CL 2/74

- 8 MAY 1986
DEPT. OF MINES
REF. No. 4372/86

29 April, 1986

Elisna Pty Ltd,
C/o L.R. Wastell & Co,
19 Paterson Street,
Launceston, Tas. 7250.

Dear Mr Murchie,

In reference to my letter of 28 June 1985 and your reply dated 9 July
I present herewith a copy of the report concerned, one entitled
Macquarie Harbour Exploration Project: Phase II. It is proffered on
the understanding that, until 1999, contents will not be made
available to anyone but staff of your department or of Tasmania's
Environmental Department.

Yours sincerely,

Robin Harvey

S.R.M. Harvey

H. Murchie Esq.
Director of Mines,
Box 56, Rosny Park,
Tasmania 7018.

Please hold in restrictive file until further
notice -Dougls.

AMG REFERENCE POINTS ADDED

001

To the Participants

Macquarie Harbour Mineral Exploration Project

Phase II

Restricted File until further notice

S.R.M. Harvey
Princeton
New Jersey

July 1974

ABSTRACT

In the second and third quarters of 1973 the Holb group searched for, found, and conducted a reconnaissance survey of copper bearing sediments lying in an enclosed bay in Tasmania, Australia. In December, Cities Service International agreed to sponsor further study of the deposit.

During the past six months Holb has enlarged the exploration licence to include the most mineralized part of the bay, cored sediments over the entire area of the bay and secured 2,158 chemical analyses of the 334 samples collected. The survey has cost US $32,000.

The survey defined two deposits. One is the body of sediment containing concentrations of copper, molybdenum, cobalt, silver and gold previously discovered by Holb. The body fans out from the mouth of the King River over an area of about twenty-four square miles, varying in thickness from two to twenty feet and in copper grade from 0.07% to 0.18%. The material varies in value from two to five dollars per cubic yard and has an average value of some three dollars per cubic yard. The material is finely divided, unconsolidated and free of overburden. Most of the deposit lies under water one to twenty-five fathoms deep; a small fraction of the deposit protrudes above waterlevel. About one hundred million cubic yards of this material are available for dredging. Probable reserves contain an additional thirty million cubic yards of ore worth approximately four dollars per cubic yard. Possible reserves embrace a further 160,000,000 cubic yards of ore worth roughly three dollars per cubic yard.

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The second deposit has yet to be examined in detail, but
appears to be worth $400,000,000, at least. It consists of
brine permeating and presumably overlying unconsolidated sed-
iments of the bay floor. Specimens from the upper four yards
of the sediment column, the section cored, yielded concentrat-
ions of uranium, lithium, iodine, bromine, boron and arsenic
when dried and analysed. Brine capable of producing the ob-
served values would have a value of approximately 45 cents per
cubic yard of sediment of 65% porosity, or 85 cents per ton of
free brine. Contents of potassium and other elements likely to
be concentrated in the brine should increase the deposit's value.

Attempts by laboratories in the United States to concentrate
copper bearing fractions of sediment from the King delta deposit
have not been particularly successful, but the study involved
standard separation procedures only, and no more than twelve
man-weeks' effort. Mineralogy and chemistry of the sediment
await detailed study. If an economical method of extracting
much of the copper contained in these sediments can be perfected,
it will have immediate application in treating tailings at copper
mines all over the world. Over 66,000,000 short tons of un-
recovered copper, roughly equal to the world's total primary
copper production over the last decade, are estimated to exist
in tailings. Approximately one-third of these tailings, contain-
ing copper worth some $33,000,000,000, occur at mines in the
United States.

It is recommended that work on development of an accept-
able separatory procedure for the copper bearing sediments be
accelerated and that the inferred brine deposit be examined further.

Undertaken in conjunction with the Holb group, with equipment

and chemical companies and with overseas labs, this program

should be capable of making significant advances in six to

twelve months at a cost of $200,000.

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1.0   BACKGROUND

1.1   Concept and Target

Some geologists believe that certain deposits of copper and of uranium found in sedimentary rocks consist of metals introduced as the host materials accumulated. If this is the case it should be possible to find such deposits forming now. Harvey (1968) showed that modern bodies of this type could prove economic to mine. They are likely to be lower in grade than hard rock deposits, but as they have not yet consolidated or been buried they require no drilling, blasting, stripping crushing, or milling. Bodies of this kind found near shore may be dredged and pumped direct to processing plants. By thus short-circuiting standard mining procedures, substantial savings result, and ore grades well below those traditionally considered profitable become acceptable. Economies of scale also are likely, because low grade deposits, in approaching average abundances of copper and uranium in the earth's crust, should be larger and, parenthetically, more numerous than higher grade bodies from which most primary production of the metals derives.

Deposits in sediments should occur where key metals are being introduced relatively fast, and conditions exist for their concentration and retention. Metals are likely to come principally from gases and liquids of volcanic origin, from weathering and mining of mineralized terrain and from organisms associated with upwellings of nutrient-rich oceanic water. Probable hosts are sediments forming comparatively slowly under reducing conditions,

particularly sediments high in sulphides, organic remains or
expanding clays. Reducing bottom occurs where the oxygen supply
of overlying waters is consumed faster than it is replenished.
The condition should occur in basins which are deep in relation
to surface area, for instance in fjords, and in areas of high
organic productivity such as continental shelf areas enriched
by upwelling waters. In general, bottom of this type is too
toxic or poor in oxygen to support life, thus it is improbable
that careful dredging will damage such an environment biologically.

Macquarie Harbour, a bay in western Tasmania, Australia
(Figure 1), was selected as a likely target. It is an estuary,
six miles wide, twenty miles long and up to 180 feet deep, al-
most cut off from open sea by a spit. The entrance is no more
than a couple of hundred yards wide and in places is less than
thirty-six feet deep. The Harbour abuts one of the richest known
mining fields, containing what was the world's largest tin mine
and its largest scheelite deposit. In Australia, the field's
production of lead, zinc and silver is second only to that of
Broken Hill. The Mount Lyell mine, Queenstown, seventeen miles
northeast of Macquarie Harbour at the headwaters of streams
draining into the Harbour, has accounted for over one-third of
Australia's total copper production, and up till a few years ago
was the biggest open pit operation in the Commonwealth. The cur-
rent value of ore mined and on reserve in northwest Tasmania's
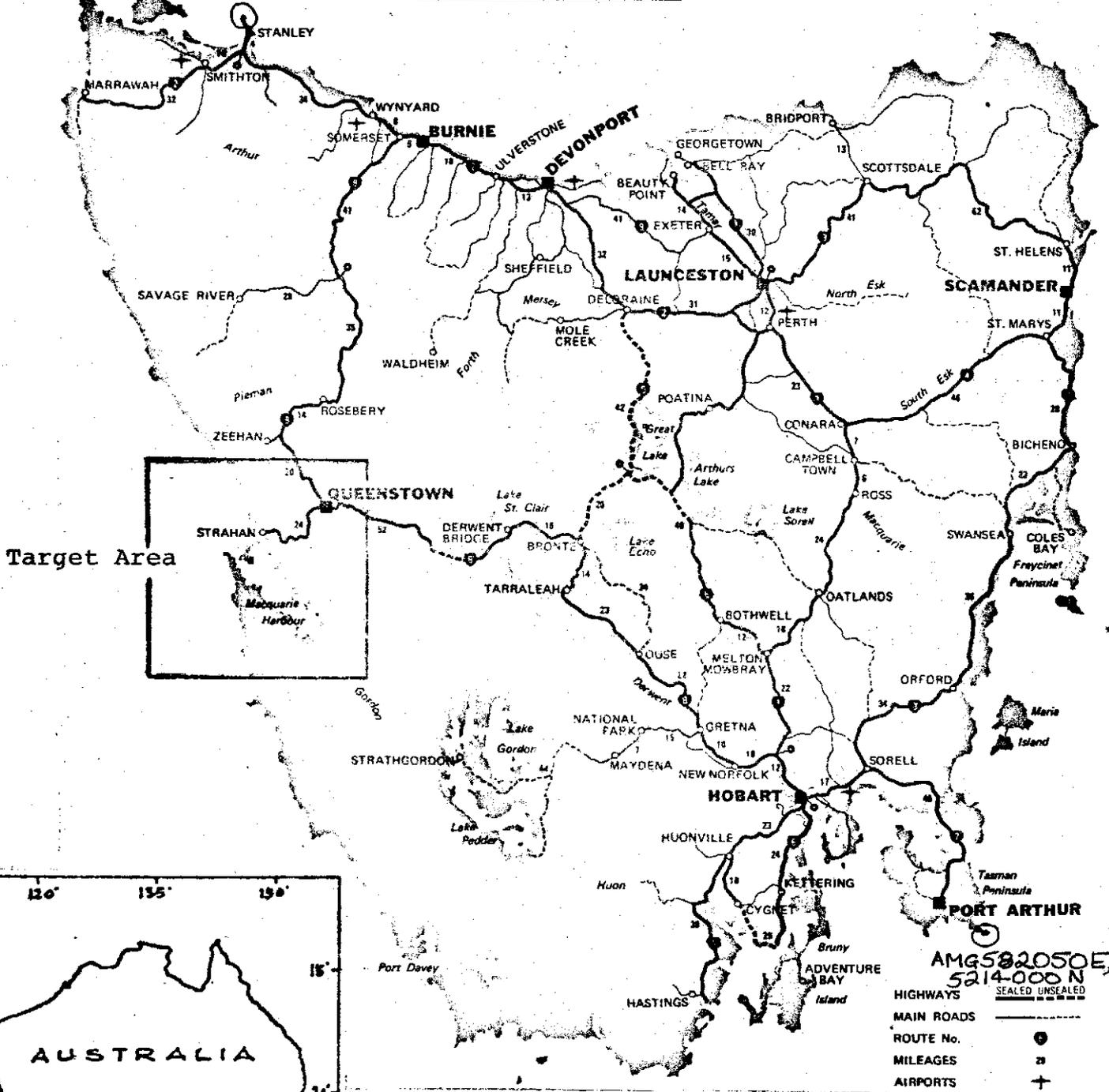metal mines is about $6,000,000,000, not including the value of
iron ore.

Figure 1.   Locality Map

AMG REFERENCE POINTS ADDED

1.2 Previous work

At least four surveys of parts of Macquarie Harbour had
been conducted prior to the present one, the first of the four
in 1965 by Hunting Surveys and the Snare Corporation of New
York on behalf of Pickands Mather, the second in 1971 on be-
half of Fimiston Mining of Sydney, the third in 1971 by
E.H. Macdonald for Electrolytic Zinc, and the fourth by Mount
Lyell Mining Company in 1972.

The Pickands Mather investigation is primarily an eng-
ineering study concerning the Harbour's possible use as a ship-
ping point for iron ore. Hard bottom underlying sands in the
vicinity of the entrance channel was inadequately defined using
hydrosonde equipment. Two boreholes were sunk in the same region.
Jar samples of sediment bored are held at Strahan by the
representative of the Hobart Marine Board but are said to have
been mixed up by local fishermen.

Fimiston Mining appears to have been persuaded to sponsor
a general investigation of the Harbour sediments. Numerous
samples were collected and assayed but objectives were confused
and the program was incompetently administered.

Macdonald's study covers an investigation of beach materials
on the spit partially closing the Harbour. Several drill holes
5 to 12 feet deep were driven into the beach face, and heavy
mineral contents of the sands recovered were studied. Ilmenite,
rutile, leucoxene, cassiterite, chromite and zircon were shown
to be present. Tonnages apparently were considered too small
to warrant continued attention. I note that an insignicant

fraction of the total sand body was investigated and that holes
were sited in one of its less alluring parts.

The Mount Lyell survey covered a search for pyrite in
mine tailings which have accumulated at the delta of the King
River, in the northeastern part of Macquarie Harbour. Some 470
samples were collected from holes drilled ten to twenty feet
into exposed parts of the delta. Pyrite averages 5% by weight
of the sediment cored. When the bounty on sulfur production
was removed, Mount Lyell stopped the survey. The survey was
conducted painstakingly, if in somewhat pedestrian fashion;
results appear to be fairly reliable.

All four studies above are on open file at the Tasmanian
Department of Mines.

1.3 Holb survey

The current investigation began in March 1973, when
S.R.M. Harvey, Overseas Natural Resources Company, R.P. Lucas
and E.G. Brady (Appendix A) applied for an exploration licence
of 148 square miles covering Macquarie Harbour and the beach
lying west and northwest of it. About fifty samples were collected
from the upper foot or two of the Harbour floor. Sample sites
are spaced along a traverse zig-zagging down the length of the
Harbour. The bay bottom proved to be reducing as predicted.
Sediments were seen to be unconsolidated, fine grained, high in
organic remains, a minimum of five yards thick and readily dredge-
able. As anticipated, the sediments were found to contain con-
centrations of sulfide and of several metals. Copper, silver
and cobalt concentrations increase toward the King River Mouth.
Molybdenum and uranium concentrations extend bay wide.

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Preliminary estimates based on the reconnaissance data indicated that metals probably present throughout the upper three yards of sediment found in the northern third of the Harbour should be worth several hundred million dollars in place, and that further investigation of the bay thus was warranted. Results of this first phase of exploration were presented to the participants last July in a comprehensive report (Harvey, 1973), together with recommendations concerning a second phase of exploration.

The exploration licence applied for was received from the Mines Department later in the year, valid from 29th June to 28th December, 1973, and renewable thereafter.

2.0   PHASE II

2.1 Backing

In October 1973, Cities Service International Incorporated
(Appendix A) expressed willingness to join the project and to
fund Phase II exploration. A formal agreement (Appendix A)
was prepared jointly by Holb and Cities. Operations began on
10 December when the document was signed by Holb. Minor mod-
ifications acceptable to both parties were made later. In essence,
the Agreement grants Cities and any partners it may bring in a
total interest of 94% in anything found, and an option to par-
ticipate with Holb in similar investigations launched elsewhere.
Cities, with or without stock issues, partners of its own choos-
ing and by other means, funds all necessary exploration and
development, guaranteeing Holb a constant 6% interest together
with board representation. The Agreement specifies that Phase II
be conducted by Holb according to a mutually devised program,
and that Cities assume increasing responsibility for work sub-
sequently called for.

2.2 Objectives

Phase II was designed with four main objectives in mind

- Lease the King delta, not available when the main exploration
  licence was secured; possibly lease Port Davey and Bathurst
  Harbour, a similar area 50 miles south of Macquarie Harbour.
- Examine areal and vertical distribution of target metals
  throughout upper parts of bay floor sediments.

- Investigate concentration and distribution of other elements, such as gold, sulfur, iodine, boron and bromine likely to be present in the sediments.
- Study ways in which metalliferous fractions of the sediment might be concentrated, separated and processed.

At a meeting in Princeton on 27 November 1973, Cities agreed to sponsor and direct the latter study under Cities' budget. At the same meeting Cities requested that samples of water and sediments from selected streams entering the bay be obtained and that data on the geology and geography of the region be collected.

As first conceived, Phase II was scheduled to begin on 1 December 1973, to be completed in six months, and to cost an estimated U.S. $25,000. Holb was later advised that, if required, expenditure might run to between $35,000 and $40,000.

2.3   Operations

The Holb group assumed responsibility for every aspect of Phase II except mineralogical and processing studies,which Cities had agreed to handle. Holb's program got under way in mid-December, about one month behind schedule because of delays in connection with the Agreement. Except for this thirty-day shift in scheduling, all licencing, sampling, assaying and data collection were completed on time.

Cities mislaid bulk samples airfreighted in March and consequently did not initiate processing studies unti mid-May. Cities referred the promised mineralogical work to an outside contractor at the same time.

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The Holb report has been held back to include results of these
studies, but they are still outstanding at mid- September thus
the report will be distributed without benefit of this information.

Personnel and Agents Holb activities in Australia were directed
by Harvey, who remained in the Commonwealth from 18th December
until 26th April. Temporary staff employed to assist in sampling
were engaged with the survey vessel. Office services have been
obtained on a contract basis.

Mr. L.R. Wastell, Chartered Public Accountant, of 27 Paterson
St , Launceston, Tasmania, was appointed project accountant.
Bailleau Bowring Ltd , also of Paterson St ,   handle insurance
for the project. Shields, Heritage,Stackhouse and Martin of Cameron
Street, Launceston, were engaged as legal counsel. In the United
States Holb is represented by Sidley and Austin of Washington
D C and Chicago. Banking needs are met by the ANZ Bank in
Australia, and Princeton Bank and Trust Company, N J , in the
United States.

Accounts and Progress Reports   These have been prepared monthly
in compliance with licence requirements and are distributed to all
participants and to the Tasmanian Mines Department; Wastell main-
tains a duplicate set of reports and accounts in Launceston.

iture reported to Mines totalled US $ 56,649.5(,39 % of this
sum relating to Phase I investigations and the remainder to those
of Phase II. The commitment to Mines for both phases is
US $34,000.   Project funds are lodged under Harvey's name
in special accounts at Princeton and Launceston. L.R. Wastell
is an alternate signatory for both accounts and R.P. Lucas is an
alternate for the Launceston account.

Data   Important data relating to Phase I were presented to par-
ticipants prior to or with the Phase I report. In the case of
Phase II, such data have been sent to both Cities and to Lucas.
Harvey in Princeton and Wastell in Launceston maintain duplicate
sets. Copies of most of these data, for instance assay results,
licence, and Agreement, are included in Volume Two of this report.

The southwestern quarter of Tasmania, into which all but the
northern third of Macquarie Harbour falls, is virtually uninhabited.
Little detailed information exists concerning geology, mineral de-
posits, soils and similar aspects of the district. On the other
hand, quite good approximations at regional scale are available
in the Atlas of Tasmania. It contains fair climatic data too.

Hydrographic information and additional data on climate are
available in the relevant volume of the Australia Pilot (Appendix B)
Until recently, a weather station was maintained at Cape Sorrell at
the entrance to Macquarie Harbour by CSIR's Fisheries Division.
Stereo photo cover extends over the Harbour and its shores, but
detailed topo maps are available only for northern and eastern
extremities of the Harbour. The Lands and Surveys Department in
Hobart avers that outstanding sheets will be released in 1975.
Bathymetric charts of acceptable standard have been published for
Bathurst Harbour, Port Davey, Macquarie Harbour entrance, and the
approaches to Strahan in the north of the Harbour, but the body
of the bay is covered at reconnaissance level only.

Cities have been furnished with copies of the Tasmanian
Atlas, geological and exploration   licence maps, with all topo-
graphic maps obtained, and with the Macquarie chart. Harvey holds
duplicates and other bathymetric charts. Harvey and Cities each
hold air photos covering the Harbour.

Numerous papers concerning geology, mineralogy, mining and
treatment of Mt Lyell ores and those of all other major deposits
of northwestern Tasmania have been published in scientific period-
icals and by the Tasmanian Geological Survey. They are listed in
Section 9.1 of this report.

Equipment Gear obtained during the course of fieldwork is stored
in Launceston and Strahan, Tasmania (Appendix F). Contributions
were made toward purchase of the sampling winch and the electric
thermometer used for measuring bottom temperatures. This was the
least expensive way of obtaining temporary use of such equipment.
Though the equipment may be borrowed at no cost for future work
it is the property of Brid River Fishing Company.

3.0   EXPLORATION LICENCES

3.1   Macquarie Harbour

E L   16/73   The main exploration licence, taken out in Harvey's name on Holb's behalf in 1973, has been renewed twice since then (Appendix C). Each renewal, like the original issue, is for a period of six months. The latest renewal covers the period 29th June to 28th December, 1974.

E L   2/74   Under Tasmania's Mining code an individual is permitted to hold only one exploration licence at a time. As Harvey holds E L 16/73, E L 2/74 is held on Holb's behalf by L.R. Wastell. An indenture like that shown at Appendix C was drawn up between Wastell and Harvey, releasing Wastell from responsibility in every matter relating to the licence and guaranteeing that upon request the licence be made available, without encumbrance of any kind, to Holb or its designates. The Mines Department agreed that E L 2/74 be covered by programs, expenditure and security bond relating to E L 16/73, and accordingly issued E L 2/74 under the same terms as those covering E L 16/73. E L 2/74 has been renewed once. The licence in force at the time of writing expires 28th December, 1974, at the same time as E L 16/73.

Terms   Principal terms under which the licences are issued are that exploration of approved caliber and extent be carried out continuously, and that results and expenditure be reported to the Mines Department monthly. Cores and sample splits should be retained for Mines' sample collection. It is stipulated further that exploration be conducted so as not to damage the environment.

Figure 2. Macquarie Harbour Exploration
Licences

036021

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To this end a security bond of A $500.00 has been posted by Holb.
It is recoverable if exploration is conducted and completed
satisfactorily.   All Phase I and II commitments regarding
exploration and expenditure on both licences through 30th June,
1974, have been met and have been accepted by Mines as met.

Renewals in force were granted on the understanding that we
proceed with Phase III researches as specified in the renewal
application dated 8th June and shown at Appendix H. We are
committed, from the start of Phase I in 1973 through 28th December,
1974, to a total expenditure of US $100,000, about $ 43,350 in
excess of the total reported to 30th June. Our proposed intro-
duction of an eighteen-month extension of Phase II calls for sub-
mission to Mines of a modified version of the program on which
the latest renewal of E L 16/73 and E L 2/74 was granted. Mines
are likely to accept such modification provided it calls for un-
interrupted work on the licences and provided that the work is
financed adequately. Note that the Mines Department closes for
several weeks about 18th December annually, thus licences due for
renewal at year end should be lodged early in December at latest.

Transfers, Conversions   Tasmanian exploration licences held by
individuals or corporate bodies may be assigned to any party,
individual or corporate, nominated by the licensee and approved
by the Mines Department. One of the transfer forms is shown at
Appendix C. If the move can be justified by the licence holder,
Government will convert valuable parts of an exploration licence
to a Mining Lease.

Figure 3. Port Davey, Bathurst Harbour

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3.2   Port Davey, Bathurst Harbour

Contouring Bathymetric charts of this region shows that most parts of the bottom slope seaward, consequently chances are small of finding substantial areas under impounded water likely to be stagnant and depleted in oxygen. Sediments collecting under normally oxygenated seawater are unlikely to contain much undigested organic matter or much authigenic sulfide. In turn, such sediment has comparitively low ability to trap and retain metal ions and thus is not a good target for enrichment of the kind found throughout Macquarie Harbour. Whether river sediments entering the Davey Bathurst bays are rich in metalliferous detritus like the King River sediments is largely unknown. Cassiterite may enter Melaleuca Inlet from a small field on its shores, but the area, both exposed and submerged, has been under licence to a Tasmanian group for several years. Holb may undertake limited sampling in the Davey Bathurst region later, but in the light of the discovery regarding its bottom topography the need to do soon falls away.

4.0   FIELDWORK
_____

Fieldwork was carried out in February and March. It involved ex-
tensive sampling of submerged sediments and was supplemented by
some geophysics.

4.1 Sampling

     The main objectives of the sampling program were fourfold:

     · first, to obtain samples representing the upper five

       yards of sediment over the entire floor of Macquarie

       Harbour

     · second, to test deeper targets under any prominent zones

       of mineralization revealed by the program's initial

       stage

     · third, to collect bulk samples of ore and of average

       bay sediment for lab study of concentrating and separa-

       tory procedures

     · fourth, to sample stream waters and sediments entering

       the Harbour

Bay Sampling This part of the program was conducted from the 50-ft.
steel fishing vessel "Brid River" of Launceston and Bridport, owned
and skippered by G.O. Roozendaal. Roozendaal has conducted marine
surveys on behalf of Anglo American and others, looking for, and
finding, deposits of tin and of phosphate off north and west coasts of
Tasmania. Currently he is president of the state's Professional
Fisherman's Association.

     i. 2000-yd Core Samples

          In order to examine areal and vertical distribution

     of various metals throughout the upper five yards of the
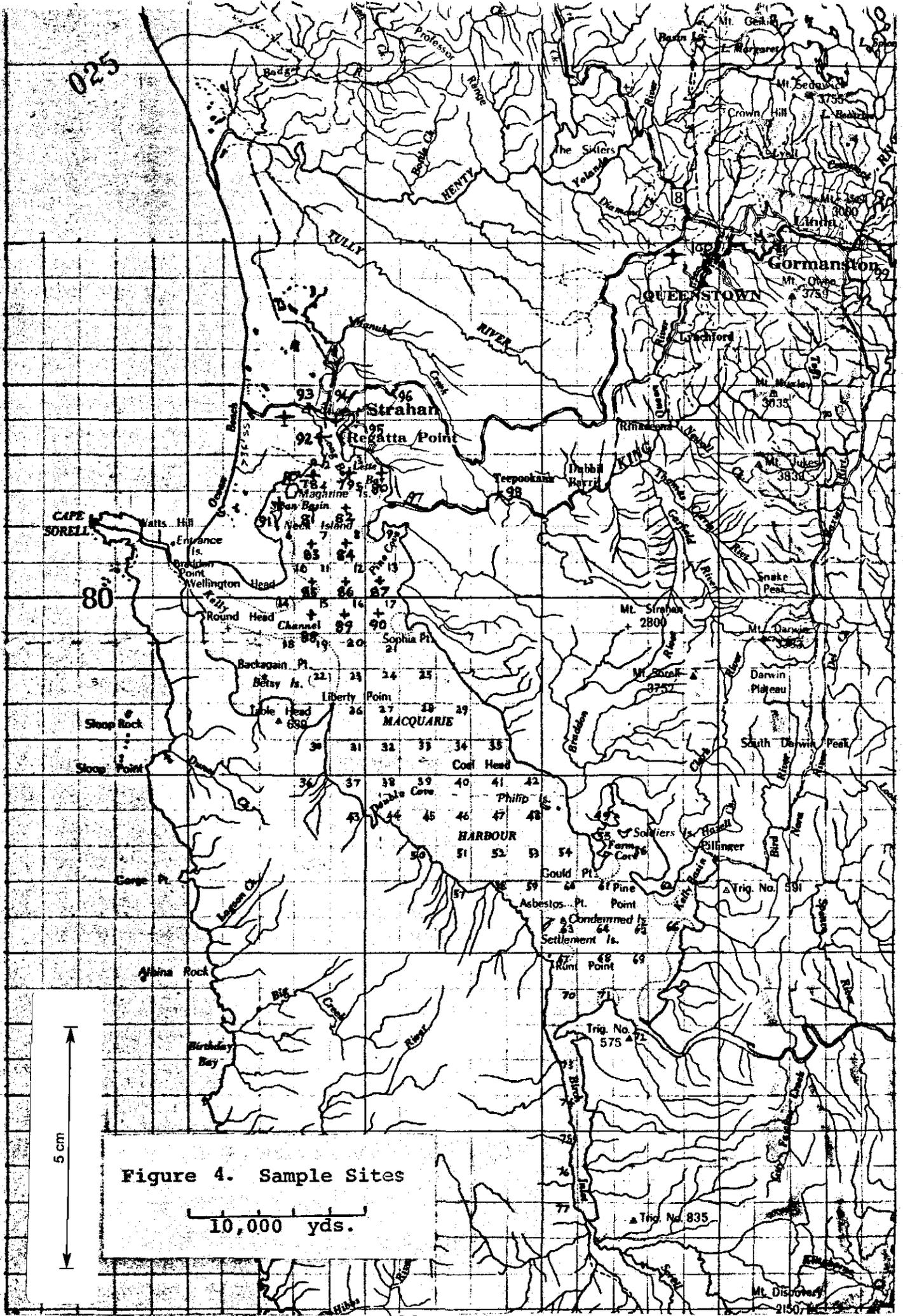
Figure 4. Sample Sites

5 cm

10,000 yds.

Harbour floor sediments, the newest and largest map covering Macquarie Harbour was gridded. The map used is Sheet 5 of the state's 1:250,000 series, published in 1961. The map's 10,000-yd grid, oriented north-south and east-west, was subdivided into 2000-yd units over the full extent of Macquarie Harbour and its surrounds (Figure 4, and Plate II). All grid intersections falling within apparently navigable parts of the Harbour were numbered as potential sampling sites. Numbering begins at the northernmost grid line and proceeds from west to east across each line, shifting sequentially to more and more southerly grid lines. A total of seventy-seven sampling sites thus was obtained.

In the field, sites were occupied with the aid of ship's radar. The accuracy of this method is consistent with the scale and reconnaissance nature of the base map used. Three sites proved too shallow to be occupied safely by the Brid River, which draws six feet. At twelve near-shore sites, bottom proved too hard to be cored by the equipment employed. Cores collected at the other sixty-two sites range from three to nineteen feet in length and on the average are twelve feet eight inches long. Coring data are summarized in Table 1 and amplified in Table 2. Resistance indices shown in Table 1 provide a measure not only of the relative hardness of the sediment but also of several other factors. Sediments of high resistance generally are coarser grained, denser, less porous, lower in organic matter and lie under less stagnant water than sediments with lower indices.

Table 1.   Core data,   2000-yd grid,   Macquarie Harbour

Site	Cored	Resistance	Site	Cored	Resistance	Site	Cored	Resistance
1	6'	6.0	31	16 5/6'	3.9	61	13 5/12'	5.3
2	15'	4.4	32	5 1/3'	7.4	62	10 7/12'	3.4
3	9'	1.8	33	17 1/3'	5.1	63	18 2/3'	5.3
4	15'	5.8	34	3 5/6'	8.0	64	17 1/6'	3.5
5	0'		35	0'		65	17 1/3'	3.2
6	11'	5.2	36	?*	?	66	9 3/4'	2.7
7	13 1/2'	5.4	37	17'	3.5	67	15'	2.6
8	0'		38	0'		68	14 1/2'	3.1
9	8'	2.0	39	17'	5.2	69	9 3/4'	3.1
10	4'	6.3	40	17 5/6'	5.1	70	7 3/4'	2.1
11	15'	5.4	41	9 3/4'	4.7	71	0'	
12	6 2/3'	5.4	42	?*	?	72	3'	5.7
13	4 1/2'	3.0	43	14'	3.0	73	15 1/3'	1.1
14	0'		44	0'		74	16 1/3'	0.7
15	0'		45	11 1/6'	5.4	75	15 1/2'	0.6
16	3'	8.0	46	18'	5.0	76	12 1/4'	0.1
17	0'		47	6 2/3'	6.6	77	?*	?
18	0'		48	0'				
19	10'	5.6	49	8 3/4'	2.7			
20	17 1/6'	5.2	50	17'	3.5			
21	11'	4.4	51	19'	3.8			
22	10 1/3'	5.1	52	17'	5.2			
23	17 5/6'	5.1	53	17 3/4'	4.9			
24	17 3/4'	5.1	54	0'				
25	13 1/4'	3.7	55	18 1/2'	2.4			
26	3 2/3'	7.0	56	11 5/6'	3.9			
27	16 5/6'	5.2	57	8 3/4'	4.1			
28	3 1/4'	8.8	58	17'	3.7			
29	13 1/2'	4.2	59	11'	4.8			
30	18 1/12'	3.3	60	16 5/6'	5.2			

Σ, 779 1/4'
Av., 12 2/3' at 62 sites cored.
Resistance =Feetcored $\div$ water depth, expressed or 1-10 log scale, con- verted to corresponding position on 5-0 normal scale, x 2.   Average values; northern half of harbour, 5.1;   southern half; 3.7; whole bay, 4.4.

*
<2 fathoms;unoccupiable

Figure 5. Coring

Cores were taken with a free-falling 400-lb V-corer built in Launceston for the project. With fins, the instrument is 20 feet long. In use it is linked by swivels, shackles, and 1/4 ins. diameter steel hawser running through single blocks at the boom head and atop the wheelhouse to the vessel's sharking winch. This in turn is coupled via a 6-to-1 reduction box to the ship's hydraulic system. When the latter system proved unable to break the corer free, the hull was rocked or the capstan was used in conjunction with the corer's safety line.

Cores were divided into three-foot lengths measured from the surface of the sediment cored downwards. The lowermost sample from each core may be less than three feet long. In one or two instances, where the core penetrated slightly more than three feet or a whole multiple of it, for example 3 ft 1 ins. or 15 ft 3 ins., the few additional inches of core were added to the lowermost three-foot sample. Exact intervals represented by each sample are given in Table 2.

On recovery, two splits of each core sample were taken and the remainder of the cores were boxed. Each split was placed in a twelve-dram plastic vial numbered on the cap and engraved on the base. One set of splits was set aside for assay; the other set is maintained by Holb for reference purposes. At selected sites in the northern part of the Bay the splits taken for assay were larger, measuring about 12 ounces each. These samples were stored in plastic containers too.

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Table 2. Sample List, Phase II; Holb 54 - Holb 388

Summary:

Holb#	Type	Locality	Site	Material
54-318	1-yd core	2000-yd sites,Harbour	1-77	silt
319-321	composite	Samples 54-183,N half"	1-43	silt
322-324	composite	Samples 184-318,S half"	44-77	silt
325-326	dredge	Lette Bay, NE Harbour	3.	ore, surface
327-329	dredge	Lette Bay, NE Harbour	5	ore, surface
330-333	channel	W Strahan,Harbour Shore	94	exposed beds
334-335	channel	E Strahan,Harbour Shore	95	exposed beds
336	composite	W Strahan,Harbour Shore	94	pyrite
337-338	channel	2mi NE Strahan,roadside	96	exposed beds
339-341	grab	Teepookana, King River	98	H_2O,silt,sand
342-344	grab	King River, near mouth	97	H_2O,silt,sand
345-383	1-yd grab	1000-yd sites,N Harbour	78-93	silt
384-385	grab	Queen River,LyellHighway	100	H_2O, silt
386-387	grab	King River,HobartHighway	99	H_2O, silt
388	composite	Samples 319-324, Harbour	1-77?	Decanted H_2O

Details:

Holb#	Type	Region	Site	Fathoms	Footage	Material
54	Core	Bay	3	3	0-3	Silt
55	"	"	"	"	3-6	"
56	"	"	"	"	6-9	"
57	"	"	4	19	0-3	"
58	"	"	"	"	3-6	"
59	"	"	"	"	6-9	"
60	"	"	"	"	9-12	"
61	"	"	"	"	12-15	"
62	"	"	6	13	0-3	"
63	"	"	"	"	3-6	"
64	"	"	"	"	6-9	"
65	"	"	"	"	9-11	"
66	"	"	7	17	0-3	"
67	"	"	"	"	3-6	"
68	"	"	"	"	6-9	"
69	"	"	"	"	9-12	"
70	"	"	"	"	12-13 1/2	"
71	"	"	9	3	0-3	"
72	"	"	"	"	3-6	"
73	"	"	"	"	6-8	"
74	"	"	1	10	0-3	"
75	"	"	"	"	3-6	"

Holb#	Type	Region	Site	Fathoms	Footage	Material
76	Core	Bay	2	12	0-3	"
77	"	"	"	"	3-6	"
78	"	"	"	"	6-9	"
79	"	"	"	"	9-12	"
80	"	"	"	"	12-15	"
81	"	"	10	8	0-4	"
82	"	"	11	21 1/2	0-3	"
83	"	"	"	"	3-6	"
84	"	"	"	"	6-9	"
85	"	"	"	"	9-12	"
86	"	"	11	21 1/2	12-15	"
87	"	"	12	9	0-3	"
88	"	"	"	"	3-6 2/3	"
89	"	"	13	3	0-3	"
90	"	"	"	"	3-4 1/2	"
91	"	"	16	13	0-3	"
92	"	"	21	9	0-3	"
93	"	"	"	"	3-6	"
94	"	"	"	"	6-9	"
95	"	"	"	"	9-11	"
96	"	"	20	27	0-3	"
97	"	"	"	"	3-6	"
98	"	"	"	"	6-9	"
99	"	"	"	"	9-12	"
100	"	"	"	"	12-15	"
101	"	"	"	"	15-17 1/6	"
102	"	"	19	14	0-3	"
103	"	"	"	"	3-6	"
104	"	"	"	"	6-10	"
105	"	"	22	12	0-3	"
106	"	"	"	"	3-6	"
107	"	"	"	"	6-10 1/3	"
108	"	"	23	25 1/2	0-3	"
109	"	"	"	"	3-6	"
110	"	"	"	"	6-9	"
111	"	"	"	"	9-12	"
112	"	"	"	"	12-15	"
113	"	"	"	"	15-17 5/6	"
114	"	"	24	26	0-3	"
115	"	"	"	"	3-6	"
116	"	"	"	"	6-9	"
117	"	"	"	"	9-12	"
118	"	"	"	"	12-15	"
119	"	"	"	"	15-17 3/4	"
120	"	"	25	8	0-3	"

Holb#	Type	Region	Site	Fathoms	Footage	Material
121	Core	Bay	25	8	3-6	Silt
122	"	"	"	8	6-9	"
123	"	"	"	"	9-13 1/4	"
124	"	"	29	10	0-3	"
125	"	"	"	"	3-6	"
126	"	"	"	"	6-9	"
127	"	"	"	"	9-12	"
128	"	"	"	"	12-13 1/2	"
129	"	"	28	19	0-3 1/4	"
130	"	"	27	25	0-3	"
131	"	"	"	"	3-6	"
132	"	"	"	"	6-9	"
133	"	"	"	"	9-12	"
134	"	"	"	"	12-15	"
135	"	"	"	"	15-16 5/6	"
136	"	"	26	10	0-3 2/3	"
137	"	"	30	9	0-3	"
138	"	"	"	"	3-6	"
139	"	"	"	"	6-9	"
140	"	"	"	"	9-12	"
141	"	"	"	"	12-15	"
142	"	"	"	"	15-18 1/2	"
143	"	"	31	11	0-3	"
144	"	"	"	"	3-6	"
145	"	"	"	"	6-9	"
146	"	"	"	"	9-12	"
147	"	"	"	"	12-15	"
148	"	"	"	"	15-16 5/6	"
149	"	"	32	16 1/2	0-3	"
150	"	"	"	"	3-5 1/3	"
151	"	"	33	24	0-3	"
152	"	"	"	"	3-6	"
153	"	"	"	"	6-9	"
154	"	"	"	"	9-12	"
155	"	"	"	"	12-15	"
156	"	"	33	24	15-17 1/3	"
157	"	"	34	15 1/2	0-3 5/6	"
158	"	"	41	9 1/4	0-3	"
159	"	"	"	"	3-6	"
160	"	"	"	"	6-9 3/4	"
161	"	"	40	19 1/2	0-3	"
162	"	"	"	"	3-6	"
163	"	"	"	"	6-9	"
164	"	"	"	"	9-12	"
165	"	"	"	"	12-15	"

Holb#	Type	Region	Site	Fathoms	Footage	Material
166	Core	Bay	40	19 1/2	15-17 5/6	Silt
167	"	"	39	23	0-3	"
168	"	"	"	"	3-6	"
169	"	"	"	"	6-9	"
170	"	"	"	"	9-12	"
171	"	"	"	"	12-15	"
172	"	"	"	"	15-17	"
173	"	"	37	9 1/2	0-3	"
174	"	"	"	"	3-6	"
175	"	"	"	"	6-9	"
176	"	"	"	"	9-12	"
177	"	"	"	"	12-15	"
178	"	"	"	"	15-17	"
179*	"	"	43	6 1/2	0-3	"
180	"	"	"	"	3-6	"
181	"	"	"	"	6-9	"
182	"	"	"	"	9-12	"
183	"	"	"	"	12-14	"
184	"	"	45	14	0-3	"
185	"	"	"	"	3-6	"
186	"	"	"	"	6-9	"
187	"	"	"	"	9-11 1/6	"
188	"	"	56	8	0-3	"
189	"	"	"	"	3-6	"
190	"	"	"	"	6-9	"
191	"	"	56	8	9-11 5/6	"
192	"	"	49	4	0-3	"
193	"	"	"	"	3-6	"
194	"	"	"	"	6-8 3/4	"
195	"	"	55	6 1/2	0-3	"
196	"	"	"	"	3-6	"
197	"	"	"	"	6-9	"
198	"	"	"	"	9-12	"
199	"	"	"	"	12-15	"
200	"	"	"	"	15-18 1/2	"
201	"	"	61	16	0-3	"
202	"	"	"	"	3-6	"
203	"	"	"	"	6-9	"
204	"	"	"	"	9-12	"
205	"	"	"	"	12-13 5/12	"
206	"	"	64	9 1/2	0-3	"
207	"	"	"	"	3-6	"
208	"	"	"	"	6-9	"
209	"	"	"	"	9-12	"
210	"	"	"	"	12-15	"

*179a; wood from sample 179

Holb#	Type	Region	Site	Fathoms	Footage	Material
211	Core	Bay	64	9 1/2	15-17 1/6	Silt
212	"	"	68	7	7	"
213	"	"	"	"	3-6	"
214	"	"	"	"	6-9	"
215	"	"	"	"	9-12	"
216	"	"	"	"	12-14 11/12	"
217	"	"	70	3	0-3	"
218	"	"	"	"	3-6	"
219	"	"	"	"	6-7 3/4	"
220	"	"	73	3 1/2	0-3	"
221	"	"	"	"	3-6	"
222	"	"	"	"	6-9	"
223	"	"	"	"	9-12	"
224	"	"	"	"	12-15 1/3	"
225	"	"	75	3	0-3	"
226	"	"	"	"	3-6	"
227	"	"	"	"	6-9	"
228	"	"	"	"	9-12	"
229	"	"	"	"	12-15 1/2	"
230	"	"	76	2 1/4	0-3	"
231	"	"	"	"	3-6	"
232	"	"	"	"	6-9	"
233	"	"	"	"	9-12 1/4	"
234	"	"	74	3	0-3	"
235	"	"	"	"	3-6	"
236	"	"	"	"	6-9	"
237	"	"	"	"	9-12	"
238	"	"	"	"	12-15	"
239	"	"	"	"	15-16 1/3	"
240	"	"	67	6	0-3	"
241	"	"	"	"	3-6	"
242	"	"	"	"	6-9	"
243	"	"	"	"	9-12	"
244	"	"	"	"	12-15	"
245	"	"	63	11	0-3	"
246	"	"	"	"	3-6	"
247	"	"	"	"	6-9	"
248	"	"	"	"	9-12	"
249	"	"	"	"	12-15	"
250	"	"	"	"	15-18 2/3	"
251	"	"	65	8 1/2	0-3	"
252	"	"	"	"	3-6	"
253	"	"	"	"	6-9	"
254	"	"	"	"	9-12	"
255	"	"	"	"	12-15	"

035

Holb#	Type	Region	Site	Fathoms	Footage	Material
256	Core	Bay	65	8 1/2	15-17 1/3	Silt
257	"	"	69	5	0-3	"
258	"	"			3-6	"
259	"	"			6-9 3/4	"
260	"	"	72	5	0-3	"
261	"	"	66	4	0-3	"
262	"	"	"	"	3-6	"
263	"	"	"	"	6-9 3/4	"
264	"	"	62	6	0-3	"
265	"	"	"	"	3-6	"
266	"	"	"	"	6-9	"
267	"	"	"	"	9-10 7/12	"
268	"	"	60	19 1/2	0-3	"
269	"	"	"	"	3-6	"
270	"	"	"	"	6-9	"
271	"	"	"	"	9-12	"
272	"	"	"	"	12-15	"
273	"	"	"	"	15-16 5/6	"
274	"	"	53	18	0-3	" "
275	"	"	"	"	3-6	"
276	"	"	"	"	6-9	"
277	"	"	"	"	9-12	"
278		"	"	"	12-15	"
279	"	"	"	"	15-17 3/4	"
280	"	"	59	11	0-3	"
281	"	"	"	"	3-6	"
282	"	"	"	"	6-9	"
283	"	"	"	"	9-11	"
284	"	"	58	10 1/2	0-3	"
285	"	"	"	"	3-6	"
286	"	"	"	"	6-9	"
287	"	"	"	"	9-12	"
288	"	"	"	"	12-15	"
289	"	"	"	"	15-17	"
290	"	"	52	19 1/2	0-3	"
291	"	"	"	"	3-6	"
292	"	"	"	"	6-9	"
293	"	"	"	"	9-12	"
294	"	"	"	"	12-15	"
295	"	"	"	"	15-17	"
296	"	"	47	14 1/2	0-3	"
297	"	"	"	"	3-6 2/3	"
298	"	"	46	20	0-3	"
299	"	"	"	"	3-6	"
300	"	"	"	"	6-9	"

Holb#	Type	Region	Site	Fathoms	Footage	Material
301	"	"	"	"	9-12	Silt
302	"	"	"	"	12-15	"
303	"	"	"	"	15-18	"
304	"	"	51	12	0-3	"
305	"	"	"	"	3-6	"
306	"	"	"	"	6-9	"
307	"	"	"	"	9-12	"
308	"	"	"	"	12-15	"
309	"	"	"	"	15-19	"
310	"	"	57	6 1/2	0-3	"
311	"	"	"	"	3-6	"
312	"	"	"	"	6-8 3/4	"
313	"	"	50	9 1/2	0-3	"
314	"	"	"	"	3-6	"
315	"	"	"	"	6-9	"
316	"	"	"	"	9-12	"
317	"	"	"	"	12-15	"
318	"	"	"	"	15-17	"
319	Composite	#54-183	1-43	14 av*	11 3/4'av	"
320	"	"	"	"	"	"
321	"	"	"	"	"	"
322	"	#184-318	44-77	9 av*	13 5/6'av	"
323	"	"	"	"	"	"
324	"	"	"	"	"	"
325	Dredge	Lette Bay	3	3	0-1	Py. silt
326	"	" "	"	"	" "	" "
327	"	" "	5	2	" "	" "
328	"	" "	"	"	" "	" "
329	"	" "	"	"	" "	" "
330	Grab	WStrahan	94	Exposed	18' asl	Carb. wood
331	Channel	"	"	"	14-18' asl	silt
332	"	"	"	"	9-14' asl	", sandy
333	"	"	"	"	43-46' asl	silt
334	"	EStrahan	95	"	10-13' asl	", wthrd
335	"	"	"	"	7-10' asl	", fresher
336	Composite	WStrahan	94	"	19' asl	Pyrite**
337	Channel	2 mi NE	96	"	Q'twn	Sandy silt
338	Grab	of Strahan	"	"	H'way	silt
339	"	Teepookana	98	Surface	King R	River water
340	"	"	"	"	"	River silt
341	"	"	"	"	"	River sand
342	"	nr. mouth	97	"	"	River water
343	"	"	"	"	"	River silt
344	"	"	"	"	"	River sand
345	"	N bay	78	12	3	silt

* bay average, 12 ftms
** replacing carbonized wood

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Holb#	Type	Region	Site	Fathoms	Footage	Material
346	Grab	N. bay	78	12	6	Silt
347	"	"	79	14	1/4	"
348	"	"	"	"	3	"
349	"	"	"	"	6	"
350	"	"	82	15	3	"
351	"	"	"	"	6	"
352	"	"	81	15	1/4	"
353	"	"	"	"	3	"
354	"	"	83	19	1/4	"
355	"	"	"	"	3	"
356	"	"	"	"	6	"
357	"	"	"	"	9	"
358	"	"	"	"	12	"
359	"	"	84	20	2	"
360	"	"	"	"	5	"
361	"	"	"	"	8	"
362	"	"	"	"	11	"
363	"	"	85	11	2	"
364	"	"	"	"	5	"
365	"	"	86	17	2	"
366	"	"	"	"	5	"
367	"	"	"	"	8	"
368	"	"	87	9	2	"
369	"	"	"	"	5	"
370	"	"	"	"	8	"
371	"	"	"	"	11	"
372	"	"	90	13	1/4	"
373	"	"	"	"	3	"
374	"	"	"	"	6	"
375	"	"	"	"	9	"
376	"	"	89	20	1	"
377	"	"	"	"	4	"
378	"	"	"	"	7	"
379	"	"	92	8	3	"
380	"	"	93	2 1/2	3	"
381	"	"	"	"	6	"
382	"	"	"	"	9	"
383	"	"	"	"	12	"
384	"	Queenstown	100	Surface	Queen R,	River water
385	"	"	"	"	Lyell H'way	Bank silt
386	" }	1.5 mi E {	99	"	King R,	River water
387	" }	of Linda {	"	"		River silt
388	Composite	#319-324	1-77	2-27	0-19'	Pore water

ii   1000-yd samples

Inspection of the 2000-yd cores and of correspond-
ing assay results showed that mineralization of economic
proportions is confined to upper parts of the sedimentary
column, hence detailed investigation of deeper layers of
the sediment appeared unwarranted. In case additional
samples were needed from the mineralized layer, a further
sampling site was located at the center of each 2000-yd
grid square lying in the northern third of the Harbour.
Samples were collected from these sites using a dart with
cups arranged at 3-foot intervals down its length.

iii   Composite samples

Three fist-sized cuts of each of the 2000-yd core
samples were abstracted when the cores came on deck.   By
adding together one such cut of each of every core sample
taken, three identical composite samples were formed.
Each composite was collected in a plastic cray bag con-
tained in a galvanized can of 10-imperial gallon capacity.
Water draining from ·   composites into the cans was de-
canted as it accumulated.   One set of three such composites
represents samples from the northern half of Macquarie
Harbour.   A second set represents samples from the southern
half of the Harbour (Table 2).

iv   Dredge samples

Bulk specimens of mineralized sediment were recovered
with a bucket dredge of 9-ft^3 capacity.   The dredge is
of 3/16" plate and was constructed in Launceston at the
start of Phase II.   Dredge samples were put into plastic

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Figure 6.   Sampling

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cray bags surrounded by heavy gauge waterproof PVC sheet
and were then placed in 10-gallon galvanized cans for
transport to labs. Water draining from the samples was
decanted as it accumulated. In the case of dredge samples
airfreighted to the United States, paper wadding was placed
between can and sample to absorb any additional water
which might collect during transport. Recipients were ad-
vised by cable of the samples' impending arrival.

Shore Sampling Three sets of materials found in the region sur-
rounding Macquarie Harbour were sampled, notably bedded sediments,
sediments in streams entering the Harbour, and stream waters.

    i   Exposed Beds

            A series of unconsolidated silts, sands and boulder
beds is exposed at various points along the Harbour shore
(Figure 7). According to the Geological Map of Tasmania
the materials are Pleistocene in age. They are stratified.
Beds of finer grained material are horizontal or dip at
low angles. Sands exhibit cross bedding. Boulder beds
and gravels have irregular bases cutting across underlying
bedding; layers within the gravels are concordant with layers
in underlying beds. Finer grained sediments contain much
organic matter, mainly of vegetable origin. Thin layers
of semi-carbonized wood containing individual fragments
up to four feet long are not uncommon. Much of the car-
bonaceous material is encrusted or partially replaced by
pyrite. Silts and sandy silts of the series are dark when
fresh but weather light gray. Lower beds appear to re-
present a lagoonal or estuarine phase similar to the present

Strahan, Macquarie Harbour

Inter-stratified clays, sands, and
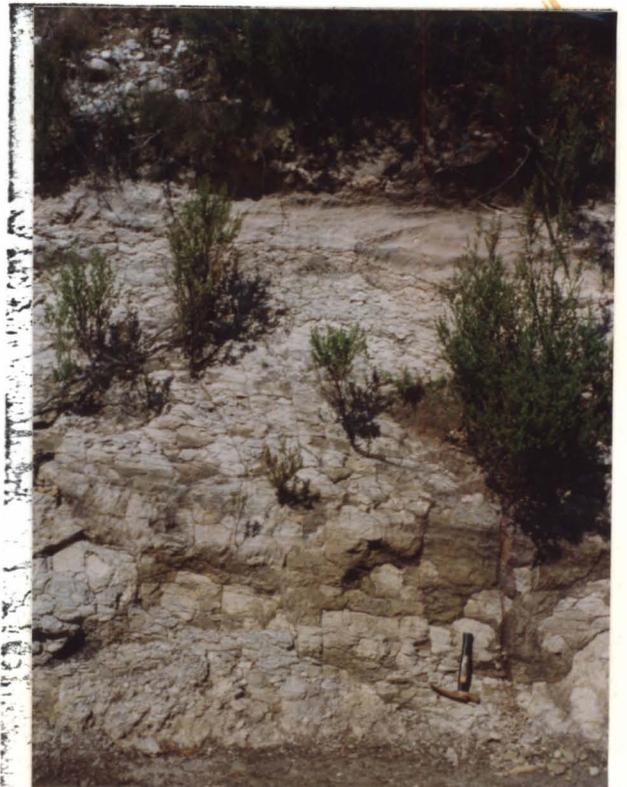boulder beds, foreshore, Strahan

Figure 7.   Exposed beds

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phase of the Harbour's history. Overlying sands and boulders represent a marine incursion. The series is associated with Tertiary materials deposited in the Macquarie graben, thus the discordances and irregular dips probably are linked to Recent faulting as well as to global changes in sea level.

Exposed silts, pyritic material and carbonized wood were sampled so that metal contents revealed by appropriate assaying could be compared with corresponding contents of sediments from the existing floor of the Harbour.

ii   Stream Sediments

Sediments of the King River and its tributary the Queen River were sampled to allow us to measure the approximate content of key metals in mine tailings discharged into the Queen River and in normal sediment of the King River above its confluence with the latter tributary. Other samples of this category were taken to permit us to estimate further dilution that may take place between the confluence above and the river mouth. Both fine and coarse cuts of the sediment were collected so that we would be able to see if any partitioning of metalliferous fractions is taking place on the basis of grain size.

iii   Stream Waters

Water samples were taken in conjunction with samples of stream sediment, at Cities'. request. Cities' intention is to measure the amounts of key metals in solution in these waters. Samples were acidified upon collection with dilute sulfuric acid. Methyl orange was used as an indicator, thus

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036044

Ocean Beach, Strahan

Figure 8.   Beach & valley

King River near mouth

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the samples now should have a pH of about 2.8.

One other water sample was collected but represents pore waters of bay sediments rather than stream water. It was drained from the composite samples. It has not been acidified as this would upset its H_2S content. H_2S is one of the components of this sample requiring quantitative analysis.

Originally it had been intended to collect and analyse samples of sand from the belt of dunes and beach running along the northwest edge of EL 16/73 (Figure 7). This step has been postponed until results on open file at Mines can be reviewed thoroughly.

4.2   Geophysics

In Phase I it was noticed that the 200 Khz Furuno sounder on the Cape Martin, the vessel used for the survey, produced reflections of hard bottom underlying thinner margins of Harbour floor silts. For Phase II a Koden sounder was obtained, operating at the same frequency as the Cape Martin's Furuno. The Koden transducer was mounted in a heavy skid and linked to the recorder by a twenty-five fathom cable attached to a support line. At each sampling site the transducer was lowered to within a few fathoms of the bottom thus in effect increasing the strength of the output signal. Some of a complicated series of echoes from the sea surface first were interpreted as sub-bottom reflections. They are visible down to 70 feet below the Harbour floor. Later, this interpretation was discounted. Records (Appendix D) await further analysis.

Depths at each sample station were measured with the Brid River's 50 Khz Furuno. Depths shown on the fathometer traces should be in-

Figure 9.
Temperature
measurement,
bathymetry

creased by one fathom to correct for the depth of the Brid River's transducer, which is mounted on the bottom of the hull approximately one fathom below the sea surface.

Most of the sounding records show a prominent interface lying at a depth of about 4 1/2 to 7 fathoms below surface. The upper water mass is a brackish body consisting of fresh water from rivers, runoff, seepage and rain, admixed with tidally impelled influxes of seawater. The interface lies approximately at the depth of Harbour sill. Water below the interface appears to be an older, largely inert and toxic body, probably impoverished in oxygen and high in H_2S and in some components of brines.

Water temperatures measured in March (Figure 9) were 25° to 26° C from the interface to the surface, and 22° C from the interface to the bottom. The latter temperature is higher than that to be expected in a trapped and covered water mass.

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5.0   LAB STUDIES

5.1 Chemistry

Analysts   Study of the chemistry of sediments from Macquarie

Harbour begun by Australian Mineral Development Laboratories

(Amdel) during Phase I was continued by the same group during

Phase II. Amdel is the prime contractor in this field to the

Australian mineral industry. In Phase II Amdel examined con-

tents of valuable elements in all samples collected from the

Harbour, that is, in cores, composites and dredge samples.

   The Tasmanian Department of Mines metallurgical lab in

Launceston examined samples of exposed beds and river sediments,

and as a check and a preliminary to separatory work the lab is

testing duplicates of the composite and dredge samples previous-

ly studied by Amdel.

Methods, accuracy   The majority of Amdel analyses are by atomic

absorption spectrography. Those of Mines are by x-ray fluorescence.

Contents of uranium and boron and the two halides tested for were

determined by methods which neither lab has specified.

   Amdel places the accuracy of its AAS determinations to with-

in plus or minus ten percent of the actual values. Mines are re-

luctant to cite accuracy ranges where values determined approach

detection limits; at levels well above detection limits they allow

that results probably are accurate to within plus or minus ten

percent.

Results   All assay data received from Amdel and from Mines are

reproduced in the original at Appendix E. Results are divided
according to class of sample in Tables 3 through 8.

Table 3. Analyses of core samples

Inspection of metal values listed shows that the
higher concentrations occur in surface and near surface
portions of cores collected in northern parts of the Harbour.
In general, the thickness of this mineralized layer lessens
with progress away from the mouth of the King River. There
are exceptions, for example at Sites 19 and 41 where mineral-
ization is thicker than it is at some more northerly points,
and at Site 6 where the deepest sample is the most mineralized.

Lead values in part run contrary to trends outlined
above, being lower in some surface samples than in underlying
material and attaining greatest concentration in southern
rather than northern parts of the bay.

Table 4. Analyses of selected cores

A search for concentrations of elements other than
Cu, Pb, Zn, Co, Mo and Ag was conducted on the 12-ounce
splits of core samples from several sites in the northern
part of Macquarie Harbour. In brief, tungsten, tin, zircon-
ium, titanium and vanadium concentrations follow those of
copper, zinc, cobalt, molybdenum, silver, gold, cadmium
and bismuth shown in Table 3,whereas concentrations of
uranium, lithium, iodine, boron and bromine tend to occur
below the layer enriched in copper and the metals concentrated
with copper.

Table 3.   Chemical analyses, core samples.   Values in ppm.
Detection limits bracketed.   Analyst,   AMDEL.

Holb#	Site	Footage	Cu (2)	Pb (5)	Zn (1)	Co (5)	Mo (3)	Ag (1)	Au (.05)	Cd (1)	Bi (1)
54	3	0-3	870	25	240	75	50	<1		2	
55	"	3-6	950	82	220	65	55	1		2	
56	"	6-9	190	45	110	12	22	<1		1	
57	4	0-3	850	30	140	85	55	<1	0.2	1	1
58	"	3-6	310	78	110	20	18	1	<.05	1	x
59	"	6-9	25	22	55	10	15	<1	<.05	1	x
60	"	9-12	30	32	65	10	15	2	<.05	2	x
61	"	12-15	38	30	60	10	20	1	<.05	1	x
62	6	0-3	80	12	45	8	12	<1	<.05		x
63	"	3-6	12	5	40	5	12	<1	<.05		x
64	"	6-9	12	8	48	8	10	<1	<.05		x
65	"	9-11	160	15	80	15	25	<1	<.05		x
66	7	0-3	920	5	170	95	55	<1	0.1		1
67	"	3-6	750	5	180	65	40	<1	<.05		1
68	"	6-9	55	18	75	12	30	<1	<.05		x
69	"	9-12	32	18	60	10	20	<1	<.05		x
70	"	12-13 1/2	30	20	60	10	20	<1	<.05		x
71	9	0-3	780	5	140	90	50	<1			
72	"	3-6	820	5	160	50	35	<1			
73	"	6-8	160	18	60	15	10	<1			
74	1	0-3	240	22	50	10	12	<1			
75	"	3-6	38	8	12	5	10	<1			
76	2	0-3	880	8	170	55	35	<1			
77	"	3-6	60	28	50	10	22	<1			
78	"	6-9	38	22	50	10	12	<1			
79	"	9-12	95	28	60	10	15	<1			
80	"	12-15	48	25	55	10	10	<1			
81	10	0-4	12	8	22	5	12	<1			
82	11	0-3	70	30	60	12	25	<1			
83	"	3-6	15	22	55	12	10	<1			
84	"	6-9	15	20	50	10	12	<1			
85	"	9-12	38	30	55	10	10	<1			

x not detected

050

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
86	11	0-15	28	25	60	10	10	< 1
87	12	0-3	850	5	160	70	45	"
88	"	3-6 2/3	330	8	110	22	28	"
89	13	0-3	870	5	160	75	48	"
90	"	3-4 1/2	32	15	70	10	3	"
91	16	0-3	810	5	150	50	40	"
92	21	0-3	300	30	130	22	20	"
93	"	3-6	15	18	65	12	10	"
94	"	6-9	15	12	30	5	5	"
95	"	9-11	22	15	40	8	8	"
96	20	0-3	180	40	100	18	15	"
97	"	3-6	18	22	55	12	20	"
98	"	6-9	18	25	50	12	25	"
99	"	9-12	18	22	50	12	18	"
100	"	12-15	22	30	60	12	20	"
101	"	15-17 1/6	18	28	60	12	25	"
102	19	0-3	730	20	160	32	20	"
103	"	3-6	610	30	140	28	15	"
104	"	6-10	410	55	110	20	15	"
105	22	0-3	22	20	50	12	10	"
106	"	3-6	22	15	50	12	4	"
107	"	6-10 1/3	20	22	55	8	6	"
108	23	0-3	140	50	130	18	10	"
109	"	3-6	20	28	60	15	45	"
110	"	6-9	18	28	60	12	38	"
111	"	9-12	20	28	55	10	18	"
112	"	12-15	18	28	60	10	15	"
113	"	15-17 5/6	38	25	60	10	15	"
114	24	0-3	220	70	130	18	15	"
115	"	3-6	22	28	60	12	18	"
116	"	6-9	18	25	55	12	22	"
117	"	9-12	18	12	60	12	18	"
118	"	12-15	22	40	65	12	15	"
119	"	15-17 3/4	22	30	60	12	18	"
120	25	0-3	120	35	80	15	22	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
121	25	3-6	15	22	48	10	12	< 1
122	"	6-9	15	32	48	10	8	"
123	"	3-13 1/4	15	18	38	5	8	"
124	29	0-3	22	25	50	10	35	"
125	"	3-6	18	25	50	10	10	"
126	"	6-9	15	22	48	10	8	"
127	"	9-12	18	28	55	10	4	"
128	"	12-13 1/2	22	30	55	10	3	"
129	28	0-3 1/4	20	20	50	10	18	"
130	27	0-3	50	32	90	18	12	"
131	"	3-6	18	28	60	18	30	"
132	"	6-9	18	25	65	15	12	"
133	"	9-12	18	25	60	12	18	"
134	"	12-15	18	28	60	12	15	"
135	"	15-16 5/6	18	28	60	12	15	"
136	26	0-3 2/3	18	15	38	8	4	"
137	30	0-3	42	30	50	8	12	"
138	"	3-6	20	22	48	10	10	"
139	"	6-9	28	22	50	10	12	"
140	"	9-12	18	20	55	10	12	"
141	"	12-15	15	20	50	8	15	"
142	"	15-18 1/12	18	22	55	10	15	"
143	31	0-3	25	28	70	12	15	"
144	"	3-6	18	28	65	12	35	"
145	"	6-9	18	25	55	12	25	"
146	"	9-12	18	25	60	12	12	"
147	"	12-15	25	22	55	12	6	"
148	"	15-16 5/6	20	20	42	8	6	"
149	32	0-3	20	22	80	12	90	"
150	"	3-5 1/3	20	20	60	10	20	"
151	33	0-3	28	28	90	18	15	"
152	"	3-6	20	25	75	18	20	"
153	"	6-9	20	25	65	15	25	"
154	"	9-12	18	28	70	15	15	"
155	"	12-15	22	25	65	15	18	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
156	33	15-17 1/3	22	28	65	15	20	< 1
157	34	0-3 5/6	20	20	50	10	6	"
158	41	0-3	700	12	180	30	15	"
159	"	3-6	360	20	130	20	12	"
160	"	6-9 3/4	110	40	80	12	12	"
161	40	0-3	100	40	85	18	8	"
162	"	3-6	20	22	55	15	25	"
163	"	6-9	20	25	60	12	22	"
164	"	9-12	18	25	55	12	15	"
165	"	12-15	18	20	50	12	28	"
166	"	15-17 5/6	18	25	60	10	18	"
167	39	0-3	25	25	110	15	12	"
168	"	3-6	20	22	70	18	25	"
169	"	6-9	18	22	65	18	25	"
170	"	9-12	18	22	60	12	30	"
171	"	12-15	20	20	55	10	12	"
172	"	15-17	18	22	60	10	10	"
173	37	0-3	40	25	60	10	15	"
174	"	3-6	22	20	50	10	15	"
175	"	6-9	20	18	50	10	12	"
176	"	9-12	20	20	40	10	12	"
177	"	12-15	18	20	45	10	10	"
178	"	15-17	18	22	48	10	10	"
179	43	0-3	20	10	48	10	18	"
180	"	3-6	18	12	38	10	15	"
181	"	6-9	15	10	40	10	15	"
182	"	9-12	22	12	45	12	12	"
183	"	12-14	28	12	48	12	8	"
184	45	0-3	20	20	55	12	25	"
185	"	3-6	15	18	60	10	38	"
186	"	6-9	18	12	42	10	18	"
187	"	9-11 1/6	15	8	28	5	10	"
188	56	0-3	15	15	48	10	10	"
189	"	3-6	15	12	45	10	12	"
190	"	6-9	15	12	42	10	12	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
191	56	9-11 5/6	15	15	38	10	10	< 1
192	49	0-3	12	12	48	10	15	"
193	"	3-6	15	12	40	10	20	"
194	"	6-8 3/4	5	5	8	5	6	"
195	55	0-3	42	20	60	8	18	"
196	"	3-6	12	15	60	8	22	"
197	"	6-9	12	15	40	10	15	"
198	"	9-12	12	15	45	10	18	"
199	"	12-15	12	15	50	10	18	"
200	"	15-18 1/2	12	20	50	10	22	"
201	61	0-3	20	12	48	10	18	"
202	"	3-6	12	10	45	10	18	"
203	"	6-9	12	15	45	8	15	"
204	"	9-12	12	12	38	8	12	"
205	"	12-13 5/12	12	15	42	8	10	"
206	64	0-3	45	20	85	10	15	"
207	"	3-6	12	10	45	8	12	"
208	"	6-9	12	10	48	8	18	"
209	"	9-12	12	10	38	8	12	"
210	"	12-15	15	10	42	8	15	"
211	"	15-17 1/6	18	10	42	8	15	"
212	68	0-3	35	28	55	5	12	"
213	"	3-6	10	20	45	5	10	"
214	"	6-9	8	10	28	8	12	"
215	"	9-12	12	10	32	8	12	"
216	"	12-14 11/12	12	10	35	8	18	"
217	70	0-3	10	5	35	5	12	"
218	"	3-6	12	30	32	8	12	"
219	"	6-7 3/4	12	10	32	8	12	"
220	73	0-3	18	15	38	10	12	"
221	"	3-6	15	10	32	8	12	"
222	"	6-9	12	10	38	8	12	"
223	"	9-12	12	10	40	8	12	"
224	"	12-15 1/3	15	10	35	8	15	"
225	75	0-3	18	10	55	10	12	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
226	75	3-6	15	10	38	10	12	< 1
227	"	6-9	15	12	42	8	12	"
228	"	9-12	15	12	45	8	15	"
229	"	12-15 1/2	15	15	42	10	15	"
230	76	0-3	15	12	35	10	12	"
231	"	3-6	12	10	42	10	12	"
232	"	6-9	15	12	40	10	12	"
233	"	9-12 1/4	15	12	40	10	12	"
234	74	0-3	18	12	40	10	12	"
235	"	3-6	15	10	38	10	12	"
236	"	6-9	15	12	42	10	12	"
237	"	9-12	15	12	38	10	15	"
238	"	12-15	18	10	42	8	15	"
239	"	15-16 1/3	15	12	38	10	15	"
240	67	0-3	15	10	35	8	18	"
241	"	3-6	12	38	32	8	18	"
242	"	6-9	12	38	30	8	15	"
243	"	9-12	12	12	35	8	18	"
244	"	12-15	12	10	40	8	18	"
245	63	0-3	60	42	50	8	20	"
246	"	3-6	18	28	45	8	22	"
247	"	6-9	15	15	35	8	18	"
248	"	9-12	15	10	42	8	18	"
249	"	12-15	15	10	40	8	18	"
250	"	15-18 2/3	15	10	45	8	20	"
251	65	0-3	18	50	42	8	12	"
252	"	3-6	12	12	42	8	10	"
253	"	6-9	12	32	35	8	12	"
254	"	9-12	10	15	35	8	12	"
255	"	12-15	12	10	32	8	12	"
256	"	15-17 1/3	12	10	38	8	12	"
257	69	0-3	15	5	22	5	10	"
258	"	3-6	5	5	15	5	10	"
259	"	6-9 3/4	8	50	18	5	10	"
260	72	0-3	12	12	22	5	8	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
261	66	0-3	8	35	28	5	8	< 1
262	"	3-6	8	28	22	5	8	"
263	"	6-9 3/4	8	10	30	5	8	"
264	62	0-3	25	30	70	10	18	"
265	"	3-0	12	28	38	10	15	"
266	"	6-9	10	40	32	8	12	"
267	"	9-10 7/12	10	8	25	8	12	"
268	60	0-3	90	70	70	12	18	"
269	"	3-6	15	20	48	10	22	"
270	"	6-9	12	38	40	10	12	"
271	"	9-12	12	15	40	10	18	"
272	"	12-15	12	18	35	10	20	"
273	"	15-16 5/6	10	38	35	8	12	"
274	53	0-3	150	60	95	12	12	"
275	"	3-6	22	18	45	12	25	"
276	"	6-9	15	38	50	10	15	"
277	"	9-12	15	48	40	10	28	"
278	"	12-15	15	42	45	10	12	"
279	"	15-17 3/4	15	42	48	10	12	"
280	59	0-3	15	15	42	10	25	"
281	"	3-6	12	50	40	10	25	"
282	"	6-9	12	22	42	10	22	"
283	"	9-11	12	15	38	10	25	"
284	58	0-3	38	25	60	10	25	"
285	"	3-6	15	60	40	10	25	"
286	"	6-9	12	42	42	10	22	"
287	"	9-12	15	30	45	10	18	"
288	"	12-15	15	50	45	10	12	"
289	"	15-17	15	28	42	10	12	"
290	52	0-3	38	190	65	12	8	"
291	"	3-6	15	20	45	10	22	"
292	"	6-9	12	22	45	10	30	"
293	"	9-12	15	28	42	10	15	"
294	"	12-15	15	55	42	10	28	"
295	"	15-17	15	90	45	10	50	"

Holb#	Site	Footage	Cu	Pb	Zn	Co	Mo	Ag
296	47	0-3	18	70	55	10	15	< 1
297	"	3-6 2/3	18	20	50	10	5	"
298	46	0-3	110	55	90	15	5	"
299	"	3-6	18	22	48	12	22	"
300	"	6-9	15	20	45	12	28	"
301	"	9-12	18	22	50	12	15	"
302	"	12-15	15	22	55	10	10	"
303	"	15-18	15	22	50	10	15	"
304	51	0-3	22	20	50	10	22	"
305	"	3-6	22	22	65	8	15	"
306	"	6-9	15	22	45	8	12	"
307	"	9-12	15	22	48	10	12	"
308	"	12-15	18	25	48	10	15	"
309	"	15-19	15	25	50	8	15	"
310	57	0-3	22	22	55	10	12	"
311	"	3-6	32	25	55	10	10	"
312	"	6-8 3/4	20	18	65	12	6	"
313	50	0-3	18	22	40	8	15	"
314	"	3-6	18	20	50	8	15	"
315	"	6-9	15	22	45	8	10	"
316	"	9-12	15	20	45	8	12	"
317	"	12-15	15	22	38	8	15	"
318	"	15-17	15	22	48	8	15	"

Table 4.   Chemical analyses, selected core samples. Values in ppm.
            Detection limits bracketed. Analyst,   AMDEL.

Holb#	Site	Foot-age	W (50)	Sn (1)	Zr (10)	Ti (100)	U	V (10)	Li (1)	I (10)	Br	B	S
57	4	0-3	50	10	200	3,000	10	100	80	<10	60	45	35,000
58	"	3-6	x	3	100	2,500	12	100	150	60	265	150	24,000
59	"	6-9	x	1	50	2,000	18	80	300	60	290	190	29,500
60	"	9-12	x	1	30	2,500	8	50	120	30	230	180	31,500
61	"	12-15	x	1	50	2,000	8	50	150	25	225	190	35,500
62	6	0-3	x	1	80	2,000	8	50	120	35	170	80	12,500
63	"	3-6	x	3	50	2,000	8	30	150	35	205	130	21,500
64	"	6-9	x	1	30	2,000	14	50	200	30	205	160	19,500
65	"	9-11	x	3	150	2,500	14	80	200	20	145	120	22,500
66	7	0-3	50	10	250	3,000	12	100	100	<10	30	25	41,500
67	"	3-6	x	5	150	3,000	12	100	100	15	100	50	27,000
68	"	6-9	x	1	50	1,500	14	30	200	45	245	200	27,000
69	"	9-12	x	1	50	2,000	8	50	200	40	205	200	29,500
70	"	12-13 1/2	x	1	50	2,500	8	80	200	25	190	250	31,000

Table 5.   Analyses of composite samples

Values given in Table 5 permit results arrived at
independently by Amdel and by Mines to be compared, and
the table provides further data regarding areal distribution
of the elements tested.

Mines' values correspond well with those of Amdel in
the cases of cobalt, molybdenum and bromine. Correspondence
in values for copper, lead, zinc and uranium is fair, though
Mines' figures are approximately 30% above Amdel's. Mines'
values for iodine and boron are less than 30% of Amdel's.
For Cu, Pb, Zn, Co and Mo, a third set of values has been
arrived at; they were calculated by summing and averaging
values given in Table 3 for the individual samples from
which composites were formed. Where appreciable differences
exist between the various sets of analyses, Amdel results are
to be preferred to those of Mines, and   calculated values
to those arrived at by direct measurement. Reasons for
these preferences are that the Mines lab is considerably
older, smaller and less well financed than Amdel and there-
fore likely to be less well equipped and staffed, and that
the calculated values each embody about 130 separate de-
terminations per metal rather than a single measurement for
each metal in each composite; further, calculated values
are based on determinations relating to samples of exactly
equal weight containing most of their original pore water,
whereas the real composites were drained of much pore water
before analysis and were composed of fractions of each com-
ponent sample no more than approximately equal in weight.

Table 5. Chemical analyses of composite core samples. Values in ppm.
Amdel detection limits bracketed.

Holb#	Sites	Analyst	Cu (2)	Pb (5)	Zn (1)	Co (5)	Mo (3)	Ag (1)	Au (.05)	Bi (1)	Sb (30)	As (50)	Ni (5)
321	1-43	Mines	210	27	160	17	21	<.5				40	25
319	"	Amdel	150	22	110	18	20	< 1	<.05	x	x	x	x
54-183	"	Amdel*	132	24	73	17	19	< 1					
324	44-77	Mines	22	14	150	<13	17	<.5				26	39
322	"	Amdel	22	8	95	8	15	< 1	<.05	x	x	x	x
184-318	"	Amdel*	18	23	43	9	15	< 1					
321&324	1-77	Mines*	116	20	155	12	19	<.5				33	32
319&322	"	Amdel*	86	15	102	13	17	< 1	<.05	x	x	x	x
54-318	"	Amdel*	75	23	58	13	17	< 1					

Holb#	Sites	Analyst	W (50)	Sn (1)	Zr (10)	Ti (100)	U	V (10)	Li (1)	I (10)	Br	B	S
321	1-43	Mines					16			< 9	140	33	
319	"	Amdel	x	1	100	3,000	12	100	200	30	155	150	24,500
324	44-77	Mines					16			< 9	150	28	
322	"	Amdel	x	1	80	2,000	8	80	80	25	135	170	26,500
321&324	1-77	Mines*					16			< 9	145	30	
319&322	"	Amdel*	x	1	90	2,500	10	90	140	27	145	160	25,500

* calculated values
x not detected

Table 6.   Analyses of dredge samples

Amdel results presented here are in broad agreement
with figures in Table 3 referring to sample Holb 54, which
was collected at the same site as the dredge sample analy-
sed in Table 6.

Other analyses of dredge samples have been conducted
by Cities, Colorado School of Mines Research Institute,
Hazen Research of Denver and probably by the Tasmanian Mines
Department.   The only set of these other analyses yet sub-
mitted to Holb is that prepared by CSMRI from a specimen
compounded of equal parts of dredge samples collected at
Sites 3 and 5.   CSMRI results converted to parts per million
from weight percent and ounces per ton read as follows:
Cu, 900; Fe, 89,300; Pb,   100; Zn, 2,060; Co, 200; Mo,   100;
U (from U_3O_8), 42; Ag,   0.33; Au,   0.16.   Compared with all
Amdel, Mines and Mount Lyell results for several hundred
samples from northern parts of Macquarie Harbour, the CSMRI
values are too low in silver, too high in uranium and cobalt
and far too high in zinc.   The anomalous zinc value probably
stems from contamination of some sort, possibly from the
drums in which samples in question were airfreighted.   Sol-
ution of a layer of galvanizing no more than one-two thou-
sandth of an inch thick and twelve inches high from the inner
surface of the drums could produce the observed zinc enrich-
ment.   Precautions described in Section 4.1 of this report
were taken to guard against such contamination but it was
never intended that the samples remain in the drums for one-
and-a half months after shipment, as it seems they did.

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Table 6. Chemical analyses of dredge samples. Values in ppm.

Amdel detection limits bracketed.

Holb#	Site	Analyst	Cu (2)	Pb (5)	Zn (1)	Co (5)	Mo (3)	Ag (1)	Au (.05)	Bi (1)	Sb (30)	As (50)	Ni (5)
326	3	Amdel	720	40	160	85	45	1	0.1	1	x	x	
329	5	Mines											

Holb#	Site	Analyst	W (50)	Sn (1)	Zr (10)	Ti (100)	U	V (10)	Li (1)	I (10)	Br	B	S
326	3	Amdel		5	100	2,500	12	100	50	10	28	40	29,500
329	5	Mines											

x not detected

Table 7.   Analyses of exposed sediments

Values in this table compared with corresponding figures for composites and core samples from the southern half of the Harbour show that processes responsible for the bay-wide enrichment of certain elements concentrated in sediments of the present floor of the Harbour probably have been in operation for some thousands of years and possibly for a million years. Testing Miocene sediments from Macquarie graben would allow us to discover whether the processes operated in Tertiary times. Samples 337 and -8 may be Tertiary material.

Note that the first seven silver values, against which I have placed a question mark, appear to be ten times too high, reproduced as received from Mines. In two other sets of analyses from Mines the detection limit for silver is 0.5 ppm, not 5 ppm as in the determinations questioned.

Several elements appear to be slightly more abundant in weathered than in fresh silt. Cobalt is strongly concentrated in pyrite, here unequivocally authigenic. Uranium which it was anticipated would be concentrated in the carbonized wood or possibly in the pyrite is in relatively low abundance in woody and pyritic material and highest in whole samples of silts containing the largest boron values of any samples of exposed sediment; in the latter case, uranium of the exposed beds follows the course it exhibits in Table 4. Halide and boron values are significantly lower in the exposed beds than they are in submerged sediments analysed in Tables 4 and 5.

Table 7. Chemical Analyses of exposed sediments. Values in ppm.

Analyst, Tasmanian Mines Department

Holb#	Site	Locality	Type	Material	Cu	Pb	Zn	Co	Mo	Ag	Au
330	94	W. Strahan	Grab	Carb. wood	65	28	54	< 5	<10	5?	<.5
331	"	"	3'chnl.	Dark silt	24	12	67	16	14	< 5?	<.5
332	"	"	5' "	Sandy silt	30	12	83	10	12	< 5?	<.5
333	"	"	2-1/2'*	Upper silt	20	6	59	10	<10	< 5?	<.5
334	95	E Strahan	3'chnl.	Wthrd silt	30	24	62	< 5	<10	7?	<.5
335	"	"	3' "	Fresher silt	30	14	48	9	<10	< 5?	<.5
336	94	W Strahan	Composite	Pyrite*	40	70	30	235	12	6?	<.5
337	96	2mi NE of 94	3'chnl.	Sandy silt	52	53	28	< 13	< 5	<.5	
338	"	"	Grab	Dark silt	48	52	15	< 13	< 5	<.5	

Holb#	Site	Locality	Type	Material	Wo_3	Sn	U_3O_8	I	Br	B
330	94	W. Strahan	Grab	Carb. wood	<50	24	11	31	23	18
331	"	"	3'chnl.	Dark silt	<50	<7	< 5	<9	21	4
332	"	"	5' "	Sandy silt	<50	<7	19	<9	< 2	24
333	"	W Strahan	2-1/2'*	Upper silt	<50	<7	16	<9	<2	39
334	95	E Strahan	3' "	Wthrd silt	<50	<7	9	<9	18	12
335	"	"	3' "	Fresher silt	<50	<7	7	<9	4	10
336	94	W Strahan	Composite	Pyrite*	<50	10	5	110	6	16
337	96	2mi NE of 94	3'chnl.	Sandy silt			12			
338	"	"	Grab	Dark silt			12			

* replacing carbonized wood

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Table 8.   Chemical analyses of river sediments.   Values in ppm.   Analyst, Tasmanian Mines

Holb#	Site	Locality	Type	Material	Cu	Pb	Zn	Co	Mo	Ag	Au	U_3O_8
340	98	King R, Teepookana	Grab	Silt	1020	110	310	45	57	x	x	20
341	"	"	"	Sand	1670	60	220	31	25	x	x	17
343	97	King R, Nr. Mouth	"	Silt	1190	150	240	64	67	< .5	< .5	16
344	"	"	"	Sand	1270	83	210	50	50	< .5	< .5	12
385	100	Queen R, Q'town	"	Sed't	2220	120	220	61	49	< .5	x	12
387	99	King R, Hobart Rd.	"	Silt	28	36	54	13	5	x	x	17

x not detected

Table 8.   Analyses of river sediments

Results in Table 8 show that copper is slightly more abundant in sandy than silty fractions, and that for zinc, cobalt, molybdenum and uranium the reverse is the case.

Summary   Comparing elemental abundances given in the preceeding six tables with corresponding abundances for the Earth's crust shows that at least fifteen elements are concentrated in wet sediments of Macquarie Harbour. Molybdenum, tungsten, gold, sulfur, iodine, bromine and boron are concentrated twenty to fifty times their average level in the crust, copper and arsenic ten to twenty times, and cobalt, uranium, silver, zinc, cadmium and lithium one to ten times.

Concentrations of uranium, molybdenum, lithium, arsenic, sulfur, boron, iodine and bromine extend bay wide. These concentrations are believed to be made up for the most part of elements dissolved in pore waters, and in brine lying below the Harbour's 5-7 fathom interface.

Contents of uranium, lithium and arsenic in the bay sediments represent concentrations in the inferred brine 2000 to 6000 times the metals' abundance in seawater; the iodine content represents a concentration 700 times the element's abundance in seawater.

Copper, gold, silver, cobalt, zinc, cadmium and tungsten are concentrated in material entering Macquarie Harbour from the King River. Molybdenum, uranium and sulfur concentrations found throughout the Harbour also occur in the King River discharge. In addition, small concentrations of tin and bismuth, and probably of selenium and antimony are believed to be entering the bay via the King system. Most of the elements listed reach the King system via its tributary the Queen River. The elements are contained in tailings released to the Queen River from the Mount Lyell mine at Queenstown. Part of the influx into the Harbour may consist of metals in solution.

Chemistry of the Phase II samples was unraveled mainly by Amdel. Analyses were distributed to participants in the Macquarie project as soon as they were received from the labs.

5.2   Mineralogy

Harvey undertook preliminary microscopy on mineralized sediment from the Harbour floor in 1973 and summarized findings thus (Phase I Report)

> "Bottom sediment sampled in Macquarie Harbour appears moderately uniform mineralogically and texturally. Its chief characteristics are as follows:

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Components	Avg weight percent	Grain min	Diameter, avg	mm max
Opaque minerals	10	.001	.05	.15
Plant remains	8	.006	.07	.2
Clays	37	.003	.02	.1
Micas	13	.003	.01	.03
Quartz, etc	32	.006	.01	.1

The sediment varies from a medium clay to a very fine sand. Most of the sediment, with an average grain diameter of about 0.02mm, ranks as a medium silt.

The opaque minerals appear to be sulfides mainly. A substance tentatively identified as marcasite accounts for the bulk of the opaque matter. Pyrite is present in most samples. Near the King River pyrite is common and chalcopyrite ? and bornite ? occur. Some of the sulfide found near the King River is sub rounded and comparatively coarse grained; probably it is detrital. Elsewhere most of the sulfide probably formed in the sediments, very possibly through the agency of anaerobic bacteria".

Our understanding of the sediments has yet to progress much further.

Cities began x-ray examination of Macquarie sediment prior to the start of Phase II and confirmed Phase I data given above. Specifically it was found that the clay-sized fraction of the sediment, taken by Cities as that $<$ 0.005mm in grain diameter rather than that $<$ 0.003, varies from 35% to 65% by weight and consists principally of quartz, hydrous mica and kaolinite. Subordinate quantities of a mineral regarded as chlorite ? also occur in this fraction. In the fraction composed of grains $>$ 0.005 in mean diameter, quartz, mica and pyrite were discovered; chalcopyrite,

digenite, stannite and stromeyerite are said to have been ident-
ifed tentatively. More detailed studies including work with
the Company's electron probe were promised for Phase II but have
not been forthcoming. Holb has been informed that the mineral-
ogical work was referred to Hazen Research Incorporated. The
only mineralogical data received from Hazen is embodied in a
single paragraph of a letter to the backers in which it is stated
that the fraction of sample Holb 327 investigated - that greater
than 0.01mm in grain diameter - contained "chalcopyrite accompan-
ied by pyrite and traces of sphalerite". It was stated further
that the sulfides "appear to be reasonably well liberated from
gangue constituents".

Effective methods of concentrating valuable fractions of
Macquarie sediments are unlikely to be perfected fast and rela-
tively inexpensively unless the mineralogy of the sediments is
studied properly, both at a quantitative as well as a qualitative
level. Results of such a study were needed some months ago, be-
fore attempts to produce concentrates began.

As Cities has failed to produce this information, I have
commissioned Amdel to conduct the study. Results will not be ready
for inclusion in this report but should be available to us early
in September.

Supplementary information regarding mineralogy of the bay
sediments can be culled from papers on the geology of Mt Lyell and
areas near it. According to Solomon and Elms (1965) the chief
ore minerals at Mt Lyell are chalcopyrite, bornite and pyrite.
Minor quantities of chalcocite, digenite, tetrahedrite, tennantite

and enargite occur, also cuprite, native copper, free gold, galena,
sphalerite and stannite. Other sources report that cupriferous
pyrite, magnetite, siderite and goethite are present too.

While most of the metals concentrated in the northern part
of Macquarie Harbour should prove to be contained mainly in frag-
ments of ore minerals listed above, and elements such as lithium,
boron, iodine and bromine almost certainly exist within the Harbour
largely in a dissolved state, the site of most of the uranium and
molybdenum concentrated in dried specimens of King River sediment,
bay floor silt and in the exposed silts remains unknown. The ex-
tensive spread and rather uniform concentration of these two elements
suggests that they are dispersed either in solution or via very fine
grained particles. As molybdenum reaches its greatest level in the
King River discharge and was concentrated markedly in the sink
fraction of Holb's heavy liquid separation, reported in the follow-
ing section of this report, the element probably enters the bay
partly in solution and then is taken into lattices of sedimentary
sulfides. Partial concentration of the uranium below the ore zone
in the layer rich in brine elements may mean that much of this ele-
ment remains in solution. Results of water analyses promised by
Cities may help to resolve these questions.

6.0   RESERVES

It appears that the Holb licences at Macquarie Harbour
contain at least three mineral deposits, namely the metall-
iferous sediments of the King River and northern part of the
Harbour, the bay wide body of brine, and sands extending along
the northwestern edge of EL 16/73 containing heavy minerals.
The latter two deposits are imperfectly defined and of uncertain
potential. The sketchy information about them we do possess is
presented at the end of this section of the report.

6.1   Metalliferous deposit

The deposit embraces bay sediments and waters, deltaic sed-
iments and waters, river sediments and waters, and mine tailings
and waters. Little is known at this stage about contents of val-
uable metals in the four categories of water mentioned,thus they
will not be included in reserve estimates which follow. It should
be noted in passing,however,that mine waters from a sulfide de-
posit of Lyell type reasonably may be expected to be acid and
relatively high in dissolved metals. Seepage and runoff from a
region of widespread mineralization over which Mt Lyell's
smelter fumes were discharged for half a century well might rank
as an additional source of dissolved metals. Some solution of
metals is likely to take place during river transport of sulfide
particles over the eighteen miles from Queenstown to the sea. Also,
metals may be dissolved partially,after deposition,by pore waters
of the deltaic and bay-floor sediments. Below the 5 to 7 fathom

interface, bay waters and presumably pore waters are believed to be charged with H_2S. As the mineralized sediment has been in place for 1 to 70 years, that is, for an average of about 35 years, pore waters should for the most part have attained equilibrium with the sediment they permeate and the mineral grains they surround.

Core samples of mineralized sediment were packed for dispatch to Amdel in the state in which they were taken from the bay and therefore are likely to have contained most of the original pore fluid.

Metal contents determined for dried fractions of these samples consequently represent metal contents originally present in solid and liquid fractions of each sample. As neither the concentration of any one metal nor the overall salinity is likely to have been particularly high in pore liquids, metal contents of the corresponding solid fractions of samples probably experienced little dilution and are essentially the same as the reported values. Although the presence of metals in pore fluids thus has been taken into account and appears unimportant in the analyses, their presence warrants attention in terms of reserve volume, ore treatment and mining economics. Even if metal concentrations in pore fluids are low by absolute standards, the very large quantitiy of such fluids involved, the fact that the host ore probably would require dewatering in any case, and the economy with which materials in solution can be handled and recovered are considerations which make this aspect of the total reserve picture one well worth examining in forthcoming stages of the investigation.

Estimates of metal reserves in solid fractions of the min-

eralized sediment depend upon the thickness, extent, density and grade of material in the bay, delta and river, and on the quantity and grade of the mine discharge. The grade of ore in these four categories decreases from mine to bay; tonnages increase.

Thickness   Thicknesses of mineralized sediment in Macquarie Harbour were derived in two stages from assays of core samples collected at 2000-yd grid sites and from data published in the Mount Lyell reports on their delta drilling.

     First, thicknesses of mineralized sediment intersected by Holb cores were measured. The point at which mineralization ends within a three-foot core sample can be calculated by finding the proportion of the sample composed of sediment having the average copper content of all wholly mineralized overlying samples and the proportion consisting of unmineralized bay sediment underlying the ore zone. For example, a 3-foot core running 545 ppm Cu collected between overlying samples averaging 800 ppm Cu and underlying samples averaging 30 ppm Cu is assumed to consist of one-third underlying unmineralized bay sediment (30 ppm x 0.33 = 10 ppm) and two-thirds ore (800 ppm x 0.67 = 533 ppm), that is, of 533 ppm and 10 ppm, or 543 ppm Cu. Two of the three feet of this sample consequently are regarded as mineralized. If two overlying 3-foot samples are mineralized, then the calculated thickness of ore at this coring site is taken as 3ft + 3ft + 2ft, that is, as 8 feet. At sites where there are no fully mineralized overlying samples, values from the nearest fully mineralized 3-foot sections are extrapolated, applying appropiate corrections for distance.

Table 9.   Ore volume & tonnage

Grid square	yds KR	Measured T, ins+	Cu,++ ppm	From curves Cu,ppm	T, yds	Area M yd²	Volume M yd³
5,5E,8	delta		1600"	1600	7.00"	1.80	12.60
5	1500			980	3.66	3.00	11.00
8	2000			945	3.05	2.80	8.54
7	3000	74	835	880	2.14	4.00	8.56
3	3200	79	910	875	2.00	2.52	5.04
4	3200	12	850	875	2.00	4.00	8.00
12	3600	51	850	890	2.39	4.00	9.56
2	4000	37	880	855	1.53	2.64	4.04
9	4000	78	800	855	1.53	1.48	2.83
11	4600	2		830	1.25	4.00	5.00
13	4600	36	870	830	1.25	3.33	4.16
6	5400	10(132)		810	0.92	3.73	3.44
1	5600	9		800	0.83	1.60	1.33
16	5600	36	810	800	0.83	4.00	3.32
10	6000			790	0.75	1.48	1.14
17	6000			790	0.75	2.48	1.86
15	7200			760	0.50	2.64	1.32
20	7700	9		750	0.44	4.00	1.76
21	8200	15		740	0.39	5.29	2.06
19	8400	96	670	730	0.36	3.69	1.36
18	8800			715	0.33	2.40	0.80
23	9600	7		705	0.31	4.00	1.24
24	10100	11		690	0.28	4.00	1.12
22	10400	0		680	0.28	0.68	0.19
Σ						73.56	100.47

Reserve	T, yd	M yd²	M yd³	tons/yd³	M tons	%
River""	4.00	0.634	2.53	0.95	2.41	2.50
Delta	7.00	1.80	12.60	1.00	12.60	13.50
Bay	1.25	71.76	87.87	0.90	79.10	84.00
Total		74.19	102.80		94.11	100.00
Average	1.38			0.92		

+ assay conversion; ++ average;   " Mt Lyell sampling; "" 18 mi x 20 yds

In fresh cores the mineralized layer generally looks khaki or
dark brassy gray, and barren underlying sediment dark brown. On
exposure the ore becomes rusty; unmineralized bay sediment ex-
periences scant change. Thicknesses of mineralization revealed by
these color differences accord well with those arrived at by cal-
culation.

The second stage in reckoning thicknesses of bay ore in-
volves plotting the calculated thickness at each mineralized site
against the distance of the site from the King River mouth
(Figure 10). Next, a curve is fitted to the points plotted, and
revised thicknesses are read from the curve. The procedure helps
remove both negative and positive variations of a localized nature
which it would be unreasonable to project over the large areas
between sites. Calculated thicknesses and smoothed thicknesses
are shown in Table 9. Thicknesses well in excess of those taken
from the curve apparently exist where the bay floor is channeled,
for instance at Site 6 and at Site 19. Site 19 lies on the edge
of the present entrance to the Harbour. Site 6 lies near a deep
gutter extending westward across the Harbour floor from the mouth
of the King River; the feature represents an extension of the
present valley, developed when sea level was lower or land higher
than it is now and the spit currently shutting off most of the
Harbour from open sea had yet to form. For sites in the mineral-
ized zone which proved too sandy to core or too shallow to occupy,
projected thicknesses are used, again taken direct from the curve.

In estimating reserves, the thickness of mineralized sed-
iment determined for each coring site is regarded as the thickness
extending over all mineralized parts of a 2000-yd grid square
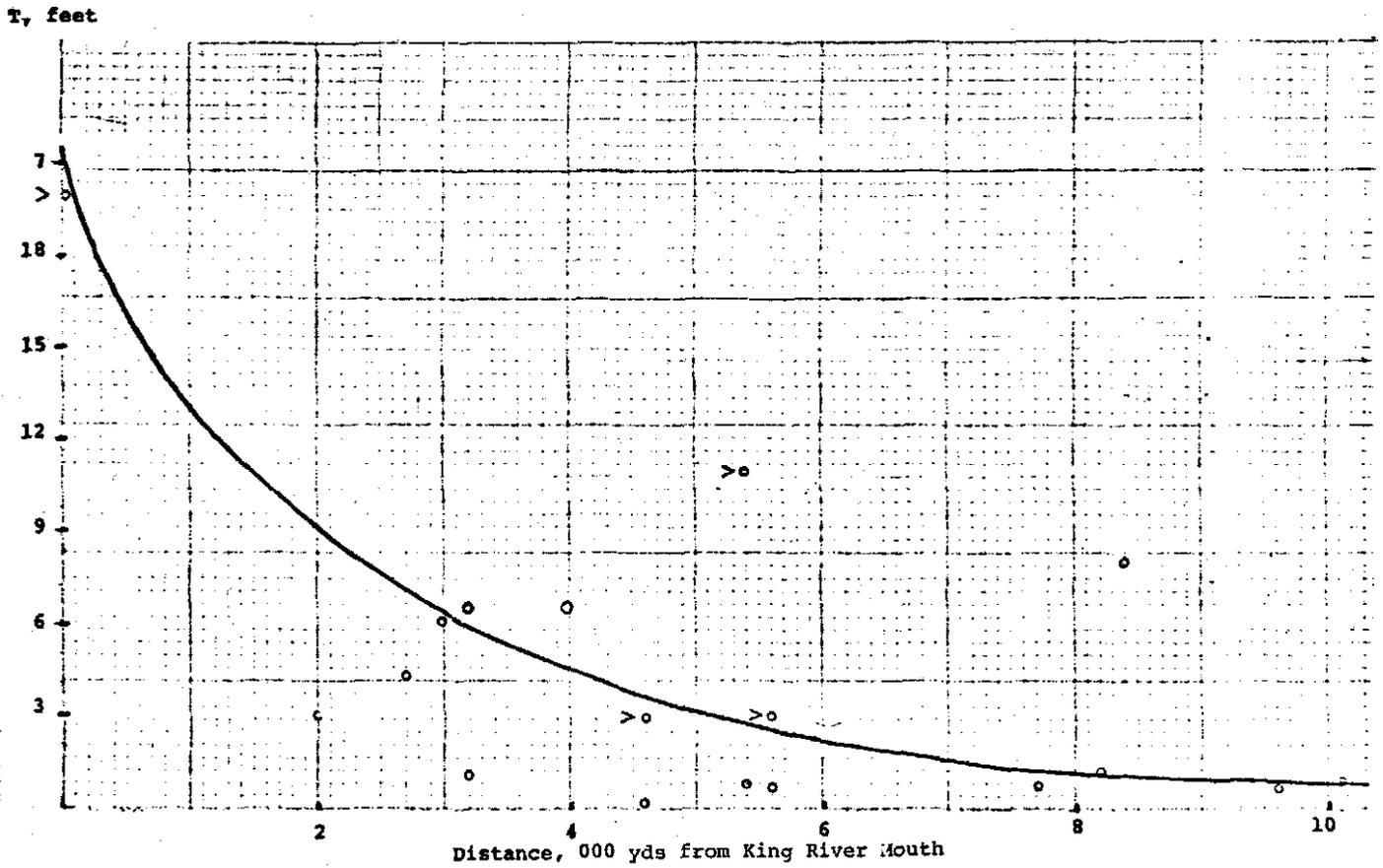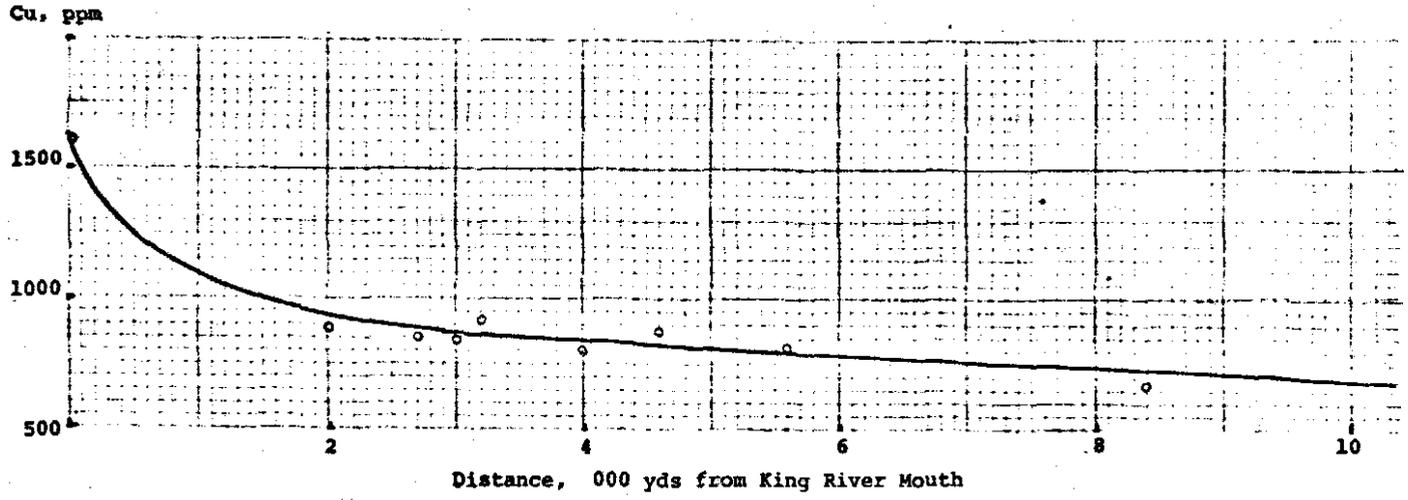
Figure 10.   Curves for thickness and copper content of mineralized silt.

centered on the site under consideration.

Twenty-one feet is adopted as the thickness of mineralized sediment   proved to exist in the King River delta. This is held to be a safe figure for several reasons.

* Mount Lyell coring did not reach the ore base,though many of the holes were drilled to a depth of twenty feet
* Sixty feet of water are said to have existed early this century under the rail bridge at Teepookana, four miles up-stream of the King River mouth
* The Admiralty chart puts the delta foot at about 13 fathoms and a more recent survey places it at approximately 15 fathoms

In other words, the delta appears to have built up somewhere between sixty and ninety feet since dumping of mine tailings began. A mean thickness of mineralized sediment of thirty to forty-five feet over the delta's whole area is more likely than the seven yard. figure used in the case of proven reserves.

Extent   Marking all sampling sites at which mineralized sediment was cored shows that such material covers about two thirds of Mac-quarie Harbour, or roughly eighty square miles of bay floor (Figure 11).

The average thickness of the mineralized layer over the southern two-thirds of this area is less than one foot although locally mineralization extends down at least 4 1/2 feet, for in-stance at Site 41 near the Bradden River mouth. Dredging a layer less than a foot thick would be difficult and would not greatly increase tonnages unless very large areas were covered. Ore in this southern two-thirds of the mineralized region accordingly is
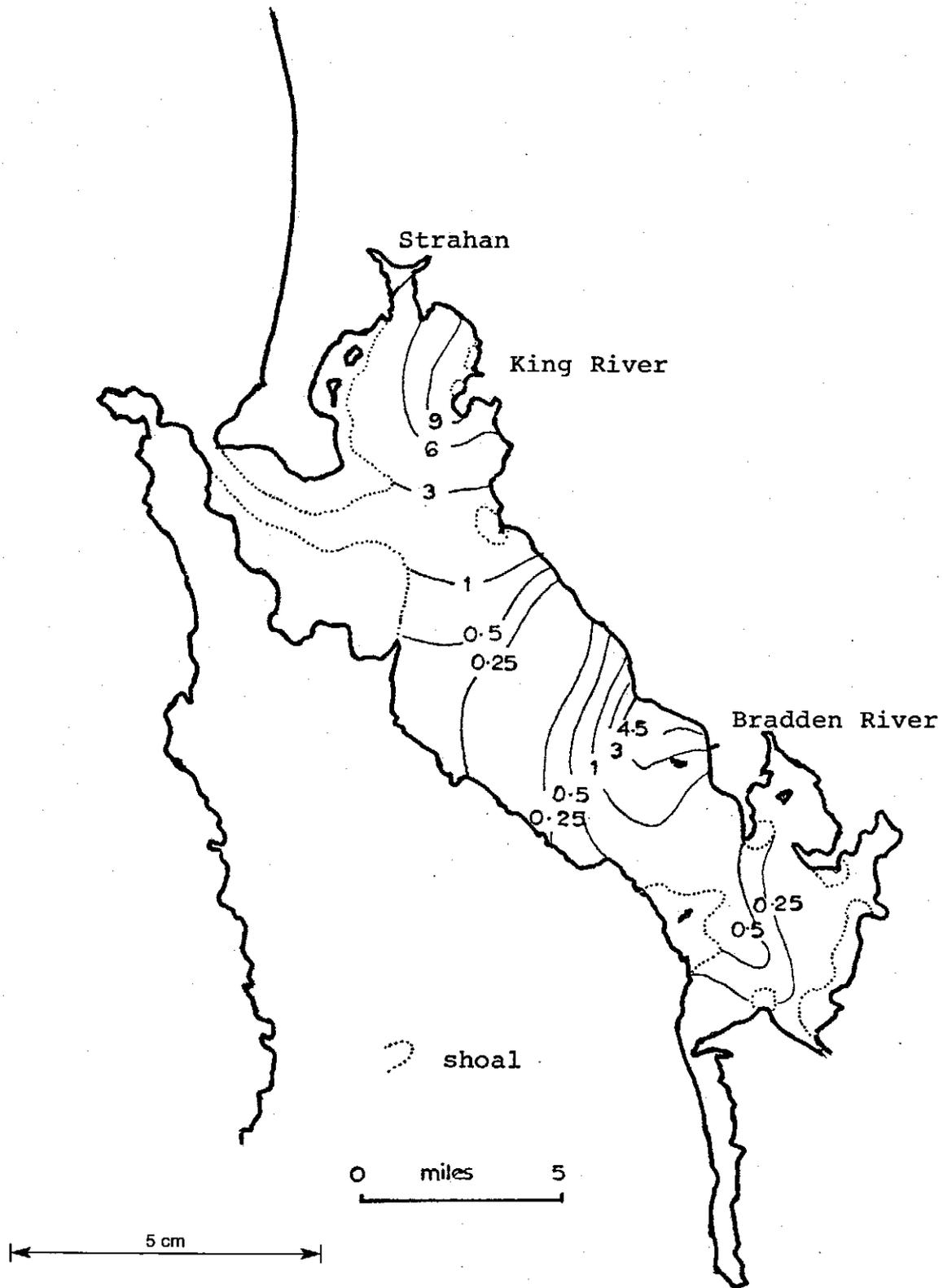
Figure 11.   Mineralized silt, Macquarie Harbour;
thickness in feet.

not included in the following estimates. The Bradden region de-serves attention later.

The extent of thicker mineralized ground, confined approx-imately to the northern quarter of Macquarie Harbour, is estimated to be about twenty-four square miles. The figure was arrived at by shifting the 2000-yd grid so that each coring site falls at the center of a grid square, by estimating to the nearest tenth the mineralized area lying within each square, and by adding all such areas. This allows fractions of certain squares overlapping land or the barren sand banks converging on western margins of the de-posit from the spit and the Harbour entrance to be excluded from estimates.

The area covered by deltaic material was calculated in the same way and includes submerged portions down to the ten-fathom line as well as exposed portions. Areas of mineralized ground used in computing bay and delta reserves are listed in Table 9.

Accuracy of results above may be improved slightly by sub-stituting Plate I for the 1:250,000 sheet used to date and by ob-taining areas with a planimeter rather than by estimation.

Volume   Ore volumes for bay and delta (Table 9) simply represent the area of mineralized ground in any unit multiplied by the thick-ness of such ground. In the case of mineralized sediment in beds of the Queen and King River, the volume reached is the product of the joint valley system's length, and the average width and thick-ness of its bed. Its length is taken as 18 miles, its width and thickness as 20 yards and 4 yards respectively.

The average width is that for a system increasing exponent-

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ially from 5 yds to 50 yards. The average thickness is taken as half the average center depth of a bed increasing exponentially in depth from 2 1/2 yards to 25 yards.

Density and porosity   Ore volumes derived above may be converted to tonnages of dry material in place if densities and porosities of the various categories of sediment are known. In Table 10 estimates of likely densities and porosities are derived from data available. Comparable values derived from separate sets of data can be seen to lie within $\pm$ 2-4% each other and thus probably approximate true values rather closely. Note in passing that the water content of deltaic sediments presented by Mt Lyell in the report on delta sampling cannot be reconciled with bulk densities and SGs of dry solids cited for the same samples. From estimates given here in Table 10 it appears that Mt Lyell's water contents are too low.

Values in Table 10 agree well with values published by E.L. Hamilton of the Navy Electronics Lab at San Diego, California, for corresponding types of sediment of the continental shelves.

Regime	Material	gm /ml	% porosity
Macquarie	Silt	1.28(1.42)1.48	61-65*
Shelves	Silt	1.25(1.45)1.85	50(73)85
Macquarie	Ore	1.55(1.66)1.78	57-62*
Shelves	Sandy silt	1.50(1.75)1.90	45(55)70

( ) average   * best value

The Macquarie ranges, based on fewer samples, are smaller than Hamilton's but lie within his ranges. Average densities of the

Table 10. Density Calculations

Vial Samples

Hole#	Sediment				Ore	
	220	224	267	345	54[1]	351[2]
Packed weight, gm	37.33	36.18	50.60	32.95	43.38	36.04
Vial weight, gm	8.12	8.12	8.12	8.12	8.12	8.12
Sample weight, gm	29.21	28.06	42.48	24.83	35.26	27.92
Sample volume, ml	26	22.5	26	22	23	17.5
Density, gm/ml	1.12	1.24	1.63	1.13	1.54	1.60
x0.84 = tons/yd³	0.94	1.04	1.37	0.95	1.29	1.34
Mean tons/yd³		1.15				
Average tons/yd³		1.08			1.31	
Working value tons/yds³		1.10			1.30	
Adjusted for water loss & space gain in packing & storage tons/yd³		1.23			1.43	
Adjusted for water & space gain in sampling, tons/yd³		1.25			1.50	

Drum Samples

Hole#		Sediment				Ore	
	319+322	320+323	321	324	325	326	327
Shipped weight, lbs	212	218	1.04	116	123	112	152
Drum, packing, lbs	–	26	–	–	11	10	11
Sample weight, lbs	208	192	103	115	112	102	141
Dry weight, lbs	71					70	
Brine, lbs	137					32	
Sample vol., ft³	3.05	2.72	1.28	1.45	1.28	0.96	1.45
Density, lbs/ft³	68.35	70.04	80.30	102.00	93.50	1.06	97.70
tons/yd³	0.921	0.952	1.090	1.377	1.262	1.430	1.347
Mean, tons/yd³			1.149			1.346	
Average, tons/yd³			1.085			1.346	
Working value, tons/yd³			1.10			1.35	
Adjusted for decanted H₂O & for drum space, tons/yd³ [2]			1.15				
						1.40	
Adjusted for H₂O & vol. gain in sampling, tons/yd³			1.20				

[1]bay sample [2]river sample

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Mt Lyell Samples

Sample				Ore, King R. delta		
				#1	#2	#3
Density	lbs/ft³			118[1]	91.3[1]	96.2[1]
	tons/yd³			1.59	1.23	1.29
Mean,	tons/yd³				1.41	
Average, tons/yd³					1.37	
Working value, tons/yd³					1.38	
Adjusted to offset H_2O						
& space gains in sampling, tons/yd³					1.45	

Figures derived from data above

Sample	Material	Unit values					Values in place	
		SG	lbs/ft³	lbs/ft³	lbs/yd³	tons/yd³	Vol%	Wt%
Bay sed,drums	Dry Sed.	2.21	138	48	1302	0.65	35	54
	Brine	1.01	63	41	1105	0.55	65	46
	Wet Sed.	-	-	89	2407	1.20	100	100
Bay sed,vials	Dry Sed.	2.21	138	54	1453	0.73	39	59
	Brine	1.01	63	38	1037	0.52	61	41
	Wet Sed.	-	-	92	2490	1.25	100	100
Bay ore,drums	Dry Sed.	2.73	170.5	64	1745	0.87	38	62
	Brine	1.01	63	40	1055	0.53	62	38
	Wet Sed.	-	-	104	2800	1.40	100	100
Intermed.,vials	Dry Sed.	2.80	175	73	2040	1.02	43	68
	Water	1.00	62.4	39	960	0.48	57	32
	Wet Sed.	-	-	112	3000	1.50	100	100
Delta ore, Lyell	Dry Sed.	2.88	180	69	1848	0.92	38	64
	Water	1.00	62.4	38	1046	0.53	62	36
	Wet Sed.	-	-	107	2894	1.45	100	100

Summary		ton/yd³ sed	lbs/ft³ sed	wt % solids	por- osity %	tons/yd³ brine	SG dry solids	tons/yd³ solids
Sediment,drums	*	(1.08)-1.20	89	54	65	0.55	2.21	0.65
vials		(1.08)-1.25	92	59	61	0.52	2.21	0.73
Ore, bay[2]	*	(1.35)-1.40	104	62	62	0.53	2.73	0.87
intermed[3]		(1.31)-1.50	112	66	57	0.49	2.80	0.99
delta[2]		(1.37)-1.45	107	64	62	0.52	2.88	0.92

[1]from Lyell rept; other figures derived. [2]surface ore. [3]near-surface ore. * best values

Macquarie material are a bit lower than those for shelf material. This is in keeping with the very recent and totally surficial nature of the Macquarie sediment measured; the shelf averages probably include a fair fraction of sub-surface and much older sediment which reasonably may be expected to be denser.

Densities in Table 9 applied to total volumes of mineralized sediment in bay, delta and river reserves are 1-3% above the values in Table 10, which refer almost wholly to materials from upper surfaces of these bodies.

Tonnages   Tonnages of each category of ore are shown in Table 9, calculated from volumes and densities in the same table. The tonnages listed are considered sufficiently definite as minima to rank as proven, despite the relatively wide spacing of core sites on which the figure for bay ore, making up 84% of the total reserve, is based. In many metalliferous deposits in solid rock, ore shoots, veins, faults, folds, metamorphic and weathering effects cause sharp variations in the extent and grade of mineralization, requiring that estimates of ore considered proven be based on extensive drilling. In the sheet-like Macquarie body, the only variable considered important is that of distance from the King River mouth, the factor controlling the area over which the river's discharge of mineralized sediment is spread and the degree to which such sediment is diluted. Figure 10 illustrates both rates and the systematic and predictable manner in which these changes take place. The figure shows that dependable estimates may be made on the strength of comparatively few test holes. Denser testing is necessary in areas represented by the steeper part of the curve,

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that is, on the King delta. Mount Lyell undertook such testing
and provided results in reports on the delta. The tonnage of proven
ore present in beds of the Queen and King River is derived mainly
from the length and width of the two beds. Length and width are
taken from accurate maps, thus there is little room for substantial
error.

Grade   Metal contents of bay, delta and river ore used in reserve
estimates are derived in Figure 10 and Tables 9,11, and 12, and are
summarized in Table 13.

i Bay ore

Average maximum contents of Cu, Pb, Zn, Co and Mo
in mineralized sediment of the northern quarter of Macquarie
Harbour based on the highest values found in analyses of
core samples are presented in Table 11. They are adjusted
in the same table by $\pm$0-3% according to a weighted average
established for copper. The latter figure was obtained by
multiplying the tonnage of mineralized sediment available
in each grid square by the average copper content of the
square, read from the appropiate curve in Figure 10, and
by summing and averaging resultant products. Tonnages and
average copper contents of each square involved appear in
Table 9. The curve for average copper values smooths out
localized irregularities and was prepared from figures in
Table 9 in the same manner as accompanying figures for
thickness; derivation of smoothed thicknesses of mineral-
ized sediment at each site is described in earlier pages.

Table 11. Metal values, ppm *

Bay

Site	Cu	Pb	Zn	Co	Mo	Cd	U
7	920	5	170	95	55		
3	910	53	230	70	52	.2	
4	850	30	140	85	·55	1	10
12	850	5	160	70	45		
2	880	8	170	55	35		
9	820	5	160	50	35		
13	870	5	160	75	48		
16	810	5	150	50	40		
19	730	20	160	32	20		
41	700	12	180	30	15		
Average	849	12	170	62	41		

Region

Site	Cu	Pb	Zn	Co	Mo	Cd	U
King R above Linda	28	36	54	13	5		14
Strahan beds	20	13	67	8	11		
Bay beds below ore	33	23	57	10	16		
Queen R, Q'town	2220	120	220	61	49		
King R below "	1290	101	245	47.5	50		13.5
Delta	1600						
Bay ore, measured	849	12	170	62	41		12
adjusted	875	12	175	60	42		12

* Maxima, 3-ft cores

ii   Delta ore

Contents of Cu, Pb, Zn, Co and Mo in delta ore
are based on Holb assays of mineralized sediment from
bay and river, adjusted to fit delta ore running an
average 1600 ppm Cu. The average copper value is founded
on several hundred core samples collected and analysed
by Mount Lyell.

iii   River ore

Cu, Pb, Zn, Co and Mo values for sediments in the
bed of the Queen-King river system are taken from Holb
analyses.

iv   Gold, silver

Gold and silver in the various categories of min-
eralized sediment have been calculated using the grade
of Mt Lyell ore as a starting point, and copper values
in ore, tails, river, delta and bay as a measure of dil-
ution taking place en route from the Lyell deposit to the
floor of Macquarie Harbour (Table 12). A shortcoming of
this technique is that it assumes copper, gold and silver
are transported, deposited, dissolved and precipitated
in the same way and at the same speed. The method's
chief advantage is that it provides at least a rough
estimate of gold and silver contents in a situation where
assay results are largely lacking and are difficult to
obtain because of the very small proportions and quantities
of these metals present in the mineralized sediments.

Table 12   Formation of △ ore

tails	River	Deposit
Au, ppm	Au, ppm	Au, ppm
0.095	0.524△	0.170△
0.104	0.524△	0.154*

* from March '85 samples

△ derived from March '85 samples.

Table 12. Formation of delta ore

Mt. Lyell production, 1898 - 1971

	Mtons	M tpa	Ore Cu	Ag	Au	Mtons	M tpa	Tails Cu	Ag	Au
tons,f.ozs	125.7	1.696	699,033*	16,644,477*	677,489*	120.5	1.628			
recovery, %	4.20		75	80	67	95.80				
ppm,in ground			7,415	5.38	0.268			1,933	1.12	0.095

Mt Lyell reserves** 1972 - 1985

tons,f.ozs	35.3	2.5	463,500	1,958,000	318,000	34.0	2.425	51,500	514,000	106,000
recovery, %	3.60		90	80	75	96.40				
ppm,in ground			14,600*	2.33*	0.400*			1,520	0.498	0.104

Dilution by King River system

	Mt	Tails M tpa	Cu,ppm	Mt	River M tpa	Cu,ppm	Mt	Deposit Mtpa	Cu,ppm
1898 - 1971	120.5	1.628	1933	25.4	0.343	28	145.9	1.971	1600
%Σ deposit	82.5			17.5			100		
1972 - 1985	34.0	2.425	1,520	4.81	0.343	28	38.81	2.77	1335
%Σ deposit	87.6			12.4			100		
			Ag,ppm			Ag,ppm[Δ]			Ag,ppm
1898 - 1971	120.5	1.628	1,120	25.4	0.343	0.05	145.9	1.971	0.92
%Σ deposit	82.5			17.5			100		
1972 -1985	34.0	2.425	0.498	4.81	0.343	0.05	38.81	2.77	0.45
%Σ deposit	87.6			12.4			100		
			Au,ppm			Au,ppm[Δ]			Au,ppm
1898 - 1971	120.5	1.68	0.095	25.4	0.343	0.004	145.9	1.971	0.079
%Σ deposit	82.5			17.5			100		
1972 - 1985	34.0	2.425	0.104	4.81	0.343	0.004	38.81	2.77	0.092
%Σ deposit	87.6			12.4			100		

* published: other figures estimated or derived
** proven: approximately 6 Mt similar grade probable & possible
Δ average crustal abundance

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Values derived in Table 12 for gold and silver

in bay ore are fairly similar to values calculated from

the few analyses available

	Ag, ppm	Au, ppm
From Table 12	0.51	0.044
From analyses	0.5-0.7	0.150

The lower figures, taken from the table, are the ones

used in the reserve estimates.

v   Tungsten,titanium, uranium, lithium

Contents of these metals in bay and river ore

are taken from Holb analyses. Contents in delta ore

are interpolated from those of river and bay ore.

Value   Dollar values of the various categories of ore based on

grade in the ground and on the average price of each component

metal over the last twelve months are presented in Table 13,

together with a summary giving the total worth of proven ore

in river, delta and bay reserves. Note that copper in the ore

accounts for about 60% of the overall value of proven reserves

and that seven-eighths of the total value of proven reserves is

contained in bay ore.

Individual values of some other metals included in the

total are small and alone would not warrant attention. However

they are likely to be concentrated up to extractable levels by

processes recovering copper and thus should be included in assess-

ing overall values of the mineralized sediments. We do not have

Table 13. Ore & reserve values

	Cu		Pb		Zn		Co		Mo	
$ / ton	1500		360		540		3333		4000	
¢ / lb	85		18		27		166		200	
ppm / ¢	5.8		28.0		18.5		3.0		2.5	
	ppm	cents	ppm	cents	ppm	cents	ppm	cents	ppm	cents
River ore	1265	218.6	130	4.6	245	13.2	55	18.3	50	20.0
Delta ore	1600	276.0	90	3.2	210	11.3	57	19.0	50	20.0
Bay ore	875	151.0	12	0.4	175	9.5	60	20.0	42	16.8
Wtd av.	987	170.4	25	0.9	181	9.8	59	19.7	47	18.8
Future ore*	1335	230.6	130	4.6	.245	13.2	55	18.3	50	20.0

	Ag		Au		Li		W		Ti	
$/ton (/t.o.)	2.50(t.o.)		100(t.o.)		18,000		4000		100	
¢ / lb					900		200		5	
ppm / ¢	0.133		0.0033		0.55		2.5		100	
	ppm	cents	ppm	cents	ppm	cents	ppm	cents	ppm	cents
River ore	0.45	3.4	0.083	24.9	13	23.6	50	20.0	3000	30.0
Delta ore	0.92	6.9	0.079	23.6	13	23.6	50	20.0	3000	30.0
Bay ore	0.51	3.8	0.044	13.2	12	21.8	30	12.0	3000	30.0
Wtd av.	0.56	4.2	0.050	15.0	12	21.8	33	13.2	3000	30.0
Future ore*	0.44	3.3	0.092	27.6	13	23.6	50	20.0	3000	30.0

	M tons	% tons	$/ton**	%exCu	M $	% $
River ore	2.41	2.50	3.766	58.0	9.080	3.2
Delta ore	12.60	13.50	4.336	63.5	54.600	19.3
Bay ore	79.10	84.00	2.785	53.6	220.000	87.5
Total	94.11	100.00			283.680	100.0
Average			3.04	59.6		
Future,per year	2.77		3.912	59.0	10.83	3.8
25 years	69.25		3.912		271.00	95.6

* at King River Mouth

** excluding value of Se, Te, Sb, & S

090 enough information yet to evaluate selenium, antimony and sulfur contents of the sediments. These contents should prove of sufficient magnitude in concentrates of the sediment to increase its total value above levels given in Table 13.

Grade, quantity and value of proven ore arrived at in preceeding pages may be compared in Table 14 with corresponding figures of the two earlier estimates. The latter two were sent to participants and backers in October '73 and April '74 respectively. The first set is based on reconnaissance data only, a fact emphasized when the material was distributed. The second set represents a preliminary evaluation of Phase II data, prepared at the close of fieldwork. The current set of figures is based on additional data and on a far more comprehensive analysis of the material.

Total ore reserves   Total ore reserves include probable and possible ore as well as proven ore. Total reserves are presented in Table 15.

i   Probable ore

Two bodies of mineralized sediment likely to be included in the total mass available for dredging are the body representing the difference between Holb and Mt Lyell estimates of ore in the delta, and the body of river-diluted mine tailings expected to accumulate over the next five years.

Close spaced drilling on the King River delta undertaken by Mt Lyell in 1972 yielded over 470 samples

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Table 14.   Reserve estimates

Grades, ppm

	Cu	Pb	Zn	Co	Mo	Ag	Au	U	W	Ti
1 Oct,'73	830	62	190	66	38	0.53		10		
6 Apr,'74	819	20	160	62	41	0.66		10		
15 Jul,'74	987	25	181	59	47	0.56	0.050	12	33	3,000

Tonnage & value

	yd	Myd^2	Myd^3	t/yd^3	Mtons	$/ton	M $
1 Oct,'73	3.00	46.5	139.5	1.33	1 87	1.86	348
6 Apr,'74	1.42	43.0	61.0	1.55	94.4	2.065	192
15 Jul,'74	1.38	74.19	102.8	0.92	94.11	3.04	283.5

and permitted the Company to make a reliable estimate of the quantity of pyrite available. The reports of this enterprise put the reserve at 300,000 tons of pyrite in the upper five feet of exposed parts of the delta. The average content of pyrite present is 5% by weight. On this basis the quantity of sediment involved is 6,000,000 tons. As some drill holes went to depths of 20 feet without reaching the base of the sediments the probable quantity involved is at least 4x6 Mt, or 24,000,000 tons. Taking into account submerged parts of the delta, the figure may be increased by a minimum of 25%, raising the safe total to 30,000,000 tons. Proven reserves established by Holb include 12,700,000 tons of this total, leaving a balance of 17,300,000 for inclusion in probable reserves.

The grade and quantity of mine tailings likely to enter the Queen-King river system over the next five years may be estimated if ore grades currently worked and on reserve at Mt Lyell are known, together with production rates and metal recoveries. These figures are available and have been used in Table 13 to account for copper values measured in river, delta and bay ore, to estimate likely contents of silver and gold in these three categories of material, and to predict the grade and quantity of mineralized sediment expected to be released into Macquarie Harbour in future. The Table 12 also shows the proportion of river sediment added to tailings in their passage to the sea. Additional

Table 15.   Total ore reserves

	Cu,ppm	M tons	$/ton	M $
Proven				
ex production, 1898-1973	987	94.11	3.04	283.5
Probable				
ex production[1],1898-1973	1600	17.3	4.336	74.9
ex reserves[2], 1974-1978	1335	13.8	3.912	54.1
		31.1	4.14	129
Possible				
ex production[3],1898-1973	875[4]	~~141.2~~ *26.2*	2.785	390.5
ex reserves[5], 1979-1987 1/2	1335	26.3	3.912	102.8
		~~167~~ *52.5*	2.95	493.3

[1] difference between Mt Lyell & Holb estimate of delta ore body.

[2] Mt Lyell & King R discharge at current rates for 5 years.

[3] difference between calculated discharge & total in proven & probable reserves.

[4] scaled from 1600 ppm down to bay grade by adding 85% bay sediment.

[5] discharge from mining balance of Mt Lyell's published reserves; 9.5 yrs supply.

dilution by bay sediment can be calculated in the same way.

Five years' future supply of mine tailings is considered safe because Mt Lyell's defined reserves are sufficient for 14 1/2 years' operation at the present production rate. Even if conservation pressures mount, it is unlikely that Mt Lyell would be compelled by the Reece government to alter its dumping practise. It is improbable that Mt Lyell will do so voluntarily or that it will be able to reduce tailings grades much further within five years' time.

ii   Possible ore

This class of reserve comprises the river-diluted tailings which would result from mining that fraction of Mt Lyell's present reserves not included in probable reserves, and it comprises that fraction of mineralized sediment derived from all past mining operations which is not included in proven and probable classes of reserve.

The first of these two types of possible ore is based on an additional 9 1/2 years' tailings discharge at present production and recovery rates. Grade and quantity of tailings involved is fairly definite, for the reserves have been blocked out and recovery rates are high already. It is doubtful whether today's recoveries could be improved substantially without large expenditure, which for the time being is better devoted to mine and plant expansion and to defining new reserves.

Additional ore reserves almost certainly will be found and will increase eventual tailings production further. The major uncertainty in considering either the 9 1/2 years' tailings discharge or any subsequent discharge is that concerning the future legality of river dumping.

Possible ore of the second variety includes material which should exist in the delta between twenty feet below sea level and its base at an estimated sixty to ninety feet below sea level, plus bay material found in channels beneath the sheet-like body and in mineralized parts of the Harbour beyond its northern quarter. Ore near the Harbour's present entrance and in the drowned lower reaches or canyon head of the King River falls in this class, together with that found in southeastern parts of the Harbour near the Bradden River. This last concentration is of uncertain origin, though its grade suggests that it is simply a southern extension of mineralization affecting northern parts of the Harbour.

Summary   Proven and probable ore reserves total over 135,000,000 cubic yards of mineralized material currently worth some $3 per cubic yard, or a total of over $400,000,000 in place.

The total deposit is equivalent to an oil pool of about one - to two-hundred million barrels, priced at the former standard of $4/bbl, or to a porphyry copper deposit. The Macquarie body is about one-sixth the grade of the average porphyry in terms of copper equivalent, but contains two to four times the ore, is free of overburden, unconsolidated and is pre-milled and wetted.

These factors offset and ultimately may prove to outweigh the grade disadvantage.

6.2 Brine

Existence   Data regarding brine inferred to exist within Macquarie Harbour appear in Table 16. Although dispersion characteristics, solubilities and geochemical considerations regarding most of the elements in question support the contention that they occur chiefly in solution, it should be emphasized again that their presence primarily as brine is deduced from analyses of dried samples of bay floor sediment, not from analyses of probable host waters which permeate and presumably overlie such sediment. Likely existence of mineralized brine emerged after the close of fieldwork, during a search for elements other than target metals perhaps concentrated in Macquarie sediment. Thorough sampling and direct analysis of pore and overlying waters await further fieldwork. Limited confirmation of the composition of the pore fluid is possible pro tem by analysing sample Holb 388, re-*p*resenting water drained from composite specimens of bay sediment.

Chemistry   Partial composition of the inferred brine appears at line 5, Table 16. This assumes the bulk of uranium and arsenic measured occur in solution. Contents of sodium, potassium, magnesium, chlorine and other elements generally concentrated in brine have not been determined yet. Comparing values for elements detected with those in fully analysed brines suggests that brine of

Table 16. Brine data

	U	Li	I	Br	B	As	K	Na	Mg	Σ
Average bay content	12	140	27	145	160	33				
Av content, N Bay[1]	12	200	30	220	190	40				
Estimated content, seds.	1	10	1	5	#5	1				
Evaporate content, N.Bay	11	190	29	215	185	39				
Brine content,[2] N Bay	13	224	34	253	218	46				

Oilfield waters dominated by sodium chloride[3] & other brines

	U	Li	I	Br	B	As	K	Na	Mg	Σ
Tiszakurt field,Hungary[3]		84	2.1	22	89	5.8	89	4,930	22	14,200
Cymric field,Cal. U.S.A.[3]		4.3	23	30	140	0	132	5,820	115	17,100
Searles Lake,Cal.U.S.A		81	29	860	3,380	198	26,000	110,000	–	336,000
Michigan Basin, U.S.A.		70	–	2,910	380	?	9,120	22,500	9,960	331,000
Av content of earth's crust	2	30	0.3	3	3	2				
Av content of seawater	.002	.01	0.5	65	4.6	.024				
N. Bay Brine										
Conc. relative to crust	6.5	7.5	113	88	73	23				
Conc. relative to seawater	6,500	2,240	680	4	47	1,920				
'73 values: ppm/cent	0.55	9	2.5	25	16.7					
N. Bay Brine, cents/ton	24	25	13	10	13					85

Assuming 0.55 tons brine per yd^3 average N bay sediment below ore zone & assuming 85% solids recovery,value of U,Li,I,Br, & B recoverable is 40 cents per yd^3

[1] below ore zone
[2] for sediment running 46% brine by weight, in place
[3] page F 30, Data of Geochemistry

Macquarie Harbour is akin to oilfield water dominated by sodium chloride. If this resemblance is correct then the Macquarie waters should have the following approximate contents, expressed in parts per million:

Mg	100
Na	6,000
K	150
Cl	9,500
Dissolved solids	17,000

Water of this composition represents a 50:50 mixture of fresh water and seawater, except that the magnesium content is six times lower than it would be in such a mixture. Sample 388 tastes less salty than seawater.

It is not known whether the composition of pore water in surficial sediment of Macquarie Harbour is the same as that of overlying water, but as some of the sediment sampled was deposited as recently as this century and as overlying waters seem essentially stationary and cut off from surface circulation there is little reason why the deep water should differ appreciably in composition from immediately underlying water permeating sediment. Indeed, water below the upper, brackish layer, 5 to 7 fathoms thick, is known to be saline because of the prominent reflections from its top surface picked up by electric sounding equipment. The density increase is too large to result from the small temperature drop recorded across this interface and thus can only relate to a significant rise in salinity.

<u>Value</u>   Existence of the inferred brine is important from two

standpoints. First, such a brine might well prove toxic to most

marine and fresh water organisms. If fact, this will be needed

when discussing with the Mines Department environmental effects

of dredging. Second, the inferred brine may prove valuable

commercially. This aspect is likely to depend chiefly upon the

state in which uranium detected in the dried sediment is found

to exist in the bay. If uranium is mainly in solution, as appears

likely, the concentration observed should prove great enough to

allow profitable extraction of the metal. A process was developed

a few years ago in Britain allegedly capable of recovering traces

of uranium from solution economically. If the uranium were worked

then further concentration of some of the lithium, iodine, boron,

bromine and perhaps potassium might result, justifying their ex-

traction as by-products. Uranium was the only one of these

elements produced in Australia at June, 1969. It is questionable

whether any of the other elements would be worth extracting without

benefit of the uranium.

Figures in Table 16 refer principally to brine inferred to

exist in sediment flooring the ore zone in the northern part of

Macquarie Harbour. This is the material most likely to be de-

veloped, because of its proximity to copper bearing sediment.

Values found in sediment from the rest of the Harbour are not much

lower; such sediment appears to contain about the same amount of

uranium and roughly 75% the content of each of the other elements.

Sediment in the ore zone yielded smaller concentrations of Li, I,

Br and B but not much less uranium. Pore water from the ore zone

may contain recoverable concentrations of target metals as well.

Quantities   Quantities of pore and overlying waters in Macquarie Harbour are large. Saline waters found below the 5 to 7 fathom interface blanket about two-thirds of the Harbour and extend down to 30 fathoms. If the average depth of the Harbour floor is 14 fathoms and the top of the body is put at a depth of 7 fathoms, then the quantity of this water is 7 fathoms x 80 square miles, that is, (80 x 3.1 x 7 x 2) million cubic yards, say 3,500 million cubic yards or about 3,000 million tons. If this water does run 12 ppm uranium as anticipated, it contains 36,000 tons of the metal, worth about $650,000,000 in place.

Pore water in silt underlying copper bearing sediments which cover the northern quarter of Macquarie Harbour appears to be worth at least 85 cents per ton in the ground. This reduces to a minimum of 45 cents per cubic yard in sediment of the density and porosity of bay material. Assuming that 18 square miles of mineralized and dredgable bottom lie below the 5 to 7 fathom interface in the Harbour's northern quarter and assuming that a layer of silt four yards thick is classed as a reserve, the value of U, Li, I, Br and B it contains in pore water should prove to be approximately $(18 x 3.1 x 4 x 0.4) M, that is, about $89,000,000.

The value of Li, I, Br and B in pore water of the overlying layer of mineralized sediment should be about $(18 x 3.1 x 1.25 x 0.125) M., that is, about $8,750,000. Metals dissolved in such pore water should increase its value further.

The value of the latter four elements, plus uranium, in pore

waters permeating the upper four yards of silt across all parts of the bay floor deeper than 7 fathoms is about $400,000,000. This layer was cored during Phase II. The sediment probably is thicker than four yards. There is no apparent reason why values of the upper four yards should not extend downwards. The value assigned to the layer is established by analysis and will stand, even if uranium or any of the brine elements turn out to be present in solid rather than dissolved form.

6.3 Other reserves

Sand   Sand reserves within EL 16/73 are substantial. Beach and dune materials extend down the northwestern part of the licence from the vicinity of the mouth of the Little Henty River to the entrance of Macquarie Harbour, a distance of 16 miles. The belt is at least 1 1/2 miles wide. Sand extends from below sea level to a maximum elevation in excess of 100 ft above sea level. Much of the sand is unconsolidated; some of it is dry. Assuming an average thickness of 20 yards and a dry density of one ton per cubic yard in place, exposed portions of the reserve embrace between one and two billion tons of sand.

Submerged but accessible sand reserves occur within Macquarie Harbour south and north of the entrance channel and along the eastern side of the spit between the channel and Strahan. This sunken reserve comprises about 200,000,000 tons of material, assuming the sand has an average thickness of at least 15 feet and has the same dry density in place as sand in the exposed reserve.

Previous investigations have shown sand on the seaward side of the spit to be titaniferous and to carry small amounts of tin, zirconium and chromium. Heavy minerals containing these elements should be concentrated within the bay near its entrance, an area swept by currents reaching six to nine knots. Beyond the Harbour, heavy minerals should be concentrated near the Little Henty River. Much of the sand in the beach and dune belt is believed to have reached the sea via the Little Henty. If this is correct and grain sizes of heavy minerals in the sand are similar to grain sizes of other fractions, the south setting inshore current and the average angle of wave attack should have combined to produce the predicted partitioning. Neither of these two targets has been examined, either by Holb or in earlier studies.

Bay silt   Mineralized sediment from which metal bearing fractions have been removed, or underlying sediment dredged and de-watered to yield mineralized pore waters might prove suitable as soil, or for manufacture of bricks. Iodine and other trace elements in the sediment, together with its relatively high content of organic matter, may give it special value as soil. In firing such sediment the organic matter should burn and reduce the amount of fuel needed. A source of soil could be useful in the Strahan region, where much of the land is surfaced by quartzitic sand. Soil that does exist is generally thin and acid. Large areas of flat land are available and rainfall is high. Dredge wastes could be pumped to these areas.

Sub-surface   Thickness and structure of the Tertiary section in
Macquarie graben deserve measurement.   In publications on the
geology of Tasmania the section is assigned a thickness of 800
feet, but it is not clear when or how this was established.   The
figure smacks rather of those solitary observations which are
passed for years from one text to another.   No seismic work or
drilling has been undertaken on which such a figure might be based.
Differences in Paleozoic and Precambrian sections abutting north-
ern and southern shores of the Harbour appear to me to indicate
a throw across Harbour faults of several thousand feet at least:
if this proves the case, the graben section may well be thicker
than formerly supposed, and perhaps Mesozoic in part.   Such a
section could contain gas or petroleum.   The graben lies on a
continental margin and follows a geosynclinal trend first man-
ifested as early as the Cambrian.   Oil and gas are recovered from
the Tertiary / pre-Tertiary section in Bass Strait, about 200
mile northeast of Macquarie Harbour.

7.0   BENEFICIATION

Objectives   Having established that large quantities of metals
exist in dredgable sediment of Macquarie Harbour, the next task
is to find how they can be removed from such silt fast and econom-
ically.   This would involve recovering about 75% of the quantity
of each target metal present in the silt. Wet silt would be ex-
tracted at the rate of approximately 45,000 cubic yards per day.
Costs of the operation should not exceed a total of $1.25 per
cubic yard of wet silt. Two basic steps are envisaged.

First, a rough concentrate comprising say 20% of the total
sediment raised should be formed on board dredges, as extraction
proceeds; about 11 cubic yards of silt would be extracted per
minute by each unit of a 3-dredge operation. Rough concentration
would permit 80% of the sediment raised to be piped directly back
to the bay floor, considerably reducing the quantity to be pumped to
separating plant ashore. Ideally, shipboard concentration should
be effected by gravity or other mechanical means. Chemical meth-
ods are undesirable on board because in general they call for
larger, costlier plant (conditioners, agitators, holding tanks, etc.)
and they increase risks of contaminating surrounding waters. The
rough concentrate should retain approximately 85% of each target
metal. Metal grades in this concentrate would be about 4 1/4 times
grades in raw silt.

In the second step, rough concentrate should be taken ashore,
upgraded further, and its metals extracted. Allowing 5 cents per
cubic yard to cover the cost of raising wet silt, and 20 cents per

cubic yard of silt to cover costs of producing the rough con-
centrate, the sum available for these subsequent stages of treat-
ment would be $5.00 per cubic yard of rough concentrate. Overall
recovery rates for such stages should be $(\frac{75}{85} \times 100)$%, that is,
approximately 87%. Total throughput from 3 dredges would be
about 9,000 cubic yards per day.

The prime goal in meeting these objectives is to find
methods capable of yielding specified recoveries at the process-
ing rates anticipated. The cost goal is perhaps best regarded
as a separate objective. In searching for suitable methods of
concentration, ways of concentrating barren fractions of the silt
should be considered, as well as ways of concentrating pay fract-
ions. Either approach would permit gangue to be separated from
mineralized material.

Responsibility, Tests   The Holb group initiated a preliminary
beneficiation test after the close of Phase I. The test was run
by Amdel. At the planning conference in November, 1973, Cities
undertook to assume responsibility for beneficiation studies to
be conducted during Phase II, and decided to award the work to
Hazen Research of Denver. No work had been begun by mid-May, 1974,
so Holb offered to assist and requested that part of the study be
carried out by Colorado School of Mines Research Institute. This
was agreed to.

The Research Institute submitted its initial findings in
a three-page letter report, containing four tables, at 30 May,
on schedule. The Institute was asked to expand the study. It

Table 17. Heavy liquid concentration; Phase I composite sample*. Separation
& analyses by Amdel.

Fraction	Wt%	Analytical method	Values in parts per million					
			Cu	Pb	Zn	Co	Mo	Ag
Float	96.05	AAS	390	48	120	10	8	<.1
Sink	3.95	Semiquant. emmission spec.	2000	200	1000	500	400	5
Head	100	Calculated from sink/float values	454	54	155	30	24	<.3

Metal Distribution	Values in weight per cent					
	Cu	Pb	Zn	Co	Mo	Ag
Float	82	85	74	32	32	<33
Sink	18	15	26	68	68	>67

*Composite of sample Holb 12,13,15,16,17,18,19,22,23,24,25,26,27
28, 31, 32, 33, 34, 35, 36, 37 & 38
from surface of bay floor below 10 fathoms. Slime fraction
of unspecified weight per cent decanted and not included in
test. Separation made in liquid of SG 3.8.

completed labwork a month afterward, again on time. Results

arrived three weeks later in a 25-page report, illustrated by

25 tables. By late July Hazen's findings are still not to hand.

Test results appear in Appendix G and are discussed briefly

below.

7.1 Australia

<u>Amdel testing</u>   Microscopy carried out by Holb in Phase I in-

dicated that most of each of the metals present in Macquarie silt

is likely to occur in sulfides and on surfaces of sulfide grains.

Amdel was commissioned to test the idea by analysing a sulfide

concentrate prepared from a composite sample of Macquarie silt.

It was requested that the concentrate be obtained by floating off

all particles of SG 3.8 or less. Results of this test are given

in Table 17.

Amdel did not include the slime fraction of the composite

in the test and, as the total amount of sample was small, was

not able to analyse metal values in the concentrate by AAS

techniques but only by emission spectroscopy, which is less

accurate. Although these two considerations reduce the degree

of precision which may be attached to the results, the test clearly

upholds the basic contention that metals are significantly con-
centrated in the sulfide fraction of the silt. The test shows
that in a concentrate containing one-twenty sixth the bulk of
the sample, copper, lead and zinc values are increased fourfold
to sixfold, and values of cobalt, molybdenum and silver are in-
creased sixteenfold. The concentrates recovered are estimated
to contain 15% to 26% of the first three elements and an esti-
mated 68% of the latter three.

Probably, this means that the bulk of the sample's silver,
molybdenum and cobalt occur in pyrite, and that pyrite constitutes
about two-thirds the weight of the concentrate. The remaining
third is expected to be composed mainly of magnetite and ilmenite,
which in subsequent tests could be removed magnetically. Copper,
lead and zinc presumably occur partly in sulfides of these metals,
sulfides which should prove to comprise one-seventh to one-fourth
of the concentrate by weight, and partly in lower density fract-
ions of the silt. Copper, lead and zinc of the latter category
should be

- adsorped on clays
- in organo-metallic complexes
- in solution
- in fine grained sulfide mixed with gangue

Phase I microscopy indicated that some 10% of the silt by
weight is composed of opaque minerals. If two-thirds or 6.7% of
the total sample is pyritic as suggested by observation above,
then pyrite in the concentrate, totalling an estimated 2.7% of
the sample weight, represents about 40% of the sample's total
content of pyrite.

<u>Mt Lyell flotation</u>   Additional information on concentrates
produced from Lyell/ Macquarie material is presented in Table 18.
Data on concentrates prepared from mineralized sediment of the
King River delta are based on the assumption that the head samples
used in the three tests averaged 1600 ppm in copper content.
Knowing grades of copper and cobalt in the concentrate,it was
then possible to calculate proportions of concentrate and tail
and to derive tailings grades and percentage recoveries of copper
and cobalt. Flotation figures taken from 1971 mine production
at Mount Lyell are given for comparison in the lower half of the
table.

In summary, flotation tests on delta sediment show that a
concentrate comprising one-thirtieth the weight of the sediment
contains slightly more than one-fifth of its copper and one-third
of its cobalt. Probably it contains a good deal more than one-
third of the cobalt because the derived head value of 94 ppm Co
is considerably more than the 57 ppm Co value for delta ore
arrived at elsewhere in this report. If the latter value is sub-
stituted for the derived head value, then the fraction of total
cobalt recovered in the concentrate becomes 61%. This cobalt
recovery and the copper recovery cited above correspond closely
to those obtained in the sink fraction of Holb's heavy liquid
separation.

If all cobalt in the concentrate occurs in pyrite and all
pyrite in the concentrate is cobaltiferous, then the concentrate
contains about 2% pyrite, or some 40% of the average delta sample's
total content of pyrite.

Table 18. Mount Lyell flotation

Material	Fraction	Wt%	Pyrite ppm	Wt%	Copper ppm	Wt%	Cobalt ppm	Wt%	Silver ppm	Wt%	Gold ppm	Wt%
Sediment,	(Head	100			1,600	100	94	100				
King R. delta;	(Con	3.3			10,600	22	1,058	37				
av. 3 samples	(Tail	96.7			1,300	78	61	63				
Total Ore,	(Head	100			10,290	100			2	100	0.4	100
1971 mine	(Con	3.56			256,000	89.19			41	75	5.1	47
production	(Tail	96.44			802	10.81			0.52	25	o.22	53

<u>Mines Department testing</u>   The metallurgical labs of the
Tasmanian Mines Department have agreed to investigate possibilities
of upgrading Macquarie silt and have been given appropiate samples
and analytical data. As there is no charge for this service it
is run according to the Department's own schedule. So far, no
results have been received from Mines.

A study believed to have been undertaken by the Mines Lab-
oratories succeeded in recovering quite high percentages of finely
divided pyrite from a Precambrian carbonaceous shale exposed at
Port Sorrell. Jennings and Noldart (1967, p. 60) summarize the
research thus:

> "_ _ _. The pyrite is mostly very fine grained with much
> of it in the size range 2-10 microns. Beneficiation tests
> indicate that a concentrate containing about 46% sulfur with
> a recovery of 52.5 per cent can be obtained by flotation
> methods. For a lower grade concentrate of about 40% sulfur
> the recovery would be increased to 65 to 70 per cent."

The ore is said to contain more than 10% sulfur (that is, about
19% pyrite).

7.2   North America

<u>CSMRI report</u>   Results of the study arrived too late to be re-
viewed in detail. They may be reported upon later, under separate
cover. Only salient features of the study will be discussed here.

Work was conducted on a composite sample made up of equal
weights of a sample from Site 3 and another from Site 5, two
stations lying short distances away from the King delta. Contents

of several metals in the composite were determined. Thereafter, the investigation was confined to a study of the way in which copper is distributed in the composite material and the way copper bearing fractions of the sample respond to various beneficiation techniques.

About half the sample consists of coarse silt and of coarser material in the sand size range. A third of the sample consists of very fine silt and of finer grained particles in the clay size range. Copper is distributed rather evenly between all size fractions.

CSMRI experimented with six basic methods of upgrading the ore, four mechanical and two chemical. Five of the methods yielded concentrates. None of the concentrates meets target specifications.

Flotation and cold acid leaching are the two methods yielding concentrates which come closest to some of the specifications, but the gap is still considerable, and the methods are unsuitable in being chemical rather than mechanical.

The Super Panner test gives results of correct proportion if incorrect scale. If the copper recovery reported in this test would scale up proportionally upon increasing the percentage of concentrate produced, the method would yield a rough concentrate of approximately the dimensions required, thus:

	Wt %	% Cu recovery
test result	6.4	20.1
scaled up	25	80

The heavy liquid separation was made in liquid of SG 2.98, in response to Holb's request for a cut in the vicinity of SG 3.0.

The result, ~~seven~~ *five*-thirtyfifths of the sample weight containing
~~twentyone~~ *fourteen*-thirtyfifths of the copper, strengthens the deduction

made from results of Holb's previous heavy liquid separation,

namely that a considerable fraction of the copper occurs in or on

low density material. This well may prove to be the fraction of

the copper extracted by acid leaching.

Neither cyclosizer nor hydrosizer proves able to concentrate

copper bearing fractions of the sediment significantly.

In review, CSMRI results show that

- some of the copper occurs in sulfides and possibly

  in other heavy materials

- some of the copper occurs in non sulfide fractions

  and in minerals other than heavy minerals

- some of the copper occurs in acid-soluble state

This picture of the varied way in which copper is distributed.

in Macquarie sediment endorses the view arrived at from analysis

of Tables 17 and 18. No single method of concentration is likely

to be able to recover all of these various forms of copper. On the

other hand, a combination of methods, each designed to tap a sep-

arate form of copper occurrence, should permit overall recovery

of target specifications to be realized. An appropriate combination

of methods can be designed as soon the mineralogy of the sediment

and the distribution of the copper throughout component fractions

of the sediment have been unravelled. Such study must include

analysis of water samples held by Cities.

HRI report   The investigation is still not complete, according to

Hazen's letter on the subject, consequently there is little to be

reviewed here. It is worth noting that Hazen finds an average 30% of the samples to be acid soluble, supporting CSMRI's observation. Hazen reports copper to be distributed evenly through all size fractions of the sample and finds the bulk of the sample to be composed of coarse silt and coarser material and of very fine silt and finer material, again confirming CSMRI's discoveries. Hazen ran several flotation tests with results similar to those obtained by CSMRI. Hazen proposes to carry out further flotation work.

<u>Lakefield Research Inc., Canada</u>   Cities has commissioned Lakefield Research to conduct beneficiation studies. It appears that once again the emphasis will be on flotation procedures. It is pointed elsewhere in this report that flotation methods are too slow and dirty for ship-board use and probably are too expensive. They may have limited application ashore in later stages of processing, but the prime objective still is development of a method which will yield a rough concentrate at the dredge head.

Additional flotation tests conducted by Lakefield, Hazen or any other lab remain a waste of time, effort and money until we know how the copper is distributed. No refinement of sulfide flotation will increase copper recoveries if, say, 40% of the copper is in brine and trapped by organic matter and clays.

8.0   FUTURE INVESTIGATIONS

It was intended originally that if Phase II results were satisfactory, we would proceed direct to a third phase of investigation in which mining and processing were to be conducted at pilot plant scale (Appendix H). Phase II studies defined ore reserves of sufficient volume and grade to warrant advancing to Phase III, but not enough work has been done yet in finding applicable separatory procedures to allow us to say whether metals present in the ore reserves can be extracted economically. It is unwise to proceed to Phase III while this uncertainty exists. Phase II should be extended as Phase II-A to allow the matter to be resolved. Some of the tasks scheduled for Phase III may be transferred to Phase II-A. The program for Phase II-A (Appendix H) is described below.

8.1   Macquarie program

Agreement   An addendum to the existing agreement between Holb and Cities should be drawn up to cover Phase II-A. It should be ensured that adequate funds are available for the program. A sizable fraction of these funds should be available in advance.

The buffer fund agreed to for Phase II but never established must come into existence at the start of Phase II-A to ensure that it is not again necessary to sustain operations with Holb funds while awaiting cash replenishments.

Provision also should be made in the addendum to ensure that Cities accept only that part of the Phase II-A program which

it has time to handle. Once Cities has accepted such respons-
ibilities they should be discharged properly.

It is further essential that in Phase II-A Cities meet
obligations of the Agreement regarding prompt exchange of data.
In Phase II Holb adhered to its side of the program punctiliously
but had considerable difficulty in extracting information from
Cities. This occured in cases of preliminary AAS analyses, pre-
liminary X-ray information, the Hazen report and that of time spent
on the project by Cities. None of these data was contributed
voluntarily, as provided for in the Agreement. Information on
time devoted to the program is needed monthly for inclusion in
reports to Mines. By including Cities' time we meet work com-
mitments faster and for lower cash outlay.

Licences   To retain licences we are committed to spend an
additional $30,000 to $40,000 by the end of 1974. Thereafter
through Phase II-A, expenditure of approximately $66,000 per half
year will be called for to ensure that we retain the licences.
We must continue to report to Mines each month on progress and
expenditure. Also, quarterly returns are required by Mines.
Another return concerning the licences is submitted to the Common-
wealth Statistician annually. Mines should be advised of the
delay in commencing Phase III and of the Phase II-A program temp-
orarily substituted for it. The licences will require renewal
in December, 1974. Less interesting fractions of the larger
licence should be relinquished during the current or forthcoming
licence period. This will demonstrate that exploration is pro-
gressing.

Transfer of title proposed for Phase III had best be postponed until a company is formed. No such company is needed until Phase III begins. Moves toward incorporation of a suitable vehicle may be initiated in the latter part of the program if Phase II-A advances successfully.

Backing   If results available before Phase II-A is completed are encouraging, it may be worth beginning a hunt for additional Australian participation at that time. The larger mining companies established in the area would be useful allies. E Z Industries (Electrolytic Zinc) is a prime candidate. It would be politic to have Mt Lyell or its parent, Goldfields of Australia, as minority participants at least. Northwest Acids operated jointly by E Z and Mt Lyell is another possible venturer, and one which perhaps could use any surplus pyrite ever produced from Macquarie Harbour. Cleveland Tin, another local group, would qualify because of its Australian ownership (Aberfoyle) and perhaps because of its expertise in recovering fine grained copper sulfides. Imperial Chemical Industries (Australia), Colonial Sugar Refiners and other Australian companies producing chemicals comprise an additional collection of potential partners.

Fieldwork   Bulk samples of mineralized sediment from Macquarie Harbour are needed for further processing studies.

Pore water of the mineralized sediments and bay water both above and below seven fathoms all require sampling.

Possibly, limited sampling of submerged and exposed sand deposits at Macquarie Harbour may be undertaken.

Some bathymetry is required in the northern part of the Harbour.

Chemistry, Mineralogy   Standard silicate analyses of Harbour sediment and mineralized silt are needed, together with AAS analyses of the various categories of water to be collected. Cursory information is required on the distribution of Se, Ge, Te, Hg and Cl in Harbour materials. More data are needed regarding contents of U, Ag, Au, W, Ti and Li in these materials.

Requirements in the mineralogical field cannot be determined until the Amdel study, commissioned recently, has been completed and examined. The occurence of any undissolved uranium which might be found in Harbour sediments is a likely subject for such investigation.

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Beneficiation   Studies in this field constitute the most important part of Phase II-A.

It is recommended that numerous independent investigations of the problem be initiated. Some should be conducted by Amdel, the Tasmanian Mines Department and other groups oriented toward research and consulting. Additional studies should be made by manufacturers of separatory equipment, and by chemical companies making frothers, depressants, scavengers, flocculants, activators, acids, heavy media, ion exchange resins and other products used in mineral processing and similar activities. Such manufacturers have a direct interest in any operation potentially capable of using large quantities of plant or chemical they supply, and consequently will often undertake investigations of the kind needed with greater speed and purpose and at lower cost than most consultants will. Also, a producer of cyclones, flotants, or similar items generally has a better idea of their capabilities and of the state of the relevant art than consultants do.

Some overlap and duplication is desirable in commissioning processing studies, particularly in early stages of the enquiry before possibilities have been narrowed to the more promising methods and investigators.

Attention should be focussed not only upon ore dressing and mineral recovery procedures, but also upon technology perhaps available in other sectors of industry, especially in sectors concerned with handling large volumes of fine grained material such as ash, coal dust, clay, flour, carbon black, fertilizer. Industries treating slurries, sludge, industrial waste and

materials from which trace quantities of impurity require to be removed are another class worth examining. Densely populated, highly industrialized countries lacking extensive mineral resources, for example Japan and West Germany, are likely to have the best developed technologies for treating either wastes or low grade ores.

Data should be gathered on techniques used for economic recovery of very finely divided mineral particles, for instance, the gold extracted at Carlin, Nevada, or copper and tin recovered at Mount Cleveland, Tasmania.

In considering treatment processes for Macquarie ore it is wise to aim initially for fairly high recovery rates. At the same time, it should be borne in mind that with a large volume of ore capable of being extracted at unusually low cost, considerably lower recoveries could well prove economically attractive. An alternative is to restrict interest to relatively high grade fractions of the deposit. Apart from the grade gain involved, these fractions are coarser grained than lower grade material and should prove easier and thus less expensive to treat.

Beneficiation studies should include an examination of the methods and economics of recovering valuable elements from the inferred brine.

Site, dredge and plant investigations   Phase III was to have included preliminary design and cost studies concerning dredges and processing plant. Also, a plant site was to have been selected. If results of beneficiation tests are encouraging these activities should be begun in Phase II-A.

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<u>Schedule and budget</u>   Cities has requested that Phase II be
extended by eighteen months to allow the search for acceptable
ways of recovering metals from Macquarie silt to be concluded.
Such a program should run in six-monthly periods, corresponding
to licencing periods, thus:

> Phase II-A   29 June to 28 December, 1974
>
> II-B   29 December to 28 June, 1975
>
> II-C   29 June to 28 December, 1975

If successful recovery methods can be perfected in Phase II-A
or II-B, the subsequent phase or phases would be replaced by Phase III.

We obtained licence renewals covering the period of Phase II-A
from the Mines Department for a commitment of $66,000. It would
be difficult to secure further renewals at substantially lower
rates, thus the total sum earmarked for a full eighteen months'
work should be approximately $200,000. Quite apart from this con-
sideration, it would be unrealistic to suppose that one could
obtain a new process for much less than this. Several million
dollars were spent in cracking the problem of gold recovery at
Carlin for example.

A likely schedule for Phase II-A is presented below, with
budget. Similar details for Phases II-B and II-C will be devised
later, if extensions prove necessary.

II-A schedule:

July   Plan. Fund. Modify Agreement.

August   Initiate bench testing. Modify proposal to Mines.

September   Bulk and water sampling, Tasmania. Bench testing.

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October   Assaying. Commission bulk tests.

November   Bulk tests. Obtain report.

December   Review progress. Renew licence. Select

              Phase III or II-B, or stop.

II-A budget:

Fees, internal	US $ 18,000
Travel	10,000
Office	1,000
Equipment	2,000
Services	25,000
Contingencies	10,000
Total	66,000 *

* excluding time and services contributed by Cities.

8.2 Other areas

A quick reconnaissance should be made of the most likely targets of Macquarie type existing elsewhere. They might prove to contain coarser sulfide than the Macquarie deposit or to be more mineralized.

Regions of the world probably containing concentrations of such deposits have been outlined by Harvey (1968). British Columbia, Alaska, Mexico, Norway, Iceland and Spitzbergen contain many of the more promising areas. Targets of maximum potential may be selected by comparing merits of individual areas within these regions.

It will be difficult to develop beneficiation techniques

for Macquarie ore without alerting other groups to the potential-ities of deposits of this class, therefore it is important to examine other areas which may contain such deposits soon. We should attempt to sample several areas in at least two of the regions during the next six months. These surveys would run along lines of the Macquarie Phase I study, which required a fortnight's fieldwork and several months' additional time for preparation, assaying, data review and reporting. At the moment, British Columbia and Norway are the two regions which appear to offer the best prospects of a strike.

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       series.   Sheets Strahan B,C & D; Pillinger A & C.   Scale,
       1: 31,680.   Unpublished, Lands Dep't., Hobart.

Tasmanian Dep't. of Lands and Surveys, 1953:   Macquarie Harbour
       airphotos;

Film	Run	Negatives
T 302	1	114,115
T 302	2	110,111
T 305	3	52-52 incl.
T 302	4	31-37 incl.
T 301	5	97-103 incl.
T 301	6	92-96 incl.
T 301	7	34-38 incl.
T 301	8	28-30 incl.
T 311	9	01-03 incl.

            East Key   76,78,80,82,84,86,88,90.
      Photography, 20,000 feet.   Scale,   1: 35,640.   Lands Dep't., Hobart.

Tasmanian Dep't of Lands and Surveys, 1961:   Tasmania; topographic
      map; Sheet 5, Queenstown.   Scale, 1: 250,000. Lands Dep't., Hobart.

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Tasmanian Dep't. of Lands and Surveys, 1974: Montgomery No 1; property and reserves map. Scale, 1:63,360. Lands Dep't. Hobart.
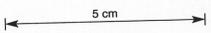
Tasmanian Dep't. of Lands and Surveys, 1971: Tasmania, topographic series. Sheets 8013, Franklin; 8011, Port Davey; 8111, Old River. Scale, 1:100,000. Lands Dep't., Hobart.

Tasmanian Dep't. of Mines, 1974: Key map of Exploration and Special Prospectors Licences at 10th April, 1974. Scale, 1:500,000. Dep't. of Mines, Hobart.

Tasmanian Dep't. of Mines, 1974: Tasmania; key map of petroleum permits and Licences. Scale, 1:1,000,000. Lands and Survey Dep't., Hobart.

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036140

Plate I

MACQUARIE HARBOUR
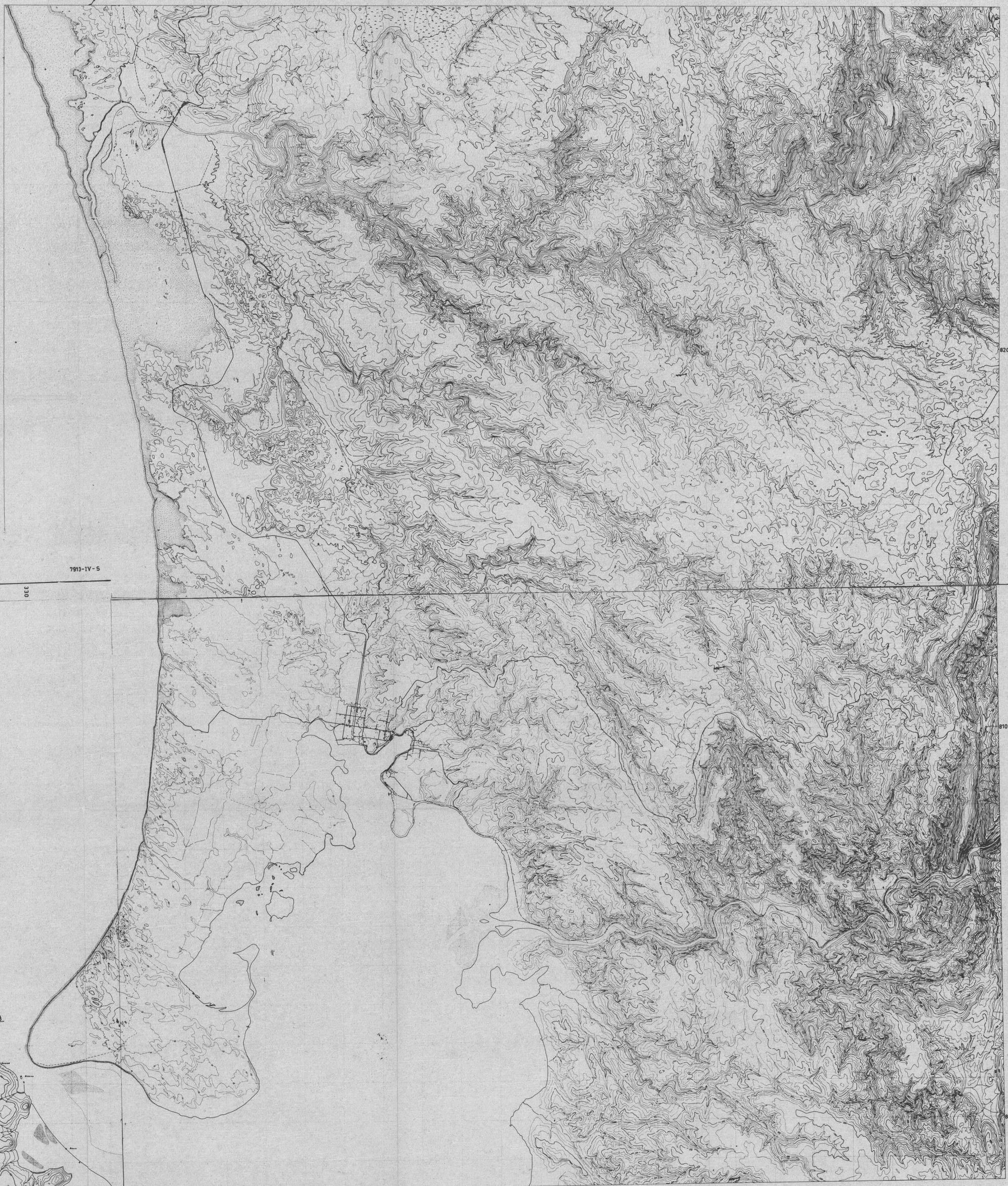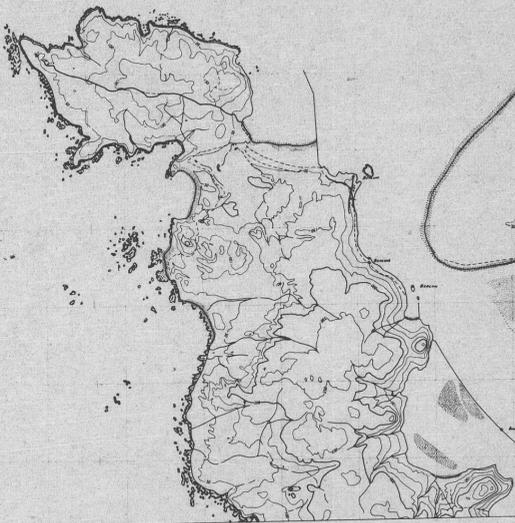
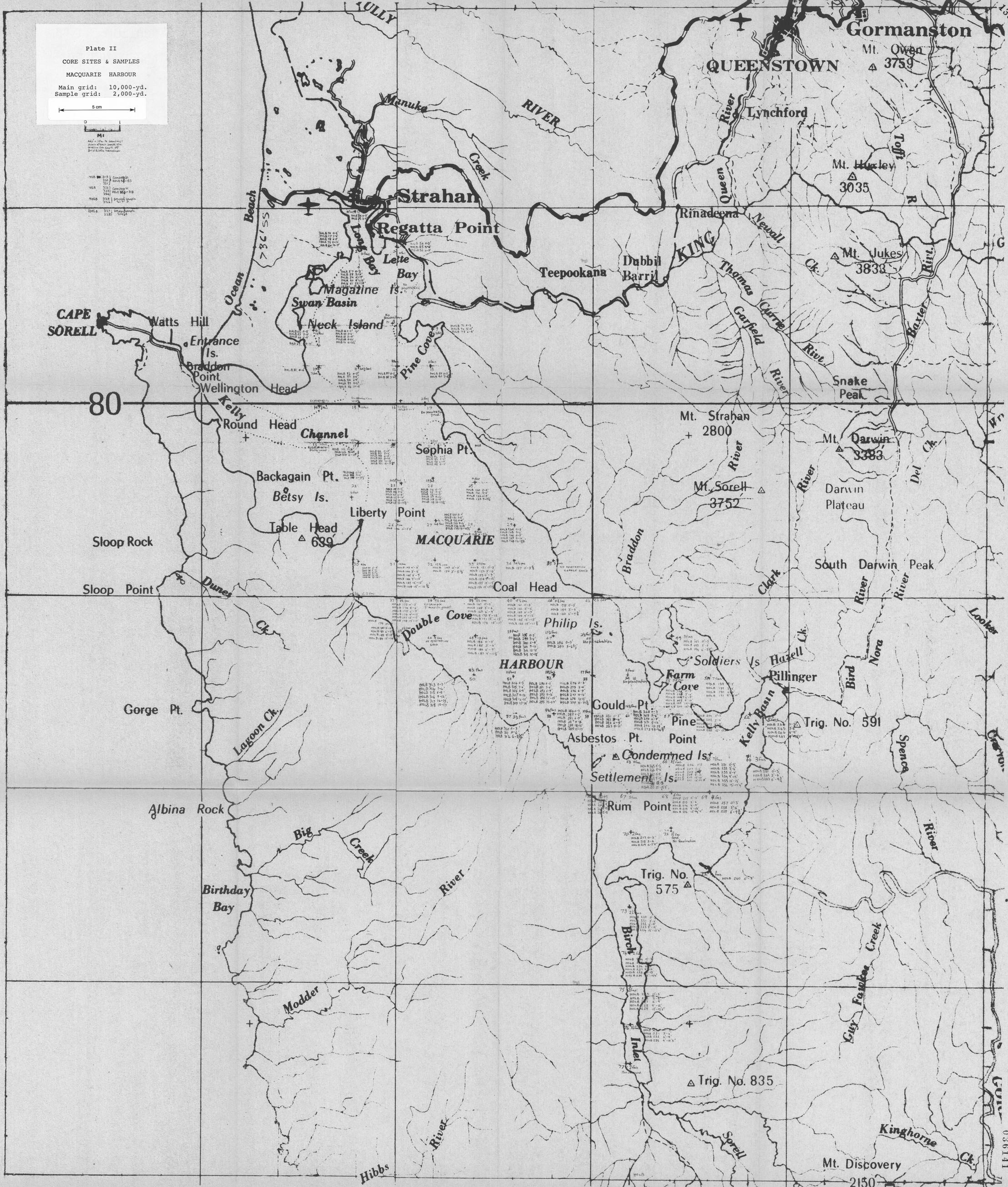NORTH PART

Scale: 1" = 3/4 mi.
Grid: 1000 - yd.

5 cm

7913-IV-S

86-2543

Plate II

CORE SITES & SAMPLES

MACQUARIE HARBOUR

Main grid: 10,000-yd.
Sample grid: 2,000-yd.

5 cm

Gormanston

QUEENSTOWN

Mt. Owen
3759

Lynchford

Mt. Huxley
3035

Rinadeena

Mt. Jukes
3833

KING RIVER

Teepookana

Dubbil Barril

Thomas River

Garfield River

Newall Ck.

Baxter River

G

Snake Peak

Strahan

Regatta Point

Leile Bay

Magazine Is.

Swan Basin

Neck Island

Pine Cove

Long Bay

Manuka Creek

RIVER

River

Queen River

CAPE SORELL

Watts Hill

Entrance Is.

Braddon Point

Wellington Head

Ocean Beach

80

Round Head

Channel

Kelly Channel

Sophia Pt.

Backagain Pt.

Betsy Is.

Liberty Point

Table Head
639

MACQUARIE

Coal Head

Mt. Strahan
2800

Mt. Sorell
3752

Mt. Darwin
3383

Darwin Plateau

South Darwin Peak

Braddon River

Clark River

Sloop Rock

Sloop Point

Dunes

Ck.

Double Cove

Philip Is.

HARBOUR

Soldiers Is.

Farm Cove

Pillinger

Hazell Ck.

Bird River

Nora River

Looker

Gorge Pt.

Lagoon Ck.

Gould Pt.

Pine Point

Asbestos Pt.

Condemned Is.

Settlement Is.

Kelly Basin

Trig. No. 591

Spence

Albina Rock

Big Creek

River

Rum Point

Trig. No. 575

Birthday Bay

Birch Inlet

Modder

Hibbs

River

Sorell River

Gully Fawkner Creek

Trig. No. 835

Kinghorne Ck.

Mt. Discovery
2150

APPENDIX A
PARTICIPANTS & AGREEMENT

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HOLB PARTICIPANTS

S.R.M. Harvey South African consultant. Previously Chief Geologist, Ocean
Mining group of companies of Anglo American Corporation/Charter Consolidated,
Alcoa and du Pont de Nemours. Senior Geologist, Rio Tinto, Africa. Govern-
ment Geologist, British Colonial Service. Twenty years' field experience:
Fiji, New Zealand, Austrlia, Philippines, Thailand, Malaya, Indonesia,
Rhodesia, South West Africa, Venezuela, Colombia, Dominican Republic, Trini-
dad, United States. Regional mapping; underwater investigations; lease acquisi-
tion; funding, design and direction of exploration programmes. Specific
studies on oil and gas, diamonds, emerald, industrial minerals and rocks,
radioactive substances, beach sands, bauxite, manganese, iron, chromium,
gold, platinum, copper, lead, zinc.

Overseas Natural Resources Company was established recently with offices in
Western Australia and the eastern United States by Australian and American
business interests to acquire and develop mineral properties throughout the
Commonwealth and to market Australian ores overseas. There are five Aus-
tralian directors: Mr. Barry Court, president of the Perth branch; Mr.
Kenneth Court, a partner in the broking firm of Carmichael and Co., Perth;
Mr. Victor Court, of the chartered accounting group Hendry, Rae and Court;
Mr. Gerald Green of Toorah, Victoria, until his retirement in 1970 General
Manager, Australasia, for the Swedish company Electrolux; Dr. G. W. Taylor,
an Australian engineer resident in the United States. The two US directors
are Mr. Julian Spector, one of the co-founders of Vernitron, a $43 million/
year electronics concern listed on the American Exchange, and Dr. Isiah
Lefkowitz, a physicist, who with Dr. Taylor edits the international period-
ical Ferroelectrics.

R.P. Lucas US consultant. Formerly Manager of Operations and Administra-
tion, IRG Inc., New York, natural resources development group; Vice Presi-
dent, Dana Construction Company; Partner, Lucas-Voukovitch, engineers and
geologists, Denver. Project Manager, Geophoto Services, Colorado. Recent
studies: laterite soils research, Thailand; non-metallic minerals survey,
Ecuador; Rio Cito phosphates evaluation, Venezuela; planning and urban
studies, Colombia; pampas drainage scheme, Argentina; rural cadaster, Hon-
duras; petroleum resources survey, Panama; agricultural economics, Sumatra;
groundwater resources, Ethopia; hydroelectric site studies, Greece; geo-
thermal power sources, Turkey; groundwater resources, Jordan. Corporate
natural resources development investigations on behalf of ITT, Westvaco,
IBM, Cerro, Toyomenka, etc.

E.G. Brady US investor, New York. Background on Wall Street and in other
sectors of American commerce.

CHINESE PETROLEUM CORPORATION—continued

Plant—Refining installations at company's Kaohsiung refinery include six topping units with total crude throughput capacity of 138,000 barrels daily; two reforming units; catalytic cracking unit; three hydro-desulfurization units; a 120,000 metric tons per year asphalt plant and an alkylation unit. Other facilities of the refinery include a sulfur unit, a sulfuric acid unit, a propylene polymer unit, Merox treating units, 250 metric ton per day coking unit. A naphtha cracking unit which will supply 120 million pounds of ethylene annually was put on stream early 1968. Throughput capacity increased to 220,000 barrels daily in 1972.

A lubricant plant of China Gulf Oil Company was erected on Kaohsiung Oil Refinery Compound under joint investment of Gulf Oil Corporation and Chinese Petroleum Corporation to manufacture and market lubricating oils in the Far East. The plant went on stream in 1965; capacity increased from 600 to 2,200 barrels daily in 1971.

Capital—NT $4,800,000 (US. $120,000,000) in NT $1,000 shares.

CIRILLO BROS. SALES CORP.   (273)

(*Incorporated* 1932 *in New York.*)

Officers—
N. W. Cirillo and W. J. Cirillo, *Senior Vice-Presidents.*
P. J. Cirillo, *Vice-President.*
International Division—H. Auld, *Vice-President.*
Offices—1040 East 149th Street, Bronx, New York, N.Y. 10455, U.S.A.
Cables: RCA Telex No. 224512; ITT Telex 421401. Phone: TA-4-5000.

Business—Marketers of petroleum products; deep water terminals in the Bronx, New York, and Albany, New York; barge terminals, Bronx, N.Y., Mt. Vernon. N.Y. and Brooklyn, N.Y.

Capital—$1,000,000, in shares of $100 each; all issued and fully paid.

Accounts—Issued to shareholders only.

CIT-CON OIL CORPORATION   (274)

(*Incorporated May* 27, 1947, *in Delaware, U.S.A.*)

Directors—S. D. Breitweiser, *President.*   W. T. Cravens, *Vice-President.*
W. H. Burnap, *Vice-President*
G. Crouch.   B. F. McCall.   J. S. Brendler.
W. L. Walker.
Plant Manager—L. D. Grubb.
New York Office—70, Pine Street, New York, 5, N.Y., U.S.A.
Secretary-Treasurer and Head Office—C. L. Watkins, (Box 1578), Lake Charles, Louisiana, U.S.A.

This company, owned 65 per cent. by Cities Service Co., and 35 per cent. by Continental Oil Co., has built a plant for production of solvent refined oils and wax products at Lake Charles, Louisiana, U.S.A. Capacity 11,000 barrels daily. Tank farm comprises 161 tanks with a capacity of 2,395,500 barrels. Selected reduced crude oil supplied from the light oil refineries of Cities Service and Continental Oil and finished oil blending stocks delivered to parent companies for blending. The plant commenced operations in September, 1949. A new wax blending plant was completed early in 1965.

Production—During 1969, 3,404,000 barrels lubricating oils and 59,000 tons petroleum waxes; 1970, 3,300,000 barrels lube oil, 59,000 tons petroleum wax.

Capital—$10,000,000, in 100,000 shares of $100 par value; 30,000 shares are issued, 10,500 held by Continental Oil Co. (Delaware) and 19,500 by Cities Service Co.

CITIES SERVICE COMPANY   (275)

INCORPORATED

(*Incorporated September* 2, 1910, *in Delaware, U.S.A.*)

Officers—R. V. Sellers, *Chairman & Chief Executive Officer.*
C. J. Waidelich, *President.*   F. H. Ramseur, jun. *Executive Vice-President.*
W. C. Ekholm, *Executive Vice-President.*   J. E. Meyer, *Executive Vice-President.*
Vice-Presidents—R. D. Dilsaver.   L. R. Hellwig.
H. B. Piatt, *Treasurer.*   M. F. Wirges, *Research & Technology.*
Group Vice-Presidents—E. B. Brooks, *Petrochemicals.*   V. R. Childress, *Chemicals & Metals.*
Secretary—P. Holland, jun.   P. J. Reilly, *Controller.*
Directors—W. L. Brown.   G. O. Nolley.   C. V. Wheeler.   R. V. Sellers.
J. E. Meyer.   T. S. Gates.   T. Sanford.   J. W. Morton.   H. I. Romnes.
E. B. Brooks.   J. F. McGillicuddy.   C. W. Michel.   J. P. Farrell.   E. P. van Marken.
C. J. Waidelich.   P. H. Ramseur, jun.   W. C. Ekholm.
Registered Offices—129 South State Street, Dover, Delaware, U.S.A.
Executive Offices—60 Wall Street, New York, N.Y. 10005, U.S.A.

Business—A natural resource company, engaged in the energy and chemical fields

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CITIES SERVICE COMPANY—continued.

of petroleum and natural gas, natural gas transmission, carbon black, petrochemicals, plastics, copper and copper products.

An integrated oil business engaging in acquisition and development of prospective and proved oil and gas lands; the production, purchase, transportation and sale of crude oil and natural gas liquids; the refining of crude oil; the production, purchase, processing and sale at wholesale of natural gas; and the manufacture, transportation and sale of petroleum products and petrochemicals. The operations of Cities Service are carried on principally in the United States, Canada and South America, and to a degree in Europe and Central America. Foreign activities are being conducted in Argentina, Australia, Belgium, Brazil, Colombia, West Germany, Great Britain, France, Holland, Indonesia, Italy, Japan, Mexico, Philippines, Iran, South Africa, New Guinea, Cameroon, Somalia.

Principal subsidiaries: Cities Service Oil Company (petroleum), Cities Service Gas Company (natural gas transmission). Other major subsidiaries include: Cities Service Cryogenics Inc. (helium), Cities Service Tankers Corporation (tankers), Cities Service Realty Inc. (real estate), Cities Service Research and Development Company (research).

At December 31, 1971, the company held 8,528,000 net acres domestic and 27,835,000 net acres abroad.

Company controls a number of oil and gas producing, transporting, refining and marketing companies, chiefly operating in U.S.A. One refinery is operated with daily capacity of 240,000 barrels of crude oil; tank cars, pipelines are owned by subsidiaries and associated companies connecting the producing oil fields with the refineries of the company, and also connecting these oil fields with the pipelines of other companies and a fleet of 14 ocean-going tankers, owned and under charter, totalling 625,325 d.w. tons, through Cities Service Tankers Corpn.

All domestic oil operations are principally concentrated in Cities Service Oil Company (wholly owned). This company engages in all phases of the petroleum business. Owns oil and natural gas producing properties in United States and (through a wholly owned subsidiary) western Canada; refinery located at Lake Charles, Louisiana; (East Chicago, Indiana, refinery closed end-1972). 76 natural gasoline plants in whole or in part. Markets petroleum products in 29 states around the Great Lakes, in the South and along to the Atlantic Seaboard.

Cities Service Pipe Line Co. gathers and transports crude oil principally in Kansas, Oklahoma and Texas. Cities Service also owns 13.98% interest in Colonial Pipeline Co. and varying interests in other common carrier pipeline companies.

Cities Service Export Inc., wholly owned, carries on marketing operations in various parts of the world, principally in Western Europe.

Cities Service holds 25 per cent. interest in the CAGC group of companies engaged in exploring for and producing oil and gas in the Gulf of Mexico.

Cities Service Gas Co. purchases, transports and sells natural gas in the mid-Continent area, principally in the states of Kansas, Missouri, Nebraska, Oklahoma and Texas along its 8,100-mile interstate gas transmission system; also operates intrastate natural gas transmission subsidiary within Kansas.

Canada-Cities Service Ltd. (wholly owned) produces crude oil and natural gas principally in western Canada.

Cities Service has a 30 per cent. interest in Syncrude Canada Ltd., formed to develop crude oil from the Athabasca oil sands of northern Alberta. Syncrude has been granted permission to construct facilities to produce 125,000 barrels a day of synthetic crude commencing in 1976.

Cities Service Company holds 65 per cent. of the outstanding share capital of Cit-Con Oil Corpn. (*q.v.*) operating a lubricating oil refinery, rated capacity 10,000 barrels daily, at Lake Charles, Louisiana.

Cities Service has 16% interest in Societe Carbochimique S.A., a Belgian company engaged in production and marketing of nitrogen fertilizers, coke and chemicals, and a 28 per cent. interest in Calcasieu Chemical Corporation which owns an ethylene glycol plant.

In Colombia, wholly owned Colombia Cities Service Petroleum Corp. holds 25 per cent. interest in a concession at El Carare in the Magdalena River Valley. Cities Service is operator in the Corazon-Payoa producing area. In the Payoa field a gasolene plant has been placed in operation with a capacity to process

50 million cubic feet of gas and recover 2,000 barrels of gas liquids daily. Cities Service's net oil production in Colombia in 1971 averaged 1,700 barrels daily.

Cities Service holds 25 per cent. interest in Petroquimica Argentina S.A. which operates a petrochemical plant near Rosario, in Argentina, and 70% interest in Cia. Petroquimica Brasileira, producer of carbon black &c. in Brazil.

Wholly owned Argentina-Cities Service Development Company continues to operate the producing properties in Argentina covered by a development contract, in which Cities Service holds 63½ per cent. interest, with Yacimientos Petroliferos Fiscales (Argentine) in respect of 118,000 acres near Mendoza. Production averaged 45,600 barrels per day in 1971. Cities Service, as operator for two groups, acquired two exploration permits, Ramblones and Bermejo, on 1.75 million acres in the North Mendoza area during 1969; Cities Service interest 25%.

Overseas petroleum exploration activities are being conducted offshore, Indonesia, the U.K. and Dutch sectors of the North Sea, offshore and onshore Colombia, New Guinea and Somalia.

Cities Service holds a 25 per cent. interest in the Signal Oil group which holds 7 blocks in the U.K. portion of the North Sea. Also holds one-seventh of the 50 per cent. interest held by a group in an 875 square mile block in the Iranian portion of the Persian Gulf (see Iranian Offshore Petroleum Co.).

Net Production—(including royalties received)—Barrels daily (U.S.A.) 1970, 119,900; 1971, 120,400; (Canada) 1970, 9,200; 1971, 9,400; (international, excluding Argentine) 1970, 2,100; 1971, 1,700. Natural gas liquids, 1970, 83,400; 1971, 87,100.

Natural Gas Liquids—barrels daily, net—1970, 83,400; 1971, 87,100.

Natural Gas Production—MCF daily, net—1970, 1,036,100; 1971, 1,053,400.

Net wells producing at Dec. 31 1971, 5,562 oil, 2,262 gas.

Refinery Runs—Barrels daily—1969, 254,000 (including 26,000 processed for others); 1970, 278,000 (31,000); 1971, 286,000 (31,000).

Capital—Authorised: 2.5 million shares of preferred stock and 40,000,000 shares common stock $5 par value. Issued at Dec. 31 1971 26,232,537 shares common stock, including 619,126 shares held in treasury.

Common stock split on a two-for-one basis in September, 1965, and par value reduced from $10 to $5 per share. In Oct. 1969, the company acquired 3.6 million shares of its common stock through an exchange offer to stockholders for Atlantic Richfield stock totalling 1.8 million shares. In Nov. 1971, a further 2.4 million shares of common stock received in exchange for 1.7 million shares Atlantic Richfield stock; common stock thus received was subsequently retired. Outstanding preferred and preference shares called for redemption Nov. 1970. Unissued shares of preferred and preference stock eliminated and 2.5 million shares of a new class of preferred stock authorised Feb. 1972. For previous alterations in capital, see previous vols.

Long Term Debt due after 1972—
Six-and-one-eighth per cent. Debentures, due 1978 to 1997—$100,000,000.
Three per cent. Sinking Fund Debentures due 1977 $39,300,000.
Six-and-five-eighth per cent. Debentures, due 1980 to 1999—$100,000,000 issued Aug. 1969 with warrants (expiring Sept. 1 1972) attached for purchase of 500,000 shares of Atlantic Richfield common stock at $110 per share.
Notes: $51,700,000 at 4½% to 7%, due 1973 to 1978.
7.65% Debentures, due 1982 to 2001—$100,000,000.
Long-Term Debt of Subsidiary Companies—$185,300,000.

Dividends (Common Stock—per share—cash dividends paid quarterly)—For 1956 to 1958 ($10 shs.) $2.40 and 2 per cent. stock dividend each year; 1959, $2.40; 1960, $2.40; 1961, $2.40; 1962, $2.60; 1963, $2.60; 1964, $2.65; 1965 (adj. for 2-for-1 stock split) $1.42½; 1966 ($5 shs.) $1.62½; 1967, $1.80; 1968, $2; 1969, $2; 1970, $2.20; 1971, $2.20; 1972, 55 cents March, June.

Accounts—For year ended Dec. 31 1971, submitted April 25 1972, consolidated net income $104,500,000 after providing $17,500,000 for Federal and foreign income tax, and $110,100,000 for depletion and depreciation; dividends absorbed $61,600,000; earned surplus carried forward $1,177,900,000; current assets $583,500,000, Atlantic Richfield Co. common stock (sold in 1972) at cost $17,800,000 (market value $100,000,000), securities of and advances to unconsolidated foreign subsidiaries $10,800,000, other securities and advances $33,800,000, accounts and notes receivable $24,300,000; current liabilities

$338,500,000, deferred Federal income taxes $51,200,000, minority interests in subsidiaries $7,300,000. Capital surplus $81,200,000.

Common stock is listed on New York, Boston, Midwest and Toronto Exchanges and is quoted on other exchanges. Dealings are allowed on the London Stock Exchange under Rule 163 (1) (e). Debentures listed on New York Stock Exchange. Prices (common stock), highest and lowest, (New York) 1968: $84½, $43½; 1969: $80, $39¾; 1970: $50½, $34; 1971: $49¾, $39¾.

CLARK OIL & REFINING CORPORATION   (276)
(Incorporated July 12, 1934, as Clark Super Gas Co. Inc., in Wisconsin, U.S.A.; name changed to Petco Corp. July 1, 1946, and to present title in March, 1954.)

Officers—
Chairman & Chief Executive Officer—E. T. Clark.
President—O. L. Hill.   Executive Vice-President—G. W. Jandacek.
Chairman of Executive Committee—I. H. Dawes.
Vice-Presidents—G. Willis, Crude Oil Supply and Transportation.
K. J. Palmer, Retail Marketing.   G. S. Harris, Refinery Sales.
P. J. Sheedy, Manufacturing.   G. T. Wormley, Secretary & General Counsel.
J. W. Skelly, Exploration & Production.   R. R. Clark, Product Supply & Distribution.
W. J. Labadie, Administration.
N. G. Takton, Advertising and Public Relations.
J. A. Bruss, Finance & Treasurer.
Controller—C. B. Archibald.

Directors—J. Crichton.   K. J. Palmer.   P. A. Treiber.   E. T. Clark.
I. H. Dawes.   O. L. Hill.   M. F. Snyder.   G. W. Jandacek.   G. T. Wormley.
General Offices—8510, West National Avenue, Milwaukee, Wisconsin 53227, U.S.A.
Cables: FTK—Milwaukee.   Phone: (414) 321-5100.
Refineries—131st and Kedzie Avenue, Blue Island, Chicago, Illinois 60406; North Side Hawthorne Street, Wood River, Hartford, Illinois 62048.

Business—Oil and gas exploration; refiners and marketers of petroleum products. Exploration and development facilities in the Rocky Mountains, Alaska, Louisiana, Texas, New Mexico. The company is participating in exploration in Canada, principally in the Arctic Islands and Saskatchewan.

Through its participation in the SCAAND group of companies, wholly owned Clark Oil Producing Co. holds interests averaging 16⅜% in nine tracts totalling 45,541 acres offshore Louisiana in the Gulf of Mexico.

A 25 per cent. working interest is held in a concession covering approximately 231,000 acres in Brunei, North Borneo; test drilling performed in 1969.

The company owns a refinery in Chicago, Illinois, throughput capacity 70,000 barrels daily, and adjacent petrochemical plant, and a refinery at Wood River, Illinois. Capacity 37,000 barrels daily.

Wholly owned Clark Chemical Corp. (formerly Colab Resin Corp.) operates Clark's petrochemical and resin business.

In 1967, Clark joined with another company to form Southcap Pipe Line Company which has 20.62% interest in the Capline 630-miles 40-inch diameter crude oil pipe-line extending from the Louisiana Gulf Coast area to Patoka, Illinois. Clark also has 33.2 per cent. interest in Chicap Pipe Line Company, formed in 1967 to own and operate a 205 miles, 26-inch diameter crude pipeline built from the Patoka terminal to Mokena, Illinois. A 33.83% interest is held in Capwood, a spur extending 50 miles from Patoka to Wood River, Illinois, also 11 per cent. in Wolverine Pipe Line Co. and 8 per cent. in West Shore Pipeline.

Net Production—Crude oil and condensate, barrels, 1970, 1,129,000; 1971, 906,000; natural gas, mcf, 1970, 2,930,267; 1971, 3,381,472.

Crude Oil Processed—barrels—1970, 34,761,000; 1971, 32,656,000.

Capital—Authorised: $10,000,000, in common shares of $1 each; 7,120,432 shares issued and fully paid at December 31 1971, including 2,173 held in treasury. Authorised capital increased from $2,000,000 in March, 1966, and outstanding stock split on a two-for-one basis. Stock split two-for-one Nov. 1968.

Early in 1968, Clark acquired Colab Resin Corporation, Tewksbury, Mass., in exchange for 32,258 shares of Clark Oil.

Effective Jan. 31 1969, Clark purchased the fixed assets and inventories of

APPENDIX B
GEOGRAPHIC & HYDROGRAPHIC DATA

N.P. 14

AUSTRALIA PILOT

VOL. II

+ Suppl. #2 1972

COMPRISING

THE SOUTHERN AND EASTERN COASTS OF AUSTRALIA FROM CAPE NORTHUMBERLAND TO PORT JACKSON, INCLUDING BASS STRAIT AND TASMANIA

FIFTH EDITION, 1969

INDEX TO
ADMIRALTY CHARTS
ALLUDED TO IN THIS WORK

A number against a place thus:—P. Arthur 1475 shows that a separate plan is published with that number.

A star and a number thus:—Seal B. 1694* indicates that a plan is given on the chart numbered 1694.

The limits of the book are shown by the tinted coast.

NOTES

The charts and plans shown on this index represent those published at the date given at the foot. They are liable to alteration and amendment.

For details of Scales, Prices, &c., see Chart Catalogue.

See also Charts 2759*, 788, 2483 and 2683.

The Australian charts shown on this index are reprinted in the U.K. by the Hydrographer of the Navy. Other Australian charts in the area of this index are shown in the Catalogue and Index of Australian Charts (A.H.P.9).

SEE AUSTRALIA PILOT, VOL. I

SEE AUSTRALIA PILOT. VOL. III

NEW SOUTH WALES

VICTORIA

TASMANIA

BASS STRAIT

TASMAN SEA

5 cm

the rate of one knot, but a small proportion are stronger, with rates of
between one and 2 knots. These stronger currents may also set in any
direction, including westerly ones. In the region of Bass strait and the
coast of Victoria currents exceeding 2 knots are rare; elsewhere, in the open
5 ocean, no currents exceeding 2 knots have been recorded, in any direction.

Cape Northumberland to Cape Otway and Bass strait.—There is a
resultant flow of water in easterly directions off the coast between Cape
Northumberland and Cape Otway and through Bass strait. This part of
the Southern Ocean current, between the coast and 40° S., is just as
10 variable as that in the open ocean, described above, so that currents in any
direction may be experienced. On an average throughout the year,
excluding the small proportion of the total number of currents observed
which set due north or south, out of every five currents three have an
easterly component and two a westerly component. The maximum rate
15 of current, in any direction, is usually about 1½ knots, but a few currents
reaching or exceeding 2 knots have been reported. A considerable pro-
portion of weak currents, with rates of less than one-quarter of a knot,
occur throughout the year.

Sets with a component onto the Australian shore are frequent through-
20 out the year in this region. These currents sometimes exceed one knot.
Vessels making the land about Cape Otway during a continuance of
strong westerly winds should be prepared for a southerly set, though some-
times in these circumstances the current is found to set towards the land.

Many wrecks have occurred on the west coast of King island, see
25 page 62. With strong or continued westerly winds the resultant of the
current and the east-going tidal stream may produce a south-easterly
onshore set with rates up to about 2½ knots.

Tasmania.—In the bight of the northern coast of Tasmania, between
Circular head (40° 46′ S., 145° 18′ E.) and Cape Portland, the current
30 is said to set almost constantly eastward during the greater part of the
year. No current observations are available off the western coast of
Tasmania, except a few near its southern part. The currents probably
set in accordance with the wind for most of the time, but when westerly
winds are strong or long-continued the resulting easterly or south-
35 easterly currents will tend to pile water against the western coast of
Tasmania, resulting in a southerly flow of current along the coast.

Relatively few observations are available off the eastern coast of Tas-
mania but the general tendency is for north-easterly sets. occasionally,
especially in late winter or spring, however, the east-going current
40 emerging from the Bass Strait may give south-easterly or southerly sets
along the northern part of the eastern coast of the island.

East Australian Coast current.—The East Australian current sets
southward throughout the year along the southern coast of Queensland
and the coast of New South Wales to the vicinity of Cape Howe (37°
45 30′ S., 149° 59′ E.). The part of this current contained in the region
covered by the present volume is less strong and constant than the more
northern part, which is described in Australia Pilot, Vol. III. This is
due to water branching off from the seaward side of the current between
32° S., and 34° S., turning south-eastward and passing into the open ocean.
50 Currents setting in any direction, including northerly ones in opposition
to the main flow, may be experienced in the region of the East Australian
Coast current between 34° S., and Cape Howe. Currents with an onshore
component therefore frequently occur and some of these set directly
onshore. The period of greatest constancy of the south-going current is
55 from December to February, when about half the currents observed set
in directions between south-west and south-south-east inclusive. During

the rest of the year app
directions.

The usual maximum
2 knots in all months.
exceed the rate of 2 kno
exceeding 3 knots has
ponents may exceed the
a rate exceeding 2 knot

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September to February
current as a whole is pr

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predominantly north-go

Tasman sea.—Outs
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To face page 8.

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vation of 2,129 feet
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Lake Tarrago and
quarie are connected

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p rock. Granite rocks
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d correspond to the
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2'uarina or she-oak,
i and mallee scrub;
n profusion, of these
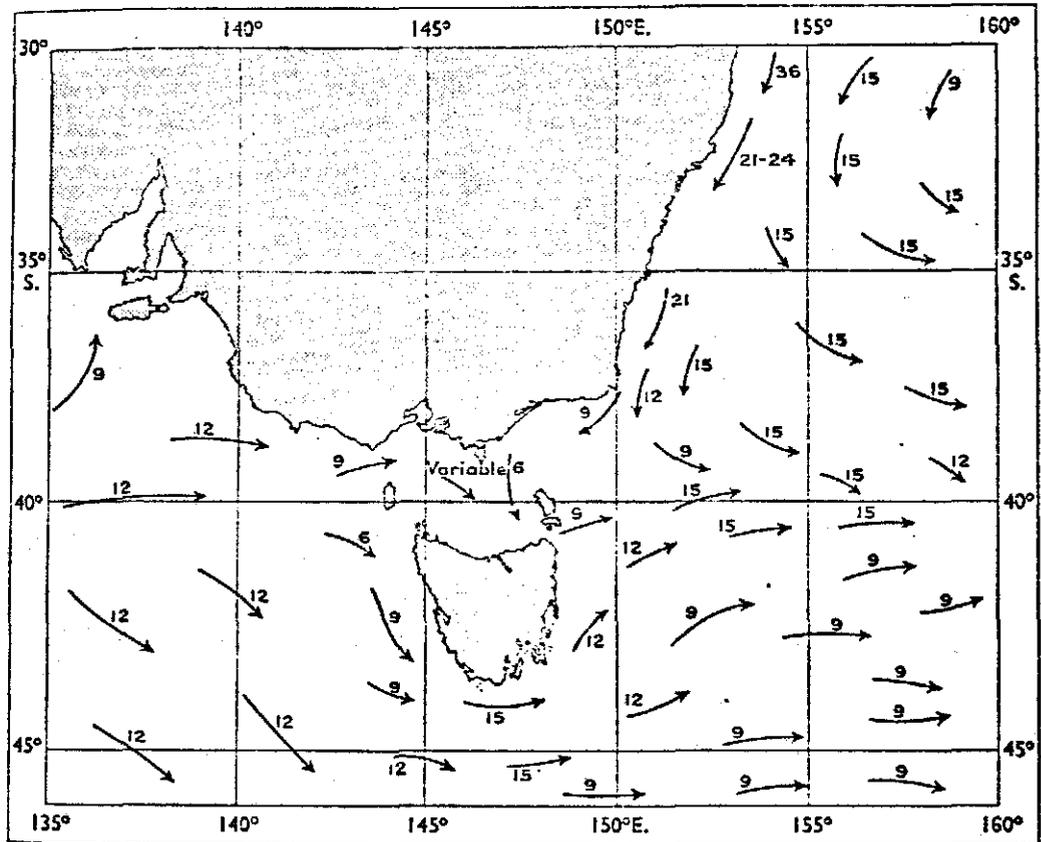
Fig. A. Predominant direction of currents — February (Summer)

5 cm

To face page 9.

the waratah or native t
are some of the most ↗
Fauna.—Among the
kangaroo, wallaby, p↗
or native bear, native
Bats are very numero
mouse.
The feathered tribe i
of which there are ov↗
or laughing jackass, n
emu, lyre and bower l
Snakes are very num
the most dangerous.
The lizard tribe is w↗
is found in the swamps
Leeches abound in r
prolific.
Among the fish arc
flathead, garfish, Murr.
Sydney oysters are muc
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South Wales are the l
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tobacco, sugar cane, fr
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plastic materials, news↗
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Excluding interstate
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CURRENTS.—Two r
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The Southern Ocean
is a region of variable c
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winds. The currents at
or lately prevailing, and
The majority of the
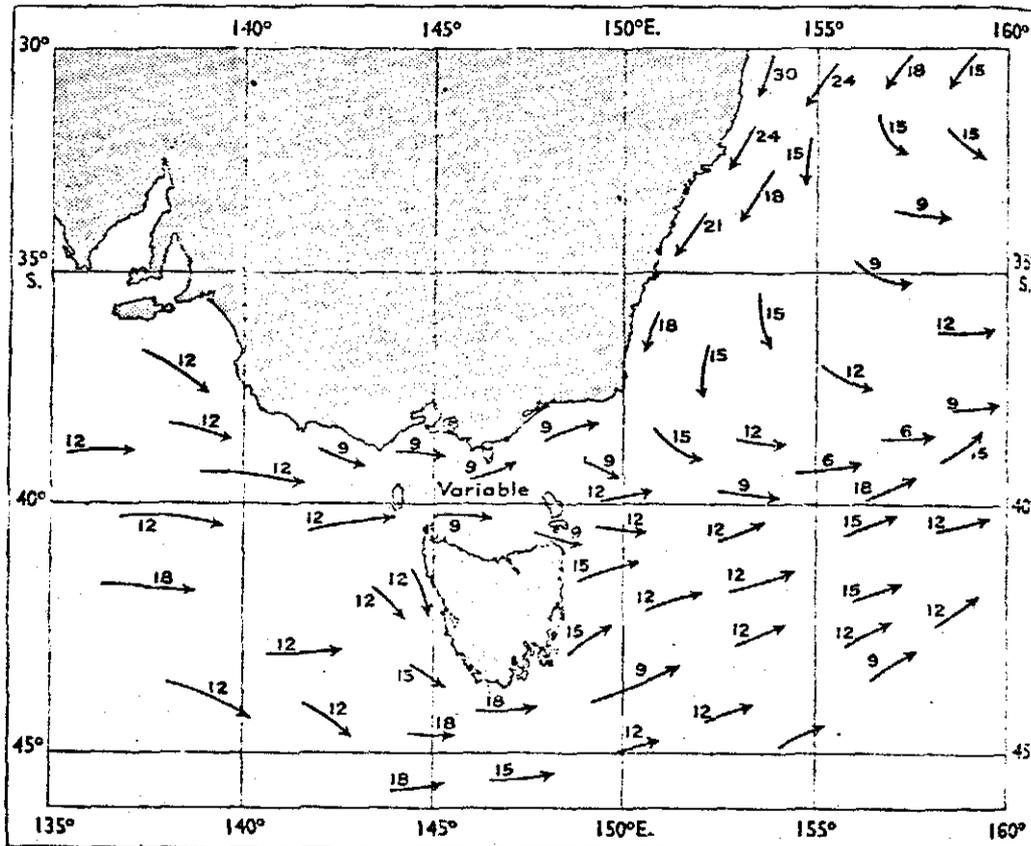
Fig. B.   Predominant direction of currents — August (Winter)

|←————— 5 cm —————→|
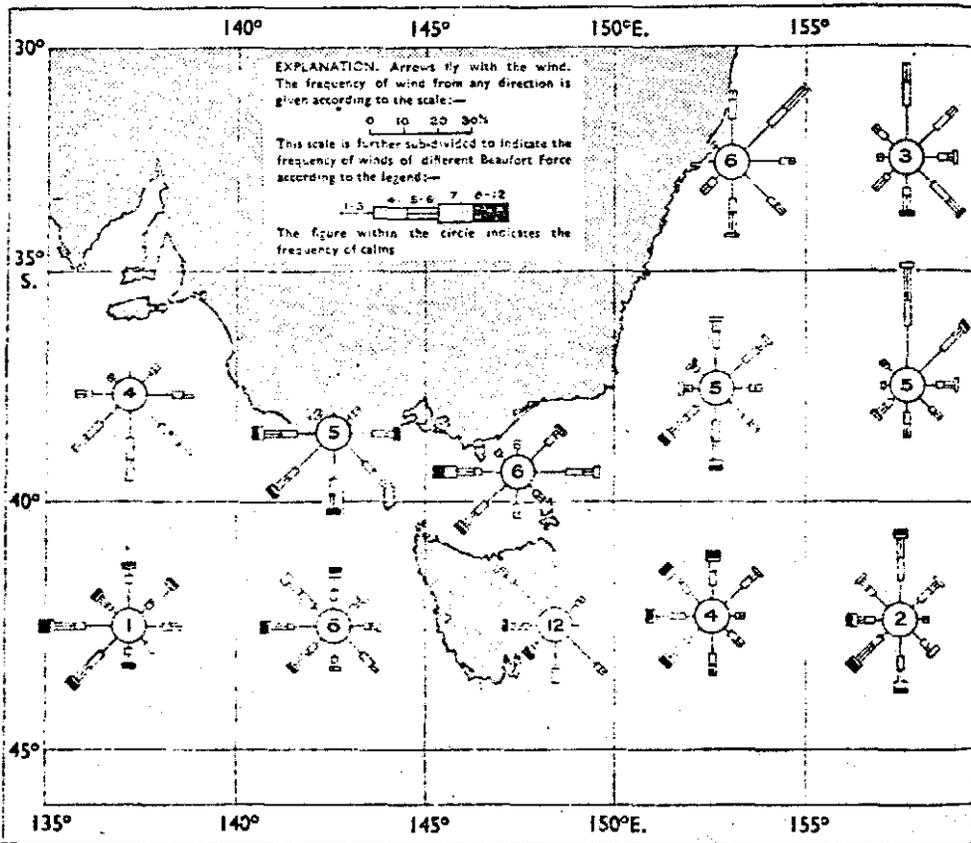
Fig. 5. Wind frequency distribution — January

Fig. 6. Win

5 cm

EXPLANATION. Arrows fly with the wind.
The frequency of wind from any direction is
given according to the scale:—

0   10   20   50%

This scale is further sub-divided to indicate the
frequency of winds of different Beaufort Force
according to the legend:—

1-3   4   5-6   7   8-12

The figure within the circle indicates the
frequency of calms
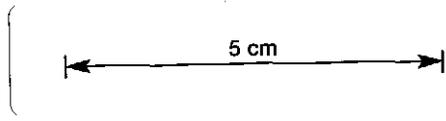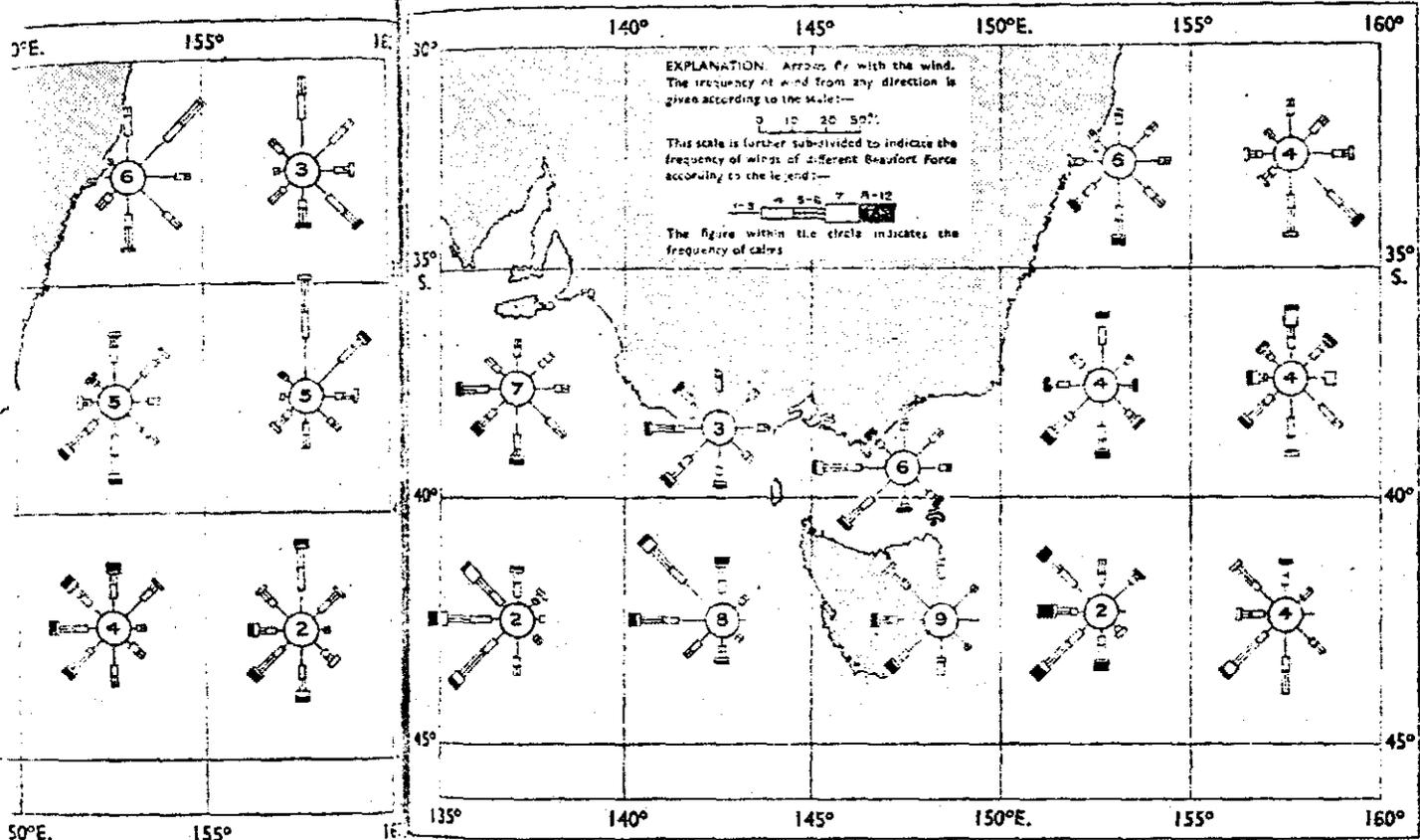
Fig. 6. Wind frequency distribution — April

tion — January

5 cm
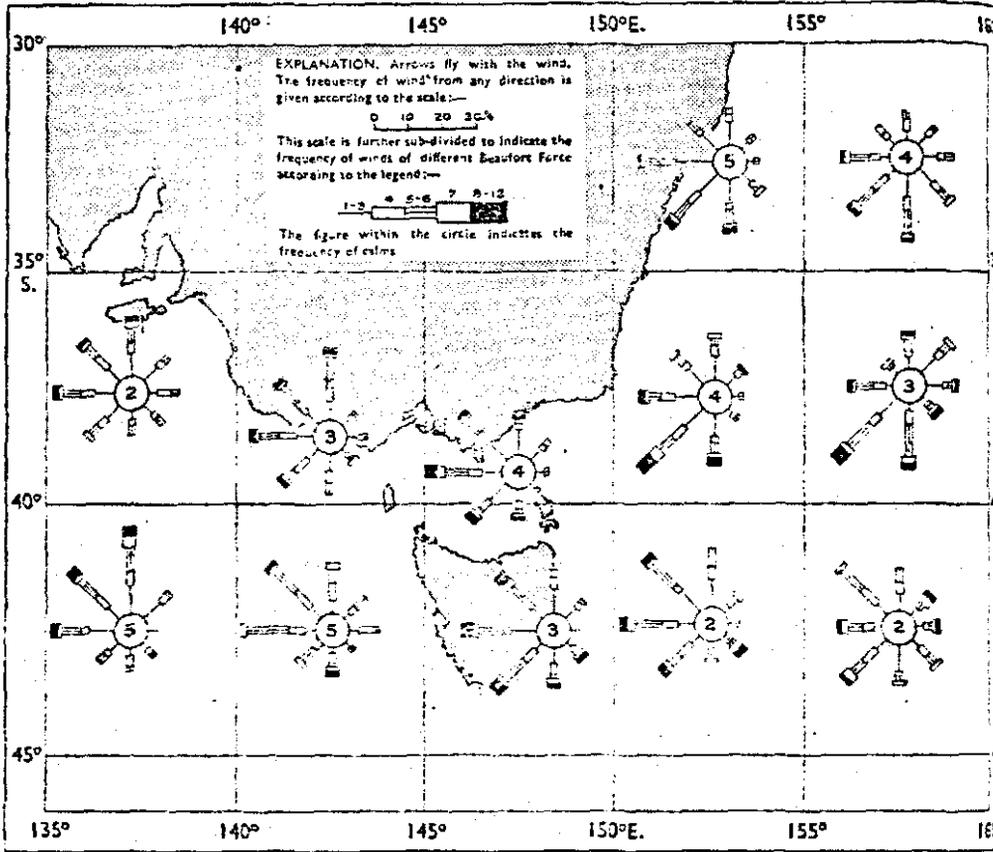
Fig. 7. Wind frequency distribution — July

Fig. 8. Wind

5 cm
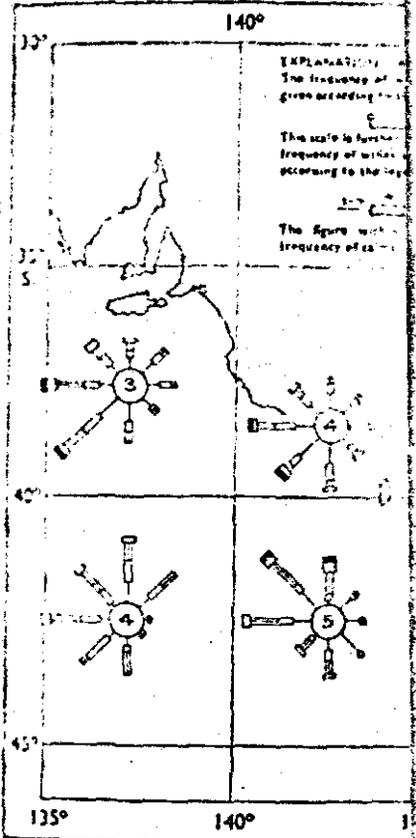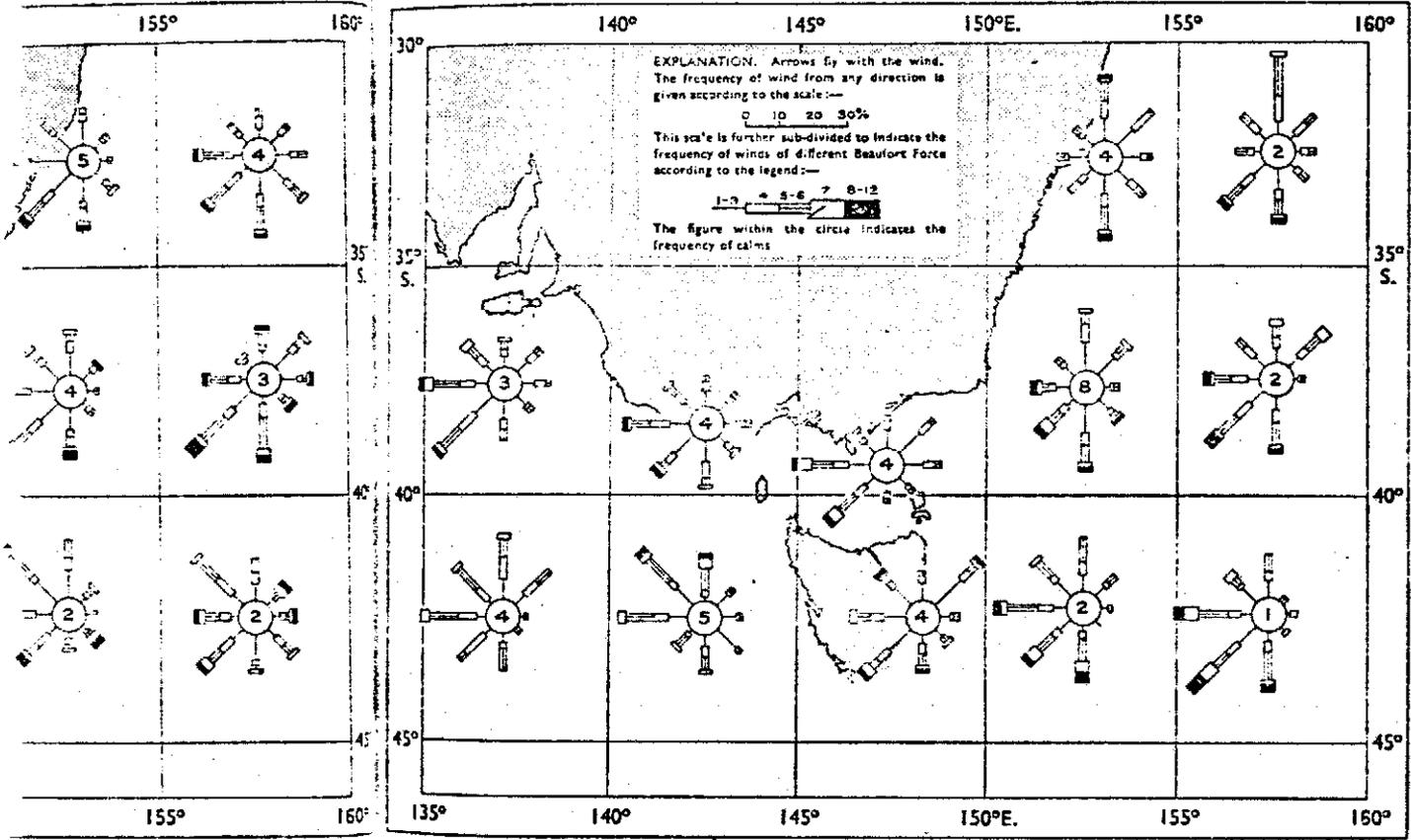
Fig. 8. Wind frequency distribution — October

— July

5 cm

To face page 31.
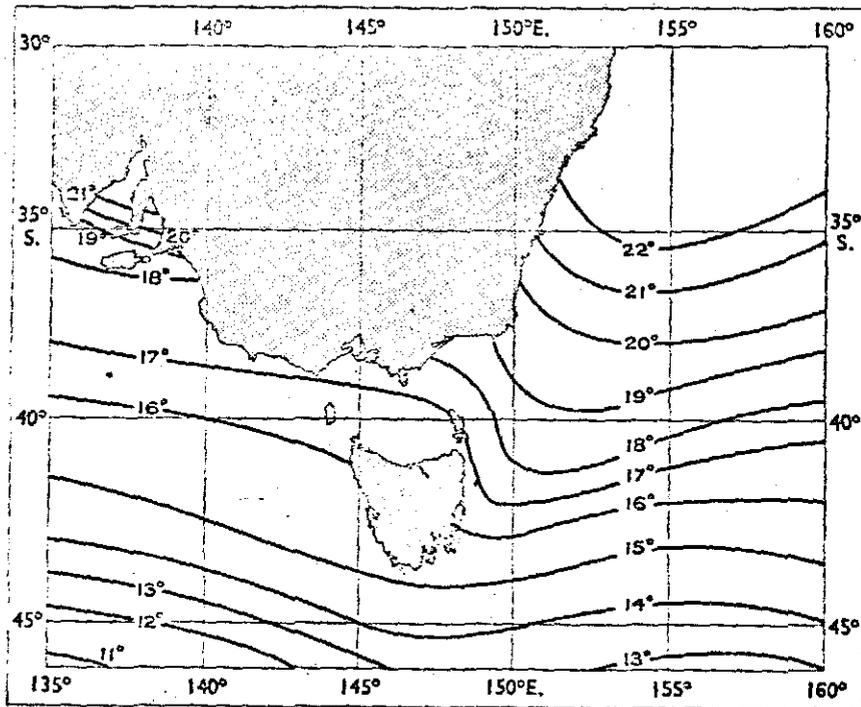
Fig. 10. Average sea surface temperature (°C) — February
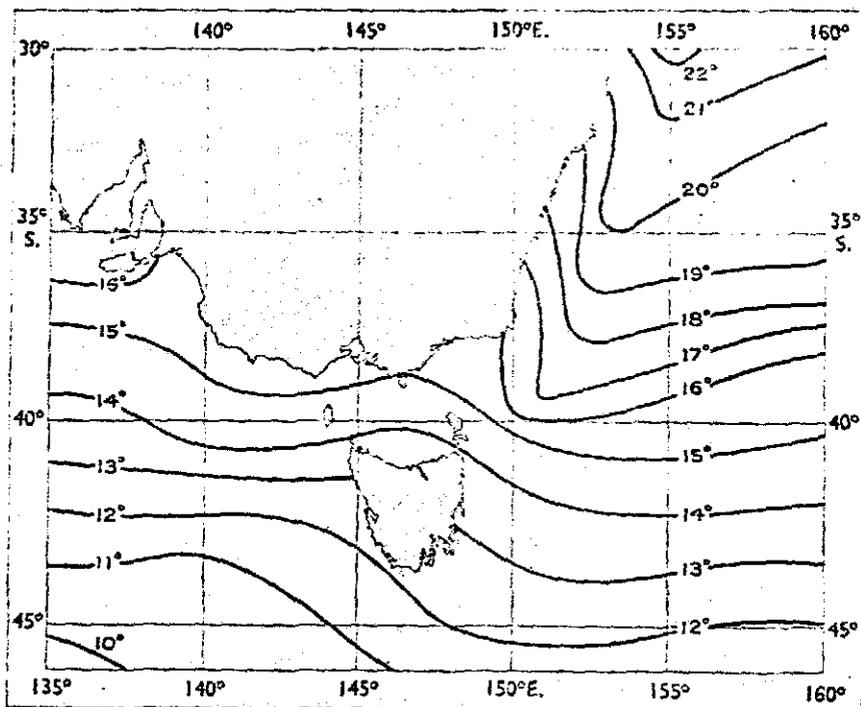
Fig. 11. Average sea surface temperature (°C) — May

5 cm

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the 0900 values varie
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156
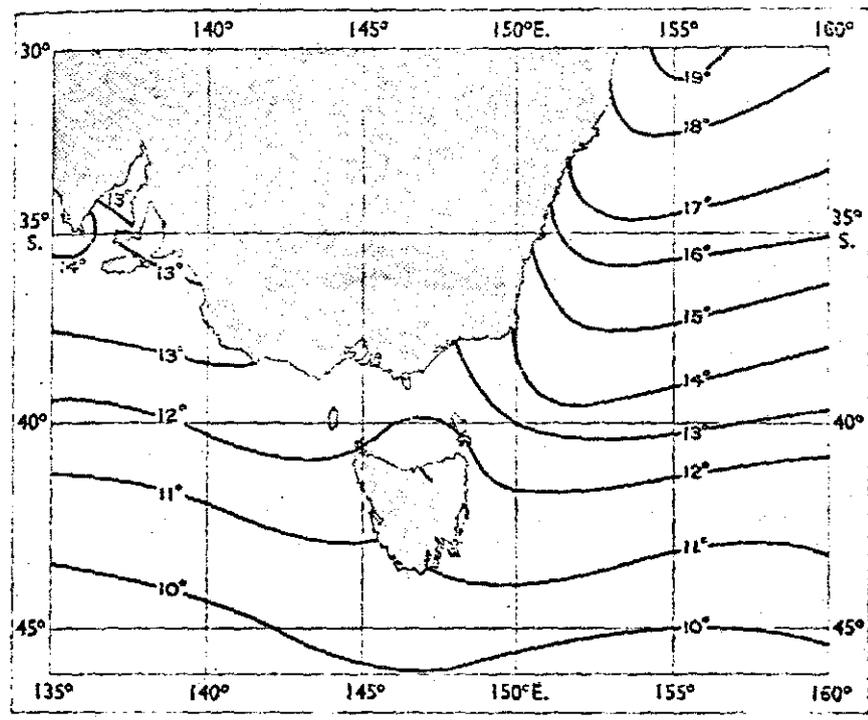
Fig. 12. Average sea surface temperature (°C) — August
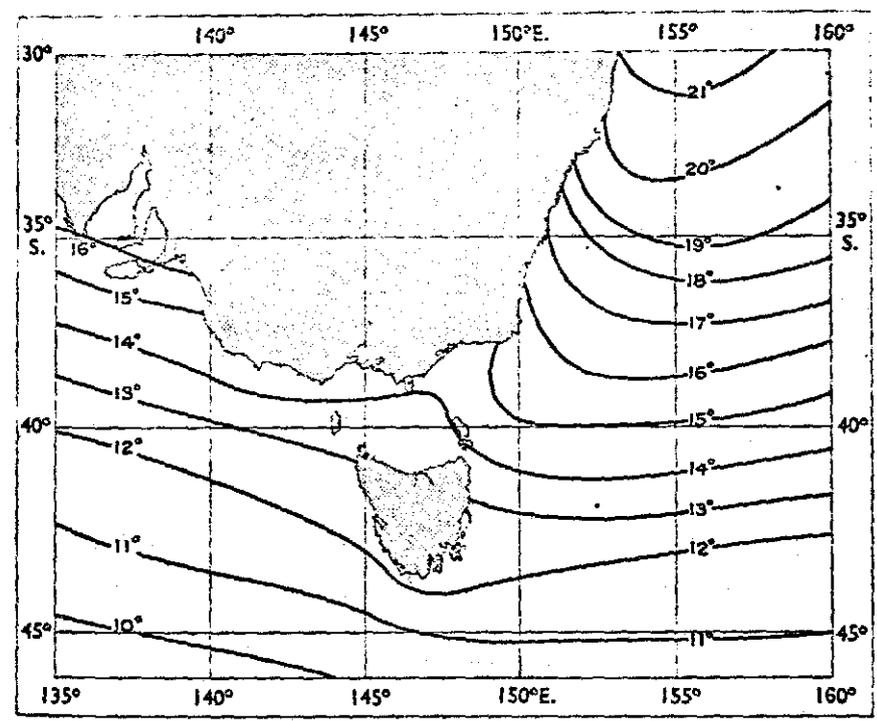
Fig. 13. Average sea surface temperature (°C) — November

5 cm

256
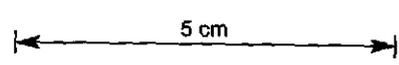
CHAPTER VIII

TASMANIA—WESTERN COAST

Chart 1079. ·

WESTERN COAST OF TASMANIA.—General remarks.—The western coast of Tasmania is mostly rocky, of sterile appearance, with reefs extending from it for as much as from 3 to 4 miles offshore in places,
5 and a heavy swell usually rolls in upon it from south-westward. The prevailing winds are south-westerly, and bring much bad weather, especially in the winter months of June, July and August. The northern part of this coast is comparatively low, but from abreast West point, about 16 miles southward of Cape Grim (*40° 41′ S., 144° 41′ E.*), the
10 land rises and attains an elevation of 4,756 feet (1,449m6) at Frenchmans Cap, about midway along the coast. Southward of this mountain the coast is backed by ranges between 2,000 and 4,500 feet (609m6 and 1,371m6) high.

The only harbours on this coast are Macquarie harbour, with its
15 entrance about 93 miles south-south-eastward of Cape Grim, which is available for small vessels with local knowledge; and Port Davey, with its entrance about 15 miles north-north-westward of South West cape (*43° 35′ S., 146° 02′ E.*), which is available for vessels of deep draught.

Caution.—The waters off the western coast of Tasmania have been
20 little surveyed, and less water than charted and unknown dangers may exist.

Chart 3687.

COAST.—Dangers.—Cape Grim, on the western side of the north-western extremity of Tasmania and Steep rock, have been described on
25 page 163.

From Cape Grim, black cliffs extend about 4½ miles southward to Bluff point, northward of which is a flat-topped bluff, about 350 to 400 feet (106m7 to 121m9) high. Valley bay lies close south-eastward of Steep rock, and three exposed bays, Studland bay, Calm bay and Canal
30 bay, lie between Bluff point and a point about 3¼ miles south-south-eastward.

Chart Aus. 353.

From the southern entrance point of Canal bay, the coast trends south-south-westward for about 6¾ miles to Green point, and is fringed
35 with rocks in its northern part. Mount Cameron West, 546 feet (166m4) high, rises about midway along this stretch of coast, and between it and Green point is Ann bay, at the head of which is the town of Marrawah, which is connected to the State highway. An above water rock lies close off Green point and a reef lies about three-quarters of a mile west-south-
40 westward of it.

Nettley bay, a small indentation, lies about 2 miles south-westward of Green point with West point (*40° 57′ S., 144° 37′ E.*), about one mile farther south-westward. The latter point is sandy, and above water rocks extend about one mile from it.

Chart Aus. 353.

Light.—A light is e
a white metal framew
West point.

Off-lying dangers.
(5m5) over it, on whic
ward of West point.

Porpoise shoal, with
sea breaks occasionally
have been obtained, lie

Coast (*continued*).—
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southern end of which
high, rises about 7½ mil
rock, on which there
south-westward of the
mate and it has not bee
south-eastward for abc
Gardiner point, the sou
southward for about 4
bay at the head of whi
a depth of less than 6
of the northern entranc
2¾ miles southward of
extend about one mile

Temma harbour, wi
about 5½ miles southw
entered between Gaffn
side, and Richardson p
by road with Marraw
extend about 1¼ miles
of 60 feet and 12 fath
westward of the same
Richardson point is H
tending about 1¼ miles
extends about half a
south-eastward of Rich
side and another bay
ground extends about
southern entrance poi
water, extend about on
A bank, with a depth
westward of the point
6 miles southward, th
end of which is Kennet
in this bight. Rocks,
westward and 1½ mi
Thornton river and Pec
ward and 5 miles soutl

Mount Balfour, 1,34
feet (431m3) high, rise ;
and Mount Hazelton, 2
feet (757m7) high, whi
eastward and 9¾ miles
(*41° 26′ S., 144° 45′ E*
Lofty range.

[Chap. VIII.

9), from a white
] on Sandy cape.
r, about 6¾ miles
ich foul ground
rd, and Johnson
d 4¼ miles south-
oon river the coast
sandy beach, and
to Rupert point.
e north-westward

outh-eastward of
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river and Conical
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an river the land
contour, and then
(487m7) high, and
ntrance to Lagoon
es about 7¼ miles
feet (780m3) high
it 17 and 20 miles
l, 300 feet (91m4)
ical Rocks point

of the entrance to
nt change; in fine
d depth, but after
ns it. With north-
vith heavy breakers,
l of Conical Rocks
hs are greater than
, but entry should

miles south-south-
w water, extending
the latter point is
outh-south-eastward
a rock, with a depth
of a mile offshore.
ut 8½ miles, and is
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ated about midway
illage of Remine at
ward of Granville
sed to winds between
all vessel with local
not recommended.
d with the rail head
east-north-eastward.
beach, which extends
entrance point of

Chart Aus. 353.
Macquarie harbour, about 18 miles southward. Little Henty river and
Henty river flow into the sea about 2¾ and 7¾ miles south-south-eastward
of Trial harbour. There are depths of 12 and 13 fathoms (21m9 and
23m8) about 1¼ miles off the long sandy beach to within about 3 miles   5
of Braddon point.

Mount Heemskirk, 2,446 feet (745m5) high and conspicuous, rises about
4 miles northward of Trial harbour, and is visible from seaward for
30 miles. Mount Agnew, 2,765 feet (842m8) high, and Mount Zeehan,
2,296 feet (699m8) high, rise about 3¼ miles north-eastward and 6¾ miles   10
eastward, respectively, of Trial harbour. Mount Dundas, 3,746 feet
(1,141m8) high, rises about 7 miles east-north-eastward of Mount Zeehan,
and is the western summit of the Great Western Tiers (chart 1079), of
which Mount Ossa (Cradle mountain), 5,230 feet (1,594m1) high, situated
about 38 miles eastward of Trial harbour, is the highest summit in   15
Tasmania.

Charts 3531, 1629.
APPROACH TO MACQUARIE HARBOUR.—Entrance channel.
—The approach to Macquarie harbour lies between the southern part of
Ocean beach and Cape Sorell, about 2¾ miles west-north-westward. The   20
harbour entrance lies between Macquarie heads, about 2½ miles south-
westward of Cape Sorell and Braddon point *(42° 13' S., 145° 14' E.).*
Chart 3531.
Hells Gates, the entrance proper, is only about half a cable wide, and
lies between Macquarie heads and Entrance island, a mass of rock on   25
which stands a lighthouse (page 260), and from the northern extremity of
which detached rocks extend about half a cable northward. Entrance
island lies about half a mile north-westward of Braddon point and close
off Kawatiri shoal, which has depths of less than 18 feet (5m5) over it
and parts of which dry, extending about 1½ miles north-north-westward   30
of the point. The sea breaks heavily on the north-western extremity of the
shoal, the northern side of which is unsurveyed.

Hells Gates is approached by a narrow channel between the western
side of Kawatiri shoal and West breakwater, which extends about 4½
cables northward from Beach rock, on the eastern side of Pilot bay,   35
situated about 3½ cables north-westward of Macquarie heads. This
channel is obstructed by a bar, which in 1964, had a least depth of 16 feet
(4m9) over it, close north-eastward of Beach rock *(42° 13' S., 145° 13' E.).*
Chart 1629.
Cape Sorell is the rocky north-western extremity of a long and tapering   40
peninsula of moderate elevation which forms the western side of Mac-
quarie harbour. It is low, terminates in bare detached rocks of brown
appearance, and the coast on either side is very rocky and sterile. Many
above-water and sunken rocks lie close off this part of the coast, and one
small above-water rock lies about 2 cables north-westward of the western   45
extremity of the cape.
Charts 3531, 1629.
From Cape Sorell to the western side of the harbour entrance and for
about 3 miles within the entrance, the land on the western side is steep
and rises to irregular ranges of rocky hills of quartzite and sandstone   50
covered with button grass, contrasting with the land on the eastern side,
which is low and covered with dense scrub and marram grass.
Charts 1629, 1079.
Mount Strahan, 2,796 feet (752m2) high, and Mount Sorell, 3,748 feet
(1,142m4) high, stand on the northern side of the harbour, about 13   55

miles eastward and 14½ miles east-south-eastward, respectively, of Braddon point, with Frenchmans Cap (page 256), about 11½ miles eastward of the latter mountain.

5 *Charts 3531, 1629.*

Between Cape Sorell and Lucas point the north-western entrance point of Pilot bay, about 1¾ miles eastward, the coast is fronted by rocks, above and below water. Watt hill, a remarkable rocky hill, rises about a quarter of a mile south-westward of Lucas point, and Prater rock and
10 Tide Gauge rock, both above water, lie about one cable south-eastward and 3 cables southward, respectively, of the same point. Depths of less than 18 feet (5m5) extend about 3 cables from the head of Pilot bay. The head of this bay is formed by a sandy beach, backed by sand hills and dense scrub. Outer bay, which is shallow, lies on the north-western
15 side of Macquarie heads. Mount Anthill, about one mile south-south-eastward of Watt hill and similar to it, but having a remarkable double summit; and Wellington head, about one mile above the entrance, which rises rather abruptly and is easily identified by its table top, 249 feet (75m9) high, and by a prominent quarry on its eastern slope. From the offing,
20 Wellington head appears isolated before the lower ground, connecting it with the hills westward of it, becomes visible.

Chart 1629.

Lights.—A light is exhibited, at an elevation of 186 feet (56m7), from a white round tower, 100 feet (30m5) in height, situated on Cape Sorell.
25 This lighthouse is connected by telephone with Strahan (*42° 09′ S., 145° 20′ E.*) (page 265).

Chart 3531.

A light is exhibited, at an elevation of 34 feet (10m4), from a white six-sided wooden tower, situated on the western extremity of Entrance
30 island.

For the lights which mark the channel over the outer bar and the entrance channel, *see* page 263.

A light is exhibited, at an elevation of 24 feet (7m3), from close southward of the north-eastern extremity of Macquarie heads.
35 Tidal information.—Tidal information can be obtained by radio-telephone from the western entrance point, where watch is kept when vessels are expected.

Signals.—The following signals, shown on the western entrance point, indicate that the bar is dangerous or that the channel is blocked:—
40 By day, a red square flag at the masthead.

At night, two *red* lights, vertically disposed, at the yardarm.

Tidal stream signals are shown from the same place; for these *see* the plate facing this page.

When the signals for slack water are shown, a vessel should endeavour
45 to enter and not wait for the signal for the in-going stream, for at times this stream does not run but the out-going stream sets out more strongly than before slack water.

Vessels should sound their sirens or whistles when they have made out the night signals.

50 *Chart 1629.*

Anchorage.—There is no shelter from winds between west and north for any but small vessels outside the bar in the approach to Macquarie Harbour entrance. North-westerly and westerly gales frequently blow here with great violence, and when there is a prospect of the wind
55 blowing from these quarters it is unsafe for vessels to anchor outside the bar.

TIDAL STREAM SIGNALS

DAY		NIGHT
	Very strong out-going stream (Over 5 Knots.)	
	Strong out-going stream. (2½ to 5 Knots.)	
	Moderate out-going stream. (Under 2½ Knots.)	
	Very strong in-going stream. (Over 5 Knots.)	
	Strong In-going stream. (2½ to 5 Knots.)	
	Moderate in-going stream. (Under 2½ Knots.)	
	Slack Water.	

Chart 1629.

In fine weather, vessels waiting for a favourable tidal stream, or for a pilot, can anchor in depths of 36 to 42 feet (11m0 to 12m8), sand, about 1¼ miles north-westward of the head of West breakwater.

Charts 3531, 1629.   **5**

Caution.—Directions.—In north-westerly gales or when a heavy westerly swell is running, dangerous breakers form across Macquarie Harbour approaches eastward of Cape Sorell in depths of 24 to 30 feet (7m3 to 8m1). Vessels should not attempt entry in such conditions.

A vessel entering Macquarie harbour should follow the recommended **10** track, shown on the chart, keeping Bonnet Island light-tower (page 263) open between the light-structures on Entrance island and the western entrance point and one-third of the way from the latter. When the knuckle of West breakwater is abeam to starboard, distant about 200 feet (61m0), she should steer for the middle of the entrance bearing 154°. **15**

MACQUARIE HARBOUR.—General remarks.—From its entrance, Macquarie harbour extends as a narrow entrance channel for about 5 miles south-eastward and eastward. It is then divided into two arms, a northern arm, extending about 5 miles northward to the town of Strahan, and a south-eastern arm, extending about 13 miles south-eastward to the **20** mouth of Gordon river. Macquarie harbour is under the jurisdiction of the Marine board of Strahan.

Though this harbour is deep above its entrance channel, a depth of only 13 feet (4m0) could be carried through that channel in 1967, and as the position of the channel over the outer bar is liable to change, **25** vessels should not attempt to enter without local knowledge. Vessels over 240 feet (73m2) in length proceeding through Hells Gates should guard against being set on to Entrance island (*42° 13′ S., 145° 14′ E.*) by the tidal streams, which run obliquely across that passage.

Chart 3531.   **30**

Prohibited landing.—Landing is prohibited on Entrance island and Bonnet island, *see* below, without permission from the authorities.

Pilotage.—Regulations.—Vessels bound for Strahan should advise the Harbour master of their expected time of arrival at the bar at least 8 hours beforehand; this may be done through the coastal radio station, **35** but preferably by radiotelephone to Macquarie heads, where watch is kept when vessels are expected. On receipt of the expected time of arrival the Harbour master will communicate to them the condition of the bar and local tidal information.

As a rule, the pilot will board vessels abreast the head of West break- **40** water; in approaching this position vessels should keep Bonnet Island light-structure more nearly in line with the western entrance point light-structure than with that of Entrance island.   ·

Entrance channel.—Dangers.—Training walls.—Kidney cove, a small cove with a tide gauge on its southern side, indents the eastern **45** side of Macquarie heads, with its southern entrance point half a cable south-south-westward of Entrance Island light-tower.

Nigger Head rock, a pinnacle rock which dries 2 feet (0m6), lies close inshore on the eastern side of the southern entrance point of Kidney cove.

Gate hill, 148 feet (45m1) high, and Bell hill, 195 feet (59m4) high, rise **50** about 3 cables south-westward and 4½ cables south-south-westward, respectively, of Macquarie heads. A small T-headed jetty is situated about one cable south-south-westward of Nigger Head rock. From this jetty the coast trends south-eastward for about one mile to Wellington head (*42° 14′ S., 145° 14′ E.*). The Cap, an above water rock, and Bonnet **55**

Chart 3531.

island lie about 3 and 3½ cables north-north-westward of the head. A training wall extends about one cable northward from the shore on the northern side of Wellington head to within half a cable of the Cap, enclosing the eastern side of Bonnet bay which is filled with a drying sand bank. Close westward of the head of Bonnet bay is a pine tree (1964). Two white rocks stand about 2 cables south-westward and half a cable south-eastward, respectively, of the root of the training wall. Close north-eastward of the latter rock, foul ground, with a depth of 7 feet (2m1) over it, extends a short distance towards the fairway.

Within Hells Gates, the entrance channel trends about 3 cables south-ward passing close eastward of Nigger Head rock, and westward of the bank, which extends about 4 cables westward from Braddon point. Thence the channel trends south-eastward for about 8 cables passing south-westward of Bowra rock, with a depth of 3 feet (0m9) over it, lying on the edge of that bank about a quarter of a mile southward of Braddon point, and thence eastward of Bonnet island and the Cap.
Charts 3531, 1629.

From Braddon point the low, scrub-covered coast trends east-south-eastward for about 1¾ miles to River point, and thence east-north-east-ward for about 1¼ miles to Yellow bluff, the western entrance point of the northern arm of Macquarie harbour, *see* page 264. Fraser flats, with depths of less than 18 feet (5m5) over it and which dries in places, extends about one mile offshore between Braddon point and Yellow bluff (42° 14′ S., 145° 18′ E.), and about one mile eastward from the latter point. Back channel is entered about 3 cables south-eastward of Braddon point and leads close inshore of the flats. There is a small wooden jetty at the northern entrance point of Back channel.
Chart 3531.

Between the western end of Fraser flats and Wellington head is the inner bar, which, in 1967, had a depth of 13 feet (4m0) over it, on the leading line, *see* below. Channel bay lies between Wellington head and Spur point, the north-western extremity of Round head, about one mile south-eastward. Mosquito cove, in the northern part of the bay, is entered between Camp point, about 1½ cables southward of Wellington head, and a point about 4 cables south-south-westward. Channel hill, 261 feet (79m5) high, rises close to the head of Channel bay, and Round hill, 311 feet (94m8) high, rises about 1¾ cables west-south-westward of Round head. A training wall extends about 1½ miles south-eastward from Wellington head across the entrance to Channel bay. Near its root is a small gap, and about 1¾ cables south-eastward a white stone stands on the wall.
Chart 1629.

Between Round head and Liberty point, the south-western entrance point of the eastern arm of Macquarie harbour, about 4 miles south-westward, the coast is formed by three bays, separated from each other by Backagain point and Table head, situated about 1½ and 3 miles south-eastward. Table Head hill, 635 feet (193m5) high, rises about one mile south-westward of Table head. The whole of this stretch of coast is fronted by sand banks, most of which are covered, extending up to 2 miles offshore, only the northern edge of which has been surveyed. Elizabeth (Betsey) island, with Bird islet and Shag islet, about a quarter of a mile northward, lies about three-quarters of a mile east-south-eastward of Backagain point (42° 16′ S., 145° 16′ E.).

Kelly channel, the upper part of the entrance channel, has its western end abreast Spur point. It trends about 3 miles east-south-eastward and

Chart 1629.

east-north-eastward, bounded northward by Fraser flats, and southward by the upper part of the training wall and by the sandbanks fronting the coast between Round head and Liberty point.
Chart 3531.

Lights.—Beacons.—Buoyage.—The entrance lights are described on page 260. The remaining aids are described below in the order of their use from seaward:—

A light is exhibited, at an elevation of 45 feet (13m7), from a white six-sided wooden tower situated on the northern end of Bonnet island.

A light is exhibited from Wall light-beacon, a three-pile beacon, standing alongside the training wall extending from Wellington head, and about 2½ cables northward of Spur point.

Six leading lines, described below, lead up the channel from Hells Gates to Kelly channel.

A pair of leading beacons, half a cable apart, each with a triangular topmark, stand on Entrance island, with the front beacon situated one-quarter of a cable south-eastward of Entrance Island light-tower. In line, astern, bearing 003°, they lead from Hells Gates to the leading line marked by Inner Leads.

Lights are occasionally exhibited from Inner Leads, a pair of light-beacons standing one-quarter of a cable apart, with the front beacon situated 5½ cables southward of Entrance Island light-tower. In line, bearing 177½°, they lead from the above-mentioned leading line to that marked by Main Leads.

Lights are occasionally exhibited from Main Leads, a pair of light-beacons standing half a cable apart, with the front beacon situated 2¼ cables south-south-westward of Entrance Island light-tower. These light-beacons in line, astern, and in line with an unlit beacon half a cable north-westward of the rear beacon, and bearing 322½°, lead from the leading line marked by Inner Leads to a position close eastward of Bonnet island.

Braddon red can buoy is moored on the south-western edge of the bank extending from Braddon point, and one-quarter of a cable eastward of the junction of the leading lines marked by Inner and Main Leads, both of which clear the bank.

A pair of leading beacons, each with a triangular topmark, are situated with the front beacon on the training wall 3¼ cables south-south-westward of Wellington Head summit, and with the rear beacon on the shore one cable south-south-eastward of Spur point; in line they bear 156½° and lead from abreast Bonnet island (42° 13′ S., 145° 14′ E.) to abreast Wellington head.

Lights are occasionally exhibited from Bonnet Bay leads, a pair of light-beacons standing nearly half a cable apart, with the front beacon situated three-quarters of a cable south-westward of the light-tower on Bonnet island. These light-beacons in line, astern, and in line with both a black beacon with a triangular topmark 6½ cables north-westward of the front light-beacon, and a beacon with a square topmark on the training wall projecting northward towards the Cap, bearing 318½°, lead from abreast Wellington head to a position eastward of Wall light-beacon.

A red can buoy is moored 1½ cables north-eastward of the summit of Wellington head and about one-quarter of a cable north-eastward of the junction of the leading lines that meet off Wellington head.

Mosquito Cove Leads, a pair of leading beacons, 85 feet (25m9) apart, each with a diamond topmark, are situated with the front beacon 2¼ cables south-south-westward of Wellington Head summit. These

Chart 3531.

beacons, in line, astern, and in line with a beacon with a square topmark, 1¼ cables west-north-westward of the front beacon, and a beacon with a white circular topmark on the training wall 5½ cables east-south-eastward of the front beacon, bearing 295¾°, lead from the position eastward of Wall light-beacon into Kelly channel.

No. 1 can buoy, painted red and white in chequers, is moored about 2¼ cables eastward of Wall light-beacon, and three-quarters of a cable north eastward of the junction of the leading lines marked by Bonnet bay and Mosquito Cove Leads.

A light is exhibited from No. 2 light-beacon, situated on the northern side of the western entrance to Kelly channel, and 9¼ cables eastward of Spur point.

A pile and a beacon stand on the southern side of the entrance to Kelly channel, about 1¼ and 2 cables south-westward of No. 2 light-beacon.

Chart 1629.

The northern side of Kelly channel is marked by Nos. 2A, 3 and 4 light-beacons; farther north-eastward, it is marked by No. 5 beacon, and by No. 7 light-beacon, situated on the eastern extremity of Fraser flats. The southern side of the channel is marked by two beacons standing about 6½ cables south-westward, and 3½ cables south-eastward, respectively of No. 5 beacon.

Chart 3531.

Submarine cable.—Beacons.—A submarine cable is laid across the entrance channel in a west-north-westerly direction from the northern entrance point of Back channel to the western shore, where its landing place is marked by two beacons. *See page 17.*

Anchorages.—Sheltered anchorage for small craft, in a depth of about 8 feet (2m4), can be obtained about half a mile east-north-eastward of Bonnet island in the entrance to Back channel. Bonnet Island light-tower (*42° 13′ S., 145° 14′ E.*) in line with a beacon with a triangular topmark situated 1¼ cables westward of it, bearing 260°, astern, leads from the entrance channel to the anchorage.

Anchorage may be obtained in a depth of about 18 feet (5m5) in Mosquito cove, about half a cable eastward of the front beacon of Mosquito leads.

Charts 3531, 1629.

Tides and tidal streams.—Freshets.—The tides are mainly diurnal and have a small mean range, but the rate and duration of the tidal streams are very much influenced by great freshets which flow into the harbour from the high mountains in the interior during the prevalence of rainy weather; and also by the change in the level of the water due to the winds; with south-westerly winds the level of the water is lowered and with northerly winds is raised. The out-going stream may continue to run while the tide is rising, especially after heavy rains, and at such times there may be a sub-surface in-going stream.

During freshets, the out-going stream in the entrance channel runs very strongly, often attaining a rate of 8 or 9 knots in Hells Gates and 6 knots in other parts of that channel. At such times the tidal stream will run out of the harbour for two or more days; with strong northerly winds it will run in for the same period. The tidal streams set obliquely across Hells Gates.

Chart 1629.

Channel to Strahan.—Beacons.—Buoy.—The northern arm of Macquarie harbour, which forms the approach to Strahan (page 265) extends northward of a line joining Yellow bluff to Sophia point, about 3½ miles east-south-eastward. A deep channel extends through this

Chart 1629.

arm to Strahan between the shore banks on either side. This channel is broad for the first 3½ miles to the entrance to Long bay, between Town point and Dead Horse point, above which it has a width of about 2 cables.

Swan basin is an area which mostly dries, lying on the western side of the channel westward of a line joining the northern end of Neck island, about 2 miles northward of Yellow bluff, Cat island and Magazine island. A beacon stands close south-westward of the latter island.

Smith cove, on the western side of the channel, about one-quarter of a mile westward of Town point, is a small indentation forming a natural dock, in the greater part of which there are depths of 12 feet (3m7) or more. There is a depth of 10 feet (3m0) in its entrance, from the western side of which a ledge of rocks extends east-south-eastward and from the eastern side of which rocks extend a short distance southward. This cove should only be used by small craft with local knowledge. A rocky spit, with depths of less than 18 feet (5m5) over it, extends about a quarter of a mile south-eastward from Town point (*42° 11′ S., 145° 20′ E.*).

Defriez bay lies on the southern side of Magazine point, situated about one mile northward of Town point, and Mill bay or Pine bay is entered at the north-western end of Long bay between Magazine point and Strahan point, about 3½ cables north-eastward.

Sophia point is low, and from it a reef extends about half a mile south-westward, its outer end being marked by a three-pile beacon, with a platform.

King point, about 2½ miles north-north-westward of Sophia point, has a reef extending about half a mile south-westward from it, the southern edge of this reef being marked by a pile beacon. Pine cove, on the eastern side of King point, affords good anchorage for small vessels with local knowledge, in a depth of 18 feet (5m5). In addition to the reef extending from King point, a rock, with a depth of 3 feet (0m9) over it, lies in the middle of the entrance. The tidal streams are scarcely perceptible in this cove.

King (Kings) river, which flows into the eastern side of the channel about one mile north-eastward of King point, has a shallow mouth and is only accessible to boats. Lettes bay lies between the northern entrance point of King river and Dead Horse point, and is shallow.

Lights.—No. 7 light-beacon has been described on page 264.

A light is exhibited from No. 8 light-beacon, situated on the outer end of the reef extending south-eastward from Town point (*42° 11′ S., 145° 20′ E.*).

The front light of a pair of leading lights is exhibited from Regatta point, on the eastern side of Long bay, three-quarters of a mile northward of Dead Horse point; the rear light is exhibited from the south-eastern part of the town of Strahan, 4 cables northward of the front light; in line they bear 005° and lead into Long bay between Dead Horse point and the dangers off Town point.

Explosives anchorage.—Vessels carrying explosives must anchor southward of a line joining Regatta point to Magazine point.

Wharves.—Port facilities.—There are two wharves in Strahan harbour. Strahan wharf has a length of 270 feet (82m3), with depths of 9½ to 19 feet (2m9 to 5m8) alongside. Regatta Point wharf has a length of 390 feet (118m9), with depths of 7 to 14 feet (2m1 to 4m3) alongside; the latter is used for cargoes of coke and explosives. Ore jetty has a length of 400 feet (121m9) between dolphins, with a depth of 15½ feet (4m7) alongside. Both wharves and the ore jetty are connected to the railway system. On the ore jetty is a bulk conveyor be'·'·nder '·· vritic

Chart 1629.

which can be loaded at a rate of 240 tons per hour. The maximum permissible length of a vessel berthing at the jetty is 400 feet (121m9).

Water can be supplied by hose and from tanks on lighters.

5   Strahan is the principal port on the western side of Tasmania. It is in regular communication by sea with Melbourne, Hobart and Sydney. The principal industry in this town is timber milling, and in the neighbouring district the principal industries are timber and mining. Queenstown, about 22 miles by railway from Strahan, is situated in the most
10 important mining district in Tasmania, the chief ores mined being copper, silver and gold.

The chief imports are general cargo, coke and explosives, and chief exports are ores, copper concentrates and blister copper.

South-eastern arm of Macquarie harbour.—Caution.—Beacon.—
15 The south-eastern arm of Macquarie harbour, which extends about 11 miles south-eastward of a line joining Liberty point and Sophia point, has been imperfectly surveyed and should not be used without local knowledge.

Double cove, on the south-western side about 3 miles southward of
20 Liberty point, has depths of from 3 to 6 feet (0m9 to 1m8) in it, and affords good shelter for small craft in all weathers.

Between Double cove and Sarah (Headquarters) island (*42° 23′ S., 145° 27′ E.*), about 6 miles south-eastward, the south-western shore consists of rocky points and small bights mostly fringed by sunken rocks,
25 the land behind being thickly wooded.

Sarah island lies on the inner part of a reef which extends about 1¼ miles east-north-eastward from the south-western shore about 6 miles east-south-eastward of Double cove; a few above-water rocks lie on this reef, and near its outer end is Grummet islet. Rum point, the north-
30 western entrance point of Birchs (Birches) inlet; see below, is situated about one mile southward of Sarah island, and from it a reef with rocks above and below water, extends about three-quarters of a mile east-north-eastward.

There is anchorage in depths of 18 to 30 feet (5m5 to 9m1) between
35 Sarah island and the reef extending from Rum point.

The north-eastern shore, from Sophia point for about 4½ miles to Coal head, is thickly wooded. Coal head is bold with thick scrub on it and forest behind, and is easily identified by a patch of yellow clay on it. Thence for about 3¾ miles to Gould point, the western entrance point of
40 Farm cove this shore is heathy and barren, rising inland to Mount Sorell and Mount Strahan (page 259). Phillip island lies about half a mile off this shore, at the southern end and close inside the outer edge of shallow rocky ground which fills the bight between Coal head and a point about 1¼ miles south-eastward of it.

45 Farm cove is entered between Gould point and Pine point (*42° 22′ S., 145° 30′ E.*), about three-quarters of a mile east-south-eastward; it is much obstructed by sandbanks and reefs, also by Soldier island which lies in its centre. A beacon marks the southern extremity of a reef extending about 4 cables south-eastward from Gould point.

50 The head of the south-eastern arm is divided into three branches. Kelly basin, at the head of the north-eastern branch, is a natural basin which affords excellent anchorage in all weathers to small craft with local knowledge. Gordon river, the middle branch, is obstructed at its entrance by a bar, with a depth of 10 feet (3m0) over it, after crossing
55 which the channel lies mainly in the centre of the river and small craft

Chart 1629.

entered between Rum point and Gordon point, about 2 miles south-eastward, is only navigable by small craft. Sorell river enters the inlet at its head.

Charts 1629, Aus. 353.
5   **COAST.—Dangers.—**Between Cape Sorell (page 259) and Point Hibbs, about 25 miles southward, the coast consists of a succession of rocky bights and points. The land rises gently for 2 or 3 miles behind this coast and it appears smooth and uniform, but destitute of trees and almost barren. Mount Lee (Direction), 2,409 feet (734m3) high, the highest
10 summit of the Daguilar range, rises about 15 miles eastward of Point Hibbs.

From Cape Sorell the coast trends southward for about 7 miles to Sloop point, and is fronted by rocks, above and below water, extending about 1½ miles offshore. Sloop rock, above water, lies near the edge of the above bank, about 1½ miles northward of Sloop point.
15

From Sloop point to Gorge point the coast continues southward for about 3¼ miles and thence 4 miles farther southward to the northern entrance point of Birthday bay.

Chart Aus. 353.

Varna bay, at the head of which Modder river enters the sea, is situated
20 about 8½ miles southward of Gorge point (*42° 22′ S., 145° 13′ E.*). Rocks, with depths of less than 6 feet (1m8) over them, extend about half a mile westward from the entrance of Modder river. Hibbs bay lies between a point about 4 miles south-south-eastward of the entrance to Modder river, and Point Hibbs, about 3 miles south-south-westward. Above
25 water rocks extend about three-quarters of a mile south-westward from the northern entrance point of the bay, and Hibbs river flows into the sea near the northern end of the bay.

Point Hibbs is higher than the neck of land connecting it with the mainland. Rocks, above and below water, extend about half a mile
30 westward from the point. Hibbs Pyramid, 300 feet (91m4) high and conspicuous, is so-named from its shape, and lies near the edge of foul ground extending about 1½ miles north-eastward from the point. This rock seen from southward of Point Hibbs on north-north-easterly bearings, appears like the crown of a hat over the extremity of that point. Rocks,
35 above and below water, extend about half a mile westward, one mile southward and 1½ miles south-eastward, respectively, from Point Hibbs.

Off-lying dangers.—Caution.—Albina rock, above water, lies about 3 miles south-south-westward of Gorge point.

Two rocks, awash, were reported in 1955 to lie about 2¾ and 4¾ miles
40 north-north-westward of Point Hibbs (*42° 37′ S., 145° 15′ E.*).

Breakers have been reported to lie about 3 miles offshore between Sloop point and Point Hibbs, and vessels are cautioned to keep a good offing between these points.

Coast (*continued*).—**Dangers.—**Condor point, close southward of
45 which is an above water rock, is situated about 4½ miles south-eastward of Point Hibbs, and separates Spero bay on its north-western side from Endeavour bay on its south-eastern side. Wanderer river enters the sea at the head of Christmas cove, about 5¼ miles south-south-eastward of Condor point, and is said to afford anchorage for small vessels with
50 local knowledge. High Rocky point, situated about 2½ miles southward of Christmas cove, is fronted by high rocks, extending three-quarters of a mile south-westward, and foul ground extends about one mile north-north-westward.

From High Rocky point the coast trends south-south-eastward for
55

Chart Aus. 353.

about 6¼ miles to Mainwaring inlet, at the head of which Mainwaring river flows into the sea; thence the coast continues south-south-eastward for about 3¼ miles to Diorite point, and thence for about 4¾ miles south-ward to Low Rocky point. Foul ground extends about half a mile north-westward from Mainwaring inlet, and between that inlet and Diorite point, rocks above and below water, extend up to 1¼ miles offshore. Acacia rocks, 20 feet (6m1) high, lie near the outer edge of the latter area of foul ground, about 1½ miles south-westward of Mainwaring inlet.

Lewis river flows into the sea about midway between Diorite point and Low Rocky point. Rocks, above and below water, extend about three-quarters of a mile north-westward and three-quarters of a mile south-westward, respectively, from Low Rocky point.

The land between Point Hibbs and Low Rocky point is somewhat more elevated and not so destitute of trees as that northward of Point Hibbs. Mount Osmund, 1,207 feet (367m9) high, *the southern summit* of the Daguilar range, rises about 8 miles north-north-eastward, and Mount Sprent (Wilmot range) (chart 1079), 3,483 feet (1,061m6) high, the northern summit of the Frankland range, rises about 24 miles east-north-eastward, respectively, of Low Rocky point (*43° 00′ S., 145° 30′ E.*).

Light.—A light is exhibited, at an elevation of 179 feet (54m6), from a metal framework tower, 60 feet (18m3) in height, on the southern end of Low Rocky point.

Chart 1079.

Coast (*continued*).—Between Low Rocky point and a rounded projection about 13 miles south-eastward, the coast forms a bight in the centre of which is Elliot bay (cove). From the south-eastern end of this bight the coast trends about 10 miles south-south-eastward to Point St. Vincent, which is fronted by a reef on which lie the West Pyramids, a group of islets and rocks, extending from about one mile north-westward to about one mile westward of that point.

From Point St. Vincent the coast trends about 2 miles south-eastward to North head, which is fronted by a reef with above-water rocks on it, thence it trends about one mile eastward to Pollard head (*see* below).

For about 19 miles south-eastward of Low Rocky point the coast is high, and inland are several white bare peaks, which appear as if covered with snow. The Propsting (De Witt) range attains an elevation of 2,445 feet (745m2) at its southern end, about 18 miles south-eastward of Low Rocky point. The summit of the peninsula terminating in Pollard head and forming the western side of the northern arm of Port Davey (page 269), is 1,122 feet (343m0) high.

Off-lying islets and dangers.—Green islet lies about 6 miles north-north-westward of Point St. Vincent.

Trumpeter islets, a group of four islets connected by a reef, lie about 2 miles north-north-westward of Point St. Vincent.

Duck islet lies about one mile westward, and a reef lies half a mile south-ward, respectively, of North head.

Off-lying depths.—A depth of 26 fathoms (47m5) was reported in 1967 to lie about 7 miles west-north-westward of Point St. Vincent (*43° 17′ S., 145° 50′ E.*).

Charts 3410, 3411.

PORT DAVEY.—General remarks —The entrance to Por[t] [Da]vey li[e]

Charts 3410, 3411.

eastward, where it is divided into two arms; the northern arm extends about 5 miles to the entrance to Davey river (page 271); Bathurst channel (page 272), the eastern arm, extends about 7 miles to Bathurst harbour (page 274).

Chart 3410.

Bramble cove (page 271), which lies immediately northward of the western end of Bathurst channel, affords the most secure anchorage in Port Davey.

Chart 3410, plan of Port Davey.

When nearing Port Davey the land on either side presents a most rugged and barren aspect, and eastward it is steep and mountainous. The two summits above Pollard head are well defined conical peaks, which are easily identified in the approach, and the entrance may be identified by Big Caroline islet. Hilliard head is a high, craggy, pro-jecting point rising to an elevation of about 750 feet (228m6), about one mile south-eastward. *See* view [32].

Islets and dangers in the approach.—The islets and dangers on the northern side of the approach have been described above.

Stokes rock, with a depth of less than 6 feet (1m8) over it, on which the sea breaks occasionally, lies about 1¾ miles southward of Pollard head.

Big Caroline islet, about three-quarters of a mile north-north-west-ward of Hilliard head, is about 250 feet (76m2) high.

Swainson islet, about 200 feet (61m0) high, with sunken rocks close round it and an above-water rock close off its north-western side, lies about half a mile north-eastward of Hilliard head.

Sunken rocks lie close off Pollard head, but there are depths of 30 feet (9m1) about one cable off that head. Hilliard head also has sunken rocks close off it.

Mutton Bird islet, lying close offshore, about 1¼ miles south-eastward of Hilliard head (*43° 23′ S., 145° 55′ E.*), is low, it has no defined summit and from seaward appears like part of the coast; a smaller islet lies close off its north-eastern side.

East Pyramids are a group of peaked islets, more or less connected by rocks, lying from about one mile to one-quarter of a mile southward of Hilliard head; Sugar Loaf, the southern islet, about 250 feet (76m2) high, is the highest of this group and it is similar in appearance to Big Caroline islet. *See* view [32].

Mutton Bird islet and the East Pyramids have been reported to lie about one mile farther southward than charted. There are sunken rocks between Mutton Bird islet and the East Pyramids, but there are no known dangers outside the latter.

Outer part and northern arm of the port.—Caution.—Islets and dangers.—Light.—The outer part of Port Davey extends about 3 miles east-north-eastward between Pollard head and Garden point, on the northern side, and between Hilliard head and Hannant point, on the southern side; the northern arm extends above a line joining Garden point to Ashley head, about 1½ miles east-north-eastward. These portions have been imperfectly surveyed and they should be used with great caution. Vessels should avoid anchoring anywhere seaward of Bramble cove, as a shift of wind to southward or south-westward will bring a heavy sea right into and up the port.

Nares rock, awash in places, lies about 1¼ miles east-north-eastward of

point, about one mile east-north-eastward of Hilliard head, has depths of from about 24 to 30 feet (7m3 to 9m1) in it; a heavy swell always sets into this cove, rendering it impossible for a boat to effect a landing at any time.

Hay islet lies close off Knapp point, the eastern entrance point of Norman cove, and about half a mile eastward of it are two above-water rocks, lying in the middle of the entrance to Spain bay. This bay has not been examined, but on its south-western side a boat may effect a landing with winds between east and south, with the wind with any westing in it this would be impossible.

Shanks islets, three-quarters of a mile north-westward of Hannant point, the Breaksea islands and Kathleen island, which lie in the approach to Bramble cove, are described on page 271.

Hannant inlet is entered between Hannant point and O'Brien point, about 2 cables northward; it is nearly barred across by an islet close inside its entrance. This inlet extends about one mile eastward then 3 miles southward, but it is useless for any but very small craft, the depths above the islet being shallow.

The fairway of the northern arm has depths decreasing from about 54 feet (16m5) at its southern end to 24 feet (7m3), about 3 miles higher up, at the southern end of Payne bay, the northern portion of the arm. The shores of this arm as far as Earle point, on the western side about 2 miles above Garden point, and Berry (Bluff) head on the eastern side, about three-quarters of a mile above Ashley head (43° 17′ S., 145° 57′ E.), may generally be approached to half a mile in depths of from 30 to 36 feet (9m1 to 11m0); but off Earle point and between Berry head and Woody point, on the eastern shore 1¾ miles higher up, there are depths of from 18 to 24 feet (5m5 to 7m3) about half a mile offshore.

A light is exhibited from a square metal framework tower, 14 feet (4m3) in height, on Garden point.

The western shore between Garden point and Earle point, is fringed by reefs, and sunken rocks and a shoal bank extend about one-quarter of a mile eastward and northward of Earle point. Whaler cove is a slight indentation in this shore between Garden point and an islet close offshore about one mile northward of it. The coast from abreast this islet to about half way to Garden point is fringed by a reef extending about 2 cables offshore. There are depths of from about 30 to 42 feet (9m1 to 12m8) about 2 cables offshore in the south-eastern part of Whaler cove, where tolerably sheltered anchorage may be obtained in north-westerly or westerly gales, but it is exposed to the wind and sea if blowing hard from south-westward.

On the eastern shore, Ashley head and Berry head are each bordered by a rocky ledge, but they may be approached within about one cable in depths of not less than 30 feet (9m1). From Berry head to Fitzroy point, about 1¾ miles above Woody point, this shore is mostly fronted by islets and rocks. The mouth of Coffin creek lies midway between Berry head and Pym point, about one mile higher up.

Bond bay, on the western side of the arm, which is entered between Earle point and Curtis point, about 1¼ miles northward, is mostly shallow, and at its head is an opening, about 1½ cables wide, leading into Kelly basin, which is also shallow.

Payne bay, above a line joining Curtis point to the southern of the Fitzroy islets, which lie off Fitzroy point, is shallow and encumbered with rocks. The Fitzroy islets dry about 3 feet (0m9) except the north-western which is 10 feet (3m0) high.

A rock, awash, the position of which is doubtful, lies about half a mile south-westward of Fitzroy point (43° 14′ S., 145° 57′ E.).

Davey river flows from northward into the north-western corner of Payne bay, its mouth being about half a mile wide between Observatory point on the western shore about a mile above Curtis point, and Bar point on the eastern shore about half a mile above Fitzroy point. The approximate course of the channel across its bar, is indicated on the plan; the depth in this channel is 3 feet (0m9), over hard sand, but this depth is increased after freshets.

Chart 3410, plan of Bathurst channel, sheet 1.

Bramble cove.—The entrance to Bramble cove lies between Turnbull head, about 1½ miles north-north-eastward of O'Brien point, and Milner head, about 4 cables north-north-westward, with the Breaksea islands lying in the middle of the approach and having a channel on either side. This cove is a safe and commodious harbour, surrounded by hills and protected by the Breaksea islands from the heavy sea which rolls into Port Davey.

On its southern side, between Turnbull head and Hixson point, about half a mile eastward, is the entrance to Bathurst channel, its entrance proper being between Turnbull head and Sarah island, better known as Tonguers island, which is 100 feet (30m5) high and is only separated from Hixson point by a boat passage. A rocky ledge, with depths of less than 18 feet (5m5) over it, extends about three-quarters of a cable northward from the northern end of Sarah island.

Within its entrance the depths in Bramble cove decrease regularly from about 14 fathoms (25m6) in mid-channel to about 24 feet (7m3) about one cable offshore. Between Datum point and Aylen point, situated about half a mile and three-quarters of a mile eastward of Milner head, there are small sandy beaches, and also close eastward of Aylen point; elsewhere in the cove it is fringed with rocks.

Morning hill, 670 feet (204m2) high, Stainer hill, 643 feet (196m0) high, and Mount O'Brien, 625 feet (190m5) high, rise about 3, 6 and 10 cables south-south-westward of Turnbull head (43° 20′ S., 145° 59′ E.). Mount Milner, 610 feet (185m9) high, and Mount Greer, 725 feet (221m0) high, rise about 4 cables northward and 8 cables north-eastward, respectively, of Milner head. Mount Misery, 1,570 feet (478m5) high and very precipitous on its southern side, directly overlooks the cove. It is the southern summit of a prominent range, which extends northward from it. Mount Berry, about three-quarters of a mile farther inland, and the highest part of this range, is 2,120 feet (646m2) high, but it is completely hidden from the cove by Mount Misery. Round hill, 790 feet (240m8) high, rises about three-quarters of a mile southward of Mount Misery.

Islands and dangers in the approach.—Channels.—The approach to Bramble cove is obstructed by Kathleen island, the Breaksea islands and Shanks islets, between which two channels lead to the cove northward and southward of the Breaksea islands.

South passage, the deeper of these two channels, lies between Shanks islets and the southern end of the Breaksea islands; it has a least width of 2 cables, with depths of 60 feet to 16 fathoms (18m3 to 29m3) in it, and through it depths of over 36 feet (11m0) can be carried to Bramble cove. Shanks islets, on the southern side of this passage, are eight in number, the highest and largest having an elevation of about 200 feet (61m0), *see* view [31]; sunken rocks lie close round these islets and an 18-foot (5m5) patch lies 1¾ cables northward of the summit of the largest islet.

Chart 3410, plan of Bathurst channel, sheet 1.

Breaksea islands, on the northern side of South passage, lie from about half a mile northward of Shanks islets to three-quarters of a mile westward of Milner head. They are three in number, and all are faced with cliffs, the middle and longest being 250 feet (76m2) high near its centre, the northern 255 feet (77m7) high, and the southern, which is almost joined to the middle island, 175 feet (53m3) high; *see* view [31]. A rock, 13 feet (4m0) high, lies about one cable west-south-westward of the southern extremity of the southern island, and above-water and sunken rocks lie close off the sides of all these islands, but there is deep water about one cable off their western sides and depths of not less than 30 feet (9m1) about 1½ cables off their eastern sides. The islands are connected with the mainland near Milner head by a 30-foot (9m1) bank, but between the middle island and the south-eastern side of the approach there are depths of over 36 feet (11m0) for a least width of about one cable.

Two patches, with depths of 28 and 30 feet (8m5 and 9m1) over them, respectively, lie close together on the southern side of South passage, about half a mile north-westward of O'Brien point. On the south-eastern side of the approach, between O'Brien point and Turnbull head, depths of less than 36 feet (11m0) extend as much as about 2 cables offshore. A rock, 6 feet (1m8) high, lies close north-westward of Turnbull head (43° 20′ S., 145° 59′ E.).

North passage lies between the northern end of Breaksea islands and Boil rock, 5 feet (1m5) high, about 3½ cables northward. It has a least width of about 2 cables and through it a least depth of 30 feet (9m1) can be carried to Bramble cove. Kathleen island, faced with cliffs and 360 feet (109m7) high, lies about half a mile north-north-westward of Boil rock; *see* view [31]. Needle rocks, a group of islets and sunken rocks lying between Kathleen island and the shore, are separated from that island by a clear passage which is useful for boats.

About half a mile northward of Milner head is Roaring beach, backed by cliffs. Two rocks, awash, lie about 2½ cables west-north-westward and 3 cables north-westward, respectively, of the southern end of the beach.

Anchorages.—The best anchorages in Bramble cove are in depths of about 42 and 39 feet (12m8 and 11m9), about 1¾ cables south-south-westward and 1½ cables south-south-eastward, respectively, of Datum point. These positions give good shelter from north-westerly winds, which have the reputation of being the strongest hereabouts; the bottom is hard sand.

Charts 3410, 3411, plans of Bathurst channel.

Bathurst channel.—Bathurst channel, which connects the western part of Port Davey with Bathurst harbour, *see* page 274, has a deep fairway, throughout its length with a least width, which is in The Narrows, *see* page 274, of about 200 feet (61m0). The water in this channel has a peculiar coffee colour, which entirely hides any signs of uneven bottom, and is caused by the fresh-water streams which flow through the peaty soil of the button-grass plains in their course to the sea; this colour is noticeable under all wet conditions, and is to be seen in the smallest mountain stream.

Chart 3410, plan of Bathurst channel, sheet 1.

At the entrance to Bathurst channel from Bramble cove, the fairway is 1¾ cables wide, between a point about one-quarter of a mile east-south-eastward of Turnbull head and the south-western side of Sarah island. Thence the fairway trends about three-quarters of a mile east-south-eastward to Mundy or Woody island. The northern shore is indented by small shallow bays separated from each other by Hammond

Chart 3410, plan of Bathurst channel, sheet 1.

point, May point (43° 20′ S., 146° 00′ E.), Helby point and Deep point, situated about 4 cables south-eastward, 5½ cables, 6½ cables and one mile east-south-eastward, respectively, of Hixson point. Heather hill, 185 feet (56m4) high, stands close northward of the first named point. Beabey point, on the southern shore, close southward of which is Schooner hill, 395 feet (120m4) high, is situated about midway between the point a quarter of a mile east-south-eastward of Turnbull head and Forrester point, about three-quarters of a mile south-eastward.

Mundy island, very thickly wooded, lies midway between Helby point and Forrester point, and divides the channel into two branches, the main fairway leading southward of the island and continuing about one mile east-south-eastward to abreast Branson point. Cover ledge, with depths of less than 18 feet (5m5) over it, extends a short distance eastward from the eastern end of the island.

Schooner cove, on the southern side of the channel, between Forrester point and Night islet, about 3 cables south-eastward, is only suitable for small craft, its southern part being shallow. A rock, awash, lies about one cable off its western shore about one-quarter of a mile south-south-westward of Forrester point.

Charts 3410, 3411, plans of Bathurst channel, sheets 1 and 2.

Between Noon point, situated about 3 cables eastward of Night islet, and Pine point, the eastern entrance point of Horseshoe inlet, about 1½ miles farther eastward the southern side of the channel is backed by a ridge, on which are Mount Nares, 995 feet (303m3) high, Mount Nicholls, 1,170 feet (356m6) high, and Mount Curran, 1,025 feet (312m4) high, situated about half a mile southward, one mile south-eastward and 1½ miles east-south-eastward, respectively, of Noon point (43° 21′ S., 146° 01′ E.).

From abreast Branson point the fairway trends about one mile eastward to Little Woody islet, the depths northward of a line joining Branson point and Little Woody islet being shallow. Mount Parry, 950 feet (289m6) high, and Mount Mackenzie, 990 feet (301m7) high, rise about three-quarters of a mile northward and one mile north-eastward, respectively, of Branson point. Thence the fairway trends about three-quarters of a mile east-north-eastward and eastward, passing about 2 cables southward of Opossum point and 3 cables northward of Pim point. The fairway then curves south-eastward, eastward and north-eastward, round the shoals, with depths of less than 18 feet (5m5) over them, extending about half a mile west-south-westward and three-quarters of a mile north-westward from Farrell point, the northern entrance point of The Narrows, about 1½ miles eastward of Little Woody islet. Gravelly beach, composed of pure white quartzite gravel, situated about 3½ cables eastward of Pim point is conspicuous, and about a quarter of a mile southward is Balmoral hill, with a round bare summit, 500 feet (152m4) high.

Chart 3411, plan of Bathurst channel, sheet 2.

Horseshoe inlet, on the southern side of the channel, with its entrance close south-westward of Pim point, is only available for small craft with local knowledge, its depth being only about 6 feet (1m8). Its shores are low-lying and, except off its northern shore, banks that dry extend a considerable distance from them. About one mile above its entrance are two patches of rocks which dry and considerably obstruct the channel on its north-eastern side; when entering, these patches should be left on the port hand and they should be given a good berth.

Joe Page or Long bay, on the northern side of Bathurst channel extends

Chart 3411, plan of Bathurst channel, sheet 2.

about 1¼ miles northward of its entrance eastward of Opossum point. Its southern end affords a useful anchorage for vessels of moderate draught, with good protection from north-westerly winds, which blow with considerable force between Little Woody islet and the western end of The Narrows. A 16-foot (4m9) patch lies about 3 cables south-south-eastward of Pauline point, situated about 4 cables northward of Opossum point. About 6 cables northward of the former point is Hehir islet (*43° 19′ S., 146° 03′ E.*), from which reefs extend about a quarter of a mile north-eastward. Lindsay hill, 525 feet (160m0) high, rises about one mile north-north-westward of Farrell point. A spit, with depths of less than 18 feet (5m5) over it, and a rock, which dries 2 feet (0m6) on its outer end, extends about 2 cables south-westward from a point about 3 cables westward of Lindsay hill. Cone islet lies about one cable north-ward of the 2-foot (0m6) drying rock. About 4 cables northward Pauline point and Cone islet, spits with depths of less than 18 feet (5m5) over them, extend from either side of the bay, almost joining to form a bar.

Spring river, which flows into the head of the bay, is navigable by boats drawing up to 5 feet (1m5) for about 3½ miles, but the bar at its entrance should be navigated with caution, keeping about 90 feet (27m4) from the bluff on its eastern side. The channel at the head of the bay, close inside the river mouth, is very shallow and dries in places.

Chart 3411, plan of Bathurst channel, sheet 2, and plan of The Narrows.

The Narrows, from its western entrance between Farrell point and Joan point, trends about 2 miles eastward where it opens out into Bathurst harbour between Platypus point and Nixson point. The fairway through it, which is less than half a cable in width at the western entrance, follows the general contour of its shores, its least width being abreast Eve point, on the southern shore about three-quarters of a mile east-ward of Joan point; shoal banks extend some distance from its points, more especially from a point on the southern shore about 4 cables north-westward of Nixson point, where a reef, with Gull islet at its outer end and a shoal bank, extend half way across the channel. Mount Rugby, on the northern side of The Narrows, is 2,520 feet (768m1) high and rugged-topped; it is precipitous on all sides, except on its northern side. Mount Beattie, 955 feet (291m1) high, rises about three-quarters of a mile south-westward of Nixson point (*43° 21′ S., 146° 08′ E.*).

Indentations in the northern shore of The Narrows are Ila bay close eastward of Farrell point, and Starvation bay about midway between Farrell point and Platypus point, and in the southern shore, Clyte cove, between Joan point and Eve point, and Iola bay, about half a mile east-south-eastward of Eve point.

Chart 3411, plan of Bathurst harbour.

Bathurst harbour.—From the eastern end of The Narrows, Bathurst harbour extends about 4 miles eastward; apart from a 13-foot (4m0) rocky patch near its centre about 1¼ miles east-north-eastward of Platypus point, it has a very even bottom, with depths of from about 18 to 27 feet (5m5 to 8m2), the deeper water being in its eastern part. Immediately eastward of The Narrows, the depths decrease very rapidly to from 15 to 21 feet (4m6 to 6m4). With north-westerly or westerly winds, a very short and steep sea, dangerous for boats, gets up very rapidly in the harbour.

Celery Top islands, six in number, with White rock, which is con-spicuous, close off their north western end, lie in the south western

Chart 3411, plan of Bathurst harbour.

southward and ending in a large shallow basin, to which this creek is navigable for boats drawing up to 5 feet (1m5). About the middle of the southern shore is Dixon islet, which is conspicuous and lies on a shallow spit extending about 2 cables offshore.

The northern shore is indented by three bays. Near the middle of the entrance to the western and largest of these bays is Swan islet, with a very foul channel westward of it and with foul ground extending about one quarter of a mile southward of it, the channel eastward of this islet has not been examined. North river flows into the head of this bay. Old river flows into the head of the eastern and smallest of the three bays. The south-eastern corner of the harbour is indented by Moulter cove (*43° 23′ S., 146° 13′ E.*).

Charts 3410, 3411.

Tides and tidal streams.—Water level.—From observations made during a short period in Port Davey, it appears that the tides are greatly influenced by the force and direction of the winds, for, previously to a strong westerly breeze the water rose from 4 to 5 feet (1m2 to 1m5) and fell but 2 feet (0m6). When the fine weather returned, 2 feet (0m6) appeared to be the extent of the rise, and this was about the time when the moon changed.

The tidal streams run through The Narrows at a maximum rate of about 2 knots; the west-going stream is stronger and is of longer duration than the east-going stream.

Chart 3410, plan of Port Davey.

Directions.—The entrance to Port Davey affords no difficulty apart from Stokes rock, which should be given a good berth.

Charts 3410, plan of Port Davey, 1079.

Coming from southward, a vessel should pass at least one mile off South West cape (page 276) and the East Pyramids, and between 2 and 3 cables off Big Caroline islet.

Chart 3410, plan of Bathurst channel, sheet 1.

To enter Bramble cove or Bathurst channel, the vessel should approach North passage, by steering for the northern extreme of the Breaksea islands, and pass between them and Boil rock, or steer for the South passage and thence in mid-channel to Bramble cove, which is easy of access from either passage. Both sides of this cove are bold, and may be approached to one cable in depths of 24 feet (7m3).

Chart 1079.

COAST.—Aspect.—From Hilliard head (page 269) the coast trends south-south-eastward for about 12 miles to South West cape, the south-western extremity of Tasmania. The land is mountainous and presents a barren and desolate appearance, *see* views [32], [33].

Windowpane bay, about midway between Hilliard head and South West cape (*43° 35′ S., 146° 03′ E.*), is so called on account of the glistening mica schist of its hillsides. Seen with the evening sun shining on these wide expanses, this apt designation can be fully appreciated.

ATLAS

OF

TASMANIA

edited by

J. L. DAVIES

Senior Lecturer in Geography, University of Tasmania

i
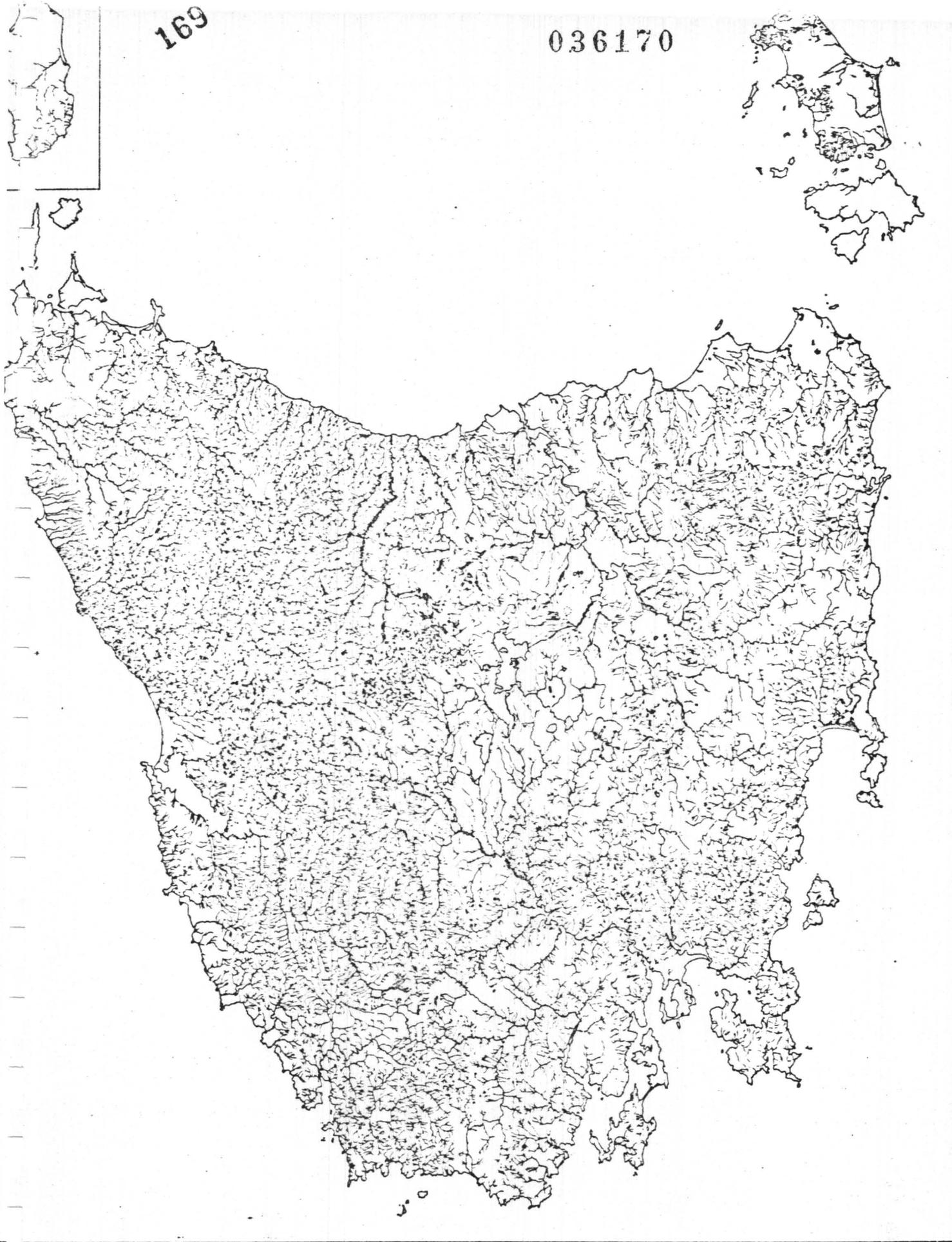
Figure 23 — Drainage. This map was produced by reduction of the blue plate on the 1 : 500,000 map. Some inequalities of representation may be expected due to variations in the standard of mapping but the overall impression is correct.

5 cm

AMG REFERENCE POINTS ADDED

Flinders
Island
Whitemark

Cape Barren Island

Clarke Id.

Banks Strait

Three Hummock Id.

Hunter Id.

C. Grim

Robbins Id.

Stokes Pt.

AMG556450E,
548075ON
C. Portland
Swan Id.

Stanley

Smithton

Table Cape
Wynyard
Burnie
Penguin
Devonport
Ulverstone
Latrobe
Beaconsfield

Arthur River

St. Valentines Pk.

Sheffield

andy Cape

Mt. Roland

Eddystone Pt.

R. Tamar
George Town

Scottsdale

Launceston
Westbury
Deloraine
Perth
Longford

Mt. Barrow

St Helens

Ben Lomand

St. Marys
St. Patricks
Head

Cradle Mt.

Great

Western

Poatina

Rossarden

River

Esk

South

Pieman R.

Rosebery

Zeehan

Mt. Ossa

Great
Lake

Tiers

Arthurs Lake

Campbell Town

INDIAN

Queenstown

Strahan

C. Sorell

Macquarie Harb.

Lake St. Clair

L. King William

Frenchmans Cap

Lake Echo

Lake Sorell

Table Mt.

Oatlands

Tarraleah

Derwent

Bothwell

Toams Lake

L. Leake

Swansea

Oyster
Bay

Schouten Id.

Gordon

River

Mt. Field West

River

Maria Id.

New Norfolk

Hobart

Mt. Wellington

OCEAN

Low Rocky Pt.

POPULATION 1961

NUCLEATED
SETTLEMENTS

No. of Persons
100,000
50,000
15,000
5,000
1,000
500–750
250–500
0–250

DISPERSED
SETTLEMENTS

30 PERSONS

Huan River

Arthur Range

Lake Pedder

Port Davey

AMG421750E,
5175050ON
S.W. Cape

Maatsuyker Group

Mt. La Perouse

S.E. Cape

Geeveston

Hartz Mt.

Cygnet

Bruny

Island

Haohvoo

Storm
Bay

Tasman Peninsula

C. Raoul

Tasman Id.

TASMAN SEA

SCALE 1:1,800,000

| Miles | 10 | 5 | 0 | 10 | 20 | 30 | 40 | 50 Miles |

Projection : Transverse Mercator

145°   146°   147°   148°

40°
41°
42°
43°

TYPES OF FARMING

BASS STRAIT

C. Wickham

King Island

Currie

Stokes Pt.

Flinders Island

Whitemark

Cape Barren Island

Clarke Id.

Banks Strait

5 cm

Three Hummock Id.

Hunter Id.

C. Grim

Robbins Id.

Stanley

Smithton

Table Cape
Wynyard

Burnie

Devonport

Ulverstone

C. Portland

Swan Id.

R. Tamar

George Town

Scottsdale

Eddystone Pt.

St Helens

Arthur River

Mt. Roland

Launceston

Deloraine

Longford

St Marys

Sandy Cape

Pieman R.

Rosebery

South Esk River

INDIAN

Great Lake

Arthurs Lake

Campbell Town

L. Leake

Queenstown

Strahan

C. Sorell

Lake St. Clair

Lake Echo

L. King William

Macquarie Harb.

Lake Sorell

Tooms Lake

Oatlands

Bothwell

Swansea

Oyster Bay

Schouten Id.

Gordon River

Derwent

New Norfolk

Hobart

Maria Id.

Lake Pedder

Huon River

Storm Bay

Tasman Peninsula

Geeveston

Bruni

C. Raoul

Tasman Id.

Low Rocky Pt.

Port Davey

S.W. Cape

Maatsuyker Group

S.E. Cape

OCEAN

TASMAN SEA

Extensive pastoral

Intensive sheep and cash cropping

Mixed livestock

Dairying

Mixed crop and livestock farming

Horticulture

SCALE 1:1,800,000

Miles 10 5 0 10 20 30 40 50 Miles

FORESTRY

J. M. Gilbert

RESOURCES

THE AREA OF Tasmania's forests is estimated at 7.8 million acres, or 47 per cent of the State. At 30th June, 1964, 2.5 million acres had been dedicated as State Forests (Figure 68).

The distribution of the forests is shown in Figure 69, where they are divided into two types, based on the Vegetation Map (page 31). The rain forest type includes rain forest and eucalypts with an understorey of either rain forest species or so-called wet scrub (*Pomaderris apetala, Olearia argophylla, Acacia dealbata*, and so on).

By far the most important component of the forests is provided by the eucalypts, with *delegatensis, obliqua* and *regnans* the species of greatest value. In general, the better quality forests (mature tree height above 135 feet) grow in regions between the 30 inches and 60 inches isohyets. Rain forest species, of which myrtle (*Nothofagus cunninghamii*) is predominant, appear as understorey trees with rainfall at about 45 inches a year and exclude the eucalypts over large areas with the rainfall above 60 inches. Below 30 inches the forests have *globulus, linearis, obliqua, ovata, pauciflora* and *viminalis* as the main eucalypts with a future as pulpwood and fuel, except in the more favoured sites where some saw-logs and poles can be cut.

There are three main commercial forest zones:

(*i*) *northwest* from Deloraine to Marrawah and inwards from the coast for 30 miles with tongues back for 50 miles (e.g., Mersey valley). Large areas of forests on soils derived from basalt have been cleared for farming;

Figure 69 — Distribution of forests, with isohyets for 30 inches and 60 inches indicated.

(*ii*) *northeast* from the Tamar estuary to the east coast and from Ben Lomond to the plains along the north coast. Forests on basalt have been cleared for farming around Scottsdale and in the Ringarooma valley;

(*iii*) *Huon-Derwent* — a 20-mile-wide strip stretching for 110 miles from Lake St. Clair to the south coast. Two important outliers are South Bruny Island and the Tasman Peninsula. The forests along the Huon Estuary and lower D'Entrecasteaux Channel were the centre of the early sawmilling industry and the State's most advanced and extensive areas of eucalypt regrowth occur here. *E. globulus* is locally abundant.

WOOD-USING INDUSTRIES

The values of production have been taken from annual reports of the Forestry Commission. Total value has risen from £5.9 million in 1947/48 to £32 million in 1962/63 (see Figure 70). In 1960/61 the value per head of population was £16.4 compared with the Australian average of £5.0.

Sawn timber and plywood: A little over 300 million feet of logs are used each year, two-thirds coming from Crown lands. Of the sawn timber produced, not quite half is exported, mainly to Victoria.

Pulp and Paper: Fine writings and printings — Production started at Burnie by Associated Pulp and Paper Mills Ltd. in 1938. Output has now reached 86,000 tons a year. *E. delegatensis* makes up the bulk of the wood used, most coming

Figure 68 — Distribution of State Forests.

appropriate gear. In 12 years between 1944 and 1956 the catch per hook fell from 2.01 to 0.99 pounds. In most Tasmanian ports the fishery is operated on a seasonal basis. In the first nine months of 1963 more than three-quarters of the total catch of school sharks (1,039,000 pounds) came from the Bass Strait area; areas south of Hobart yielded 106,000 pounds and fishermen from the three east coast ports of Triabunna, Bicheno and St. Helens landed 146,000 pounds weight of shark.

Whereas the greater part of the shark catch was taken off the northern part of the State, more than half of the catch (350,000 pounds) of "barracouta" (*Leionura atun*) in the first nine months of 1963 came from areas south of Hobart. East coast landings were less than half of the southern total (153,000 pounds) and the Bass Strait barracouta fishermen caught only 14,000 pounds or one-tenth of the east coast catch. During the period 1946 to 1950, Bass Strait catches of barracouta were much higher than those of the east coast but in recent years southern catches have been higher than the Bass Strait ports. In the past 15 years from 1949, the Tasmanian barracouta catch has fallen from seven million pounds weight to less than one million pounds. Early records show that the average weight of barracouta was formerly greater (six to eight pounds) whereas the present run of barracouta have an average weight of three to four pounds. The reason for the change is not generally understood as the same method of catching is still used.

Australian salmon (*Arripis trutta*) now ranks fourth in weight of fish landed at Tasmanian ports (747,000 pounds). Methods in this fishery have changed spectacularly. No longer is the catching of salmon dependent on the sighting of a surfacing school close inshore, as now schools are observed from searching "spotter" aircraft. The operation of encircling these schools, not yet seen from the surface craft, with beach seines is radio controlled from the aircraft. This improved technique for capturing salmon has more than trebled the Tasmanian catches of a few years ago. In 1963 (January to September) the yield was 747,000 pounds compared with 195,000 pounds for 12 months in 1956.

The other beach seine fishery of importance is that for the sea garfish (*Hemirhamphus melanochir*). During the first nine months of 1963 over 205,000 pounds of sea garfish were landed. This figure represents a considerable increase in landings over those of other years. The yield from this fishery has been rising steadily due to an increased demand for this quality fish which now provides the sixth fishery in this State. The main centres of this fishery are in the shallow bays and inlets of the Flinders Island area and of the east coast.

Less commercially important are hook and line fishery for flathead (*Trudis bassensis*) and the Tasmanian rock cod (*Physiculus barbatus*) which yielded over 60,000 pounds in 1963, while the set net and beach seine fisheries for trevally (*Usacaranx nobilis*), Tasmanian bastard trumpeter (*Latridopsis forsteri*) and yellow-eye mullet (*Aldrichetta forsteri*) totalled 75,000 pounds. A small trolling fishery for southern blue fin tuna (*Thunnus thynnus maccoyi*) landed 24,000 pounds of this tuna.

At present Tasmania has little or no oyster fishery but during the period 1860 to 1880 there was a lucrative dredge fishery for the native mud oyster (*Ostrea angasi*). In the early days of the settlement oysters were collected for food and the shells burnt for lime. By 1860 a sizeable fishery for that period had built up in the estuaries of southern Tasmania. At Southport six to seven boats were engaged solely in dredging oysters, their catch yielding nearly three and one-half million oysters annually; in the same year over eight million were taken in Spring Bay. By 1882 the fishery had collapsed and the yield thereafter was about 200,000 oysters annually. Occasionally new beds were found, when the
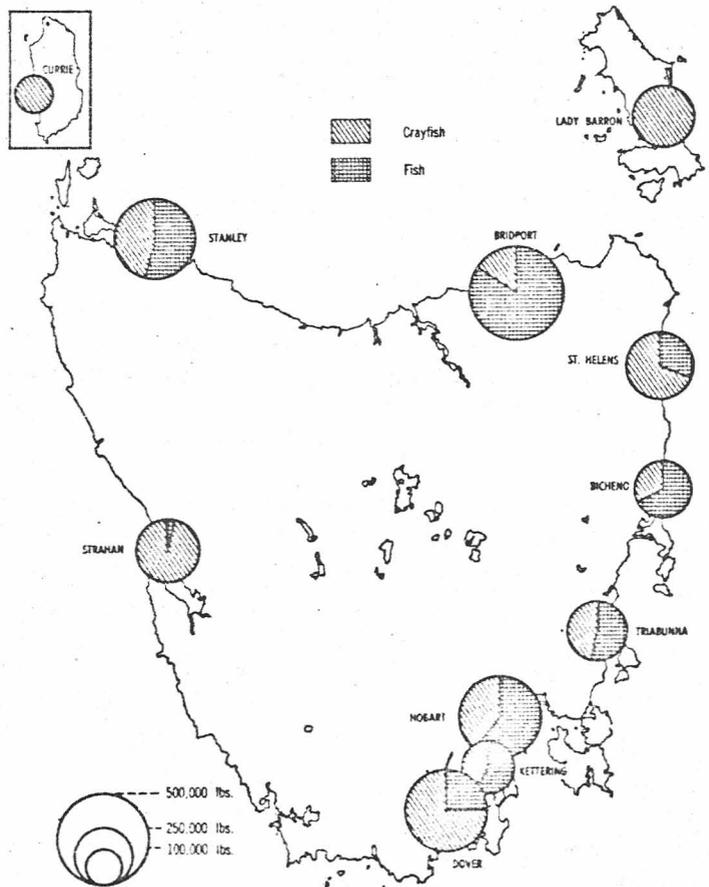
Figure 80 — Fish landings at main fishing ports, January to September, 1963.

catch curve would rise sharply, only to fall just as steeply to the former level.

In 1886 Sydney rock oysters (*Crassostrea commercialis*) were imported and set out in a reserve off Battery Point near Hobart, where they survived for at least two years. Subsequently other shipments were made from New South Wales and transferred to the Tamar and Derwent estuaries where they survived for some years. Unfortunately, acclimatization was not successful and these rock oysters died out. Further attempts were made in 1948 to establish the Sydney rock oyster in the Tamar estuary, but these too were unsuccessful. In 1947, spat of the fast growing Japanese oyster (*Gryphaea gigas*) was introduced into Australia and set out in Pittwater, Tasmania. This oyster has now been introduced on the Bass Strait coast and is spreading successfully.

75

5 cm

144° 145° 146° 147° 148°

B A S S S T R A I T

Victoria
Melbourne
East Australian Ports
Pacific and Far East
Sydney

C. Wickham

King Island
Wynyard
Smithton
Strokes Pt.

Flinders
Island
Whitemark

Three Hummock Id.
Hunter Id.
Robbins Id.
C. Grim
Stanley
Table Cape
Wynyard
Burnie
Devonport
Leven
Liverpone

Cape Barren Island
Clarke Id.
Banks Strait
C. Portland
Swan Id.
New Zealand

Europe Middle East and Australian Ports

Arthur River
St Valentines Pt.
Mt Roland
George Town
R. Tamar

Eddystone

Scottsdale
Mt Arthur
Mt Barrow
St Helens

Sandy Cape
Cradle Mt.
Deloraine
Launceston
Longford
Ben Lomond
St. Marys
St. Patricks Head

Pieman R.
Rosebery
Mt. Ossa
Western
Great Lake
Arthurs Lake
Esk River
Campbell Town

INDIAN

Queenstown
Strahan
C. Sorell
Lake St. Clair
Lake Echo
Lake Sorell
Swansea
Oyster Bay
Schouten Id.

Macquarie Harb.
L. King William
Frenchmans Cap
Table Mt
Tooms Lake
Oatlands
Bothwell
Maria Id.

Gordon River
Mt. Field West
Derwent
New Norfolk
Hobart
Mt. Wellington

Victorian and Northern Tasmanian Ports
East Australian Ports Pacific and Far East

Lake Pedder
Huon River
Huonville
Storm Bay
Tasman Peninsula
C. Raoul
Tasman Id.

Low Rocky Pt.
Arthur Range
Geeveston
Cygnet
Hartz Mt.
Bruny Island

Port Davey
S.W. Cape
Maatsuyker Group
Mt. La Perouse
S.E. Cape

South Africa

O C E A N

T A S M A N S E A
New Zealand

Shipping Routes Proportional to Tonnage
Vehicular Ferry
Ports handling Overseas Shipping
Commercial Airports
Air Services Interstate
Air Services Intrastate
Railways
Bus Services

SCALE 1:1,800,000
Miles 10 5 0 10 20 30 40 50 Miles

Projection Transverse Mercator

5 cm

036176

144° 145° 146° 147° 148°

BASS STRAIT

C. Wickham

King
Island

Currie

Stokes Pt.

Flinders

Island

Whitemark

Cape Barren Island

Clarke Id.

Banks Strait

Three Hummock Id.

Hunter Id.

Robbins Id.

C. Grim

Stanley

Smithton

Table Cape
Wynyard

Burnie

Devonport

R. Tamar

George Town

Scottsdale

C. Portland

Swan Id.

Eddystone Pt.

41°

Arthur

River

Ulverstone

St. Valentines Pk.

Mt. Roland

Mt. Arthur

Launceston

MT. BARROW
NATIONAL PARK

St Helens

Sandy Cape

Deloraine

Longford

BEN LOMOND
NATIONAL PARK

St. Marys
St. Patricks
Head

Piemon R

Cradle Mt.

Great

Western

Rosebery

CRADLE MT.

Mt. Ossa

LAKE ST. CLAIR

Tiers

South

Esk

River

Great
Lake

Arthurs Lake

Campbell Town

L. Leake

Queenstown

Lake St. Clair

Lake Sorell

Swansea

Strahan

Lake Echo

Oyster
Bay

FREYCINET PENINSULA
NATIONAL PARK

C. Sorell

Macquarie Hbr

FRENCHMANS CAP
NATIONAL PARK

L. King William

Table Mt.

Tooms Lake

Schouten Id.

Oatlands

Gordon

River

MT. FIELD
NATIONAL PARK

Derwent

Bothwell

New Norfolk

Hobart

Mt. Wellington

Maria Id.

Low Rocky Pt.

LAKE PEDDER
NATIONAL PARK

Huonville

Huon River

Cygnet

Storm
Bay

Tasman Peninsula

Bruny

C. Raoul

Tasman Id.

43°

Arthur Range

HARTZ MOUNTAINS
NATIONAL PARK

Geeveston

Island

Port Davey

Mt. La Perouse

S.W. Cape

Maatsuyker Group

S.E. Cape

INDIAN OCEAN

TASMAN SEA

Historic Sites and Buildings

Miscellaneous Reserves

Waterfall Reserves

Cave Reserves

National Parks and Reserves

Fauna Reserves and Sanctuaries

SCALE 1:1,800,000

Miles 10 5 0   10   20   30   40   50 Miles

Projection Transverse Mercator

ADMINISTRATIVE BOUNDARIES

5 cm

036177

144°   145°   146°   147°   148°

BASS   **STRAIT**

King Island
C. Wickham
Currie
25
Stokes Pt.

Flinders Island
14
Whitemark

Cape Barren Island

Clarke Id.

Banks   Strait

MUNICIPALITIES
as at 1.7.1964
Municipal Centres _____ • Huonville

Three Hummock Id.

Hunter Id.

C. Grim

Robbins Id.

Smithton

Table Cape

Wynyard
Burnie
Penguin
Ulverstone   Devonport
48
Arthur   5   32   10   Latrobe
7   River   45   26
Sheffield
Waratah
23
46
Sandy Cape

R. Tamar
George Town   39   38
15   Scottsdale   Ringarooma
Lilydale   34
Beaconsfield   28
1
Launceston   42   St. Helens
47   27   St. Leonards
Deloraine   Westbury
Evandale
Longford   12   Fingal
9   29   South   13
Esk   River
6   Campbell Town

INDIAN

Pieman R.
49
Zeehan

Great Lake
Arthurs Lake
L. Leake
Ross
Lake Sorell   36   16
Swansea
Oyster Bay
Schouten Id.

Queenstown   35   Gormanston
Strahan   Lake St. Clair
C. Sorell   18   Lake Echo
L. King William
Macquarie Harb.
20   Derwent   Oatlands   31
Hamilton   19   41
Kempton   Triabunna
Maria Id.

Gordon   River
43   3   Richmond
30   Sorell
New Norfolk   17   40
Glenorchy   Bellerive
Hobart   8
22   21   Storm   Tasman Peninsula
Huonville   Bay   Port Arthur   44
Huon   River   Kingston   C. Raoul   Tasman Id.
Low Rocky Pt.   24
11   Geeveston   Cygnet   33
Bruny
Alonah

Tooms Lake   37

Lake Pedder

Port Davey

S.W. Cape
Maatsuyker Group
S.E. Cape

SCALE 1:1,800,000
Miles 10 5 0   10   20   30   40   50 Miles

OCEAN

TASMAN   SEA

Projection: Transverse Mercator

Eddystone Pt.
C. Portland   Swan Id.

1. BEACONSFIELD
2. BOTHWELL
3. BRIGHTON
4. BRUNY
5. BURNIE
6. CAMPBELL TOWN
7. CIRCULAR HEAD
8. CLARENCE
9. DELORAINE
10. DEVONPORT
11. ESPERANCE
12. EVANDALE
13. FINGAL
14. FLINDERS ISLAND
15. GEORGE TOWN
16. GLAMORGAN
17. GLENORCHY
18. GORMANSTON
19. GREEN PONDS
20. HAMILTON
21. HOBART
22. HUON
23. KENTISH
24. KINGBOROUGH
25. KING ISLAND
26. LATROBE
27. LAUNCESTON
28. LILYDALE
29. LONGFORD
30. NEW NORFOLK
31. OATLANDS
32. PENGUIN

34. PORTLAND
35. QUEENSTOWN
36. ROSS
37. RICHMOND
38. RINGAROOMA
39. SCOTTSDALE
40. SORELL
41. SPRING BAY
42. ST. LEONARDS
43. STRAHAN
44. TASMAN
45. ULVERSTONE
46. WARATAH
47. WESTBURY
48. WYNYARD

APPENDIX C
LICENCES, TRANSFER FORM

TASMANIA

036179

THE MINING ACT 1929

EXPLORATION LICENCE UNDER SECTION 15B

Issued to...S.R.M. HARVEY.............................of .Box .2211, .Princeton,.......................
New Jersey, 08540 U.S.A.

in respect of ..One .hundredsquare miles of land in the Land District of ...MONTAGU.......................
and forty eight (148)

vicinity of MACQUARIE HARBOUR................. as described in the schedule hereto. ·

This licence shall remain in force until the Twenty eighth....day of December ...., 19.73.

This licence is subject to the following conditions:—

That the licensee shall immediately on the issue of this licence take
steps to commence preliminary works necessary for the investigation
of the area.

That the licensee shall carry out investigations as may be necessary
to determine the potential of the area and in particular will
commence a reconnaissance sampling of the area for analysis combined
with a survey of the underwater topography. If results warrant this
will be followed by sampling at much higher density and measurement
of shallow sediments.

That the licensee shall employ such technical and other staff and
equipment as may be necessary effectively to carry out such investigations.

That the licensee shall furnish the Director of Mines, Hobart, with
complete records including plans of drilling and other work within
the compass of the programme of exploration. Such records and plans
shall be held for official purposes during such time as the areas
involved are lawfully held by the licensee or as otherwise agreed to.

That the licensee shall observe the provisions of Section 35 of the
Mines Inspection Act, 1968, with regard to notification of boreholes
preservation of cores and disposal thereof.

If required by the Director of Mines, the licence holder will forward
duplicate samples of rock and mineral samples obtained in the licence.
area to a place approved by the Director of Mines.

That a Statement of Expenditure verified by statutory declaration
shall be lodged with the Director of Mines, Hobart, at the end of
each calendar month from the date of this licence.

That such Statement shall be accompanied by a progress report of
operations.

This licence shall apply to all minerals.

When no longer required, all large or deep excavations, particularly
those made by bulldozer or other earth moving equipment, shall be
filled in, or otherwise made safe, in accordance with the Mines
Inspection Act, 1968, and reasonable rehabilitation measures taken
to the satisfaction of the Director of Mines.

The licensee shall conduct operations so as not to disturb the
environment except in so far as this may be necessary to undertake
the programme of exploration required by this licence:
and in particular shall -

(a) not clear any natural vegetation or make excavations which may
     be visible from populated areas;

(b) discuss with the local Municipal Council any proposal to clear
     areas of natural vegetation and shall comply with the reasonable
     requirements of such Council.

12. The licensee shall observe any instructions which may be given by the Director of Mines with a view of minimising or preventing damage to public or private property.

13. If it is found, that the operations hereby authorised, are causing any undue damage to, or erosion of, the subject land or other land in the vicinity thereof or are unnecessarily disturbing the environment, the Minister may cancel the licence without compensation to the licensee by giving seven days' notice in writing of his intention so to do.

14. The licensee shall not light any fires without the approval of the Rural Fires Board or other relevant authority.

15. Where any aboriginal relic or objects of historic interest are discovered, operations shall be conducted so as not to damage or interfere with such site or object and details of such discovery must be reported to the Director of Mines.

16. The licensee shall notify the local representative of the Forestry Commission before entering on a State Forest and shall comply with the reasonable requirements of such officer in operations on any such State Forest.

17. The licensee shall not interfere in any way with native fauna or bird life.

18. The licensee shall notify the owner and occupier of private land before entering such land.

19. That the security provided by Section 15B (5) of the Mining Act, 1929, (see below) shall be lodged with the Director of Mines before entering private land.

20. Where investigations are undertaken near the coastline or in sand dune areas or where erosion is likely the following conditions shall apply in addition to the foregoing conditions.

  (a) Earth moving equipment comprising bulldozer, back hoes, or similar mechanical equipment is not to be used and operations are to be conducted by means of drilling or by the use of hand tools or equipment.

  (b) The licensee shall conduct operations as not to cause any damage to shrubs, trees, or other native flora growing on the area demised.

  (c) Where it is necessary to remove native or other grasses to enable prospecting operations by boring or otherwise the licensee shall keep to a minimum the area of surface to be disturbed.

  (d) All surface soil and grasses shall be stacked separately for replacement.

  (e) All excavations shall be filled in as soon as practicable and surface soils and grasses replaced.

21. The licensee shall deposit an amount of $500 as security that the conditions contained herein shall be observed. Upon expiry or sooner determination of the licence, if the licensee satisfies the Director of Mines that such conditions have been complied with, the Director shall refund such deposit, or such portion thereof, as he may determine.

SCHEDULE

Commencing at the posted notice situate at a north east corner of the area whose grid co-ordinates are 820,000 yards N. 334,000 yards E. thence grid east to 340,000 yards E. grid south to 800,000 yards N. again grid east to low water mark on the shoreline of Macquarie Harbour thence by that shoreline of Macquarie Harbour aforesaid and Birch Inlet in a general south easterly, south westerly and north westerly direction to 803,000 yards N. again grid east to low water mark on Ocean Beach thence by that low water mark in a general northerly direction to 830,000 yards N. again grid east to 334,000 yards E. aforesaid thence again grid south to the point of commencement.

180

ENDORSEMENTS

EXCLUSIONS

The area embraced by this licence shall be exclusive of:-

(a) All municipal and public reserves and roadways.

(b) All forms of mining tenements and water licences including leases, water licences, easement licences, special and exploration licences, prospectors licences, miners rights, permits to enter, owners consents and owners rights which were in lawful possession or marked out prior to the date of marking out of this licence.

(c) Land exempt from the provisions of the Mining Act, 1929.

(d) Land under the National Parks and Wildlife Act, 1970, not subject to the Mining Act, 1929.

(e) Any Crown reservations or other land set apart or dedicated for any public purposes.

MINISTER FOR MINES.

3 July, 1973.

EXTENSION

This licence is extended under the provisions of Section 15C (6) of the Mining Act, 1929, until the 28th June, 1974.

MINISTER FOR MINES.

17 January, 1974.

EXTENSION

This licence is extended under the provisions of Section 15C (6) of the Mining Act, 1929, until the 28th December, 1974.

MINISTER FOR MINES

July, 1974.

EXTRACTS FROM THE PROVISIONS OF THE MINING ACT 1929

Exploration Licences

SECTION 15A (3) An exploration licence—

    i Has effect in relation to such area, and for such period, as the Minister may determine:

    ii Shall be granted upon and subject to such terms and conditions as are prescribed in this section and such other terms and conditions (including conditions as to the fees and rent to be paid by the holder thereof) as the Minister may determine:

    and

    iii While in force, has effect to authorize the holder thereof, subject to the observance of the terms and conditions thereof and to the provisions of this Act, to enter upon and pass over or across Crown Lands and, subject to subsection (5) of this section, private lands, within the area to which it relates, and to prospect and search thereon for such mining products as may be specified in the licence and to do all such other acts and things as may be reasonably necessary to enable the holder thereof to engage in large scale exploration work.

  (4) The holder of an exploration licence shall, subject to this Act—

    i Engage, to the satisfaction of the Minister, In such aerial, geological, or geophysical surveys and exploration as the Minister may direct or approve:

    ii Furnish the Director with such periodical reports and returns as the Minister may direct or approve:

    and

    iii Keep an adequate record of all operations conducted under the authority of the licence, and at all reasonable times permit the Director, or any officer authorized by the Director so to do, to examine those records and inspect any specimens or materials obtained in the course of those operations.

  (5) The holder of an exploration licence shall not enter on private land thereunder unless he has given security as provided in subsection (2) of section seventy, and, upon entering on private land, is subect to sections seventy-one and seventy-two, as if his exploration licence were a permit under section seventy.

15C (6) Upon application made in that behalf by the holder of a special prospector's licence or of an exploration licence before the expiration of the period for which it is granted to have effect the Minister may extend the licence for such further period or periods, and upon such conditions, as he thinks fit but so that in the case of a special prospector's licence, the aggregate period for which the licence is, and all extensions thereof are, granted, does not exceed twelve months.

  (7) Where a licence is extended pursuant to subsection (6) of this section, the Minister may—

    i On the recommendation of the Director, add to: or

    ii Reduce the area of land comprised in the licence.

  (8) If the holder of a special prospector's licence or of an exploration licence contravenes or fails to comply with any of the provisions of this Act or any of the terms and conditions to which the licence is subject, the Minister may, by notice in writing to the holder, revoke the licence.

  (9) With the consent of the holder of a special prospector's licence or an exploration licence—

    i A prospector's licence, mining lease, water licence, or easement licence may be granted in respect of land comprised therein as if the special prospector's licence or exploration licence did not exist: and

    ii A Miner's right may be exercised as if the land comprised in the special prospector's licence or exploration licence were unoccupied land.

  (10) Special prospector's licences and exploration licences may, with the consent of the Minister, be transferred as prescribed on payment of the prescribed fee.

REGULATION 4 (5) Where application is made for a special prospector's licence or an exploration licence, and a licence is granted thereon in respect of an area less than that comprised in the application, the holder, within seven days after the issue of such licence shall affix to his datum-post an amended notice showing the area which he is authorized to prospect.

181

TRANSFER OF LEASE OR LICENCE

I, ...

of ....

being the holder of a.................No..................., under " The Mining Act,

1929," of a Mining Tenement, containing...........................acres, situate at

....

do, by these presents, transfer and assign all my right, title, and interest in

* Here insert the name, address, and occupation of the proposed transferee.

the said lease to* ....

....

† Here insert the amount of consideration or purchase money directly or indirectly paid, in words at length, and cause the Stamp Duty to be affixed or paid in accordance with the law relating to Stamp Duties in force for the time being, as per Scale on back hereof.

in consideration of the payment to me of the sum of†...........................

....

In witness whereof I have hereunto set my hand and seal this

.... day of.., 19........

Signed, sealed, and delivered by the said ⎞

....in ⎟ ....

my presence ⎬

⎟

Signature of Witness .... ⎠

WE, the abovenamed transferees, do accept the above transfer. In

witness whereof the Common Seal of the Company has been hereunto affixed

in our presence, this...day of

..............................., 19........

.... ⎞

⎬ *Directors*

.... ⎠

This Transfer was registered in the Office of the Director of Mines this

....day of..........................., 19........

....
Director of Mines

NOTE.—The Lease or Licence must accompany this Deed of Transfer when forwarded
to the Director for Mines for Registration

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I, <u>SHANE ROBIN MICHAEL HARVEY</u> of 27 Paterson Street Launceston
in Tasmania Geologist hereby acknowledge that I have entered into
the Indenture (a photocopy of which is attached hereto) on behalf
of the following persons:

Overseas Natural Resources Co. N.J.

Robert P. Lucas

Edward **G.** Brady

Myself

<u>DATED</u> this   day of   1974.

<u>SIGNED</u> by the said <u>SHANE ROBIN</u>)
)
<u>MICHAEL HARVEY</u> in the presence)
)
of   )

DATED   1974

MR. S. R. M. HARVEY

—— to ——

MR. G. O. ROOZENDAAL

DEED   OF   INDEMNITY

SHIELDS HERITAGE STACKHOUSE & MARTIN

Solicitors,

LAUNCESTON.

This Indenture madethe   day of

One thousand .

nine hundred and seventy four B E T W E E N   SHANE ROBIN MICHAEL HARVEY

of 27 Paterson Street Launceston in Tasmania Geologist (hereinafter called

"the Principal" which expression shall where the context permits include

his executors and administrators) of the one part and GERHARD ODILIUS

ROOZENDAAL of Bridport in Tasmania Fisherman (hereinafter called "the

Agent" which expression shall where the context permits include his ..

executors and administrators) of the other part————————————

WITNESSETH as follows:

1. The Principal hereby appoints the Agent to apply for and obtain on .

behalf of the Principal from the Mines Department in Tasmania an ......

Exploration Licence for an area of approximately one hundred square ...

miles covering the Port Davey/ Bathurst Harbour region and also for this

purpose to sign all documents necessary to obtain such licence.————

2. The Agent hereby accepts such appointment and will make the said ..

application and do all things necessary to obtain the said licence and

to renew or extend the same when requested by the Principal so to do.

3. The Agent by his execution of this Indenture hereby acknowledges -

  (a) That he holds the said Licence as agent for the Principal.

  (b) That all rights and gains which may accrue from the said Licence

     or derivative licence will be passed on to the Principal as soon

     as reasonably possible.————————————————

  (c) That he has no beneficial interest in the said licence.————

  (d) That he will transfer the benefit of this Indenture and all licences

     and other rights derived thereunder at any time when requested so

     to do by the Principal to any person or persons nominated by the

     Principal.————————————————

  (e) The Principal will re-imburse the Agent for all expenditure incurred

     by him which results from his carrying out the terms of this ....

     Agreement and will also re-imburse the Agent for any expenditure

     incurred by him in carrying out his obligations under the terms of

     the said licence.————————————————

4. The Principal hereby indemnifies the Agent against all claims which

may be made against the Agent resulting from his holding the said licence.

IN WITNESS whereof these presents have been duly executed the day and

year firstly hereinbefore written.————————————

SIGNED SEALED AND DELIVERED by the said)
SHANE ROBIN MICHAEL HARVEY in the   )
presence of   )

185

SIGNED SEALED AND DELIVERED by the said)
GERHARD ODILIUS ROOZENDAAL in the)
presence of)

036187

APPENDIX D
FATHOMETER TRACES

187

APPENDIX E
CHEMICAL ANALYSES

amdel

The Australian Mineral Development Laboratories

NATA CERTIFICATE

18 February 1974

Dr S.R.M. Harvey,
C/– L.R. Wastell,
207 Paterson Street,
LAUNCESTON, Tas 7250

REPORT AN 3050/74

YOUR REFERENCE:	Amdel application dated 14/2/74
IDENTIFICATION:	As listed
DATE RECEIVED:	14/2/74

Enquiries quoting AN 3050/74 to Officer in Charge please
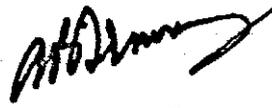
Officer in Charge, Analytical Section: A.B. Timms

for F.R. Hartley
Director

mhb

— 1 unrevised
2 penetrability

TT	Sample No.	Sit FL	Cu	Pb	Zn	Co	Cd	Mo	A
4·30 1	HOLB 54	3 0/3	870	25	240	75	2	50	<1
2	STD 58								
3	5	3/6	950	82	220	65	2	55	1
4	6	6/9	190	45	110	12	1	22	<1
5	7	4 0/3	850	30	140	85	1	55	<1
6	8	3/6	310	78	110	20	1	18	1
7	59 x	6/9	25	22	55	10	1	30	<1
8	60	9/12	30	32	65	10	2	15	2
9	HOLB 61	12/15	38	30	60	10	1	20	1
10	59 ⌄								
11	BLK		—	—	—	—	—	—	—
12	STD 50								
13									
14			Cu Pb Zn Co Cd —			Code C1			
15			Mo -Ag —			Code C2			
16									
17									
18									
19									
20									

amdel
The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

Please address all correspondence to the Director
In reply quote: AN6/625/0 - 2447/74

PART REPORT 1   NATA CERTIFICATE   28 March 1974

Mr S.R.M. Harvey
Box 2211
PRINCETON
New Jersey   08540
USA

REPORT AN 3447/74

YOUR REFERENCE: Letter dated 11/3/74

IDENTIFICATION: As listed

DATE RECEIVED: 14/3/74

Enquiries quoting AN 3447/74 to Officer in Charge please

Officer in Charge, Analytical Section: A.B. Timms

for F.R. Hartley
Director

c.c. Mr S.R.M. Harvey
     C/- L.R. Wastell
     27 Paterson Street
     LAUNCESTON   Tas 7:

pkm

---

amdel
The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

Dear Sir,

This is to acknowledge receipt of:

*Your order/letter Ref: .... Dated: 11.3.74....

*Your samples numbered: ....

The work requested will be carried out as soon as possible
but in the event of any queries please refer to our:

File No: .8/625/0........ Job No: F.N.3.447/74.

for F.R. Hartley
Director.

191
036193 AMDEL ANALYTICAL SERVICE
Results in ppm unless otherwise stated
z penetrability BATCH Nº 1/2

FORM 6 JOB

TT	Sample No.	Site Ft	Cu	Pb	Zn	Co.	Mo	Ag	fms'	P²
1	HOLE 71	9 0/3	780	<5	140	90	50	all <	2	400
2	2	3/6	320	<5	160	50	35	1 ppm		
3	3	6/3	160	18	60	15	10			
4	Sто 58									
5	4	1 0/3	240	22	50	10	12		9	66
6	5		38	8	12	<5	10			
7	6	-/3	880	8	170	55	35		11	1.36
8	7	3/6	60	28	50	10	22	u		
9	8	6/9	38	22	50	10	12			
10	9	9/12	95	28	60	10	15			
11	80	12/15	48	25	55	10	10			
12	1	10 0/4	12	8	22	<5	12		7	.56
13	2	11 0/3	70	30	60	12	25	u	20½	.83
14	3	3/6	15	22	55	12	10			
15	4 x	6/9	15	20	50	10	12			
16	5	9/12	36	30	55	10	10			
17	6	12/15	28	25	60	10	10			
18	7	12 0/3	850	<5	160	70	45	n	8	.84
19	HOLB - 88	3/6½	330	8	110	22	28			
20	4 x									
1	HOLB 89	13 0/3	870	<5	160	15	48		2	2.50
2	90	3/4½	32	15	70	10	3			
3	1	16 0/3	810	5	150	50	40	n	12	.25
4	92 x	21 0/3	300	30	130	22	20		8	1.38
5	3	3/6	15	18	65	12	10			
6	4	6/9	15	12	30	<5	5			
7	5	9/11	22	15	40	8	8			
8	6	20 0/3	180	40	100	18	15	"	26	.95
9	7	3/6	18	22	55	12	20			
10	8	6/9	18	25	50	12	25			
11	9	9/12	18	22	50	12	18			
12	100	12/15	22	30	60	12	20			
13	STD 58							u		
14	1	15/17½	18	28	60	12	25			
15	2	19 0/3	730	20	160	32	20		13	.77
16	3	3/6	610	30	140	28	15			
17	4	6/10	410	55	110	20	15			
18	5	22 0/3	22	20	50	12	10	n		
19	HOLB 106	3/6	22	15	50	12	4	all <	11	.97

Results in ppm unless otherwise stated

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FORM 16   JOB 3447/74   BATCH No 3/4

TT	Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	fms'	p²
1	HOLB 107	22,unt)½/6½	20	22	55	8	6	all <		
2	8	23 0/3	140	50	130	18	10	1 ppm	24½	·99
3	9	3/6	20	28	60	15	45			
4	110	6/9	18	28	60	12	38	\		
5	11	9/12	20	28	55	10	18			
6	12	12/15	18	28	60	10	15			
7	STD 58									
8	13	15/17½	28	25	60	10	15	⌊ 11		
9	14	24 0/3	220	70	130	18	15	(	25	·99
0	15	3/6	22	28	60	12	18			
11	16	6/9	18	25	55	12	22			
2	17	9/12	18	12	60	12	18	⌝		
13	18	12/15	22	40	65	12	15	} 11		
4	19	15/17½	22	30	60	12	18			
15	20 X	25 0/3	120	35	80	15	22		7	1·89
6	1	3/6	15	22	48	10	12			
17	2	6/9	15	32	48	10	8	⌝		
8	3	9/13½	15	18	58	8	8	} 11		
19	HOLB 124	29 0/3	22	25	50	10	35		9	1·50
0	20 X									
1	HOLB 125	3/6	18	25	50	10	10	⌝		
2	6	6/9	15	22	48	10	8			
3	7	9/12	18	28	55	10	4	} 11		
4	8	12/13½	22	30	55	10	3			
5	9	28 0/3½	20	20	50	10	18		18	·18
6	30 X	27 0/3	50	32	40	18	12	⌝	24	·93
7	1	3/6	18	28	60	18	30			
8	2	6/9	18	25	65	15	12	} 11		
9	3	9/12	18	25	60	12	18			
0	4	12/15	18	28	60	12	15			
1	5	15/16⅝	18	28	60	12	15	⌝		
2	6	26 0/3½	18	15	38	8	4		9	·41
3	7	30 0/3	42	30	50	8	12	11	8	2·25
4	8	3/6	20	22	48	10	10			
5	STD 58									
6	9	6/9	28	22	50	10	12	⌝		
7	40	9/12	18	20	55	10	12			
8	1	12/15	15	20	50	8	15	11		
9	HOLB 142	15/18½/12	18	22	55	10	15			

RA930B   3447/74   ² penetrability BATCH Nº   5/6

Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	Ins' P²
HOLE 143	31 0/3	25	28	70	12	15	all <	10 1.66
4	3/6	18	28	65	12	35	1 ppm	
5	6/9	18	25	55	12	25	4	
6	9/12	18	25	60	12	12		
7	12/15	25	22	55	12	6		
STD 58								
8		20	20	42	8	6		
9	32 0/3	20	22	80	12	90	4	15½ .34
150	3/5½	20	20	60	10	20		
1	5/3	28	28	90	18	15		23 .96
2	3/6	20	25	75	18	20		
3	6/9	20	25	65	15	25		
4	9/12	18	28	70	15	15	4	
155 X	12/15	22	22	65	15	18		
6	15/17⅓	22	28	65	15	20		
7	34 0/3⅝	20	20	50	10	6		14½ .26
8	41 0/3	700	12	180	30	15		8¼ 1.18
9	3/6	360	20	130	20	12	4	
HOLE 160	6/9¾	110	40	80	12	12		
Sample 155 X								
HOLE 161	40 0/3	100	40	85	18	8		18½ .96
2	3/6	20	22	55	15	25		
3	6/9	20	25	60	12	22	4	
4	9/12	18	25	55	12	15		
5	12/15	18	20	50	12	28		
6	15/17 ⅙	18	25	60	10	18		
7	39 0/3	25	25	110	15	12		22 .94
8	3/6	20	22	70	18	25	4	
9	6/9	18	22	65	18	25		
170 X	9/12	18	22	60	12	30		
1	12/15	20	20	55	10	12		
2	15/17	18	22	60	10	10		
3	37 0/3	40	25	60	10	15	4	8½ 2.00
4	3/6	22	20	50	10	15		
STD 58								
5	6/9	20	18	50	10	12		
6	9/12	20	20	40	10	12	4	
7	12/15	18	20	45	10	10		
HOLE 178	15/17	18	22	48	10	10		

AMUEL ANALYTICAL SERVICE
Results in ppm unless otherwise stated

JOB 3447/74   penetrability   BATCH Nº 7/8

TT	Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	fins P
1	HOLE 179	43 0/3	20	10	48	10	18	all <	5½ 2
2	180	3/6	18	12	38	10	15	1 ppm	
3	1	6/9	15	10	40	10	15	{	
4	2	9/12	22	12	45	12	12		
5	3	12/14	23	12	48	12	8		
6	STD 58								
7	4	45	20	20	55	12	25		13 .8
8	5	3/6	13	18	60	10	38	} 4	
9	6	6/9	18	12	42	10			
10	7	7/11½	15	8	28	8	10		
11	8	56 0/3	15	15	46	10	10		7 1.7
12	9	3/6	15	12	45	10	12		
13	90 X	6/9	15	12	42	10	12	} 4	
14	1	9/11¾	15	15	38	10	10		
15	2	49 0/3	12	12	48	10	15		3 2.9
16	3	3/6	18	12	40	10	20		
17	4	6/8¾	5	<5	8	<5	6	}	
18	5	55 0/3	42	20	60	8	.18	} 4	5½ 3.3
19	HOLE 196	3/6	12	15	40	8	22		
22	Sample 90 X								
1	HOLE 197	6/9	12	15	45	10	15		
2	8	9/12	12	5	50	10	18	}	
3	9	12/15	12	15	50	10	18	} 4	
4	200	15/18½	12	20	50	10	22		
5	1	61 0/3	20	12	48	10	18		15 .89
6	2x	3/6	12	10	45	10	18		
7	3	6/9	12	15	45	8	15		
8	4	9/12	12	12	38	8	12	} 4	
9	5	12/13½	12	15	42	8	10		
10	6	64 0/3	45	20	85	10	15		8½ 200?
11	7	3/6	12	10	45	8	12	}	
12	8	6/9	12	10	48	8	18	} 4	
13	9	9/12	12	10	38	8	12		
14	STD 58								
15	10	12/15	15	10	42	8	15		
16	11	15/17½	18	10	42	8	15		
17	12	68 0/3	35	28	55	5	12		6 2.49
18	13	3/6	10	20	42	5	10	} 4	
19	HOLE - 214	6/9	8	10	28	8	12		

T	Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	Fins¹ P²
1	HOLB 215	9/12	12	10	32	8	12	dis<	
2	16	12/4 11½	12	10	35	8	18	1 ppm	
3	17	70 0/3	10	5	25	8	12	}	2 3.87
4	18	3/6	12	30	32	8	12		
5	Sto 58								
6	19		12	10	32	8	—		
7	20	73 0/3	18	15	26	10	12	}	2½ 6.12
8	1	3/6	15	10	32	8	12	} h	
9	2	6/9	12	10	36	8	12		
10	3	9/12	12	10	40	8	12		
11	4	12/15 3	15	10	35	8	15		
12	5	75 0/3	18	10	55	10	12	}	2 7.75
13	6	3/6	15	10	38	10	12	} n	
14	7 x	6/9	15	12	42	8	12 .		
15	8	9/12	15	12	45	8	15		
16	9	12/15½	15	15	42	10	15	}	
17	30	76 0/3	15	12	38	10	12	} n	1½ 9.80
18	1	3/6	12	10	35	10	12		
19	HOLB 232	6/9	15	12	42	10	12		
20	7 x								
1	HOLB 233	9/12½	15	12	40	10	12		
2	4	74 0/3	18	12	40	10	12		2 8.17
3	5	3/6	15	10	38	10	12	} n	
4	6 x	6/9	15	12	42	10	12		
5	7	9/12	15	12	38	10	15 .		
6	8	12/15	18	10	42	8	15	}	
7	9	15/16 3	15	12	38	10	15		
8	40	67 0/3	15	10	25	8	18	} n	5 3.00
9	1	3/6	12	38	32	8	18		
10	2	6/9	12	38	30	8	15		
11	3	9/12	12	12	35	8	18		
12	4	12/15	12	10	40	8	18	} n	
13	5	63 0/3	60	42	50	8	20		10 1.87
14	6	3/6	18	28	45	8	22		
15	Sto 58								
16	7	6/9	15	15	35	8	18	}	
17	8	9/12	15	10	42	8	18		
18	9	12/15	15	10	40	8	18	} n	
19	HOLB 250	15/18 ⅔	15	10	45	8	20		

036198 AMDEL ANALYTICAL SERVICE

Results in ppm unless otherwise stated

²penetrability

BATCH Nº 11/12

JOB Ju447/74

T	Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	Fms[1]	P[2]
1	HOLE 251	65 0/3	18	50	42	8	12	all<	7½	2.31
2	2	3/6	12	12	42	8	12	1 ppm		
3	Sru58									
4	3	6/9	12	32	35	8	12			
5	4	9/12	10	15	35	8	12			
6	5		12	10	32	8	12			
7	6	5,3	12	10	38	8	12			
8	7	69 0/3	15	5	22	<5	10	h	4	2.43
9	8	3/6	8	5	15	<5	10			
0	9	6/9 3/4	8	50	18	5	10			
1	60	72 0/3	12	12	22	5	8		4	.75
2	1	66 0/3	8	35	28	5	8		3	3.25
13	2	3/6	8	28	22	5	8	h		
14	3 x	6/9 3/4	8	10	30	5	12			
15	4	62 0/3	25	30	70	10	18		5	2.12
16	5	3/6	12	28	38	10	15			
17	6	6/9	10	40	32	8	12			
18	7	9/10 7/12	10	8	25	8	10	h		
19	HOLE 268	60 0/3	90	10	70	12	18		18½	.91
1	Sample No. 2.0									
1	HOLE 269	3/6	15	20	48	10	22			
2	70	6/9	12	38	40	10	12			
3	1	9/12	12	15	40	10	18	h		
4	2	12/15	12	18	35	10	20			
5	3	15/16 ⅝	10	38	35	8	12			
6	4	53 0/3	150	60	43	12	12		17	1.04
7	5 x	3/6	22	18	45	12	25			
8	6	6/9	15	38	50	10	15	h		
9	7	9/12	15	48	40	10	28			
10	8	12/15	15	42	45	10	12			
11	9	15/17 3/4	15	42	48	10	12			
12	80	59 0/3	15	15	42	10	25		10	1.10
13	1	3/6	12	50	40	10	25	h		
14	2	6/9	12	22	42	10	22			
15	Sru58									
16	3	9/11	12	15	38	10	25			
17	4	58 0/3	35	25	60	10	25		9½	1.79
18	5	3/6	15	60	40	10	25	h		
19	HOLE 286	6/9	12	42	42	10	22			

T	Sample No.	Site Ft	Cu	Pb	Zn	Co	Mo	Ag	Fins' P²
1	HOLB 287	1/12	15	80	45	10	15	all <	
2	8	12/15	15	50	45	10	12	1 ppm	
3	9	15/17	15	28	42	10	12		
4	Sro 58								
5	90	0/3	28	100	65	12	8		18½ ·92
6	1	3/		20	45	10	22		
7	2		12	22	45	10	30		
8	3	9/12	15	28	42	10	15	"	
9	4	12/15	15	55	42	10	28		
0	5	15/17	15	90	45	10	50		
11	6	47 6/3	18	70	65	10	15	?	13½ ·49
12	7	3/6 ⅔	18	20	50	10	5		
13	8	46 0/3	110	55	90	15	5	"	19 1·00
14	9	3/6	18	22	48	12	22		
15	300	6/9	15	20	45	12	28		
16	1 x	9/12	18	22	50	12	15	?	
17	2	12/15	15	22	55	10	10	"	
18	3	15/18	15	22	50	10	15		
19	HOLB 304	51 0/3	22	20	50	10	22		11 1·72
TT	Sample No.		–						
1	HOLB 305	3/6	22	22	65	8	15		
2	6	6/9	15	22	45	8	12		
3	7	9/12	15	22	48	10	12	"	
4	8 x	12/15	18	25	48	10	15		
5	9	15/19	15	25	50	8	15		
6	10	57 0/3	22	22	55	10	12		5½ 1·59
7	11	3/6	32	25	55	10	10	"	
8	12	6/8¾	20	18	65	12	6		
9	13	50 0/3	18	22	40	8	15		8½ 200
10	Sro 58								
1	14	3/6	18	20	50	8	15		
2	15	6/9	15	22	45	8	10		
3	16	9/12	15	20	45	8	12	"	
4	17	12/15	15	22	38	8	15		
15	HOLB 318	15/17	15	22	45	8	12		
6	8 x								
17	BLANK		–	–	–				
8				Part 1					
19				Code c1					

AMDEL ANALYTICAL SERVICE

Results in ppm unless otherwise stated

FORM 198 JOB 3447/74   BATCH N° 1/2

TT	Sample No.			Mo		Ag			
1	HOLB 71			50					
2	2			35					
3	3			10					
4	STD 57								
5	4			12					
6	5			10					
7	6			35					
8	7			22					
9	8			12					
10	9			15					
11	80 X			10		all < 1 ppm			
12	1			12					
13	2			25					
14	3			10					
15	4			12					
16	5			10					
17	6			10					
18	7			45					
19	HOLB 88			28					
20	80 X								
1	HOLB 89			48					
2	90			3					
3	91 X			40					
4	2			20					
5	3			10					
6	4			5					
7	5			8					
8	6			15					
9	7			20					
10	8			25		all < 1 ppm			
11	9			18					
12	100			20					
13	STD 57								
14	1			25					
15	2			20					
16	3			15		all < 1 ppm			
17	4			15					
18	5			10					
19	HOLB 106			4					
20	91 X								

AMDEL ANALYTICAL SERVICE

Results in ppm unless otherwise stated

FORM 6   JOB 3447/74   U362\01 T   BATCH Nº 3/4

TT	Sample No.			Mo		Ag			
1	HOLB 107			6					
2	8			10					
3	9			45					
4	10			38					
5	11			18					
6	12			15					
7	STD 57								
8	13			15					
9	14			15					
10	15			18					
11	16			22					
12	17			18					
13	18			15					
14	19			18					
15	20 X			22					
16	1			12					
17	2			8					
18	3			8					
19	HOLB 124			35					
20	20 X								
1	HOLB 125			10					
2	6			8					
3	7			4					
4	8			3					
5	9			18					
6	30 X			12					
7	1			30					
8	2			12					
9	3			18					
10	4			15					
11	5			15					
12	6			4					
13	7			12					
14	8			10					
15	STD 57								
16	9			12					
17	40			12					
18	1			15					
19	HOLB 142			15					

AMDEL ANALYTICAL SERVICE

Results in ppm unless otherwise stated

FORM. 6 JOB 3447/74

036202 BATCH Nº 5/6

TT	Sample No.			Mo		Ag			
1	HOLB 143			15					
2	4			35					
3	5			25					
4	6			12					
5	7			6					
6	STD 50								
7	8			6					
8	9			90					
9	150			20					
10	1			15					
11	2			20					
12	3			25					
13	4			15					
14	155 X			18					
15	6			20					
16	7			6					
17	8			15					
18	9			12					
19	HOLB 160			12					
11	Sample 155 X								
1	HOLB 161			8					
2	2			25					
3	3			22					
4	4			15					
5	5			28					
6	6			18					
7	7			12					
8	8			25					
9	69 x			25					
10	70			30					
11	1			12					
12	2			10					
13	3			15					
14	4			15					
15	STD .57								
16	5			12					
17	6			12					
18	7			10					
19	HOLB 178			12					

TT	Sample No.		Mo		Ag				
1	HOLB 179		18						
2	80		15						
3	1		15						
4	2		12						
5	3		8						
6	STD. 57								
7	84		25						
8	5		3?						
9	6		18						
10	7		10						
11	8		10						
12	9		12		all <				
13	90		12						
14	1		10						
15	92 x		15						
16	3		20						
17	4		6						
18	5		18						
19	HOLB 196		22						
TT	Sample No. 97								
1	HOLB 197		15						
2	8		18						
3	9		18						
4	200		22						
5	1		18						
6	2 x		18						
7	3		15						
8	4		12						
9	5		10						
10	6		15						
11	7		12		all <				
12	8		18						
13	9		12						
14	STD 57								
15	10		15						
16	11		15						
17	12		12						
18	13		10						
19	214		12						

AMDEL ANALYTICAL SERVICE 036204

FORM 6 JOB 3447/74 Results in ppm unless otherwise stated BATCH Nº 9/10

TT	Sample No.		Mo.		Ag				
1	HOLE 215		12						
2	16		18						
3	17		12						
4	18		12						
5	S-057								
6	9		12						
7	20		12						
8	1		12						
9	2		12						
10	3		12						
11	4		15		<				
12	5		12						
13	6		12						
14	7 x		12						
15	8		15		all				
16	9		15						
17	30		12						
18	1		12						
19	HOLE 232		12						
20	7 x								
1	HOLE 233		12						
2	4		12						
3	5		12						
4	6		12						
5	7		15						
6	8		15						
7	9		15						
8	40		18						
9	1		18						
10	2		15						
11	3		18		<				
12	4		18						
13	5		20						
14	6		22		all				
15	S-50								
16	7		18						
17	8		18						
18	9		18						
19	HOLE 250		20						

203 JOB
FORM 6   3114?/74

TT	Sample No.		Mo		Ag				
1	Hole 251		12						
2	2		10						
3	500 57								
4	3		12						
5	4		12						
6	5		12						
7	6		12						
8	7		10						
9	8		10						
10	9		10						
11	60		8		∨				
12	1		8						
13	2		8						
14	3 x		12						
15	4		18		all				
16	5		15						
17	6		12						
18	7		10						
19	Hole - 267		18						
20	Sample No. 2								
1	Hole 269		22						
2	70		12						
3	1		18						
4	2		20						
5	3		12						
6	4		12						
7	5x		25						
8	6		15						
9	7		28						
10	8		12						
11	9		12						
12	80		25		∨				
13	1		25						
14	2		22						
15	500 57				all				
16	3		25						
17	4		25						
18	5		25						
19	Hole 286		22						

AMDEL ANALYTICAL SERVICE   036206

FORM 6   JOB 2447/74   Results in ppm unless otherwise stated   BATCH N° 13/14

TT	Sample No.		Mo		Ag				
1	HOLE 287		18						
2	8		12						
3	9		12						
4	Sw 57								
5	90		8						
6	1		22		all < 1 ppm				
7	2		30						
8	3		15						
9	4		25						
10	5		50						
11	6		15						
12	7		5						
13	8		5						
14	9		22						
15	300		25						
16	1x		15						
17	2		10						
18	3		15						
19	HOLE 304		22						
TT	Sample No.								
1	HOLE 305		15						
2	6		12						
3	7		12		all < 1 ppm				
4	8x		15						
5	9		15						
6	10		12						
7	11		10						
8	12		6						
9	13		15						
10	Sw 57								
11	14		15		all < 1 ppm				
12	15		10						
13	16		12						
14	17		15						
15	HOLE 318		12						
16	8x								
17	Blank		—		—		Part 1		
18									
19						MoAg — Code C2			

036207

amdel
The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA62520

Please address all correspondence to the Director
In reply quote: AN6/625/0 - 3447/74

PART REPORT 2

NATA CERTIFICATE

24 May 1974

Mr S.R.M. Harvey
PO Box 2211
PRINCETON
New Jersey 08540
USA

REPORT AN 3447/74

YOUR REFERENCE: Letter dated 11/3/74

IDENTIFICATION: As listed

DATE RECEIVED: 14/3/74

Enquiries quoting AN 3447/74 to Officer in Charge please

Officer in Charge, Analytical Section: A.B. Timms

for F.R. Hartley
Director

c.c. Mr S.R.M. Harvey
     C/- Mr L.R. Wastell
     27 Paterson Street
     LAUNCESTON   Tas 7250

pkm

AMDEL ANALYTICAL SERVICE

206 FORM 6   JOB 3447/74   Results in ppm unless otherwise stated   BATCH Nº 1

TT	Sample No.			Au					
1	HOLE 57		–	5–3	0·2				
2	8			3–	<0·05				
3	9			–3	<0·05				
4	60 X				<0·05				
5	1				<0·05				
6	2				<0·05				
7	3				<0·05				
8	4				<0·05				
9	5		–		<0·05				
10	6		–		0·1				
11	7			3–6	<0·05				
12	8			6–9	<0·05				
13	STD 108 E				—				
14	9			5–2	<0·05				
15	70				<0·05				
16	319				<0·05				
17	HOLE 322				<0·05				
18	60 X				—			Code C3	
19	BLK				—			Results in ppm	
20									

FORM 6   JOB 3447/74

AMDEL ANALYTICAL SERVICE   036209

Results in ppm unless otherwise stated   BATCH Nº 1

TT	Sample No.	Furnace	Cu	Pb	Zn	Co	Ag	Mo	
1	62		80	12	45	8	<1	12	
2	63		12	<5	40	5	<1	12	
3	64		12	8	48	8	<1	10	
4	STD 58								
5	65		160	15	80.	15	<1	25	
6	66		130	<5	170	95	<1	55	
7	67		150	<5	180	65	<1	40	
8	68 X		55	18	75	12	<1	30	
9	69		32	18	60	10	<1	20	
10	70		30	20	60	10	<1	20	
11	319		150	22	110	18	<1	20	
12	322		22	8	95	8	<1	15	
13	68 X							.	
14	BLK		—	—	—	—	—	—	
15									
16									
17				CuPb Zn Co -		Code C1			
18				Mo Ag -		Code C2			
19									
20									

Σ 62-70   2051   ~100   758   228   <1   224

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES 036210

x = not detected at the limits quoted

REPORT AN __3447/74__

FORM 91 Results in ppm unless otherwise stated.   Detection limits in brackets.

Sample No	V (10)	W (50)	Nb (20)	Li (1)	Sn (1)	Zr (10)	Ti (100)	Sb (30)	Bi (1)
HOLB 57	100	50	x	80	10	200	3,000	x	1
— 53	100	x	x	150	3	100	2,500	x	x
59	80	x	x	300	1	50	2,000	x	x
9-12 60	50	x	x	120	1	30	2,500	x	x
12-15 61	50	x	x	150	1	50	2,000	x	x
6-? 62	50	x	x	120	1	80	2,000	x	x
3-6 63	30	x	x	150	3	50	2,000	x	x
6-9 64	50	x	x	200	1	30	2,000	x	x
9-? 65	80	x	x	200	3	150	2,500	x	x
5-? 66	100	50	x	100	10	250	3,000	x	1
3-6 67	100	x	x	100	5	150	3,000	x	1
6-? 68	30	x	x	200	1	50	1,500	x	x
9-? 69	50	x	x	200	1	50	2,000	x	x
12-13½ 70	80	x	x	200	1	50	2,500	x	x
half 319	100	x	x	200	1	100	3,000	x	x
half 322	80	x	x	80	1	80	2,000	x	x

Geo.

$A_1 \ (16 \times 4) = 64$

$A_2 \ (16 \times 4) = 64$ } 160.

$A_4 \ (16 \times 1) = 16$

$A_6 \ (16 \times 1) = 16$

ppm/c	2.5	2.5	5	9	3	100	50	10	1,20
	40	20	<2	20	30	2	20	<2	1
Nbs/wc	20	<0.4	<2	22	0.8	1	20	<2	<1
world MS	20	120	<15	20	344	74	120	66	—

Results are semi-quantitative.   Elements apparently present in concentrations of economic interest should be redetermined by an appropriate accurate analytical technique.

REPORT COMPLETE

NATA CERTIFICATE

21 June 1974

Dr S.R.M. Harvey
Box 2211
PRINCETON
New Jersey 08540
U.S.A.

REPORT AN 3447/74

YOUR REFERENCE: Letter dated 11/3/74

IDENTIFICATION: As listed

DATE RECEIVED: 14/3/74

Enquiries quoting AN 3447/74 to Officer in Charge please

Officer in Charge, Analytical Section: A.B. Timms

for F.R. Hartley
Director

c.c. Dr S.R.M. Harvey
     C/- L.R. Wastell
     27 Paterson Street
     LAUNCESTON   Tas 7250

pkm

TOTAL DRY WEIGHT OF SAMPLE RECEIVED

(lbs)

Sample	
HOLB 319	36
HOLB 322	35
HOLB 326	70

TT	Sample No		Cu	Pb	Zn	Co	Ag	Mo	A"
1	HOLE 326 A		720	40	160	85	<1	45	0·1
2	58								
3	HOLE 326 x		720	40	160	85	<1	45	
4	BLK		—	—	—	—	—	—	—
5									
6									
7			Part 2						
8			Cu	Pb Zn	Co	— Code C1			
9				Ag Mo	—	Code C2			
10				Au	—	Code C3			
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Sample N°	ppm U	ppm I	ppm Br		ppm B		ppm Au		% S
JLB 57	10	<10	60		45				3.5
58	12	60	265		150				2.4
59	13	60	290		190				2.95
60	8	30	230		180				3.15
61	8	25	225		190				3.55
62	8	35	170		80				1.25
63	8	35	205		130				2.15
64	14	30	205		160				1.95
65	14	20	145		120				2.25
66	12	<10	30		25				4.15
67	12	15	100		50				2.7
68	14	45	245		200				2.7
69	8	40	205		200				2.95
JLB 70	8	25	190		250				3.1
JLB 319	12	30	155		150				2.45
322	8	25	135		170				2.65
JLB 326	12	<10	28		40		0.1		2.95

JOB: 3447/74

AMDEL ANALYTICAL SERVICE
Semi-Quantitative Spectrographic Analysis Schemes A1, A2, A3, A4, A5 & A6

BATCH ....

Form 60

Results in ppm unless otherwise stated.   Detection limits in brackets

213

Sample No	11NB326								Sample No	11NB326							
A1									A2 Contd.								
Co (5)									Ge (1)								
Ni (5)									As (50)	X							
Cr (20)									Sb (30)	X							
V (10)	100								A3								
W (50)	X								Te (20)								
Mo (3)									Tl (1)								
Mn (10)									P (100)								
Ta (100)									A4								
Nb (20)	X								Na (50)								
Be (1)									Li (1)	50							
Th (100)									A5								
Pt (10)									K (5)								
Pd (10)									Rb (10)								
Os (10)									Cs (30)								
Ir (2)									A6								
Rh (2)									Ba (50)								
Ru (2)									Sr (10)								
A2									Y (10)								
Cu (0.5)									La (100)								
Pb (1)									Ce (300)								
Zn (20)									Nd (300)								
Sn (1)	5								Pr (100)								
Cd (3)									Ti (100)	2,500							
Bi (1)	1								Er (100)								
Ag (0.1)									Sc (50)								
Au (3)									Eu (50)								
Ga (1)									Zr (10)	100							

Results are semi-quantitative.   Elements apparently present in concentrations of economic interest should be redetermined
by an appropriate accurate analytical technique.   X = Not detected at limit quoted.

036215

Department of Mines,

Launceston Offices,

287 Wellington Street,

South Launceston 25th March, 197

Mr. Robin Harvey,
C/O - L. R. Westell,
27 Paterson Street,
LAUNCESTON. Tas. 7250

Dear Sir,

Macquarie Harbour

740589 - 740595

Please find below results of assays on Copper,
Cobalt, Silver, Uranium, and Molybdenum.✱

Cu

HCLB	Reg. No.	ppm.
	740589	65
	590	24
	591	30
	592	20
	593	30
	594	30
	595	40

Co

Reg. No.	ppm.
740589	<5
590	16
591	10
592	10
593	<5
594	9
595	235

Mo

Reg. No.	ppm.
740589	<10
590	14
591	12
592	<10
593	<10

036217

215

U_3O_8

Reg. No.	ppm.
740589	11
590	<5
591	19
592	16
593	9
594	7
595	<5

Ag

Reg. No.	ppm.
740589	5
590	<5
591	<5
592	<5
593	7
594	<5
595	6

Analysis by: ......P. Thomas......

Fee: $35.00

Yours faithfully,

(H. K. Wellington),
Chief Chemist & Metallurgist.

* Accuracy probably ± 10%.

4 April 74 Mines, Ltd.
Commission 1 Sr B Sn W Au Pb + Zn on same time
(~ $56) To be done shortly w/ bulk sample now mixed
+ sampled ready for tests.

Tasmania

Department of Mines,

Launceston Offices,

287 Wellington Street,

South Launceston 21st May, 1974

Mr. Robin Harvey,
P.O. Box 2211,
Princeton,
NEW JERSEY. U.S.A.   08540

Dear Sir,

Please find attached results of assays on samples received from you and stated to be from Macquarie Harbour and its vicinity unless otherwise stated below.

Reg. No.	Your No.	Description
740939	HOLB 343	King R. mouth, mud
40	HOLB 344	" " , sand
41	HOLB 385	Queen R. in Queenstown
42	HOLB 387	King R. above bridge on road to Hobart.

Boron has not been determined on 740589 to 740595 inclusive nor on samples for project R.683. Results for this will be advised later.

Also attached are results for the first two samples for R.683. The last sample (high sulphide) has now been sampled and will be used for the first concentration tests when the assays become known.

The cost of the work attached is $113.00, an invoice for which is enclosed.

Yours faithfully,

(H. K. Wellington),
Chief Chemist & Metallurgist.

HKW:RA

Enc.

21st May, 1974

Assay in g/t.

No.	Cu	Pb	Zn	Co	Mo	U_3O_8	Ag	Au
Iolb 337	52	53	28	<13	<5	<12	<0.5	<0.5
338	48	52	15	<13	<5	12	<0.5	<0.5
340	1020	110	310	45	57	20	n.d.	n.d.
341	1670	60	220	31	25	17	n.d.	n.d.
343	1190	150	240	64	67	16	<0.5	<0.5
344	1270	83	210	50	50	<12	<0.5	<0.5
385	2220	120	220	61	49	<12	<0.5	n.d.
387	28	36	54	<13	<5	17	n.d.	n.d.

(n.d. not detected - g/t grams/tonne)

No.	WO_3	Pb	Sn	Zn	I	Br	Au
No. 330	<50	28	24	54	31	23	<0.5
331	<50	12	<7	67	<9	21	<0.5
332	<50	12	<7	83	<9	<2	<0.5
333	<50	6	<7	59	<9	<2	<0.5
334	<50	24	<7	62	<9	18	<0.5
335	<50	14	<7	48	<9	4	<0.5
336	<50	70	10	30	110	6	<0.5

Analyses by: ......P. Thomas...............

036220

21st May, 1974

R.683 (S.R.M. Harvey)

Interim Report

Samples

The following samples have been received for metallurgical work. They came from drilling the unconsolidated top four metres of sediment in Macquarie Harbour.

Reg. No.	Your No.	Description
740477	HOLB 321	Composite from northern half of Harbour.
740630	HOLB 324	Composite from southern half of Harbour.
740854	HOLB 329	Sulphide rich sample from top layer of sediments.

Results

	Unit	740477 HOLB 321	740630 HOLB 324
Cu	g/t	210	22
Mo	"	21	17
Co	"	17	<13
U_3O_8	"	19	19
I	"	<9	<9
Br	"	140	150
Pb	"	27	14
Zn	"	160	150
Ni	"	25	39
As	"	40	26
Ag	"	<0.5	<0.5
B	_____	to follow	_____

g/t = grams per tonne. (ppm.)

(H. K. Wellington),
Chief Chemist & Metallurgist.

HKW:RA

TELEPHONES:
Metallurgical Research
Laboratory
Mines Inspection
Explosives and Inflammable Liquids
4 2431-2
2 Lines

Registrar of Mines 2 2457

Department of Mines,

Launceston Offices,

287 Wellington Street,

South Launceston 23rd May, 1974

Mr. Robin Harvey,
P.O. Box 2211,
Princeton,
NEW JERSEY. U.S.A. 08540

Dear Sir,

The following are the boron results for samples submitted from Macquarie Harbour and its vicinity.

Reg. No.	Your No.	B (ppm.)
740589	330	18
590	331	4
591	332	24
592	333	39
593	334	12
594	335	10
740595	336	16

The boron results for R.683 samples 740477 and 740630 are attached.

Analyses by: ....

Fee Charged: $7.00

Yours faithfully,

(H. K. Wellington),
Chief Chemist & Metallurgist.

HKW:RA

Enc.

R.683

R. Harvey.   Macquarie Harbour sediments.

Reg. No.	Your No.	B (ppm.)
740477	HOLB 321	33
740630	HOLB 324	28

(H. K. Wellington),
Chief Chemist & Metallurgist.

HKW:RA

APPENDIX F
EQUIPMENT

222

Gear at M. Pepper's workshop: rear of C.H. Smith Pty Ltd.,
20 Charles Street, Launceston, Tas.

A 1 galv. can (10 gal), w/lid, containing

1 x	3 1/4"	circum.	sisal	triple block	
1 x	3 1/8"	circum.	sisal	double block	& shackle & thimble
1 x	22 1/2"	circum.	sisal	snatch block	
1 x	1 1/2"	circum.	sisal	snatch block	
1 x	1 1/2"	circum.	sisal	double block	
1 x	1 1/2"	circum.	sisal	triple block	
4 x	2"	diam.	thimbles		
2 x	1"	diam.	thimbles		
3 x			D-shackles		
2 x	large		swivels		
1 x	small		swivel		
1 x	bow		shackle		

Saw & 4 spare blades
2   chain wrenches
1   eye bolt & nut
1   pr. tinsnips
1   pr. pliers
1   roof punch
1   geol. hammer

B. 1   box containing

Methyl orange
dil. H_2SO_4
2   dropping bottles
     sample bottles

C. 1   sack containing

  1   roll white cord
  1   roll orange cord
  6   floats
220   plastic containers
  2   rolls plastic tape
  1   plastic disc
 50   plastic sandw. bags & ties
       clear plastic sheet & nails
       plastic weather strip
250   12-dram vials & stoppers

D. 1   orange plastic sheet

E. 1   shovel

F. 1   hose reel

G. 1   kerosene can

H. 2   coils 2 1/2" circum. blue rope

I. 1   coil 1 1/2"   "   white rope

J. 1   coil wire rope

K. 6   sacks

L. 22 boxes core sample

M. 1   drum containing Holb 328

N. 3   boxes, 1000yd grab & land samples

O. 1   container H_2O sample Holb 388

P. 1   roll wire

Gear at Strahan in Mt Lyell Engine Shed;

c/o L. Stubbs, Regatta Point, Strahan

V Corer

Tube Corer (bit & valves in dredge)

2" Corer w/ 2 sets detachable fins

Dart

Dredge (& chain in dredge)

Core trays

Core boxes

Sledge hammer

EL peg

Plastic containers 2 boxes

Plastic lids   2 boxes

Sounder skid

2 lengths plastic drainpipe

APPENDIX G
BENEFICIATION

036228

amdel

The Australian Mineral Development Laboratories

Flemington Street, Frewville, South Australia 5063
Phone 79 1662, telex AA82520

Please address all correspondence to the Director
In reply quote AN 4/625/0 - 282/74

NATA CERTIFICATE

9 September 1973

Mr S.R.M. Harvey
Box 2211
Princeton
NEW JERSEY   08540
U.S.A.

REPORT AN 282/74

YOUR REFERENCE: Letter dated 11/7/73

IDENTIFICATION: As listed

DATE RECEIVED: 17/7/73

Enquiries quoting AN 282/74 to Officer in Charge please

Officer in Charge, Analytical Section: A.B. Timms

for F.R. Hartley
Director

JOB 282/74

TT	Sample No.		Cu	Pb	. Zn	Co	Ag	Mo	
1	4rb. 52		390	42	120	10	< 1	8	
2	37		780	15	170	60	< 1	45	
3	36		850	23	180	35	< 1	40	
4	35 x		820	140	220	55	1	30	
5	34		300	80	100	18	< 1	10	
6	23		700	80	160	35	< 1	12	
7	22		600	130	170	28	< 1	10	
8	STD.203								
9	16	.	580	130	180	18	< 1	10	
10	4rb. 15		440	130	200	15	< 1	8	
11	. 35 x								
12	BIK.		—	—	—	⁄	—	—	
13									
14									
15					Cu Pb	Zn Co	-Code c1		
16					Ag	Mo	-Code c2		
17									
18									
19									
20									

Semi-Quantitative Spectrographic Analysis

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

036230

x = not detected at the limits quoted

REPORT AN __282/74__

RM 91   Results in ppm unless otherwise stated.   Detection limits in brackets.

Sample No	Zr (10)	Cu (0.5)	Pb (1)	Zn (20)	Ag (0.1)	Co (5)	Mo (3)			
lolb. 9	30									
20	20									
51	300									
53		2,000	200	1,000	5	500	400			
50	X									
	Geo.	A_1 (4×1) = 4)								
		A_1+A_2 (1×6) = 6)		10 DETERMINATIONS.						

Results are semi-quantitative.   Elements apparently present in concentrations of economic interest should be redetermined by an appropriate accurate analytical technique.

Form 229   Form 38   Form 38   REPORT AN _____

Sample N°		Sample N°		Sample N°				
HolB	1	.5 Grms	HolB	26	5 Grms	HolB	51	20 Gm		
	2	5 Gms		27	5 "		52	5°		
	3	5 "		28	5 "		53	0.1		
	4	5 "		29	5 "	HDR	1	10		
	5	5 "		30	5 "	HDR	2	5		
	6	5 "		31	5 "					
	7	5 "		32	5 "					
	8	5 "		33	5 "					
	9	5 "		34	5 "					
	10	5 "		35	5 "					
	11	5 "		36	5 "					
	12	5 "		37	5 "					
	13	5 "		38	5 "					
	14	5 "		39	5 "					
	15	5 "		40	2 Grams					
	16	5 "		41	1/2 gram					
	17	5 "		42	Nil					
	18	5 "		43	1/2 gram					
	19	5 "		44	Nil					
	20	5 "		45	1/2 Gram					
	21	5 "		46	1/2 Gram					
	22	5 "		47	Nil					
	23	2 Grms		48	Nil					
	24	5 "		49	Nil					
	25	5 "		50	20 Gram					

ANALYSIS
PPM

Sample Mark	Uranium U
Holb 39	10
33	10
19	10
3	<2

Heavies Separation

A Heavy mineral fraction was prepared from the initially requested samples to form the composite.

The heavy fraction at S.G. 3.8 gave 3.95% by weight and is labelled Holb 53.

The light fraction is labelled Holb 52. Insufficient sample of Holb 53 was available for Code C1 and C2 analysis and for this reason a spectrographic analysis is given.

Similarly insufficient sample was available for XRF analysis for Zr and a spectrographic analysis is given for these samples.

Approximate remaining wts of samples is listed. Bromine could be determined by XRF on 10grms of sample. with a detection of 5ppm. The cost per individual sample would be $10.50 Code 04 or $2 per determination for a minimum batch of 10, Code B1.

Our normal standard for - 80 mesh is the British Standard.

Colorado School of Mines Research Institute

May 30, 1974

Mr. Douglas D. Jinks
Staff Geologist-Minerals
Cities Service International, Inc.
521 South Boston, Box 34
Tulsa OK 74102

Dear Mr. Jinks:

As per your request of May 10, 1974, during your visit to CSMRI, the
two samples bearing your Numbers 325 and 327 have been composited,
blended and analyzed. This composite sample is designated in this
report as "composite head sample". Following are the results of the
analyses you requested:

SCREEN ASSAY

The composite head sample was wet screened to determine the percent
plus and minus five micron material present. Table 1 shows the results
of this analyis:

<u>Table 1. Percent Plus and Minus Five Micron Material
in Composite Sample</u>

Size	g	wt % (dry basis)
+5 micron	3.7212	68.4
-5 micron	1.7200	31.6
Total	5.4412	100.0

The composite head sample was also screened at 325 mesh to determine
the percent plus and minus 325 mesh (Tyler). Table 2 shows the results
of that analyses:

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COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

Mr. Douglas D. Jinks
Cities Service International, Inc.
May 30, 1974
Page 2

Table 2. Percent Plus and Minus 325 Mesh
in Composite Head Sample

Size (Mesh Tyler)	g	wt % (dry basis)
+325	5.85	19.6
-325	24.05	80.4
Total	29.90	100.0

A comparison of the data in Tables 1 and 2 indicates the composite head sample contains 19.6% +325 mesh (43 micron), 48.8% (-) 43 microns (+) 5 micron and 31.6% -5 micron sized material.

CHEMICAL ANALYSES

Chemical analyses were performed on the plus and minus five micron fractions of the composite sample and on the composite head sample. Table 3 shows the results of those analyses (all analyses performed by Atomic Absorption):

Table 3. Chemical Analyses

Element	Products Assayed (%)		
	Composite Head	+5 micron	-5 micron
Cu	0.102	0.092	0.117
Pb	0.009	0.008	0.037
Zn	0.272	0.305	0.426
Ag	0.0009	0.0009	0.0009
Mo	0.01	0.01	0.01

These data show no significant variation between the values for Cu, Ag, or Mo in either of the size fractions. Significant increases in Pb and Zn were found in the -5 micron fraction in comparison with the composite head sample.

HYDROMETER ANALYSES

A hydrometer analysis was performed on the composite head sample primarily to determine the percent -2 micron clay mineral material in the

COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

Mr. Douglas D. Jinks
Cities Service International, Inc.
May 30, 1974
Page 3

sample. In essence, all material left in the suspension after 24 hours
should be mineral phases having specific gravities around 2.65 (quartz,
clay minerals, etc.) and a size of two microns or less. The sample does
contain heavy mineral phases that have specific gravities well over 2.65.
These phases are not amenable to hydrometer analyses; therefore, it
should be realized that the percentage of -2 micron noted may not include
all of the -2 micron material actually in the sample. In other words,
there may be heavy mineral phases in the -2 micron range that were not
detected by the hydrometer analysis. Two hydrometer analyses were
performed, one with a deflocculation agent (calgon) and one without.
This was done to check the effectiveness of such an agent on any clay
phases present. These analyses showed that without the calgon additive,
about 8% -2 micron clay material was detected and that with the calgon
additive, about 9% was detected. These values indicate the deflocculation
agent did have some effect on the suspension characteristics of the clay
material in the sample.

On May 28, 1974, Mr. Robert P. Lucas called and authorized us to analyze
the composite head sample for cobalt and uranium, and to perform fire
assay analyses to more accurately determine the silver and gold contents
in the sample. This work is now underway.

Sincerely,

M. G. Pattengill
Senior Project Engineer
Chemical Division

/cjm

cc: Mr. R. P. Lucas

Colorado School of Mines Research Institute

July 22, 1974

CSMRI Project A40519

Mr. Jinks:

This is a preliminary topical rough draft of the report. There may be some changes on the finished report that will be submitted to you today or tomorrow. I'm reasonably sure all of the numbers and basic conclusions are accurate.

Mr. Douglas D. Jinks
Staff Geologist - Minerals
Cities Service International, Inc.
521 South Boston, Box 37
Tulsa OK 74102

M. G. [signature] 7/23/74

Dear Mr. Jinks:

A letter was sent to you on May 30, 1974, detailing the results of studies of two small samples bearing your Numbers 325 and 327. On June 14, 1974, two larger samples, representing the two smaller samples previously studied, were obtained from Hazen Research, Inc. At your request, the two larger samples were split and one-half of each composited into one sample (CSMRI No. 3). Studies were to be performed on this composite sample to determine if the copper in the sample could be extracted or concentrated economically.

The objective of the work was to perform preliminary metallurgical tests to determine the feasibility, and develop data that would indicate which basic process appeared most promising in regard to the recovery of copper from the composite sample.

The scope of the work was to involve initial heavy liquid, flotation, gravity separation, hydro-classification, and cyclone tests. An interpretation of the data derived was to be made and recommendations made as to which process, if any, looked most feasible in terms of copper recovery.

SUMMARY AND CONCLUSIONS

The following summary and conclusions are based on work performed at CSMRI on a composite of two samples obtained from Hazen Research, Inc.

Chemical Analyses

Chemical analyses of the composite sample showed it to contain:

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Element	%
Cu	0.090
Fe	8.930
Pb	<0.01
Mo	≈0.01
Zn	0.206
U_3O_8	0.005
Co	0.02
	oz/ton (Fire Assay)
Gold	<0.005
Silver	<0.01

Following is a tabulation showing the best copper concentration and recovery results from the composite sample using various processes:

	Concentrate		
Method	Wt. % (dry wt.basis)	% Cu	% Cu recovery
Heavy Liquid Separation at sp.gr. 2.98	14.35	0.23	39.1
Super Panner	6.4	0.26	20.1
Cyclosizer	23.5	0.11	36.8
Flotation	4.4[1]	0.772	26.7
	48.0[2]	0.14	81.2
Hydrosizer (elutriation)	43.6	0.082	41.7
Acid Leach (Cold H_2SO_4)	----	-----	38.04

1/ Best copper assay.
2/ Best copper recovery.

Based on the processes examined, flotation appeared to be technically the best in terms of concentrating copper but economically unfavorable. Considering the copper values in the sample to be $1.44 (0.09% Cu in the head and copper at $0.80/lb.), the flotation reagent cost for the best test (Flotation Test 2, Exhibit 4) amounts to $2.67. It should be noted, however, that the flotation system is by no means the best possible that could be obtained in the laboratory, either in terms of reagent consumption or in terms of maximizing the flotation response of the copper minerals.

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The overall particle size of the sample, i.e., 80% -325 mesh and 32%
-5 micron, is too small, and the copper distributed too uniformly to make
cyclone, gravity, and hydro-classification (elutriation) processes applicable.

The results of the acid leach tests (cold H_2SO_4) showed only a 38.04% Cu
recovery which produces a calculated $0.55 recoverable copper value per
ton of feed. An acid consumption of 52 lb. per ton was required to obtain
this recovery. Even if acid could be obtained at $0.01/lb., this test in-
dicates acid leaching is not economically favorable.

RECOMMENDATIONS

The following recommendations are based on work covered by this report.

Owing to the poor copper recoveries obtained using a variety of standard
metallurgical concentration and extraction processes, it is recommended
that no further work be done along the lines of conventional practice.

If further work is to be performed, it would have to be geared toward the
development of unconventional or new concentration techniques. Enough
basic research might develop some process or processes by which the
copper could be concentrated economically. However, the development
of such a method is at best problematical and the further expenditure of
funds for this purpose does not seem to be technically warranted.

If further work is justified based on other favorable circumstances, such
as reserves, potential sale of an achievable product, etc., we would sug-
gest that a continuation of the program should first determine in some
depth the exact nature of the problem that has prevented obtaining accept-
able grade and recovery. The development of flotation techniques that
would be effective in the fine size range characteristic of this material
should then be given primary attention. It should be kept in mind, how-
ever, that selective flotation in this size range has been the subject of
study for many years, and a successful technique has yet to be developed.

DISCUSSION

SAMPLES (GENERAL)

On June 14, 1974, two samples were obtained from Hazen Research, Inc.
One sample weighed 44 lb. (wet weight basis), contained 20.7% moisture,
and was labeled HRI 6898-1. The other sample weighed 56 lb. (wet weight

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basis), contained 28.6% moisture and was labeled HRI 6898-2. Each of
the samples were received in sealed plastic bags.

Sample Preparation

Each sample was split in two portions and one-half of each passed through
a four-mesh screen, then blended. This composite sample was labeled
CSMRI No. 3 and was the sample used throughout this study.

CHARACTERIZATION OF SAMPLE

The composite sample was analyzed chemically and a cursory mineral-
ogical study made to characterize it. Following are the results of these
studies:

Chemical Analyses

At your request, the composite sample was analyzed for certain elements.
These elements and the results of the analyses are shown in Table 1:

Table 1. Chemical Analyses

Element	%
Cu	0.090
Fe	8.930
Pb	<0.01
Mo	$\approx$0.01
Zn	0.206
U_3O_8	0.005
Co	0.02
	oz/ton (Fire Assay)
Gold	<0.005
Silver	<0.01

This analysis was used as the head sample analyses for work performed
during this study.

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Mineralogical Analyses

Petrographic microscope and x-ray diffraction analyses of the sample showed it to contain major quartz, chlorite and mica (biotite, in part), minor apetite and pyrite and trace amounts of feldspar and chalcopyrite. It was noted some of the quartz grains had a greenish coating on them.

No further mineralogical work was performed as it was understood Hazen Research was to perform a detailed mineralogical analysis.

CYCLOSIZER TEST ON COMPOSITE SAMPLE

A Worman cyclosizer test was performed on the total composite sample. This cyclosizer consists of a bank of five continuous microcyclones which act to split the sample into certain size ranges. This test was performed to determine the relationship of copper distribution in the composite sample based on size fractionization. Following are the results of that test (see also Appendix, Exhibit 2, Test 1):

Table 2. Cyclosizer Results on Total Composite Sample

Size Range (μ)		Wt %	% Cu	% Cu Distribution
	+34.1	23.5	0.11	36.8
-34.1	+26.6	8.8	0.09	11.3
-26.6	+17.8	7.0	0.07	7.0
-17.8	+11.6	7.8	0.06	6.7
-11.6	+ 8.5	4.9	0.06	4.2
- 8.5		48.0	0.05	34.1

This test showed two basic things: (1) The copper assay in all size fractions was very uniform, and (2) 70.9% of the copper in the sample is evenly distributed in the +34.1 micron and -8.5 micron fractions.

HEAVY LIQUID SEPARATION

A heavy liquid separation was performed on the composite sample at sp.gr. of 2.98. The purpose of the separation was to concentrate the heavy mineral phases, which will include copper-bearing phases such as chalcopyrite. In this process, the composite sample was centrifuged for three minutes at 1000

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rpm in 2.98 sp.gr. media. The sink and float products from this separation were subsequently each centrifuged three times in the heavy media (1000 rpm for three minutes), then all sink and float fractions combined and assayed. Following are the results of the heavy liquid analyses:

Table 3. Heavy Liquid Analyses (2.98 sp.gr.)

Test No.	Wt % (+)2.98	Wt % (-)2.98	% Cu (+)2.98	% Cu (-)2.98	% Cu Distribution (+)2.98	% Cu Distribution (-)2.98
1	14.3	85.7	----	----	----	----
2	14.4	85.6	----	----	----	----
Average	14.35	85.65	0.23	0.06	39.1	60.9

These values show that 60.9% of the copper in the sample was left in the lighter than 2.98 sp.gr. fraction with only 0.23% Cu grade achieved in the heavy fraction. It may be concluded that this material generally is not amenable to gravity concentration.

The float fraction (<2.98 sp.gr.) was subjected to a Worman cyclosizer separation. The test was performed on the float portion to determine if the 60.9% copper in this fraction was concentrated in any one size range. Following are the results of this test (Appendix, Exhibit 2, Test 3):

Table 4. Cyclosizer Test of <2.98 sp.gr. Fraction

Size Range (u)		Wt %	% Cu	% Cu Distribution
	+34.1	21.2	0.048	17.2
-34.1	+25.5	8.4	0.026	3.4
-25.5	+17.8	5.9	0.022	1.7
-17.8	+11.6	8.8	0.024	3.5
-11.6	+ 8.5	5.6	0.038	3.5
- 8.5		50.1	0.080	70.7

This test indicates that the heavy liquid separation was most effective for the larger (+8.5 micron) copper-bearing minerals. This is based on the data in Table 4 that shows most of the copper remaining in the float fraction is in the -8.5 micron size fraction.

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SUPERPANNER TESTS

Three superpanner tests were run on the composite sample to investigate, by means other than heavy liquid, the possibility of accomplishing a gravity separation of the copper minerals. The superpanner is a shaking trough type of laboratory device that simulates shaking tables and other similar types of gravity separation equipment, but is more efficient and capable of closer separation than other gravity devices. The machine is adjustable as to stroke, slope, speed, percent solids, etc. Three tests were performed varying certain parameters (Appendix, Exhibit 3). The results of these three tests are shown below:

Table 5. Superpanner Tests

Test No.	Product	Wt%	%Cu	%Cu Distribution
1	Conc.	5.9	0.26	16.9
	Tail	94.1	0.08	83.1
2	Conc.	6.4	0.26	20.1
	Tail	93.6	0.07	79.8
3	Conc.	5.6	0.22	15.8
	Tail	94.4	0.07	84.2

As may be noted from these data, the best results obtained, Test 2, showed a copper recovery of 20.1% at a grade of 0.26% copper.

FLOTATION TESTS

The composite sample was subjected to four different flotation tests. The first two were made without regard to reagent quantities in an attempt to recover as much copper as possible in the concentrate (Appendix, Exhibit 4, Tests 1 and 2). Following are the results of these tests:

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Table 6. Results of Flotation Tests 1 and 2

Test No.	Product	Wt%	%Cu	%Cu Distribution
1	Conc.	18.9	0.22	58.8
	Tail	81.1	0.036	41.2
2	Conc.	48.0	0.14	81.2
	Tail	52.0	0.03	18.8

These tests show that 58.8% of the copper can be recovered at a grade of
0.22 in 18.9% of the sample. The data also show that 81.2% of the copper
can be recovered at a grade of 0.14% by pulling a greater weight of product
into the concentrate.

A Worman cyclosizer was run on the flotation tailings from Flotation Test
No. 1. This was done to determine if the flotation process was selectively
floating a certain copper-bearing mineral size (Appendix, Exhibit 2, Test
2). The results of that test showed that only 10.1% of the copper in the
composite sample was left in the -8.5 micron fraction after flotation (the
cyclosizer test on the total composite sample showed 34.1% of the copper
to be in the -8.5 micron fraction). The test also showed that 12.6% of the
copper in the composite was left in the +33.3 micron fraction after flotation
(the cyclosizer test on the total composite sample showed 36.8% of the copper
to be in the +34.1 micron fraction). In essence, this indicates that the flo-
tation process tended to float the -8.5 micron copper minerals, as well as
the +33 to +34 micron size copper-bearing minerals.

The third flotation test involved a higher pH flotation system in which the
reagents were added in stages with the pulp pH controlled by additions of
CaO. The results of that test are shown in Table 7.

Table 7. Results of Flotation Test 3

Product	Wt%	% Cu	% Cu Distribution
Conc.	26.9	0.190	60.3
Tail	73.1	0.046	39.7

The results of this test show the same basic trend as Flotation Tests 1 and 2.

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Flotation Test No. 4 involved the desliming of the sample at 400 mesh Tyler and making three different flotation tests of the -400 mesh slime fraction using increasing dosages of Na_2S, Z-200, Z-6 and M1BC reagents (Appendix, Exhibit 4, Test 4). The pH and flotation times were held constant. Following are the results of these tests:

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Table 8. Results of Flotation Test 4

Desliming of Sample

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Size (Tyler Mesh)	Wt%	% Cu	% Cu Distribution
+400	32.0	0.088	32.5
-400	68.0	0.086	67.5

<div align="center">

Flotation of Slime Fraction

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Product	Wt%	% Cu	% Cu Distribution Slime Circuit	Total Sample
Flotation Test A:				
Conc.	6.8	0.574	45.3	30.6
Tail	93.2	0.050	54.7	36.9
Flotation Test B:				
Conc.	4.4	0.772	39.6	26.7
Tail	95.6	0.054	60.4	40.8
Flotation Test C:				
Conc.	30.9	0.178	62.8	42.4
Tail	69.1	0.046	37.2	25.1

The trends shown in these tests are basically the same as for the other three tests, i.e., as copper grade goes up, copper recovery decreases, and as copper recovery increases, weight percent in the concentrate increases. Flotation Test B above yielded the highest grade of any test performed in this study, but the copper recovery for the overall sample was only 26.7%.

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Assuming the present price of copper to be $0.80 per pound (E/MJ, June 1974) and using the results of Flotation Test B, in order to recover $0.38 worth of copper, $2.20 worth of flotation reagents were required.

HYDROSIZER (ELUTRIATION) TESTS

An elutriation test was performed on the composite sample to determine if the lighter sp.gr. fraction could be preferentially washed from the heavier sp.gr. fractions. In this test, the sample was placed in a vertical cell and water introduced from the bottom at a rate of 1.5 liters per hour. Six overflow samples, of about 10 liters each, were obtained and analyzed, and the residual concentrate in the cell after testing was also analyzed (Appendix, Exhibit 5). The results of these tests showed that no concentration was achieved and that the distribution of copper was almost identical to the weight percent of material in each sample.

ACID LEACH STUDIES

The composite sample was subjected to a cold acid leach using a five percent H_2SO_4 solution and a two-hour leaching period (Appendix, Exhibit 6). The results of this test showed that 38.04% of the copper (0.68 lb. of Cu/ton at $0.80/lb. = $0.55 worth of Cu/ton of feed) was leached from the sample at an acid consumption rate of 52 lb. of H_2SO_4 per ton of material. Assuming that acid could be obtained for $0.01 per pound and using the 38.04% copper recovery figure ($0.55 copper recovered per ton of feed), this process does not appear economically feasible.

It is apparent from the foregoing studies that none of the conventional process methods tested will be capable of achieving good recovery and a saleable grade of copper in a concentrated product. Even if reasonable grade could be achieved, on the order of 0.6% to 0.8% Cu, it is questionable if such a product could be marketed even as feed material to a conventional concentrator plant. In view of the characteristics of such a product, the conventional plant would be unable to treat it further to obtain the usual desired end product of 20% to 30% Cu, and, therefore, would have no use for such a feed. Leaching could conceivably be tested further to treat physically concentrated material in the hope that the acid-consuming constituents present in the original feed would not be present in the copper concentrate. However, the economics of physical concentration plus a leaching step (even with materially lower acid consumption) appear highly questionable.

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It is possible that a much more intensive study of this material might lead
to more knowledge and eventually to the development of an effective con-
centration method. Based on the present information, however, the chances
of such a success appear remote and further study is not recommended. The
overall prognosis of liquid-solid separation and washing efficiencies on this
type of material is also very poor.

If you have any questions concerning this report, please contact us.

Sincerely,

M. G. Pattengill
Senior Project Engineer
Chemical Division

S. Zaman
Senior Project Engineer
Metallurgical Division

/cjm

Enc.

APPENDIX

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EXHIBIT 1

Heavy Liquid Test No. 1

Purpose: Separate sample into (+) and (-) 2.98 sp.gr. fractions.

Sample: Composite head sample (CSMRI No. 3).

Procedure: 200g of feed was pulverized to -100 mesh and split in half. Each sample was centrifuged in heavy liquid (sp.gr. 2.98) at 1000 rpm for three minutes. Three cleaning cycles were run on the initial sink-float fractions, using the same procedure. Products were washed with acetone, dried and combined into composite sink and float products.

Results:

Heavy Liquid Products	Test No.	% Weight	% Weight	Chemical Analysis % Cu	% Distribution
Head (calc)				0.0843	(100.00)
Head (Assayed)				0.090	
Sink (>2.98)	1	13.58	14.3		
Float (<2.98	1	81.39	85.7		
Sink (>2.98)	2	14.31	14.4		
Float (<2.98	2	85.22	85.6		
Composite Sink (>2.98)			14.35 (avg)	0.23	39.1
Composite Float (<2.98)			85.65 (avg)	0.06	60.9

Observations: All distributions based on calculated head.

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EXHIBIT 2

Cyclosizer Test No. 1

Object:	To observe if there are one or more size fractions of the sample that may contain major portions of the copper values.
Sample:	50 gms. CSMRI Composite 3.

Test Conditions:

Apparatus: Worman Cyclosizer
Pressure: 54 Temperature 24
Flowmeter Reading: 175 Time: 21 minutes

Results:

Product (size in microns)		% Weight	Chemical Analysis % Cu	Chemical Analysis % Fe	% Distribution Cu	% Distribution Fe
calculated head		100.0	0.071	8.93	100.0	100.0
	+34.1	23.5	0.11	12.0	36.8	38.2
-34.1	+26.6	8.8	0.09	11.7	11.3	13.9
-26.6	+17.8	7.0	0.07	11.3	7.0	10.7
-17.8	+11.6	7.8	0.06	10.0	6.7	10.6
-11.6	+ 8.5	4.9	0.06	11.2	4.2	7.4
- 8.5		48.0	0.05	2.96	34.1	19.2

Observations: The results of -8.5 micron fraction indicates that the copper minerals in this fraction might not be chalcopyrite. It appears that copper distribution is very uniform all throughout the size fractions investigated.

EXHIBIT 2

Cyclosizer Test No. 2

Object:	To observe if additional copper can be recovered from the flotation tail (Flotation Test No. 1) by size fractionation.
Sample:	50 gms of rougher tail from the Flotation Test No. 1.

Test Conditions:

Apparatus:	Worman Cyclosizer
Pressure:	54 Temperature: 26
Flowmeter Reading:	175 Time: 20 minutes

Results:

Product (size in microns)		% Weight	Chemical Analysis % Cu	Chemical Analysis % Fe	% Distribution Cu Indiv.	% Distribution Cu Overall	% Distribution Fe Indiv.	% Distribution Fe Overall
calculated head		100.0			100.0	41.2	100.0	54.5
	+33.3	21.2	0.054	7.04	30.7	12.6	24.8	13.5
-33.3	+25.0	13.4	0.038	6.36	13.7	5.6	14.3	7.8
-25.0	+17.4	9.0	0.038	6.00	9.2	3.8	9.0	4.9
-17.4	+11.4	12.9	0.040	6.00	13.9	5.7	12.9	7.0
-11.4	+ 8.3	7.2	0.040	6.40	8.1	3.4	7.7	4.2
- 8.3		36.3	0.025	5.18	24.4	10.1	31.3	17.0

Observations:	It appears from the results that an overall 29.4% of the weight of material may be rejected as minus 8.3 micron slimes with 10.1% copper loss.

EXHIBIT 2

Cyclosizer Test No. 3

Object: Size fractionation of the heavy liquid (2.98 sp. gr.) float product by cyclosizer to observe the distribution of copper in various size fractions.

Sample: 50 gm heavy liquid (2.98 sp. gr.) float product from the Heavy Liquid Test No. 1.

Test Conditions:

Apparatus: Worman Cyclosizer
Pressure: 54 Temperature: 24
Flowmeter Reading: 175 Time: 21 minutes

Results:

| Product (size in microns) | % Weight | Chemical Analysis | | % Distribution | | | |
		% Cu	% Fe	Cu Indiv.	Overall	Fe Indiv.	Overall
calculated head	100.0	0.058	4.5	100.0	60.9	100.0	----
+34.1	21.2	0.048	1.88	17.2	10.5	8.9	----
-34.1 +25.5	8.4	0.026	1.76	3.4	2.1	3.3	----
-25.5 +17.8	5.9	0.022	2.52	1.7	1.0	3.3	----
-17.8 +11.6	8.8	0.024	4.40	3.5	2.1	8.6	----
-11.6 + 8.5	5.6	0.038	6.60	3.5	2.1	8.2	----
- 8.5	50.1	0.08	0.082	70.7	43.1	67.7	----

Observations:

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EXHIBIT 3

Superpanner Test No. 1

Object: To observe if sulfide minerals could be conveniently pre-
concentrated by gravity separation technique.

Sample: Approximately 40 gms of CSMRI Composite 3.

Test Conditions:

Speed: 200 rpm   Forward Horizontal Stroke: 3/4-inch
Stroke: 5/8-inch   Rear Horizontal Stroke: 5/8-inch

Results:

Product	% Weight	Chemical Analysis		% Distribution	
		% Cu	% Fe	Cu	Fe
Calculated Head	100.0	0.091	9.05	100.0	100.0
Assayed Head	---	0.090	9.3	---	---
Superpanner Concentrate	5.9	0.26	37.2	16.9	24.1
Superpanner Tail	94.1	0.08	7.3	83.1	75.9

Observations: Considerable pyrite in the concentrate. Appears to be
good sulfide concentrate, particularly pyrite.

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EXHIBIT 3

Superpanner Test No. 2

Object: To observe if sulfide minerals could be conveniently pre-concentrated by gravity separation technique.

Sample: Same as Superpanner Test No. 1.

Test Conditions:

Speed: 210 rpm   Forward Horizontal Stroke: 3/4-inch
Stroke: 3/4-inch   Rear Horizontal Stroke: 5/8-inch

Results:

Product	% Weight	Chemical Analysis		% Distribution	
		% Cu	% Fe	Cu	Fe
Calculated Head	100.0	0.082	9.12	100.0	100.0
Assayed Head	---	0.090	9.3	---	---
Superpanner Concentrate	6.4	0.26	38.8	20.1	27.1
Superpanner Tail	93.6	0.07	7.1	79.8	72.9

Observations: Change in speed and stroke did not improve either the grade or the recovery of copper to concentrate.

EXHIBIT 3

Superpanner Test No. 3

Object: To observe if sulfide minerals could be conveniently pre-
concentrated by gravity separation technique.

Sample: Same as Superpanner Test No. 1.

Test Conditions:

Speed: 160 rpm   Forward Horizontal Stroke: 3/4-inch
Stroke: 3/4-inch   Rear Horizontal Stroke: 5/8-inch

Results:

Product	% Weight	Chemical Analysis		% Distribution	
		% Cu	% Fe	Cu	Fe
Calculated Head	100.0	0.078	8.95	100.0	100.0
Assayed Head	---	0.090	9.3	---	---
Superpanner Concentrate	5.6	0.22	31.6	15.8	19.8
Superpanner Tail	94.4	0.07	7.6	84.2	80.2

Observations: Keeping other parameters the same (Test 2), the lowering
of speed from 200 to 160 rpm has definitely reduced the
concentrate grade and the recovery of copper.

EXHIBIT 4

Flotation Test No. 1

Object:	To observe flotation amenability of copper minerals (sulfides) under best dispersed condition and without regard to the quantity of reagents used.
Sample:	Approximately 150 gms (dry) of CSMRI Composite 3.
Test Conditions:	Light pull of froth.

Three Stages of Rougher Flotation:

Flotation Time in Minutes	pH	Reagents: lbs/ton of flotation feed								AP	
		H_2SO_4[1]	Na_2S[2]	Calgon	Sodium Silicate	Na_2CO_3	Z-200	AF-31	Z-6	3477	MIBC
14.5	8.5-9.1	19.0	3.6	3.3	0.7	26.7	0.1	0.3	2.1	0.3	1.0

[1]Total H_2SO_4 added in various stages to maintain pH between 8.5-9.1.

[2]Na_2S on 100% purity basis.

Results:

Product	% Weight	Chemial Analyses		% Distribution	
		% Cu	% Fe	Cu	Fe
Calculated Head	100.0	0.071	8.9	100.0	100.0
Assayed Head	---	0.090	9.3	---	---
Rougher Concentrate	18.9	0.22	21.5	58.8	45.5
Rougher Tail	81.1	0.036	6.0	41.2	54.5

Observations:	Sulfide flotation visually appeared to be slow. Stage addition of reagent helps floating additional sulfides. Considerable amount of pyrite floated in the rougher concentrate.

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EXHIBIT 4

Flotation Test No. 2

Object: Attempt to float copper minerals from the total ore with as high a recovery as possible and without regard to the quantity of reagents used.

Sample: Approximately 150 gms (dry) of CSMRI Composite 3.

Test Conditions: Heavy pull for froth removal to obtain as high a recovery as possible.

Three Stages of Rougher Flotation:

Flotation Time in Minutes	pH	H_2SO_4 [1]	Na_2S [2]	Calgon	Sodium Silicate	Na_2CO_3	Z-200	AF-31	Z-6	AP 3477	M1BC
14.5	8.5-8.8	18.5	3.6	3.3	0.7	26.7	0.1	0.3	2.1	0.3	1.1

Reagents: lbs/ton of flotation feed

[1] Total H_2SO_4 in various stages added to maintain pH between 8.5-8.8.

[2] Na_2S on 100% purity basis.

Results:

Product	% Weight	Chemical Analysis % Cu	% Fe	% Distribution Cu	Fe
Calculated Head	100.0	0.083	8.23	100.0	100.0
Head Assayed	---	0.090	9.30	---	---
Rougher Concentrate	48.0	0.14	10.4	81.2	60.4
Rougher Tail	52.0	0.03	6.3	18.8	39.6

Observations: Note the large quantity of Na_2CO_3 used as lbs/ton basis. This is because of small quantity of solids taken. Also for Golden tap water which contains high Ca^{++} ions, the amount of Na_2CO_3 needed for pH control is usually high as compared to relatively softer Ca-hardness water.

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EXHIBIT 4

<u>Flotation Test No. 3</u>

Object: To observe the flotation response of copper minerals with several stage addition of reagent and flotation, at a higher pH (9.5) of the pulp controlled by lime (CaO).

Sample: 500 gms (dry) sample of CSMRI Composite 3.

Test Conditions:

Four Stages of Equal Time Rougher Flotation:

Total Rougher Flotation Time in Minutes	pH	Reagents lbs/ton of flotation feed				
		CaO	Z-6	Na_2S	M1BC	$CuSO_4$
20	9.5	5.4	0.24	0.40	0.35	0.40

Results:

Product	% Weight	% Assay Cu	% Distribution Cu
Calculated Head	100.0	0.085	100.0
Assayed Head	---	0.090	---
Rougher Concentrate	26.9	0.190	60.3
Rougher Tail	73.1	0.046	39.7

Observation: pH control by inexpensive lime (CaO) does not appear to be deleterious for flotation. Note the much smaller quantities of reagents used in this test as compared to the other three tests.

EXHIBIT 4

Flotation Test No. 4

Object: To observe flotation response of slime fraction (minus 400 mesh) of the composite sample under various dosage of reagents.

Sample: CSMRI Composite 3.

Procedure:

Composite Sample 3 (495.9 gms dry)

↓

400 mesh screening (wet)

- 400 mesh (slime) 68.0% by weight of the composite

+400 mesh fraction (sand) 32.0% by weight of the composite

split into 3 equal parts

Part A   Part B   Part C

Rougher Flotation A   Rougher Flotation C

Rougher Conc C   Rougher Tail A   Rougher Conc C   Rougher Tail C

Rougher Flotation B

Rougher Conc B   Rougher Tail B
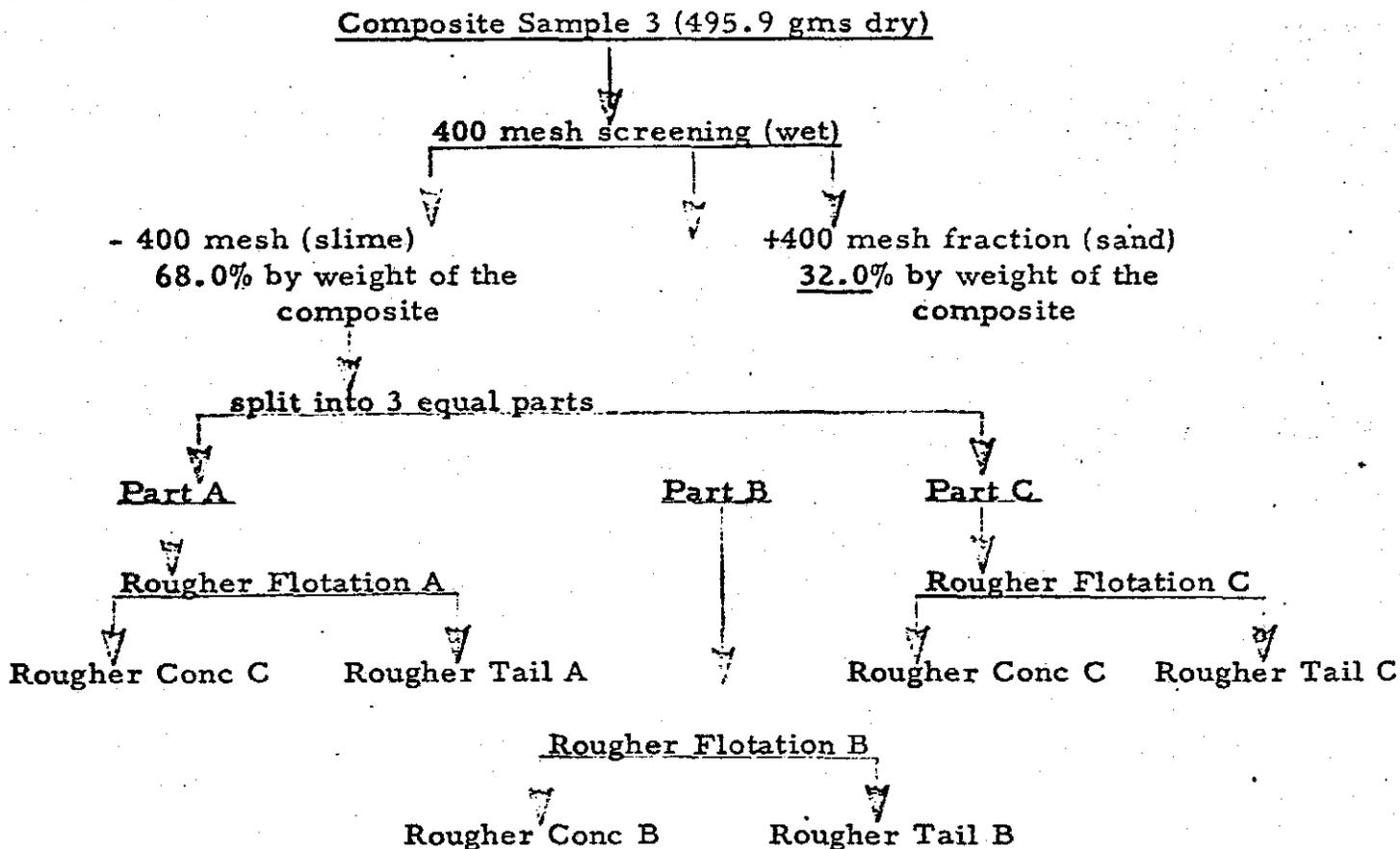
Test Conditions:

	Total Rougher Flotation Time in Minutes	pH	Reagents lbs/ton of slime feed			
			Na_2S[1]	Z-200	Z-6	MIBC
Flotation A[2]	12	8.0-8.4	1.08	0.48	0.36	2.30
Flotation B	12	8.0-8.4	2.10	0.96	0.70	4.60
Flotation C	12	8.6-8.7	4.20	1.89	1.42	6.30

[1] Na_2S (100% Pure).
[2] Two stage rougher flotation six minutes each with 1/2 the dosage of reagent at each stage after conditioning 10-15 minutes at each stage prior to flotation. Followed same for B and C.

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EXHIBIT 4

Flotation Test No. 4 (Continued)

Results:

Flotation Test A:	% Weight	% Assay Cu	% Cu Distribution	
			Slime Circuit Alone	Overall Circuit Sand & Slime
Head (assayed)	100.0	0.086	100.0	67.5
Rougher Conc. A	6.8	0.574*	45.3	30.6
Rougher Tail A	93.2	0.050	54.7	36.9
Flotation Test B:				
Head (assayed)	100.0	0.086	100.0	67.5
Rougher Conc. B	4.4	0.772*	39.6	26.7
Rougher Tail B	95.6	0.054	60.4	40.8
Flotation Test C:				
Head (assayed)	100.0	0.086	100.0	67.5
Rougher Conc. C	30.9	0.178*	62.8	42.4
Rougher Tail C	69.1	0.046	37.2	25.1

*Calculated, based on slime head assay of 0.086.

CSMRI Composite 3	% Weight	% Cu Assay	% Distribution Cu
+400 mesh (sands)	32.0	0.088	32.5
-400 mesh (slime)	68.0	0.086	67.5
Combined Sand & Slime	100.0	0.087	100.0

036260

EXHIBIT 5

Hydrosizer Test No. 1

Purpose: To evaluate possible concentration of copper minerals using
             a hydrosizer elutriation column.

Sample: CSMRI Composite 3.

Procedure: rpm = 50; flowrate = 1.5 liters/hour. The sample was made
             into a slurry and added to the hydrosizer. A laboratory mixer
             was on a drive mechanism for the hydrosizer. After 13 minutes,
             the drive was shut off and the cell was used only as an elutriation
             column. All bulk samples were thoroughly agitated and a re-
             presentative sample was removed as an assay sample. The
             density was calculated and based on the volume of the respective
             sample, the weight distribution was determined.

Results:

Product	Approx-mate Volume Liters	% Solids	Weight %	Weight %	Chemical Analysis Cu %	Chemical Analysis Fe %	% Distribution Cu	% Distribution Fe
Head (actual)		2.028	(453.6)		0.072	8.00		
Head (calc.)			(397.7)	(100.0)	(9.086)	(8.85)	(100.0)	(100.0)
Residual Concentrate Sample	9.0	1.535	138.2	34.8	0.096	10.80	38.2	42.5
Overflow Sample 1	10.0	1.733	173.3	43.6	0.082	7.80	41.7	38.5
Overflow Sample 2	10.0	0.581	58.1	14.6	0.082	7.80	13.9	12.9
Overflow Sample 3	10.5	0.171	18.0	4.5	0.082	7.80	4.6	4.0
Overflow Sample 4	10.5	0.014	1.5	0.4	0.085	7.14	0.3	0.3
Overflow Sample 5	11.0	0.008	0.9	0.2	0.051	6.32	0.1	0.1
Overflow Sample 6	10.0	0.077	7.7	1.9	0.064	8.12	1.2	1.7

Observations: The concentrate appeared to have been upgraded slightly.

EXHIBIT 6

Acid Leach Test No. 1

Purpose: Determine Cu recovery from head ore and acid consumption of head ore.

Sample: Composite Sample No. 3.

Procedure: Use 5% H_2SO_4 solution. Titrate with standard NaOH solution to determine acid concentration using methyl orange indicator. Add 100.000 grams (dry wt. basis) of head ore to 400 ml of H_2SO_4 solution. Stir for two hours with no heating. Filter the solution and analyze for Cu and titrate the solution for H_2SO_4 strength with standard NaOH solution. Standardize NaOH solution against a standard H_2SO_4 solution. No washing of the residue is necessary for analysis of Cu in filtrate. The residue may be washed with the H_2SO_4 solution in order to analyze the residue for Cu. These washings are not to be added to the original filtrate. Determine m.e. of H_2SO_4 solution by titration using a pH meter and titrating to a pH of 3.2.

Results:

Calculations:

% Cu Recovery (head sample contains 0.09% Cu)

0.0856 grams of copper/liter of filtrate $\therefore$ $0.0856 \times \dfrac{400}{1000} = 0.03424$ grams

of copper recovered from 100 grams of head sample $\therefore \dfrac{0.03424}{0.09} = 38.04\%$

Cu recovery.

Acid consumption (head sample contains 0.09% Cu)

5% H_2SO_4 solution: before leaching = 70.60 m.e.; after leaching = 61.52

m.e. $\therefore$ $61.52 \div 70.60 = 87.14$; $0.05 \times 400 = 20g$ of H_2SO_4 added $\therefore$ $0.87 \times$

$20 = 17.40$ $\therefore$ $20-17.40 = 2.6g$ of $H_2SO_4/100$ grams of head sample; $\dfrac{2.6}{100} =$

$\dfrac{x}{2000} = 52$ lb. of H_2SO_4/ton of ore.

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO · 80401
TELEPHONE 303/279-4501

July 26, 1974

Dr. Douglas D. Jinks
Cities Service International, Inc.
521 South Boston, Box 37
Tulsa, Oklahoma 74102

·Re: HRI Project 1571

Dear Dr. Jinks:

This letter report covers the preliminary scoping work which we have done to determine the potential for concentrating the copper values contained in your "Metalliferous Mud" samples.

Sample Receipt

On April 15, 1974 we received, here at Hazen, two 30-gallon drums of the mud samples. These drums were labeled 325 and 327 and were assigned HRI numbers 6898-1 and -2, respectively. Samples of the material in each drum were taken by means of a sample auger to avoid drying of the material before sampling.

Sample Analysis

The augered samples from the two drums were prepared and assayed for total and acid soluble copper with the following results.

Sample No.	% Total Cu	% Acid Soluble Cu
325 6898-1	0.075	0.031
327 6898-2	0.092	0.018

The acid soluble copper assays may represent dissolution of extremely fine copper sulfide in addition to the normal soluble copper oxides.

Dr. Douglas Jinks — 2 — July 26, 1974

Mineralogical Analysis

Mineralogical work on this project has been limited primarily to examination of sample 6898-2 containing 0.092 copper. While determination of mineral components was based on those particles coarser than 10 μ, the material examined contained copper only as chalcopyrite accompanied by pyrite and traces of sphalerite. The material appears to be representative of the type of material one would expect to find in a tailings product from a copper flotation milling operation. The sulfides appeared to be reasonably well liberated from the gangue constituents, with only minor amounts of locking.

Experimental Work

To determine the potential for concentration of copper by discarding selected size fractions, a sub-sieve size analysis was carried out. Data from this evaluation are as follows:

Size Fraction	Weight %	Cu %	Cu Distribution %
+30 microns	67.1	0.083	61.8
-30 +20	8.7	0.081	7.7
-20 +10	7.1	0.072	5.8
-10 microns	17.1	0.130	24.6

These data indicate that desliming of the mud prior to concentration would cause severe losses of the contained copper.

A series of four preliminary flotation tests was carried out on Sample 6898-2 to check the response of the material to normal flotation procedures. Details of these tests are shown in the attached data sheets.

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	Test F-1	Test F-2	Test F-3	Test F-4
Feed assay % Cu	0.094	0.12	0.08	0.09
Feed size	As rec'd	-10 μ	-400M +10 M	-400 M +10 M
Rougher conc % Cu	0.489	0.25	0.38	0.37
Rougher conc % Cu recovery	57.4	25.0	58.3	49.7
Cleaner conc % Cu	0.885	0.87	0.43	0.44
Cleaner conc % Cu recovery	43.3	10.2	48.1	40.2

These tests, while not conclusive, indicate that the sulfides in the coarser fractions can be concentrated by flotation. In Test F-1 the rougher concentrate, carrying 57 percent of the copper values in 11 percent of the weight, was essentially a pyrite concentrate. Attempts to depress the pyrite while floating the chalcopyrite in the cleaner operation resulted in severe copper losses with only a minor increase in copper grade.

As expected, the application of conventional flotation techniques to the minus 10-micron slime fraction was ineffective, yielding a low grade concentrate with poor recovery.

Additional Test Work

Only a limited amount of test work is currently planned on the metal-liferous mud samples. A table test will be run on the minus 400-mesh plus 10-micron material to check the possible application of gravity concentration procedures. Flotation concentrates will be analyzed for zinc content to determine zinc distribution in the flotation products. A limited test series employing a novel flotation procedure applicable to ultrafine feed materials will be undertaken.

We would expect all work on this project to be completed within the next three weeks.

Yours very truly,

F. M. Stephens, Jr.
Vice President

FMS/cm
Encl.

HRI   FLOTATION   TEST

TEST NO.: F-1
PROJECT: 1571
DATE: 6/19/74
PAGE: OF

TITLE:

OBJECTIVE: Initial flotation test

REMARKS:

SAMPLE: ≈1000 g   6878-2
as received
WATER: Tap   MACHINE: Agitair   BY: J.C.G.

TEST CONDITIONS

OPERATION	Grind	Cond	Ro Flot		Cond	1 Clnr										
CELL	Pebble	2000	2000		1000	1000									
TIME, MINUTES	10	3	20		5	15									
pH	8.15	8.15	8.53		7.65	8.30									
TEMPERATURE, °C	20	25	25		25	25									
REAGENTS LBS/TON — Na-silicate	1.0	–	–		–	–									
Soda ash	4.0	–	–		–	–									
Z-200	0.05	–	0.017		–	–									
DF 250	–	0.04	0.04		0.01(2)	–									
NaCN	–	–	–		0.05	–									
SO_2	–	–	–		0.20	–									
% solids	50	15	14		3	2									

TEST PRODUCT	DRY WT (g)	WT %	ASSAYS, %					UNITS					DISTRIBUTION, %			
			Cu					Cu					Cu			
Head (assay	–		0.094													
First cleaner conc	41.51	4.60	0.885					0.0407					43.3			
First cleaner tails	57.94	6.42	0.206					0.0132					14.1			
Rougher tails	802.70	88.98	0.045					0.0400					42.6			
Head (calculated)	902.15	100.00	0.094					0.0939					100.0			
Rougher concentrate	99.45	11.02	0.489					0.0539					57.4			

hrl 50-22

HRI FLOTATION TEST

TITLE: Cities Service

OBJECTIVE:

REMARKS:

SAMPLE: HRI 6898-2

-10µ decant material

WATER: Tap   MACHINE: Agitair

DATE: 7/1/74

PAGE: 1   OF 1

BY: J.C.G.

TEST CONDITIONS

OPERATION	Cond	Ro Flot		Cond	1 Clnr										
CELL	1000	1000		500	500										
TIME, MINUTES	5	10		3	6										
pH	6.82	7.27		7.17	7.62										
TEMPERATURE, °C	25	25		25	25										
Xan 350	2.5 ml	–		1 ml	–										
DF 250	3 drops	–		–	–										
Na-silicate	5 ml	–		–	–										

REAGENTS LBS/TON

TEST PRODUCT	DRY WT (g)	WT %	ASSAYS, % Cu				UNITS Cu					DISTRIBUTION, % Cu			
Head (assay)	–	–	0.09												
First cleaner conc	3.65	1.38	0.87				0.0120					10.2			
First cleaner tails	27.06	10.22	0.17				0.0174					14.8			
Rougher tails	233.99	88.40	0.10				0.0884					75.0			
Head (calculated)	264.70	100.00	0.12				0.1178					100.0			
Rougher concentrate	30.71	11.60	0.25				0.0294					25.0			

hri 50-22

HRI FLOTATION TEST

TITLE: Cities Service

OBJECTIVE: Comparison of metallurgy: Flotation of (-400M +10µ) material

REMARKS:

SAMPLE: HRI 6898-2   - 400 M

+10µ , ~1000 g

WATER: Tap   MACHINE: Agitair

DATE: 7/1/74

PAGE: 1   OF 1

BY: J.C.G.

TEST CONDITIONS

OPERATION	Cond	Ro Flot	Cond	Sc Flot		Cond	1 Clnr	Cond	2 Clnr									
CELL	1000	1000	1000	1000		500	500	500	500									
TIME, MINUTES	10	12	5	6		5	7	5	4									
pH	8.40	8.30	8.67	8.65		11.05	10.70	12.23	12.15									
TEMPERATURE, °C	25	25	25	25		25	25	25	25									
Xan 350	0.06	0.04	0.04	–		–	0.02	–	–									
NaCO₃	2.00	–	–	–		–	–	–	–									
Na-silicate	0.50	–	–	–		–	–	–	–									
DF-250	0.04	0.02(4)	0.02(4)	–		–	–	–	–									
AF 65	–	0.01(4)	–	–		–	–	–	–									
Na₂S	–	–	0.50	–		–	–	–	–									
CaO	–	–	–	–		1.00	–	2.00	–									
NaCN	–	–	–	–		–	–	0.02	–									

REAGENTS LBS/TON

TEST PRODUCT	DRY WT (g)	WT %	ASSAYS, % Cu					UNITS Cu					DISTRIBUTION, % Cu				
Head (assay)	–	–	0.09														
Second cleaner conc	64.79	6.13	0.51					0.0313					35.0				
Second cleaner tails	39.82	3.77	0.31					0.0117					13.1				
First cleaner tails	38.51	3.64	0.25					0.0091					10.2				
Scavenger conc	11.72	1.11	0.29					0.0032					3.6				
Scavenger tails	902.01	85.35	0.04					0.0341					38.1				
Head (calculated)	1056.85	100.00	0.09					0.0894					100.0				
First cleaner conc	104.61	9.90	0.43					0.0430					48.1				
Rougher conc	143.12	13.54	0.38					0.0521					58.3				
Scav tails + scav conc	913.73	86.46	0.04					0.0373					41.7				

hri 50 - 22

036268

HRI FLOTATION TEST

TITLE: Cities Service

OBJECTIVE: Comparison of metallurgy:

REMARKS:

SAMPLE: HRI 6898-2, -400 M

+ 10 µ

WATER: Tap   MACHINE: Agitair   BY: J.C.G.

TEST CONDITIONS

OPERATION	Cond	Ro Flot	Cond	Sv Flot		Cond	1 Clnr											
CELL	1000	1000	1000	1000		1000	1000											
TIME, MINUTES	5	12	5	8		2	10											
pH	7.10	7.40	7.85	7.77		7.78	7.78											
TEMPERATURE, °C	25	25	25	25		25	25											

REAGENTS LBS/TON

	Cond	Ro Flot	Cond	Sv Flot		Cond	1 Clnr										
Z-200	0.04	0.03	-	-		-	-										
Na-silicate	1.21	-	-	-		-	-										
DF-250	0.03	0.01	-	-		-	-										
AF-65	0.01	-	-	-		-	-										
Na₂S	-	-	0.24	-		-	-										
Xan 350	-	-	0.08	-		-	-										

TEST PRODUCT	DRY WT (g)	WT %	ASSAYS, %				UNITS					DISTRIBUTION, %			
			Cu				Cu					Cu			
Head (assay)	-	-	0.09												
First cleaner conc	103.34	8.31	0.44				0.0366					40.2			
First cleaner tails	46.64	3.75	0.23				0.0086					9.5			
Scavenger conc	42.73	3.43	0.35				0.0120					13.2			
Scavenger tails	1051.38	84.51	0.04				0.0338					37.1			
Head (calculated)	1244.09	100.00					0.0910								
Rougher conc	149.98	12.00	0.37				0.0452					49.7			
Scav conc + scav tails	1094.11	87.94	0.05				0.0458					50.3			

APPENDIX H
FUTURE PROGRAM

PHASE III EXPLORATION PROPOSAL · EL 16/73 & 2/74 MACQUARIE HARBOUR

PROGRAMME

- Broaden project backing, preferably increasing Australian participation
- Incorporate; register in Tasmania
- Write and let phase III contracts
- Cancel less mineralized parts of licence(s); transfer title
- Prepare environmental study and lodge with trial application for mining lease
- Further sampling and assaying of 3 ore bodies defined in Phase II
- Sample and assay bay and sub-bottom waters
- Temporarily lease with 30 year option site for shore plant and wharf
- Plan and erect pilot scale plant to treat concentrate
- Obtain pilot scale dredge and concentrator
- Run pilot scale tests
- Design test full scale mining units, plant and support facilities
- Apply for mining lease
- Report on Phase III
- Prepare for phase IV—Mine Construction

SCHEDULE

July	Funding. Incorporate, register. Secure contractors. Sample.
August	Reduce licence. Lease site. Environmental report. Design pilot operation.
Sept.	Construct pilot scale plant.
Oct.	Run pilot tests.
Nov.	Design mine. Apply for Mining Lease.
Dec.	Phase III report. Phase IV preparations.

PROGRAM

Australia: Modify existing proposal
                    Reduce license 16/73
                    Bulk sample sediments
                    Sample baywaters, orewaters, sediment waters
                    Chemical and mineralogical studies
                    Beneficiation tests
                    Pilot plant design and contracts
                    Beach sampling

United States: Contract modification
                    Routine reporting and license maintenance
                    Beneficiation tests
                    Dredge design and costing
                    Brine treatment and economics
                    Expand backing
                    Define and rank new targets

Various: Reconnaissance sampling $\pm$ lease acquisition of
                    2-3 targets of optimum potential; probably in
                    British Columbia, Alaska, Iceland or Norway.