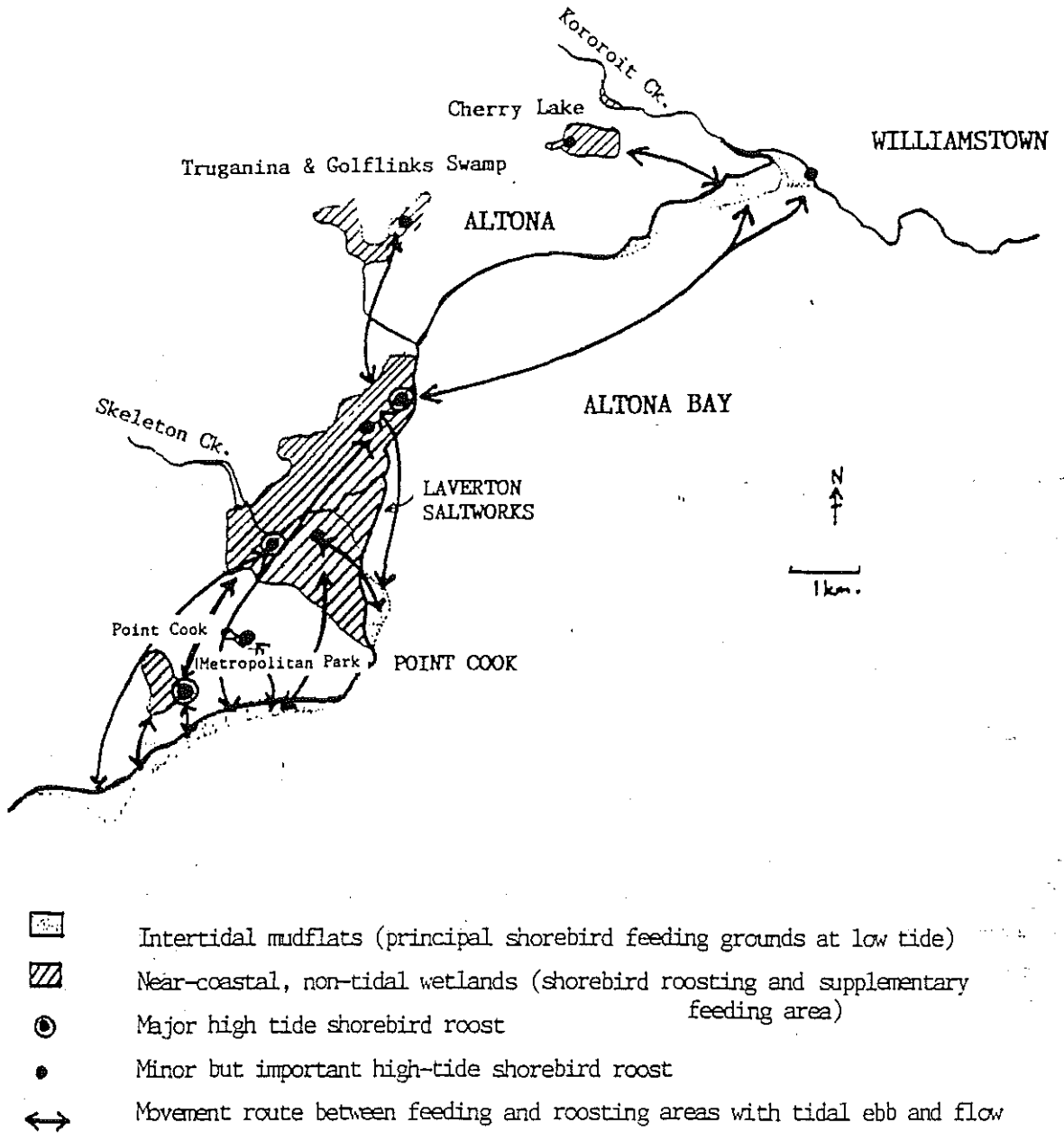


Figure 11. Map of the Altona-Laverton region showing shorebird usage and context of the Laverton Saltworks.

period.

Table 1 gives the average number of each species of shorebird counted on the saltworks from 1981 to 1990 (from RAOU/AWSG unpublished data base). These results are also expressed as a percentage of the equivalent figure for Port Phillip Bay (1981-90), for Victoria (1981-85) and of the national population (based on Watkins, in prep.). Migratory and resident species are indicated.

This table shows that 0.4% of Australia's migratory shorebirds regularly use the Laverton Saltworks in the summer months. The percentage is higher for some species. More than 1% of the national populations of the Red-necked Stint and Curlew Sandpiper regularly use the saltworks. A wetland which regularly holds more than 1% of the biogeographic population of a waterbird qualifies for inclusion on the list of wetlands of international importance under the Ramsar Convention. The saltworks are thus internationally significant for these shorebird species.

Table 1 shows that the area supports more than 5% of the migratory shorebirds in Victoria and just under 5% of the total resident shorebirds in Victoria. Accordingly, using the criterion of Lane et al. (1984), they are of state significance for this group of birds. The species for which the saltworks are of state significance are: Banded Stilt (8.1%), Red-necked Avocet (9.1%), Marsh Sandpiper (8.7%), Black-tailed Godwit (5.4%), Sharp-tailed Sandpiper (5.9%), Red-necked Stint (5.6%) and Curlew Sandpiper (8.4%).

Table 1 also shows that over 13% of the migratory shorebirds and more than 15% of the resident shorebirds which regularly occur in Port Phillip Bay occur in the Laverton saltworks. For some species, the Laverton Saltworks support a higher proportion. More than 5% of the Port Phillip Bay population of most species of shorebird in the bay occur on the Laverton Saltworks. Regionally, the area is of greatest importance for Red-necked Avocet (27.3%), Banded Stilt (25.9%), Curlew Sandpiper (17.4%), Red-necked Stint (14.5%), Marsh Sandpiper (14.3%), Black-winged Stilt (13.6%) and Sharp-tailed Sandpiper (11.5%).

To summarize, the Laverton Saltworks are of international, state and regional significance for shorebirds. They are the most important high tide roost for shorebirds in the Altona region and they provide the largest supplementary high tide feeding habitat for shorebirds in this region. The survival of a substantial proportion of the shorebird populations in the Altona region and in Port Phillip Bay depends on the Laverton Saltworks.

Some areas of the Laverton Saltworks are used more frequently or by larger numbers of shorebirds than others. Patterns of usage vary between species. Figures 12 to 23 show the percentage of the total numbers of each shorebird species observed on each lagoon during the field survey.

The small migratory shorebirds (Sharp-tailed Sandpiper, Red-necked Stint and Curlew Sandpiper) occurred on most lagoons but had a preference for NE9, NE10, N7, S2, S3, S6, S8, SE6 and SE7/8. They occurred in lagoons with salinities up to 18%.

Table 1: Average counts of shorebirds at Laverton Saltworks in regional, state and nation context.

SPECIES	LAVERTON COUNT	PPBAY COUNT	% PPBAY	VIC. COUNT	% VIC.	NATIONAL COUNT	% NAT'L.	RATING‡
Years	1981-90	1981-90		1981-85		1981-90		
MIGRANTS (Summer only)								
Lesser Golden Plover	1	231	0.4	448	0.2	7000	0.0	
Double-banded Plover	6	1162	0.5	2967	0.2	7000	0.1	
Wood Sandpiper	‡	1	0.0	5	0.0	500	0.0	
Grey-tailed Tattler	‡	33	0.0	53	0.0	17000	0.0	
Common Sandpiper	‡	3	0.0	9	0.0	?		
Greenshank	33	556	5.9	1216	2.7	20000	0.2	R
Marsh Sandpiper	16	112	14.3	183	8.7	8000	0.2	R S
Lathaa's Snipe	3	66	4.5	227	1.3	36000	0.0	
Black-tailed Godwit	2	24	8.3	37	5.4	82000	0.0	R S
Red Knot	‡	533	0.0	3480	0.0	160000	0.0	
Sharp-tailed Sandpiper	1083	9428	11.5	18209	5.9	155000	0.7	R S
Red-necked Stint	2774	19186	14.5	49638	5.6	260000	1.1	R S I
Long-toed Stint	‡	1	0.0	1	0.0	500	0.0	
Curlew Sandpiper	2419	13889	17.4	28655	8.4	140000	1.7	R S I
Ruff	‡	1	0.0	2	0.0	?		
Wilson's Phalarope	‡	‡		‡		‡		
TOTAL MIGRANTS	6337	47877	13.2	122618	5.2	1500000	0.4	
RESIDENTS (Summer & Winter)								
Pied Oystercatcher	2	122	1.6	1324	0.2	9000	0.0	
Sooty Oystercatcher	‡	2	0.0	199	0.0	2000	0.0	
Masked Lapwing	23	671	3.4	3063	0.8	260000	0.0	
Banded Lapwing	‡	6	0.0	82	0.0	?		
Red-kneed Dotterel	5	100	5.0	510	1.0	26000	0.0	R
Red-capped Plover	51	525	9.7	3149	1.6	100000	0.1	R
Black-fronted Plover	‡	50	0.0	368	0.0	16000	0.0	
Black-winged Stilt	74	543	13.6	1869	4.0	280000	0.0	R
Banded Stilt	504	1946	25.9	6248	8.1	150000	0.3	R S
Red-necked Avocet	234	858	27.3	2585	9.1	105000	0.2	R S
TOTAL RESIDENTS	893	5748	15.5	19563	4.6	948000	0.1	

‡ Rating: R = Regionally significant population (>5% PPBay)
S = State significant population (>5% Victoria)
I = Internationally significant population (>1% Australia)

Figure 12. Occurrence of Sharp-tailed Sandpiper at Cheetham Saltworks, Laverton

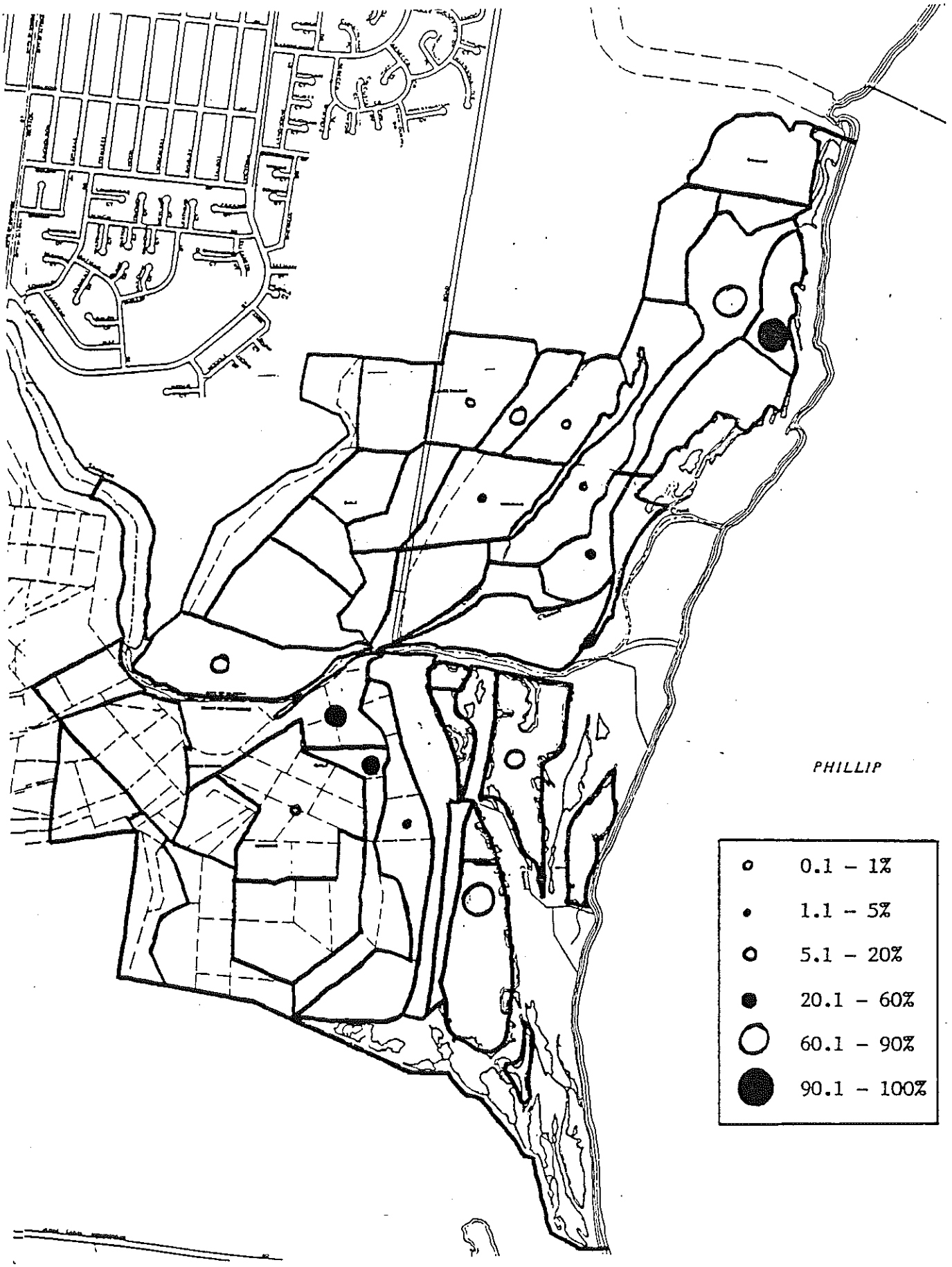


Figure 13. Occurrence of Red-necked Stint
at Cheetham Saltworks, Laverton

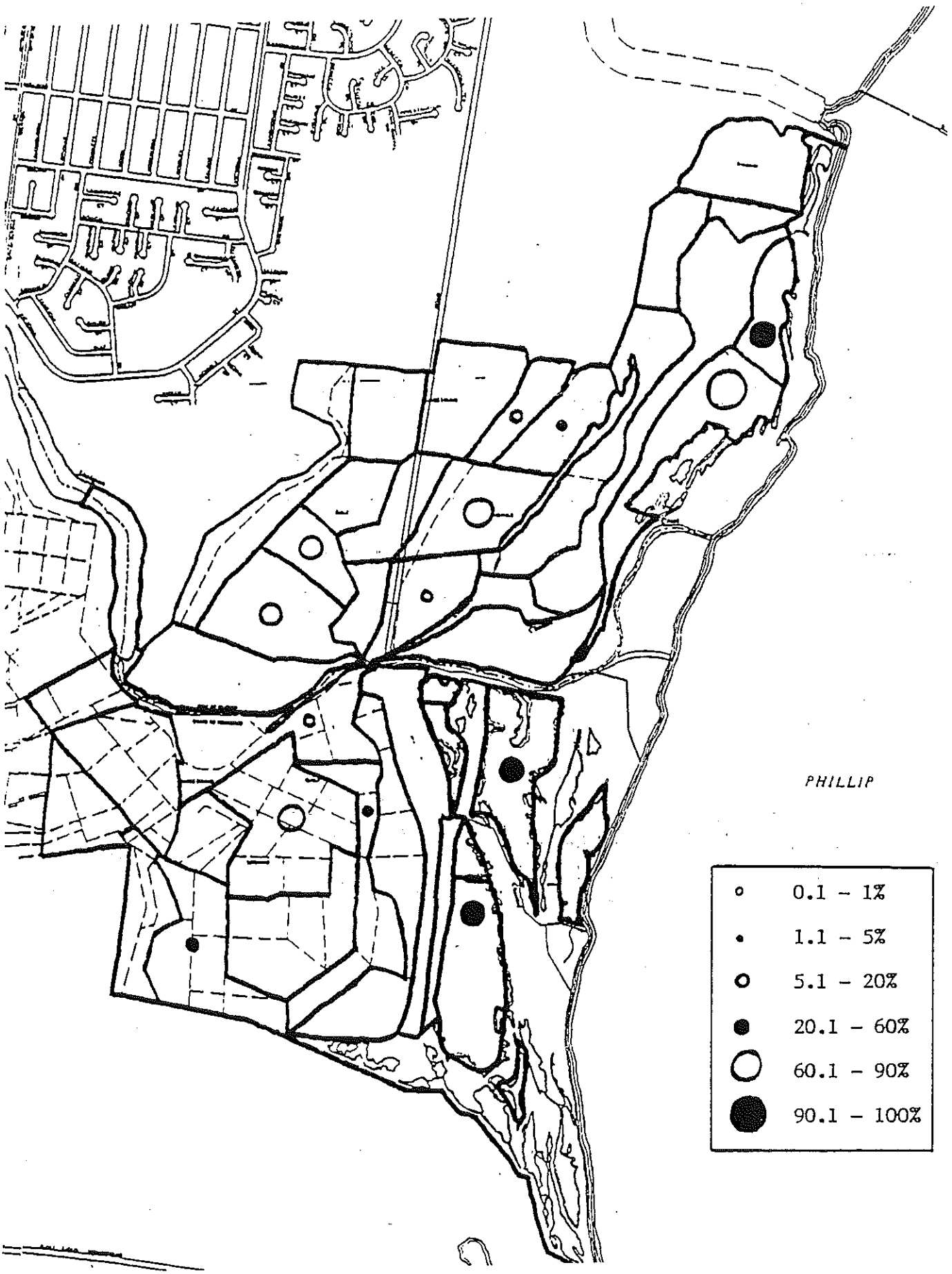
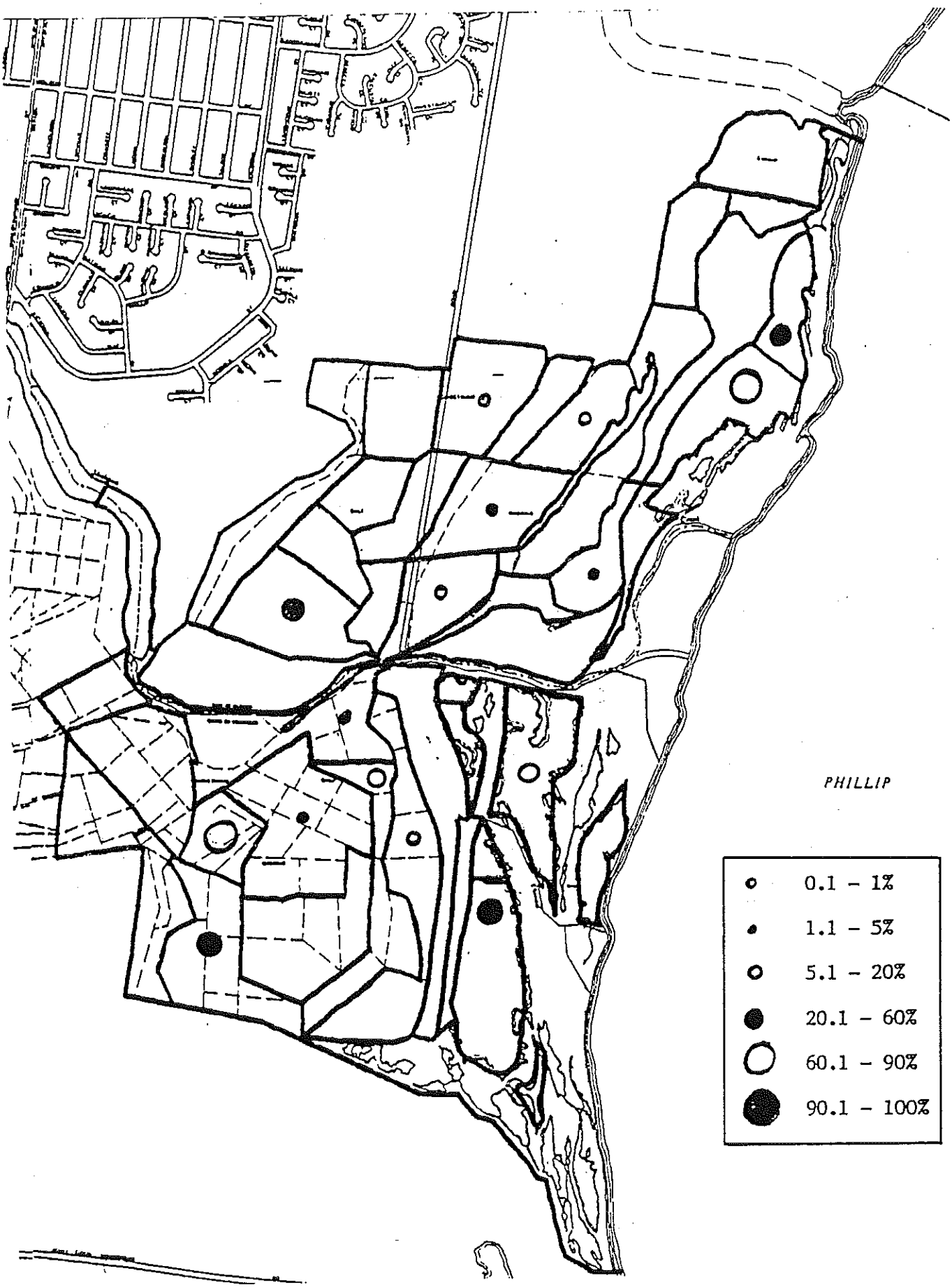


Figure 14. Occurrence Of Curlew Sandpiper
at Cheetham Saltworks, Laverton



The Greenshank (Fig. 15) occurred on many lagoons but NE5, N7, N8, S3, S4 and SE7/8 held most of them. They occurred in lagoons with salinities up to 18%.

The Marsh Sandpiper (Fig 16) was observed on only five lagoons, with salinities up to 18%, with N7 and SE4 being particularly preferred.

Double-banded Plovers are a winter visitor to the saltworks from breeding grounds in the south island of New Zealand. They seldom feed in the saltworks but roost there at high tide after feeding at low tide on the intertidal mudflats on the coast of the saltworks, and Point Cook Metropolitan Park and RAAF Base. They roosted exclusively on lagoon NE10.

Red-capped Plovers (Fig 17) are a resident species, breeding in the saltworks and elsewhere in coastal and inland parts of Australia. They occurred on many lagoons with salinities up to 25%. Most occurred on lagoons NE10, S6 and S8 as well as along the sandy beaches on the coast of the saltworks.

Black-winged Stilts (Fig 18) were widespread on lagoons up to 18% salinity but most occurred on lagoons with a salinity of 9% or less, notably NE4, NE5, NE6 and NE7. Up to 30 pairs were breeding in October and November 1989, building small platform nests of algae and saltmarsh twigs on small islands in the evaporation pans in the northern part of the area listed above.

Banded Stilts occurred only once during the survey: a flock of 280 birds on lagoon S9 (salinity c. 18%) in March 1990. The 1989-90 period was very wet with the result that most Banded Stilts spent the summer inland; in drier years, up to several thousand can be seen in the area. Previous observations show that they generally prefer lagoons with salinities above 9%, especially S4 and S3 (pers. obs.).

Red-necked Avocets (Fig 19) are more catholic in their choice of lagoons than Banded Stilts. Most occurred on N7, S3 and S6, although small numbers also occurred elsewhere in the area.

The salinity, depth and shape of lagoons appear to influence their usage by shorebirds. Generally, the small shorebirds can only use the shallowest lagoons, although they vary in the range of salinities they can tolerate. The larger the shorebird, the deeper the water in which it can feed. The Red-necked Avocet and Banded Stilt commonly swim while feeding and are capable of feeding in all but the very deepest lagoons. The two small plovers on the other hand, being visual feeders, rarely feed in water, preferring to take insects and larvae which they can see from mudflats and shores. As the depth of the lagoons varies depending on pumping and evaporation, shorebirds would be expected to use different lagoons at different times. Time constraints precluded a detailed analysis of the data to document changes in shorebird usage in response to this. Table 2 summarises the preferred habitats of the common shorebirds in the Laverton Saltworks.

SPECIES	HABITAT					
	Salinity (%)				Depth*	
	3.5	9	18	25	S	D
Red-capped Plover	<--------->				X	
Black-winged Stilts	<--------->				X	X
Banded Stilts		<--------->				X
Red Necked Advocet		<--------->			X	X
					X	X
Greenshank	<--------->				X	
Marsh Sandpiper	<--------->				X	
Sharp-tailed Sandpiper	<--------->				X	
Red-necked Stint	<--------->				X	
Curlew Sandpiper	<--------->				X	

*Depth: S = shallow (<0.15m); D = deep (>0.15m).

Table 2: Lagoon Salinity and deapth preference of common species of shorebirds at Laverton Saltworks

Figure 15. Occurrence of Greensank at Cheetham Saltworks, Laverton

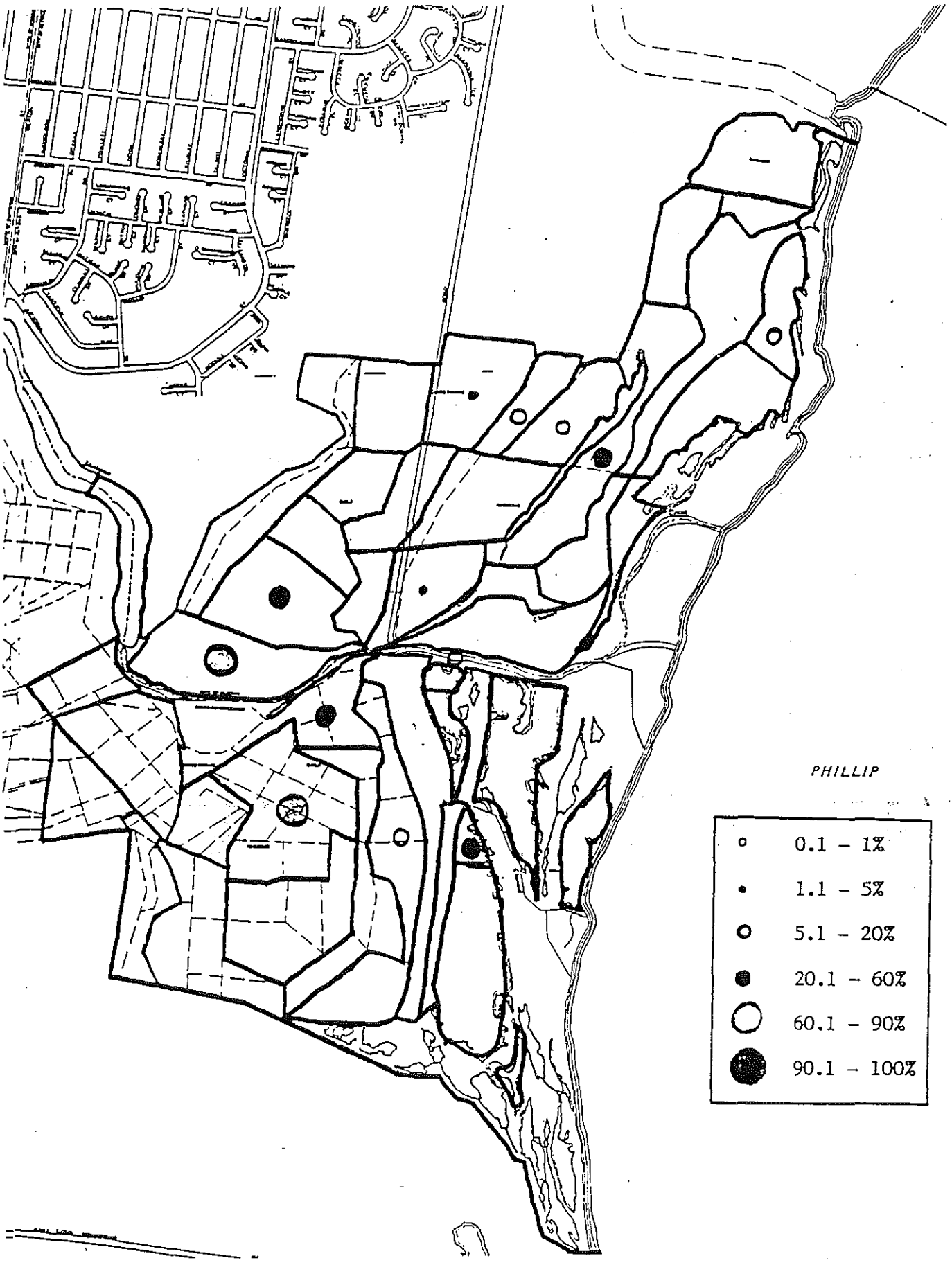


Figure 16. Occurrence of Marsh Sandpiper at Cheetham Saltworks, Laverton

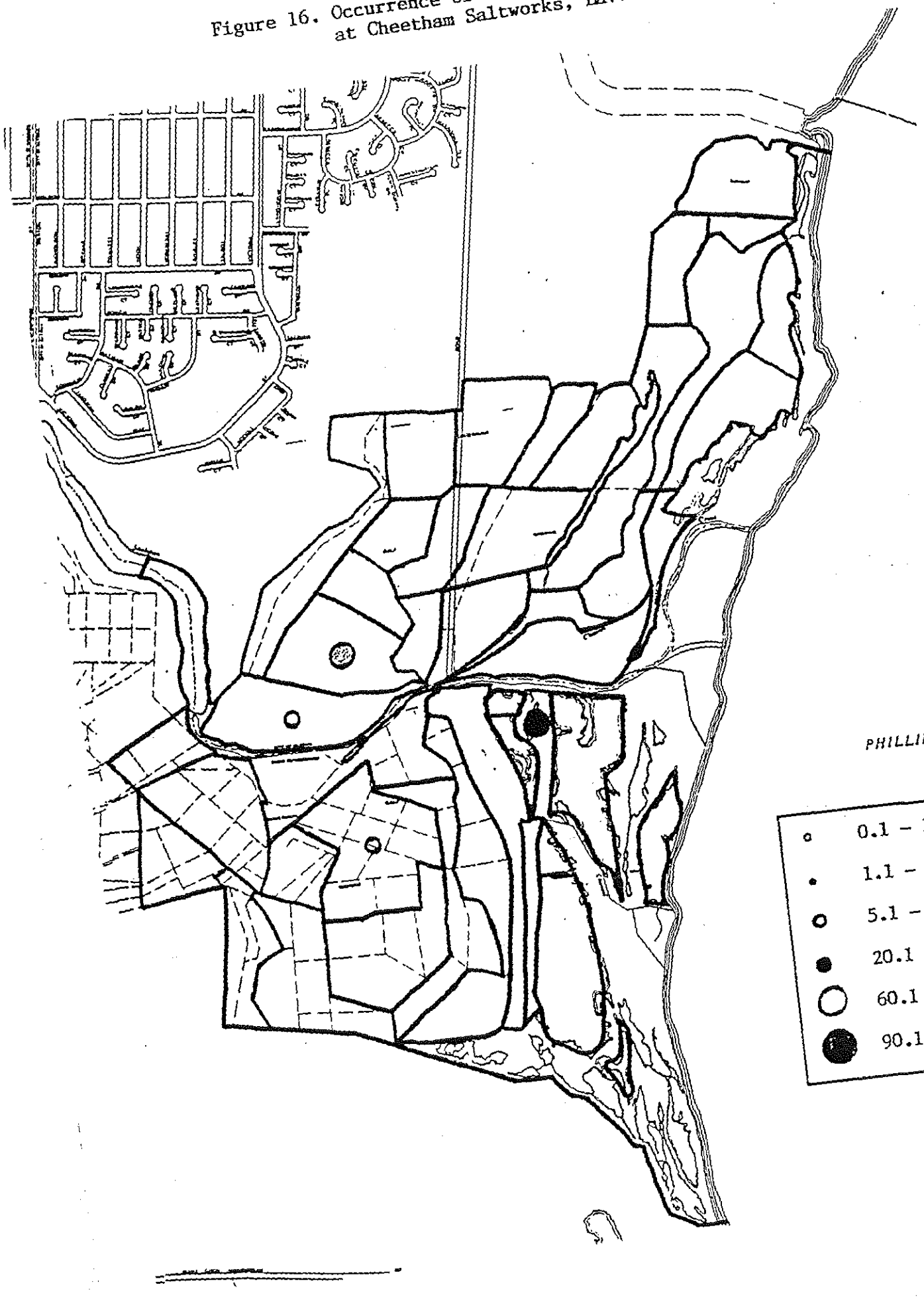


Figure 17. Occurrence of Red-capped Plover at Cheetham Saltworks, Laverton

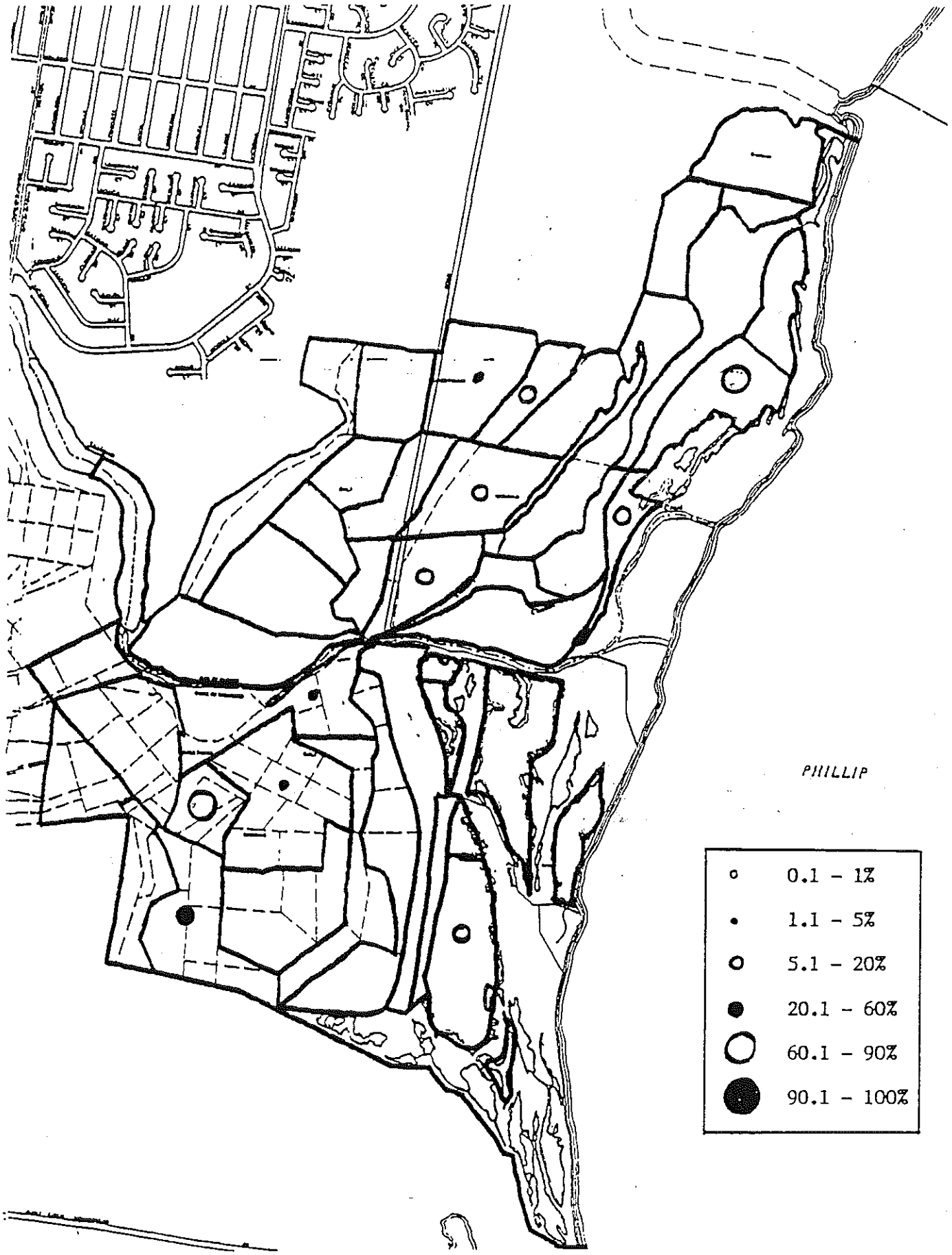


Figure 18. Occurrence of Black-winged Stilt at Cheetham Saltworks, Laverton

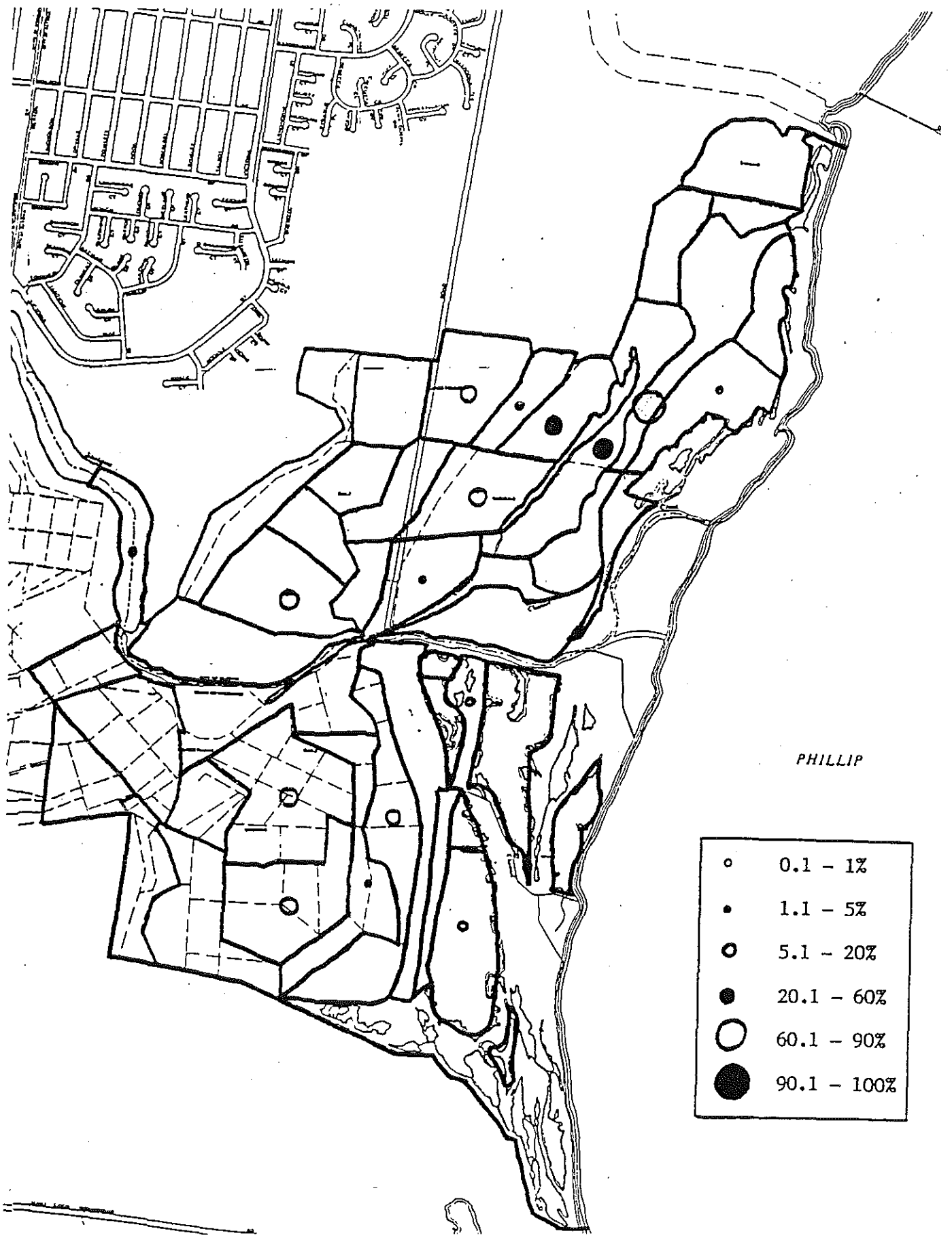
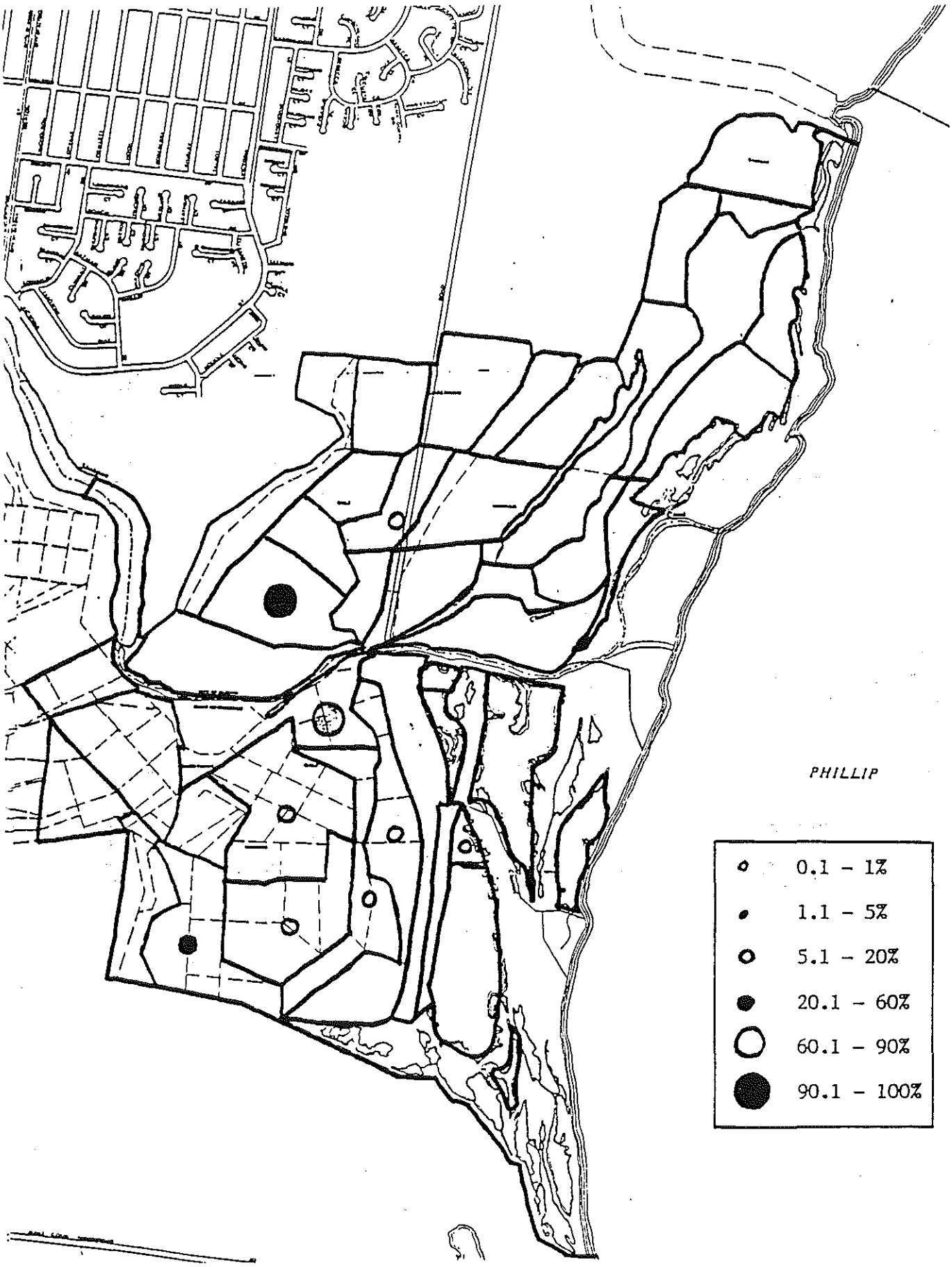


Figure 19. Occurrence of Red-necked Avocet at Cheetham Saltworks, Laverton



Wildfowl (Ducks and Swans)

After the shorebirds, the wildfowl are the most significant group of birds on the Laverton Saltworks. A total of 25 species of wildfowl have been recorded on the saltworks.

Wildfowl in Victoria respond to continental-scale changes in rainfall and consequent wetland habitat availability. They tend to move inland in winter and coastward in summer. However, droughts can force them to stay in coastal areas for extended periods and inland floods can keep them inland for considerable periods. Morgan (1954) described the changes in numbers of wildfowl at Laverton Saltworks in the early 1950's in relation to their movement patterns. He found that numbers were generally higher in spring, summer and autumn. A similar pattern was observed during the current study, although it was complicated by there being a different salt production regime (see later).

The saltworks are one of three principal wildfowl habitats in the Altona Region. The other two are Cherry Lake and Spectacle Lake in the Point Cook Metropolitan Park. Some species, notably Chestnut Teal also use the nearshore shallow waters off the saltworks and at the north end of Altona Bay either side of the mouth of the Kororoit Creek.

Table 3 gives the average numbers of each wildfowl species counted during the RAOU's annual wildfowl counts since 1988, for the Laverton Saltworks and Port Phillip Bay. The results for Laverton Saltworks are also presented as percentages of the Port Phillip Bay populations. The table shows that about 2 % of the wildfowl in Port Phillip Bay regularly use the Laverton Saltworks in February, when numbers in Victoria are usually near their peak. The only species which reaches the 5% regionally significance level is the Grey Teal, with 6.2% of the bay population. In two of the three years considered (1988 and 1990), Australian Shelduck (Fig 22) also attained regionally significant numbers. These findings indicate that the Laverton Saltworks are of regional significance for Grey Teal and Australian Shelduck.

The wildfowl were recorded in largest numbers on coastal lagoons and evaporation pans generally deeper than 10 centimetres and with a salinity of up to 9% (see Figures 20,21 and 22). Their preference for the deeper lagoons resulted in a degree of complimentarity between waders and wildfowl in their usage of habitat in the saltworks. However, lagoons with uneven shorelines, islands for roosting and varying depths, such as SE6, SE7, SE8, N7 and N8 held good numbers of both groups of water bird.

Black Swans (Fig 23) were confined to fresh water and lagoons with a salinity of up to 9%, favouring NE5, N7 and N8.

Large Wading Birds

This group (the Ciconiiformes) includes the herons, egrets, ibises and spoonbills. Eight species have been recorded on the Laverton Saltworks, six of which occur regularly. Data are not available on the populations and movements of these birds in Victoria, so it is difficult to place the saltworks in their wider context. Suffice it to say that some species, especially White-faced Heron and Royal Spoonbill, are a significant component of the area's birdlife. Furthermore, Little and Great Egrets occur more regularly at the saltworks, albeit in small

Table 3. :Maximum counts of ducks and waders at Laverton Saltworks.

SPECIES	MAXIMUM COUNT			
	1950-53	1989-90	1988-90	1981-90
Source:	ASG	CI	RAOU	RAOU
DUCKS/ETC				
BlSw	340	242	242	
Shel			654	
PaBD	232	8	7	
GrTl	5600	2169	1101	
ChTl	5	591	294	
AShv	190	0	0	
PeaD	400	0	0	
HHGr	150	26	0	
Coot	0	83	0	
WADERS				
MLap	308	56		115
LGPl	110	36		5
DbPl	240	305		43
RcPl	200	100		249
BwSt	350	203		178
BaSt	900	280		3650
RnAv	510	133		1476
Tust	4	1		1
Grsh	40	52		58
MaSp	4	15		65
ReKn	0	3		7
BtGw	48	1		1
StSp	2133	713		2640
RnSt	2250	5437		8800
CuSp	1000	2073		7400
Ruff	0	1		2

Source:
ASG = Altona Survey Group
CI = Current Investigation
RAOU = Roy. Austr. Orn. Union
See over page for key to species

Figure 20. Occurrence of Chestnut Teal at Cheetham Saltworks, Laverton

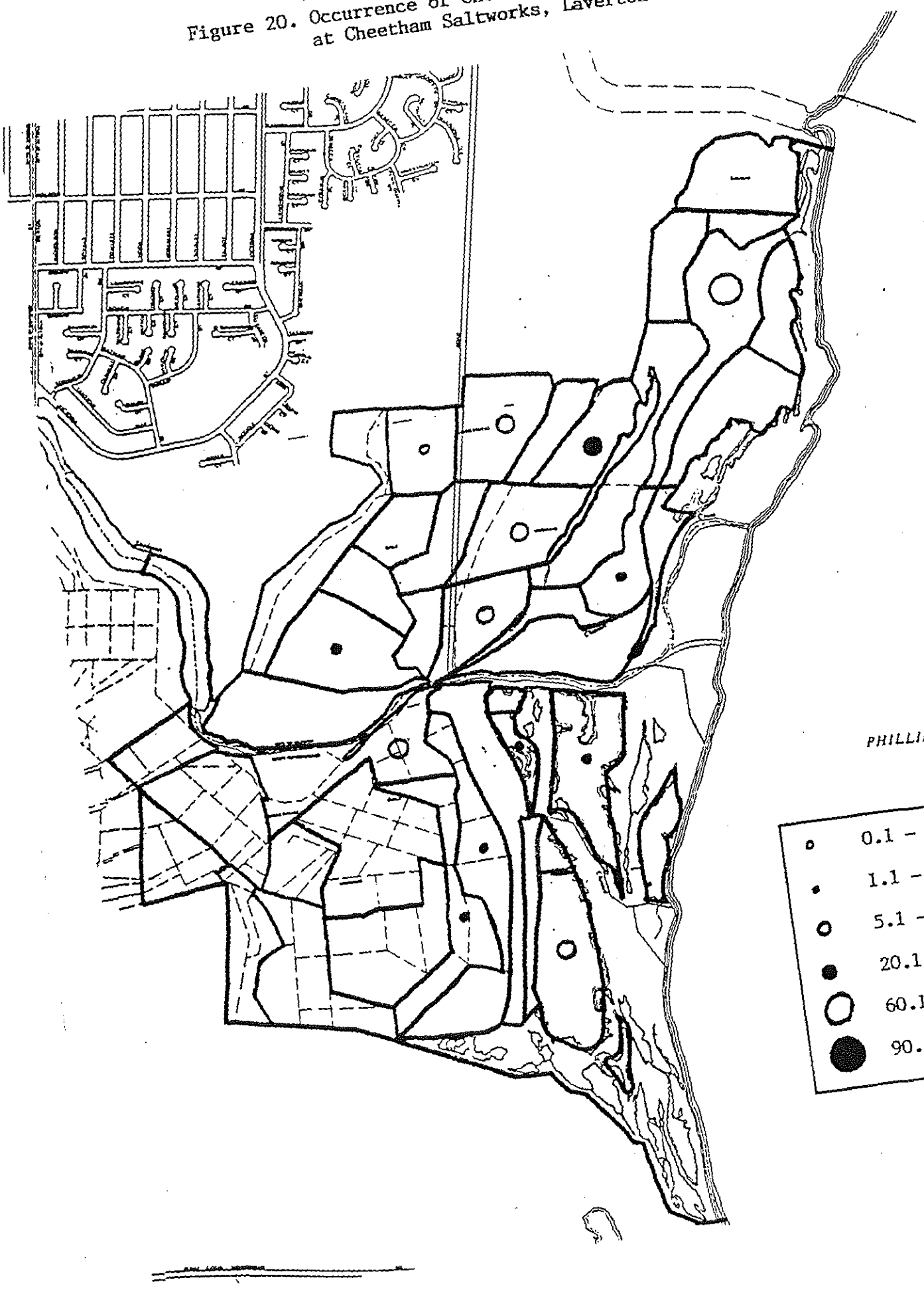


Figure 21. Occurrence of Grey Teal at Cheetham Saltworks, Laverton

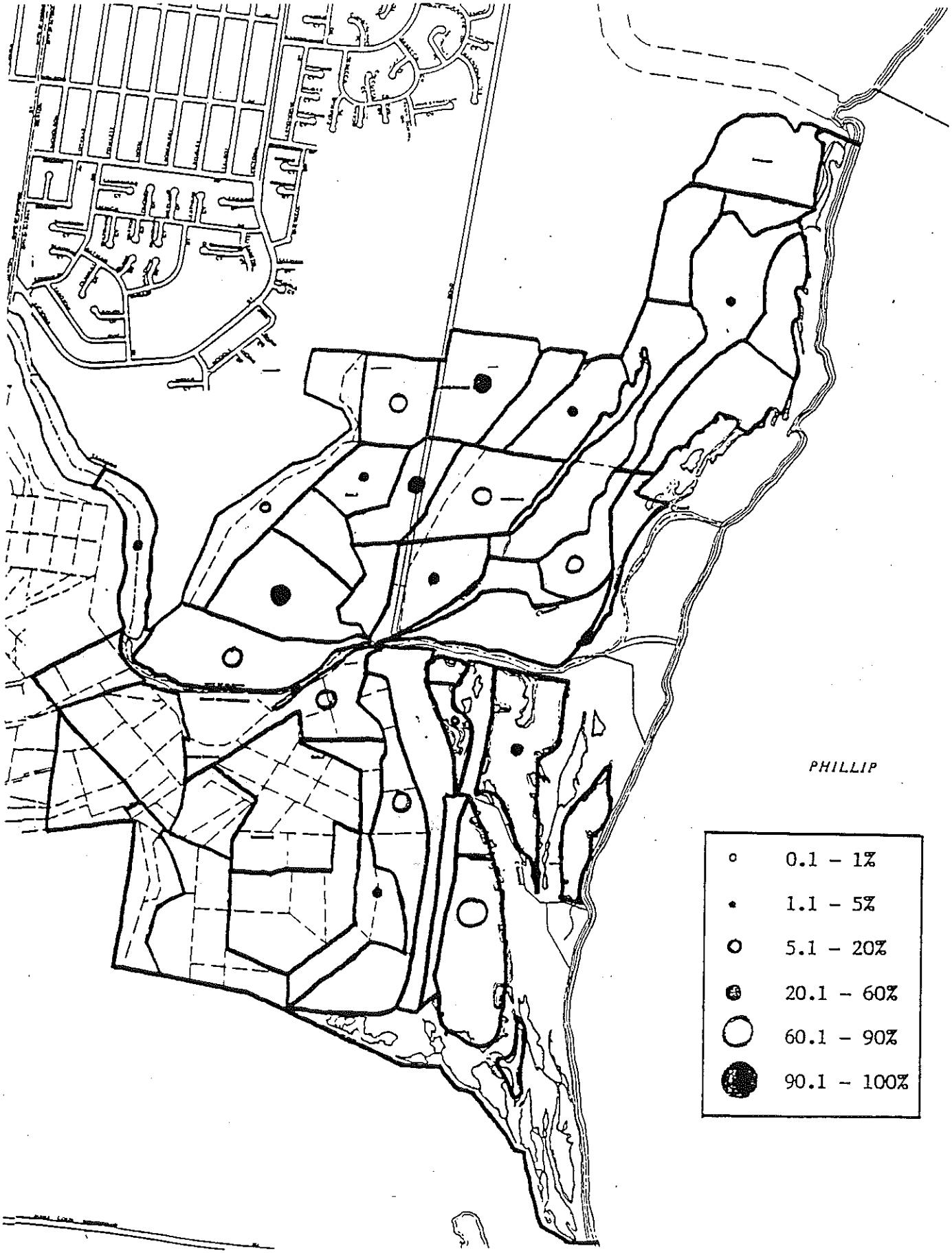


Figure 22. Occurrence of Australian Shelduck at Cheetham Saltworks, Laverton

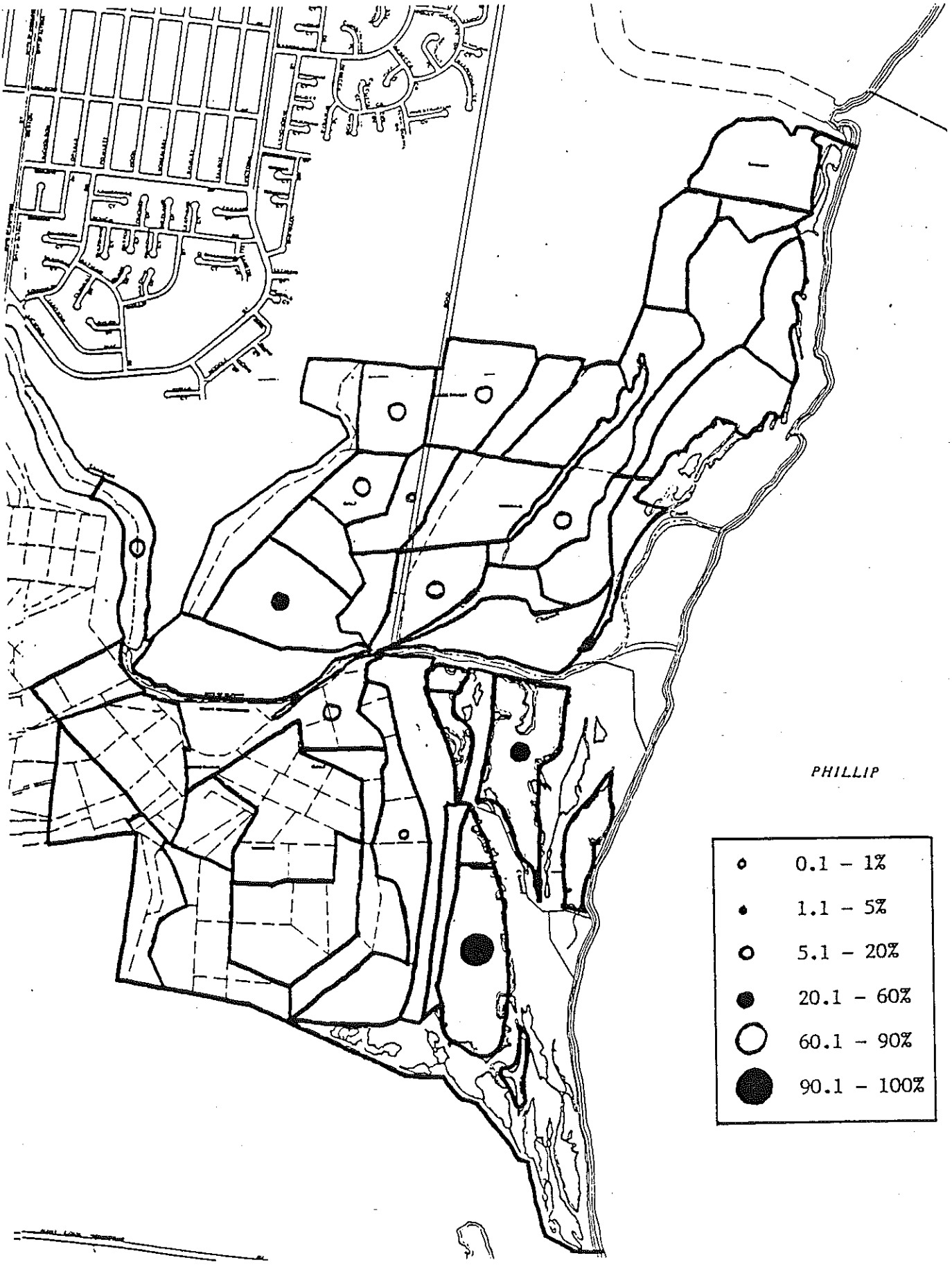
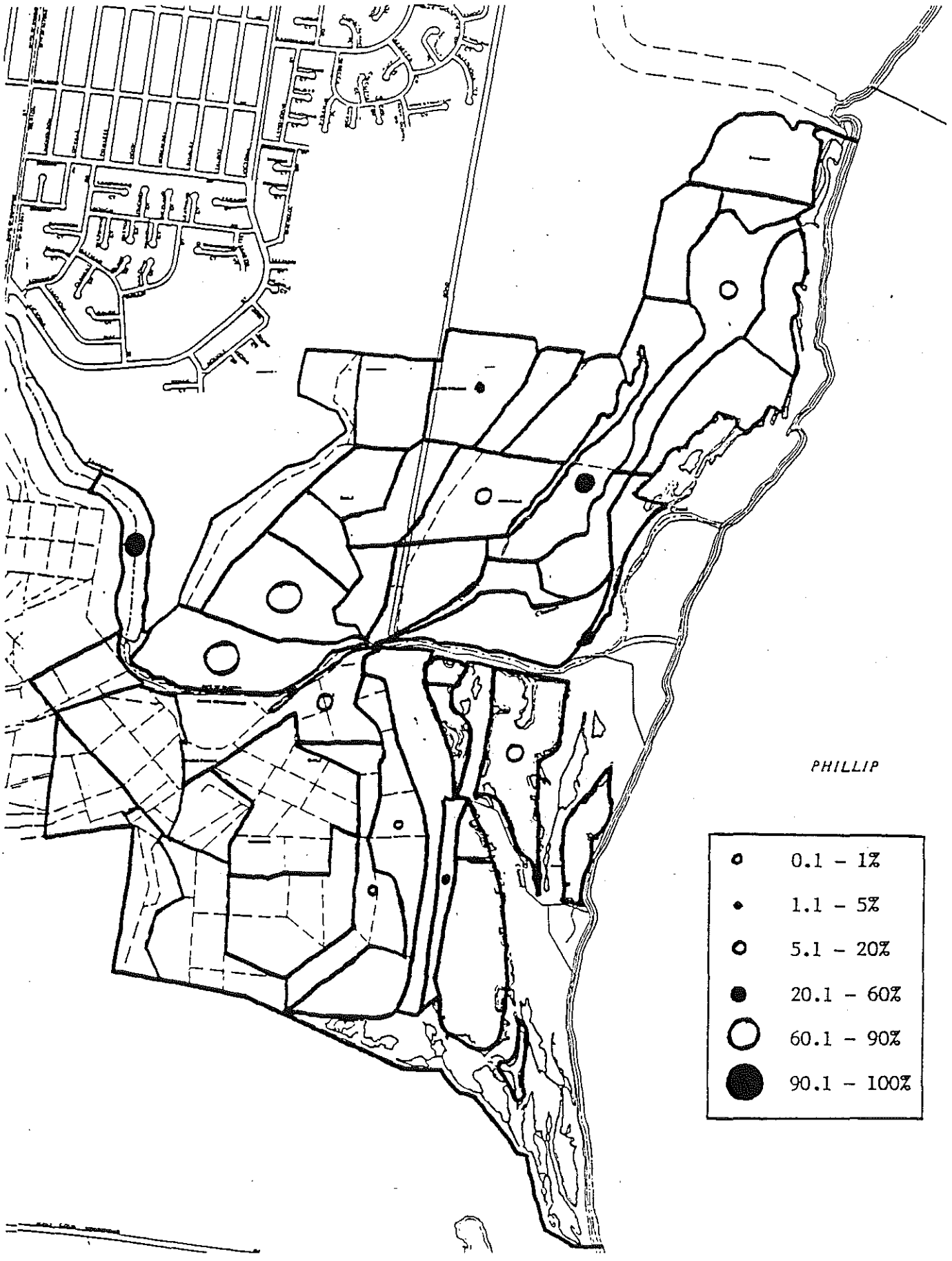


Figure 23. Occurrence of Black Swan at Cheetham Saltworks, Laverton



numbers (usually less than five), compared with many other parts of Port Phillip Bay (Lane et al., 1984).

White-faced Herons were the most abundant of the large wading birds and they occurred mostly in the northern part of the saltworks and along Skeleton Creek, both above and below the ford. During the current study, there were few records of the species in pans with salinities greater than 9%. They also fed at low tide on intertidal mudflats on the coast of the saltworks and Point Cook Metropolitan Park, as well as in the northern part of Altona Bay either side of the mouth of Kororoit Creek.

Royal Spoonbills occur in the northern part of the saltworks in small numbers. The largest numbers were seen in March 1990, when 23 were seen roosting above the ford on the south bank of Skeleton Creek.

Terns

A total of 9 species of tern have been recorded on the Laverton Saltworks. Of these, four species were recorded during the current study.

The coast of the saltworks supports good numbers (up to 60) of feeding Crested Terns. Little and Fairy Terns occur occasionally: three Fairy Terns and a single Little Tern were observed in October 1989 during the current study. The Fairy Tern has been recorded breeding on the sandy beaches on the coast of the saltworks (in the early 1950's; Wheeler, 1955), although there are no recent breeding records. Two migratory terns from northern hemisphere breeding grounds have been recorded in the past and were seen during the current study: the Common Tern (19 in November 1989) and the White-winged Tern (1 in November 1989). Whiskered Terns have been recorded in the past although none were seen during the current study.

The Little, Fairy, Common, Whiskered and White-winged Terns feed on both the saline lagoons of the saltworks and in shallow, near-shore waters along the coast of the saltworks. The Crested Tern feeds generally in shallow, near-shore waters on the coast although there are a few records of them feeding in the coastal lagoons of the saltworks. The Caspian Tern occurs occasionally and confines itself to the shallow near-shore waters along the coast of the saltworks.

When not feeding, terns roost on the rocks at Point Cook, Seaholme and Williamstown Rifle Range, on sandy points near the mouth of Skeleton Creek and on the northern coast of the saltworks and on islands and posts in the saltworks, particularly on posts in S4.

Pelican and Cormorants

The Australian Pelican and three species of cormorant occur regularly at the Laverton Saltworks. They occur in only small numbers (generally less than 10) in the saltworks proper, notably above and below the ford in Skeleton Creek. However, larger numbers feed in shallow near-shore waters along the coast of the saltworks. These roost on prominent coastal features, such as the derelict piers, rock groins and rocky and sandy promontories (e.g. at the mouth of Skeleton Creek and at Point Cook). Up to twenty cormorants were seen roosting on offshore sand banks exposed at low tide along the coast of the saltworks.

The most abundant species of cormorant is the Little Black Cormorant, although its occurrence is seasonal. At other times of year, the Little Pied Cormorant is numerically dominant. Pied Cormorants, which breed at Werribee Sewage Treatment Complex, also occur in good numbers (up to 30). The Great Cormorant occurs in the area infrequently, being more abundant on the eastern side of Port Phillip Bay (Lane et al. 1984). Small numbers of Australian Pelicans (up to 15) rest on the lagoons of the saltworks and above the ford in Skeleton Creek but they generally feed in shallow near-coastal waters off the coast of the saltworks.

Other Water Birds

Few other water birds occur regularly at the Laverton Saltworks, although Hoary-headed Grebe and Eurasian Coot were found in Skeleton Creek, above the ford, in March 1990. Spotted Crake and Banded Landrail occur regularly in dense saltmarsh.

Terrestrial Birds

Some species of native terrestrial bird have been recorded at the Laverton Saltworks. Few however have resident populations. The species listed below are represented by resident breeding populations in areas of saltmarsh (S) and grassland (G).

Horsefield's Bronze-Cuckoo (S)
Calamanthus (S & G)
White-fronted Chat (S & G)
Golden-headed Cisticola (G)
Superb Fairy-wren (S & G)
Little Grassbird (S)
Richard's Pipit (G)
Brown Thornbill (S)
Yellow-rumped Thornbill (G)
Willy Wagtail (G)
Australian Magpie (G)
Little Raven (S & G)

In addition, there are regular wintering populations of the Blue-winged Parrot, Flame Robin and Grey Fantail. On rare occasions in winter, small numbers of the endangered Orange-bellied Parrot occur in saltmarsh areas, although the site is not one of their regular wintering areas (Loyn, et al.1979, 1986).

A total of 13 species of Raptores have been recorded on the Laverton Saltworks (Garnett et al 1986). Of these the following seven species occur regularly.

Black-shouldered Kite
Whistling Kite
Brown Goshawk
Marsh Harrier
Australian Hobby
Brown Falcon
Australian Kestrel

4.2 TERRESTRIAL FAUNA

Totals of five native and five introduced species of terrestrial mammal have been recorded at the Laverton Saltworks (Atlas of Victorian Wildlife). These and the most recent years they were recorded are listed in Appendix 2. Two of the native species, the Koala and the Short-beaked Echidna have not been reported in the area since the 1960's and another, the Yellow-bellied Sheath-tail Bat is known from one specimen collected in 1928. There is a recent record of the White-striped Mastiff Bat (1988) and a number of records of the Fat-tailed Dunnart (up to 1988).

Fat-tailed Dunnats are a small marsupial mouse which inhabits grasslands and saltmarshes in a number of parts of Melbourne's western region (e.g. Werribee; Schulz, 1987). They occur often in areas with outcropping basalt boulders under which they shelter during the day in small nests.

The mammal fauna of the Laverton saltworks is now dominated by introduced species. Foxes and feral cats are common. The former was seen often during the current study, as were the remains of its prey, including adult and young ducks, Grass Skinks and Eastern Blue-tongued Lizards. Black Rats and House Mice are widespread in the area and Rabbits are abundant.

Reptiles

Ten species of reptile have been recorded from the Laverton Saltworks (Atlas of Victorian Wildlife). These and the most recent years in which they were recorded are listed in Appendix 3. The saltworks had not been thoroughly surveyed for reptiles until 1988-89 when officers of the Department of Conservation and Environment searched the area as part of the department's survey of the fauna of the Melbourne region. During this recent search, six of the ten recorded species were found. The status of the remaining four is not known.

The Mainland Tiger Snake is the most common snake on the saltworks and they occur in areas of pasture, saltmarsh and grassland throughout the area. Little Whip Snakes have also been recorded frequently in the area. The White-lipped Snake, a species considered to be rare in the Melbourne region (Schulz, 1987) has not been recorded from the saltworks since 1961. There is an undated specimen of the Eastern Brown Snake in the Museum of Victoria from the saltworks. All the foregoing reptile species have been recorded elsewhere in the western region of Melbourne in recent years (e.g. Werribee; Schulz, 1987).

The most abundant lizards on the saltworks are the Eastern Blue-tongued Lizard and the Grass Skink. Both are preyed upon regularly by foxes. Two other small skinks, the Three-lined Skink and the Metallic Skink were recorded in 1988, during the recent survey of the area by the Department of Conservation and Environment (Atlas of Victorian Wildlife). The latter is considered rare in Melbourne's western region (Schulz, 1987), although there have been recent records from Werribee (Schulz, 1987). For this reason, the saltworks can be considered to be of regional significance for this species.

There are specimens of the Striped Legless Lizard from the Laverton Saltworks as recently as 1979. More survey work would be required to determine if this rare species still occurs on the saltworks. The more widespread Cunningham's Skink as recorded in

the area in 1982 but its current status requires more investigation.

Frogs

A total of 8 species of frogs has been recorded from the Laverton Saltworks (Atlas of Victorian Wildlife). These are listed in Appendix 4 together with the year of the most recent record. Frogs avoid saline areas such as the lagoons of the saltworks and marine areas. They are found only in freshwater areas such as the Skeleton Creek above the ford and temporary puddles in pasture and grassland on the periphery of the saltworks. The most abundant species on the saltworks is the Spotted Marsh Frog.

Insects

An insect survey of the Laverton Saltworks was not conducted. The Altona region is home to an isolated population of the Altona Skipper Butterfly (Hesperilla flavescens flavescens). This species is considered to be rare and vulnerable, and occurrences to be of state significance (Crosby, 1989).

A distinct form of this species occurs in Altona, Point Cook Metropolitan Park and at Point Wilson (Crosby, 1989). These three sub-populations are isolated from one another, although the Altona and Point Cook populations may once have been continuous.

The Altona Skipper Butterfly lives in and feeds exclusively on the leaves of the sedge Gahnia filum. There are some areas of this plant in the saltworks and a survey should be conducted to determine if the species lives in them. It is known to occur in sedgelands adjacent to the northern boundary of the saltworks, near the Altona Tip.

4.3 FLORA

Much of the Laverton Saltworks has been extensively altered for the purposes of salt production. For these reasons, it is difficult to identify discrete plant associations or communities. Much of the vegetation is regrowth, with colonisation of developed areas by the more vigorous species having occurred. Two broad categories of vegetation can be recognised however: the saltmarsh association; and the coastal dune association. The latter has been least altered from its natural state. Some aquatic plants grow in the coastal lagoons and saline evaporation pans.

This consideration of the flora of the saltworks in divided into two parts. The first discusses changes in the vegetation since European settlement and the second describes the current vegetation.

Historical Changes

The Saltworks are the delta of the Skeleton Creek (see Section 2.1). As such, the area was once a natural wetland and probably showed a diverse range of vegetation communities, characterised by distinct zones of plant associations in and on the margins of saline and freshwater wetland areas. Since the advent of the saltworks, substantial changes have been made to the topography and water regime in the area. This has greatly altered the vegetation of the area.

Early maps (Figs. 4-7) show that the Skeleton Creek ended in a series of shallow, saltmarsh fringed tidal lagoons. A similar pristine lagoon still exists at The Spit Fauna Reserve on the southern coast of the MMBW Werribee Treatment Complex and it is likely that the vegetation communities which exist here once occurred around the lagoons on the lower reaches of Skeleton Creek. Intertidal mudflats probably existed in these lagoons. These were probably fringed by thick stands of Shrubby Glasswort (Sclerostegia arbuscula). Behind this, a zone of Beaded Glasswort (Sarcocornia quinqueflora herbfield probably grew. At the back of the marsh, where tidal inundation was less frequent, a more diverse association of plants probably existed, with extensive areas of Grey Glasswort (Halosarcia halocnemoides).

The construction of the saltworks has significantly altered the vegetation of the area and the old lagoons can still be seen in the shapes of some of the saltpans (see Fig. 2). These areas have now become isolated from tidal influence and they support a range of salt tolerant species derived from the original tidal marshes. The species present depend on the salinity of the soil around the salt pans and they are described in the following section.

It is likely that some species have been lost and that some associations have been eliminated or greatly reduced in area as a consequence of the construction of the saltworks. However, the existing vegetation appears to be stable within the saltworks with the exception of a slow invasion of weeds. On the coast, natural geomorphic processes regularly alter the shape of the coastline. Consequently, erosion of dune vegetation and saltmarsh is a common occurrence, as is colonisation of new beach ridges by a succession of saltmarsh and dune plants.

Current Vegetation

The broad plant associations in the saltworks are described below.

Saltmarsh Vegetation

Much of the saltworks away from the coast is clothed in saltmarsh vegetation. The plants in this vegetation are halophytic, or adapted to high soil salinities and regular or intermittent inundation with salt water. (see Plate 1)

Saltmarsh vegetation occurs along shores of the coastal lagoons and most of the evaporation ponds with a salinity less than 9%. Furthermore, it grows extensively along most of the banks separating the evaporation ponds, including those in areas with ponds of salinities above 9%.

The dominant species of halophytic plant in the coastal lagoons is the Beaded Glasswort (Sarcocornia quinqueflora). Often, this is co-dominant with Austral Seablite (Suaeda australis) and, in places, the Shrubby Glasswort (Sclerostegia arbuscula). In higher shore areas of the coastal lagoons, Sea Heath (Frankenia pauciflora) and Salt Marsh Grass (Distichilis distichophylla) grow together with Rounded Noon Flower (Disphyma clavellatum). In the coastal lagoons, saltmarsh grades up the shores into the dune vegetation. There are many depressions in the coastal dune areas which hold saltmarsh vegetation, notably Beaded Glasswort.

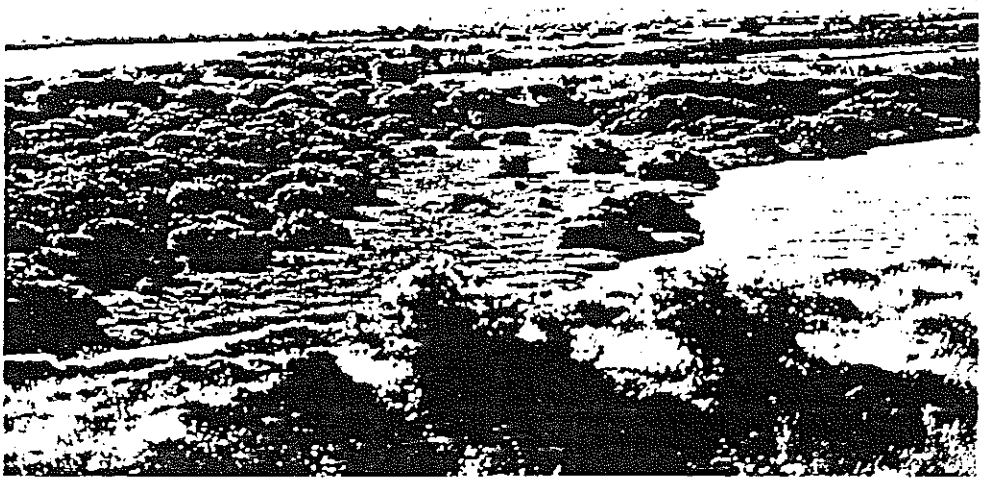
The banks of the evaporation ponds are clothed extensively in the halophytic species mentioned above, with the higher shore species occurring on the tops of the banks. In higher salinity areas, Grey Glasswort (Halosarcia pergranulata), another glasswort H. halocnemoides and Sea Heath dominate the banks between evaporation ponds. Introduced weeds, notably Boxthorn (Lycium ferocissimum) shrubs also occur on ponds banks throughout the saltworks. In places, the lagoon banks have a vegetation with includes not just saltmarsh species but species more characteristic of the dune vegetation, such as Knobby Club-rush (Isolepis nodosa) and Seaberry Saltbush (Rhagodia candolleana).

Dune Vegetation

Along the coast of the saltworks there is an extensive system of low, sandy dunes with intervening saline depressions (see Section 2.1). These hold the other main vegetation type on the saltworks: the dune vegetation. (see Plate 2)

The dune vegetation is dominated by grasses and rushes, with different species occurring in different settings. The coastward margin of the dunes is dominated by Hairy Spinifex (Spinifex hirsutus), along with Knobby Club-rush and Grey Saltbush (Atriplex cinerea). These appear to be the first species to colonise open sandy areas. Substantial areas of this foredune vegetation include Austral Seablite.

Behind the coast, the dunes are dominated either by a closed tussock grassland of Blue Tussock-grass (Poa poiformis) or Speargrass (Stipa flavescens). In the higher dune areas, rushes, notably Spiny-headed Mat-rush (Lomandra longifolia), occur.



1. Saltmarsh Vegetation

2. Dune vegetation

The small-leaved Clematis (Clematis microphylla) still occurs extensively in the dunes, and in places, Running Postman (Kennedia prostrata) grows, especially in areas dominated by rushes.

Many species of introduced weeds occur in the dunes. Box-thorn occurs extensively and the dunes are gradually being invaded by a particularly aggressive weed, Boneseed (Chrysanthemoides monilifera). This will need to be controlled soon or it will eventually dominate the dune vegetation, with the loss of most of the native species.

The dunes also hold a remnant stand of Hop Wattle (Acacia stricta).

Other Vegetation

The section of the saltworks no longer used for salt production, on the higher basalt area between Skeleton Creek and Aviation Road, is dominated by a mixture of saltmarsh vegetation and introduced pasture and weed species. (see Plate 3) There is a small plantation next to Aviation Road, north of the refinery and warehouse, dominated by Golden Wattle (A. pycnantha).

Significance of the Flora

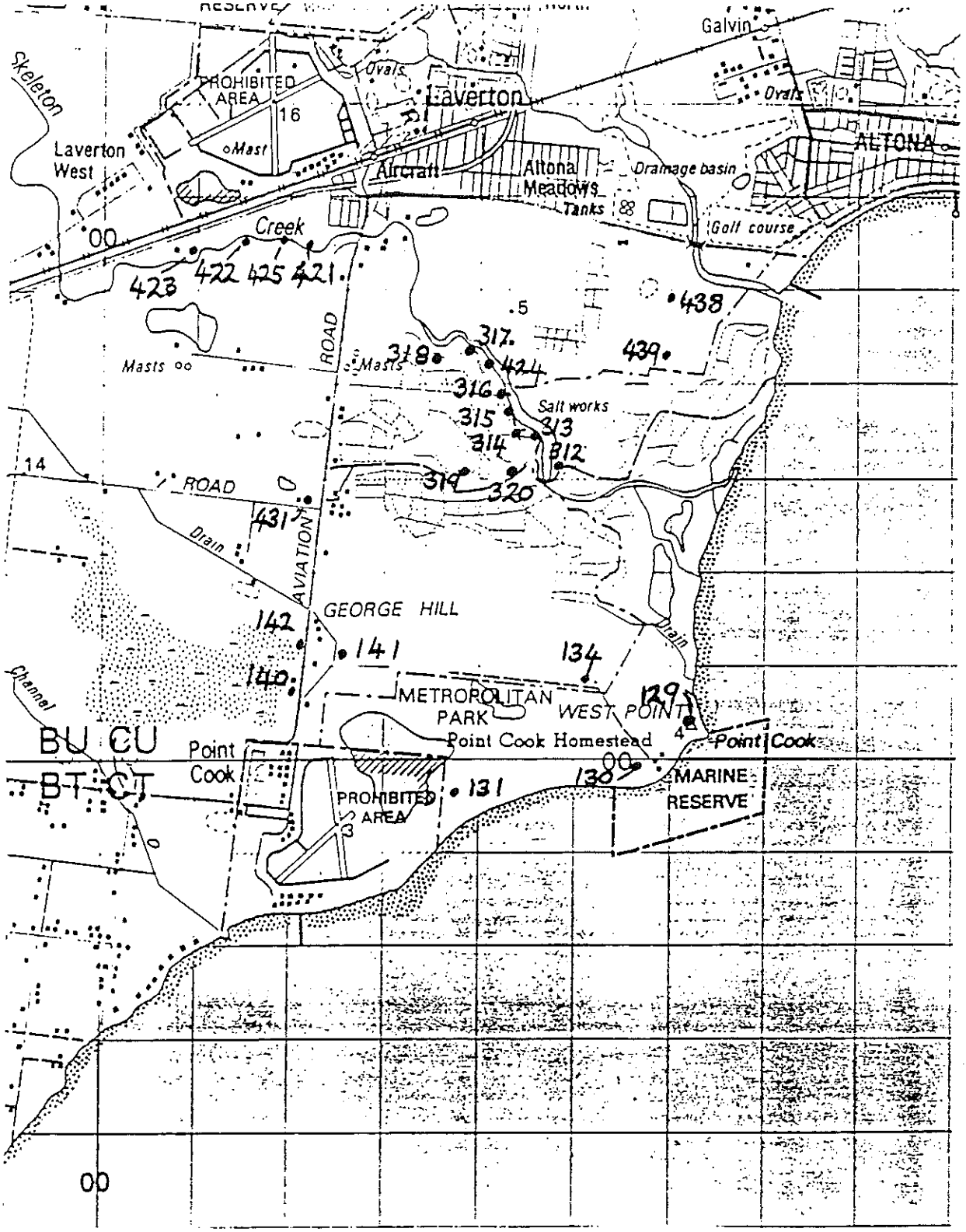
The range of coastal vegetation types in close proximity and the presence of the saltmarsh shrub Grey Glasswort (Halosarcia halocnemoides) are of high conservation value. McDougall (1987), in a review of sites of botanical significance in Melbourne's western region, considered these features warranted the designation of the coastal parts of the saltworks, together with the vegetation of the Point Cook Metropolitan Park, as a site of state significance.

3. Grassland

4.4 ABORIGINAL SITES

As noted in the survey method section 3.2 above, the areas surveyed for Aboriginal sites were generally the higher ground along the creek banks, edges of swamps and relic sand dunes. Seven sites were found on the banks of Skeleton Creek, one on the north bank and the rest on the south bank. These sites may be part of a continuous line of occupation on both banks of the creek. Other sites have been located on the creek further upstream and other watercourses in the district have similar linear concentrations of artifacts. (du Cros 1989a & b, Ellander & Weaver, VAS site register) Two other sites were found north of what would have originally been an extensive fresh water swamp in eroded ground among salt pans. These sites may indicate difuse occupation of the area. (see Fig 24)

The sites are generally diffuse scatters of waste flakes eroding out of cleared ground on slopes adjacent to the creeks.



312-320 Sites located in this study

129 - 438, Previously recorded sites

Figure 24. Location of Aboriginal Sites.

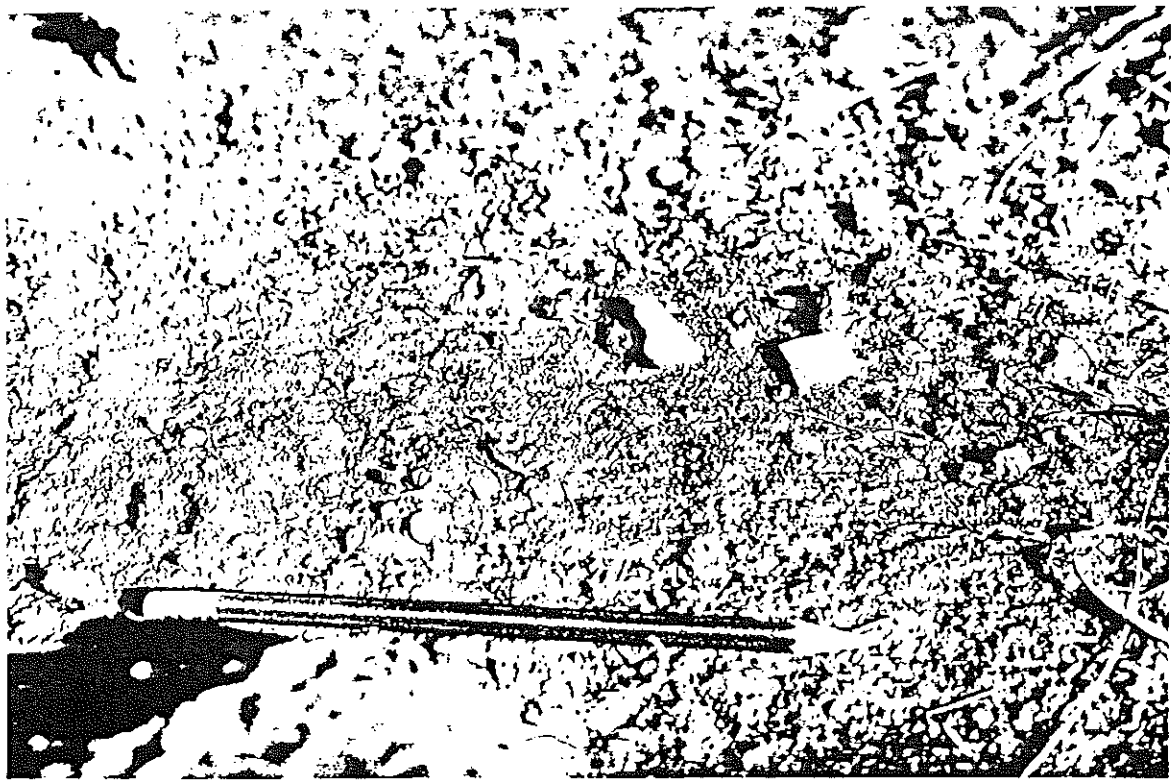
AB1

VAS Site Register Number 7822/2/312

Map Ref. 1:25000 Truganina 7822-II 048 030

The site is located in a small triangular area formed by the creek to the west, the edge of the salt pans to the east and a line of boxthorn to the north, 100 metres east of the Skeleton Creek ford, near the site of a demolished building. (see House site 2) A single silcrete waste flake was found among a large quantity of shell fragments difusely scattered over an area of about 50 by 100 metres. The shell is mostly very small fragments making it difficult to establish species of original sizes but a few medium sized abalone and mussel shells suggest at least the possibility of Aboriginal origin of the material. However, some of the shell has clearly been brought in with sand excavated from the beach and has been spread by clearing and bulldozing. In a few places, thin lenses of shell on relatively undistrurbed chocolate-brown clay soil may be of Aboriginal origin.

The site is of low integrity and grossly disturbed, weed infestation is considerable with the boxthorn, originally planted as a hedge to the north, having spread considerably. The boxthorn has recently been slashed and burnt. The site is also covered in European cultural material from early occupation debris. A single conifer remains from the garden.



4. Aboriginal site 1.

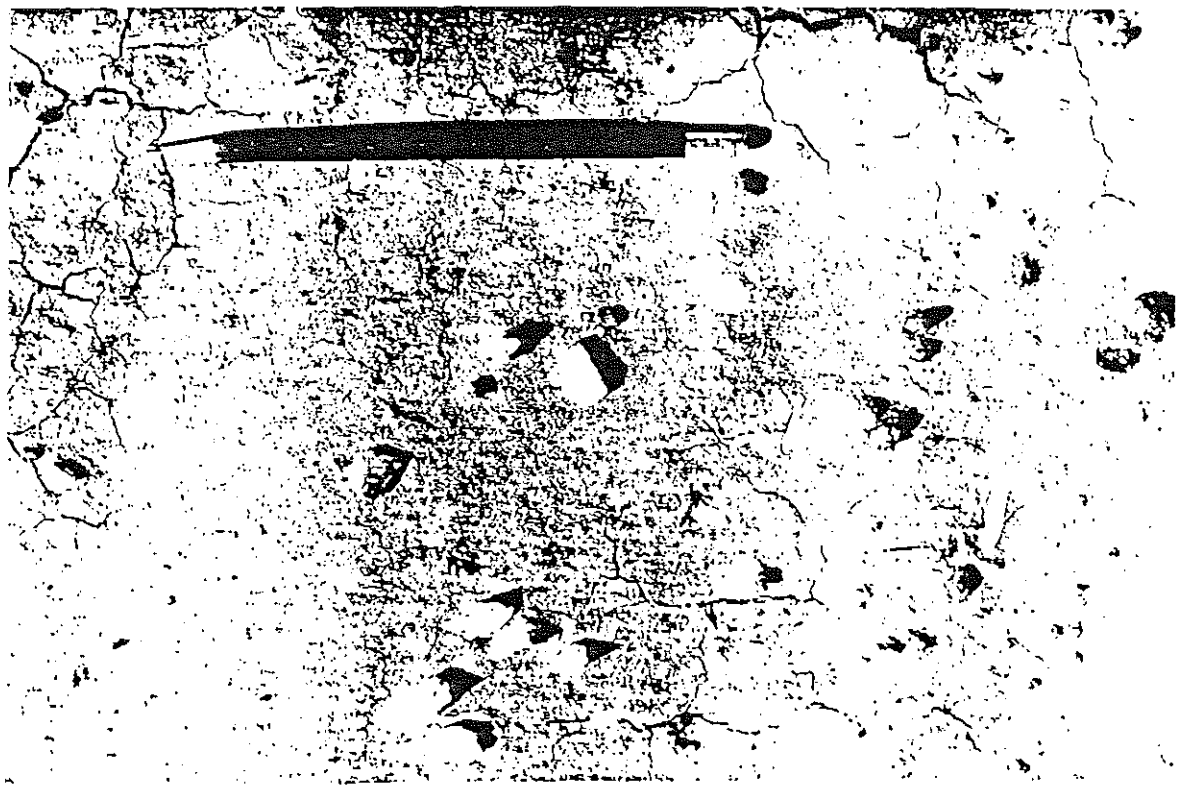
AB2

VAS Site Register Number 7822/2/313

Map Ref. 1:25000 Truganina 7822-II SW 0455 0350

Located on the west bank of Skeleton Creek about 20 metres from the present water's edge near an access track. Small white quartz flakes and fragments are distributed regularly over an area of c. 10 by 5 metres. Localized soil disturbance along the track and in shallow drainage gullys appears to be causing the flakes to erode out of the topsoil. Otherwise the area retains some native vegetation, predominantly Poa and Themeda grass species.

As well as the Quartz fragments, a fine grained bi-face with a prominent bulb of percussion and a grey quartz flake with retouched edges were found. These latter two artifacts appear to have use wear, ie fractured cutting edges and edge polish. As with all the sites, proximity to fresh water appears to have determined site location.



5. Aboriginal Site 2.

AB3

VAS Site Register Number 7822/2/314

Map Ref. 1:25000 Truganina 7822-II 0440 0350

Located in similar circumstances to AB 2 & 4 on eroded ground adjacent to the track and about 20 metres from Skeleton Creek on the south bank. A small clay pan has formed where run-off from the track and bare ground along the edge of the salt pan embankment has accumulated. Erosion in this area appears to have begun in the late 1940s with the construction of the High Level area of salt pans and ploughing of firebreaks around the site.

As in AB2, the artifacts are a diffuse scatter of small quartz flakes, some showing the matrix of smooth pebbles. Also found were a silcrete waste flake, a grey chert flake, an orange coloured silcrete notched flake and a large quartz waste flake with a matrix surface.

This material is spread over quite a large area approximately 10 by 20 metres. Although the artifacts found were all in disturbed contexts, there is some ground in the vicinity which is undisturbed.

6. Aboriginal Site 3.

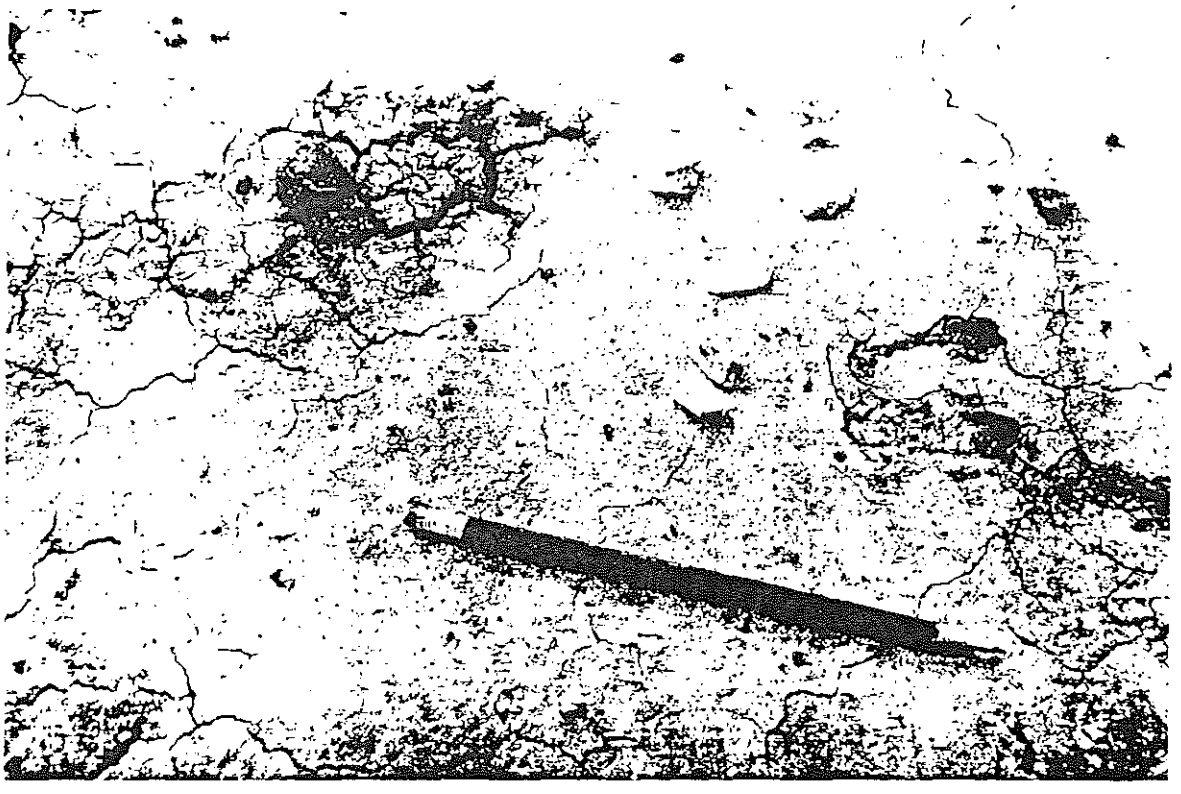
VAS Site Register Number 7822/2/315

Map Ref. 1:25000 Truganina 7822-II SW 0425 0375

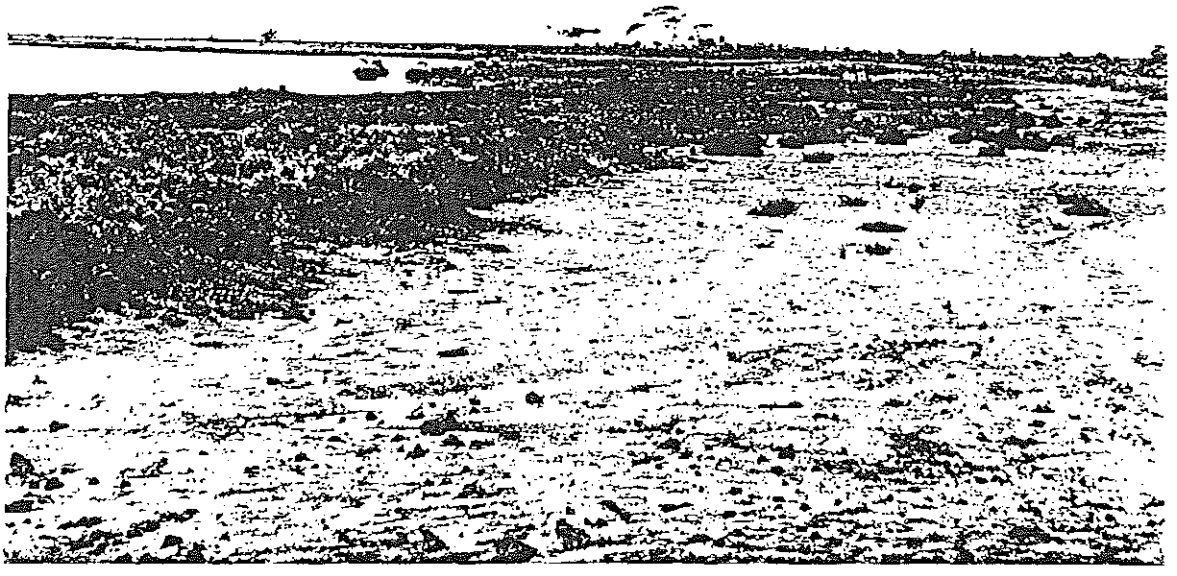
Again a site located close to Skeleton Creek comprising a very thin scatter of quartz flakes. The ground here is also considerably disturbed and like AB3 has formed into a clay pan of eroded sediments on the track and firebreak.

The quartz material are generally waste flakes but one piece was a very thin piece with fine crystaline structure showing edge retouch. One end appears to have been damaged, suggesting this is a broken and discarded spear point.

The site covers an area of about 10 by 25 metres.



7. Aboriginal Site 4.



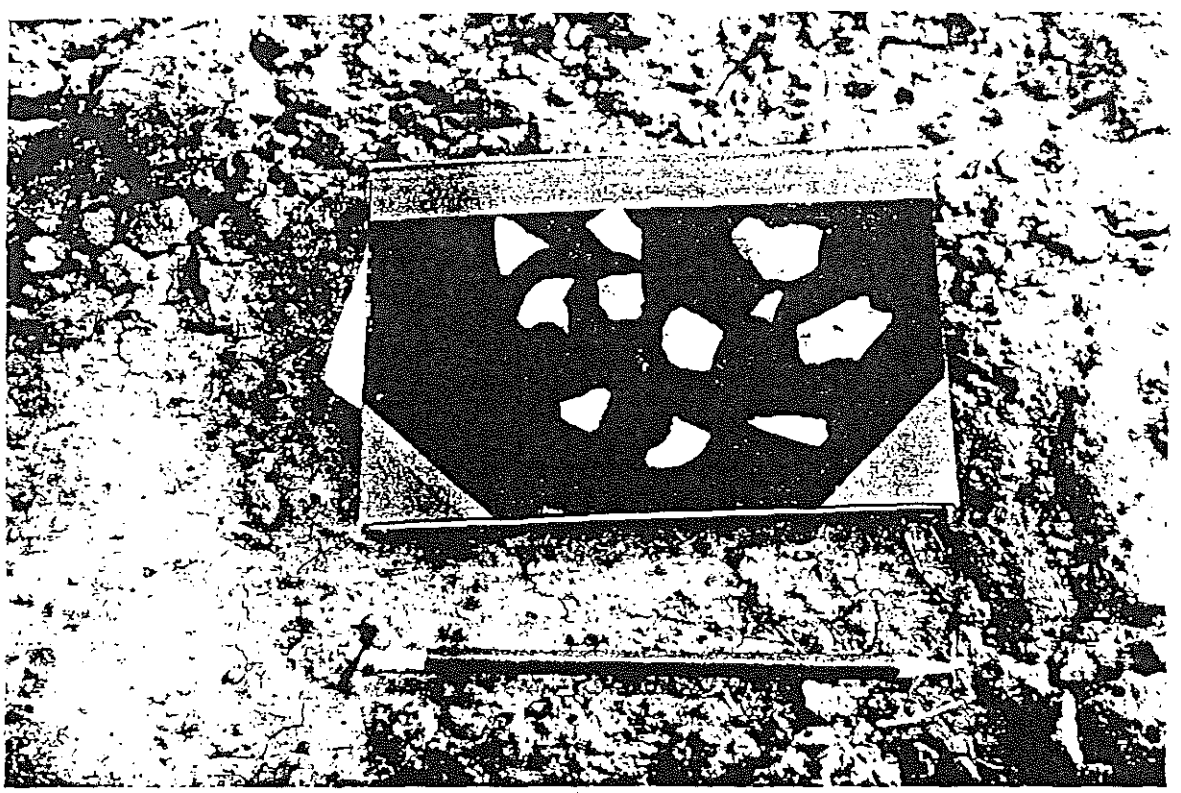
8. Aboriginal site 4. General view of surrounding area, note bare ground.

AB5

VAS Site Register Number 7822/2/316

Map Ref. 1:25000 Truganina 7822-II SW 0420 0390

This site is smaller in area only covering a small mound in the middle of the track about 2 metres square and is located about 20 metres from the creek. The ground surface is stony with what was probably a fairly thin topsoil having been eroded away. Eleven pieces of fine-grained mottled grey silcrete were found in close proximity. All were waste flakes of identical material suggesting a site created by a single event, probably the manufacture of one or more blades from a core. The successfully struck blades and the core were obviously carried away leaving only the debitage of the toolmaking process.



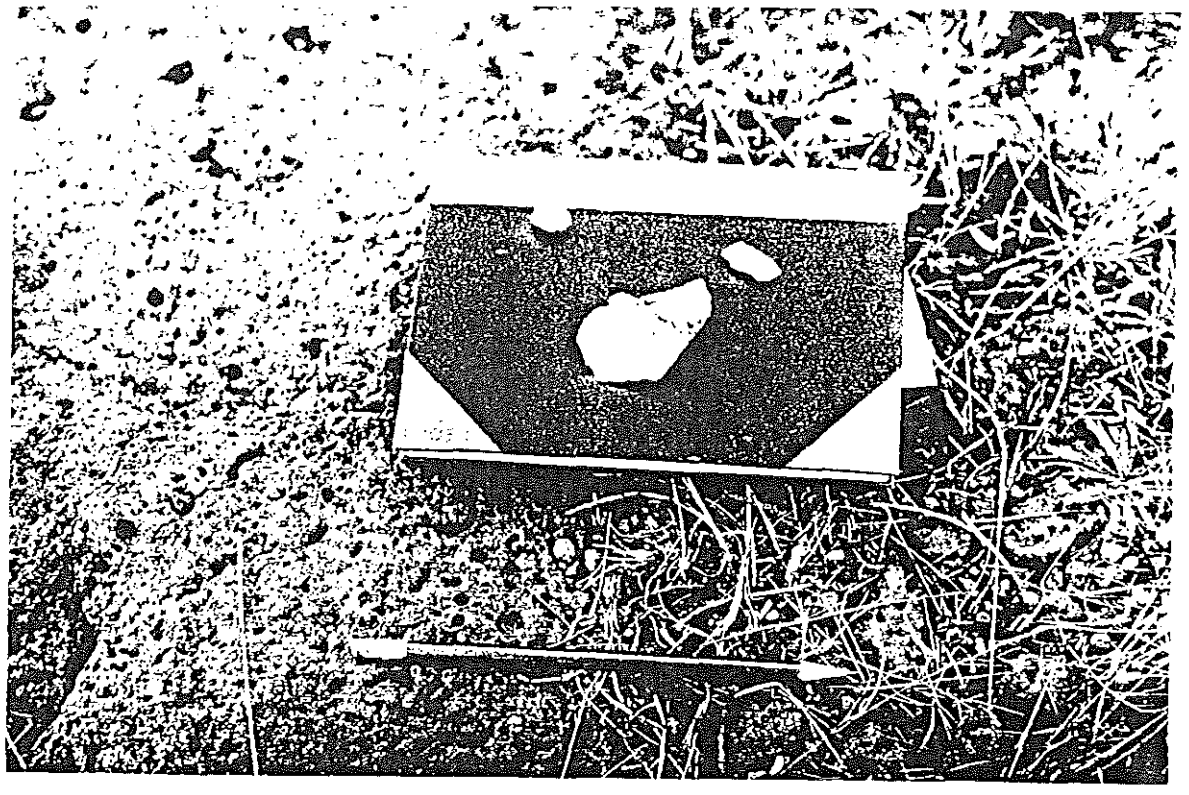
9. Aboriginal Site 5.

VAS Site Register Number 7822/2/317

Map Ref. 1:25000 Truganina 7822-II SW 0400 0430

A small number of quartz flakes were found on a rocky outcrop on the inside bend of the creek. Aerial photographs from the 1950s show this site to be near one of the larger permanent waterholes in the creek. The raising of the weir has flooded the creek well beyond this point.

A large dark brown flake of a form of granitic material was found among the rocks on the creek bank slope. Weed infestation, particularly of boxthorn, is moderate on the site and the area has been extensively disturbed by rabbit burrows and erosion from the track. However it still has potential for undisturbed stratigraphic deposits.



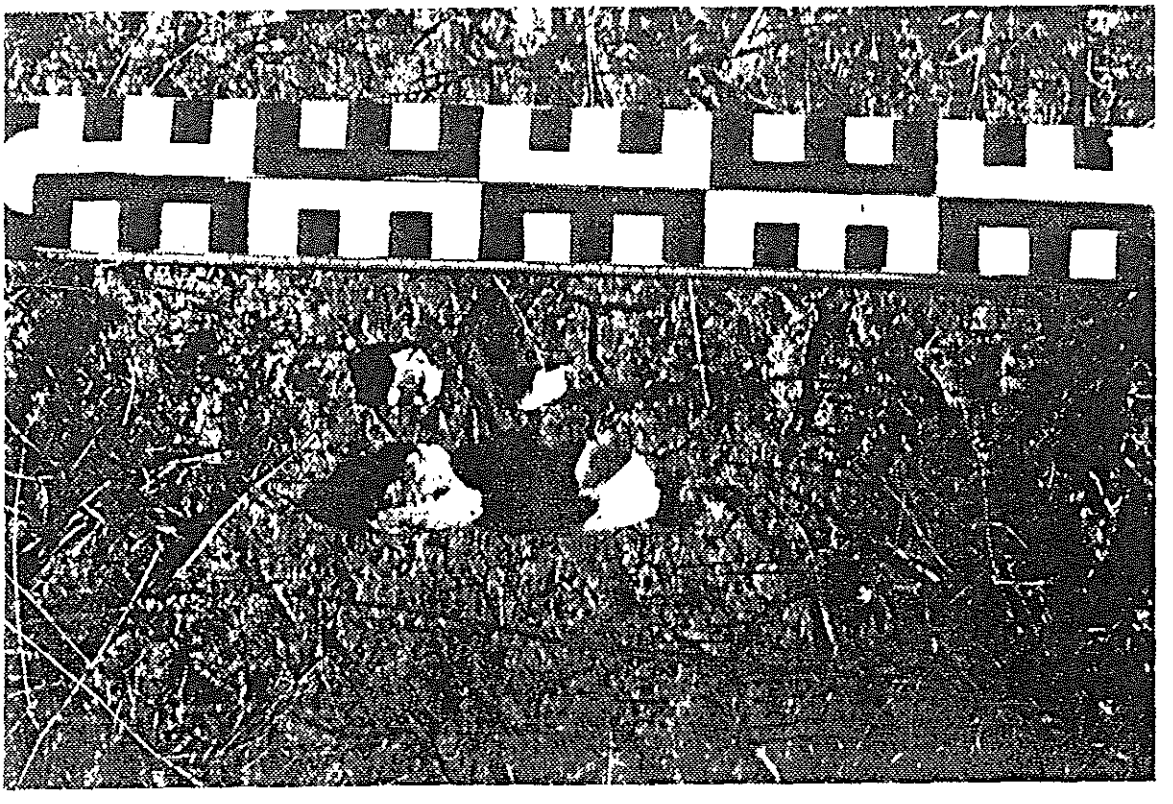
10. Aboriginal Site 6.

VAS Site Register Number 7822/2/318

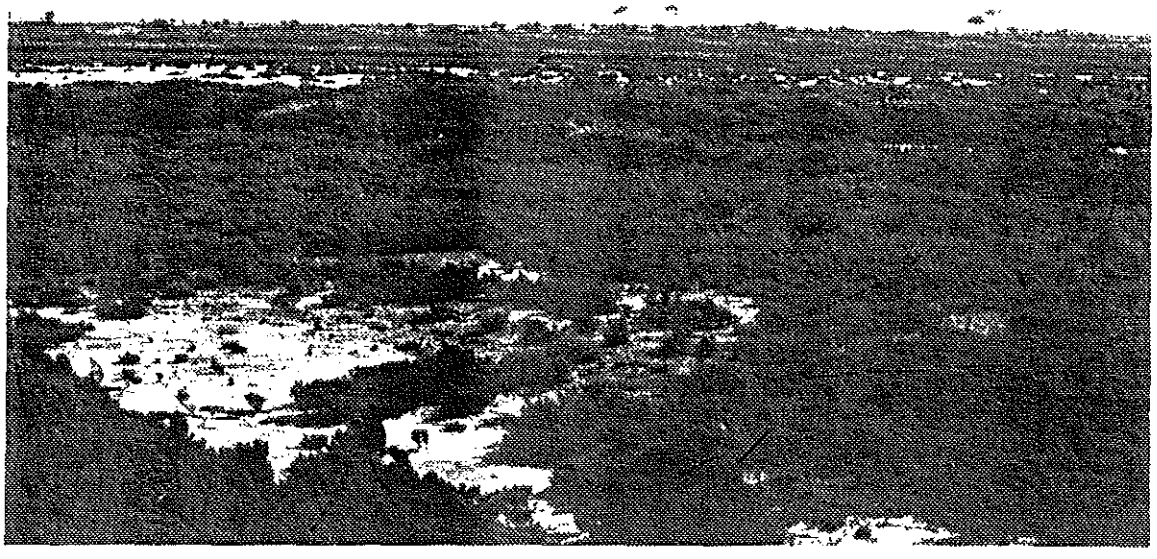
Map Ref. 1:25000 Truganina 7822-.1 SW 0860 0425

This site is slightly furtner rrom the creek than otners in this area. It is about 50 metres from the bank near a section or the creek with permanent waterholes. The banks or the creek rise from a waterlogged marshy area to rocky slopes inrested with ooxthorn, articnoke thistle and briar rose. Visibility in this area, potentially a desireable aboriginal habitat, is very low and as a result, no artifacts were found close to the creek. Within the salt pans, clearing of topsoil to construct the salt pan walls has created bare ground on which artifacts are easily seen.

Several small grey silcrete waste flakes, a large silcrete amorphous block and a small silcrete exhausted core were round along with a number of quartz flakes and fragments. None or these pieces had any evidence of retouch or usewear.



11. Aboriginal Site 7.



12. Aboriginal Site 7. General view of locality

AB8

VAS Site Register Number 7822/2/319

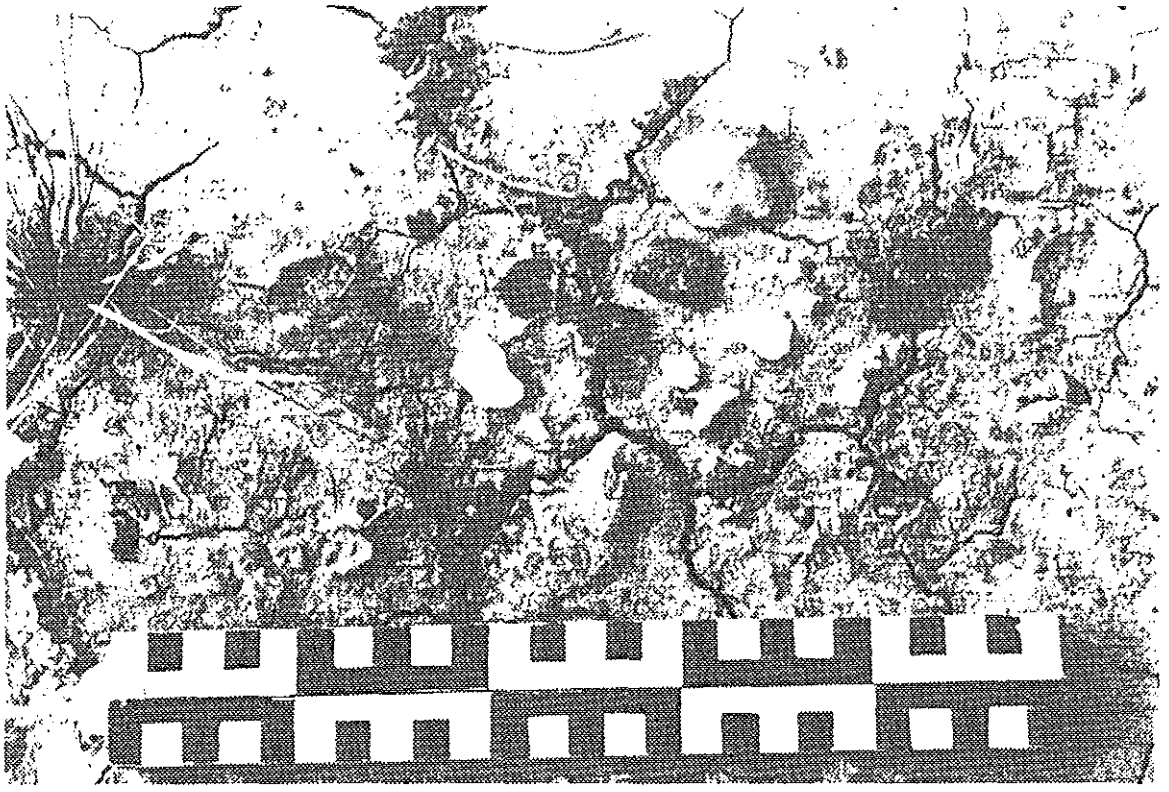
Map Ref. 1:25000 Truganina 7822-II SW 0380 0290

An eroded firebreak and soil borrow area, 55 metres north of the access track below the salt pan wall has a regular, but diffuse scatter of artifacts over a wide area. Quartz fragments are most numerous. Large numbers of small waste flakes were observed along with a pebble core. A variety of material was evident including silcrete, quartzite, grey and yellow coloured chert, and other fine grained stone.

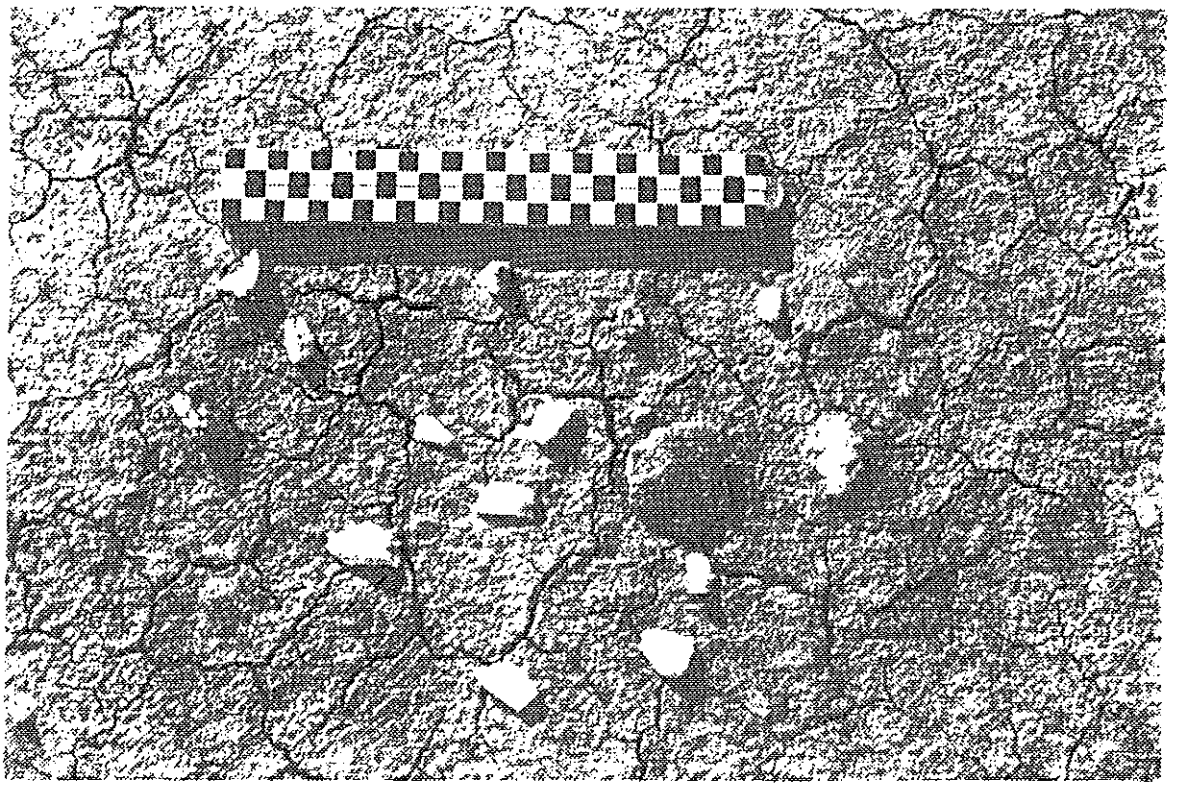
Possible formal tools included a broken silcrete backed blade and a broken quartz point.

The site is located on slightly raised ground with light brown clay soil near the salt crystalizers which were once an area of extensive fresh water swamps.

13. Aboriginal site 8. Note pieces of stoneware ginger-ale bottle.



14. Aboriginal Site 8. Note large silcrete scraper



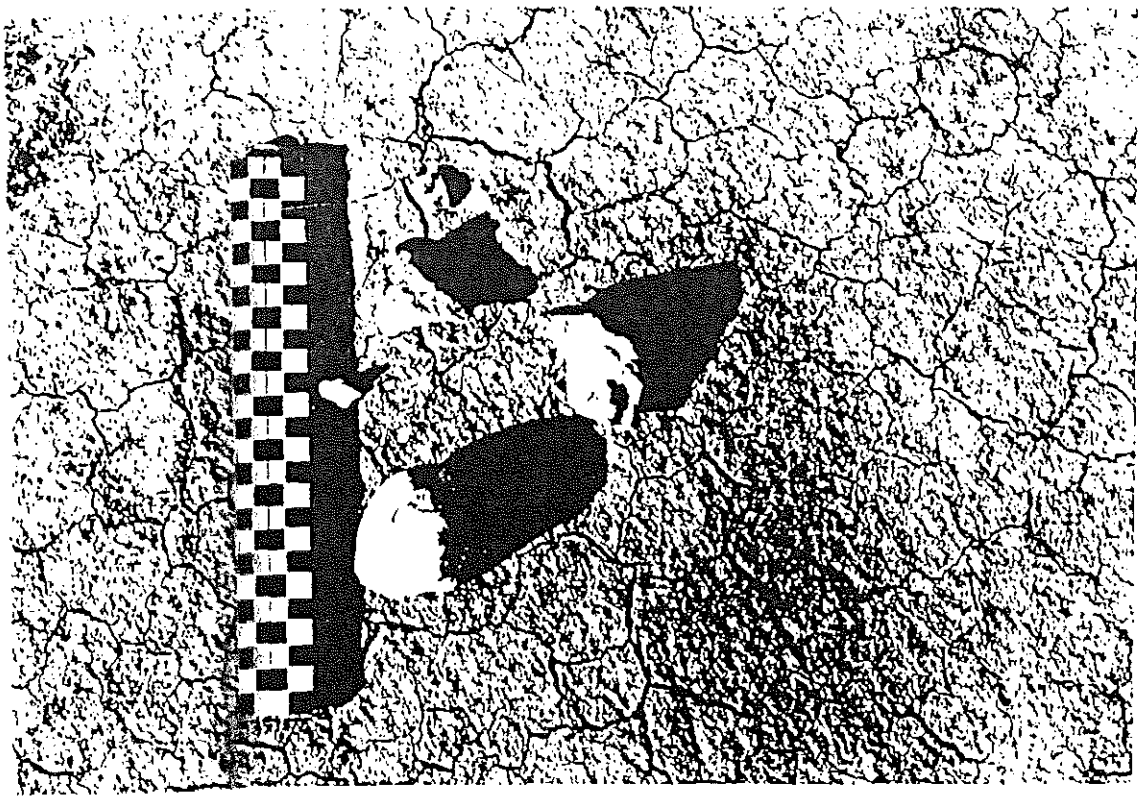
15. Aboriginal Site 9.

VAS Site Register Number 7822/2/320

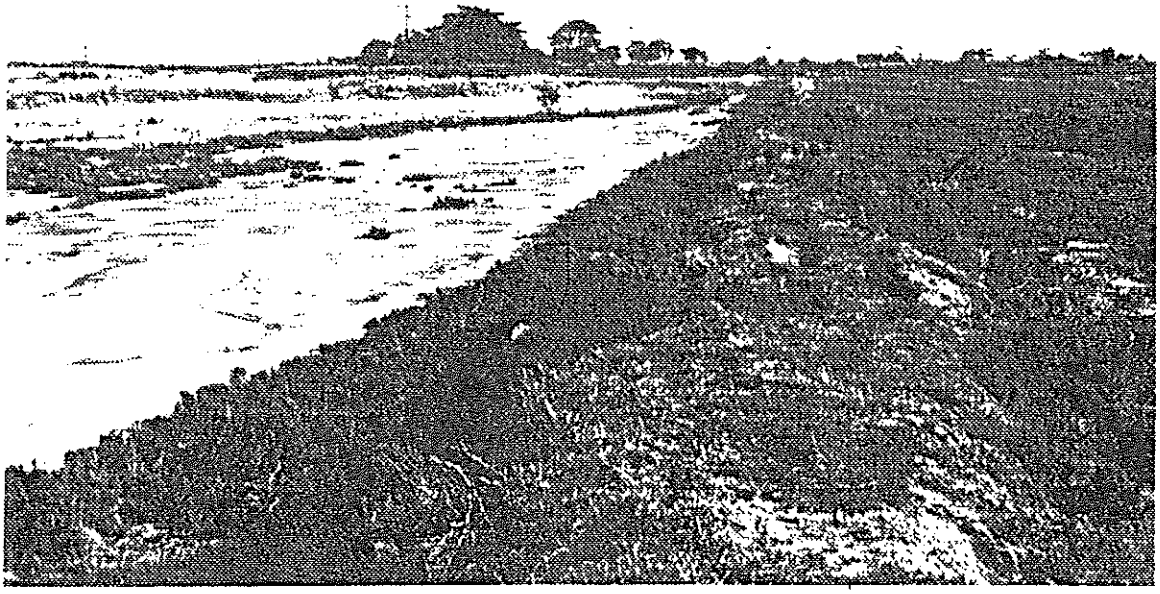
Map Ref. 1:25000 Truganina 7822-II SW 0430 0305

Opposite the Melbourne University testing station on cleared ground within the salt pans. A variety of material was found on a extensively eroded surface. Bull dozing for construction of the salt pan walls has removed topsoil from a large area and so revealed artifacts. Like site AB8, this site is adjacent to the extensive swampland which once covered the saltworks and is on what would have been dry ground.

Artifacts found include aver 20 quartz flakes, 2 yellow silcrete microliths and a large orange silcrete scraper with one faceted surface, edge retouch and use wear evidet on two edges. Two blocks of quartz found together with several flakes indicate a possible tool manufacture site within salt pan No 10 of the High Level Area.



16. Aboriginal Site 9. Large quartz cores



17. Aboriginal Site 9. General view of site

4.5 HISTORIC AND INDUSTRIAL SITES

General

The Saltworks spreads over an area of approximately nine square kilometres with most of this ground covered by earth and timber walled evaporation pans and modified natural lagoons. Initially crystalization pans were built at the western end of the site and large evaporation basins are mainly in the eastern part of the site south of Skeleton Creek. The various coding of pans on the Cheetham plans may indicate a sequence of construction. Earlier ones are given alpha numeric codes while the pans north of the creek are named after early landowners, Cropley's, Forsyth's, Tyquin's, Cherry's, etc. (see Fig 2)

Comparison of Aerial photographs shows that after the 1950s additional areas of the delta have been reclaimed for salt pans, and a large area of higher ground in the north west of the study area has been terraced for evaporation pans. With each expansion, the roads and tramways were re-arranged along with the channels, pipelines and pumps for distribution of brine.

Refinery

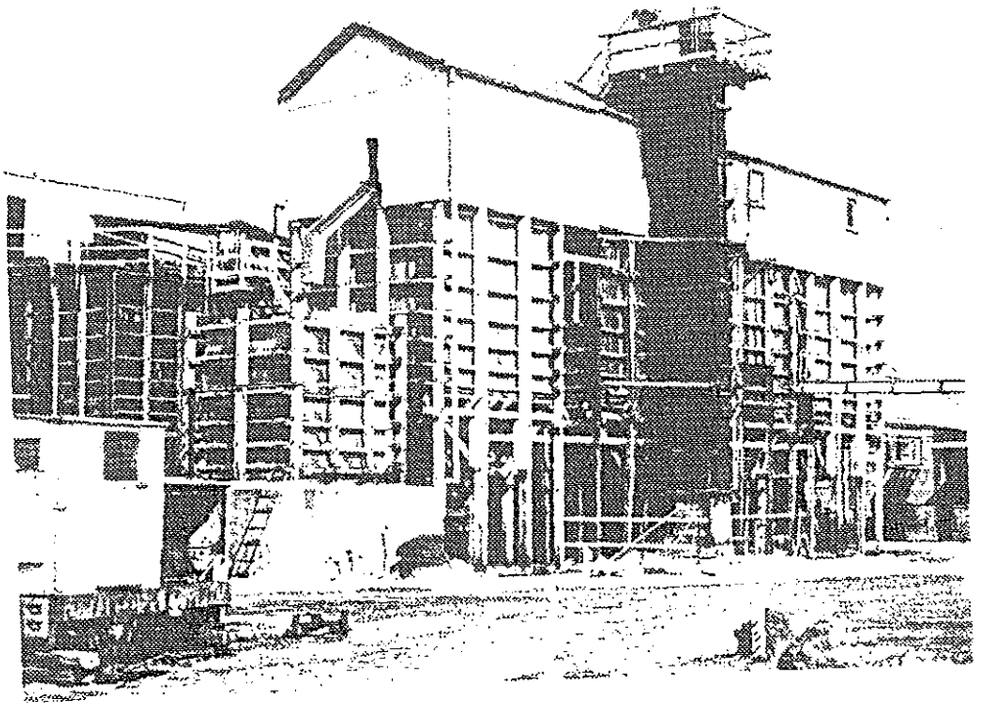
When the saltworks was originally constructed raw salt was collected from the tramway terminus, then north of the present collection lines, and transported by road to the Geelong refinery. Access to the works was by a narrow strip of land connecting to Aviation Rd. However, by 1940 additional land had been purchased and a complete refinery complex had been built giving Laverton independence from Geelong. (see Fig 25)

The main section of the works building comprises a brick two storey factory with a single storey warehouse on the west side. A feature of the refinery is the bank of storage hoppers on the north side. This construction is entirely of timber. Four hoppers are supplied by a bucket elevator which lifts salt from a tipping bin below ground level. A conveyor along the top of the hoppers distributes salt while shaker devices under the hoppers feed another conveyor which transfers the salt to the mill. (Plate 18)

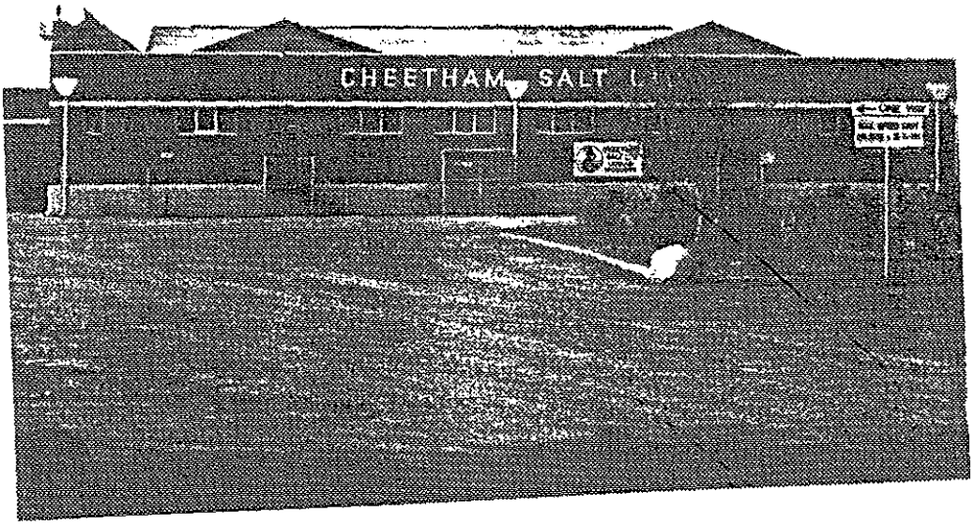
Inside the mill most of the machinery has been replaced or drastically modified so that little of the original plant remains. On the northern end of the building the present washing plant is a modern compact device which replaced much more complex equipment which was installed at several levels. The timber framing and several of the elevators which served this equipment survive and provide the potential for reconstruction of how this process worked.

Beyond the washing area, centrifuges and rotary kilns dry the salt crystals and crushing and sieving plant grade the salt grains. This machinery is all comparatively new as is a bagging plant in the adjoining store room. Externally, the refinery and stores are substantially intact. An additional bay for extra warehousing was erected on the south side of the building after 1950. (Plate 19)

North of the refinery are the workshops where rolling stock and equipment were manufactured and maintained. This originally had a tramway spur entering the building. West of the workshop is the old timber yard which was also served by a tramway in the past. The workshop comprises two buildings, the eastern section being

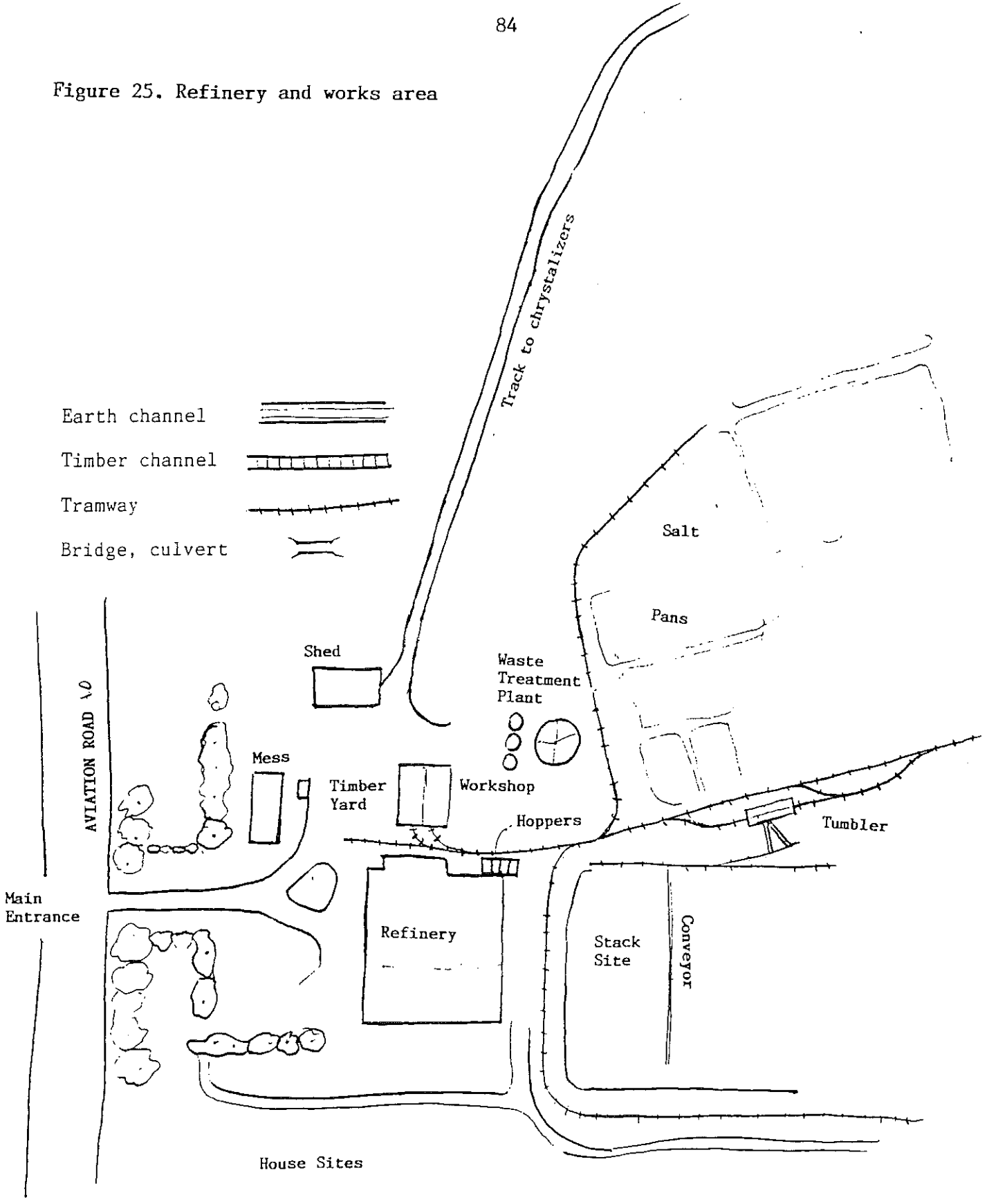


18. Salt storage bins at the refinery



19. Front view of warehousing at the refinery

Figure 25. Refinery and works area



the earliest and possibly relocated from the original salt transfer area north of the crystalizing pans and the western part having been transferred from the Geelong works in the 1950s. (Plate 20)

Waste brine from the washing plant is piped to a treatment plant for precipitating sediments. This comprises three wood stave tanks and a sediment pool which are located north of the refinery. (Plate 21)

Other buildings on site include a corrugated iron shed and timber mess building west of the workshops. The mess is all that is left of the accommodation provided for seasonal workers employed during the salt harvest in the early days. (Plate 22) A small galvanized iron storage shed (Plate 23) stands between the mess and workshop. In what is now the carpark adjacent to the mess, lines of pine trees and decorative stone borders mark the location of about 8 small huts.

Of the 12 or more larger houses built around the refinery only two survive on Aviation Road near the original site access road. Most of these houses were constructed in the 1940s and 50s but not demolished until the last 5 or 6 years.

Bulk raw salt is stored in the open adjacent to the mill. Travelling conveyors feed salt to the stack from a tumbler which inverts the railway trucks to empty them. (Plate 24)

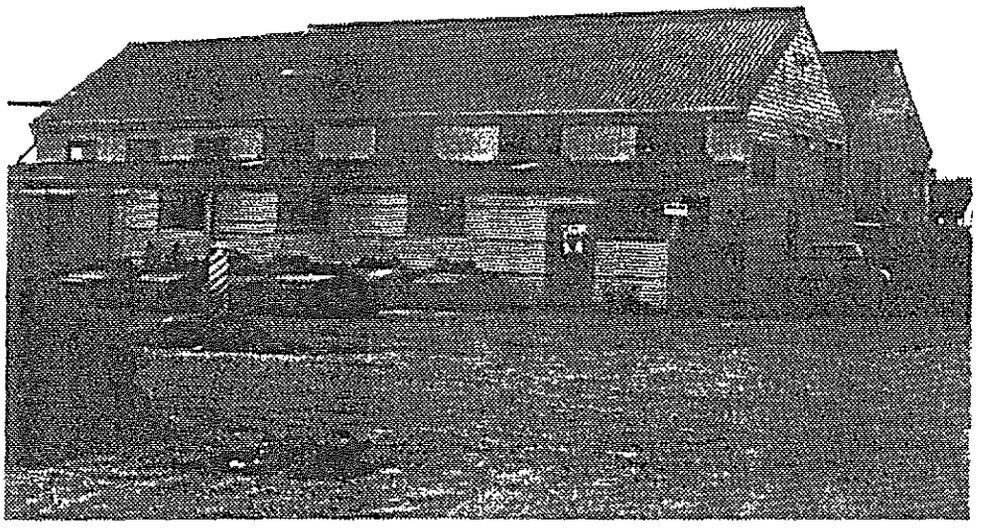
Tramways

The Melbourne sheet of the 1930s series of topographic maps of Victoria shows the tramways extending south from a road which connects with Aviation Road. Three branch lines extended eastward between the crystalizing pans. These are still in use but have been altered to link them to a tramway to a longer double track section running to Skeleton Creek. The original feeder line was closed and dismantled in the late 1930's when the refinery was constructed and connected to the tramway network. An additional loop runs around the raw salt stack site for transporting salt to the refinery and small sidings give access to the workshops and parking areas for empty trucks. (see Fig 7)

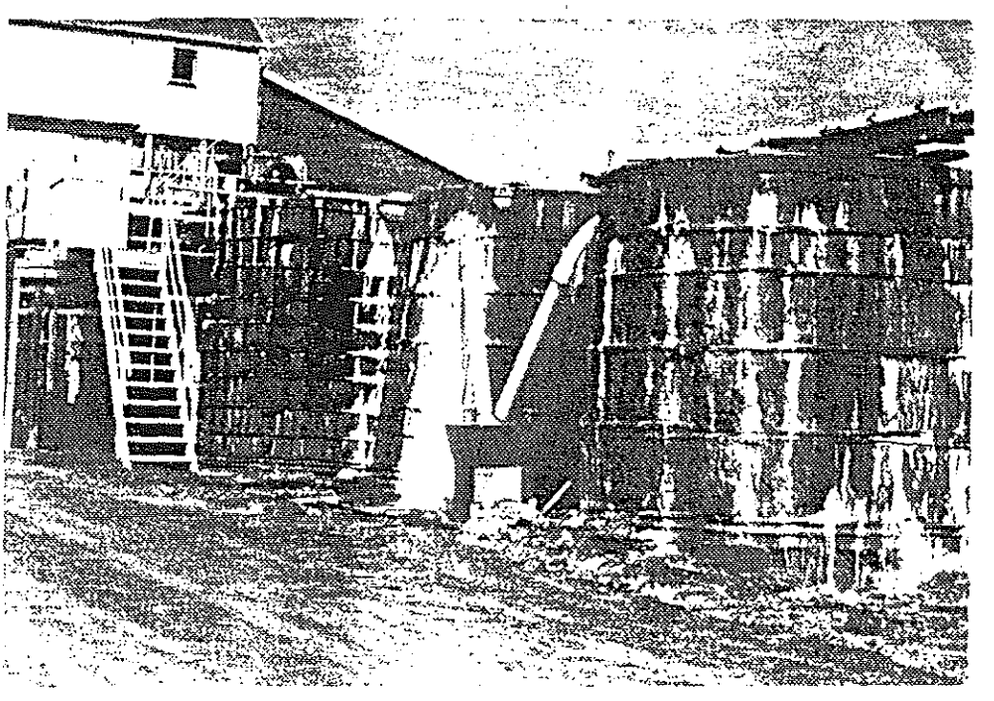
The tramways are of metre gauge on hardwood sleepers at about 500mm intervals with hand operated stub points. Rails are 40 pound near the works area and 30 pound elsewhere. The lines were originally laid with very light 16 pound rail but little of this remains. Rust has caused the rail to be replaced much sooner than would normally be required with the degree of use and wear experienced on the tramways. In several areas prefabricated sections of track have been used which employ pressed iron sleepers bolted to four metre lengths of rail. Several sections of this track, including some prefabricated points are stacked near the "West Junction". These portable tracks were used to provide temporary access to salt stacks for loading trucks to the mill. One of the side tipping hopper trucks is also located in this area. (see Plates 25 and 26)

Transfer Site

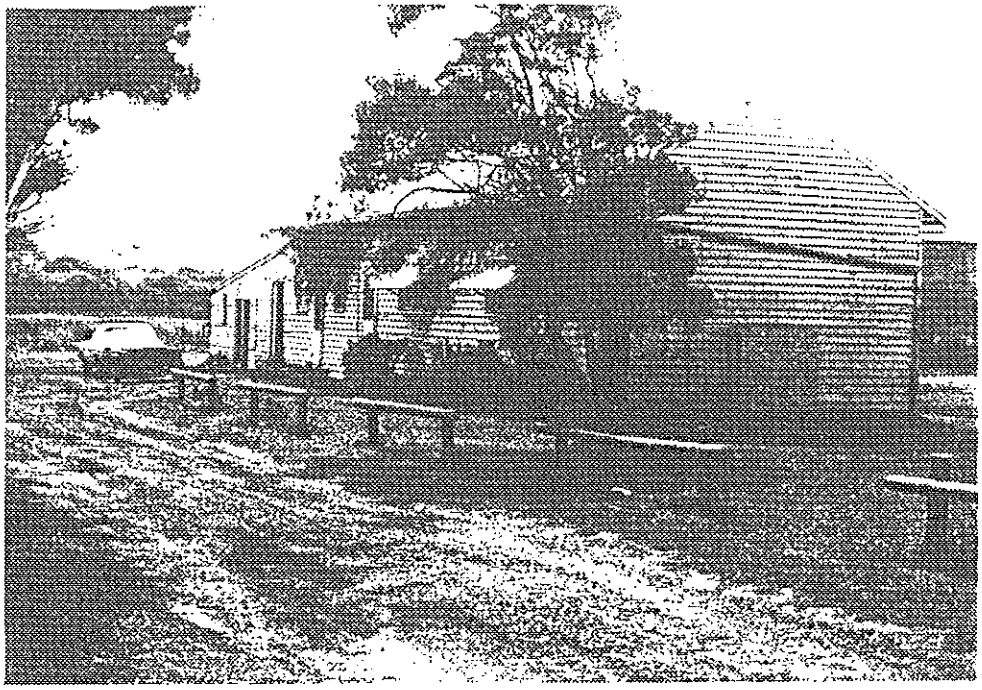
From 1924 to about 1940, salt harvested from the crystalizers was delivered by rail to a transfer site on the old access track. The route of the tramway can be traced along the old permanent way between the crystalizing pans. All that is left of



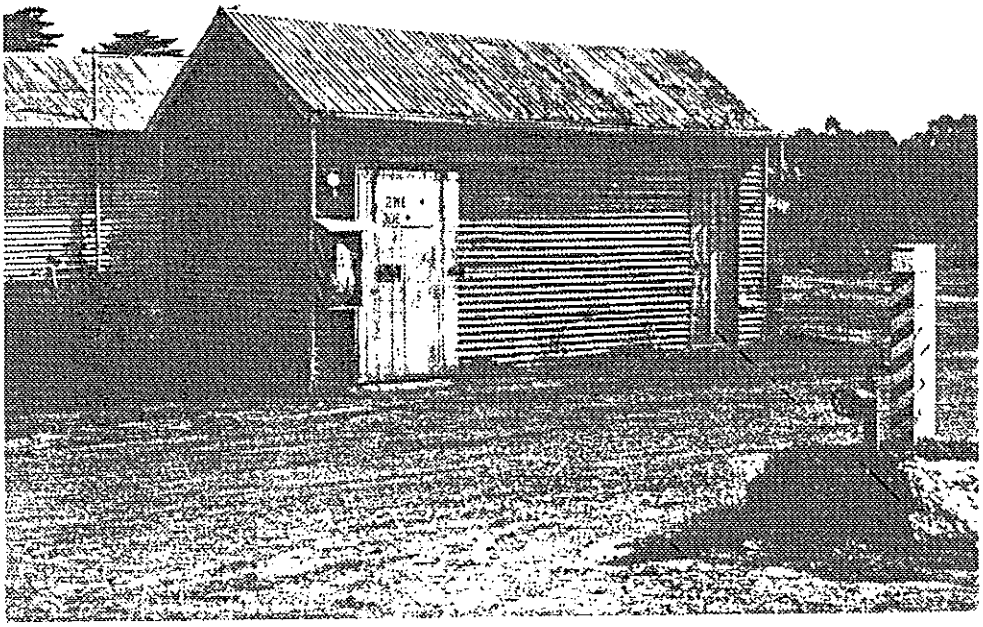
20. Workshop near the refinery: part of this building may have been brought from Geelong.



21. Waste treatment tanks



22. Mess hall



23. Small storage shed

the structures in this area are a concrete foundation, probably for an engine, and six concrete piles on the edge of a drain. (Plate 27) A timber walkway across the drain is probably of more recent origin. The arrangement of equipment or buildings in this area is unknown apart from there having been a building of some kind in the south east corner of the track - tramway junction, ie. near the six piles. This we know from the 1930 ordinance survey map. (Fig 26)

West Junction

The principal line from the refinery to crystalizing pans diverges into three branches about 300 metres east of the refinery. The central line runs between the pans and continues to Skeleton Creek. The north line loops around the pans to rejoin the others at the "East Junction" while another loop does the same to the south. A large section of the southern loop had been dismantled in late 1989 at its western end. These rails are intended for re-use elsewhere on the site. Two sets of points located about 20 metres apart give access to the three lines. (Plate 28, Fig 27)

East Junction

In this area the lines around the crystalizing pans converge and join with the twin tracks leading to Skeleton Creek. Various turnouts allow trucks to be shunted between lines, suggesting that the northern line was used as a siding for idle trucks. An interesting feature of this area are the small tramway bridges across the brine channels which have had board walks built over them to allow hand and horse working. (Plate 29)

These Bridges are marked on Fig. 28 Those marked B have no boards suggesting they were constructed or reconstructed after mechanical traction had become the norm. This was probably in the 1940s coinciding with the wartime labour shortage.

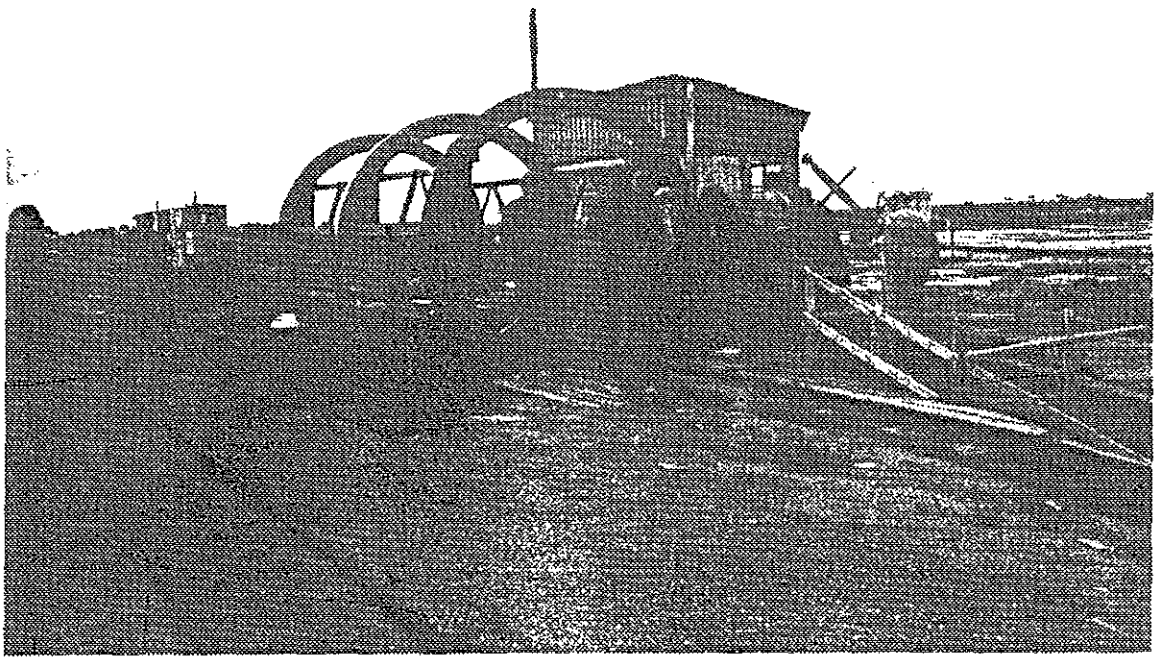
Tram End

Just west of the weir on Skeleton Creek the intact portion of the tramway network comes to an end. The two parallel lines join at a set of points then the single line crosses a drain and disappears beneath a mound af earth excavated for the enlargement of a drain on the other side. This drain, built to serve the "Forsyth" area of evaporation pans, is also crossed by a tramway bridge. A third tramway bridge retains only the timber abutments and beyond this there is no trace of the tramway until it reappears about 25 m. beyond the weir. (Plate 30)

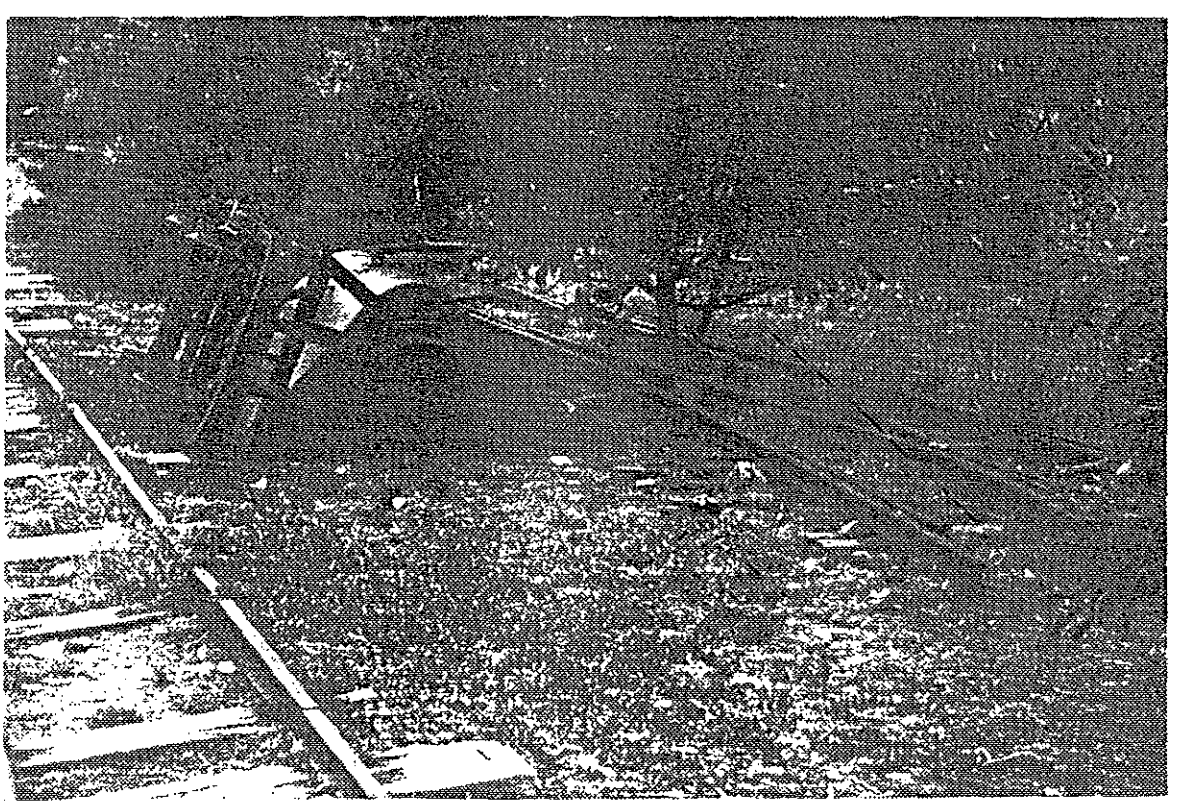
There are remnants of another line which turned south along the right bank of Skeleton Creek to the evaporation basins but this has been disconnected from the main line. This route may have been used to collect gypsum excavated from evaporation basins. A 1951 aerial photograph clearly shows the gypsum raked into heaps either side of the tramway. (Fig 29)

Sand collection line

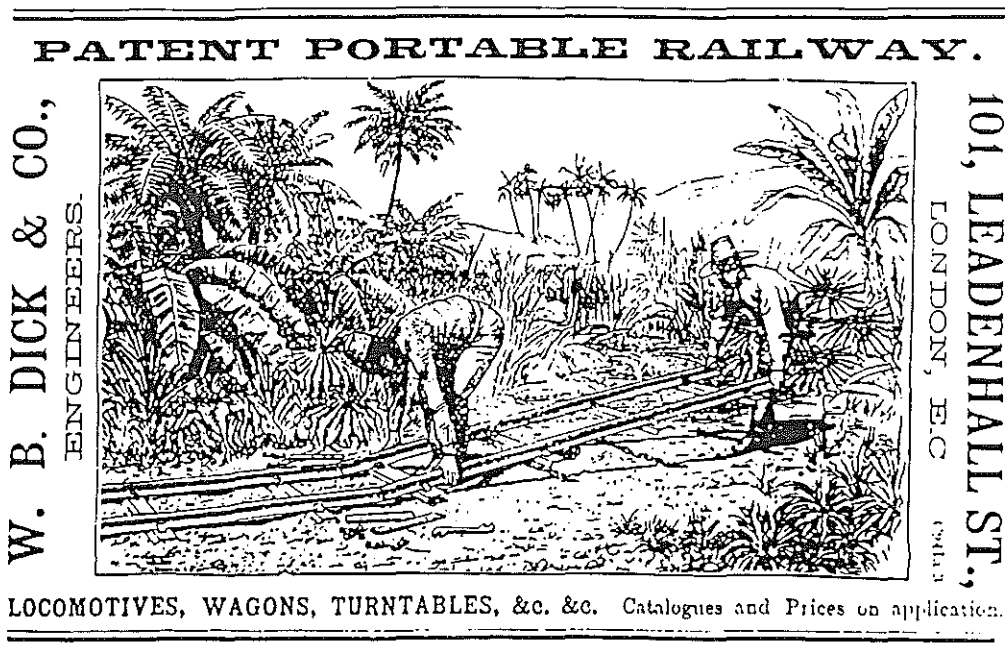
A tramway leading to the beach is known to have been used to collect sand for re-lining the crystalizing pans (Evans 1987). Its route can be traced from remains visible in several places. The line probably crossed Skeleton Creek on a trestle bridge before turning north east. Sleepers can be seen in the roadway



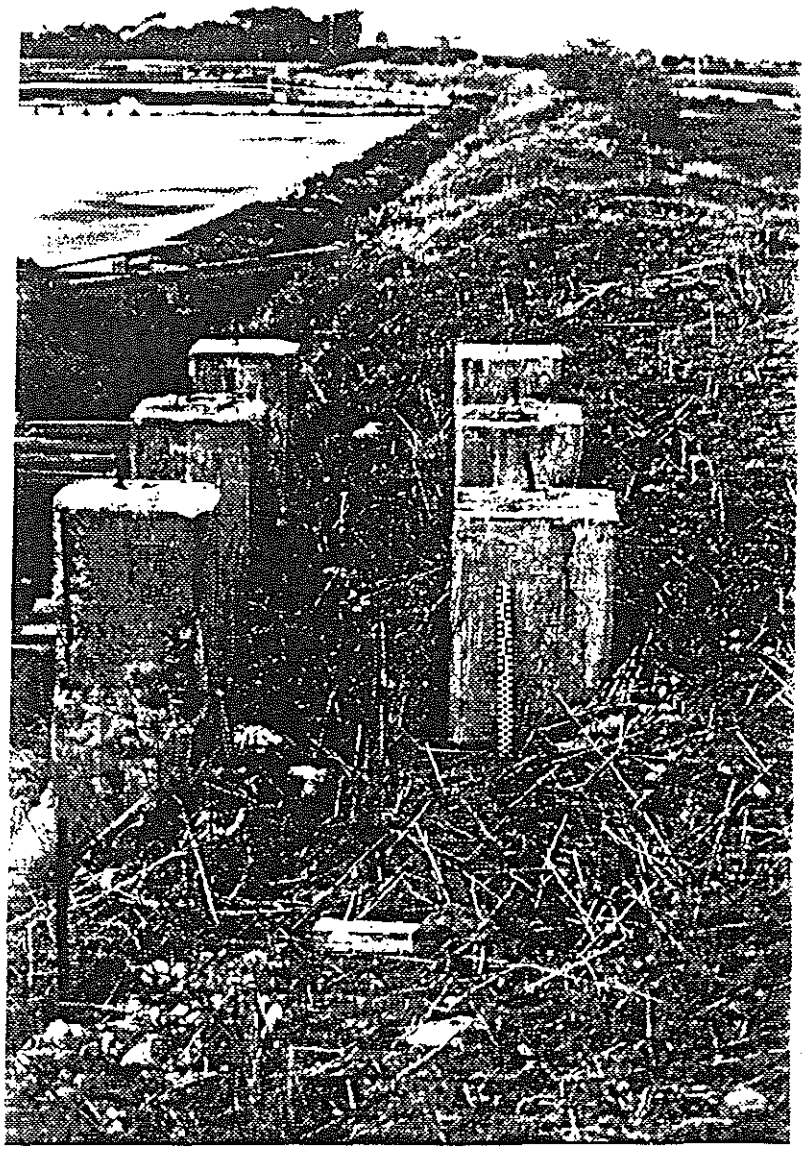
24. Railway truck tumbler



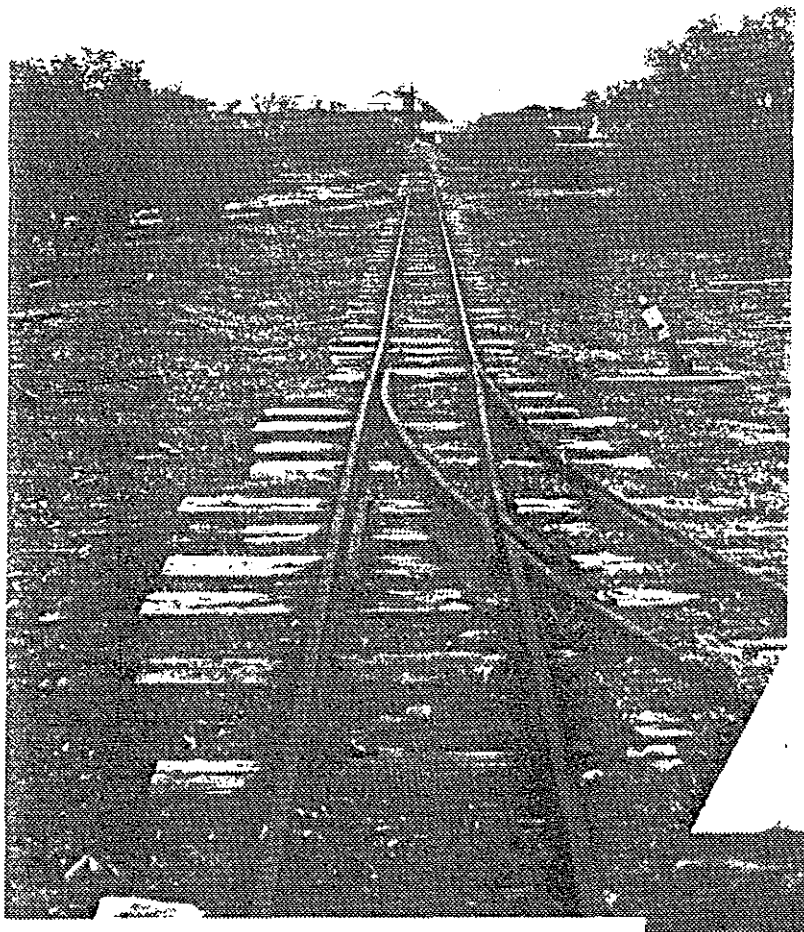
25. Side tipping hopper truck (made by Hudson's of Leeds) and sections of portable rail.



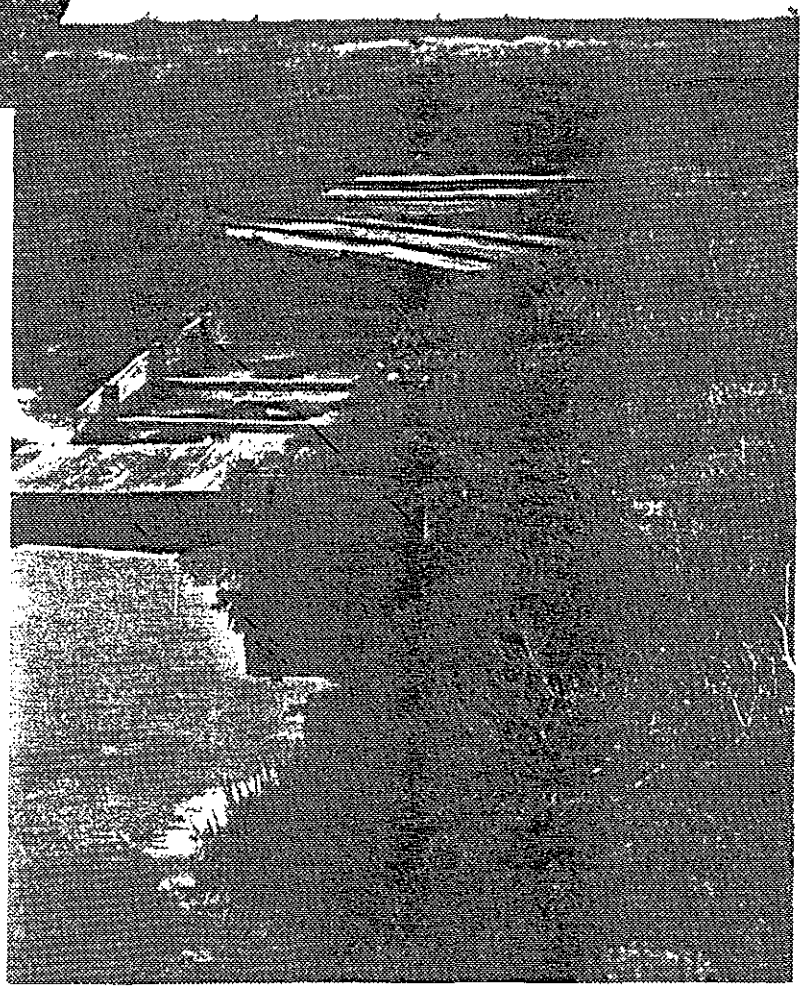
26. Portable rail (Illustration from Light Railways Number 111).



27. Concrete piles from 1920s transfer station



28. Tramway points at west junction



29. Bridges and points at east junction

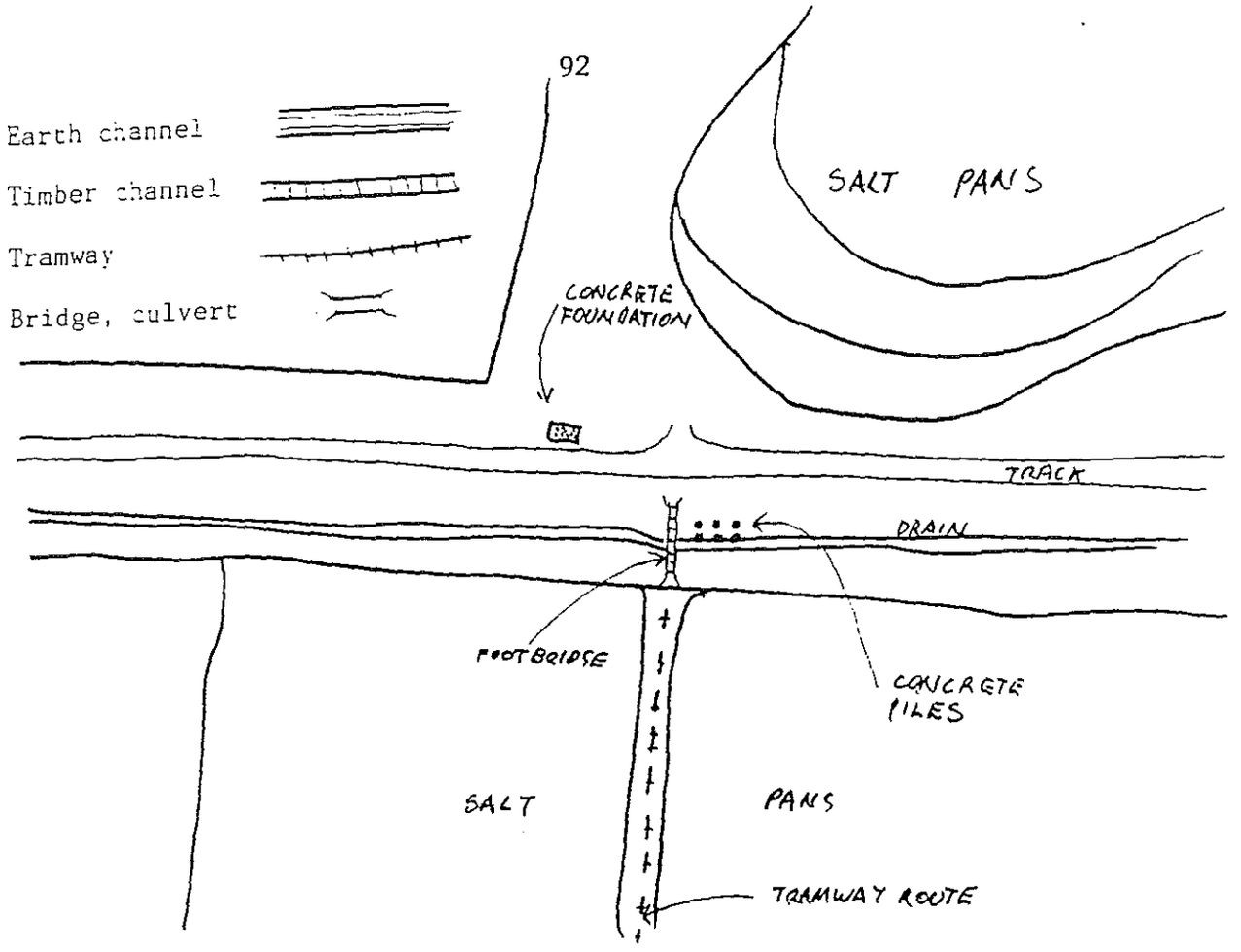


Figure 26. Transfer site

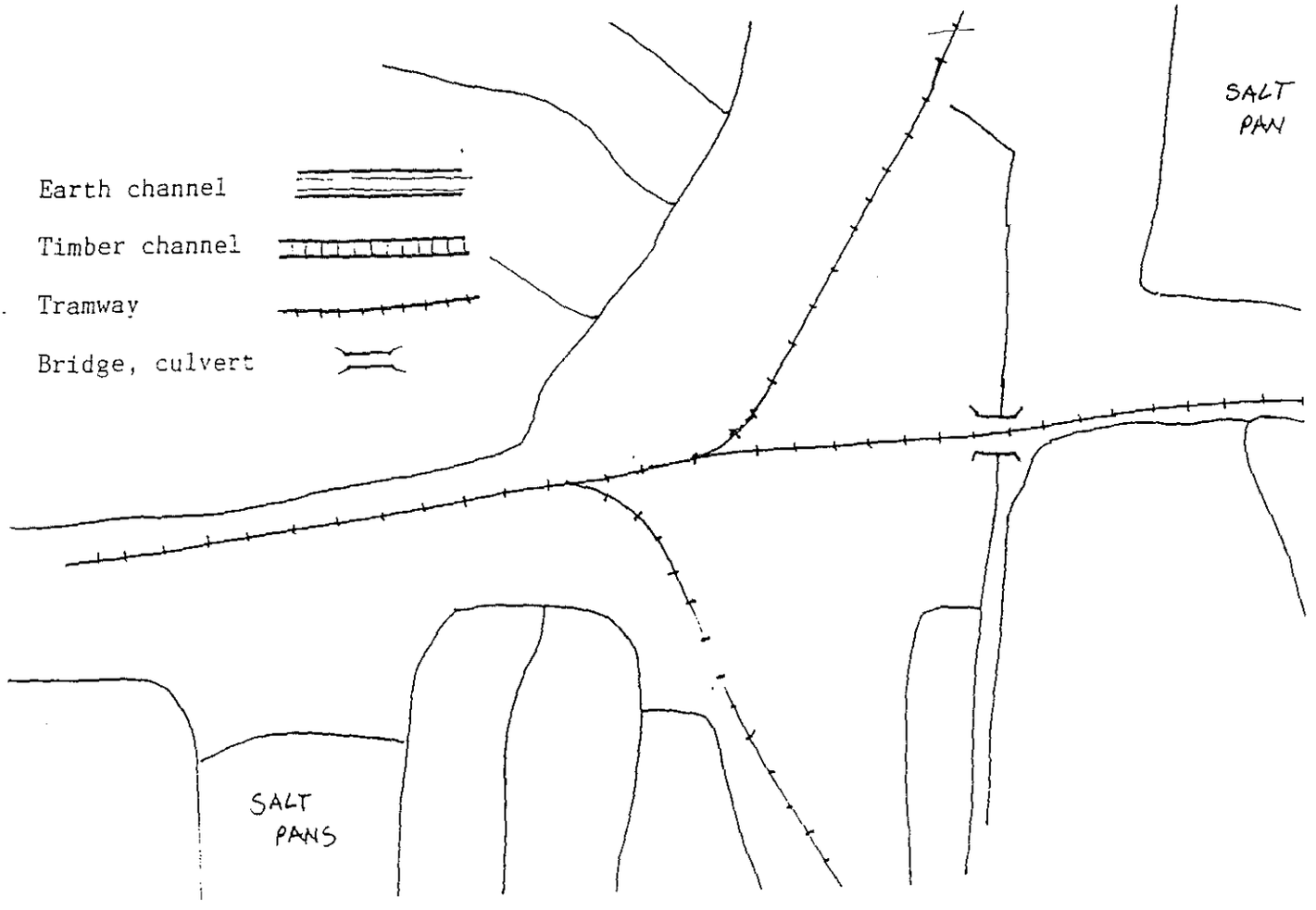
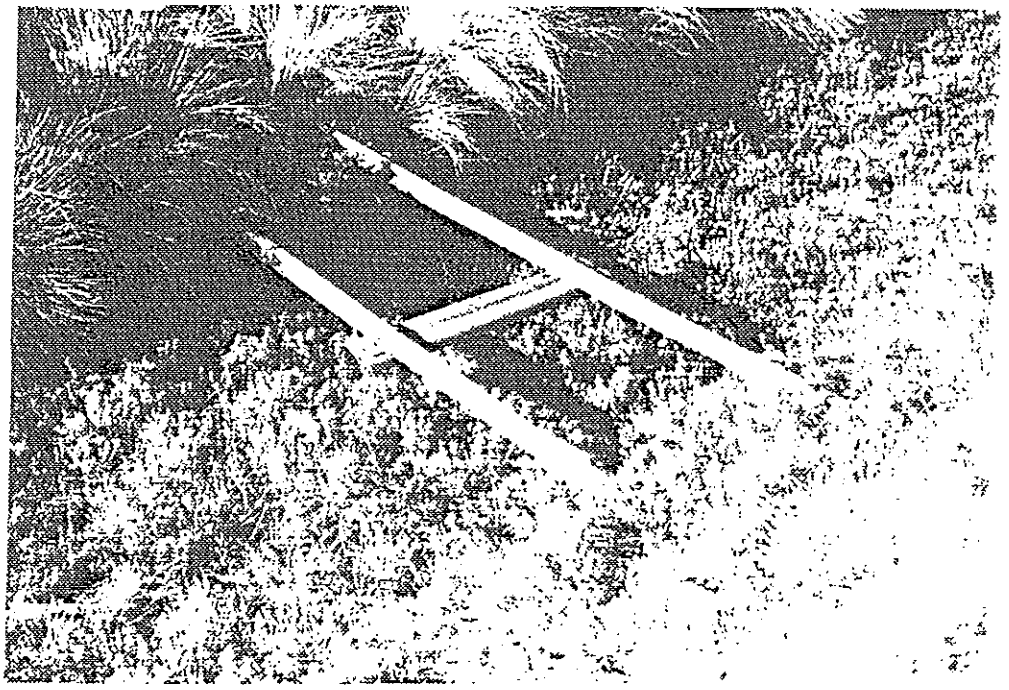


Figure 27. West Junction

30. Tramway bridges and points at tram end



31. Section of portable rail used on the sand collection line.

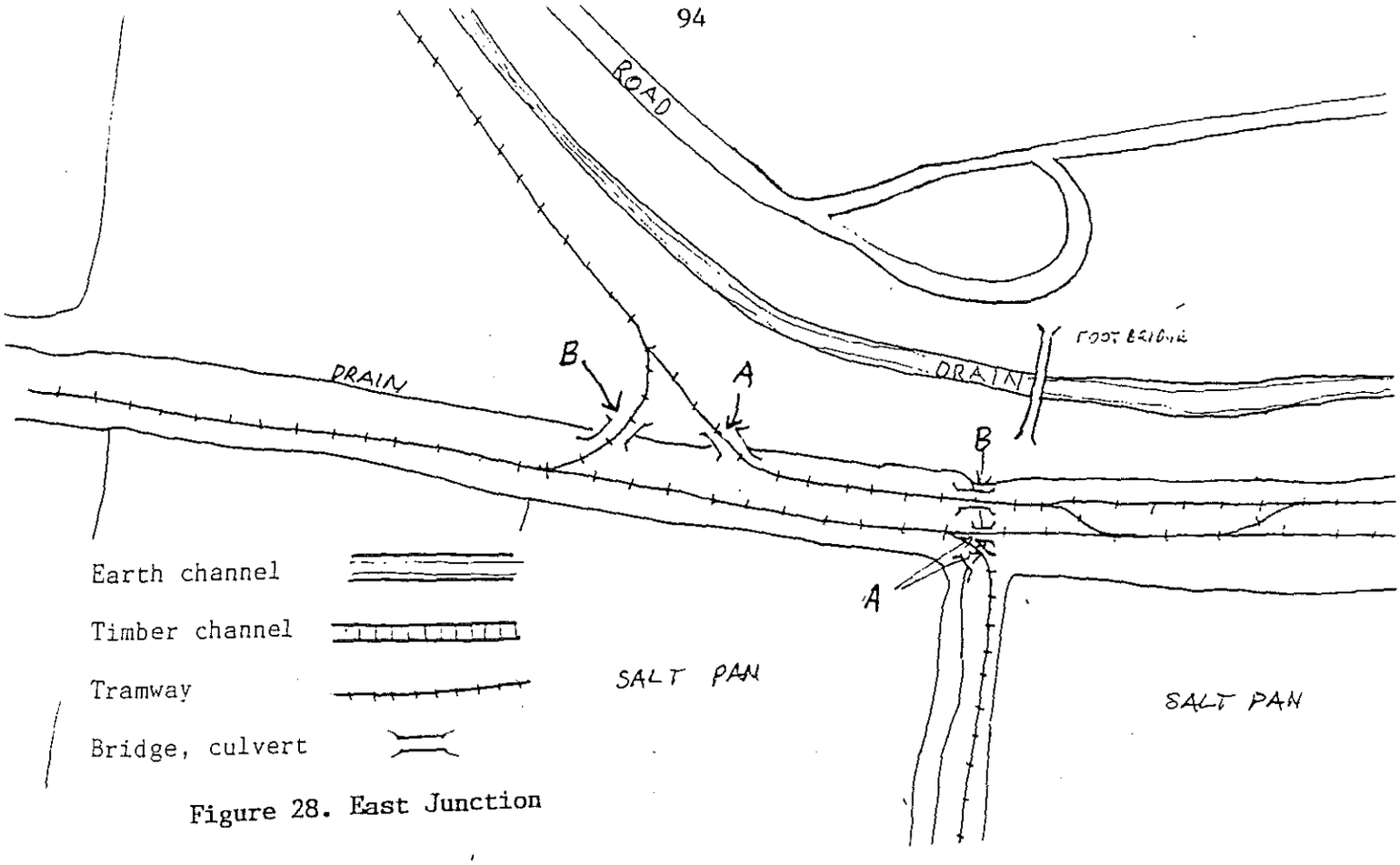


Figure 28. East Junction

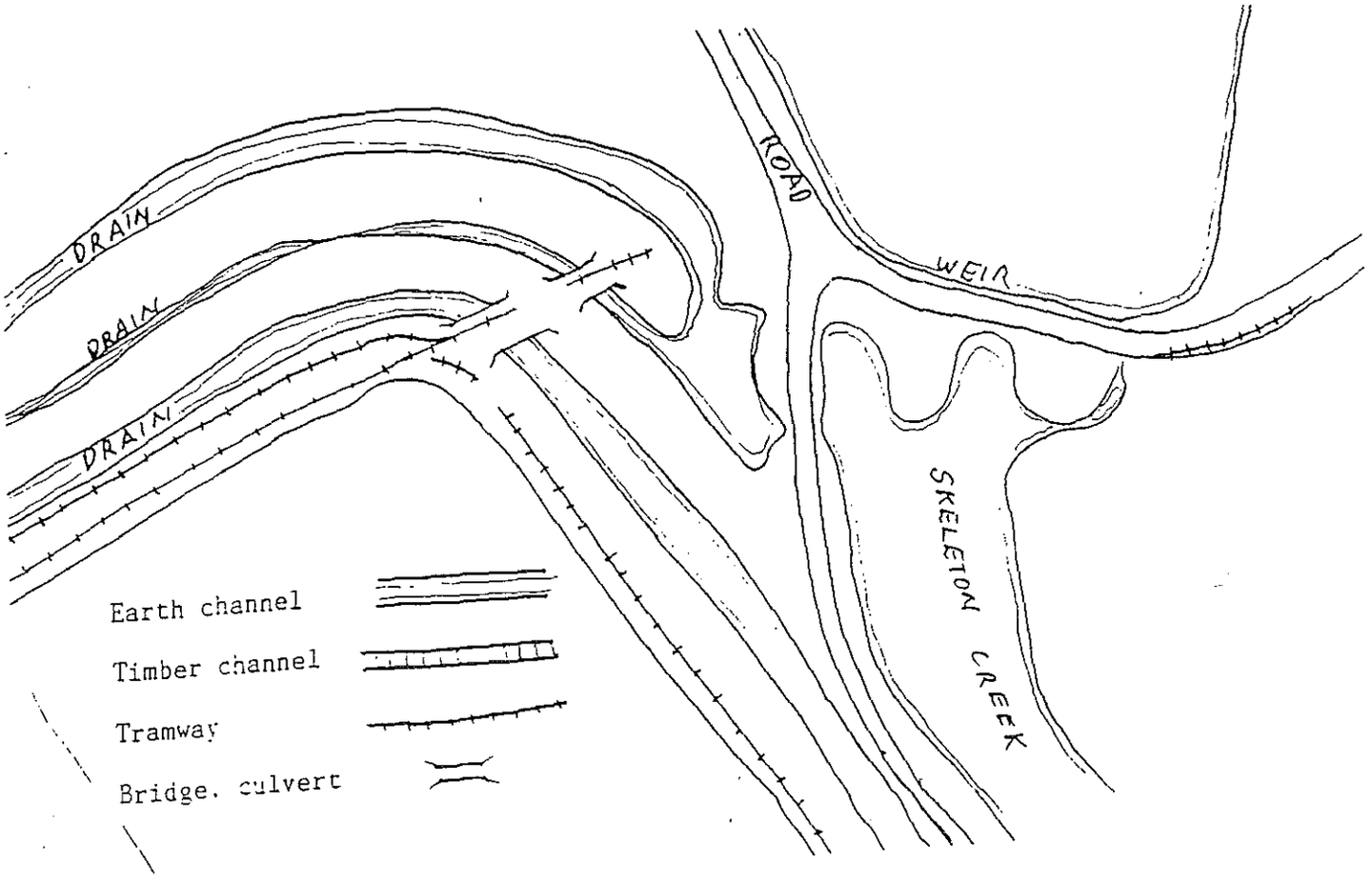


Figure 29. Tram End

just east of the weir. A section between the Tyquin no 8 salt pan and the present roadway appears to have been buried by excavated sand from the pan. The line re-appears at a turn where it heads east to the No. 1 Pump. Rails and sleepers are visible in several areas along this section. More sleepers are in the roadway just west of No. 1 Pump but no track or bridgework across the channels are visible near the pump. The track originally continued along the north bank of the Skeleton Creek and it has survived substantially intact although overgrown, in a section from about 10m east of the No. 1 Pump to close to the mouth of the creek. (Fig 30)

Aerial photographs from the 1950s show a possible extension of this tramway north along one of the relic beach ridges. Near the beach access track at No 4 salt pan explosives reserve area, (grid ref. 064 038) lengths of prefabricated track and embankments for track with excavated depressions between them show where sand has been removed. (Plate 31)

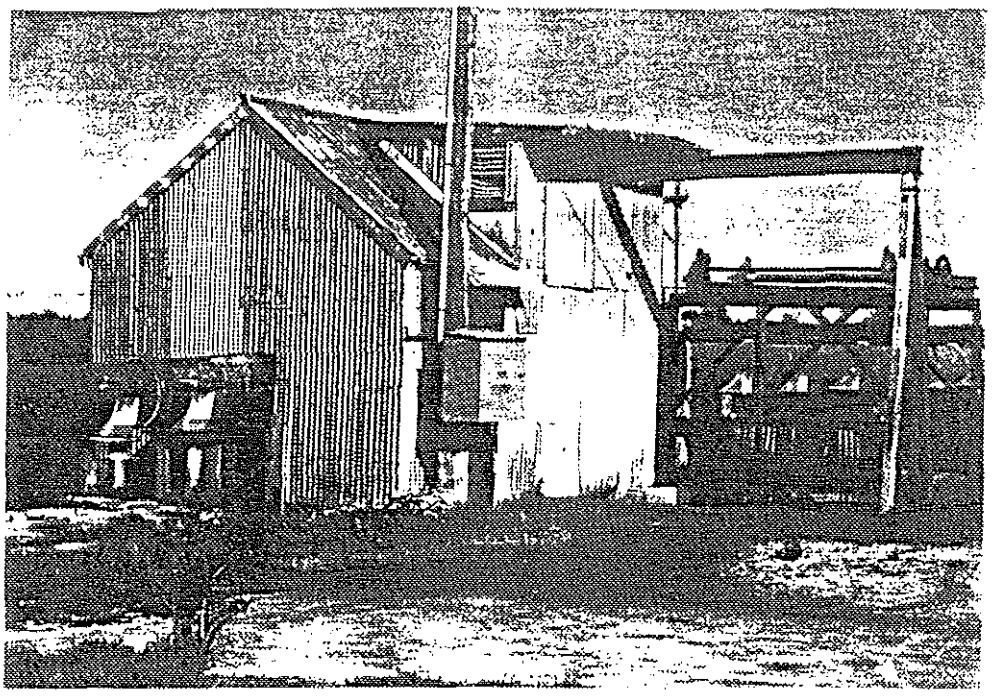
No. 1 Pump

The main pump for the salt works is situated on the north bank of Skeleton Creek at a point which appears as the head of a delta in aerial photographs. This delta is natural but has been modified as a consequence of construction of artificial channels for directing sea water to the pump, and for distribution of brine to the salt pans. Parallel with the access road on the south side are the remains of a 2'6'' tramway which has been dismantled or buried for much of its length. Wooden sleepers are buried in the roadway about 10 metres west of the pump house. On the east side of the pump the tramway continues along the north bank of the Creek for some distance but is now very overgrown. (see Fig 31)

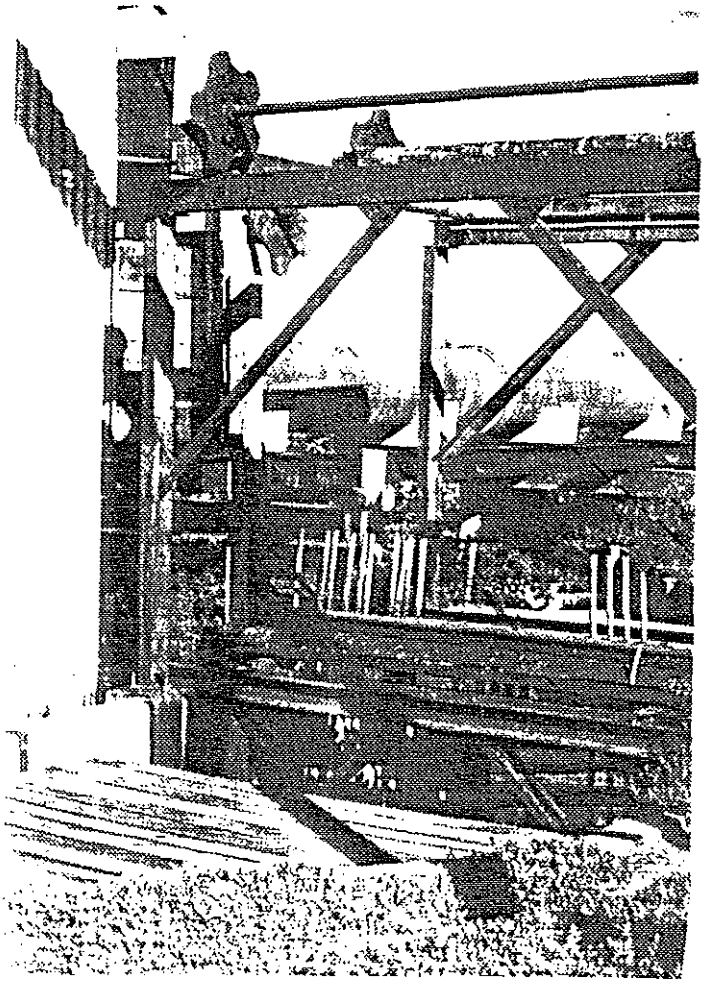
The present arrangement of the pump involves a vertically mounted centrifugal pump raising water from an intake pit connected to the creek via a straining well. The outlet from the pump is into a wooden box with sliding gates controlling the distribution of water into two 18" diameter pipes. The northern outlet pipe feeds a channel on the other side of the roadway and the longer southern pipe crosses Skeleton Creek on a pile bridge and empties into a small pond which appears to have been designed to reduce the force of water entering evaporation ponds. A sluice gate regulates water flow between the intake channel and Skeleton Creek. (see Plate 32 and Fig 32)

The present power source for the pump is a 3 phase electric motor but it was originally powered by an oil engine similar to that which survives at the No 2 Pump site. The concrete foundations for the engine are located just outside the pump shed on the north side and bolts indicate the location of the engine assembly and the flywheel and pulley bearing mounts. A fibro-cement pipe crosses above the foundations indicating it post-dates the replacement of the engine with the electric motor.

The pump house is of light frame hardwood construction clad in currugated galvanized iron. It has a single door on the west side and no windows. The roof is gabled with the southern half raised to clear a crane rail. The crane rail extends from above the electric motor and pump through the building wall and over the water intake pit. This crane was clearly built to facilitate dismantling and maintenance of the pump and motor and could be associated with clearing of the trash rack. (see Plate 33)



32. No. 1 pump house



33. Crane and trash racks at No. 1 pump

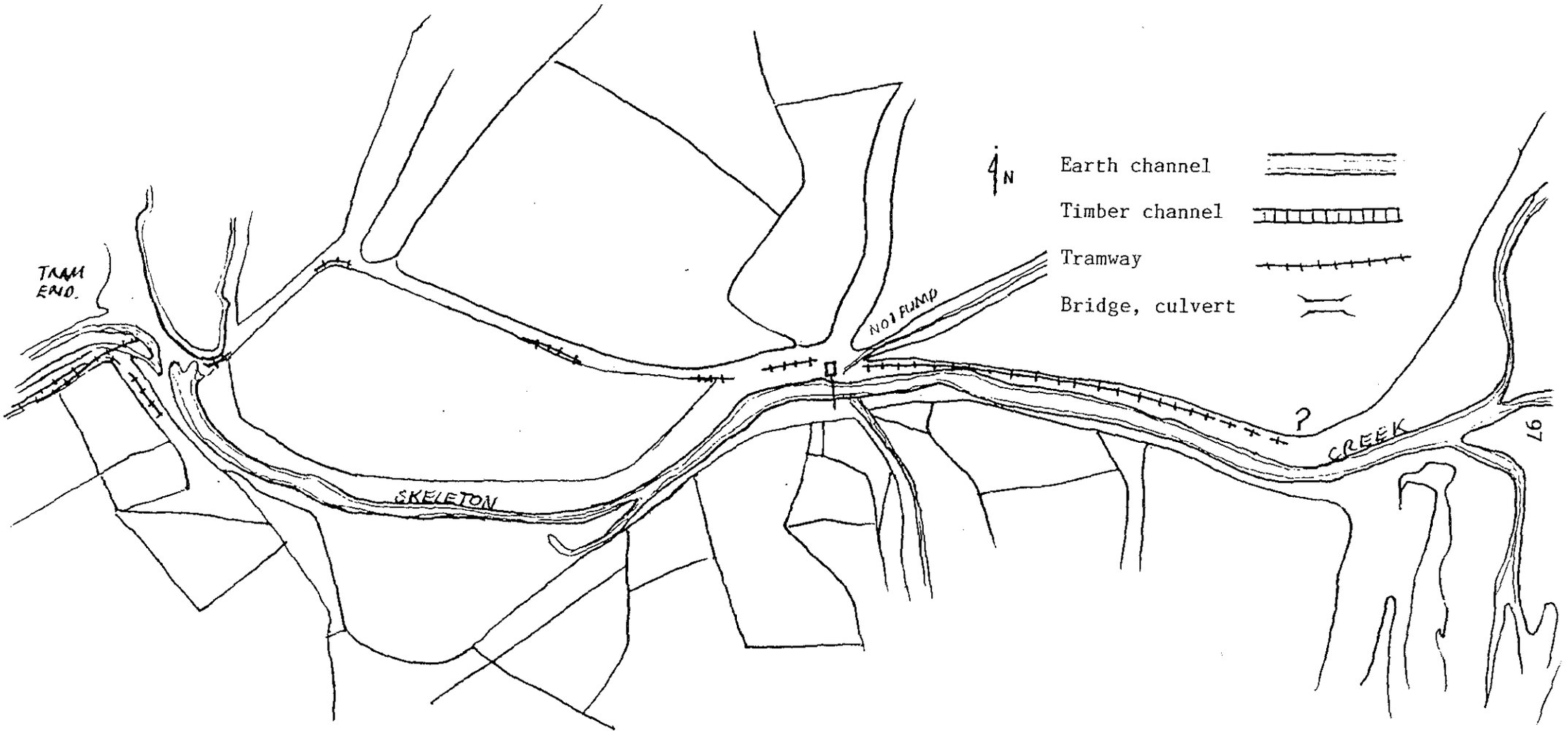


Figure 30. Sand collection line

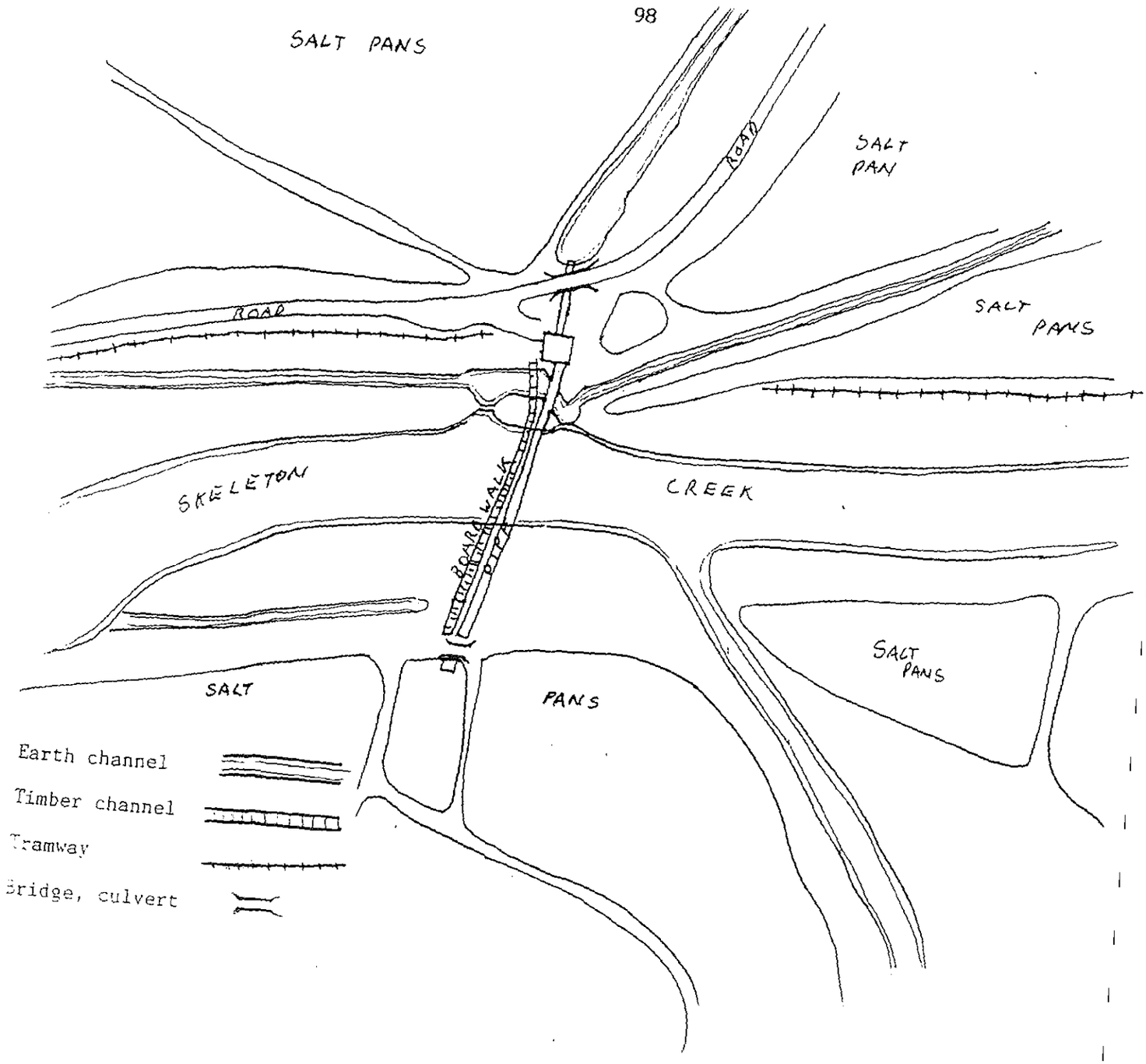


Figure 31. Number 1 pump environs

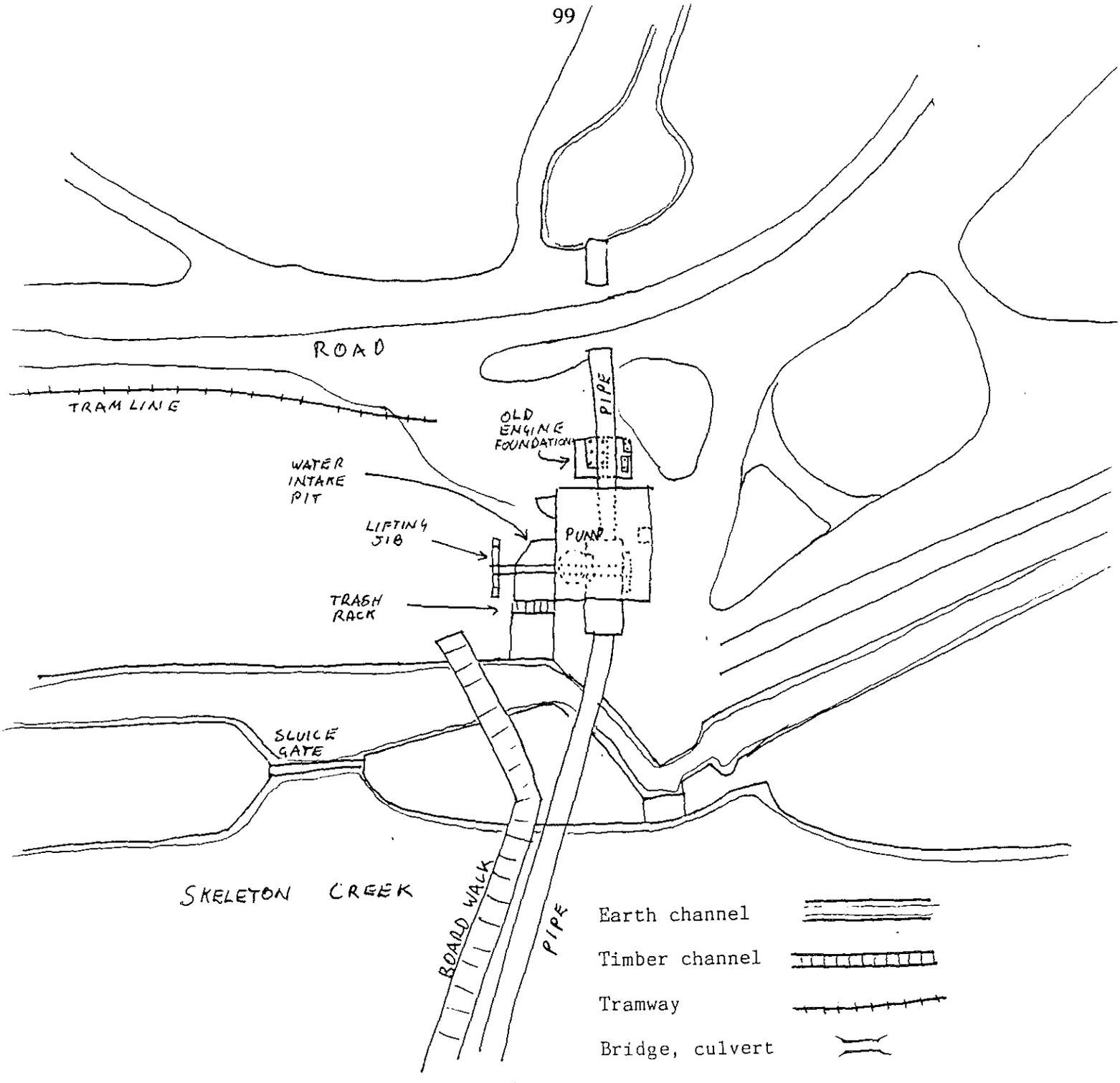


Figure 32. Number 1 pump details

No. 2 Pump

The only surviving engine from the original pumps is located on the No. 2 Pump site. The single cylinder four stroke gas engine has external valve gear and a 5 foot diameter fly wheel. These engines were commonly used by Cheetham before electrification of the pumps but were replaced early in the history of the works.

The engine and crankshaft bearing are mounted on concrete blocks similar to those at the No 1 and No. 3 pump sites. The engine is in a very poor state, missing some parts, is rusted and evidently seized. (Plate 34) The drive for the pump was via a flat belt and pulley on the end of the crankshaft. The centrifugal pump is located outside of the building and is mounted above an intake pit connected to a channel which collects water from evaporation pans. Above the pump is a wooden box where the brine is distributed to three wooden chutes and controlled by sliding gates. (Plate 35) A three phase electric motor is now used to drive the pump. To the west of the engine house is a tank stand with a collapsed wood stave water tank probably used for cooling water for the gas engine. (Fig 33)

No. 3 Pump

The purpose of the No. 3 Pump was to raise the concentrated brine for distribution to the crystalizing pans. This was achieved using a similar gas engine and centrifugal pump to that installed at the No. 1 and 2 Pump sites. Like the other sites, the engine was replaced with an electric motor and now only the concrete foundation of the engine remains. (Fig 34)

The centrifugal pump is within a timber-framed shed clad in timber, corrugated iron and fibro-cement sheeting. A wooden collection box above the pump can be used to direct brine to a wooden channel, to the crystalizing pans or to deep storage "Reeves".

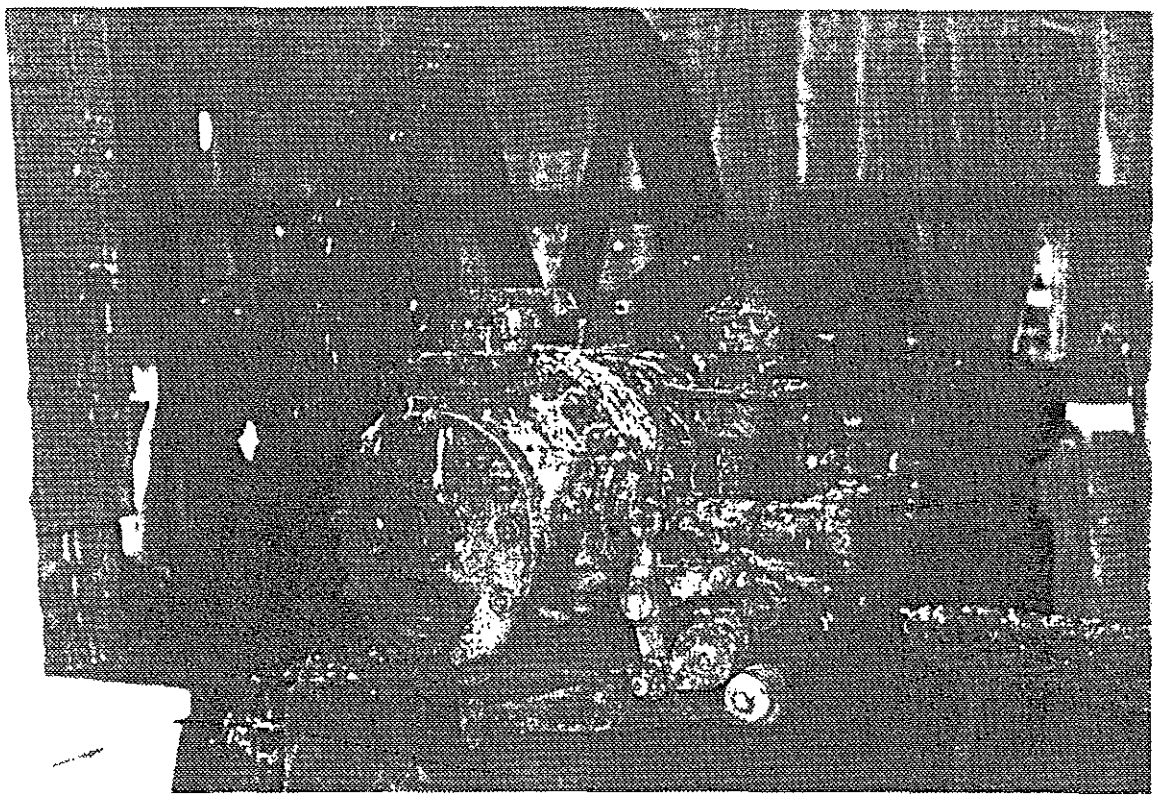
An additional wooden channel with a second pump has been installed south of the pump house to recirculate brine to the evaporation pans indicating the development and elaboration of the system in more recent years. (Plate 36)

The distribution channel uses fibro-cement spoon drains elevated on timber trestles running between the crystalizing pans. It crosses under the tramway via a siphon.

House site 1.

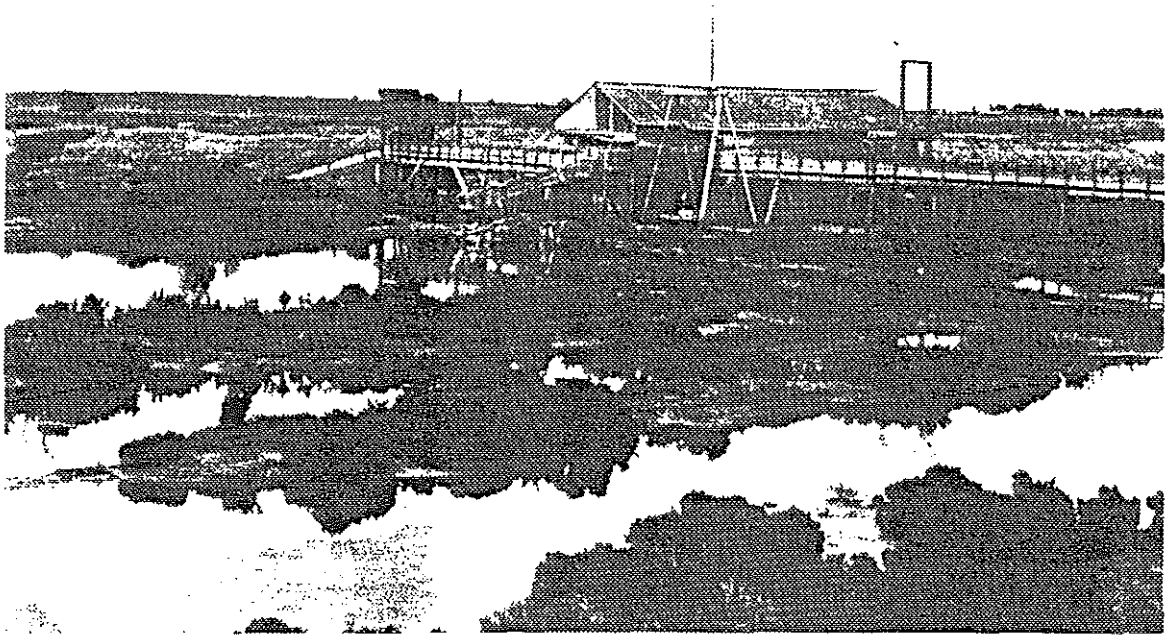
Located on the south bank of Skeleton Creek, the site is today marked by a scatter of non indigenous plants mainly boxthorn and sugar gums and some aloe cultivars. There is also a scatter of cultural material such as broken glass and crockery and red machine made bricks, probably from the fireplace of the house. It appears that a timber building with a brick fireplace was constructed here probably during the earliest period of the saltworks operation and demolished prior to 1951 when aerial photographs show the site cleared. The plan of buildings cannot be traced as the area has been cleared by bulldozer. (Plate 37)

It is believed that this and another house (HS2) were built as residences for the brine controllers whose job it was to regulate the circulation of brine and keep a check on the salt concentrations. The houses are located close to the pump sites.



34. Gas engine in No. 2 pump house

35. No. 2 pump house and timber chanels



36. No. 3 pump house

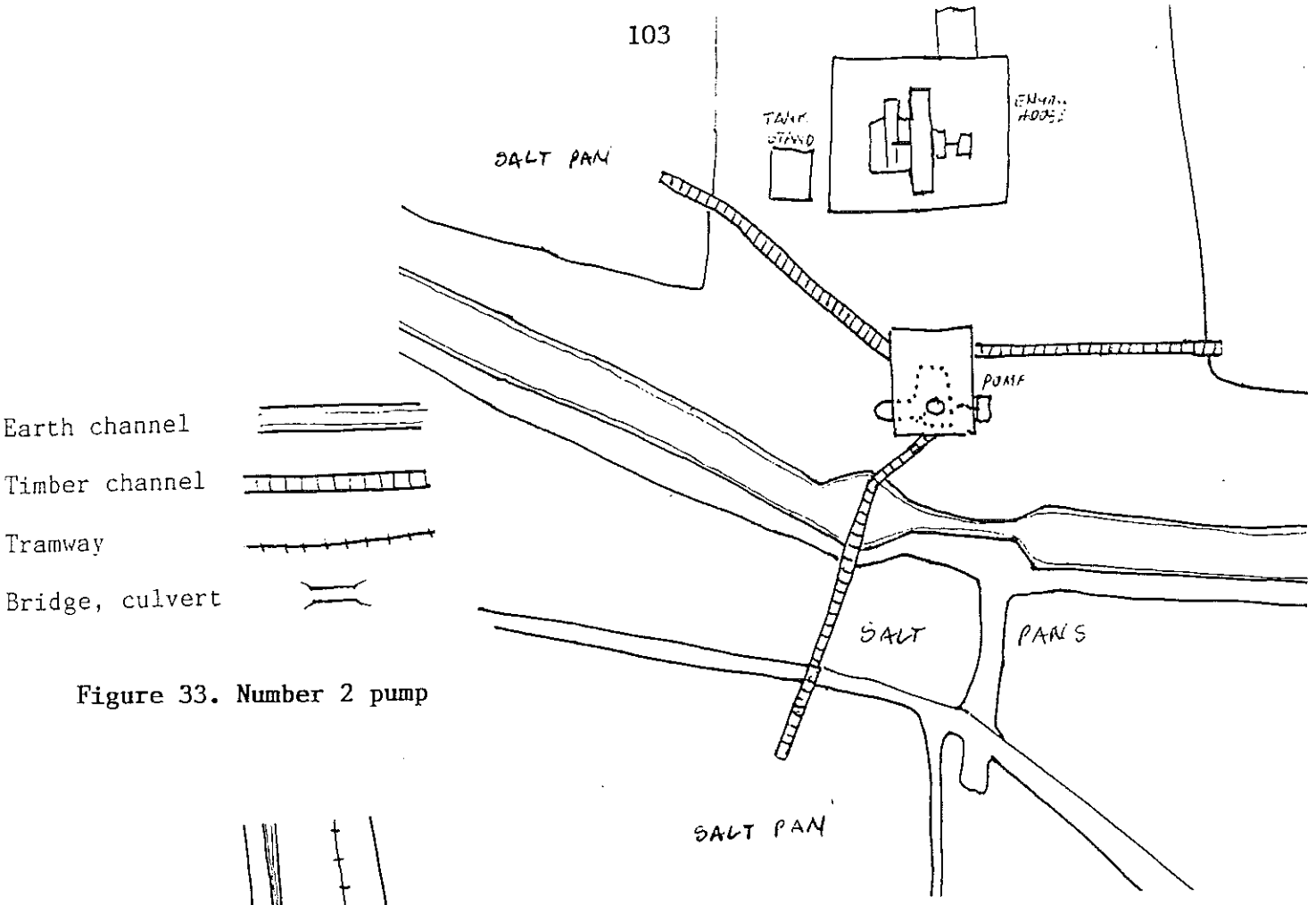


Figure 33. Number 2 pump

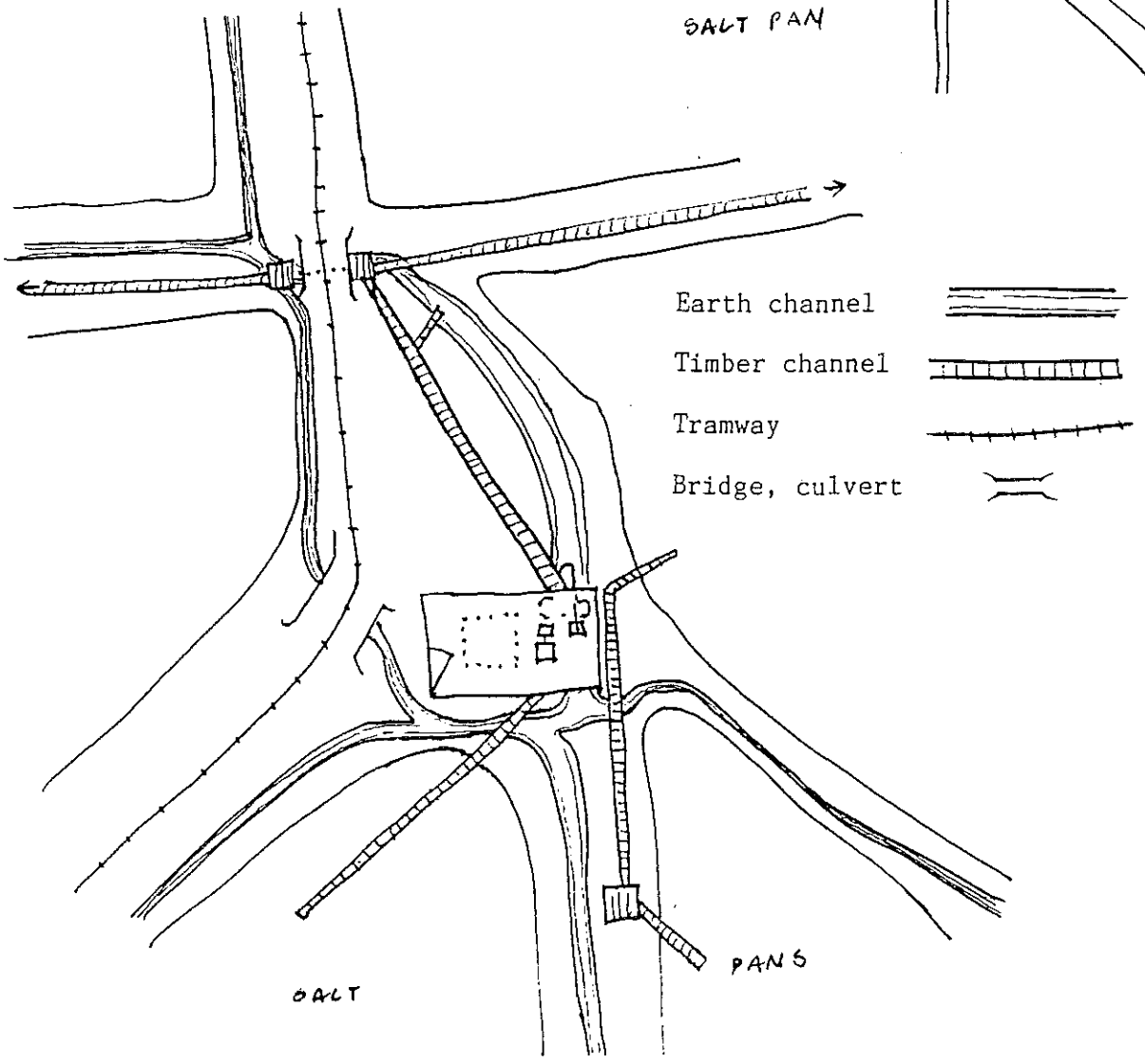
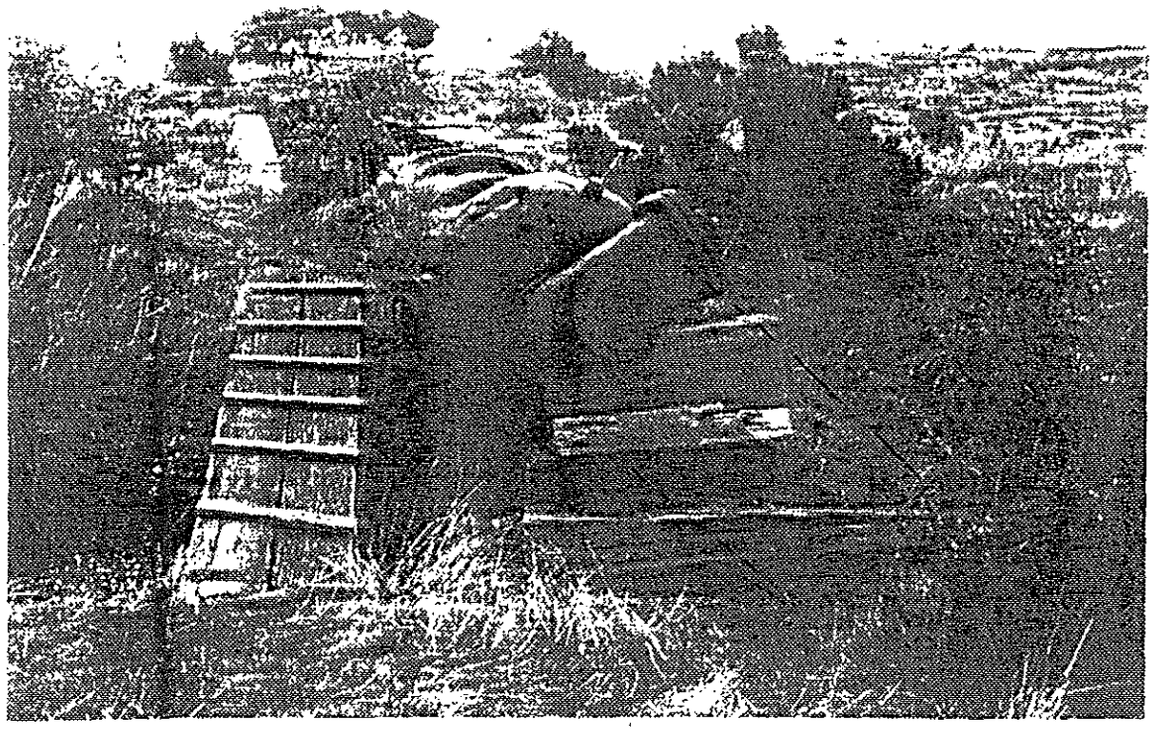


Figure 34. Number 3 pump

37. General view of house site 1, note mature conifers in the background.



38. Pipe and valve near house site 2

As the works was begun at a time when very few houses were in the area and few people had private transport it was essential for the company to provide accommodation for its workers.

The area was also used as a seasonal camp for workers during the salt harvest before mechanized harvesting was adopted. Many tents were erected here during the late summer harvest season when up to 100 men were employed to lift the salt from the pans with shovels. The site therefore represents an example of factory housing in a particularly remote situation.

House site 2.

This site which is located on the north bank of Skeleton Creek near the weir also appeared on the 1930 ordnance survey maps and is today marked by exotic plants, mainly boxthorn and a single cypress tree. The 1:2500 MMBW base map indicates the site is within the Cheetham Salt owned property although their own plans show the property boundary to the south.

A diffuse scatter of cultural material, bricks, timber, broken glass and crockery, etc indicates considerable disturbance of the site. Like the House site 1 this house was probably built for use of brine controllers and was also demolished by 1951. Boxthorn was planted as a fence just north of the house but was cleared in early 1990.

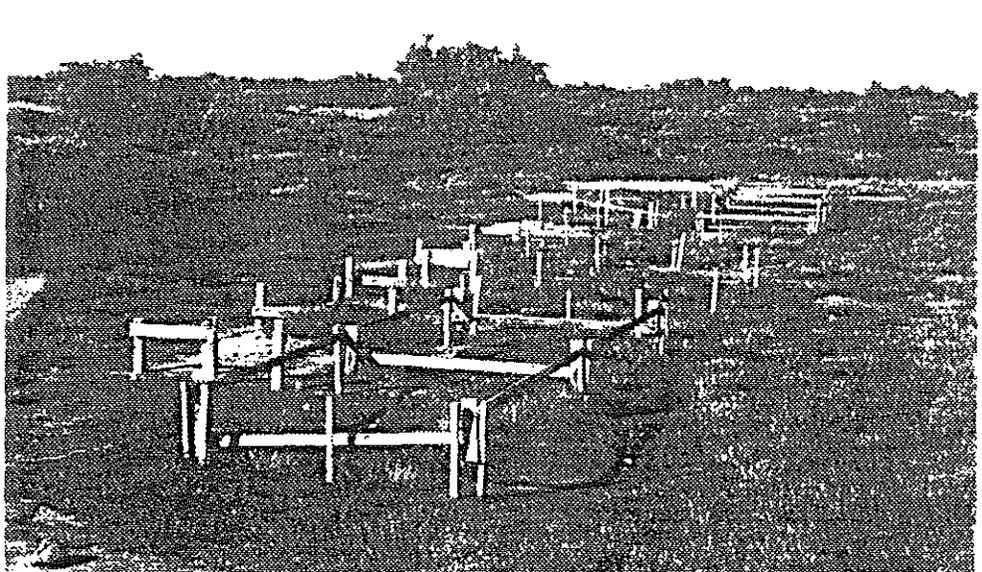
Nearby is an unusual pipe made from sections of flanged cast iron rivetted together. A gate valve is at one end and it appears to have been associated with pumping brine for the higher levels. It has been out of use for many years. (Plate 38)

House site 3.

A third house site, again associated with accomodation for the salt workers during the harvest season, is located north of the works access road about 500 m. west of the Skeleton Creek weir. Boxthorn, sugar gums and cyprus trees mark a rectangle which contained at least two buildings in 1930. These are marked on the old ordinance survey maps but do not appear on 1951 aerial photographs.

Oyster farm

Just north of Pump site No. 1 are the remains of timbers thought to be all that is left of an aborted attempt at oyster farming on the site in the mid 1980s. Timber framework covers an area of about 6 by 20 metres near the sea water chanel. (Plate 39)



39. Timber framework possibly from an experimental oyster farm.

5. DISCUSSION

5.1 Wetland habitat

The Laverton Saltworks are a significant wetland only because of the operation of the salt production process and the pumping of sea-water into shallow lagoons. In 1986, the Cheetham Salt Company suspended salt production (see Section 2.5). It resumed when pumping started again in November 1989, during the current study.

This two year gap in pumping is reflected in the numbers of shorebirds and wildfowl using the saltworks. Data are not available over this period for other groups of birds which regularly use the saltworks.

Figure 36 shows the total numbers of shorebirds on the Laverton Saltworks in February each year from 1981 to 1990. The second highest count in this series occurred in February 1987, the final season in which pumping occurred. This was ommediately followed by the two lowest counts in this period, in 1988 and 1989. In 1988 and 1989, numbers of shorebirds declined from an average of about 6,600 individuals from 1982 to 1987 (1981 was an exceptional year) to 3,744 in 1988 (a 43% decline) to 1,457 in 1989 (a 78% decline). By 1990, after salt production had resumed, numbers of shorebirds had increased again to 4,590 individuals.

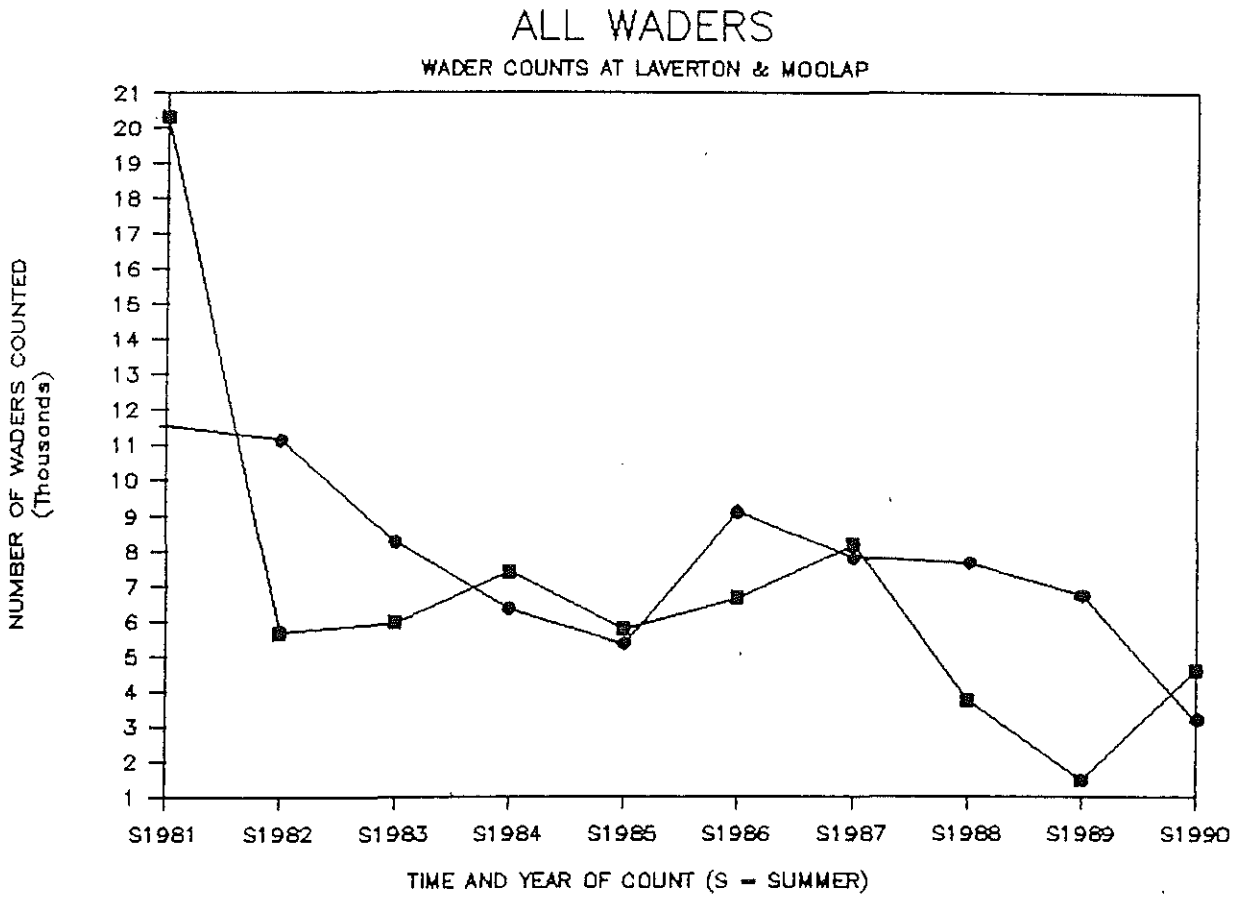
A comparison between counts at Laverton and those at Moolap Saltworks, an area with similar habitat and complement of shorebird species elsewhere in Port Phillip Bay (see Figure 36) shows that the decline in 1988 and 1989 did not occur at Moolap. This indicates that the cessation of salt production was probably responsible for the observed decline.

The wildfowl count data do not cover such a long period as the shorebird data. Indeed, the data start in 1988, after salt production was suspended. An indication of the impact of the cessation of salt production was obtained by deriving expected wildfowl counts for this period. This was done by taking the 1990 wildfowl counts for Port Phillip Bay and applying the percentage of this total at the Laverton Saltworks in 1990 (after salt production had resumed) to the earlier totals for Port Phillip Bay. Table 4 gives the observed and expected counts for the saltworks in 1988 and 1989 for the four most abundant wildfowl species: Australian Shelduck, Grey Teal, Chestnut Teal and Black Swan. Although this approach suffers from a lack of samples in more years when salt production was underway at Laverton, it provides at least some insight. It shows that for three of the four mentioned species (excluding Australian Shelduck), numbers were well below what mignt be expected.

Given the limitations of the data, a second approach was attempted. The pattern of seasonal changes in numbers of wildfowl at the saltworks reported by Morgan (1954) in the early 1950's was compared with the observed changes in numbers in 1989-90, during the current study. In the 1950s numbers of wildfowl increased dramatically in October - November each year that the survey was done. A similar pattern was observed in 1989-90 when salt production resumed with pumping in October. Pumping in October is normal practice. The seasonal changes at the saltworks may, therefore be closely linked with the pumping schedule. More surveys at appropriate times of year would be needed to confirm

SPECIES	OBSERVED NUMBERS		EXPECTED NUMBERS	
	1988	1989	1988	1989
Australian Shelduck	645	144	484	703
Grey Teal	81	696	857	926
Chestnut Teal	2	8	182	163
Black Swan	2	0	156	179

Table 4: Observed and expected wildfowl counts at Laverton Saltworks in 1988 and 1989. See text for derivation of expected numbers.



squares = Laverton Saltworks
circles = Moolap Saltworks

Figure 35. Shorebird counts Laverton and Moolap, 1981 to 1990

this association however, as it may be due to a larger-scale spring immigration of wildfowl to Port Phillip Bay.

The available evidence indicates that at least for some species of waterbirds, there is a close link between their numbers and salt production. The usage of the area by shorebirds is closely linked and the cessation of pumping and production between 1987 and 1989 caused a 73% decline in numbers in this period. The evidence for wildfowl is equivocal at this stage, although for some species, there is a suggestion that numbers were not as high as might be expected during the time when production ceased. It is not known to what extent the usage of the Laverton Saltworks by other groups of waterbirds is affected by salt production. but strong positive associations might be expected.

This intimate link between salt production and the presence of waterbird populations of international, state and regional significance has implications in view of the current uncertainty about Cheetham's salt production at Laverton. Should salt production or, more specifically, pumping of seawater into coastal lagoons and nearby evaporation pans cease, then a conservation asset of outstanding significance will be lost.

5.2 Aboriginal sites

Because of the factors outlined in the methodology above, Aboriginal sites were only identified on the periphery of the works in the few areas under specific conditions and levels of ground disturbance. Removal of vegetation and erosion of soil to expose artifacts appears to be a major factor in the success of the site survey. The richness of the biospheres available for exploitation by the Aborigines, (fresh and saltwater swamps and lakes, grassland, woodland, freshwater streams, coastal estuaries the bay, etc.) would suggest considerable occupation and utilization of the area by aborigines. This is to some extent confirmed by the results of the archaeological survey. There were, however, no sites with particularly dense cultural material and only indeterminate shell midden material.

Sites along Skeleton Creek confirm to what appears to be a regular pattern in Melbourne's west. There are linear scatters of artifacts on the banks of the creek with greater concentrations near permanent fresh waterholes in the creek.

The most common artifact material found was quartz. In some cases, fairly large quantities were evident and formal tools were found, although most of the material were waste flakes. The ratio of quartz to silcrete and other material is about 100 to 10 to 1.

Lack of success in identifying coastal sites may be due to problems of visibility and the dynamic nature of the coastal system in this area. It is also possible that coastal exploitation was uncommon in this area. With the exception of Point Cook, there is little evidence of maritime exploitation. Point Cook has the only coastal rock shelf between Altona and Point Wilson. Based on the sites surveyed in this project and a predictive model established for the Western Region (du Cros 1989a) areas of potential archaeological sensitivity (ie. where Aboriginal artifacts are likely to occur) may be identified. These areas are shown Figure 36.

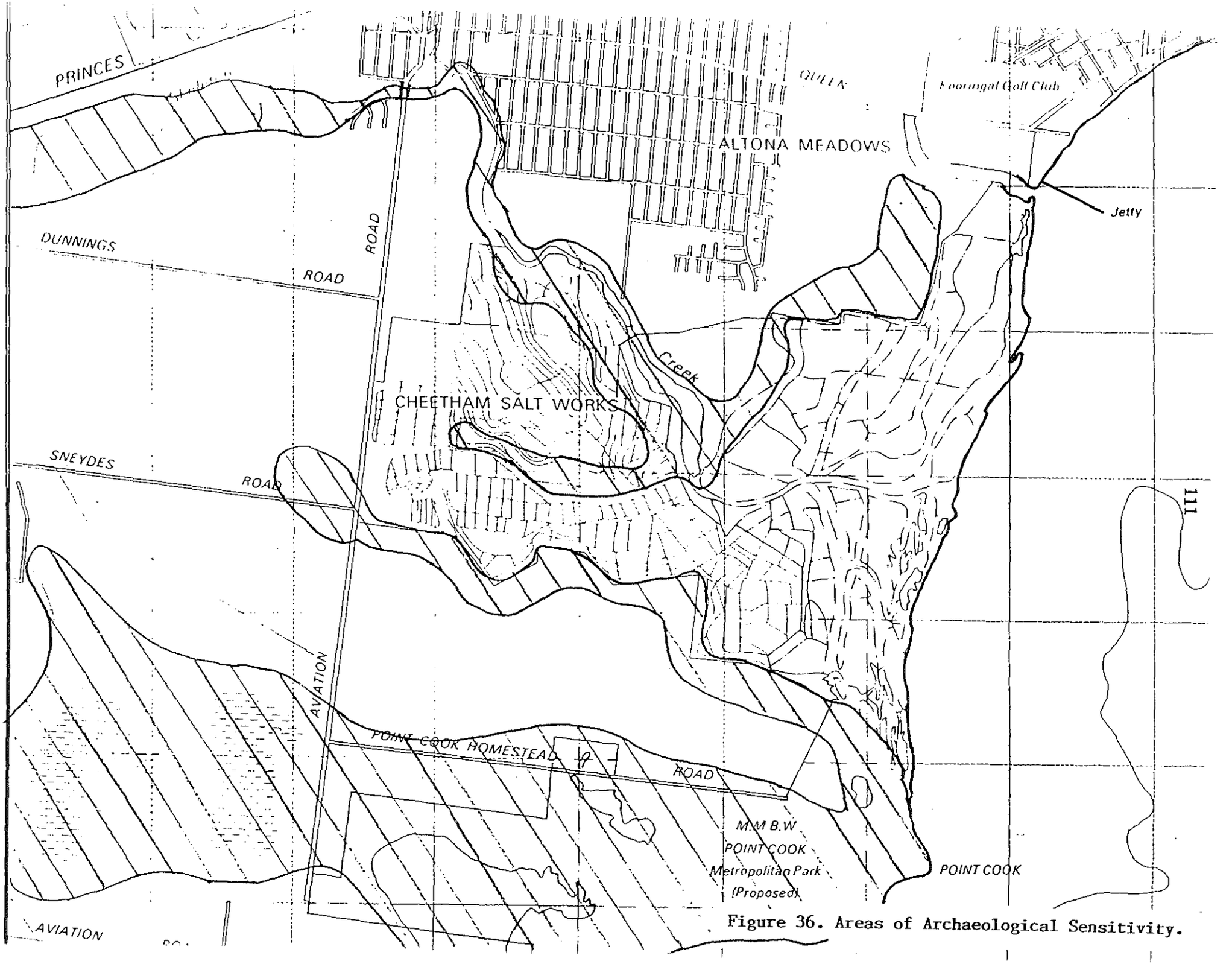


Figure 36. Areas of Archaeological Sensitivity.

The proximity of some sites, chiefly AB1 and AB3 to areas later occupied by Europeans demonstrates the importance of the topography as a major locational factor for both Aboriginal and European alike. The main factors appear to be the choice of dry ground close to permanent fresh water.

On a comparative basis, the sites within the saltworks boundary fall within the range of site types common in the region and on higher sections of Skeleton Creek. Their significance lies in their ability to demonstrate the patterns of occupation in the region and is an indication of the nature of Aboriginal resource exploitation, ie. their dependence on wetland systems as a major food source.

5.3 Historical sites

The Laverton Saltworks retains possibly the last evidence of early twentieth century salt harvesting techniques in Australia. This evidence comprises the tramway system and layout of the salt pans and some of the ancilliary eqipment of the salt works. Changes in operation such as the use of motor trucks and mechanized harvesting equipment have been adopted at Laverton as they have in other saltworks, but these changes have not obliterated all evidence of the early system.

6. ZONING MAPS

The saltworks have been zoned on the basis of features of natural, archaeological and historical significance. Separate maps are provided for each of these categories. (see Figs. 37-39) Where no features of significance exist, no zoning is given. The zones used are described below.

6.1. NATURE CONSERVATION

A International Significance

B Regional Significance

Areas of International Significance are those areas which hold conservation assets of value in a global context. Within these areas, there are also features of national, state, regional and local significance. The principal features are as follows:

* internationally significant populations of migratory shorebirds (i.e. > 1% of the population);

* populations of shorebirds of state significance (> 5% of state population);

* populations of wildfowl of regional significance (> 5% of the population in Port Phillip Bay)

* diverse coastal vegetation of state significance; and

* geomorphological features of state and regional significance.

The zones of regional and international significance are shown in Fig 37.

6.2 ARCHAEOLOGY

Based on archaeological survey and predictive model (see section 3.2) areas of archaeological sensitivity have been established (see section 5.2 and Fig. 35). However, without further detailed investigation and comparative analysis of the sites and artifacts it is not possible to apportion a level of significance on the archaeological zones. Therefore only a single zone has been identified which encompasses all the known sites as well as the areas where sites are likely to occur. The zone of significance for Aboriginal sites is shown in Fig. 38.

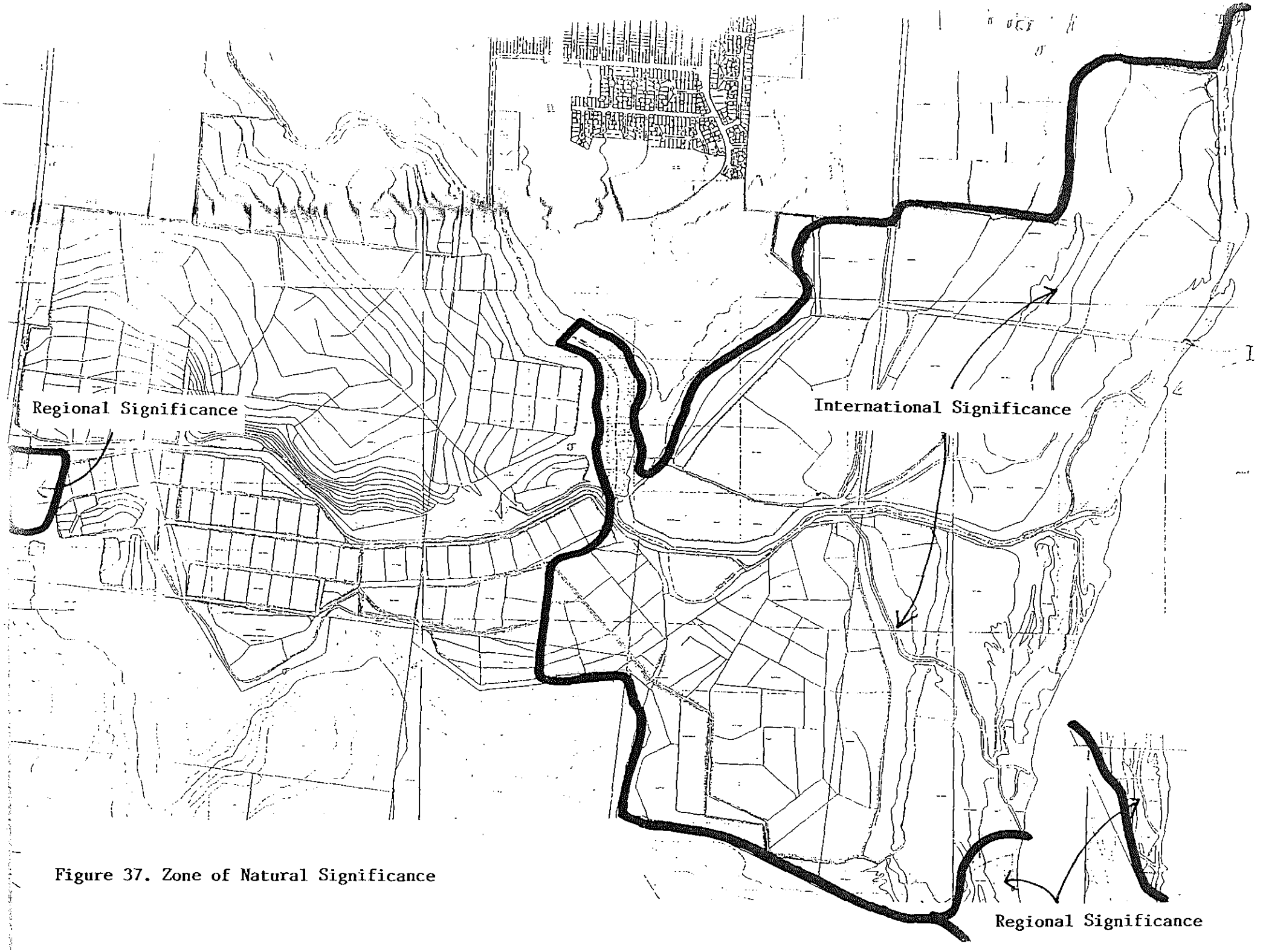


Figure 37. Zone of Natural Significance

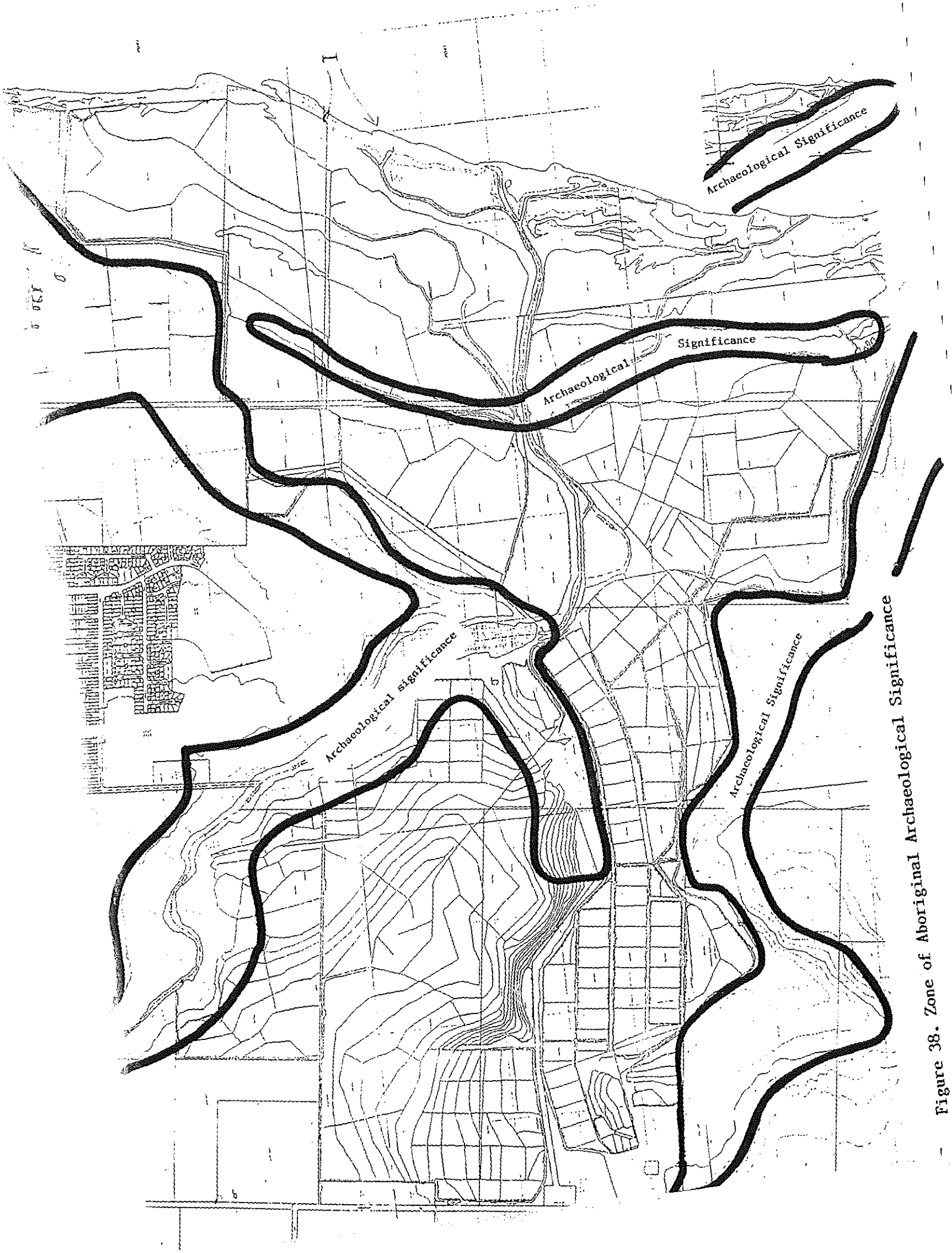


Figure 38. Zone of Aboriginal Archaeological Significance

6.3. HISTORICAL SITES

Historical sites fall into two main categories, those related to permanent occupation of the area, both for the early pastoral period and for housing the workers at the saltworks, and those related to the industrial processes carried out at the saltworks. Both categories are of local and regional significance. A comparative assessment of surviving industrial tramways in Victoria would be required before identifying additional state significance of the tramway system which on a preliminary appraisal is potentially the best preserved early twentieth century narrow guage industrial tramway in Victoria. The zone of historical significance is shown in Fig. 39.

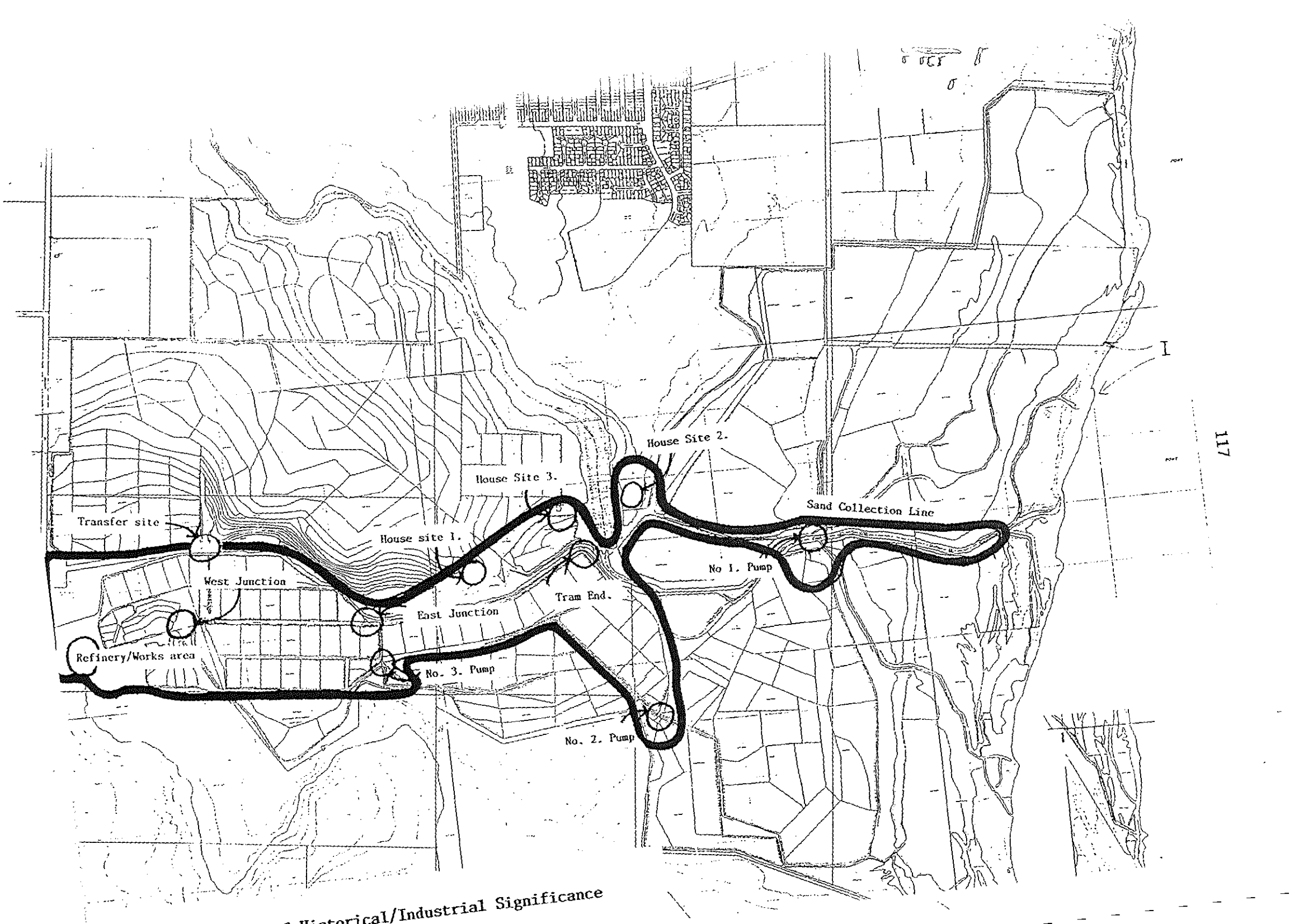


Figure 39. Zone of Historical/Industrial Significance

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7822-2 Run 11 Film 3909 186, 184, 182 Run 10 Film 3911 65, 67, 69

Altona Council oblique colour slides.

Cheetham Saltworks Plan of Works

APPENDIX 1: List of birds which have been recorded on the Laverton Saltworks. (Source: Garnett et al., 1986)

Great Crested Grebe Podiceps cristatus
Hoary-headed grebe P. poliocephalus
Australasian Grebe Tachybaptus novaehollandiae
Little Penguin Eudyptula minor
Short-tailed Shearwater Puffinis tenuirostris
Fluttering Shearwater P. gavia
White-faced Storm-Petrel Pelagodroma marina
Australian Pelican Pelecanus conspicillatus
Australasian Gannet Morus serrator
Darter Anhinga melanogaster
Great Cormorant Phalacrocorax carbo
Pied Cormorant P. varius
Little Black Cormorant P. sulcirostris
Little Pied Cormorant P. melanoleucos
Pacific Heron Ardea pacifica
White-faced Heron A. novaehollandiae
Cattle Egret Aredeola ibis
Great Egret Egretta alba
Little Egret E. garzetta
Intermediate Egret E. intermedia
Rufous Night Heron Nycticorax caledonicus
Australasian Bittern Botaurus poiciloptilus
Glossy Ibis Plegadis falcinellus
Sacred Ibis Threskiornis aethiopica
Straw-necked Ibis T. spinicollis
Royal Spoonbill Platlea regia
Yellow-billed Spoonbill P. flavipes
Black Swan Cygnus atratus
Australian Shelduck Tadorna tadornoides
Pacific Black Duck Anas superciliosus
Grey Teal A. gibberifrons
Chestnut Teal A. castanea
Australasian Shoveller A. rhynchotis
Pink-eared Duck Melachorhynchus membranaceus
Hardhead Aythya australis
Maned Duck Chenonetta jubata
Blue-billed Duck Oxyura australis
Musk Duck Biziura lobata
Black-shouldered Kite Elanus notatus
Letter-winged Kite E. scriptus
Black Kite Milvus migrans
Whistling Kite Haliastur sphenurus
Brown Goshawk Accipiter fasciatus
Little Eagle Hieraeetus leucogaster
Spotted Harrier Circus assimilis
Marsh Harrier C. aeruginosus
Black Falcon Falco subniger
Peregrine Falcon F. peregreinus
Australian Hobby F. longipennis
Brown Falcon F. berigora
Australian Kestrel F. cenchroides
Stubble Quail Coturnix novaeszelandiae
Brown Quail C. australis
Buff-banded Rail Rallus philippensis

Lewin's Rail R. pectoralis
Baillon's Crake Porzana pusilla
Australian Crake P. fluminea
Spotless Crake P. tabuensis
Black-tailed Native-hen Gallinula ventralis
Dusky Moorhen G. tenebrosa
Purple Swamphen Porphyrio porphyrio
Eurasian Coot Fulica atra
Pied Oystercatcher Haematopus longirostris
Sooty Oystercatcher H. fuliginosus
Masked Lapwing Vanellus miles
Banded Lapwing V. tricolor
Grey Plover Pluvialis squatorola
Lesser Golden Plover P. fulva
Red-kneed Dotterel Erythrogonys cinctus
Mongolian Plover Charadrius mongolus
Double-banded Plover C. bicinctus
Large Sand Plover C. leschenaultii
Red-capped Plover C. ruficapillus
Black-fronted Plover C. melanops
Black-winged Stilt Himantopus himantopus
Banded Stilt Cladorhynchus leucocephalus
Red-necked Avocet Recurvirostra novaehollandiae
Ruddy Turnstone Arenaria interpres
Eastern Curlew Numenius madagascariansis
Whimbrel N. phaeopus
Little Curlew N. minutus
Wood Sandpiper Tringa glareola
Grey-tailed Tattler T. brevipes
Common Sandpiper T. hypoleucos
Greenshank T. nebularia
Marsh Sandpiper T. stagnatilis
Terek Sandpiper T. terek
Latham's Snipe Gallinago hardwickii
Black-tailed Godwit Limosa limosa
Bar-tailed Godwit L. lapponica
Red Knot Calidris canutus
Great Knot C. tenuirostris
Sharp-tailed Sandpiper C. acuminata
Pectoral Sandpiper C. melanotus
Red-necked Stint C. ruficollis
Long-toed Stint C. subminuta
Curlew Sandpiper C. ferruginea
Broad-billed Sandpiper Limicola falcinellus
Ruff Philopmachus pugnax
Australian Pratincole Stiltia isabella
Great Skua Stercorarius skua
Arctic Jaeger S. parasiticus
Silver Gull Larus novaehollandiae
Pacific Gull L. pacificus
Kelp Gull L. dominicanus
Whiskered Tern Chilodonias hybrida
White-winged Tern C. leucoptera
Gull-billed Tern Gelochelidon nilotica
Caspian Tern Hydroprogne caspia
Common Tern Sterna hirundo
Little Tern S. albifrons
Fairy Tern S. nereis
Crested Tern S. bergii
Feral Pigeon Columba livia

Spotted Turtle-Dove Streptopelia chinensis
Common Bronzewing Phaps chalcoptera
Galah Cacatua roseicapilla
Sulphur-crested Cockatoo C. galerita
Musk Lorikeet Glossopsitta concinna
Purple-crowned Lorikeet G. porphyrocephala
Little Lorikeet G. pusilla
Budgerigar Melopsittacus undulatus
Swift Parrot Lathamus discolor
Crimson Rosella Platycercus elegans
Eastern Rosella P. eximius
Red-rumped Parrot Psephotus haematonotus
Blue-winged Parrot Neophema chrysostoma
Elegant Parrot N. elegans
Orange-bellied Parrot N. chrysogaster
Pallid Cuckoo Cuculus pallidus
Fan-tailed Cuckoo C. pyrrhophanus
Horsefield's Bronze-Cuckoo Chrysococcyx basalis
Shining Bonze-Cuckoo C. lucidus
Southern Boobook Ninox novaeseelandiae
Barn Owl Tyto alba
Tawny Frogmouth Podargus strigoides
White-throated Needletail Hirundapus caudacutus
Fork-tailed Swift Apus pacificus
Laughing Kookaburra Dacelo novaeguineae
Sacred Kingfisher Halcyon sancta
Singing Bushlark Mirafra javanica
Skylark Alauda arvensis
White-backed Swallow Cheramoeca leucosternum
Welcome Swallow Hirundo neoxena
Tree Martin Cecropis nigricans
Fairy Martin C. ariel
Richard's Pipit Anthus novaeseelandiae
Black-faced Cuckoo-shrike Coracina novaehollandiae
Blackbird Turdus merula
Song Thrush Turdus philomelos
Pink Robin Petroica rodinogaster
Flame Robin P. phoenicea
Scarlet Robin P. multicolor
Red-capped Robin P. goodenovii
Golden Whistler Pachycephala pectoralis
Rufous Whistler P. rufiventris
Grey Shrike-thrush Colluricincla harmonica
Satin Flycatcher Myiagra cyanoleuca
Rufous Fantail Rhipidura rufiventris
Grey Fantail R. fuliginosa
Willie Wagtail R. leucophrys
Clamorous Reed-Warbler Acrocephalus stentoreus
Little Grassbird Megalurus gramineus
Golden-headed Cisticola Cisticola exilis
Rufous Songlark Cinclorhamphus mathewsi
Brown Songlark C. cruralis
Superb Fairy-wern Malurus cyaneus
White-browed Scrubwren Sericornis frontalis
Calamanthus S. fuliginosus
Brown Thornbill Acanthiza pusilla
Yellow-rumped Thornbill A. chrysorrhoa
Yellow Thornbill A. nana
Southern Whiteface Aphelocephala leucopsis
Red Wattlebird Anthochaera carunculata

Little Wattlebird A. chrysoptera
Spiny-cheeked Honeyeater Acanthagenys rufogularis
Yellow-faced Honeyeater Lichenostomus chrysops
Singing Honeyeater L. virescens
White-eared Honeyeater L. leucotis
White-plumed Honeyeater L. penicillatus
New Holland Honeyeater Philidonyris novaehollandiae
Eastern Spinebill Acanthorhychus tenuirostris
White-fronted Chat Ephthianura albifrons
Mistletoebird Dicaeum hirundinaceum
Spotted Pardalote Pardalotus punctatus
Striated Pardalote P. striatus
Silvereye Zosterops lateralis
European Goldfinch Carduelis carduelis
European Greenfinch C. chloris
House Sparrow Passer domesticus
Tree Sparrow P. montanus
Diamond Firetail Emblema guttata
Zebra Finch Poephila guttata
Common Starling Sturnus vulgaris
Common Mynah Acridotheres tristis
Australian Magpie-lark Grallina cyanoleuca
Masked Woodswallow Artamus personatus
White-browed Woodswallow A. superciliosus
Australian Magpie Gymnorhina tibicen
Grey Currawong Strepera versicolor
Little Raven Corvus mellori

APPENDIX 2: List of mammals which have been recorded on the Laverton Saltworks. (Source: Atlas of Victorian Wildlife, Wildlife Management Branch, Department of Conservation and Environment, Victoria and current investigation).

SPECIES	LAST RECORDED
Short-beaked Echidna Tachyglossus aculeatus	1967
Fat-tailed Dunnart Sminthopsis crassicaudata	1988
Koala Phascolarctos cinereus	1961
Yellow-bellied Sheathtail Bat Taphozous flaviventris	1928
White-striped Mastiff Bat Tadarida australis	1988
Black Rat* Rattus rattus	1989
House Mouse* Mus musculus	1989
Rabbit* Oryctolagus cuniculus	1990
Brown Hare* Lepus capensis	1989
Fox* Vulpes vulpes	1990
Leopard Seal(v) Hydrurga leptonyx	1968
Bottle-nosed Dolphin Tursiops truncatus	1983

* = Introduced species
(v) = vagrant

APPENDIX 3: List of reptiles which have been recorded from the Laverton Saltworks. (Source: Atlas of Victorian Wildlife & current investigation)

SPECIES	LAST RECORDED
Striped Legless Lizard Delma impar	1979
Cunningham's Skink Egernia cunninghammi	1932
Grass Skink Leiopisma entrecasteauxii	1990
Three-lined Skink L. trilineata	1988
Metallic Skink Leiopisma metallicum	1988
Common Blue-tongued Lizard Tiliqua scincoides	1990
White-lipped Snake Drysdalia coronoides	1961
Mainland Tiger Snake Notechus scutatus	1990
Eastern Brown Snake Pseudonaja textilis	undated
Little Whip Snake Unechis flagellum	1988

APPENDIX 4: List of frogs which have been recorded from the Laverton Saltworks. (Source: Atlas of Victorian Wildlife and cuerent investigation)

SPECIES	LAST RECORDED
Southern Bullfrog Limnodynastes dumerilli	1965
Spotted Marsh Frog L. tasmaniensis	1989
Common Spadefoot Toad Neobatrachus sudelli	1989
Common Froglet Ranidella signifera	1990
Growling Grass Frog Litoria raniformis	1988
Brown Tree Frog L. ewingii	1988