DEPARTMENT OF MINES WESTERN AUSTRALIA IN 1987-1988

ANNUAL REPORT

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ANNUAL REVIEW

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STATISTICAL SUMMARY

FOREWORD

The 'Department of Mines Western Australia in 1987/88' is a single volume incorporating three parts: the Annual Report, Annual Review, and Statistical Summary.

The Department's Annual Report is the information presented to the Minister for Mines and tabled in Parliament on 8 November, 1988.

The Annual Review contains information which the Department believes is of importance to the Mining and Petroleum Industries and relevant to the members of the Public with a general or particular interest in the mining sector. Review material includes information on research being undertaken by Divisions of the Department of Mines and also on services provided by various Divisions to those who require guidance or assistance.

The Review seeks to demonstrate the interaction between the Department and the Mining and Petroleum Industries, with reference to how the industries have performed in areas such as health and safety, storage and handling of dangerous goods, environmental protection, and their general contribution to the economic strength of Western Australia.

The Statistical Summary includes details about the industries reflected in data collected by the Department and is a valuable reference to those within the industry and members of the public, for specific research and general information.

This volume then is a record of activities of the Department of Mines; an overview of the Mining and Petroleum Industries as monitored by the Department, and illustrates the way in which the members of the Department of Mines have carried out their duties and responsibilities.

Assistant Director -
Coal.

DEPARTMENT
OF MINES
WESTERN
AUSTRALIA

ANNUAL REPORT
1987-88

The Honourable Jeff Carr, BA, JP, MLA
Minister for Mines
Parliament House
PERTH WA 6000

Dear Minister

In accordance with Section 62 of the Financial Administration and Audit Act 1985, I submit for your information and presentation to Parliament the Annual Report of the Department of Mines of the State of Western Australia for the year ending June 30, 1988.

The Annual Report has been prepared in accordance with the provisions of the Financial Administration and Audit Act 1985.

The document follows the format established last year, whereby the Department's activities are described within the framework of corporate objectives against a background of the mining and petroleum industries in 1987/88.

Information about the Department and its activities of a more general nature, which has in the past proved of value to our clients and industry, will be published later in the year as an Annual Review.

I would like to welcome you as Minister for Mines following your appointment to the position on February 25, 1988 and, at the same time, acknowledge the great support given by your predecessor, the Honourable David Parker, BA, MLA, to both the Department and the industries that we serve.

I wish to acknowledge the loyal and responsible contribution of officers from all sections of the Department and to express my appreciation of the support given by Government throughout the past year.

Yours sincerely

D.R. KELLY
DIRECTOR GENERAL OF MINES
August 1988

DEPARTMENT OF MINES W.A.
ANNUAL REPORT 1987/88.

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DIRECTOR GENERAL'S REPORT

In 1987/88, the State's mining and petroleum industries continued to expand and diversify in response to increased demand and higher prices for many commodities.

The total value of minerals and petroleum produced in 1987/88 was a record $6946 million, an increase of $1089 million or 19% on the previous year.

The major expansion was in gold where there were 15 significant new producers with individual outputs of more than 155 kg (5000 oz). Production reached an all time high of 90.5 tonnes, easily exceeding the 61 tonnes produced in 1903. Activity was not just confined to gold and much has happened right across the mining and petroleum industries. It was no surprise that there was a high demand for the services of the Department of Mines, which places prime importance on responding to the needs of industry. Reflecting this, the Department's revenue of $208.56 million included the record amount of $166.22 million for royalties and $28.36 million for rentals and fees for service.

A most significant event in the life of the Department was the completion and occupation in November, 1987 of the new Mineral House Stage II complex. The refurbishment of Mineral House Stage I commenced in early 1988 and when completed in November, 1988 will allow all of the Department's central city offices to be consolidated into the Mineral House complex. Already, significant benefits are being derived by the Department from the better interaction between personnel made possible by being in the same building.

Early in the financial year, Dr Colin Branch was appointed to the position of Assistant Director General of Mines, which had been previously occupied by Dr Phillip Playford before his appointment as Director of the Geological Survey. Dr Branch joined the Department from a senior position in the South Australian Department of Mines and Energy.

The year under review saw the appointment of Dr John Hosking to the position of Director of the Chemistry Centre of Western Australia (previously the Government Chemical Laboratories) following the retirement of Mr Hilton Hughes.

After deliberations spanning a number of years the Government made a significant decision on the future of the Chemistry Centre, to leave it as a consolidated unit providing a range of integrated services to government agencies and the public. Planning has commenced to relocate the Chemistry Centre to a site on the Bentley campus of Curtin University.

1987/88 saw the implementation of the second phase of the Government's three year program to increase the staff of the Mining Engineering Division by 31 people. This expansion, funded by industry through additional fees, has proved most timely. Faced with a rapid expansion of mining activity frequently involving unskilled people new to the industry, the division has been called upon to make substantial efforts towards safeguarding the health and safety of mineworkers and in the rehabilitation of mined-out areas. A critical situation has been averted only by this additional staffing program, which will be completed in 1988/89 with the filling of the final 11 positions.

There has been a great deal of activity in the Corporate Services area during the year under review. The Functional Review Committee agreed to combine its review processes into the Department's corporate planning cycle. It is hoped that the resultant procedures will give the committee a "window" into the Department's operations, thus enabling the committee to discharge its obligations whilst at the same time allowing the Department to continue with ongoing planning procedures.

The year also saw strenuous endeavours to bring the Department up to full establishment, but with only limited success. Although 193 people, representing 25.7% of the Approved Staffing Level, were appointed during the year, there were 121 departures at the same time. Considering that in January, 1987 when the 'freeze' was lifted the Department had over 100 vacant positions, it is clear there is still some way to go to bring the Department to full strength. The recruitment of suitable staff in a number of fields, particularly geologists, mining engineers, petroleum engineers and computer scientists, is proving most difficult, reflecting the demand for these people in industry. Departmental officers with experience in administration of mining tenements are also in high demand in industry and there is a continual drain of able people in this direction.

The record high level of activity in the mining and petroleum industries, coupled with the staff recruitment difficulties, has placed exceptional demands on the people in the Department. Despite this and the dislocations of moves with the completion of Mineral House Stage II, staff have responded well, as I am sure will be evident in the report that follows.

THE MINING AND PETROLEUM INDUSTRIES IN 1987/88

OVERVIEW

A Year of Development

The year 1987-88 was one of considerable development in the minerals and petroleum sectors. Gold mining continued to dominate exploration and development although there was, for the first time in about six years, a welcome and long overdue improvement in the price and demand for many of the State's other mineral commodities.

The improved demand and reduction in metal stocks to low or at least more manageable levels around the world, should ensure a degree of continued stability. Even the October 1987 stock market crash did not result in across-the-board falls in commodity prices and general economic downturn. In fact, commodity prices and demand did not appear to slacken at all.

The most significant effect of the stock market crash on the mining industry was in the exploration sector where the previous easy source of exploration funds through company floats dried up instantly. A number of companies floated at the time of the crash have struggled for their existence.

Whilst an improved market situation was the norm, a notable exception was the iron ore industry. Although demand improved, prices were lower for the fourth year in a row, placing the industry in very difficult circumstances.

The mining and petroleum industries already underpin the Western Australian economy with over 60% of the State's total export earnings and about 30% of Australia's total mineral export trade. It has been estimated that 11% of all foreign currency brought into Australia is from earnings in Western Australia's mineral and petroleum sectors.

Overall, the massive investment and increasing diversity of the current mineral and petroleum activities makes this the most exciting period in the State since the emergence of the modern industry in the 1960's.

Gold Leads the Way

Of the major industries in the State, the main improvements in gross value of production in 1987-88 were in gold, petroleum, nickel, heavy mineral sands, alumina and iron ore. Diamond output declined in value, resulting from an expected fall in stone qualities.

New gold developments are taking place at the rate of 20-30 new mines a year although investment is not restricted to the gold industry. Even in these difficult times for iron ore, four new or replacement projects were committed for development during the year. Innovative marketing and changes to the traditional firm letters of intent have resulted in commitments to a number of modest developments. These will be well placed to exploit markets should the situation improve.

Downstream Processing

A major front of development continued to be downstream processing particularly in the heavy mineral sands and petrochemical industries. A number of new avenues for mineral processing were investigated and projects implemented.

Increased emphasis on downstream processing means that in dollar value terms 52% of the State's mineral exports are processed through to the smelted and/or refined product stage before shipment. This percentage is increasing with the new developments.

In the petroleum sector, work proceeded on the development of the LNG phase of the multi-billion dollar North West Shelf Project which is forecast to come on-stream in 1989.

The Global Situation

Western Australia generates a significant proportion of world trade in iron ore, nickel, alumina, ilmenite, rutile, zircon, monazite, tantalite, spodumene (lithium), diamonds and salt. About 76% of the State's mineral and petroleum output in 1987/88 was destined for the world market. In some aspects, this is not always an advantage as the health of the industry is determined by the vagaries of the world economy and commodity markets. However, the industry is increasingly accommodating market fluctuations by diversifying its commodity mix and adding value by downstream processing.

Apart from the mineral sands products, mineral and petroleum trading is largely in US dollars. Whilst for nearly five years the mineral industry has been advantaged by a weakening Australian dollar, 1987-88 saw a reversal with the dollar strengthening by nearly 10 cents against its US equivalent. Just a one cent change in the exchange rate causes a change of about $80 million in overall revenue. This is an important factor which cannot be overstressed. Offsetting this, the stronger Australian dollar does give an advantage to those companies with capital borrowings in overseas currencies.

Better Prices Help Outlook

Following nearly five years of depressed prices, two industries which experienced a significant upswing were alumina and nickel. Alumina prices have shown gradual improvement as a result of a delayed flow-on from the buoyant aluminium metal market.

Nickel price rises were spectacular. From a low of US$1.60 per pound in January 1987, prices progressively increased to more than double that by January 1988.

Prices then suddenly escalated in response to a number of temporary supply problems to reach unprecedented levels of over US$9 per pound. More importantly, the short-term escalation appears to be underpinned by a fundamental improvement in the market which suggests a brighter outlook for nickel over the next few years.

The four major heavy mineral sands products, together with gold, continued to experience the buoyant conditions of the past three years. Although the gold price did show a slight decline during the second half of the financial year, there was much greater stability than for many years. This stability was over a period where the uncertain economic environment with slow world economic growth, a stock market crash, and reversals in the value of the US dollar would normally have led to much more volatility in the gold price.

If the price remains in the range US$400 — $500 per ounce and there is not a marked change in exchange rates, then the gold industry should continue to flourish.

Rising copper and zinc prices have provided welcome relief to the world mining industry and allowed development of the Cadjebut zinc-lead operation in the Kimberley and brought about the imminent development of the Golden Grove zinc-copper project in the Murchison.

Some Depressed Prices

The Australian oil price, which was deregulated by the Commonwealth Government at the end of 1987, was depressed throughout the year. Whilst exploration activity is still relatively high in Western Australia, improvements in price are required to sustain such a level.

The iron ore industry is undergoing a difficult period with a 5% decline in prices in 1987-88 and a further 4% reduction in the negotiated price for fine ore for 1988-89. The lump product has maintained the price levels of the previous year. This difficulty was compounded by the stronger exchange rate. Fortunately, these influences were offset by increased shipments which rose 22% in 1987-88 from the previous year and are forecast to be even higher in 1988-89.

Measures to improve production efficiency continue to be implemented by all iron ore producers. They are now benefitting from these measures in the same way that other sectors of the minerals industry are benefitting from rationalisation programs undertaken during the first half of the 1980s.

Whilst the nickel industry's resurgence has been quite recent, it is becoming evident that a longer term and more systematic method of planning is now emerging from the crisis management which was in place a year ago.

Future Outlook

Compared with the last five years, overall performance in 1987-88 was significantly better and the investment on expansion and diversification will clearly provide long-term benefit to the mineral and petroleum industries and to the continued development of the State. Whilst gold and petroleum still dominate exploration activity, there are a number of identified projects in other commodities with a very significant resource base, from which a diversity of developments is currently emerging. Also, there are signs that exploration for other minerals is on the increase.

The Argyle Diamond Mine. Rich rewards from exploration in the Kimberleys and Australia's first diamond producer.

PRODUCTION AND VALUE

Increase of $1089 million

The total value of minerals and petroleum produced in 1987-88 was estimated at $6946 million, an increase of 19% or about $1089 million on the previous year. The major contributor to this increase was gold, with the value of output estimated to have increased by $544 million or 42%. This builds on the $590 million increase in 1986-87.

The contributions of iron ore and gold to the total are almost equal and together provide about 53% of the total value of production. Based on the trend in gold production over the last seven years and the projects now advancing to the operational and expansion stages, it appears likely that gold will emerge as the major commodity in value terms in the State in 1988-89.

Industry Rankings

The ranking of industries based on production value was the same as that of the previous year, except for heavy mineral sands which displaced that of diamonds, (Figure 1).

Following iron ore and gold are bauxite-alumina (17% of total value), the petroleum industry (11%), the nickel industry (6%), heavy mineral sands (4%), diamonds (4%), coal (2%) and salt (2%). The other industries individually contribute less than 0.2% to the overall value. The performance of the major industries in 1987/88 compared with the previous year is shown in Figure 2.

Iron Ore — Record Production

The value of production of iron ore rose by only 4% or $72 million despite a continued decline in prices. This was due to a 22% increase in shipments to a record 95 million tonnes. Company order books for 1988/89 suggest output will again bolster the performance of the industry, although committed contracts may stretch output capabilities to the limit.

Significant milestones were achieved during the latter part of the year by the three major producers. Hamersley shipped its 600 millionth tonne, Newman its 500 millionth tonne and Robe River its 200 millionth tonne since production commenced in 1966, 1969 and 1972 respectively.

Alumina and Nickel — Both up

The alumina industry showed steady gains in both output (6%) and value (8%) in returning to reasonable profitability.

The gain of 40% in value over the last fiscal year in the nickel industry, is due entirely to the massive rise in price as output was in fact reduced (-7%).

FIGURE 1: VALUE OF MINERAL PRODUCTION IN WESTERN AUSTRALIA 1987-88

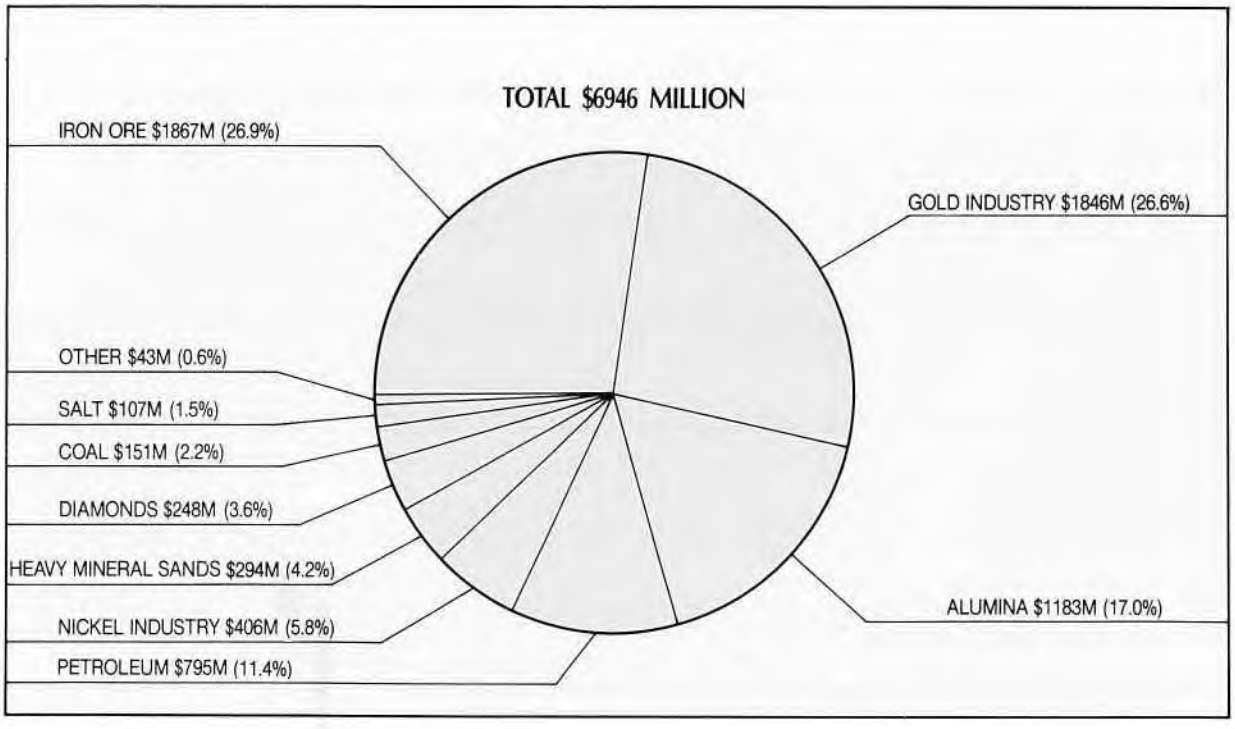
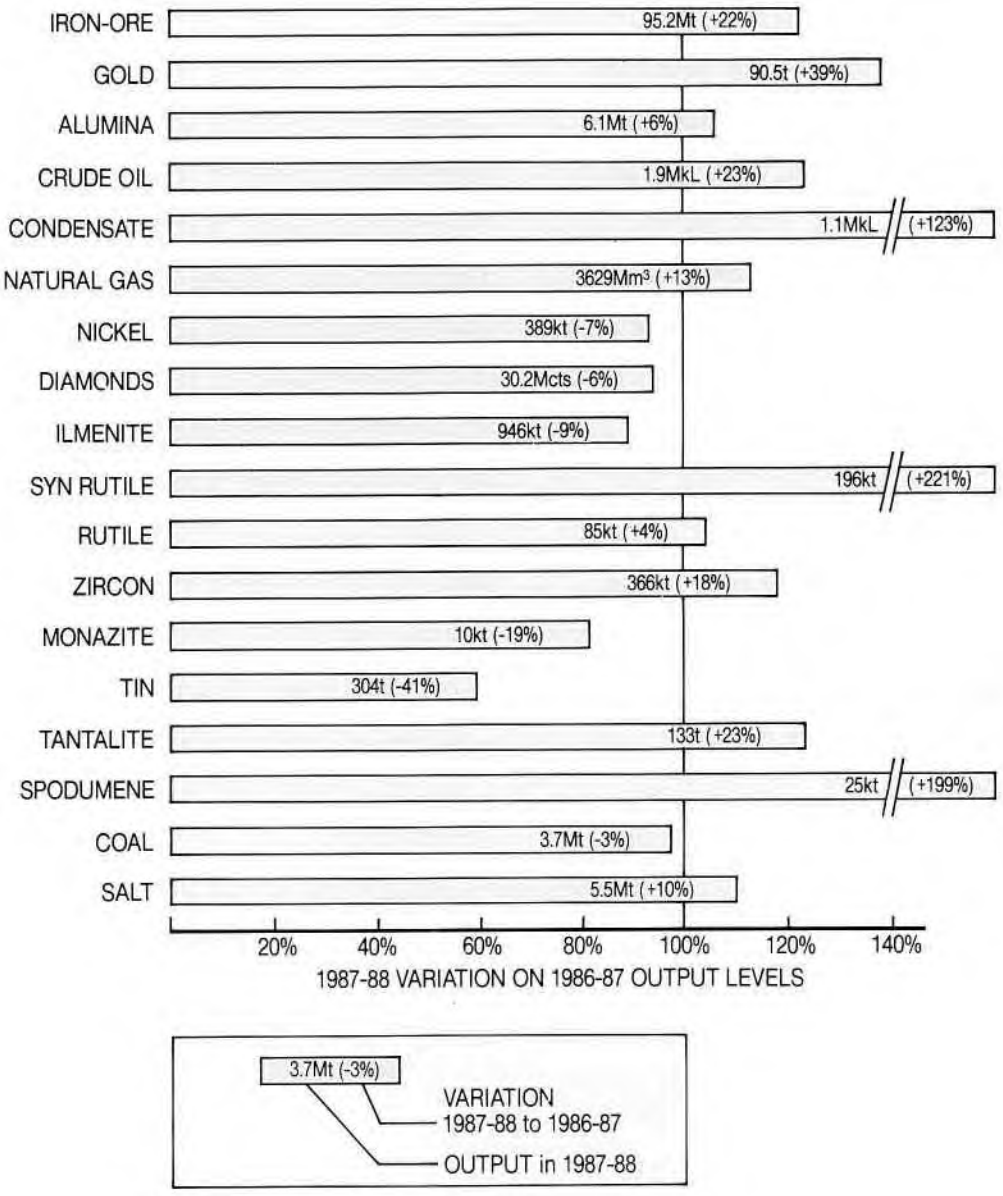


FIGURE 2: MINERAL PRODUCTION IN WESTERN AUSTRALIA 1987-88 (MAJOR INDUSTRIES)



Petroleum — Output Rising

The improved output from the petroleum sector was directly linked to the huge increase in condensate production from the North Rankin field offshore. An enhanced recovery technique known as gas recycling began in 1987 to recover greater petroleum liquid from the natural gas reserves. The process has doubled condensate production in the field from 2,000 to 4,000 kilolitres per day and is expected to continue for at least 5 more years.

The increase of 23% in the production of crude oil in the State is due to the new offshore development of the South Pepper and North Herald oil fields, and an increase in the production rate for the offshore Harriet field.

Heavy Mineral Sands — Major Improvement

The heavy mineral sands industry continued to develop downstream processing facilities. In terms of output, very strong demand for rutile and zircon resulted in increases of 4% and 18% respectively, whilst the new synthetic rutile plants added substantially to output and value. For minor products, output was about 15% down on 1986-87 levels. Strong prices in all products gave a continuing buoyancy to the industry during the year and the outlook remains promising.

Diamonds Down

Diamond production was reduced by 6% from the peak levels of 1986-87. The value was reduced by 13% reflecting the lower quality products coming from the Argyle AK1 primary pipe.

A second diamond operation at Bow River, east of Argyle, commenced production early in 1988.

Other Increases

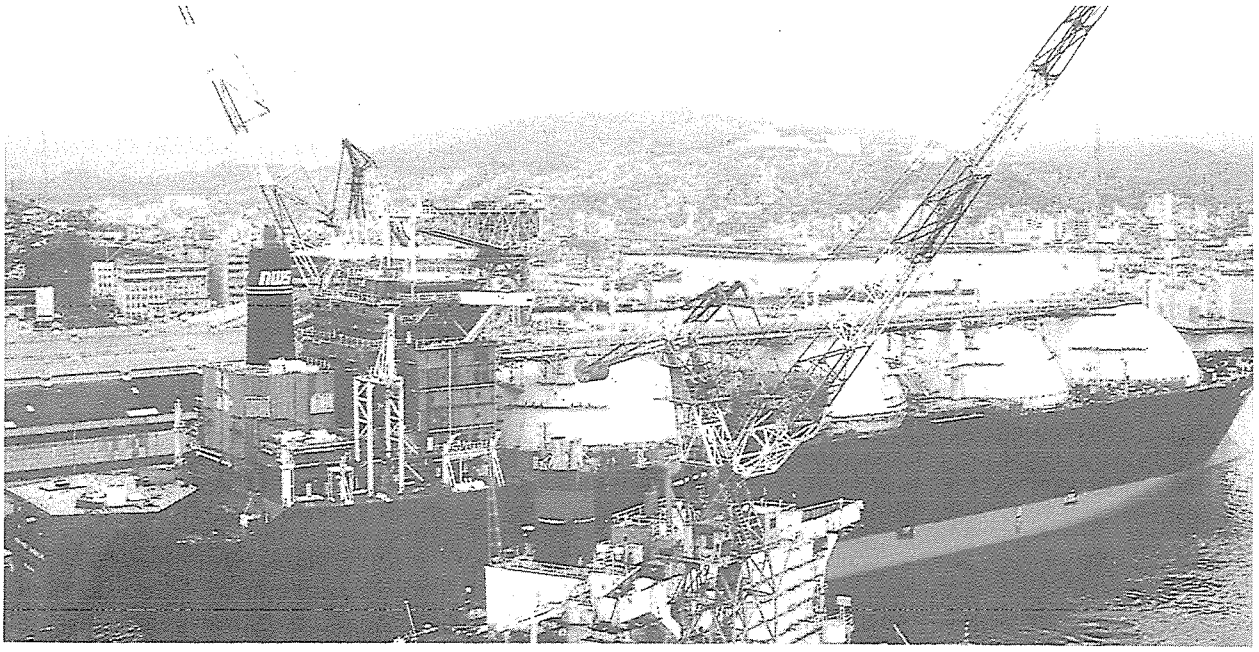
Of the smaller industries, demand for salt resulted in a 10% increase in output. The Greenbushes operation continued striving for market penetration of a diversity of products resulting in significant increases in sales of tantalite and spodumene. On the domestic market, the overall value of industrial minerals increased by 26%.

EXPLORATION AND FUTURE DEVELOPMENT

Minerals

Exploration statistics for 1986-87 (the latest available), show a continuing high level of mineral exploration activity concentrated in Western Australia compared to the rest of Australia. From a proportion of 38% of total Australian mineral exploration activity five years ago (1981-82), the State's share has progressively increased to 58% in 1986-87 (Figure 3). Although about 74% of the total expenditure in 1986/87 of $323 million was devoted to gold exploration, Western Australia also led in exploration for base metals, nickel, uranium, diamonds, iron ore and heavy mineral sands. This high level of activity continued in 1987-88. Figure 4 gives comparisons with the Australian total and the outlay on the different commodities within the State.

In **gold**, intense exploration activity continues unabated. Lead times, from the identification of a resource to production, can be less than a year and the announcement of the Commonwealth's impending taxation of gold does not appear to have unduly dampened the fervour. The stock exchange crash did, however, introduce a degree of selectivity to the myriad of grass roots projects. New developments in the order of 25-35 a year are likely to continue, whilst expansions at many of the main production centres will maintain the growth trend.



The 'Northwest Sanderling' is the first of seven special LNG transporters to be built for the Withnell Bay to Japan trade. All ships will be named after migratory birds which fly between Australia and Asia. Each of the four aluminium LNG spheres in the hull are 40m in diameter, the largest yet installed on an LNG carrier.

Improved **base metal** prices have seen a resurgence of developments and exploration in the State. Cadjebut, a small high grade zinc-lead deposit near Fitzroy Crossing in the Kimberley, is the first development of a number of similar deposits in the region; Blendevale being the most significant.

A go-ahead decision on the $130 million Golden Grove Project's Scuddles zinc-copper-silver deposit in the Yalgoo region is imminent; whilst a decision on development of the Nifty Copper Project in the Throssell Range to the east of the Pilbara could also be announced in the near future.

Exploration continues in the Throssell Range and in the Rudall River area to the south. This activity could result in the emergence of a major base metal province in the future. Longer term base metal potential is also being identified with exciting finds, at depth, in the middle of the Canning Basin.

The Rudall River area is more noted for its **uranium** potential at this stage. The Kintyre deposit has emerged as a major find with 35,000 tonnes of uranium oxide resource. Over $30 million has already been spent on the prospect since 1985 and work continues to fully evaluate the potential of the larger area, as well as define the immediate area of the deposits to the level of a potential development.

Platinum exploration is being actively pursued in a number of areas of the State, notably the East Kimberley, West Pilbara and around New Norcia to the north of Perth. No firm resource announcements have been made to date, but some results are reportedly encouraging.

The feasibility of further **alluvial diamond** extraction in the Argyle area is being evaluated, whilst further interesting finds in this region are being made.

Still in the Kimberley region, the Brockman **polymetallic/ rare earths** project near Halls Creek is emerging as a potential development over the next couple of years. It is currently progressing through the metallurgical testing phase.

Plans for rare earth extraction from monazite are proceeding for Pinjarra in the south-west. The proposed plant will be part of an integrated complex, with the first phase, that of **gallium extraction**, under construction. Gallium compounds will be recovered from the spent liquor in the alumina process.

In addition to expansions and new developments within known **heavy mineral sands** deposits in the Perth Basin, major finds near the south coast on the Scott Coastal

FIG 3: ESTIMATED EXPENDITURE ON MINERAL EXPLORATION 1981-82 to 1986-87 FOR AUSTRALIA AND WESTERN AUSTRALIA

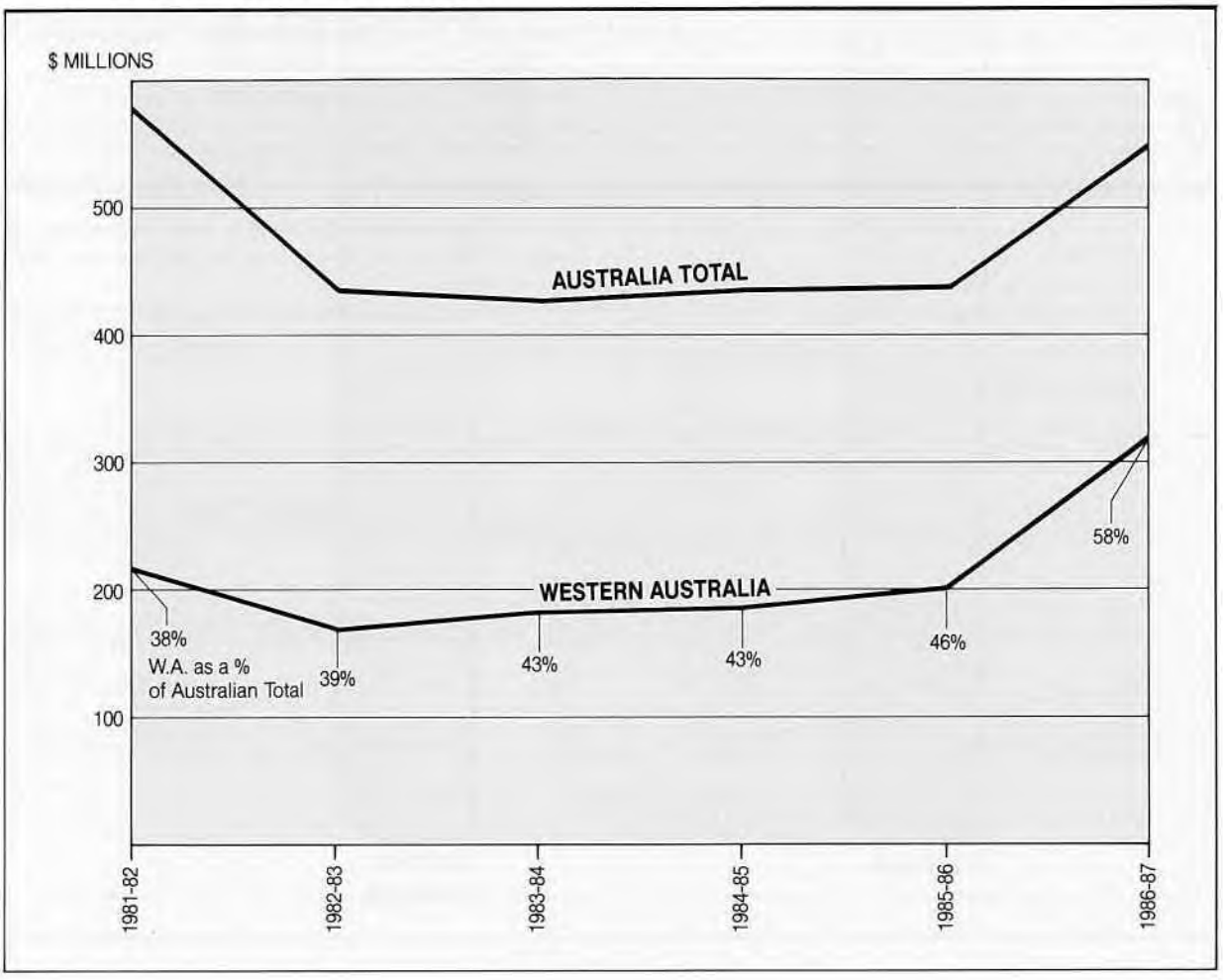
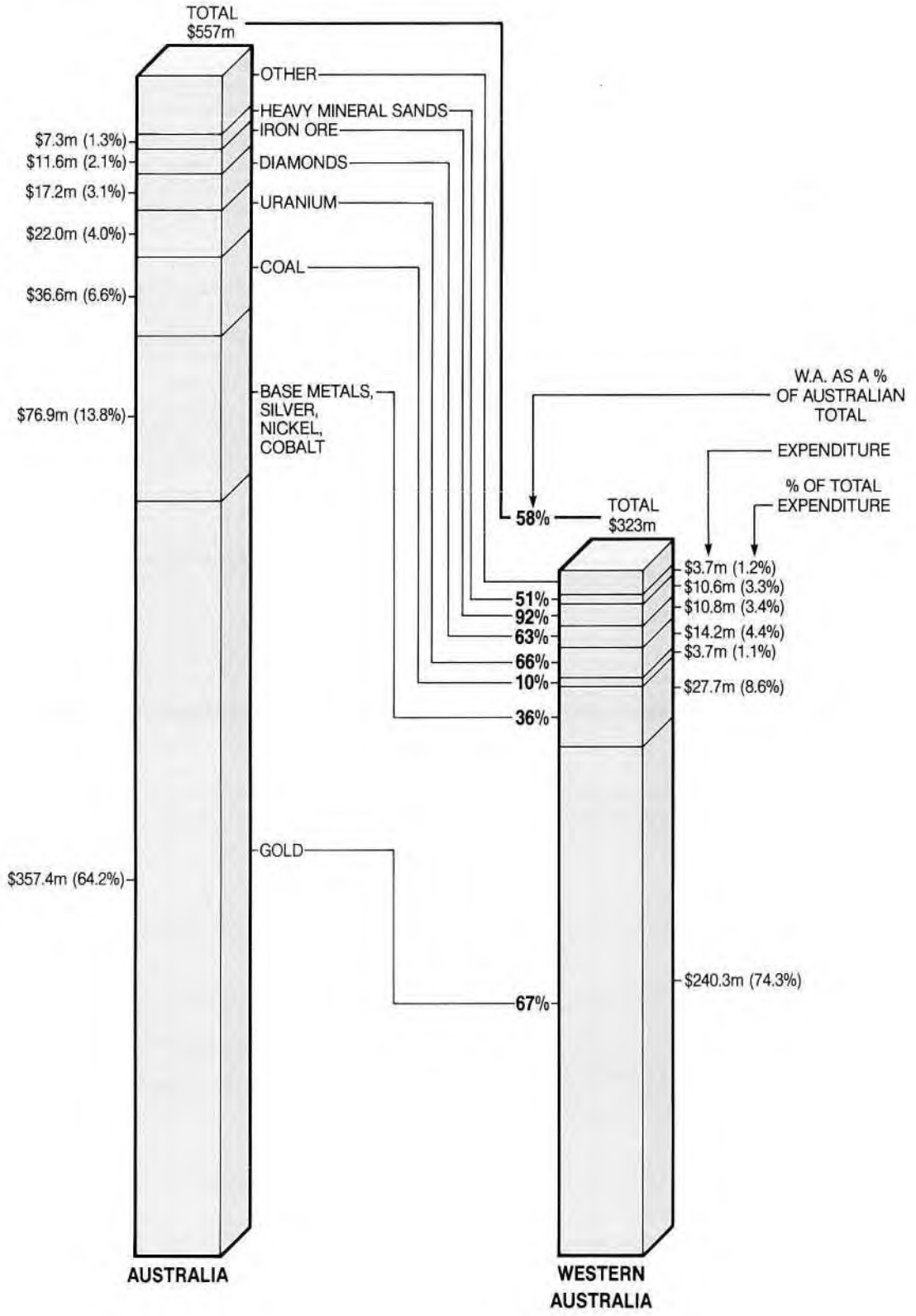


FIG 4: ESTIMATED EXPENDITURE ON MINERAL EXPLORATION 1986-87 FOR AUSTRALIA AND WESTERN AUSTRALIA



Plain are identifying the area as a new and potential major mineral sands province. A new development is planned for the area to be operational at Jangardup by 1991.

Proposals are also being finalised for development of the Cooljarloo mineral sands project to the north of Perth. This will incorporate a $300 million fully integrated downstream processing complex. The plan calls for mining, mineral separation, a synthetic rutile plant and a titanium dioxide pigment plant.

The **iron ore** industry is putting significant effort into the appraisal of scree/detrital ores to serve the current high demand for lump ores. Satellite projects at McCameys, Tom Price and Newman could be developed to meet this demand in the near future.

Of the major new developments, construction has commenced on the $250 million Hamersley-China Channar Joint Venture with scheduled commencement in 1990. Goldsworthy's extension project in the North Pilbara is planned to be in production in 1989. This includes a new beneficiation facility for treating low-grade ore. BHP is also progressing with proposals for a staged development of its Marillana Creek pisolites.

Petroleum

Petroleum exploration activity continued to increase in terms of dollars spent and wells drilled. During 1987/88, 31 exploration wells were drilled onshore and offshore compared to only 16 wells in the previous year. The increase in exploration drilling was largely due to accelerated activity in the onshore Canning Basin where 20 wells were drilled in 1987/88 compared to only 3 in the previous year. Two of these Canning Basin wells, West Terrace 2 and Lloyd 1, encountered significant oil accumulations, with the Lloyd 1 well coming on-steam as a new oil producer.

Offshore exploration activity during the year was concentrated in the Carnarvon Basin, where an oil and gas discovery was made in Rosette 1. This directional well was drilled off Varanus Island and intersected a new petroleum reservoir about 1400 metres out from the island.

Another well was drilled into the Saladin structure to confirm the extent of that field. Saladin 7 was a successful extension well, and tested over 1700 kilolitres per day of crude oil, a world class single well production rate. Development of the offshore Saladin oil field commenced using the nearby Thevenard Island as a collection, processing, storage and shipment base. Ultimate oil production rates from the Saladin field will surpass the maximum production rate ever from Barrow Island and will total around 10% of the total daily oil production rate for all of Australia. Recoverable reserves for the field are estimated to exceed 6.3 million kilolitres.

One of the highlights of the 1987/88 offshore petroleum year was the successful development of the South Pepper and North Herald oil fields. These fields were developed using state-of-the-art horizontal drilling techniques. Oil reserves in the order of one million kilolitres will be produced from the innovative development. Facilities used in the project have largely been designed to be re-used on similar projects.

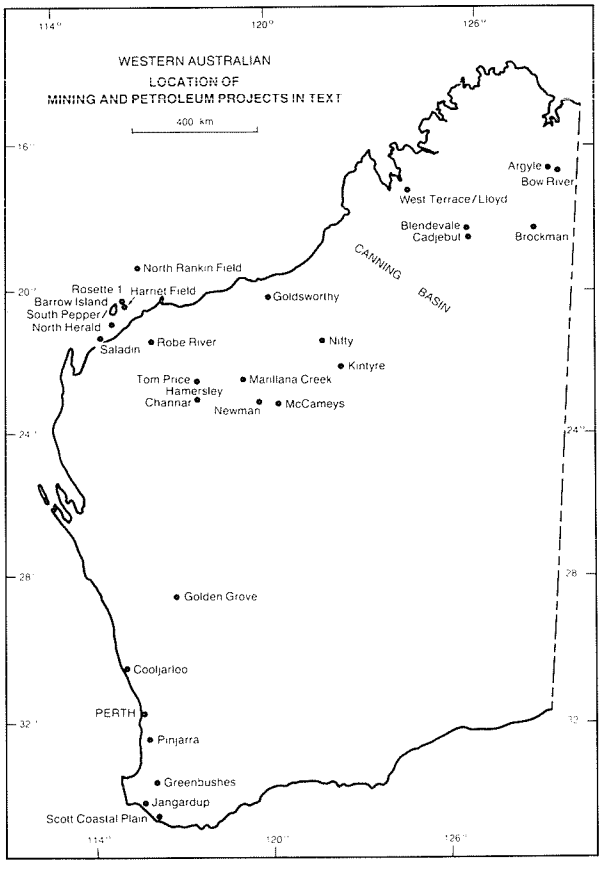
ACCESS TO LAND — A MAJOR ISSUE

A controversial issue of public discussion is that of access to land for exploration and development and the overall question of multiple land use. Industry mounted a campaign to inform the public of the usually limited and temporary nature of land requirements during the various stages of exploration and development. Emphasis is being placed on the potential sterilisation of vast tracts of available land to the industry in this State.

The recent adoption of the Bailey Report and subsequent Government Policy Statement entitled, "Mining and the Environment Balancing the Scales" on procedures for access to National Parks and other conservation reserves establishes the principles to be followed in this area.

The practical procedures for implementation of the Bailey Report, now being discussed, will be critical to the future of the industry. Decisions on the proposed reclassification of B and C class reserves are also most important as they will determine to which areas the policy procedures will need to be applied and hence the availability of ground for exploration. About 400 B and C class reserves have been identified as having little or no mineral or petroleum potential; however the remainder have potential for mineralisation or have known mineral occurrences. These will now be carefully assessed as a basis for recommendations to Government.

FIGURE 5: LOCATION OF MINING AND PETROLEUM PROJECTS REFERRED TO IN TEXT



THE DEPARTMENT OF MINES

BACKGROUND

Government policy is designed to encourage investment in exploration, extraction and utilisation of mineral and petroleum resources. Because of their major contribution to the economy for almost 100 years, mining activities have ramifications that reach directly or indirectly into the whole economic and social fabric of Western Australia. This is reflected in the wide range of activities currently administered by the Department of Mines.

The Department was established on January 1, 1894 as a regulatory body to ensure the orderly development of the mineral resources of the State, and to allow the Government and the community in general to participate in these activities. This is still the major role of the Department.

The integration within the Department of the Geological Survey which was founded in 1888, closely followed by the establishment of a system of State gold batteries, and the transfer to the Department in 1902 of the Government Analyst's Laboratory, saw the emergence of another important role - the provision of services to the mining industry.

These service facilities have evolved with the continued growth of modern mining. As the industry became prominent, and complex regulatory functions demanded greater range and depth of internal services and expertise, many of the sections of the Department traditionally involved in regulation were able to provide further services in the form of technical advice, tenement maps, and safety recommendations. Progressively this role has been extended and now the Department is called upon to provide services to many sectors of the community not directly related to the mining and petroleum industries, particularly in relation to chemistry and public safety.

The Department has again, following the 'corporate review' exercise in 1986, re-examined its role and activities against the background of contemporary industry, including the key consideration of public safety. This has been part of the corporate planning process. The Corporate Philosophy, Role, and Objectives of the Department are slightly altered for this year, reflecting the Department's proactive approach to the tasks involved.

CORPORATE PHILOSOPHY

In establishing its Corporate Philosophy, the Department of Mines has given particular attention to the relationships that exist between the Department, the Government, the community, the natural environment, and the mining and petroleum industries. These relationships are central to the way the resources of the State are developed, the industries are administered, and interaction is achieved with the community. They are summarised below:

- The mineral and petroleum resources of the State are owned by the Crown, but are explored and developed almost entirely by private enterprise.
- Exploration and development are undertaken in an organisational framework controlled and directed by Government.
- The mining and petroleum industries play a major role in the economy of the State and mineral, petroleum and groundwater resources will be required to sustain our future economic viability and living standards.
- Mineral and petroleum deposits are almost always difficult and expensive to find, small in size relative to the total land mass, finite, and non-renewable.
- Mineral and petroleum deposits are assets only after they have been discovered and delineated and the incentive to engage in high-risk exploration to find them is directly related to the potential for an appropriate financial return.
- Resource development is a temporary activity and should be integral to the principle of multiple land use.
- Changes in the economy, technology, and exploration science may lead to the re-appraisal of previously tested ground; thus the potential of any area can never be totally written off and information about it should always remain available.
- Chemical services and research outside those required for the mineral and petroleum industries are needed to ensure independent and standardised information is provided to the community.
- Public safety is of major concern in relation to the transportation and use of explosive and dangerous goods.
- Resources allocated to the Department are to be administered efficiently according to the prevailing principles and standards expected of the Public Service.
- The Department must respond quickly and effectively to changes required by the community through Government.

ROLE

The role of the Department of Mines is to ensure that the community of Western Australia:

- receives maximum benefit from the exploration for and development of minerals and petroleum;
- is protected from hazards associated with mining, petroleum activities, explosives and dangerous goods;
- has access to independent geoscientific, chemical and engineering consultancy services, and environmental advice relevant to the mining and petroleum industries, for the protection of community standards.

BROAD OBJECTIVES

1. **To ensure that exploration and development of the State's mineral and petroleum resources are carried out in a fair manner.**
   - 1.1 Provide an equitable system for giving secure exploration and development titles.
   - 1.2 Minimise potential for disputes, but facilitate their prompt settlement when they arise.

2. **To foster mineral, petroleum and groundwater exploration and development, and assist long range planning and decision making by Government.**
   - 2.1 Continually improve and update knowledge relating to the occurrence of mineral, petroleum, and groundwater resources and the geology of the State.
   - 2.2 Make available adequate mineralogical, metallurgical and water analytical services and carry out research in these areas.
   - 2.3 Disseminate geoscientific data from exploration and related activities in a timely and efficient manner.
   - 2.4 Ensure that effective geotechnical, hydrogeological, and mining engineering advice is available as required.
   - 2.5 Maintain a favourable climate for mineral and petroleum exploration and development.

3. **To ensure that the community receives a fair return from the exploitation of the State's mineral and petroleum resources; and that proper attention is given to the environment.**
   - 3.1 See the community benefits from the activities of the mining and petroleum industries.
   - 3.2 Ensure protection and rehabilitation of the environment as it may be affected by mineral and petroleum development.

4. **To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public.**
   - 4.1 Better the safety and health of workers in the mineral and petroleum industries.
   - 4.2 Minimise hazards to the public from activities involving explosives and dangerous goods.

5. **To ensure that the community has access to independent chemical research and consultancy services.**
   - 5.1 Meet the community's need for applied chemical research in the most effective and efficient manner.
   - 5.2 Ensure that the community's need for independent chemical consultancy services is met in the most effective and efficient manner.

THE ORGANIZATION

MINISTER

The Department is responsible to the Minister for Mines, the Honourable Jeff Carr, B.A., J.P., M.L.A.

ENABLING LEGISLATION

The Department is established by the Governor pursuant to Section 21 of the Public Service Act 1978 and in so doing, satisfies Section 11 of the Mining Act 1978.

PRINCIPAL OFFICERS

Dr D.R. Kelly, BE(Hons), PhD, MIE Aust.
DIRECTOR GENERAL OF MINES AND ACCOUNTABLE OFFICER (Appointed by the Governor pursuant to Section 29 of the Public Service Act)

Mr E.J. Blake, Dip Pub Admin.
ASSISTANT DIRECTOR GENERAL OF MINES

Dr C.D. Branch, BSc(Hons), PhD, MAusIMM.
ASSISTANT DIRECTOR GENERAL OF MINES

Dr P.E. Playford, BSc(Hons), PhD, MAusIMM.
DIRECTOR, GEOLOGICAL SURVEY DIVISION

Mr J.M. Torlach, BE(Min), MAusIMM.
DIRECTOR, MINING ENGINEERING DIVISION

Mr I. Fraser, BSc(Hons).
DIRECTOR, PETROLEUM DIVISION

Dr J.W. Hosking, MSc, PhD, MAusIMM, FRACI.
DIRECTOR, CHEMISTRY CENTRE (W.A.)

Mr K.O. O'Neil, MBA, AASA, Dip Pub Admin.
DIRECTOR, CORPORATE SERVICES DIVISION

Mr H. Douglas, APTC(Chem), C CHEM, ARACI, AMAusIMM.
DIRECTOR, EXPLOSIVES AND DANGEROUS GOODS DIVISION

Mr W. Phillips, Dip Pub Admin.
DIRECTOR, MINING REGISTRATION DIVISION

Mr W.R. Moore, Dip Cart, MIS, MAIC, MIEMS.
DIRECTOR, SURVEYS AND MAPPING DIVISION

Mr M.L. Meaton, BSc(Agric)(Hons), BEc.
MANAGER, ROYALTIES BRANCH

Minister for Mines
Hon. Jeff Carr

Director General
Dr D.R. Kelly

Manager Royalties Branch
Mr M. Meaton

Assistant Director General
Dr C.D. Branch

Assistant Director General
Mr E.J. Blake

Director
Geological Survey
Dr P.E. Playford

- Mineral Resources
- Hydrogeology
- Precambrian Geology
- Fossil Fuel Resources & Phanerozoic Geology
- Engineering & Environmental Geology
- Support Services
- Geophysics
- Palaeontology
- Petrology

Director
Mining Engineering
Mr J.M. Torlach

- Metalliferous
- Coal
- Research & Technical Services
- Drilling

Director
Petroleum
Mr I. Fraser

- Petroleum Resources
- Petroleum Engineering
- Administration & Titles

Director
Chemistry Centre
Dr J.W. Hosking

- Argricultural Chemistry
- Kalgoorlie Metallurgical Laboratory
- Environmental Chemistry
- Health Chemistry
- Forensic Chemistry
- Materials Science
- Mineral Science
- Mineral Processing

Director
Corporate Services
Mr K. O'Neil

- Human Resources
- Finance
  - — Financial Planning
  - — Accounting Services
- Management Services
- Internal Audit
- Computing
- Office Systems and Word Processing
- Publications & Information
- Corporate Planning

Director Explosives
& Dangerous Goods
Mr H. Douglas

- Inspectorate
- Licensing
- Baldivis Explosives Reserve
- Kalgoorlie Explosives Reserve

Director
Mining Registration
Mr W. Phillips

- Operations Units
  - — Head Office
  - — Outstations
- Tenement Surveillance
- Information Services

Director
Surveys & Mapping
Mr W. Moore

- Mapping
- Public Plans
- Surveys
- Cartographic Computing

DIVISIONS OF THE DEPARTMENT

The **Geological Survey** of Western Australia systematically records and interprets the geology of the State and provides this information to Government, industry and the general public in order to assist the exploration, development and conservation of the State's mineral, petroleum and groundwater resources.

It evaluates mineral and petroleum resources as a basis for decision making by Government and assists and advises on a variety of community needs, including urban planning, land-use matters, and engineering developments.

Mining Engineering administers mine safety legislation to safeguard and promote the health and safety of those working in the industry. It provides advice to the Government and to industry on mining engineering matters, including deep mining, open-cut mining, quarrying, drilling, the environment, and rehabilitation.

It carries out exploratory drilling and associated services for the Department and other Government organisations.

Petroleum facilitates the undertaking by industry of geophysical and drilling programs for the identification and development of oil and gas accumulations.

It ensures that sound engineering principles and standards are applied to system design and plant assembly in production facilities and applies accurate product measurement for royalty calculations.

It also maintains an effective title allocation and registration system, monitors and advises on State and Commonwealth legislative amendments, and advises on matters requiring interpretation and application of legislation.

The **Chemistry Centre W.A.** provides chemical, metallurgical and mineralogical consultancy and analytical services to Government instrumentalities, private industry and the general public. It assists in mineral processing, soil and fertiliser analysis, agricultural trials, water quality assessment, food nutritional quality evaluation, forensic science, environmental monitoring, chemical aspects of occupational and physical environments, and materials testing, and undertakes research and development in all these areas.

Corporate Services provides and coordinates administrative services for the Corporate Executive and the operational divisions of the Department. These services include the management of the Department's human resource, finance, computing, corporate planning, auditing, typing and records activities.

Explosives and Dangerous Goods reviews, formulates and administers laws, regulations and policies aimed at the safe manufacture, storage, handling and transport of explosives and dangerous goods; and provides safety advice on these matters.

Mining Registration receives applications and allocates titles that give legal rights to explore for and mine minerals in Western Australia pursuant to the Mining Act.

It maintains a mining tenement registry which records tenement holders, conditions and term of their grant, and expenditure details from which the Division monitors compliance with the provisions of the Act.

Surveys and Mapping determines and documents the boundaries of tenements and produces and updates all maps and plans necessary for the operations of the Department of Mines.

All functions from primary field survey to final map production are embraced. The range of activities includes plotting, drafting, cartography, field surveying, computations, reprographics and advice to the public as an integral part of the tenement management process.

Royalties collects all mineral and petroleum royalties on behalf of the State. Royalties works with the mining industry and other Departments to develop royalty payment and collection arrangements which are fair and equitable. The branch also collects and disseminates statistical information on the mining industry and provides economic and financial advice to aid policy development.

AREA OF OPERATIONS

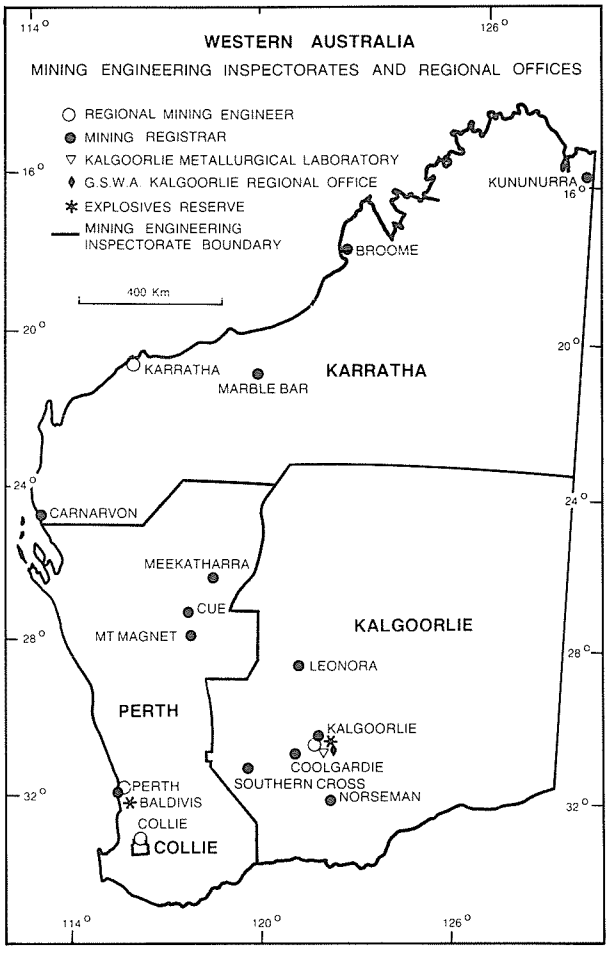
Mining and petroleum activity is spread throughout the State and offshore regions. It covers an area of approximately 2 500 000 km² or about 30% of the Australian land mass.

The officers of the Department are mostly located in Perth; however, some members of the Geological Survey, Mining Engineering, Chemistry Centre, Explosives & Dangerous Goods, and Mining Registration divisions are situated in regional centres. A number of these people work in areas that are large and remote by world standards (figure 6).

In addition to providing services for land based operations, the Department is also required to administer State and Commonwealth legislation covering offshore oil and gas exploration and exploitation.

A Department directory is included in the Appendices.

FIGURE 6: WESTERN AUSTRALIA MINING ENGINEERING INSPECTORATES AND REGIONAL OFFICES



Court fines clai jumper

Warden: Yes exploration

Off-the-peg softwa for mineral explore

Bigger fines for illegal mining

MINERAL exploration is still at a frantic pace in WA despite last October's share market collapse.

More than 2200 new mineral tenements have been pegged in the past five months.

Laverton prospector in Warden's Court

Court injunction on mining company

The activities of the Department of Mines are directed towards the achievement of five broad objectives. These are the focus for the various divisions to effectively carry out their responsibilities.

EQUITY AND TITLES

OBJECTIVE 1: To ensure that exploration and development of the State's mineral and petroleum resources are carried out in a fair manner.

Through this objective the Department seeks to provide an effective title system to encourage exploration and development of the State's mineral and petroleum resources in an efficient and equitable manner.

The divisions concerned with implementing this objective are Mining Registration, Surveys and Mapping, Petroleum, Mining Engineering, and Geological Survey.

The Mining Registration division's major role in conjunction with Surveys and Mapping is to award rights to explore for and mine minerals under the Mining Act.

A Warden's Court system operates to deal with disputation complemented by both legal and administrative appeal rights.

Technical advice is provided by the Geological Survey and Mining Engineering divisions in the process of imposing conditions on mining tenements and monitoring titles for compliance with statutory obligations.

The Petroleum division is responsible for titles and all technical, safety, exploration and production matters under the onshore and offshore petroleum acts.

Changes Improve Service

The completion of the expansion to Mineral House should lead to increased efficiencies in the service provided to industry. A "one stop" Mining Information Centre has been set up. This replaces the various divisional public counters and gives a range of essential title related services at one convenient location.

Recording of tenement and mapping information electronically - which began several years ago - has reached an advanced stage. As outlined later in this section these developments will be of significant benefit to both industry and the Department in meeting its objectives.

Need for Secure Titles

The capital intensive nature of the mining and petroleum industries makes it imperative that where exploration leads to the initiation and development of a project explorers must have secure tenure. The ground rules for access to land and security of tenure are provided by legislation from the West Australian Parliament - legislation which not only protects the rights of all land holders but requires those who have exploration or mining tenements to meet certain commitments to retain these rights.

The framework under which the Department operates is aimed at protecting the rights of all parties; from the large corporation to the small individual operator, as well as providing a fair and reasonable return to the community for the rights given to carry out mining operations and to see that such operations are carried out in harmony with other land usage.

An on-going review of legislation, procedures and policies is being undertaken to ensure that registration of titles is effected with efficiency and within acceptable time frames.

Mining Tenements

The number of Mining Tenements in force increased, continuing the pattern for the third consecutive year. At 30 June 1988 there were 24 036 tenements in force, compared with 20 304 in 1987 and 17 412 in 1986.

The "boom" activity in the gold mining sector carried on from the previous year, with a constant rate of applications to the Mining Registration division. The stock market crash of October 1987 had a major influence on activity during the year. Yet overall applications for mining tenements were only 10 per cent down on those received for 1986/87.

Despite this continuing high level of activity and the backlog from last year, the Department still maintained a five month turn-around in processing the majority of applications.

The 1 838 applications for mining leases was almost double the figure from last year. This is mainly the result of prospecting licences reaching the end of their four year term and being converted to leases. The number of leases awaiting survey increased as a consequence.

The main causes of tenement processing delays remain disputes among competing applicants, disputed land use, and the normal inter-departmental assessments of applications, which affect other land useage.

In February 1988 the Government announced its MINING AND THE ENVIRONMENT POLICY. Until such time as the necessary administrative requirements are put in place there will be delays in dealing with tenements affected by national parks, nature reserves, and various reserved lands.

There is also a very heavy workload in matters before Warden's Courts. Since the appointment of Mr D. Reynolds S.M. as the Perth Warden some relief has been given by the allocation of more of his time to Warden's

duties. By transferring matters to Perth for hearing and in certain cases the Perth Warden sitting in country courts, it has been possible to deal with the majority of pressing issues.

In respect of the monitoring of title the normal annual review of tenements for compliance with rent and expenditure conditions was carried out resulting in some 353 mining tenements being forfeited. In addition there were a number of successful prosecutions for breach of the illegal mining provisions of the Mining Act 1978.

TENDEX to be Statewide

During the year under review the mining tenement information systems index (TENDEX), already widely used by the Department and industry, has been further expanded to include a tenement charting/public plans monitoring function. These enhancements will assist the updating/ charting of tenement changes on public plans to provide better control of resources and faster release of updated plans to both industry and the public.

TENDEX is a computerised tenement index system which enables the sorting and selection of tenement data, and the production of reports which are available for sale. By the end of September 1988 TENDEX facilities will be available in the Mining Registrars offices at Kalgoorlie, Kununurra, Leonora, Meekatharra, and Mount Magnet.

Several other Mining Registrars' offices will receive the computer hardware to operate TENDEX during the 1988/89 financial year. The objective is to achieve a statewide TENDEX network.

The system will be improved further in 1988/89 by making rent/exemption/expenditure details available to industry.

Petroleum Tenements

On 30 June 1988 there were 94 permits to explore for petroleum in Western Australia. These included 32 offshore and 62 onshore permits. The permit areas comprise 485 167 km^2 made up of 143 562 km^2 offshore and 341 605 km^2 onshore. This compares with 86 permits (54 onshore, 32 offshore) totalling 655 962 km^2 at 30 June 1987. This change reflects a continuing trend in Western Australia to smaller permits. In one year the average size of permits has dropped from 7 627 km^2 to 5 161 km^2.

The number of permit surrenders, expiries and cancellations was identical in 1986/87 and 1987/88 (10). New permits granted increased from eight to 16. At the end of the fiscal year an additional seven offshore and three onshore areas had been advertised with closing dates in July.

Mapping

The Surveys and Mapping division maintained a high level of activity to position all tenements on the various maps within the State. The range of maps was rationalised this year and there are now 1331 maps which cover Western Australia. These are revised continuously to record applications and any changes in the status of tenements.

The method of processing applications has been amended to provide a faster transmittal of tenement application documents from the lodgement in local district office to Perth. This enables the information to be entered into TENDEX and onto the Public Plans within one to two weeks of lodgement of the original document compared with about six weeks in the past.

The tenement maps are basic documents supporting the role of the Department in providing a comprehensive series of maps which show the inter-relationship of all mining tenure and other land tenure. Due to the large increase in numbers of new tenements over the past few years many of these maps have reached the point at which they must be revised in order to remove the voided tenements and other associated data.

Although there are now 1331 maps, many are in urgent need of replacement. Existing resources permitted only some 220 to be replaced this year, which is a source of concern.

Strong demand for tenement maps continued from the mining industry. Copies are sold to the mining community and the public at the rate of 150 full maps and 51 photocopies of map portions, per day. This is 21 maps per hour or one every three minutes. It is important these maps be as current as possible and ways will have to be found to improve our performance in this area.

A computer-based system for generating graphical output showing petroleum titles and wells drilled for petroleum has been developed. Maps and printed reports can be produced on request and the system is extensively used by officers of the Department. Between August 1987 and May 1988 a total of 16 computer plots have been requested showing various combinations of data at scales ranging from 1: 100 000 to 1: 250 000. The base sheet for updating the annual map, showing wells drilled for petroleum in 1987, was produced from the system.

To accommodate the planned introduction of graticular sections which will help define exploration licences, a new set of matching overlays was produced. These show the graticular sections which cover each Public Plan.

The opportunity was also taken to extend this coverage offshore to the edge of the continental shelf, in anticipation of the planned Commonwealth and State offshore minerals legislation. A contract to produce computer- generated maps showing the 1' x 1' grids was let. In total 1329 maps were prepared.

The computer system (CADMAPS), currently in use for generating co-ordinates of surveyed mining tenements, is currently being re-developed by the Department of Land Administration into a new system called SIGNET. This system is designed to provide an improved route for the eventual capture of this type of data into a comprehensive land information system.

The existing traverses held by Surveys and Mapping must firstly be reviewed and redeveloped for SIGNET processing. All future traverses will be structured on a SIGNET basis. The new SIGNET in its final form is not expected to be available before 1989.

Legislation

Changes were made to both the Mining and the Petroleum Acts during the year. Details are given in the Appendix 1 'Legislation'.

Liaison with Industry

Regular meetings of the mining industry and the Petroleum Industry Liaison committees took place during the year.

Petroleum issues addressed included administration of work programmes, deregulation of technical directions, speculative seismic surveys and on-shore petroleum production regulations.

An important matter being discussed by the Mining Industry Liaison committee is the requirements for marking out mining tenements. This follows the upholding by the High Court of Australia of Warden D. Reynold's decision that the marking out must meet the minimum requirements laid down.

Other issues being considered include the proposed offshore minerals legislation and the manner of notification to pastoralists of the nature of proposed exploration to be carried out on pastoral land.

The Way Ahead

To maintain a title system that is fair and equitable to all the present important safeguards enabling affected parties to be heard through objection, Warden's Court hearings, or appeal, need to be retained as a basic component of title registration.

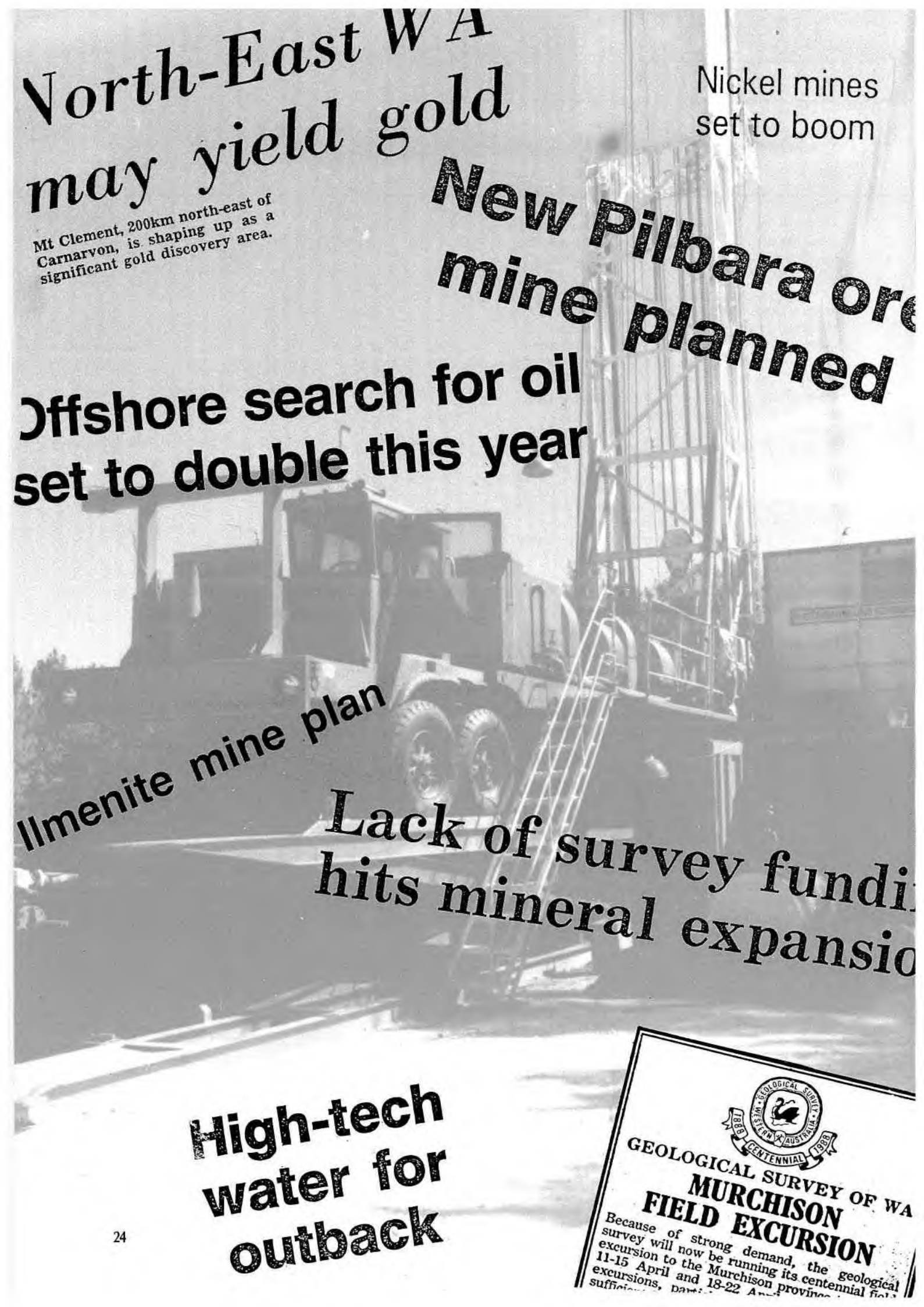
Our aim is to utilise technology to improve our capacity to make readily available relevent title information.

This will simplify tenement management and assist tenement holders by such means as advance notification of rental and other obligations.

The need for electronically assisted processing of tenement applications will increase in the future as the areas of available Crown Land lessen and the concept of multiple land use becomes more common.

Increased time will be spent in the future negotiating with other departments and authorities, on access to land for exploration/mining, and tenement conditions of approval.

Looking to the future, the introduction of the graticular section system for onshore exploration licences will also apply to offshore minerals exploration permits. The operation of offshore minerals legislation — to be based in part of the present offshore Petroleum Act — may provide a different perspective on title allocation and management.


North-East WA may yield gold
Mt Clement, 200km north-east of Carnarvon, is shaping up as a significant gold discovery area.
Nickel mines set to boom
New Pilbara ore mine planned
Offshore search for oil set to double this year
Ilmenite mine plan
Lack of survey fundi hits mineral expansio
High-tech water for outback
GEOLOGICAL SURVEY OF WA
MURCHISON FIELD EXCURSION
Because of strong demand, the geological survey will now be running its centennial field excursion to the Murchison province
11-15 April and 18-22 April

EXPLORATION AND DEVELOPMENT:

OBJECTIVE 2: To foster mineral, petroleum and groundwater exploration and development, and assist long range planning and decision making by Government.

Through this objective the Department seeks to further the discovery and development of the State's mineral, petroleum, and groundwater resources, and to provide advice to Government and the public on long-term planning and decision making, especially in relation to extraction industries, engineering, and urban development.

The divisions concerned with the implementation of this objective (with their principal relevant functions shown in brackets) are: Geological Survey (geoscientific mapping, research, and advice relating to minerals, petroleum, and groundwater), Mining Engineering (mining development operations and drilling in support of hydrogeological investigations), Petroleum (petroleum exploration, engineering and production), Surveys and Mapping (cartography), and Chemistry Centre (analytical, mineralogical, and metallurgical services).

For Government to make the best decisions with regard to development of the State's mineral and petroleum resources it needs to have the most current information and advice available.

The Department is the central location for geoscientific information provided by mining and petroleum companies, various research organisations and institutions, plus field work from within the Department and analysis from its own geoscientists.

For the past 100 years the Geological Survey division of the Department of Mines has provided a broad background of geoscientific data and advice for Government and industry. Divisional support also comes from Mining Engineering, Petroleum, the Chemistry Centre, and Surveys and Mapping.

Thus there is continuous delineation, definition, analysis, and mapping of the geological resources of Western Australia, for the benefit of residents of this State, and for the economic development of Australia.

Liaison with the Exploration Industry

Data coming from exploration by mining and petroleum companies, tertiary research institutions, as well as the results of field investigations by the Geological Survey, provide a body of geoscientific knowledge that benefits the whole community. The Geological Survey Liaison committee, established by the Minister in October 1986, brings together the interests of industry and research institutions to ensure that the work of the Geological Survey meets the needs of the State.

Two subcommittees have now been established. One is a Yilgarn Block subcommittee to meet the special needs of the extremely active Eastern Goldfields region. The second is a Hydrogeology subcommittee set up following a recommendation of a departmental inquiry into hydrogeology and drilling activities in the Mines Department.

5 Year Plan

The Geological Survey now has 12 months experience of working under the 'umbrella' of its first Five Year Plan. It has been revised, priorities reassessed, and the usefulness of such a "dynamic" plan has become more apparent through continual discussions with the Liaison committee. It was pointed out in a review of the 1987-1991 program that the number of projects being undertaken was excessive, due primarily to a large backlog of partly completed projects. In the current period the number of projects has been reduced by 20%, while the number of sub-programs (representing on-going work commitments) has remained constant.

High priority is given to field work. The target is to double the average time spent in the field in the five-year period to 1991. In the past year a 12% increase was achieved.

Geological Mapping

Geological mapping carried out during the year was concentrated in the Ashburton Fold Belt and Eastern Goldfields. A revised edition of the State geological map at 1:2 500 000 scale has been prepared for drafting, and the Albany 1:1 000 000 map sheet has been compiled from the existing 1:250 000 sheets.

Other State maps under production are a revised edition of the mineral deposits map and the first edition of a hydrogeological map of Western Australia.

The Murchison metallogenic project was completed and a set of maps issued. A field excursion to present the results of this project was held in April and attended by 120 people. Regional maps of the Carnarvon Basin and the onshore Bonaparte and Ord Basins, were also published.

A wide range of isotope geochronology is undertaken on behalf of the Geological Survey in association with Curtin University of Technology, Australian National University, and the University of Western Australia. The Geological Survey's tritium and carbon 14 laboratory was moved from Curtin University of Technology to the Chemistry Centre during the year.

Cartography

A high priority is given to disseminating geological information in the form of maps. The Surveys and Mapping Division produced and printed 19 coloured maps during 1987/88. This included reprints of six maps. The 13 new maps included three second edition maps at 1: 250 000 scale, three environmental maps at 1: 50 000 and three maps for inclusion in the Bulletin of the geology of the Murchison Province.

A further highlight was the completion of the first four maps of a new series at 1:100 000 scale. These detailed maps, in areas of economic potential, cover the greenstone belts of the Eastern Goldfields.

In addition to geological maps a further two maps were produced; one — Western Australian Localities — being the fourth edition of this map of the State at 1: 2 500 000 scale; another — Petroleum in Western Australia — Tenement Map at 1: 5 000 000 scale (2 issues): this is a

new map and is published on a six monthly basis in association with the Petroleum division.

Improved Information Flow

A program of microfilming was successfully completed during the past year. This eliminated a backlog of M-series mineral exploration reports. Lack of access to this information had caused concern to exploration companies and the Geological Survey.

The Geological Survey maintains a number of geoscientific databases. Work continued on updating WAMEX (mineral exploration data), MININFORM (resources and reserves of Western Australian minerals), and the petrological and geophysical databases. Plans were finalised to develop the WAPEX (WA petroleum exploration) data base system and are being developed for the SWRIS (groundwater resources data) database system, and data capture projects for these systems were commenced.

The progress made during the year on the comprehensive petroleum exploration data base (WAPEX) indicates the usefulness of information services in adding value to the functions of the Department. The WAPEX data base will be used as an exploration index to provide rapid access to seismic records and technical reports on previous exploration exercises.

The Department is confident that this improved service will promote further investment in this key industry. It is planned to have the reports index phase of the WAPEX system operational during the first quarter of 1988/89.

Monitoring of petroleum and mineral exploration activities continued. There were 359 petroleum exploration reports and 2855 mineral exploration reports received and recorded during the year. Monitoring of exploration has been improved by the installation of INFOPAC, a commercially- available information package of all minerals and petroleum exploration data reported to the Australian Stock exchanges.

The number of petroleum and mineral exploration reports made available to the public increased over last year by 41 per cent from 1994 to 2811. In response to industry demand sepias and dyeline prints of map compilation sheets are now released in a "freehand draft" form so the results of geological mapping can be made available more rapidly.

The geoscientific data made available on microfilm and microfiche, together with maps and publications, provide a valuable information base for industry. This information contributes towards maintaining a positive climate for exploration. While the sale of publications stayed more or less constant at $167 508, the sale of microfilm and microfiche increased nearly 200% over the previous year, to $215 075.

Assessing WA's Water Resources

The hydrogeological program of drilling shallow and deep aquifers in the Perth Basin continued. Reports were completed on the shallow aquifers in the Busselton area, and the deep aquifers along the Gillingarra line of bores in the northern Perth Basin. Drilling along the Cowaramup line in the southern Perth Basin was successfully completed. The ongoing study of groundwater in the palaeodrainages in the Eastern Goldfields was expanded to include a regional assessment of groundwater in the Kalgoorlie area. Drilling for this work continued at the time of this report.

The Geological Survey also undertakes engineering geology investigations at a number of damsites. The largest project has been the Harris River damsite, although work has also been done on the North Dandalup and Big Brook damsites, and on the Ord Dam spillway. Additional drilling was done in the Derby area to provide data for hydrogeological mapping.

During the year 129 bores were drilled (up 170%), the aggregate amount of drilling being 14 204 m.

A hydrogeological enquiry service is provided and 435 enquiries (up 20%) were answered during the year. There was a three-fold increase in hydrogeological inspections of properties from 17 in 1986/87 to 54 in 1987/88.

The Drilling branch continued to obtain basic data for the assessment of Western Australia's groundwater resources and stratigraphic information, undertaking drilling in support of investigations of town water for Carnarvon and Derby. The work was partly regional assessment, partly for specific mining projects (gold and bauxite), and for land use projects such as land salinisation and drought relief.

A mudlogging/gas detection unit is being commissioned to detect hydrocarbons on a continuous basis while deep drilling. This is for data acquisition and safety purposes.

Modifications were made to the 'JACRO' drill rig. These were successful and the new drill depth capacity of 500m is double the previous limit.

Increased Demand for Consultation and Advice

Personnel in the Mining Engineering division, Research and Technical Services branch, together with the Inspectorates, and the Petroleum division, have been required to increase the amount of time allocated to advice and assistance to industry, to Government, and the community in general, during the past 12 months.

The extra call comes from a complex interaction of economic, technical, industrial, and socio-political factors. The principal elements are:

- rapid industry growth, widely spread geographically and with increased technical complexity;
- the growth has brought an influx of new personnel into the industry at all levels: this is reflected by a lack of experience and increased demand for technical monitoring and assistance;
- changing community values which are reflected in the increased awareness of and concern for the whole environment, which require adequate and timely responses;
- the growth of downstream processing within the State;
- greater awareness and concern within industry and the community of occupational health and safety matters; and
- the rapid growth of the resource industry which has affected other government departments, many of which have required greater interaction than previously with the Department of Mines, and the Petroleum and Mining Engineering divisions in particular.

Issues addressed in relation to these criteria include multiple land use planning, Aboriginal liaison, addressing local interest groups on matters of concern, assessing the relative environmental impact of energy generation using uranium or coal as a fuel, soil conservation in areas of intense exploration and open cast mining, and co-ordination of mining development along the Golden Mile at Kalgoorlie.

Improved Chemical Analyses

The Chemistry Centre provides analytical services to Government, industry, and the general public. These services, amongst others, include the areas of mineralogy, metallurgy, and water analyses. During 1987/88 there was a marked increase in the amount of consultancy work undertaken by the centre leading to increased research.

The Chemistry Centre continues to support the Geological Survey and Mining Engineering divisions in encouraging exploration and mining by the provision of quality analytical data and advice.

The Mineral Processing Laboratory of the Chemistry Centre has assisted the development of gold, mineral sands, and other mineral based industries through metallurgical tests, research, and development programs. The centre continues to play a major role in collaborative projects with CSIRO; and Curtin and Murdoch Universities. These industry-supported projects are contributing to improvements in gold processing technology, thereby adding economic value to the State.

The Kalgoorlie Metallurgical Laboratory has responded to the increase in gold production by determining the fineness (purity) of gold in samples from over 3000 gold bars.

Petroleum Activity

During 1987/88, 31 exploration wells were commenced compared to only 16 in the previous fiscal year. The increase was largely due to accelerated activity in the onshore Canning Basin where 20 wells were drilled compared to only three in 1986/87. Only six offshore exploration wells were drilled, four less than the previous year.

Also down were seismic line kilometres which totalled 10 858 km, compared to 17 925 km in 1986/87. This includes 5 963 km offshore and 4 895 km onshore. There was a considerable drop in offshore surveys, from 14 049 km in 1986/87, which is of concern as offshore seismic activity has been steadily dropping since 1985.

The only petroleum discoveries made during the fiscal year were at Lloyd-1 in the Canning Basin and Rosette-1 (Bond Corporation) which was drilled from Varanus Island to a target 1.4 km offshore.

Production Drilling

Successful production wells were drilled by Western Mining (three in the South Pepper field and one in the North Herald field) which came on production early in 1988.

Production of petroleum liquids for the fiscal year was 3.1 million kL. A total of 8.45 billion cubic metres of gas was produced of which 4.5 billion cubic metres was re-injected for recycling in the North Rankin field.

On the North West Shelf gas project, the foundation improvement of the North Rankin 'A' platform was completed satisfactorily. The Certifying Authority (Lloyds Register) has verified in the final certificate that the main platform and flare support structure are adequate for the design criteria including, but not limited to, cyclonic storm conditions with an average occurrence of once in 100 years.

The North Rankin platform operates satisfactorily, currently producing 10 million cubic metres of gas a day for sale to the State Energy Commission of Western Australia. Twelve million cubic metres of dry gas are injected as part of a re-cycling process from which 3 400 kL of condensate are produced per day.

The South Pepper/North Herald offshore oil field was developed during the year. It commenced production at the end of 1987 and at present produces about 1 300 kL of oil per day. The development consists of two offshore wellhead platforms. A jack-up rig is used for accommodation and processing the crude oil which is transported by submarine pipeline to storage and loading facilities on Airlie Island.

Proposals for the development of the Saladin oil field have been approved. Construction is due to commence during the third quarter of 1988.

An application has been received from Woodside Offshore Petroleum Pty Ltd for statutory approval to develop the Goodwyn field.

Liaison with Petroleum Industry

The Petroleum division maintains close liaison with industry on a day-to-day basis and by means of the Petroleum Industry Liaison Committee. Department in-put is also made to such organisations as Australian Petroleum Exploration Association, Australian Mining and Petroleum Law Association, Australian Society of Exploration Geophysicists, Petroleum Exploration Society of Australia, Society of Petroleum Engineers, Australian Institute of Petroleum and the Western Australian Petroleum Club.

The Department's magazine supplement, "Petroleum in Western Australia" has been enlarged and improved and is now issued twice annually in conjunction with "Oil & Gas Australia", Australia's main petroleum trade journal, with a circulation of 8000.

Design and Displays

Eight major displays were mounted, the highlight being the Geological Survey Centennial display at the Alexander Library. This display covered the history and present operations of the Geological Survey over 100 years.

Other displays were: an Overview of Mining in WA, Environmental Geology, the AXTAT (Accident Reporting System), Cartography, New Maps and Publications, Chemistry Centre (WA), and Careers Expo.

Three poster presentations for the Chemistry Centre were prepared: Ultra Violet Degradation of Materials; Soil Science; and Agricultural Science.

General publications and presentations of the Department required preparation of a total of 813 diagrams, small maps, figures and art-work.

PUTTING A LID ON THE "GREE

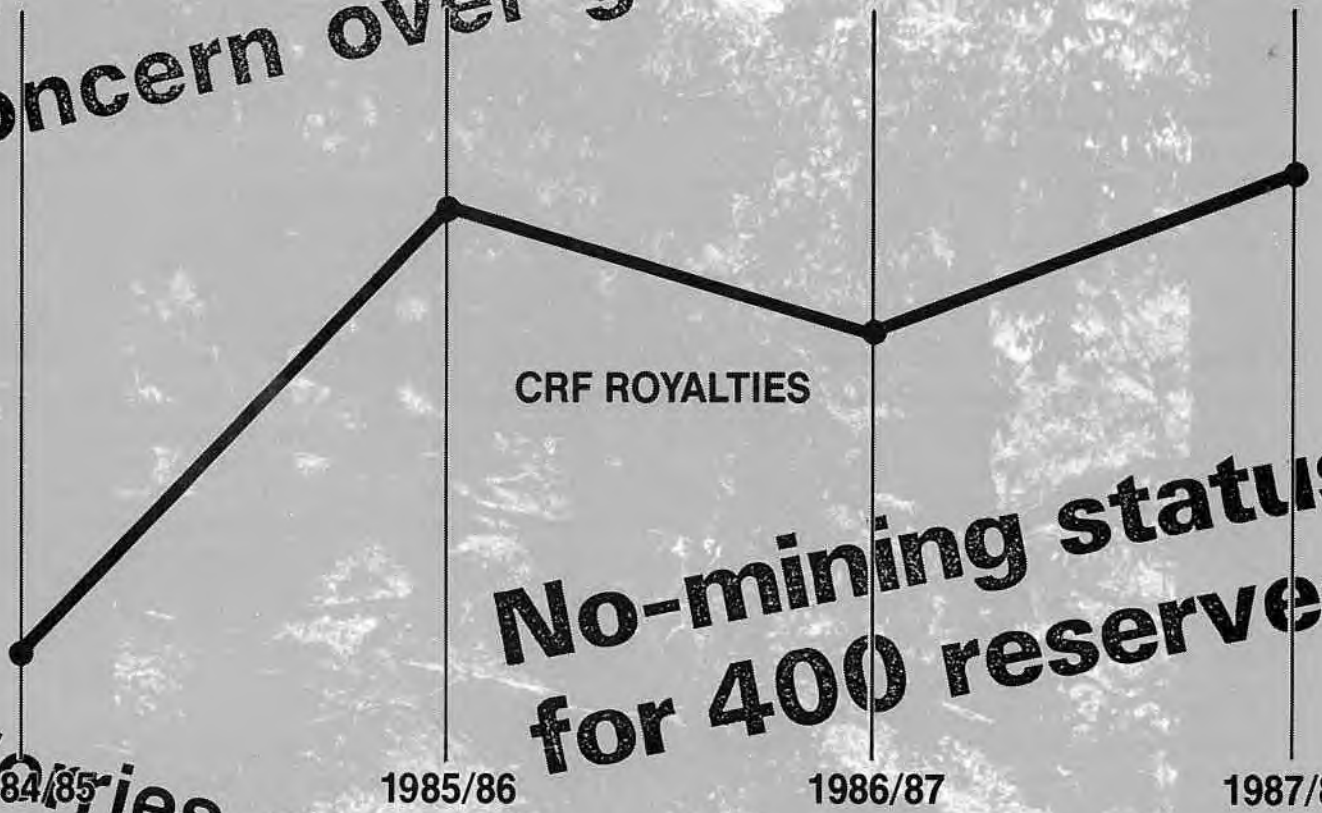
Science

The burning of fossil fuels has caused detrimental effects to the Earth's environment — effects which are of major concern to scientists.

Tackling the problems of pollution

WA joins national talks on climate

Concern over gold waste dump



No-mining status for 400 reserves

Worries over river pollution prompt study

Base metals at '20-year high'

HIGH average base metal prices in 1988-89 should make the year the strongest commodity price period for at least 20 years, surpassing the 1979-81 boom years.

present "unusually long economic recovery" suggests commodity prices can hold up beyond a mild downturn in

COMMUNITY AND ENVIRONMENT

OBJECTIVE 3: To ensure that the community receives a fair return from the exploitation of the State's mineral and petroleum resources; and that proper attention is given to the environment.

The Department is charged with ensuring that the financial and material benefit which accrues to the community, (both State and National) is commensurate with the level of industry activity and the value of the minerals and petroleum produced. These resources are an asset belonging to the community. A direct charge is appropriately made for their depletion, over and above the obvious benefit which derives from profitable, decentralised industrial development.

An essential element of this task is that the extraction of these resources is managed responsibly in respect of both husbanding these finite resources (however large), and minimising environmental impacts. It is also recognised that any industrial activity (together with agricultural and urban development) must impact on the environment, and that in addition to limiting or containing these effects, properly managed systems must be set up and maintained for appropriate rehabilitation.

The activities of most divisions contribute in some way to environmental care with four divisions having a major role in this important area: Chemistry Centre, Geological Survey, Mining Engineering and Petroleum. The Royalties branch plays the major role in assessing and determining royalty payments.

Royalties

Under legislation minerals are the property of the Crown. In return for the right to extract these, producers are required to pay royalties to State and Commonwealth Governments. The major exception to this principle is the gold industry where royalties are not paid.

The Department of Mines administers the collection of such royalties and in the year ending June 30, 1988 royalties for minerals and petroleum amounting to $166 million were credited to the Consolidated Revenue Fund, 6% more than the previous year.

These royalties were paid by more than 100 companies operating under 25 Acts, including 21 Agreement Acts written for specific projects.

During the year Royalties was expanded by the appointment of additional staff to overcome the backlog in royalty verification work, and to meet the challenges posed by the increasingly complex nature of royalty collection systems.

To help this process, new royalty collection regulations were introduced into the Mining Act. These clarify the information which is to be submitted with royalty returns. They also provide a mechanism whereby sales of minerals to related companies or transfer pricing practices can be reconciled through discussion and in exceptional circumstances, by ministerial determination.

The basic principle of royalty payments for minerals remains either a 7.5%, 5% or 2.5% rate applied to the value of minerals produced. The appropriate rate depends upon the degree of processing.

Under petroleum legislation, a rate between 10% and 12.5% of the value of production at the wellhead is levied.

For petroleum, agreements are negotiated with the company which define the method by which the petroleum recovery is to be valued for royalty purposes. These agreements are complex and can take a considerable time to negotiate. Negotiations took place for such an agreement with the Joint Venture Partners for the North West Shelf and Harriet Petroleum Projects. Discussions also commenced with the operators of the North Herald/South Pepper field.

During 1987/88 total royalties paid into the Consolidated Revenue Fund for petroleum in Western Australia increased 8.7% to $30 044 163. This was derived from $23 818 340 paid on sales on of crude oil; $4 941 808 on natural gas, and $1 284 015 on condensate, which are all up slightly from the royalties paid in 1986/87.

For offshore petroleum projects royalty revenues are shared between the State and the Commonwealth Governments. This imposes additional consultation and audit responsibility on the State.

During the year visits were made to check the calibration meter stations used for the sales of gas from the Dongara and North West Shelf gas fields. The loading and measurement of oil and condensate from storage facilities to tankers was also monitored.

MINEDEX

The first phase on the development of a mineral production statistic system (MINEDEX) commenced during the last quarter of 1987/88. The initial sub-system will contain a Departmental data base of standard references to projects, mines, commodities and ownership. The ultimate MINEDEX system will include a comprehensive data base of mineral production - which will enable the Department to provide for improved forecasting and control of mineral royalties.

Environmental Care

The Chemistry Centre assesses environmental reviews and management programs, with regard to impact of mining and industrial developments on the environment. This work is of particular importance as the use of chemicals can have an effect on the biological and social environment.

Key aspects of the Chemistry Centre environmental management program include: occupational health considerations of chemical use; stack gas or other process chemical emissions; disposal of waste chemicals or by-products; the use of local water resources, and the effect on the quality of these resources.

The Geological Survey provides environmental technical assessments, particularly in the fields of environmental

geology and hydrogeology. An important aspect of this work is in groundwater contamination and pollution studies, with drilling programs undertaken to assist as required. In 1987-88 hydrogeological investigations for the prevention or control of pollution were carried out at Mount Walton East, Kwinana, the Perth Metropolitan area, and Gnangara. During the same period Environmental Geology Maps were published, at a 1:50,000 scale, for Busselton, Capel, and Lake Clifton-Hamel..

To enable appropriate environmental protection conditions to be placed on tenements, and to determine if tenement conditions are being adhered to, the Research and Technical Services branch of Mining Engineering continued to assess proposals and inspect operations. Eighty-three new mining proposals were received and reviewed with a further 15 proposals for major expansions to existing opertions. Of the 98 in total, 69 were for gold ventures.

Four environmental guidelines have been produced and distributed during the year with positive response from Industry. The guidelines are called:

— Preparation of a Mining Proposal (Notice of Intent);

— Waste Dump Design and Rehabilitation;

— Applications for New Tailings Dams or Extensions; and

— Environmental Management of Mining in Arid Areas.

'Golden Mile' Strategy

In order to ensure co-ordinated and environmentally sensitive development of gold mining to the east of Kalgoorlie, a paper was released on the "Golden Mile Environmental Strategy", and the Golden Mile Mining Development Planning committee was established. This committee, through its subsidiary work-groups, has made considerable progress in its role to co-ordinate activities in relation to the development of extended large scale open pit development on the Golden Mile.

Regional Environmental Issues

Environmental matters are discussed with Department staff at the various regional meetings of the Chamber of Mines. The formation of local planning groups is in progress within communities adjacent to mining developments, and initially conceptual plans for the Mt Magnet and Yilgarn areas are being prepared.

Wonnerup Operation

A clean-up operation at Wonnerup commenced in October 1987, the object being to remove mineral sands and tailings with high radiation levels from rural and residential land. This operation is being carried out by Cable Sands (WA) Pty Ltd as agents for the State and is planned to be complete in three years.

Petroleum Guidelines

The Petroleum division provides advice on environmental matters related to all petroleum exploration matters and operates in co-operation with other government and industry groups.

For example, a study is underway on guidelines for seismic operators which is being produced in co-operation with the contractors, the Department of Conservation and Land Management, the Australian Petroleum Exploration Association, the Environmental Protection Authority, the Conservation Council of WA and the Pastoralists and Graziers Association.

All wells drilled in Western Australia have to meet certain environmental standards and in many cases where appropriate an Environment Management Program must be produced by the operator. During 1987/88, 7 wells were drilled under an existing ERMP (No 1). These were Talisman, North Herald 3, South Pepper 5, 6 and 7, Saladin 7, and Trap Reef 1.


Mines Regulation Act must be enforced
Oil rig safety to be scrutinised
Mining industry seminar
Pride in State's safety record
Explosion destroys facto
WORKERS at a Jandakot meta
works had a lucky
Dangerous lea
A TRUCK carrying 6000 litres of chemica
to be unloaded at Coolgardie last night wh
drums split open.
The driver pulled in to a service station
6.30pm to check his load and found two
20-litre hydrogen peroxide drums leaking.
Spill damage restricte

SAFETY FOR ALL

OBJECTIVE 4: To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public.

This broad objective encompasses the prime concern of safety for all workers within the mining and petroleum industries, as well as for the public of Western Australia. Divisions involved include Mining Engineering, Petroleum, Explosives and Dangerous Goods, Chemistry Centre, and Surveys and Mapping.

A high standard of technical competence is required in the Department's inspectorate portfolio. The Mining Engineering, Petroleum, and Explosives and Dangerous Goods divisions, supervise and administer the relevant regulations, conduct routine site visits, and investigate accidents.

Changes To The Mines Regulation Act

The Mines Regulation Act and its associated regulations have continued to be changed and updated and framing of amendments to this Act to incorporate the principles of Parts III and IV of the Occupational Health, Safety and Welfare Act (general duty of care and consultative mechanisms) has commenced.

The process of general revision of the Regulations, which started in 1986, continues. Amendments to both Act and Regulations are also being prepared to accommodate the transfer of responsibility for classified machinery on mines from the Department of Occupational Health Safety and Welfare to the Mining Engineering division.

The Coal Mines Regulation Act and Regulations are also in the process of a comprehensive review and the principles of Parts III and IV of the DOHSWA Act will be incorporated in this process.

Details of Legislative changes are in Appendix 1.

Safety in the Petroleum Industry

Petroleum operations are regularly monitored to ensure that procedures and equipment are up to the required safety standards: these include seismic surveying, well drilling, pipeline laying, underwater diving, production equipment installation, and long term field development.

A total of 44 field inspections were made in the fiscal year by the five Petroleum division inspectors. Inspection locations vary from the Great Sandy Desert to offshore from the North West coast.

In onshore areas and adjacent offshore State waters, safety is controlled by State legislation. Further offshore control is under joint Commonwealth/State authority, but is administered by the State. The legislation is constantly being revised to increase the safety effectiveness of the relevant clauses.

New 'Blowout' Course in WA

The prevention of oil and gas well blowouts is a primary concern of the Petroleum division. Standards for training courses and blowout prevention certification have been established and petroleum industry participation in the courses is required. A Western Australian firm teaches blowout prevention theory and techniques to local industry workers. This new local course will allow a streamlining of current certification requirements and improve blowout prevention understanding and awareness in the State.

Cyclones and the Rankin A Platform

Foundation improvements to the Rankin A platform, the largest offshore platform in Australia, located off Karratha, has meant that de-manning that platform for safety reasons during cyclones or severe weather will no longer be required. Emergency procedures were established and approved by the Petroleum division for implemetation. Platform workers can now sit out severe weather on the platform and without shutting down production.

Pipeline Easements

It is also a responsibility of the Petroleum division to review applications to excavate near buried petroleum pipelines which allow many activities, other than the piping of petroleum, to occur along pipeline easements within the Perth metropolitan area and in country areas.

Public Safety Through Inspections

The Explosives and Dangerous Goods division is responsible for the safe manufacture, storage, handling, and transport of explosives and dangerous goods throughout the State. This division monitors and reviews laws and regulations with regard to hazardous substances, and also provides safety advice together with an ongoing program of hazards analysis and risk assessment, while maintaining a high level of general inspections.

The public safety work of Explosives and Dangerous Goods Inspectors ranges from the inspection of safety procedures at the North West Shelf Gas Project in the Pilbara, to investigating and reporting on road tanker vehicle overturn incidents.

Hazards Analysis

The recent appointment of a full time Safety Co-ordinator has considerably enhanced the division's activities in hazards analysis and risk assessment. Additionally, the filling of two vacant inspectorate positions, returning the Inspectoral staff to its full complement, has enabled the Department to maintain a high profile to the major resource development activity at Burrup Peninsula and the Kwinana area.

Joint Operations

Development work during the year culminated in Explosives and Dangerous Goods inspectors working on joint operations with the Western Australian Police in

country areas, carrying out on-road inspections of vehicles carrying dangerous goods.

The operations were limited to particular aspects of the regulations such as documentation, storage and segregation to ensure that all information relating to the dangerous goods being carried are accurately recorded and the dangerous goods safety maintained.

Increased Public Awareness

The joint operations attracted wide media coverage, with local communities and the police particularly interested, as major highways have the highest density of vehicles carrying dangerous goods. Transport through rural communities is a significant public issue.

The media attention also helped to increase public awareness of the Government's role in ensuring dangerous goods are transported on public roads in the safest possible manner.

Hazardous Substances Advisory Committee

Cabinet approved the formation of the Western Australian Advisory Committee for Hazardous Substances (WAACHS) thereby indicating an era of increased awareness of the need to control hazardous substances.

WAACHS, consisting of the Executive Head of each Department accountable for a particular aspect of hazardous substances control (occupational health, public health, the environment and public safety), will provide immediate advice to respective Ministers and Cabinet of the need for legislative control in this area.

Dangerous Goods Regulations

As a direct result of WAACHS recommendation, Cabinet approved the drafting of dangerous goods regulations for the storage of hazardous substances. These are to consist of general requirements for the storage of all dangerous goods, including placarding of dangerous goods premises, with particular requirements for LPG, Chlorine and Cyanide.

Cabinet also approved the formation of a consultative Public Safety Sub-committee to assist in the drafting of these regulations and to advise the Minister and WAACHS of their progress.

Uniform Legislation

The Director of the Explosives and Dangerous Goods division continued to chair the Competent Authorities Sub-committee (CAS) of the Advisory Committee on the Transport of Dangerous Goods. The CAS plays a critical role in assuring conformity in dangerous goods legislation across the nation.

Also in the interest of uniformity, the Deputy Director represented the State on a working group set up by the Australian Minerals and Energy Council to consider the development of uniform legislation for the LPG industry.

Mineral Developments Continue to Expand

The gold mining sector continued to be the main growth area. There are currently some 270 mining operations for various minerals in the State which include underground mines, open cuts, quarries, treatment and processing plants, refineries, smelters, private railways to the point of ship loading, and ports. There were 177 mines in WA in 1983. This 35% increase means there are more newcomers entering the field and that this inexperience places more demand on the Department for inspections and safety advice.

Radio Network for Mining Engineering Inspectors

During the year the upgrading and extension of the long range radio network was completed. Base stations were installed at Kalgoorlie and Karratha. The inspectorate field vehicles will all be equipped with transceivers in the latter half of 1988.

This radio network will provide an improved safety factor on field operations in remote areas, as well as increased efficiency and timeliness by providing en-route communication.

AXTAT Proves A Success

The AXTAT computer-based accident data recording and analysis system has been operational since January 1987. This statewide system collects and reports on accident data for the mining and related industries, with incident/statistical reports being circulated back to industry and government.

A presentation of the AXTAT system was made by the Department in October 1987 to the National Conference of the Australian Minerals and Industry Council (AMIC).

The system functions as designed and a comprehensive analysis of the data was presented in the report "Lost Time Injuries in Western Australian Mines, 1987", for the industry as a whole and by its several sectors. Apart from its value to the inspectorate, the report continues to be in great demand from industry, government departments, and trade union organisations.

It has been circulated to mining inspectorates in Australia, New Zealand, and Papua New Guinea. Future published reports will include presentations on trends as the data capture allows.

The AXTAT system will be extended during the coming year to provide an accident recording/reporting service to the WA petroleum industry.

CONTAM

The importance attached by the Department to the health and safety of the State's mining workforce was further emphasised by the significant improvement made to the mines contaminants monitoring system (CONTAM). This redesigned on-line computer system was commissioned in December 1987 and provides a more direct, less paper intensive service to the Department, to safety organisations, and the mining industry.

Safety Seminars

The Department continues to provide expert advice on the storage, handling and use of chemicals in all areas of the mining industry, as well as in the transport of dangerous goods. Particular attention was paid to chemicals used at gold, diamond and other mine sites in 1987/88.

Mining Engineering has also continued to conduct

seminars on safe working practice in the industry. These are targetted at specific problems or issues. Seminars in 1987/88 included: "Cyanide Seminar" which dealt with the safe use of cyanide in the gold industry; "Seminar on Tyre Fires and Explosions, Causes, and Prevention" which covered tyre fires and explosions on large earthmoving equipment. The policy is to conduct these in various mining operating centres to increase the opportunity for participation by operators in the area.

A total of 10 cyanide seminars held at regional centres attracted a total of 350 mine workers.

Officers of the Mining Engineering Inspectorate voiced concern at the detection of elevated lead levels in some industry laboratory personnel (using targetted monitoring). As a result two seminars were held in Kalgoorlie, conducted jointly by the Mining Engineering division and the Department of Occupational Health, Safety and Welfare. Some 50 people attended each seminar and participants came from laboratories performing assay work located in towns as well as on minesites.

The Regional Inspectorates of Perth, Collie, Karratha and Kalgoorlie maintained regular inspections of operating minesites and coped with an increased requirement for management of peripheral matters, including environmental impact issues, as well as advice and assistance to industry, the Government and other departments.

Chemistry Centre officers have assisted with the cyanide and gold laboratory seminars and ventilation officer courses for mining industry employees. They also assist with inspections of mining operations to advise on the storage, handling and use of chemicals in laboratories workshops, and during process operations. Following a North West tour an officer returned in a consultancy capacity to train employees in specific aspects of chemical handling. A video was made for further use in employee training and development.

The Department continued its support of the occupational health and safety seminars organised by the Department of Occupational Health, Safety & Welfare.


WA killer drug find is a first
Plea for register on pesticide use
THE Royal Australian Chemical Insti
Elephant juice in race swabs
Drug tests on trainer's syringes
$26m question: is racing clean . . . or drug testing poor?
Bid for aid on tainted beef
Kit to test meat
Pesticide probe extended to more farms

CHEMICAL SERVICES AND RESEARCH

OBJECTIVE 5: To ensure that the community has access to independent chemical research and consultancy services.

The role and objectives of the Department were reviewed in 1987/88, and this fifth objective was introduced to recognise the specialist functions of the Chemistry Centre (WA) as a separate and distinct objective of the Department. In addition to its other functions the Centre is also responsible for chemical and related scientific advice, consultancy services and research in the fields of agricultural, forensic, materials and health chemistry.

The Centre's pool of expertise provides services to more than 30 Government agencies, industry and the public. The Chemistry Centre is also able to rapidly respond to a problem whether this be, for example, contamination of exported food products, a chemical spill, or exposure of workers to any potentially hazardous material.

Change of Name

During the year the old name 'Government Chemical Laboratories' was changed to the 'Chemistry Centre of Western Australia' [Chemistry Centre (WA)] to reflect the emphasis on the provision of advisory and consultancy services. The Chemistry Centre was also restructured to provide more effective management and improved interaction with and service to all clients, whether within the Department, other government bodies, industry, or the public.

The Chemistry Centre's expertise, experience, and diverse facilities were a major factor in enabling the State to respond rapidly to the problems created by the detection of organochlorine pesticide residues in exported meat. The same resources were used to assist in the establishment of a government laboratory in Bunbury and additional facilities in the commercial sector in Western Australia.

Diversity in Laboratory Analysis

The Chemistry Centre analysed 8000 soil samples as part of the Agriculture Department's trace back and farm quarantine program, whilst 8200 meat samples and 1700 plant samples were also tested for organochlorine pesticide residues.

The centre continued to analyse soil and plant samples in support of Department of Agriculture research programs which are aimed at improving agriculture production in Western Australia. Research programs in the centre have been instrumental in the development of lupins as a major export industry, a significant contribution to the future economic diversity of the State.

The Forensic Science Laboratory has responded to the high level of drug activity in Western Australia by conducting tests for various drugs on 350 specimens, thereby providing scientific support to the Police and Prisons Departments.

The Racing Chemistry Section maintained its recognised Australia-wide leadership in this area by developing techniques to detect etorphine ('elephant juice') and anabolic steroids. Through a collaborative project with Murdoch University, this section has been able to assess and refine the analytical techniques used, ensuring that the necessary results are achieved quickly and reliably.

Cyanide Monitoring for Industry

Companies involved in gold mining activities in environmentally sensitive areas were assisted with their cyanide monitoring programs by the development of analytical procedures for the accurate determination of very low levels of cyanides in effluents and groundwater. The Chemistry Centre is also working with commercial laboratories to ensure the mining industry has continued access to high quality analytical services in this area.

Applied research programs developed from similar joint efforts include the evaluation of methods for the neutralisation of cyanide effluents and spillages, and a national project to monitor the fate of cyanide residues in tailings from mining operations.

The increased usage of computer based instruments which are able to run programs unattended overnight has led to improved productivity within the Chemistry Centre. These chemical laboratory systems which include automated sampling, analysis and reporting systems, improve the service to Government and industry in general. Such systems allow a higher volume of samples to be processed than through traditional methods.

Community Services

Other activities include the testing of materials used with potable water, arson investigation, testing for metals in blood, corrosion problems, assessment of consumer products and investigation into building material failures.

Although the Department was satisfied that an acceptable standard of chemical services was provided in 1987/88, future improvements are expected. By the end of 1988/89, all the new positions created as a result of the Centre's restructure will be filled, forming a stable base from which to maintain progress. Additionally, a Chemistry Centre Advisory Council will be established and an improved system of charging finalised.

The combination of these factors will enable the provision of an even more effective and efficient chemical service to the community, continuing and enhancing the Chemistry Centre's excellent reputation for high service and standards.

PLANNING, RESOURCES MANAGEMENT AND INFORMATION SYSTEMS

HUMAN RESOURCES — THE PEOPLE WHO FORM THE ORGANISATION

Initiatives of the Government, as set down in the White Paper "Managing Change in the Public Sector" have had considerable impact on the Department. The introduction of the Financial Administration and Audit Act and the activities of the Functional Review Committee have accelerated the process of change.

The basic thrust of these initiatives is to encourage departments to better manage resources, to do more with less and equally, if not more importantly, to set priorities and to concentrate on doing the right things.

Large organisations, regardless of whether they are in the public or private sector, do not change direction easily, and the introduction of management processes within the Department, such as Strategic Planning, Operational Planning and Resource Management offer the opportunity of achieving greater organisational flexibility and autonomy. They will also ensure that the levels of accountability and responsibility required by Government are satisfied and that management remains responsive to change.

The success of such change depends on a sensitive phased implementation with the whole-hearted support of the people in the organisation. The Department is fortunate in that the reaction of staff and management to these new challenges and pressures has been positive.

PLANNING

Corporate Planning within the Department is now, with the support of the Functional Review committee, being developed into a form of ongoing internal review.

A stage in this process is the formation of staff working groups, drawn from all levels of the Department, to scrutinise activities relating to each departmental objective. These groups have generated and developed new and sometimes controversial ideas on what could be done to continue to improve efficiency and effectiveness. Their recommendations will form the basis of the draft report to the Functional Review committee.

Before these groups met the original set of corporate objectives as set out in the 1987/88 Annual Report were redefined, and the five 're-worked' objectives formed a focus for the group activities. Operational Plans were prepared on a provisional basis around budget submission figures. Staff and dollar resources were allocated against objectives and divisions to assist in the analysis of the activities of the Department.

As a result of this the Corporate Management Process, (CMP), as the composite Corporate Planning and Functional Review process is called, is developing on schedule and the report to the Functional Review committee should be completed before the end of 1988.

In parallel with this activity progress continues in developing performance indicators, although much work remains to be done. Management is keen to implement a performance measurement system but remains conscious of the need to proceed carefully and ensure that practical progress is made at each step.

RESOURCES MANAGEMENT

People In The Organisation

The adoption of employment level controls through the introduction of the Full Time Equivalent System (FTE), has enabled the Department to plan and control employment levels within budgetary allocations. It also enables the Department to operate with a greater degree of flexibility and to undertake high priority tasks within the FTE allocation. The system is aimed at maximising the output from people, by allowing them to realise their full potential and take responsibility for their results. This is being achieved through developing human resource management programs and strategies which are consistent with the Government's objectives outlined in the White Paper.

This work is progressing through co-ordination by the Human Resources branch with line managers. In addition to implementing a number of programs the Public Service Commission has delegated to the Department numerous "day to day" personnel functions such as recruitment, selection and appointments, as well as a range of conditions/entitlements to employees which previously required Public Service Commission approval.

People Planning

In 1987/88 the Department's Approved Average Staffing Level (AASL) was 751 FTE's. The Human Resources Branch commenced development on planning strategies which will provide adequately skilled and sufficient human resources to fulfill the Department's role in future years.

To assist in this development the Department is participating in a Public Service Commission Working Party to determine an appropriate human resource planning methodology for the public sector.

Productivity Improvements

During the beginning of 1988 a 4% Productivity Agreement was entered into between the Public Service Commission and the Civil Service Association, and this Agreement included initiatives to be implemented by the Department. The initiatives in the Agreement were implemented during the first half of 1988 with specific

productivity improvements being achieved.

Expenditure savings came by the payment of salaries and wages by direct funds transfer and productivity improvements were gained through the introduction of computerised systems.

Implementation of payment by direct funds transfer took effect from the beginning of 1988. With this the staff time involved in distribution of pays, together with employee time taken up by queuing to collect pays, have been eliminated.

The two computerised systems which became fully operational and for which productivity improvements were gained during the year were DANEX and TENDEX. The DANEX system for licences issued under the Explosives and Dangerous Goods Act generates and prints renewals, previously manually prepared. The advent of TENDEX, a mining tenement information system, used in the preparation of tenement maps has shown savings in FTE allocation and also in the clerical operations of the Department. The processes for obtaining statistical information, identifying tenements, and maintaining details regarding the status of tenements have been streamlined, contributing to the productivity benefit for 1987/88.

Development and Training

The Department has embarked upon a number of initiatives in the training area, some of which are:

- the introduction of an induction procedure for new employees which includes provision of an information booklet, and an induction seminar for all new staff;
- greater emphasis on individual staff training and development resulting this year in the participation of 299 staff in a range of seminars and training courses; and
- participation of senior staff (those employed within the Senior Executive Service) in the Department of Executive Personnel's Development Program.

Occupational Health, Safety and Welfare

Consistent with the policy of caring for employees, and the requirements of the amended Occupational Health, Safety and Welfare legislation, the Department is in the process of electing health and safety representatives and establishing a Health and Safety committee. The Department is committed to making every reasonable effort to reduce or eliminate the incidence and severity of accidents, injuries and work related diseases; and to provide employees with a safe and healthy place in which to work.

Equal Employment Opportunity

Reports have been submitted to the Directorate of Equal Opportunity in Public Employment concerning the fostering of a receptive organisational climate, a review of departmental personnel policies and practices, and a demographic profile of employees. These will be used as the basis for the Equal Employment Opportunity Management Plan which will be submitted by the Department to the Directorate in 1988.

Performance Management System

The Department considers performance management to be an essential tool to ensure the goals and objectives are achieved and at the same time contribute to employee satisfaction, performance and development.

Accordingly, performance management systems have already been implemented in two divisions of the Department and appropriate systems will be introduced throughout the entire Department during 1988/89.

Financial Management

The requirement for greater accountability in the effective and efficient use of financial resources has thrown the spotlight onto the appropriateness of internal and external processing, managing and reporting systems.

Internally, the Department commenced a project to develop a financial management system based on resource management concepts. This project will be carried out over the next two years with ongoing development and maintenance after this initial planning and development period.

The purpose of the development is to establish a flexible financial management approach which will provide a basis for greater control and justifiable utilisation of resources.

Development along the lines of identified programs will provide a necessary interface to the long term strategic planning objectives and will enable the Department to meet its obligations under the Financial Administration and Audit Act and also encourage the development of a more commercial business-like approach towards the utilisation of resources.

Externally the Department has made representations to central agencies on the inadequacies of existing financial management systems which inhibit realisation of the Government's stated goal for the level of accountability it seeks to achieve. The Department has been asked to make input to and be represented on the committees set up to review and redress these inadequacies.

With the progress made during the past two years the Department is well placed to meet the challenges, accept the responsibilities and gain the advantages of improved financial management.

Management Services

The activities of the Management Services branch continued to be directed mainly in two areas, namely the construction and refurbishment of the Mineral House complex, and building maintenance to provide a safe and functional place of work for the people who conduct the Department's business.

A significant increase in workload was associated with the completion of construction and occupation of Mineral House Stage II in the period under review. Planning and review of a variety of facilities was required, including the fitout co-ordination as well as organising the occupation of Mineral House Stage II over the months of November/ December 1987.

Planning associated with the refurbishment of Mineral House Stage I over all levels progressed. Completion of the total project is expected by the end of October 1988.

Other notable achievements during the year were:

- completion of construction of the Geological Survey Testing Laboratory at Carlisle;
- approval for the preliminary planning phase of the proposed new Chemistry Centre complex at Bentley;
- management of the Mineral House complex facilities;
- the submission for an upgrade of the existing overtaxed PABX;
- the co-ordination of Minor Works and furniture programs within the Department; and
- consultation and advice within the Department on systems and services.

INFORMATION SYSTEMS

Computing

During the past year the Department achieved considerable progress towards its strategic target of improving the range of information services available to industry and Government.

The Department philosophy is to implement practicable innovative information systems to streamline existing manual procedures and thus enable faster response to public and industry enquiries.

System development activities during 1987/88 were largely directed towards the strategic areas of mining and petroleum exploration, mining titles, and information relating to the health/safety of the industry workforce.

These developments included improvements to the mining exploration index (WAMEX) and the mining tenement index (TENDEX), both of which are already widely used by industry. A newly developed accident reporting system (AXTAT) was presented to the National Conference of the Australian Minerals and Industry Council, and successfully commissioned during the second quarter of 1987/88. The first phase of a comprehensive petroleum exploration data base (WAPEX) was completed during the fourth quarter with the remaining three phases planned to be completed during 1988/89.

A departmental data base of standard naming references to mining projects, mine sites, commodities and project ownership was commenced during the last quarter of 1987/88. This data base, which will be known as MINEDEX, will operate as the nucleus of a comprehensive data base on the mining industry.

In extending and adding value to the range of information services provided by the Department, considerable emphasis has been placed on the use of information technology. This emphasis will continue through the development of further strategic systems and the progressive introduction of a planned information systems architecture.

This planned architecture forms a critical part of the Department's information systems philosophy and will cover the key areas of corporate data; a common information network and central and distributed hardware. In future multifunction workstations will provide access over the planned network to corporate systems and word processing, and in addition will provide personal computing facilities.

Components of this architecture have been pilot tested during 1987/88 and the Department is now confident that it can commit to the further development of this important initiative during the coming year.

The past year can be seen as a successful milestone for the Department in computing and information systems, thanks to the continued high level of effort from staff.

Word Processing

The Word Processing branch is an active component of the Department's corporate service function.

During the past year close involvement has been necessary with the Mineral House Complex development. This ensured a smooth relocation to Mineral House Stage II and also that future cabling fitout requirements have been adequately provided for in the overall complex. A total of 30 workstations are connected to the central word processing system.

The word processing staff and system have performed well during a demanding period which involved a continuous high work volume and physical change due to the ongoing relocation of staff.

The branch has been assigned responsibility for the foyer reception desk. This includes establishment of a position to provide an information service to the public entering Mineral House.

Records Services

The Records Services branch operated under pressure for the past year with substantial increases in the number of new general and tenement files, and in the amount of incoming mail.

Information technology continued to play a significant role in providing a timely and responsive service to the Department and industry via the computerised records management system.

The branch is carrying out research into the classification of Departmental correspondence together with a move towards standardised project files which will be recorded in a corporate database.

Telephone System

The computerised Telephone Information Management System, with its peripheral management software, was installed to monitor PABX traffic and to ensure the Department would have a functional and cost effective phone communication system.

Facsimile Services

A survey of text transmission requirements was conducted across the Department. As a result of this survey facsimile facilities were rationalised within the divisions. This included the installation of a machine in the Records Services area.

Reporting

Departmental information systems not only provide the means to enable the Department to go about its activities in an efficient and structured manner but create the data for reports to be made to Government, industry and the public.

During the year a Publications Co-ordinator was appointed to co-ordinate the use of a Desk Top Publishing system for production of printed material.

INTERNAL AUDIT

The requirements of Government for greater accountability is being achieved through the integration of the Internal Audit function as a normal and necessary part of the management process.

Key elements of this process are the development of an Internal Audit Charter which establishes the authority and responsibility of the Internal Audit Section. This will ensure the section performs an effective role in the Department. Improved auditing techniques will be linked to a more systems-based auditing approach. The section was increased by the appointment of an Internal Auditor in Charge.

FINANCE
YEAR ENDED JUNE 30, 1988.

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FINANCIAL RESPONSIBILITIES

The financial responsibilities of the Department of Mines include the collection and recording of revenue, and the payment of salaries, wages and other expenses.

The Department's funds are provided from the Consolidated Revenue Fund and General Loan and Capital Works Fund with certain activities being financed from Treasurer's Advances and Trust Funds. In addition, funds are received from the Commonwealth for specific programs.

CONSOLIDATED REVENUE FUND

EXPENDITURE

This fund finances:

(i) the Department's recurrent costs;

(ii) certain projects of a capital works nature; and

(iii) items of expenditure that are related to the mining and petroleum industries but which are not an operating cost of the Department.

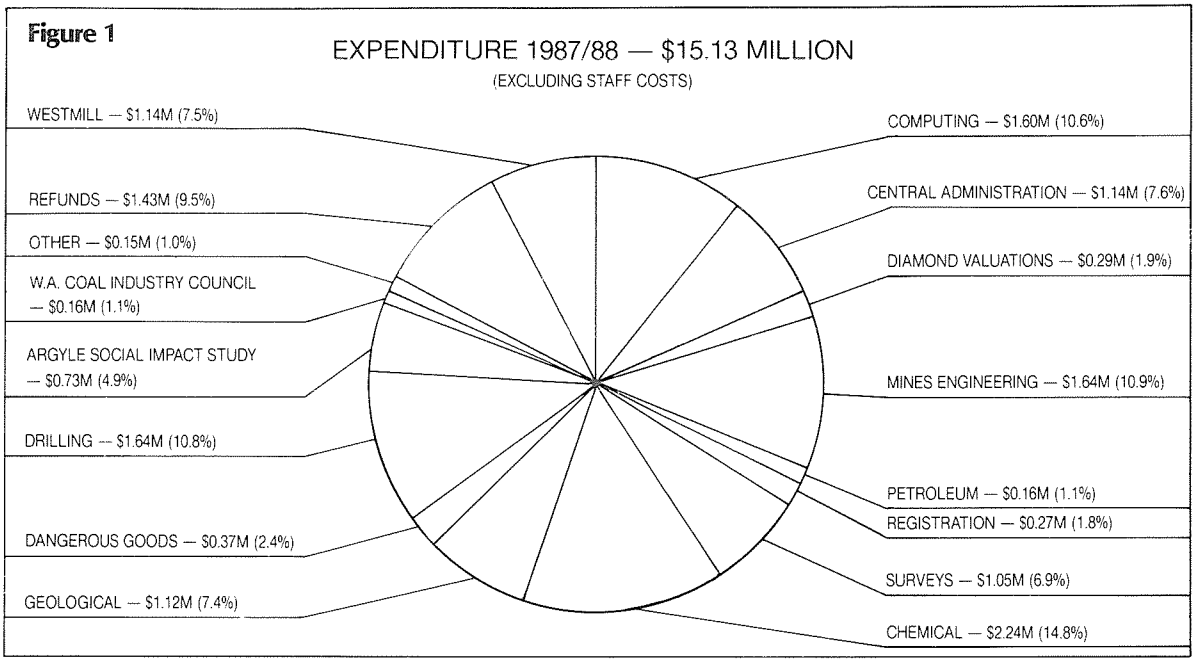
In addition any refunds of revenue collected in previous financial years appear as an expenditure commitment against the Department. For example, statutory obligations require rents to be refunded when mining tenements are refused, withdrawn or surrendered.

Included, at times, in the funding allocation from this source are funds for projects of a capital nature. The decision regarding the source of funds for capital projects rests with Treasury.

Certain items of expenditure that are related to activities of the mining and petroleum industries but which are not operational costs of the Department are also financed from this source. An example is the contribution to the Argyle Social Impact Group. This group is a joint Government and Argyle Diamond Mines Ltd exercise established in 1984 to fund the development of aboriginal social infrastructure in the East Kimberley region for a period of five years.

Figure 1 provides a breakdown of expenditure (excluding staff costs) financed from the Consolidated Revenue Fund.

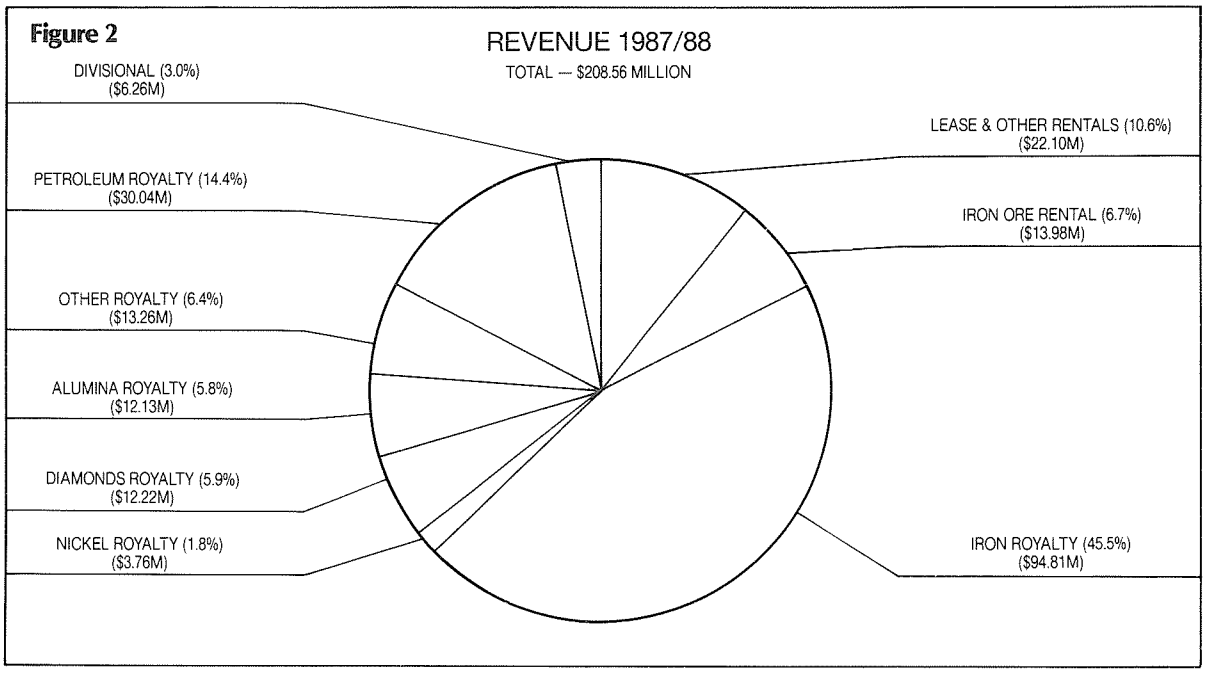
Figure 1



REVENUE

The majority of revenue collected by the Department is from mining and petroleum royalties. Figure 2 provides an analysis of the total revenue collected during 1987/88.

Figure 2

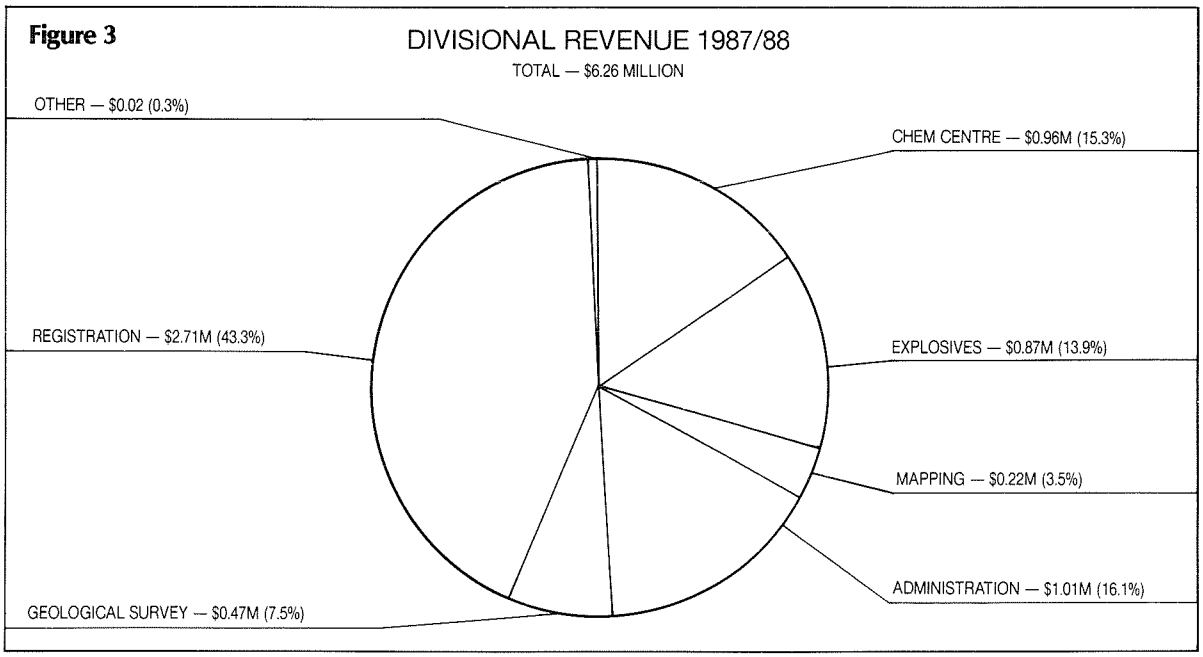


Whilst overshadowed by the magnitude of the royalty receipts, revenue is also generated from other sources. Some of these are:

- Mining tenement application fees, rentals, and registration fees collected under the Mining Act 1978.
- Petroleum tenement application, annual and registration fees collected under the Commonwealth Petroleum (Submerged Lands) Act 1967, the State Petroleum (Submerged Lands) Act 1982 and the Petroleum Act 1967. In addition application, annual and registration fees are collected for petroleum pipeline licences under the Petroleum Pipelines Act 1969.
- Lease payments and rentals associated with Special Agreement Acts involving Government and operators.
- Additional rentals based on iron ore shipments.
- Analytical services associated with doping control management for the Western Australian Turf Club, Western Australian Trotting Association and Western Australian Greyhound Dog Racing Club.
- Evaluation of mineral processing procedures and gold bullion analysis.
- Fees prescribed under the Explosives and Dangerous Goods Act 1961-1986 and regulations thereunder.
- Sale of tenement maps, geological maps, plans and other Departmental publications.
- Sale of information regarding the status of mining tenements applied for and held under the Mining Act 1978. This information is available via a computerised Tenement Information System (TENDEX).

Figure 3 provides a breakdown of the Divisional Revenue category shown in figure 2.

Figure 3



GENERAL LOAN AND CAPITAL WORKS FUND

Major capital works projects are financed under the State's Capital Works Program from the General Loan and Capital Works Fund.

In 1987/88 $7,763,980 was expended on capital works funded from this source (eg. relocation of explosives depot, laboratory equipment, buildings and associated works).

FINANCIAL MANAGEMENT

In accordance with Government's accountability concept, the Department has continued to initiate a number of reporting mechanisms which inform the Accountable Officer of the Department, the Director General of Mines, of the financial position of the Department on a periodic basis.

These reporting procedures are based on a flexible budgeting approach and enable the Executive of the Department to make the most effective use of available funds.

It is intended that these processes will be further developed to strengthen the links between the budgeting processes and strategic planning.

PRICING POLICY

Departmental fees and charges are reviewed annually and determined in accordance with Government directives, having regard to such factors as the cost of providing services, impact on industry and the public and price movements for the year.

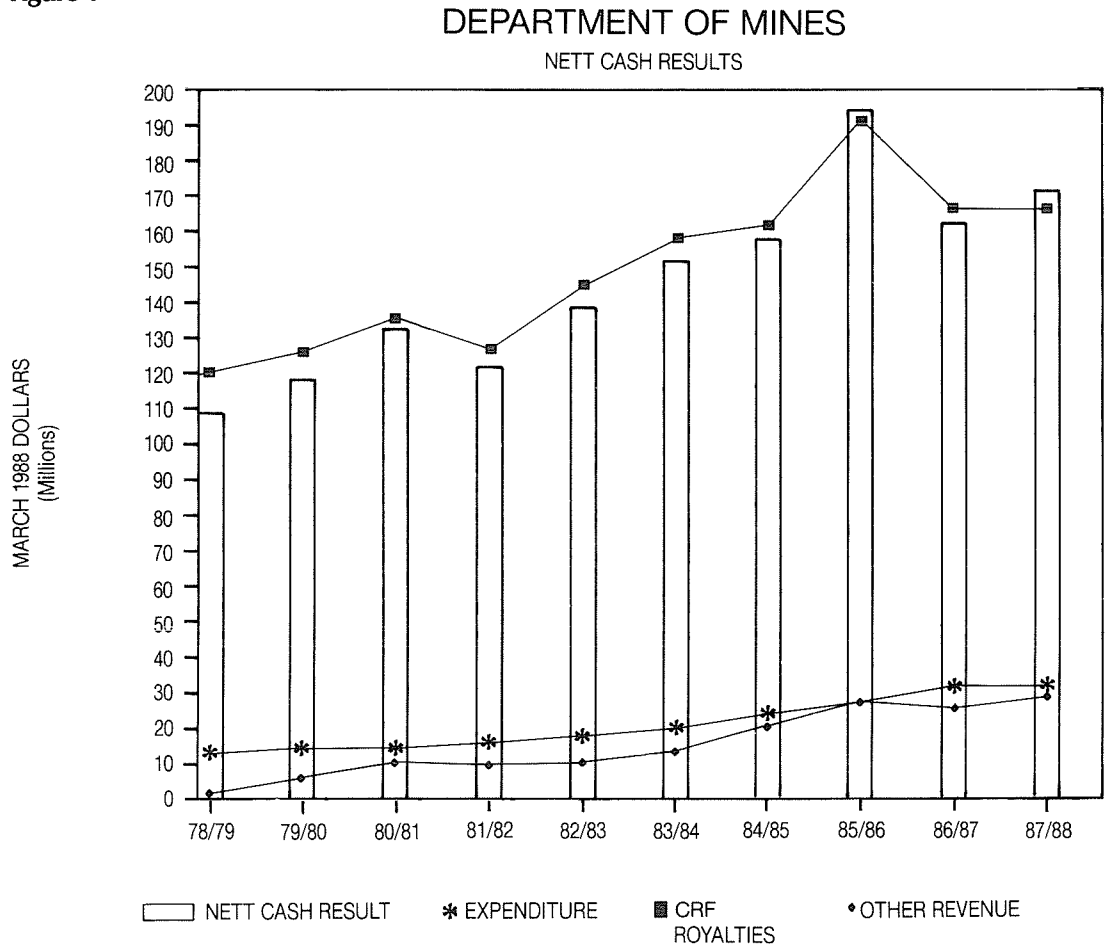
ROYALTY POLICY

The Government's policy on the raising of revenue through mineral and petroleum royalties is to ensure that royalty levels are such that all Western Australians benefit from the use of these resources. The Department aims to administer a comprehensive royalties management system which ensures that all royalties due are collected in the most cost effective manner.

CASH RESULT: A TEN YEAR COMPARISON

Figure 4 presents an indication of the cash surplus generated by the Department over the past ten years. The surplus is due to the level of royalties collected but it is important to note the relationship between Departmental expenditure and revenue generated from Departmental activities exclusive of royalties.

Figure 4



PERFORMANCE REVIEW 1987/88

During the financial year the Department's Consolidated Revenue Fund (CRF) expenditure budget of $36.309 million was overspent by $1.500 million (4.1%). However, in evaluating the financial performance of the Department two factors need consideration.

(i) Firstly, an adjustment should be made for a non-operational payment of $1.139 million to the Perth Mint for the Westmill operation.

Allowing for this adjustment, the Department overspent its CRF budget by $0.361 million (1.0%). This net result can be attributed to a number of factors but the most significant is the overspending on Salaries, Wages and Allowances ($0.501 million), which was mainly due to award increases being greater than that provided for by Treasury.

(ii) Secondly, recognition should be given to the revenue generating performance of the Department during the year.

The following table provides an indication of the cash surplus for 1987/88 and highlights the magnitude of the additional revenue generated.

	1987/88			
	Budget $m	Actual $m	Variation $m	%
REVENUE				
Royalties Revenue	151.600	166.220	+14.620	+9.6
Other Revenue	35.399	42.340	+ 6.941	+19.6
	186.999	208.560	+21.561	+11.5
EXPENDITURE	36.309	37.809	+1.500	+ 4.1
CASH SURPLUS	150.690	170.751	+20.061	+13.3

When the net cash result is considered purely in terms of operating expenditure (adjusted for abnormal and extraordinary items) and departmental revenue, the result equates to $7.999 million. This compares to the budgeted result of $1.444 million and an actual result in 1986/87 of $2.673 million.

This significant improvement in the operational cash result of the Department can be attributed to the degree of fluctuation in mining sector activity prior to and after the October 1987 stockmarket crash.

Figure 5 clearly indicates the effect of the stockmarket crash on the trend in mining tenement applications over the period from January 1986 to June 1988.

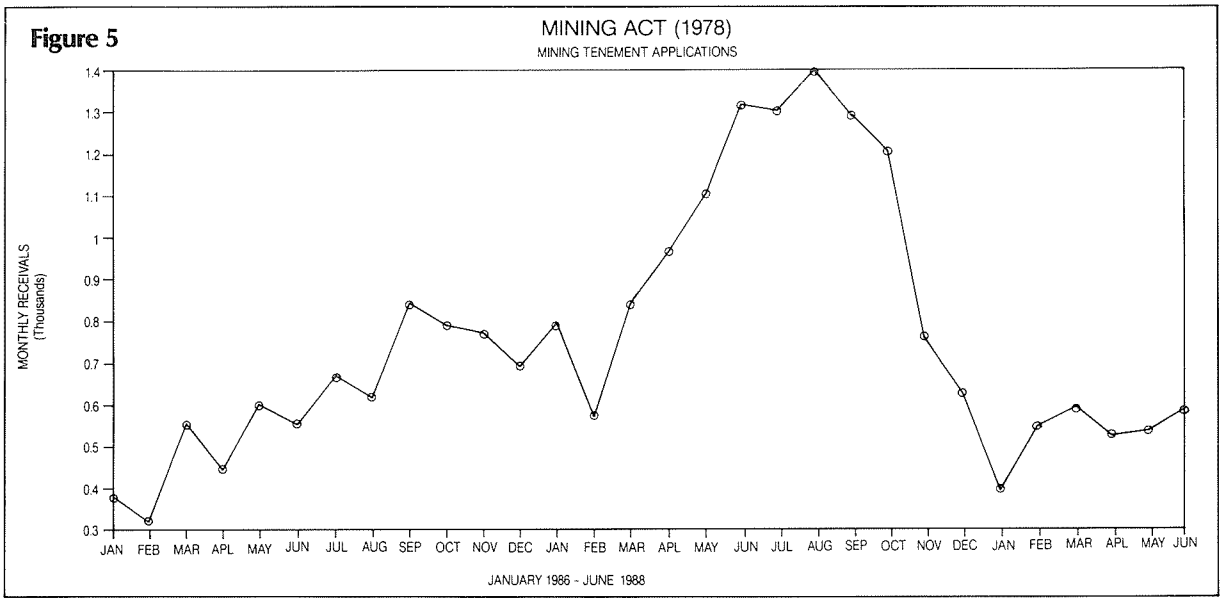
However, the considerable downturn in the number of applications received did not have an adverse effect on revenue collections when compared to the budget.

The revenue budget for 1987/88 was based on activity during the second and third quarters of 1986/87. Consequently, with the number of new companies floated prior to the "crash" (search fees) and the increases in the level of applications lodged (application fees), revenue receipts were significantly greater than that budgeted. In addition the monthly rental revenue generated by these new mining tenements continued for the remainder of the year even though the number of applications reduced significantly after October 1987.

Another contributing factor to the revenue generated in excess of budget was the significant increase in the number of applications received for exemptions (exemption fees) from expenditure commitments required under the Mining Act. As a result of the stockmarket activity, there was a 67% increase in the number of exemption applications received when compared to 1986/87.

The combined effect of these and other pressures on the Department amounted to a $6.941 million (19.6%) increase in budgeted revenue from Departmental activities.

Figure 5



MAJOR CAPITAL PROJECTS UNDERTAKEN DURING 1987/88

DEPARTMENT OF MINES

PROJECTS NOT COMPLETED AT JUNE 30, 1988

Geological Survey — Laboratory Relocation

Several Geological Survey laboratories were located on the 4th floor of Mineral House for many years. Increasing attention to occupational health and the rising standards for laboratory safety, made it necessary to relocate the laboratories on a site in Carlisle.

This project commenced in 1986/87 and an amount of roundly $1,000 is required to complete the project in 1988/89.

It is expected that on completion, the relocation will have cost $580,000, a variation of $80,000 over the original estimate.

Chemistry Centre — Noise Attenuation

An amount of $69,000 was provided in 1987/88 for noise attenuation in the mineral science laboratory where mineral crushing and grinding equipment is operated.

No funds were expended during the year and an amount of $69,000 has been provided to progress and complete the work in 1988/89.

Chemistry Centre — Room Conversions

An amount of $138,000 was provided in 1987/88 to enable conversion of existing laboratory space for mineral analysis and precious metal assaying. The conversion work will include upgrading of fume cupboards and improved storage facilities.

No funds were expended during the year and an amount of $138,000 has been provided to progress and complete the work in 1988/89.

PROJECTS COMPLETED AT JUNE 30, 1988.

Baldivis Explosives Depot — Relocation

In 1983, Government agreed to relocate explosives reserve at Woodman Point, Baldivis. The funding arrangements were for the Department to repay Cockburn Cement Ltd for costs incurred by the company in the construction of the Baldivis explosives depot. The repayments were to be in three equal annual instalments from 1985/86 to 1987/88.

The final instalment was paid in 1987/88 and the total cost of the project was $2,139,934.

BUILDING MANAGEMENT AUTHORITY

PROJECTS NOT COMPLETED AT JUNE 30, 1988

Mineral House Stage II

In order to provide adequate Departmental accommodation, Mineral House Stage II, an extension to the existing Mineral House, was commenced in 1984/85. The project is due for completion in 1988/89.

The estimated cost to complete the project is $1,330,000 and the estimated total cost of the project is $23,000,043 this is $672,000 more that the total cost estimated in the previous financial year.

PROJECTS COMPLETED AT JUNE 30, 1988.

Mining Engineering Division —
Kalgoorlie Accommodation Additions

Additions to the Mining Engineering Division's Kalgoorlie office commenced in 1985/86 and were completed in 1987/88.

The total cost of the project was $301,235.

Chemistry Centre — Fume Extraction

In 1985/86 a project was undertaken to instal fume extraction and fume scrubbers to provide for the efficient treatment of hazardous materials exhausted by the Chemistry Centre.

The project was completed in 1987/88 at a total cost of $497,283.

FINANCIAL STATEMENTS

EXPENDITURE STATEMENT
CONSOLIDATED REVENUE FUND

	Note	1986/87 Actual $	1987/88 Estimate $	1987/88 Actual $	1987/88 Variance $
Special Acts					
Petroleum (Submerged Lands) Act 1982	2	2 225 241	2 360 000	3 579 399	1 219 399
Governmental					
Salaries, Wages & Allowances	3	20 230 984	21 848 000	22 349 182	501 182
Other Staffing Costs		628 797	784 000	734 389	(49 611)
Communications	4	191 919	192 000	236 259	44 259
Services & Contracts	5	1 613 328	2 261 000	2 087 794	(173 206)
Consumable Supplies		135 977	143 000	142 992	(8)
Maintenance Plant, Equipment etc.		19 991	22 000	14 210	(7 790)
Purchase Plant, Equipment etc.	6	44 131	77 000	119 688	42 688
Grants, Subsidies etc.	7	6 201 124	1 532 000	2 602 743	1 070 743
Mining Engineering	8	1 325 806	1 626 000	1 643 269	17 269
Petroleum	9	117 948	145 000	159 234	14 234
Registration of Mining Titles		238 000	219 000	270 932	51 932
Surveys & Mapping	10	924 828	1 025 000	1 045 871	20 871
Chemistry Centre	11	1 053 281	2 402 000	2 235 064	(166 936)
Geological Surveys	12	872 054	940 000	1 118 807	178 807
Control of Dangerous Goods	13	224 843	393 000	367 075	(25 925)
Exploratory Drilling		1 563 964	1 696 000	1 634 956	(61 044)
Special Projects	14	160 000	150 000	149 983	(17)
Argyle Social Impact Study Group		677 305	731 000	733 641	2 641
W.A. Coal Industry Council	15	0	123 000	163 000	40 000
Iron Ore (Goldsworthy — Nimingarra) Agreement Act — Contribution	16	1 296 000	0	0	0
East Kimberley Impact Assessment Project		50 000	0	0	0
		37 570 280	36 309 000	37 809 089	1 500 089
GRAND TOTAL		39 795 521	38 669 000	41 388 488	2 719 488

REVENUE STATEMENT
CONSOLIDATED REVENUE FUND

	Note	1986/87 Actual $	1987/88 Estimate $	1987/88 Actual $	1987/88 Variance $
Territorial					
Royalties —	17				
Iron Ore		92 780 315	89 200 000	94 807 770	5 607 770
Petroleum		27 409 627	27 800 000	30 044 163	2 244 163
Diamonds		13 109 395	10 600 000	12 221 752	1 621 752
Alumina		10 540 226	10 300 000	12 132 983	1 832 983
Mineral Sands		4 253 295	7 300 000	8 979 041	1 679 041
Nickel		4 315 281	2 200 000	3 760 762	1 560 762
Other		3 873 729	4 200 000	4 279 517	79 517
Lease & Other Rentals	18	27 024 288	30 200 000	36 076 014	5 876 014
		183 306 156	181 800 000	202 302 002	20 502 002
Departmental					
Chemistry Centre	19	829 362	967 000	962 834	(4 166)
Explosives	20	772 038	845 000	866 744	21 744
Mines —	21				
Registration		2 170 706	1 950 000	2 709 288	759 288
Sale of Motor Vehicles		279 931	355 000	498 317	143 317
Other		1 149 609	1 082 000	1 220 399	138 399
		5 201 646	5 199 000	6 257 582	1 058 582
Commonwealth					
Community Employ. Program		11 266	0	0	0
		188 519 068	186 999 000	208 559 584	21 560 584

EXPENDITURE STATEMENT
GENERAL LOAN AND CAPITAL WORKS FUND

	Note	1986/87 Actual $	1987/88 Estimate $	1987/88 Actual $	1987/88 Variance $
Corporate Services Division —					
Mainframe Computer		780 028	0	0	0
Mainframe Printer		43 380	0	0	0
Mineral House Stage II		10 588 092	7 421 000	6 763 060	(657 940)
Explosives Division —					
Baldivis — Relocation of Depot		714 952	718 000	716 396	(1 604)
Geological Survey Division —					
Relocation of Laboratories		375 347	195 000	202 982	7 982
Govt. Chemical Laboratories —					
Alterations and Additions		43 056	0	0	0
Forensic Science Laboratories		80 020	0	0	0
Fume Scrubbing	22	440 410	69 000	1 680	(67 320)
Mineral Science Laboratory —					
Alterations	23	0	138 000	0	(138 000)
Noise Attenuation	23	0	69 000	0	(69 000)
Plant and Equipment		731 331	69 000	67 920	(1 080)
Mining Engineering Division —					
Kalgoorlie — Additions		264 200	7 000	11 942	4 942
State Batteries Division —	24				
Mobile Carbon-in-Pulp Plant		86 879	0	0	0
Noise Abatement Modifications		41 737	0	0	0
		14 189 432	8 686 000	7 763 980	(922 020)
Source of Funds —	25				
General Loan & Capital Works Fund		4 679 983	8 686 000	7 763 980	
W.A. Building Authority		9 509 449	0	0	
		14 189 432	8 686 000	7 763 980	

TRUST FUND

The Trust Fund operates under the authority of Section 9 of the Financial Administration and Audit Act.

In accordance with the Act, the Department operates a number of Trust Accounts. These are for:

(i) monies that are private in nature and held in trust;
(ii) holding balances for specific purposes; and
(iii) monies received pending identification of the purposes for which those monies were received, subject to any conditions specified by the Treasurer.

During the year the Chemistry Centre Trust Account was created (April 1988) to hold monies pending their application to specific purpose projects. Information regarding the management of this Trust Account is included in the following Trust Statement.

TRUST STATEMENT

Chemistry Centre Trust Account

Name	An account called the Chemistry Centre Trust Account shall be maintained as a Private Trust Account at Treasury.
Purpose	To hold funds for the purpose of conducting specific special projects.
Receipts	Such moneys as are received by the Department of Mines being amounts provided by industry or other organisations shall be paid to and placed to the credit of the Account.
Payments	The funds in the Account shall be applied to meeting the cost of the specific special projects.
Administration of Account	The Account shall be administered by the Director General of Mines in accordance with the Financial Administration and Audit Act, Financial Administration Regulations and Treasurer's Instructions.
Accounting Records	There shall be maintained by the Director General a detailed record of transactions processed through the Account, together with such other accounting records and procedures as are prescribed in the accounting manual.
Financial Statement	The Director General shall cause to be prepared a statement of cash receipts and payments and such other supplementary information in accordance with the requirements of Treasurer's Instructions.
Investment of Funds	Moneys standing to the credit of the Account may be invested in accordance with Section 40(a) of the Financial Administration and Audit Act.
Disposal of Funds on Cessation	Any balance standing to the credit of the Account upon cessation of operations shall be refunded to the contributors on a pro rata basis of funds contributed.

I have examined and agree Approved to the provisions of this Trust Statement.

D R Kelly

DIRECTOR GENERAL OF MINES

DATE 26/3/88

B A Sargeant

A/ASSISTANT UNDER TREASURER (ACCOUNTING)

DATE 6/4/88

ACCOUNTS OF THE TRUST FUND

Kalgoorlie Metallurgical Laboratory

The account was created to hold the equivalent amount of revenue collected by the Laboratory to offset operational costs. This practice ceased some years ago and the operations are funded by consolidated revenue as part of the Chemistry Centre's vote. As a consequence the account was closed in October 1987.

Mining Development Account

The account is maintained to hold moneys received from saleable items initially purchased from the General Loan Fund and Capital Works Fund. The balance of this account is transferred to Loan Repayments. There was no money received during 1987/88.

Survey of Leases Under the Mining Act Account

Survey fees collected under the Mining Act are paid into this account. The cost of surveys is charged to the Consolidated Revenue Fund. Fees applicable to completed surveys are transferred from the suspense account to Departmental revenue, and where appropriate refunds are made to depositors.

	1986/87 $	1987/88 $
Opening Balance July 1	2 031 464 CR	2 423 558 CR
Add Receipts		
Survey Fees	924 760	2 457 413
Less Payments		
Transferred to Revenue	165 496	232 067
Refunds	367 170	236 608
Closing Balance June 30	2 423 558 CR	4 412 296 CR

Barrow Island Royalty Trust Account

The account was created in 1985/86 under the Barrow Island Royalty Trust Account Act 1985 which provides that royalty payments received by the State under the Barrow Island lease shall be credited to the account and subsequently apportioned between the Commonwealth and the State.

	1986/87 $	1987/88 $
Opening Balance July 1	0	0
Add Receipts		
Royalties Received	58 651 652	57 872 121
State's Share of Royalty Refund	5 173 128	15 646
Commonwealth Share of Royalty Refund	15 519 386	46 938
Less Payments		
Transferred to Revenue	14 662 913	14 468 030
Remitted to Commonwealth	43 988 739	43 404 091
Refunds of Royalty	20 692 514	62 584
Closing Balance June 30	0	0

Chemistry Centre Trust Account

The account was created in May 1988 to hold moneys received by Industry and other organisations for the purpose of conducting specific special projects.

	1987/88 $	$
Opening Balance July 1		0
Receipts		
Contributions		
From: Industry	21 573	
Government	33 364	54 937
Total Receipts		54 937
Less Payments		
Salaries	6 000	
Travel	5 000	
Equipment	16 067	
Total Payments		27 067
Closing Balance June 30		27 870 CR

Deposits — Mines Department Account

Funds held in this account comprise amounts received for the issue of temporary reserves and exploratory permits pending finalisation of certain legal requirements.

Refunds of deposits and transfers to the Consolidated Revenue Fund following finalisation of outstanding requirements during the year reduced the amounts held to $296 011 at June 30, 1988.

	1986/87 $	1987/88 $
Opening Balance July 1	337 647 CR	289 420 CR
Add Receipts		
Bonds, Securities etc.	263 382	215 806
Less Payments		
Transferred to Revenue	234 319	64 090
Refunds	77 290	145 125
Closing Balance June 30	289 420 CR	296 011 CR

Loans for Development of Mining

Interest and principal repayments during the year on loans provided from the Consolidated Revenue Fund amounted to $286 and $4,738 respectively compared to $1,967 and $26,613 for the previous year finalising loans made under the scheme.

Prospecting Assistance — The scheme provided for assistance to prospectors and for the recovery of advances from the proceeds of gold won from mining activities. There were no transactions during the year. The outstanding balances at June 30, 1988 were $31,480 and $1,597 from the General Loan Fund and the Consolidated Revenue Fund respectively.

Departmental Receipts in Suspense

The account is maintained to hold moneys temporarily pending identification of the purpose for which the funds were received.

	1986/87 $	1987/88 $
Opening Balance July 1	2 249 CR	6 324 CR
Add Receipts		
Collections	1 807 999	1 560 740
Less Payments		
Transferred to Revenue, Refunds etc	1 803 924	1 542 952
Closing Balance June 30	6 324 CR	24 112 CR

Suspended Postings

The account is maintained to hold rejected credit postings pending identification of and subsequent posting to the correct account or the creation of the required account.

TREASURERS ADVANCE

Drilling

Recoverable drilling expenditure is charged, in the first instance, to an account Drilling under the appropriation Advance to Treasurer. The cost of work performed, together with overhead charges in certain instances where Departmental equipment is used, are recovered and credited to this account.

	1986/87 $	1987/88 $
Balance July 1	115 727 CR	141 368 DR
Credits	5 204 161	5 558 058
Debits	5 461 256	5 671 929
Balance June 30	141 368 DR	255 239 DR

The following information is supplied in addition to the Financial Statements.

(i) Write offs

Public and other property and revenues and debts due to the State written off during the financial year by:-

(a) Accountable Officer	$ 1 551	
(b) Minister	3 470	$ 5 021

(ii) Losses through thefts, defaults etc.

(a) Recoveries of losses	$ 65	
(b) Losses unrecouped	$ 3 090	$ 3 155

(iii) Expenditure claims unpaid (Accounts on hand as at 30.6.88) $171 438

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 1988

1. Accounting Policy

(a) The Financial Statements are prepared on a cash basis in that only collections received and payments made are reflected therein. The disbursements include a net payment of $146,000 to the Treasury Departmental Receipts in Suspense Account for accrued salaries.

(b) The financial statements included in this report have been prepared in accordance with the requirements of the Financial Administration and Audit Act, 1985.

(c) All expenditures incurred by the Department of Mines in the provision of services are not appropriated to the Department. The employer's share of superannuation pensions is met by Treasury. Rental of office accommodation is met by the Office of Government Accommodation. Maintenance of government buildings is met by the Building Management Authority. The servicing of the Department's General Loan and Capital Works Fund debt is met by Treasury.

(d) Property disposals are effected through the State Tender Board and proceeds credited to Revenue Government Property Sales. Exceptions are:-

(i) when the original acquisition was met from General Loan and Capital Works Fund the proceeds are credited to Loan Repayments;

(ii) proceeds received from the disposal of Departmental vehicles are credited to general departmental revenue.

2. Special Act

The figure is budgeted for by Treasury based on the expected Commonwealth share of royalty received from the Harriet oilfield.
The estimate did not take into account the commencement of the South Pepper oilfield in January 1988 which amounted to $0.653 million of the $1.219 million overspending in 1987/88.

3. Salaries Wages and Allowances

The overspending of $501,181 is mainly due to award increases being greater than that provided for by Treasury ($393,000). The balance of the overspending is the net effect of the Department's average staffing level of 738 FTEs being below the approved average of 751 and an increase in the number of retirements and resignations.

4. Communications

Expenditure in 1987/88 exceeded 1986/87 actual expenditure by $44,340 (23%) due to additional rental and call charges associated with an increase in the number of extensions.

The overspending of the budget in 1987/88 was due to an inadequate provision.

5. Services & Contracts

The increase in expenditure of $474,466 (29%) when compared to 1986/87 was due to the development of industry based computer systems.

6. Purchase Plant & Equipment etc.

In 1987/88 three vehicles became due for replacement. Vehicles are replaced every two years or when attaining 40,000 kilometres whichever is earlier.

7. Grants, Subsidies and Transfer Payments

	1986/87 $	1987/88 $
Refunds of Revenue		
• Mining Tenements	912 133	1 416 720
• Alteration in Petroleum Royalty Methodology*	5 173 128	15 646
Westmill	0	1 139 000
Other	115 863	31 377
	6 201 124	2 602 743

* Under a revised royalty agreement between the Commonwealth and State Governments, excess royalties collected in previous years were refunded.

8. Mining Engineering

Additional expenditure in 1987/88 due to installation of long range radio communication network and supporting inspectorate costs for additional staff.

9. Petroleum — Administration and Engineering

$14 750 was expended on a statutory royalty audit of the North West Shelf Gas Project in 1986/87. In 1987/88 the amount expended was $44,136.

10. Surveys and Mapping

	1986/87 $	1987/88 $
Contract Survey Payments	674 730	675 794
Divisional Operating Expenses	216 098	370 077
Microfilm Camera	34 000	0
	924 828	1 045 871

11. Chemistry Centre

	1986/87 $	1987/88 $
Major Capital Equipment	0	563 294
Doping Control Equipment & Expenses	0	568 000
Organochlorine Pesticide Analysis	0	33 000
Other Operating Expenditure	1 053 281	1 070 770
	1 053 281	2 235 064

12. Geological Survey

1987/88 Expenditure exceeded the previous year's expenditure level by $246,753 due to increased field trips, helicopter hire, an increase in the number of vehicles being due for replacement and the transfer of the Drill Core Shed from Collie to Dianella.

13. Control of Dangerous Goods

	1986/87 $	1987/88 $
Safety Co-ordination/Risk Assessment Analysis	0	86 122
Motor Vehicle Replacements	36 218	62 178
Other Operating Expenses	188 625	218 775
	224 843	367 075

14. Special Projects

Expenditure associated with land resource projects:

(i) Bauxite Related Research
(ii) Land Salinisation Research

15. W.A. Coal Industry Council

The budget was exceeded by $40,000 due to additional travelling.

16. Ore (Goldsworthy-Nimingara) Agreement Act — Contribution to State Development Fund

Costs associated with the construction of a water pipeline extension and associated works from South Hedland to Finucane Island payable to the State Development Fund to help finance the infrastructure concluded in 1986/87.

17. Royalties Revenue

Increased production levels were responsible for higher royalty payments on iron ore (up $5.608 million) and petroleum ($2.244 million). For alumina (up $1.833 million), mineral sands ($1.679 million), diamonds ($1.622 million) and nickel ($1.561 million) the rises were also primarily a result of higher prices and variations in the royalty rates.

18. Lease and Other Rentals

	1986/87 $	1987/88 $
Iron Ore Additional	11 059 968	13 977 683
Lease & Other Rentals	15 457 526	21 581 422
Petroleum Permits	506 794	516 909
	27 024 288	36 076 014

19. Chemistry Centre

The increase of $133,472 (16%) when compared to 1986/87 was due to additional revenue generated by the Kalgoorlie Metallurgical Laboratories.

20. Explosives

A number of licences are due for renewal late June and early July, early payment for these will result in a variation in revenue between years. This occurrence together with an increase in the number of licences issued resulted in an increase of $94,706 (12%) when compared to 1986/87.

21. Mines Revenue

	1986/87 $	1987/88 $
Administration	649 244	516 482
* Registration	2 170 706	2 709 288
** Surveys & Mapping	184 235	216 755
** Geological Survey	291 130	472 998
Mines Engineering	7 046	10 027
Petroleum	17 954	4 137
Sale of Motor Vehicles	279 931	498 317
	3 600 246	4 428 004

N.B.

* Includes mining tenement application fees revenue.
** Includes sales of maps and publications

Actual registration revenue in 1987/88 exceeded budget by $759,288 (39%) and 1986/87 receipts by $538,582 (24%) due to an increase in mining activity during the year (see Performance Review 1987/88).

Revenue from sale of motor vehicles increased by $218,386 (78%) when compared to 1986/87 due to a greater number of vehicles being sold. The budget was exceeded by $143,317 (40%) due to increased prices being achieved at auction.

22. Chemistry Centre — Fume Scrubbing

The contract expenditure was less than anticipated to complete the project.

23. Chemistry Centre — Mineral Science Laboratory

Alterations and Noise Attenuation works did not commence in 1987/88 and will be progressed in 1988/89.

24. State Batteries

The State Batteries function was transferred to Westmill in 1986/87.

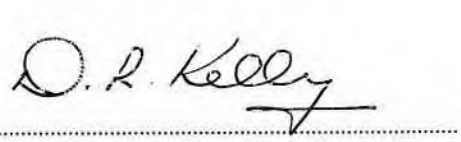
25. Source of Funds

Building Management Authority charges not included in table totalled $905,408 and $797,988 in 1986/87 and 1987/88 respectively.

CERTIFICATION OF FINANCIAL STATEMENTS

"The accompanying financial statements of the Department of Mines have been prepared in compliance with the provisions of the Financial Administration and Audit Act 1985 from proper accounts and records to present fairly the financial transactions for the year ending June 30, 1988 and the state of affairs as at June 30, 1988.

At the date of signing we are not aware of any circumstances which would render the particulars included in the financial statements misleading or inaccurate".



D R Kelly
ACCOUNTABLE OFFICER

G F Downes
PRINCIPAL ACCOUNTING OFFICER

Date August 12, 1988

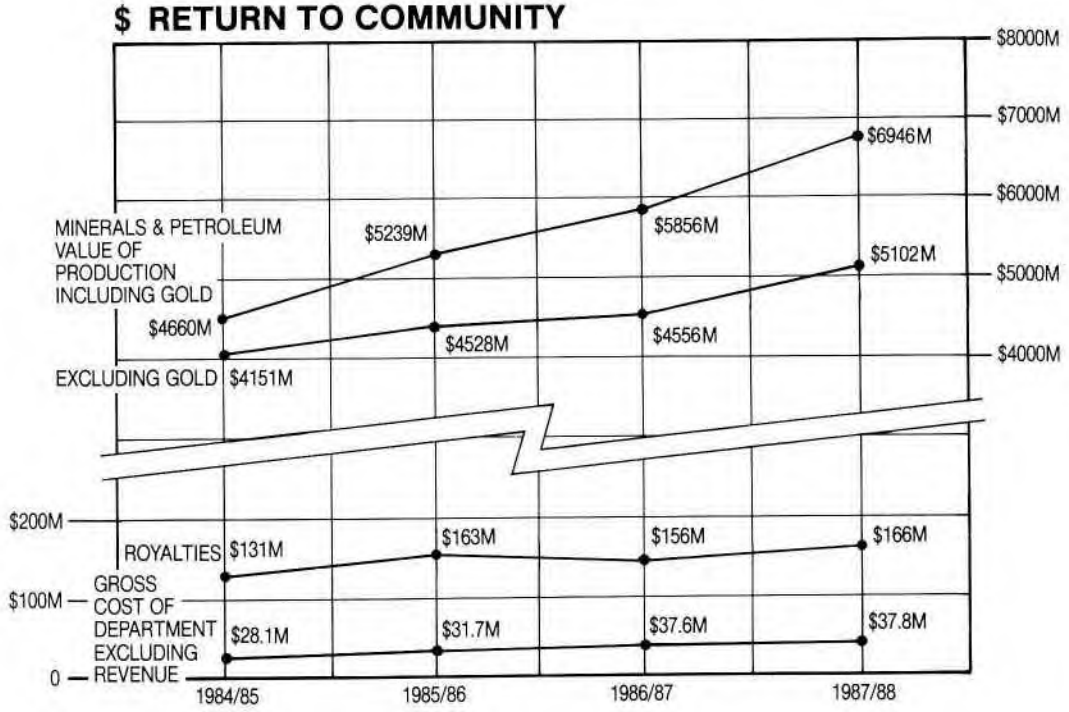
PERFORMANCE INDICATORS

Last year the Department prepared a list of statistics which reflected overall activity. These statistics gave the reader an understanding of the nature and volume of the work being undertaken.

This year considerable thought has been given to presenting a series of efficiency and effectiveness indicators; however it has proved to be a difficult task and a complete set of indicators has yet to be finalised.

For that reason, rather than put together a set of arbitrary indicators, the performance statistics first used in 1986/87 have been carried forward and where necessary enhanced to increase their meaning. As before, the performance statistics have been given relevance by linking them to the Broad Objectives of the Department. Further the human resources devoted to each Broad Objective have also been recorded so as to put into perspective the performance statistics and the activities they represent.

Performance Indicators are considered to be a valuable tool of management and even at this early stage in their development much benefit has been derived by the Department. As part of its corporate planning process these indicators will be further developed, refined, added to, or dropped as experience dictates.



BROAD OBJECTIVE 1: To ensure that exploration and development of the State's mineral and petroleum resources are carried out in a fair manner.

MINING TENEMENTS:

Applications Received

	1985/86	1986/87	1987/88
• Prospecting Licences	4 636	7 045	5 361
• Exploration Licences	1 075	1 927	1 671
• Mining Leases	676	1 089	1 838
• Other	147	255	406
TOTALS	6 534	10 316	9 276
Area Applied For (Hectares)	15 896 497	24 050 069	21 241 446

Applications Granted

• Prospecting Licences	3 966	5 266	5 197
• Exploration Licences	533	881	1 214
• Mining Leases	516	633	1 379
• Other	160	170	266
TOTALS	5 175	6 950	8 056
Area Granted (Hectares)	7 000 635	11 168 521	13 915 015

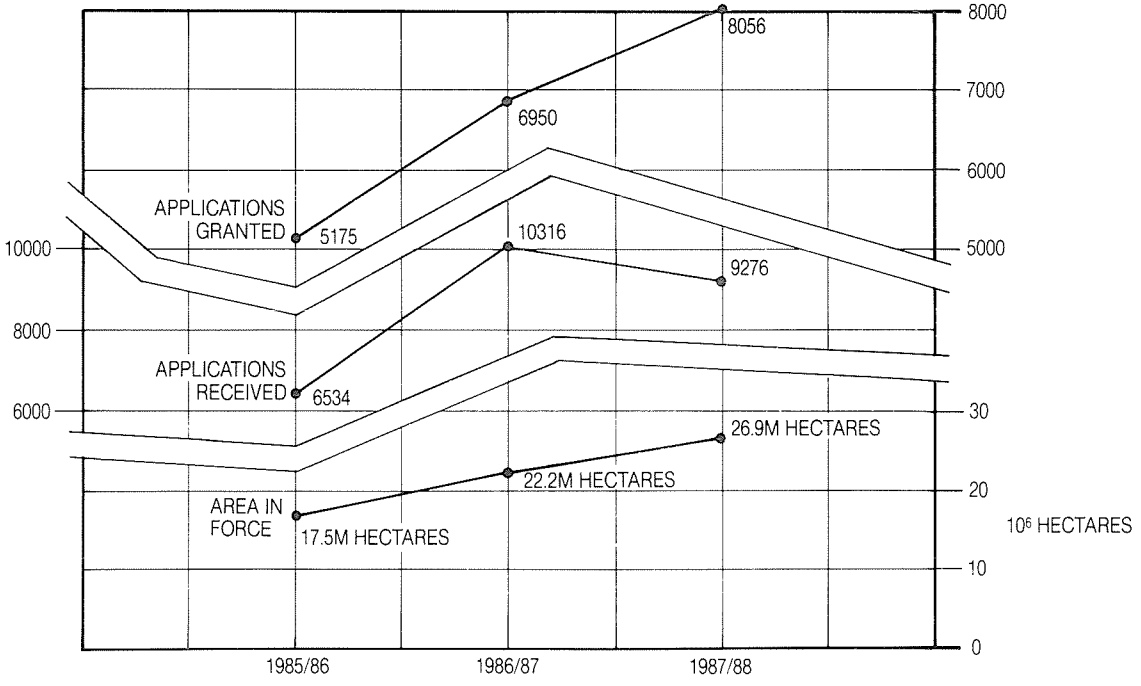
Tenements in Force

	1985/86	1986/87	1987/88
1978 Mining Act:			
• Prospecting Licences	10 286	12 976	15 216
• Exploration Licences	1 259	1 750	2 578
• Mining Leases & Others	4 503	4 691	5 690
1904 Mining Act:			
• Mineral Claims & Others	1 364	887	552
TOTALS	17 412	20 304	24 036
Area In Force (Hectares)	17 496 124	22 232 171	26 928 964

Tenements Added to Public Plans

	6 285	9 848	10 507

1. TENEMENT ACTIVITY



Surveys of Tenements			
• Surveys completed	461	583	505
• Average size of surveyed tenements (hectares)	194	134	167
• Survey diagrams processed for acceptance	2 036	1 327	1 126
Applications for Prospecting Licence Extensions	1 133	3 483	2 039

Dealings Received	16 086	17 392	20 714
Tenement Surveillance			
• Reports on Operations Received	13 120	13 790	14 914
• Applications for exemption	1 936	1 737	2 959
• Tenements forfeited	582	489	353

PETROLEUM TENEMENTS

Exploration Permits

	1985/86		1986/87		1987/88	
	No	Area (km²)	No	Area (km²)	No	Area (km²)
Advertised						
• Onshore	2	6 685	4	26 210	14	32 503
• Offshore	6	15 577	7	5 913	12	47 926
TOTALS	8	22 262	11	32 113	26	80 429
Granted						
• Onshore	6	37 202	3	13 790	10	46 017
• Offshore	3	33 153	5	8 804	6	17 838
TOTALS	9	70 355	8	22 594	16	63 855
In Force						
• Onshore	56	471 218	54	398 987	62	341 605
• Offshore	32	284 893	32	256 975	32	144 286
TOTALS	88	756 111	86	655 962	94	485 891
Production Licences						
Granted	1	154	1	231	4	1 463
In Force	16	6 083	17	6 314	20	1 540

Departmental Human Resources Committed to This Objective

Geological Survey	2.2	
Mining Registration	86.0	
Petroleum	6.2	
Surveys and Mapping	85.5	
Corporate Services	27.8	
TOTAL	207.7	FTEs (Full Time Equivalent)

Departmental Human Resources Committed to Non-Mines Objectives

In the main these are services performed for other Departments at outstations.

TOTAL 8.0 FTEs

BROAD OBJECTIVE 2: To foster mineral, petroleum and groundwater exploration and development, and assist long range planning and decision making by Government.

Petrological Examinations

	1985/86	1986/87	1987/88
• Reports completed	53	39	30
• Samples determined	1 728	937	875

Palaeontological Reports

• Compiled and issued	19	36	22

Exploration Information

Available to Public

• Petroleum (reports)	N/A	86	553
• Minerals (volumes)	927	1 908	2 258

Groundwater and Stratigraphic Evaluation

• Metres drilled	8 024	14 693	14 917

Geological Maps

• Major coloured	15	12	14
• Other	4	4	10

Petroleum Exploration

• Wells drilled	29	16	32
• Metres drilled	79 286	28 357	53 390
• Line Kilometres Seismic Surveys	40 623	17 506	10 854

Library

	1985/86	1986/87	1987/88
• Members of public using library	3 426	4 068	4 013
• No who used microfilm reader/printer facilities	858	1 114	1 171

Exploration Reports

• Petroleum exploration reports received	N/A	320	359
• Mineral exploration reports received	2 059	2 888	2 855

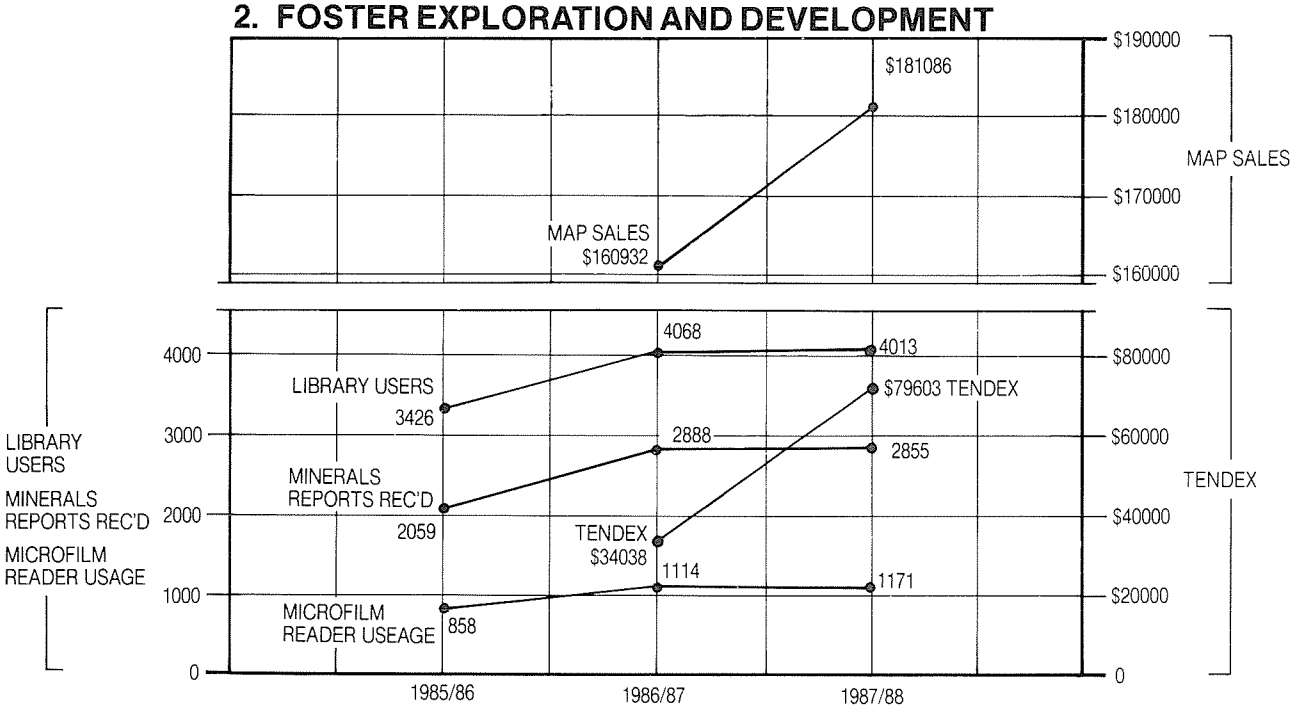
Revenue Earned from Sales

	$	$	$
• Maps	N/A	160 932	181 086
• Microfilm	53 920	72 603	218 540
• Tendex	N/A	*34 038	79 603

*commenced December 86

Departmental Human Resources Committed to this Objective

Chemistry Centre	51.8
Geological Survey	105.0
Mining Engineering	62.0
Mining Registration	4.0
Petroleum	7.2
Surveys and Mapping	36.4
Corporate Services	35.9
TOTAL	303.9 FTEs



BROAD OBJECTIVE 3: To ensure that the community receives a fair return from the exploitation of the State's mineral and petroleum resources; and that proper attention is given to the environment.

Royalties	1985/86 $m	1986/87 $m	1987/88 $m
• CRF (Note 1)	162.9	156.2	166.2
TOTAL (Note 2)	163.7	203.5	211.2
Commonwealth and State			
• State	162.9	154.0	162.6
• Cmwth	0.8	49.4	48.6
Value of Mineral and Petroleum Production (in 1987/88 dollars)	6172	6273	6839 est
Notice of Intent Received for Assessment	7	35	103

Environmental Conditions

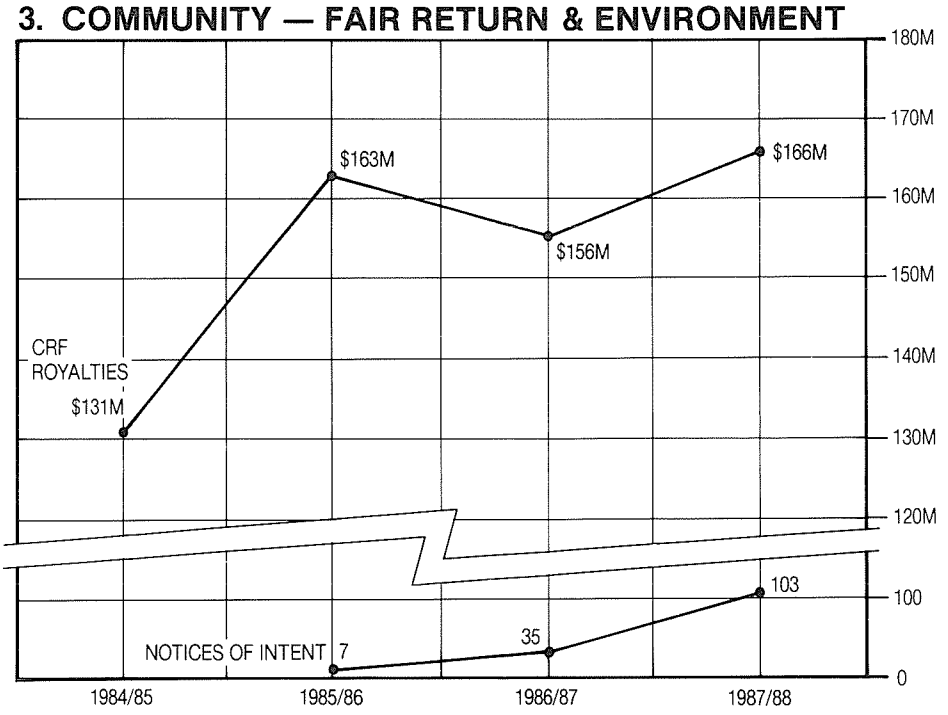
All types of mining and petroleum tenements have environmental conditions placed upon them to safeguard the environment. In order to help industry various guidelines for environmental management have been developed. It is estimated that only 0.01 per cent of the State's land area is currently disturbed by productive mining.

Departmental Human Resources Committed to this Objective

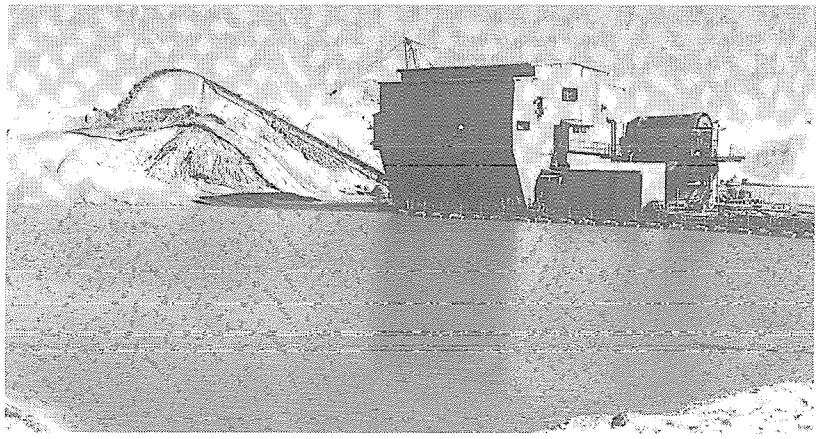
Chemistry Centre	2.0
Geological Survey	0.8
Mining Engineering	9.2
Petroleum	0.8
Royalties	6.4
Corporate Services	14.3
TOTAL	33.5 FTEs

Note 1: Revenue receipts to the State Consolidated Revenue Fund (CRF) includes some royalties collected by the Department of Mines on behalf of the Commonwealth for later reimbursement via Special Acts.

Note 2: Includes all royalties collected from WA projects by either the State or Commonwealth Governments. These are all processed through the Department of Mines WA.



THE MINING AND REHABILITATION SEQUENCE — CABLE SANDS MINING AT MINNINUP



Mining Treatment plant near dredge, and dredge pond in foreground.

Dredging operations, Minninup, W.A. 1986-87.

BROAD OBJECTIVE 4: To ensure that all operations in the mining and petroleum industries and activities involving explosives and dangerous goods are conducted in a manner that is safe for workers and the public.

Mining:

	1985/86	1986/87	1987/88
Workers	28 108	28 523	*29 240
Accidents			
• Fatal	11	4	8
• Serious	493	582	639
• Minor	1 733	1 697	1 606
	2 237	2 283	* 2 253
Accidents/1000 Mine Workers	80	80	*78

* 1987/88 figures are estimates only, subject to final audit.

Human Resources — Mining Engineering

• Total FTEs (excluding drilling)	39	56	68
• Health & Safety FTEs	33	45	50
• Health & Safety FTEs /1000 Mine Workers	1.17	1.58	1.76

Operating Mines

• Gold *	136	151	165
• Other	115	104	105
• Total	251	255	270*

* Gold Mines which produced over 100ozs

*As at March quarter.

Petroleum:

Accidents

	1985/86		1986/87		1987/88	
	Onshore	Offshore	Onshore	Offshore	Onshore	Offshore
• Minor	26	27	20	59	14	16
• Serious	22	17	5	12	12	17
• Fatal	-	-	-	-	-	1
Man hours lost	11 424	18 998	3 848	4 765	6 353	3 415

Petroleum Production Installations, Wells, Surveys

	1986/87	1987/88
• Petroleum production installations	9	12
• Offshore exploration wells	6	6
• Onshore exploration wells	10	26
• Geophysical (seismic) surveys	38	44

Field Inspections

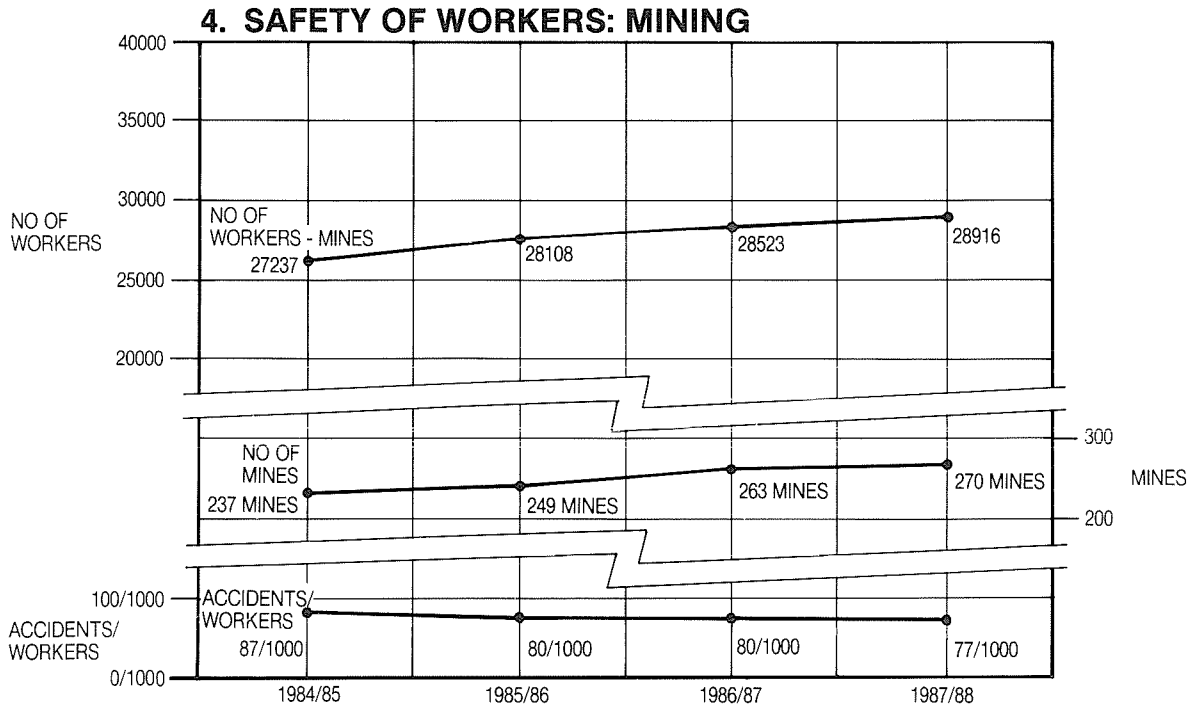
	1985/86	1986/87	1987/88
• Offshore drilling	3	4	9
• Onshore drilling	7	8	12
• Offshore production	16	20	34
• Onshore production	16	8	15
• Offshore drilling units	4	4	1
TOTAL	46	44	71

Explosives and Dangerous Goods: Licences

	1986	1987
• Explosives Licences and Permits	3438	3878
• Premises Licensed to Store Flammable Liquids	4248	4920
• Vehicles Licensed to Convey Dangerous Goods	1155	1502
• Dangerous Goods Drivers Licences	953	392
• Prosecutions Initiated	18	17
Accidents	34	57

Departmental Human Resources Committed to this Objective

Chemistry Centre	4.3
Explosives and Dangerous Goods	31.0
Mining Engineering	49.8
Petroleum	3.8
Surveys and Mapping	1.1
Corporate Services	9.7
TOTAL	99.7 FTEs



BROAD OBJECTIVE 5: To ensure that the community has access to independent chemical research and consultancy services.

Chemical Consultancy Service:
Chemistry Centre (WA)

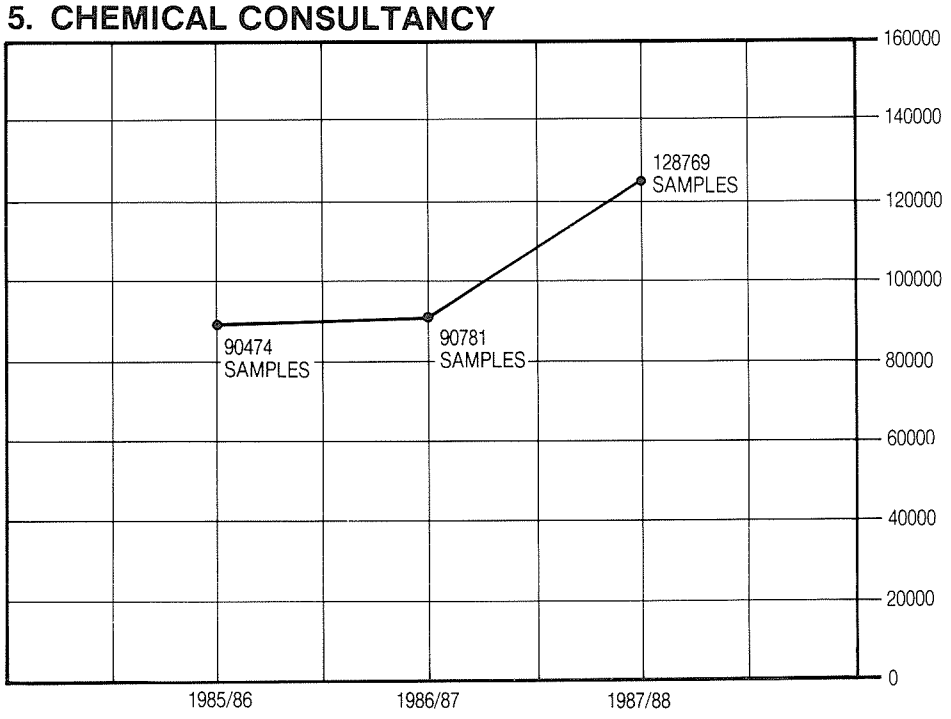
Samples	1985/86	1986/87	1987/88
• Govt Departments and Agencies	82 313	81 581	113 800
• Public	8 161	9 200	14 969
TOTAL	90 474	90 781	128 769

Laboratory

	Number of Samples /Investigations 1985/86	1986/87	1987/88
• Agriculture Chemistry	51 386	49 349	73 864
• Engineering Chemistry	186	475	1 103
• Food & Industrial Hygiene	5 692	5 203	16 321
• Forensic Science	9 669	9 674	10 056
• Kalgoorlie Metallurgical	3 527	5 043	4 545
• Materials Science	490	450	544
• Mineral Science	4 160	5 801	6 065
• Water Science	15 364	14 786	16 271
TOTAL	90 474	90 781	128 769

Departmental Human Resources Committed to this Objective

Chemistry Centre	90.9
Corporate Services	7.3
TOTAL	98.2 FTEs



CERTIFICATION OF PERFORMANCE INDICATORS

"I hereby certify that these performance indicators are based on proper records and fairly represent the performance of the Department of Mines for the year ending June 30, 1988."

D R Kelly
ACCOUNTABLE OFFICER

August 12, 1988

office of the
AUDITOR GENERAL

REPORT OF THE AUDITOR GENERAL FOR WESTERN AUSTRALIA

MINES DEPARTMENT

The accounts of the Mines Department have been audited for the period July 1, 1987 to June 30, 1988 under the provisions of the Financial Administration and Audit Act 1985 and found to be in order.

Evidence was not retained by the Department to enable verification of an amount of $171,438, representing Expenditure Claims Unpaid at June 30, 1988 as disclosed in the Supplementary Financial Information.

Except for the above matter, in my opinion

(i) the financial statements of the Receipts and Payments, Supplementary Financial Information and Notes To and Forming Part of the Financial Statements are based on proper accounts and records and have been properly drawn up so as to present fairly the transactions for the period; and

(ii) the controls exercised by the Director General of Mines were sufficiently adequate to provide reasonable assurance that the receipt and expenditure of moneys and the acquisition and disposal of property and the incurring of liabilities have been in accordance with legislative provisions.

The audit of performance indicators in the public sector is linked with a necessary phased development of performance management. I have therefore adopted a phased audit approach concentrating initially on the establishment of programme objective setting and measurement frameworks which will support the development of performance measurement.

Consistent with this phased audit approach I have not given an opinion this year on the relevance, appropriateness and fair representation of indicated performance.

However, in my opinion, the objectives of the Department of Mines are attainable and measurable. A purpose-based financial framework is being established by which inputs can be related to the outputs for which they were consumed. Upon implementation of the above initiatives it should be possible, in the future, for me to give an opinion on the fair representation of performance indicated by management.

A.D. SMITH
AUDITOR GENERAL

October 12, 1988

15th Floor, Supply House, 815-823 Hay Street, Perth, Western Australia 6000. Telephone (09) 321 9256

APPENDICES

APPENDIX 1 LEGISLATION

The Department is responsible to the Minister for Mines for the administration of 17 individual Acts of Parliament.

Principal Acts

Mining Act
Petroleum Act

Other Acts

Coal Mines Regulation Act
Coal Mine Workers (Pensions) Act
Coal Miners' Welfare Act
Coal Mining Industry Long Service Leave Act
Explosives and Dangerous Goods Act
Mines Regulation Act
Mine Workers' Relief Act
Miners' Phthisis Act
Mining Development Act
Mining on Private Property Act
Petroleum Pipelines Act
Petroleum (Registration Fees) Act
Petroleum (Submerged Lands) Act
Petroleum (Submerged Lands) Registration Fees Act
Western Australian Coal Industry Tribunal Act

The following Commonwealth legislation is administered in the Western Australian adjacent area by the State and through the Commonwealth/Western Australian Offshore Petroleum Joint Authorities:

Commonwealth Petroleum (Submerged Lands) Act
Commonwealth Petroleum (Submerged Lands) Registration Fees Act
Commonwealth Petroleum (Submerged Lands) (Royalty) Act
Commonwealth Petroleum (Submerged Lands) (Retention Lease Fees) Act
Commonwealth Petroleum (Submerged Lands) (Exploration Permit Fees) Act
Commonwealth Petroleum (Submerged Lands) (Production Licence Fees) Act
Commonwealth Petroleum (Submerged Lands)(Pipeline Licence Fees) Act

In addition to its responsibilities under the above-mentioned acts, the Department undertakes various functions in relation to a number of special Agreement Acts:

Barrow Island Royalty Trust Account Act
Barrow Island Royalty Variation Agreement Act
Mining (Validation and Amendment) Act

APPENDIX 2 CHANGES TO LEGISLATION

MINING ACT 1978

(a) Mining Amendment Act 1985 (No. 100 of 1985)

On 16 October 1987 Sections 31, 34, 38, 59, 63, 68, 69, 70, 71, 77, 78, 79, 80 and 96 of this Act were proclaimed. This now leaves only Sections 88 and 90 yet to be proclaimed. The major highlights of these amendments are:-

1. Ancillary titles

Removal of Link Tenement — The requirement to link both a general purpose lease and a miscellaneous licence to a host or parent tenement has been removed. Additionally the term for both titles has been changed to:

- general purpose lease, 21 years. Existing leases will continue, linked to their host lease or for 21 years whichever is the longer; and
- miscellaneous licence, 5 years. Existing licences will continue, linked to their host tenement, and lapse with that tenement.

2. Re-instatement of forfeited tenements

Re-instatement is now known as restoration, see — Sec. 97A Reg. 51 — Significant changes have been made to the requirements when applying for the restoration of a forfeited tenement.

The former tenement holder is now required to:

- lodge the application within 30 days of the forfeiture of the tenement or such further period as the Warden considers reasonable; and
- within 14 days of lodging such an application serve a copy of the application on any person who has since made application for a tenement over any part of the land.

The application and any objections thereto will then be heard in Open Court by the Warden.

This amendment recognises the right of a third party to be heard where application has been made for a tenement over what was at the date of forfeiture land open for mining.

3. Amalgamation within an Exploration Licence —

Section 105 has been amended to provide that where title to a secondary tenement that is wholly within an exploration licence ceases to exist and has not already been applied for or marked out by any other person, the holder of that exploration licence may make application to the Minister for amalgamation of the late tenement with the exploration licence. Such application is to be lodged with the Mining Registrar with a map of the area.

4. Ballot for Priority of Exploration Licences —

A further amendment also dealing with exploration licences is that where two competing applications are received at the same time the parties have 60 days to reach agreement as to a division of the ground. In the absence of any agreement the Warden will conduct a ballot in Open Court to determine which application has priority.

5. Discharge of Security —

Application may now be made to the Department for a security given under Section 126 to be discharged. Evidence satisfactory to the Minister is required in the form of:

- a statutory declaration stating the extent to which the conditions of the tenement and the provisions of the Act have been complied with and detailing the nature of that compliance. e.g. details of what activities had been carried out with the approval of the District Mining Engineer; and
- a map showing details of where work was carried out and access routes thereto.

6. New Report on Operations —

A new Form 5, Report on Operations was introduced on the basis of a recommendation from the Hunt Inquiry and after consideration by the Mining Industry Liaison Committee. Precise details of the nature and quantity of work carried out are required to be shown on the front page of the report. Additionally a copy of that page is now obtainable by any person upon payment of a search fee. Both the Department and third parties will be better able to assess compliance or otherwise with the expenditure requirements of the Act.

(b) Acts Amendment (Legal Practitioners Costs and Taxation) Act 1987 (No 65 of 1987), effective from 12 February 1988.

Minor amendment to section 162(2)(r) to provide that section 58W of the Legal Practitioners Act 1893 applies.

(c) Acts Amendment (Public Service) Act 1987 (No 113 of 1987), effective from 16 March 1988.

Minor amendment to section 7 by deleting "permanent head" and substituting "chief executive officer".

MINING ACT 1978 REGULATIONS

(a) Mining Amendment Regulation (No. 3) 1987, gazetted 7 August 1987.

This provides for the inclusion of Regulation 86E which provided for the nickel metal refined by Western Mining Corporation at Kwinana to be exempted from royalty payments.

(b) Mining Amendment Regulations (No. 2) 1987, in force on 16 October 1987.

These amendments were mainly to amend various regulations and forms arising from amendment to the Mining Act 1978 as contained in Mining Amendment Act 100/1985.

(c) **Mining Amendment Regulations (No. 5) 1987, gazetted on 21 August 1987.**

This amendment provided for the concessional royalty rates for mineral sands to be repealed and the Mining Act rates to be restored.

(d) **Mining Amendment Regulations (No. 6) 1987, gazetted on 6 November 1987.**

This amendment saw the royalty reduced for attapulgite produced from Lake Nerramyne.

(e) **Mining Amendment Regulations 1988, gazetted on 14 February 1988.**

This amendment saw Regulation 42B added to the Regulations. This Regulation saw "hydraulic reclamation and transport of tailings" added as a purpose for which a miscellaneous licence can be applied for.

(f) **Mining Amendment Regulations (No. 2) 1988, gazetted on 8 April 1988.**

This amendment saw the nickel metal royalty exemption repealed following a dramatic improvement in nickel prices.

(g) **Mining Amendment Regulations (No. 3) 1988, gazetted on 20 May 1988.**

This amendment saw revised royalty collection and verification procedures introduced, with provision for a royalty return and method of determining mineral values in exceptional circumstances.

MINING ACT 1978 SECOND SCHEDULE AMENDMENT

Mining (Transitional Provisions) (Anomalies Prevention) (No. 2) Order 1987, gazetted on 20 November 1987.

This amendment saw the Transitional Provisions of the amendment in relation to licenses to treat tailings.

PETROLEUM ACT

WA Petroleum Amendment Act 1987 (No. 90 of 1987), assented to 9th December 1987.

The Petroleum Act was amended to allow for the conversion of that part of Petroleum Lease 2H within waters internal to the State, to a Production Licence.

WA Petroleum Regulations 1987, gazetted 23rd October 1987

Regulations were created to allow three months for petroleum explorers and private property owners to agree to the level of compensation, prior to determination by the Local Court.

Commonwealth Petroleum (Submerged Lands) Legislation Amendment Act, 1987 (No. 106 of 1987), assented to 13th November 1987

This Act amends the Petroleum (Submerged Lands) Act 1967, the Petroleum (Submerged Lands) (Registration Fees) Act 1967 and the Petroleum (Submerged Lands) (Cash Bidding) Amendment Act 1985 so as to:

- abolish the special arrangement with Western Australia whereby disagreements in the Joint Authority are resolved on a Premier/Prime Minister basis;
- allow matters which were previously dealt with by the Joint Authority at the discretion of the Commonwealth Minister, to become automatically matters for Joint Authority decision;
- abolish 'over-the-counter' award of petroleum exploration and production titles;
- allow a location to be declared over all of the blocks which cover a petroleum pool or pools found in a permit area, and remove the restriction on the maximum size of the location (presently a maximum of 9 blocks);
- protect confidential information contained in instruments evidencing dealings registered under Section 81 of the Petroleum (Submerged Lands) Act 1967;
- allow for the 1985 amendments to Section 118 of the Petroleum (Submerged Lands) Act, which provide for improved public access to data and information, to apply to data and information supplied under the Act prior to the proclamation of the 1985 amendments;
- provide for the Commonwealth Minister to direct the Designated Authority to obtain documents related to petroleum operations being carried on in the adjacent area;
- recognise fees paid on dealings registered before July 1985 in the context of determining fees payable on transactions lodged for registration after July 1985; and
- remove the sunset clause on the cash bidding legislation to allow that legislation to remain in force after 21 November 1987.

APPENDIX 3 RESEARCH AND DEVELOPMENT PROJECTS

Chemistry Centre (WA)

Completed

- Chemical characterisation of soil reference sites in WA; joint Bicentennial project with CSIRO
- Dechlorination of overchlorinated swimming pool water
- Dissolution techniques in inorganic chemistry
- Determination of platinum group elements and gold
- Development of an immunoassay for lupin alkaloids (Stage 1); joint project with Curtin University, funded by the Grain Research Committee
- Determination of oligosaccharides in lupin breeding material
- Evaluation of fly ash content in structural concrete
- Eutrophication of Southern Estuaries, 1988 survey of phosphate status of catchment area soils
- Flushing of PVC pipes to produce acceptable lead levels in drinking water
- Kinetics of epoxy resin curing rates
- LIMS; a laboratory information system based on personal computers
- Preharvest testing for alkaloids in lupinseed
- Protozoa infestation and blockage of sprinklers at Burswood Island Golf Course
- Rust converter testing
- Report on Mt Clement Gold Prospect (Ashburton District); in conjunction with Geological Survey WA
- Stability of ethanol in blood taken in connection with sobriety driving offence
- The effect of acetone on the Drager Alcotest 71102E breath analysis equipment
- Taste/odour problems in Mundaring-Kalgoorlie water supply
- Taxonomic study of lemongrass
- Urea formaldehyde foam insulation study

Commenced and Continuing

- Alkaloid trends in commercial lupins; funded by the Grain Research Committee
- Analysis of alkanes as an index of pasture consumption
- Automated extraction procedure for lupin alkaloids
- Analysis of polymers and other substances by pyrolysis derivatisation GC
- Analysis of paint pigments by FTIR
- Corrosion of dental instruments
- Chemistry of acid soils
- Comparison of heroin seizures using fluorescent impurities
- Determination of gold in ores, residues, plant liquors and other metallurgical products
- Determination of sulphur dioxide and hydrogen sulphide in caves in the Kakadu National Park
- Development and calibration of a phosphate test for WA soils
- Development of an immunoassay for lupin alkaloids (Stage II)
- Development of a test for gypsum responsive soils
- Development of a quality assurance programme for plant and fertiliser materials in collaboration with international agencies
- Development of monitoring procedures for -carotene produced from salt lake alga
- Development of methods for determining the dietary fibre content of WA grain products
- Detection of dioxin in human fat at post mortem
- Drug disposition in race horses
- Evaluation of fluorescence as a means of characterising oils
- Glass composition by ERMA using the Cameca SX 50 electron probe at CSIRO
- Investigation of pasture contamination from gaseous fluoride emissions
- Ion chromatographic methods
- Lead analysis in water by electrothermal atomic absorption spectrometry
- Molybdenum absorption in acid soils
- Pesticide residues in south west farmland soils
- Survey of Yanchep cave area
- Survey of sand deposits between Wanneroo and Naval Base
- Study of selenium levels in blood from psoriasis patients

Explosives and Dangerous Goods

Completed

- Production plant for the manufacture of explosives at the Baldivis Explosives Reserves by DuPont Australia Ltd
- Production plant for the manufacture of explosives at Kalgoorlie Explosives Reserve by CBS Ltd
- Production plant for the manufacture of explosives at Kalgoorlie Explosives Reserve by Nitro Nobel
- Risk assessment for the handling on ammonium nitrate at Port of Bunbury.

Commenced and Continuing

- A proposed Ammonia Urea Plant
- A proposed Intergrated Chemical Plant for Petrochemicals Industries Co Ltd
- CSBP Sodium Cyanide Plant at Kwinana
- CSBP's Chlorine Plant at Kwinana
- Nu-farm's Chemical Plant at Kemerton
- Rhone Poulenc's Rare Earth Extraction Facility
- SCRA's Proposed Chemical Plant at Kemerton
- The North West Shelf Liquefaction Plant
- The Proposed Integrated Hazardous Wastes Plant to be operated by the Health Department

Geological Survey

Most of the work of the Geological Survey is involved in research and development projects to investigate, interpret and record the geology of Western Australia; relate the mineral, petroleum and groundwater occurrences and potential to that geology; and evaluate the mineral, fossil fuels and groundwater resources of the State. For a full listing of current and proposed projects see "Record 1988/1 Summary of Progress of the Geological Survey of Western Australia during 1987 and program for 1988-1992" available from the Geological Survey, 1st floor counter in Mineral House.

Mining Engineering

Completed

- "Mixtures" TLV for Underground Nickel Mines.
- Mica-Muscovite: To determine an overall standard in the iron ore industry.
- Recommendations and guidelines for using half facepiece respirators for atmospheres not exceeding 20 ppm of hydrogen cyanide.

Commenced and Continuing

- AXTAT: Accident Recording System (computerised).
- CONTAM: Contaminant Sampling in the Mining Workplace (computerised).
- Review of CONTAM incorporating revised SAA guidelines on sampling practices
- Review of Underground Fire Precautions and Procedures.
- Statistical analysis of AXTAT and CONTAM data.
- Survey of Tailings Dams characteristics.

Royalties & Statistics

A newly developed research group within the Royalties Branch commenced work examining a number of issues relevant to the collection of mineral and petroleum royalties. Particular attention was given to the revenue sharing arrangements between the State and Commonwealth Governments for royalties recovered from offshore petroleum projects. A review of the policy on the treatment of expenditure for gas recycling processes was also completed.

Iron ore royalties were also subjected to review as were the arrangements for coal, base minerals, silica sand, attapulgite.

APPENDIX 4 PUBLICATIONS

The Department produces a wide range of printed material matter, to meet the diverse needs of Divisions. These are listed as promotional, informative, or technical. The material must serve all levels of the community; from basic information for the general public, for secondary students, through all levels of industry, government and specifically interested publics. The information supplied must be aimed at the appropriate audience.

The promotional publications contain more generally worded material aimed at encouraging awareness of the industries we monitor, and to publicise and promote the philisophies behind the Department of Mines. It is only from awareness that knowledge can be acquired. The second is informative — material that can be general information as well as mildly technical such as mineral resources bulletins, which not only promote a subject but also informs a reader about the subject matter in slightly more detail and technical terms. The technical material produced is based on applied science and is of a particular and technical nature which is specifically aimed at the audience which would require and understand such information.

CHEMISTRY CENTRE (WA)

- **Informative**

Agricultural Chemistry

Four papers on soil chemistry concerning phosphate fertilizers, molybdenum absorption and gypsum.

One report on an ELISA test for lupin alkaloids to the Grain Research Committee.

One seminar report on the application of ICP AES in agricultural chemistry.

One consultancy report on study of regional laboratory facilities in West Timor.

Six papers on lupin alkaloids relating to immunochemical and capillary gas chromatography methods of assay, preharvest testing, survey of State crop, European Community guidelines and acute toxicity to rats.

Environmental Chemistry

Report 'Nutrients In The Swan' issued with The Curtin University Environmental Studies Group.

Forensic Science

Conference paper on microanalysis of glass samples.

Staff member (R.C. Hansson) edited an edition of ANALOG (Australian Forensic Drug Analysis Bulletin) and contributed an article on the drug 'Ecstasy'.

Health Chemistry

Five papers about contaminants in foods, hazards associated with the use of cyanide, determination of mercury in fish, safe laboratory practice and chemical storage and handling.

Mineral Processing Laboratory

One journal article and two conference papers on the thermal reactivation of carbon. Further conference papers on the roasting of gold ores and electrochemistry.

- **Promotional**

Health Chemistry

Assay Laboratories Seminar.
Cyanide Seminars 1987.
Ventilation Officers Course 1988.

EXPLOSIVES AND DANGEROUS GOODS

- **Informative**

Guide to Flammable Liquids Regulations
Notes for the Shotfirer
Understanding the Dangerous Goods (Road Transport) Regulations
Summary of Accident Reports, (yearly)
Some 80-90 Guideline Documents on various aspects of the Explosives, Flammable Liquids and Dangerous Goods (Road) Transport Regulations

GEOLOGICAL SURVEY

- **Informative — technical**

Bulletins, Reports, Records, Memoirs — are geoscientific publications describing the geology, mineral resources, and groundwater occurrences of particular parts of the State. Microfilm/fiche of released company reports on mineral and petroleum exploration are available for inspection or purchase.

- **Promotional**

Information pamphlets

- **Maps — technical**

1:250 000 Geological series: 163 for whole state coverage
1:2 500 000 Mineral occurrences map
1:2 500 000 State geological map
1:50 000 Urban geology/environmental series
1:2 500 000 Wells drilled for petroleum exploration map

MINING ENGINEERING

- **Informative**

Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores.

Guidelines for Evaluation of Atmospheric Contaminants in the Mining Industry.

Guidelines for Mining Project Approval in Western Australia.

Guidelines for the Preparation of a Development Proposal and "Works Approval" Application for New Tailings Dams or Extensions to Existing Dams.

Guidelines for Environmental Management of Mining in Arid Areas.

List of Operating Mines in W.A.

List of Gold Producers in W.A.

Lost time injuries in Western Australian Mines 1987.

Air Monitoring Strategies.

Development of an Effective Respiratory Protection Program.

Internal Radiation Dose Assessment.

Investigation into Radioactivity Limits for Thorium in Air — 1987.

Notification Requirements.

Pre-Operational Monitoring Requirements.

Particle Size Distribution of Radioactivity in Mineral Sands Separation Plants — 1987.

Reporting Requirements.

The Determination of Inhaled Gross Alpha Activity.

The Determination of Activity Median Aerodynamic by Inertial Separation.

- **Promotional**

Cyanide Seminars — 1987

Cyanide Seminars — 1988

Fire Assay Laboratory Safety Seminar — Kalgoorlie 1988.

Tyre Fires and Explosions, Causes and Prevention — Seminar Newman 1987.

Tyre Fires and Explosions, Causes and Prevention — Seminar Kalgoorlie 1988.

Ventilation Seminar — Paraburdoo 1988.

Ventilation Officers Course — 1987

MINING REGISTRATION

- **Informative**

Information Pamphlets

Basic Provisions
Guidelines on Reporting Requirements
Miner's Rights
Marking Out and Applying for Mining Tenement
Private Land Provisions
Transitional Provisions

Prospecting Licences — A Guide to Holders

Exploration Licence — Compulsary Partial Surrender

- **Promotional**

"TENDEX" — Computerised Mining Tenement Index System

PETROLEUM DIVISION

- **Informative**

Directions as to Drilling Operations.

Directions as to Geological and Geophysical Surveys.

List of Permittee/Licensee/Lessee Companies and titles.

'Petroleum in Western Australia' magazine.

Schedule of Specific Requirements as to Offshore Petroleum exploration and production — 1985.

ROYALTIES & STATISTICS

- **Informative**

Mineral Revenues Inquiry, Professor P Bradley.

Principal Gold Producers (produced twice a year for calendar and financial years).

Statistical Digest of Mineral Production (published twice a year to cover calendar and financial years).

SURVEYS AND MAPPING

- **Informative Maps**

Minerals Tenement Maps

Departmental Public Plans
Index to Public Plans
Mining Act — Section 57(4) Areas

Petroleum Tenement Maps

Brochure of Petroleum Tenements
Petroleum Tenement Map of the State
Petroleum Act Graticular Section Maps
Petroleum Tenement Maps

Thematic Maps

Areas which have been held under Gold Mining Lease
Administrative Divisions
Historical Map — Wiluna to Kimberley Stock Route
Index to Special Agreement Acts
Map Sheet Index
Mineral Production
Petroleum in Western Australia Tenement Map
Western Australian Localities Map

APPENDIX 5 PROMOTIONAL, PUBLIC RELATIONS AND MARKETING ACTIVITIES

- A presentation of the new State wide Accident Recording and Reporting System (AXTAT) was made to the National conference the Australian Minerals Industry Council hosted in Perth in October 1987.
- An exhibit commemorating the centennial of the Geological Survey was on display at the Alexander Library during March 1988 and subsequently in the Mineral House foyer.
- Other displays included presentations at Scarborough Library, Osborne Park Library, Karrinyup Library and State Energy Commission.
- The launch of the Laboratory Assistant Traineeship Scheme was held at the Chemistry Centre in May 1988. Fifteen trainees are employed under this scheme (seven based at the Centre), and they receive valuable work experience while studying one day a week towards a Certificate in Laboratory Practices at Technical College. The Traineeship scheme is run by the Department of Employment and Training.
- Chemistry Centre (WA) work in cyanide analyses for local gold mine has led to the formation of a project entitled 'The Fate Of Cyanide In The Environment Near Mine Tailings'. The project has been submitted to Australian Mineral Industries Research Association and, if approved, will be funded by CCWA, and mining companies.
- Members of the Corporate Executive presented an "Overview of the Mining Industry in W.A." to a series of seminars for teachers, on the theme "Mining in Society". The seminars were conducted by the Chamber of Mines.
- The magazine 'Petroleum in Western Australia' was published and distributed. This bi-annual magazine concentrates on government and industry developments with informal opinions, exploration and production statistics, and petroleum research in WA.
- The Department contributed a series of articles on technical and administrative matters to the first edition of 'Mine Life' magazine, published by the Chamber of Mines.

APPENDIX 6 THE DEPARTMENT OF MINES BOARDS AND COMMITTEES

STATUTORY

Board of Examiners for Mine Managers and Underground Supervisors
Boards of Examiners, Mine Managers and Deputies
Board of Examiners for Quarry Managers
Coal Mines Accident Relief Fund Committee
Coal Mines Accident Relief Fund Trust
Coal Miners Welfare Board
Coal Mine Workers' Pension Tribunal
Mine Workers Relief Fund Board
Selection Committee for Inspectors of Mines
Survey Board
Ventilation Board

INTERNAL MANAGEMENT COMMITTEES

Exemptions Committee
Geological Survey Computer Policy Committee
Mines Department Computer Co-Ordinating Committee
Mining Act Steering Committee
Mining Tenement Information Steering Committee
Mines Department Publications Co-ordinating Committee
WAPEX Steering Committee

BOARDS, COMMITTEES AND COUNCILS ON WHICH THE DEPARTMENT HAS REPRESENTATION

Executive

Advisory Council to the Faculty of Engineering of the University of WA
Australian International Geological Correlation Program Committee
Australian Ionising Radiation Advisory Council
Australian Minerals and Energy Council Advisory Committee
Board of Directors and Advisory Committee — WA Mining and Petroleum Research Institute
Iron Ore Officers Committee
Planning and Co-Ordinating Authority
Senate of Murdoch University
Government Management Policy Advisory Council (GMPAC)
Western Australian Water Resource Council (WAWRC)
Work Party on Conservation and Rehabilitation in the Mining Industry

Corporate Services Division

Board of Examiners (Mine Workers Relief Act)
Coal Mine Workers Pension Tribunal
Coal Mines Accident Relief Fund Trust
Coal Mines Accident Relief Fund Committee
Mine Workers Relief Board

Chemistry Centre of W.A.

Association of Official Racing Chemists
Chemical Testing Registration Advisory Committee (National Association of Testing Authorities)
Chemistry Centre Liaison Committee
Cleaning and Gardening Equipment Safety Sub-Committee
Cleaning and Polishing Products Advisory Committee (State Tender Board)
Community Consultative Committee on Chemicals
Contingency Planning Group
Detergents Advisory Sub-committee
Fire Brigade Professional Advisory Group
Government Paint Committee (Federal)
Government Paint Committee (WA)
Government Paint Committee Technical Working Group
Hazardous Substances Advisory Committee
Hospital Laundry and Linen Service Working Group
Lupinseed Technology Committee
NHMRC Food Analysis Sub-Committee
Oil and Grease Advisory Sub-Committee
Paints Advisory Sub-Committee
Publications Review Committee
Purity of Water Committee
Standards Association of Australia — Committee/Sub Committee
- MN/3/2 Chemical Analysis of Aluminium Ores
- MN/2/2 Chemical Analysis of Iron Ores
- MN/4/2 Chemical Analysis of Heavy Mineral Sands
- MN/1/1/7 Coal and Coke — Trace Elements
- MN/4Heavy Mineral Sands
- MN/-Mineral Standards Committee

State Committee for Combatting Marine Oil Pollution, Swan River Management Authority, Industrial Committee

Explosives and Dangerous Goods

ACTDG Competent Authorities Sub-Committee
ACTDG Drafting Sub-Committee
Association of Australian Port and Marine Authorities
ATAC Advisory Committee on the Transport of Dangerous Goods (ACTDG)
Conference of Chief Inspectors of Explosives
Inter-departmental Committee on Fire Prevention and Public Safety
Kwinana Industries Co-ordinating Committee
National Occupational Health and Safety Commission Chemicals Standing Committee
Professional Advisory Group on Hazardous Goods and Chemicals Information System
Road Transport Emergency Assistance Scheme Co-ordinating Committee

Standards Association of Australia Committees;
ME/15 — Storage and Handling of Liquefied Petroleum Gases
ME/17 — Storage and Handling of Flammable and Combustible Liquids
ME/59 — Road Tankers for Hazardous Liquids and Gases
State Co-ordinating Committee for the North West Shelf Gas Project
State Counter Disaster Advisory Committee
State Tender Board Polishing and Cleaning Products Advisory Sub-Committee
Transport Code Competent Authorities Working Group on the Safe Transport of Radioactive Substances

Geological Survey

Abrolhos Islands Consultative Committee
Advisory Committees on Geology and Geophysics at Curtin University
Agricultural Catchments Research Steering Committee
ALCOA Reserves Review Committee
Central East Regional Development Strategy Committee
Central South Regional development Strategy Committee
Cockburn Cement Dredging Management Committee
Cockburn Cement ERMP Working Group
Eastern Goldfields Esperance Regional Development Committee
EPA S.24 Working Group
Extractive Industries Committee
Extractive Industries Working Group
Geological Advisory Committee, Technical Education Division, Education Department
Geological Survey Liaison Committee
Goldfields Planning Council
Government Geologists Conference
Kimberley Land Use Appraisal Committee
Peel Regional Study Project Team
Peel Regional Technical Consultative Group
Proposed Coastal Planning and Development Committee and/or Marine and Estuarine Management Committee of the Coastal Management Advisory Council
Seismic Task Force of the State Advisory Committee for ATEND
Soil Conservation Advisory Group
State Liaison Committee for Remote Sensing
State Survey and Mapping Committee
Task Force on Outstanding EPA Red Book Recommendations
Tender Board Advisory Sub-Committee for the Procurement of Motor Vehicles
Venture Task Force Committee
WA Conservation Consultative Committee
WA Government Policy on Mining and Exploration in National Parks and Nature Reserves Implementation Group
WA Water Resource Council Groundwater Resources Management Committee
Water Authority — Geological Survey Liaison Committee
Worsley Alumina Conservation Working Group

Petroleum

AMEC Standing Committee on Offshore Petroleum Legislation
Australian Institute of Petroleum — WA Committee
Australian Standard Association ME/38
Australian Standing Committee on Onshore Petroleum Legislation
Engineering Heritage Committee
Industrial Tropical Cyclone Liaison Committee
North West Shelf Goodwyn Local Content Study Committee
North West Shelf Project Commonwealth/State Security Group
North West Shelf Project Energy Resource Committee
Petroleum Industry Liaison Committee
State Oil Spill Combat Committee
Work Party on Conservation Rehabilitation in the Mining Industry: Seismic Lines

Mining Engineering

Argyle Social Impact Group
Australian Drilling Industry Training Committee
Australian Institute for Non Destructive Testing
Board of Examiners for Mine Managers and Underground Supervisors
Board of Examiners for Quarry Managers
Board of Examiners, Mine Managers, Undermanagers and Deputies
Coal Industry Council Mines Rescue Committee
Coal Industry Council Occupational Health and Safety
Coal Miners Welfare Board
Coal Mines Accident Relief Fund Trust
Collie Federated School of Mines Advisory Council
Collie Coal Mines Rehabilitation Committee
Commonwealth/State Consultative Committee on Nuclear Codes and Guidelines
Commonwealth/State Consultative Committee on Radioactive Waste Management (Working Group)
Commonwealth/State Consultative Committee on Radiation Protection (Working Group)
Conference of Chief Inspectors of Mines
Golden Mile Mining Development Planning Committee
Goldfields Dust Abatement Committee (Kalgoorlie)
Goldfields Dust Abatement Committee Technical Sub Committee (Perth)
Interim Mines Radiation Committee
Mine Survey Board
Radiation Inspection Liaison Committee
Safety Reviewing Committee (SAA)
Selection Committee for Inspector of Mines
South West Inter-Departmental Regional Advisory Council Group
Standards Association of Australia ME/18 Committee
Standards Association of Australia WA Safety Reviewing Committee
Ventilation Board
WA Coal Industry Tribunal

Mining Registration

Australian Mining and Petroleum Law Association Advisory Service Committee
Mining Industry Liaison Committee

Surveys and Mapping

Conference of Chief Geological Draftsmen
Drafting Materials Supply Committee
Geographic Names Committee
Western Australian Land Information System Council
Western Australian Surveying and Mapping Advisory Council

APPENDIX 7 DEPARTMENTAL DIRECTORY

Mineral House

DEPARTMENT OF MINES MINERAL HOUSE COMPLEX
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WESTERN AUSTRALIA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3430

OFFICE OF DIRECTOR GENERAL OF MINES
8TH FLOOR
MINERAL HOUSE SOUTH
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WESTERN AUSTRALIA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3430

CORPORATE SERVICES DIVISION
8TH FLOOR MINERAL HOUSE SOUTH
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3430

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
5TH FLOOR MINERAL HOUSE SOUTH
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3633

MINING ENGINEERING DIVISION
6TH FLOOR MINERAL HOUSE NORTH
100 PLAIN STREET
EAST PERTH WA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 325 2280

MINING REGISTRATION DIVISION
1ST FLOOR MINERAL HOUSE SOUTH
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WA 6000
TELEPHONE (09) 222 3118
TELEX AA95791 MINEWA
FAX (09) 222 3333

SURVEYS AND MAPPING DIVISION
2ND FLOOR MINERAL HOUSE NORTH
100 PLAIN STREET (CNR ADELAIDE TERRACE)
PERTH WA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3342

Other Perth Offices

CHEMISTRY CENTRE (WA)
125 HAY STREET
PERTH WA 6000
TELEPHONE (09) 325 5544
TELEX AA95791 MINEWA
FAX (09) 325 8197

CHEMISTRY CENTRE (WA)
ENGINEERING CHEMISTRY
LABORATORY
19 CATHERINE STREET
BENTLEY WA 6102
TELEPHONE (09) 458 9088
TELEX AA95791 MINEWA
FAX (09) 325 7767

EXPLOSIVES AND DANGEROUS GOODS
DIVISION ALBERT HOUSE
10 VICTORIA AVENUE
PERTH WA 6000
TELEPHONE (09) 222 3390
TELEX AA95791 MINEWA
FAX (09) 325 4896

MINING ENGINEERING DIVISION
DRILLING BRANCH
HARRIS STREET
CARLISLE WA 6101
TELEPHONE (09) 362 3211
FAX (09) 362 5694

PETROLEUM DIVISION
LEVEL 3 MERLIN CENTRE
87 PLAIN STREET
PERTH WA 6000
TELEPHONE (09) 222 3333
TELEX AA95791 MINEWA
FAX (09) 222 3515

Kalgoorlie

CHEMISTRY CENTRE (WA)
KALGOORLIE METALLURGICAL
LABORATORY
95 EGAN STREET
BOX 881
KALGOORLIE WA 6430
TELEPHONE (090) 220 120
FAX (090) 912 767

GEOLOGICAL SURVEY
OF WESTERN AUSTRALIA
KALGOORLIE REGIONAL OFFICE
WA SCHOOL OF MINES
KALGOORLIE WA 6430
TELEPHONE (090) 213 066

EXPLOSIVES AND DANGEROUS GOODS
DIVISION
KALGOORLIE EXPLOSIVES RESERVE
PICCADILLY STREET WEST
KALGOORLIE WA 6430
TELEPHONE (090) 218 246
FAX (090) 213 612

MINING REGISTRATION DIVISION
MINING REGISTRATION KALGOORLIE
BROOKMAN STREET
BOX 34
KALGOORLIE WA 6430
TELEPHONE (099) 213 066
FAX (090) 912 428

REGIONAL MINING ENGINEER
DEPARTMENT OF MINES
BROOKMAN STREET
BOX 671
KALGOORLIE WA 6430

Other Country Offices

EXPLOSIVES AND DANGEROUS GOODS DIVISION
BALDIVIS EXPLOSIVES RESERVE
STAKEHILL ROAD
BALDIVIS VIA MANDURAH WA 6171
TELEPHONE (095) 241 301

MINING REGISTRAR
COURT HOUSE
BOX 28
BROOME WA 6725
TELEPHONE (091) 921 137
FAX (091) 921 878

MINING REGISTRAR
COURT HOUSE
BOX 35
CARNARVON WA 6701
TELEPHONE (099) 411 082
FAX (099) 412 779

REGIONAL MINING ENGINEER
66 WITTENOOM STREET
COLLIE WA 6225
TELEPHONE (090) 341 222
FAX (090) 341 606

MINING REGISTRAR
40 BAYLEY STREET
BOX 41
COOLGARDIE WA 6429
TELEPHONE (090) 266 066
FAX (090) 266 204

REGIONAL MINING ENGINEER
HOLLAND PLACE
BOX 518
KARRATHA WA 6714
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FAX (091) 868 251

MINING REGISTRAR
COURT HOUSE
BOX 917
KUNUNURRA WA 6743
TELEPHONE (091) 681 011
FAX (091) 681 103

MINING REGISTRAR
ROCHESTER STREET
BOX 4
LEONORA WA 6438
TELEPHONE (090) 376 106
FAX (090) 376 248

MINING REGISTRAR
BOHEMIA ROAD
BOX 7
MARBLE BAR WA 6760
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DEPARTMENT
OF MINES
WESTERN
AUSTRALIA

ANNUAL REVIEW 1987-88

SUPPLEMENT
TO THE
ANNUAL REPORT

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100 YEARS OF GEOLOGICAL SURVEY

H P Woodward arrived in Perth in January 1888 to take up the position of Government Geologist. Woodward was not the first to hold this title but he was the first to hold it on a permanent basis. Previous holders of the title - on a temporary basis, had been Ferdinand von Somer, H Y L Brown, and E T Hardman.

Ferdinand von Somer was appointed from 1847 to 1851 to examine some coal and other mineral deposits that had recently been discovered in the south-western part of the colony. He travelled widely in the area between Northampton and Mount Barren. Two of his unpublished hand-drawn maps are still in the possession of the Geological Survey.

In 1870, following a series of reported gold discoveries including the well-authenticated occurrence at Peterwangy Hill, Mr H Y L Brown was appointed to the position. Between 1870 and 1873, when the position of Government Geologist again lapsed, Brown issued three geological maps and 10 reports dealing with part of the Murchison and the south coastal areas. He also picked the site for the first successful artesian bore in the colony. There is some evidence that the position would have been made permanent at that time but for the lack of funding.

It was not until 1882 that the next Government Geologist was appointed. Stimulated by the reported discovery of gold in the Kimberley, the Legislative Council engaged E T Hardman to accompany a survey party in the area. After the completion of the Kimberley survey Hardman worked in the Bunbury hinterland. His work there contributed to the subsequent discovery of tin at Greenbushes. Mr Hardman returned to his position with the Geological Survey of Ireland in 1885.

Hardman's maps and reports on the Kimberleys clearly indicated many likely gold-bearing areas, and helped to set the scene for the Kimberley gold rush of 1885-86. At least some members of the Legislative Council were impressed by Hardman's contribution and, in 1885 the Council considered a motion to establish a permanent Geological Survey. This initiative failed through lack of finance. Had it succeeded Hardman almost certainly would have been offered the job.

Not until 1888 did the Council find sufficient money to establish a permanent Geological Survey. By that time Hardman had died and the post of Government Geologist was given to H P Woodward. During Woodward's period of service(1888 to 1895), almost all of the great goldfields in Western Australia were discovered and opened.

These included the Pilbara, Ashburton, Murchison, Yilgarn, Coolgardie, Kalgoorlie, and Dundas. Woodward visited and reported on all of these, some several times. He spent a great deal of time at Collie and was the first to point out the size and potential importance of the coal deposits. Somewhat less successfully, he tried to convince the government that it was folly to bore for artesian water in the goldfields.

Considering the means of travel, Woodward's labours can only be described as Herculean. In 1893 he was given an assistant, Mr S Goczel who also made many reports on the geology of the goldfields. Woodward resigned in 1895, and Goczel in 1896; both were lured away by the promise of higher salary in private enterprise. Before his departure Woodward published the 'Mining Handbook' and 'Geological Map of Western Australia'.

The position was given to Andrew Gibb Maitland towards the end of 1896. Maitland was an organizer and by the end of 1897 the Geological Survey had a staff of nine.

Maitland saw the Geological Survey's responsibilities as lying in two main areas: the examination and reporting on specific mining centres, and the production of regional maps covering the whole state.

Aside from his organizational achievements, Maitland's greatest achievement centred on the second of these responsibilities, the production of regional maps. By the end of his service in 1926, published geological maps at a scale of four miles to one inch had been produced for nearly half the state.

After World War I the mining industry settled into a steady state which continued through the depression years, World War II, and into the 1960s. Torrington Blatchford succeeded Maitland as Government Geologist and served from 1926 to 1934. Because of economic conditions during the depression, the professional staff of the Geological Survey dwindled to three. Blatchford was followed by Frank G Forman, who occupied the position from 1934 to 1944.

In 1945, H A (Matt) Ellis succeeded Forman as Government Geologist and set about rebuilding the Geological Survey to its previous strength and productivity. When Ellis retired in 1961 he had achieved his aim; the Survey had 10 professional staff and approval had been given for more; it had published 15 Bulletins, 7 Mineral Resources Bulletins, and two revisions of the State geological map.

J H (Joe) Lord was the next to hold the position of Government Geologist, and the last. During his term the title was changed to Director of the Geological Survey. After his appointment in 1961, Lord reorganised the Survey along sectional lines to complement the need for greater specialisation in geological work. A major achievement was the revival of the regional mapping program and by the time he retired, the entire State had been mapped and most of the resulting maps had been published.

During the 1980s, under the Directorships of A F Trendall (1980-1986) and Phillip E Playford (1986-present) there has been a renewed emphasis on the needs of Industry and Government, a clearer definition of the role of Geological Survey, including development of the Survey's first 5 Year Plan.

GEOLOGICAL SURVEY DIVISION — ANNUAL REVIEW

Dr P E Playford, BSc(Hons), PhD
Director

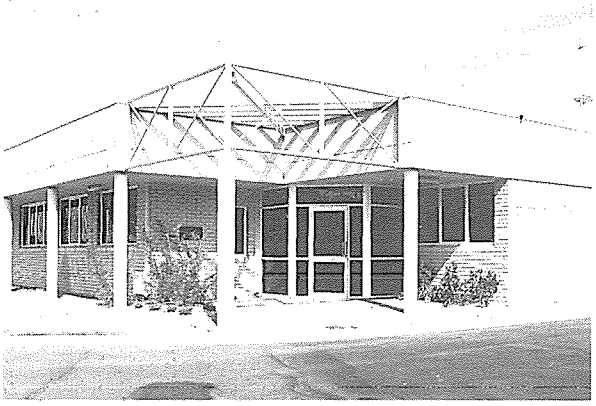
The year 1987 and the first quarter of 1988 were largely devoted to 'clearing the backlog' of Geological Survey projects which needed to be written for publication. A decision was made that staff would not go into the field to commence a new project until their previous work had been completed. In most cases this took longer than anticipated, and as a result there was not the increase in field work during the year that had been expected.

The policy did result in the completion of many outstanding projects, and the total number of projects on the program of the Survey was reduced by some 20%.

Western Australia is currently experiencing the third gold boom in its history - indeed the biggest mineral boom as far as employment opportunities for geologists are concerned. It is gratifying that under these circumstances the Geological Survey has not experienced major staff losses and has successfully recruited high-quality staff to replace those who have left.

Substantial progress was made during the year in the introduction of personal computers and their use by personnel. There is no doubt that apart from their importance in scientific applications and to database management, the use of computers by geoscientists in word processing is of major importance in speeding up the output of reports and improving their composition.

A start was also made in implementing the WAPEX petroleum database and planning for the State Water Resources Information System (SWRIS) groundwater database.



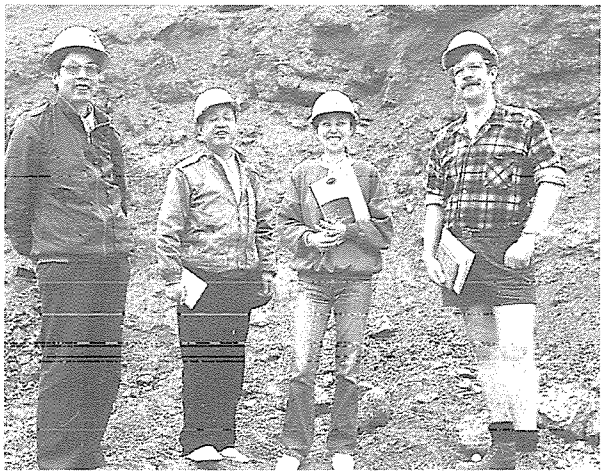
Geological Survey's new Laboratory at Carlisle, opened in August 1987, improving services to the Geological Survey.

As a result of the expansion of the mineral and petroleum industries Geological Survey is increasingly involved in administrative matters and in advising on geoscientific aspects. This inevitably affects the basic role of the Survey, to record and interpret the geology of the State.

A new Deputy Director (L. Ranford) was appointed; coming from a senior position in the Bureau of Mineral Resources, after extensive experience in that organization and the mining industry. The Assistant Director (T. Bestow), retired during the year, having given outstanding service to the Geological Survey as Supervising Geologist (Hydrogeology) and Assistant Director (Basins, Fuels, and Groundwater Branch) over a period of nearly 23 years.

The Director visited China during April 1988 under the Australian Academy of Science and Academia Sinica Exchange Program. The purpose of the three-week visit was to compare the Devonian reefs of southern China with those of the Canning Basin in Western Australia. He also spent one week in Zhejiang Province, under the sister-State exchange agreement between Western Australia and that province.

Several sections of the Geological Survey are now housed in Mineral House Stage II, and when the refurbishment of Stage I is completed during the second half of 1988 the various sections of the Survey will be housed together for the first time for almost 13 years.



Geologist Arthur Hickman (far right), with two senior technical officials and interpreter from the Peoples' Republic of China, at the Mount Gibson Gold Deposit.

Research Priorities

1988 is the second year in which the Geological Survey has had a 'rolling' 5-year plan; only the program for the first year is to be regarded as committed, and those for the succeeding years will be subject to revision. As a result of staff changes and reassessment of priorities, the 5-year program has been revised, a number of projects have been cancelled, and some new ones added.

Some key features of the work program are outlined.

Geological Mapping: The emphasis on geological mapping as the primary geoscientific role of the Geological Survey is reflected in the current program: two 1:1 000 000, six 1:250 000 and twenty-one 1:100 000 map sheets will be mapped as part of the regional mapping program, concentrating especially on the Eastern Goldfields. Four 1:100 000 and three 1:50 000 environmental geology maps, and eight 1:250 000 and six 1:100 000 hydrogeological maps are scheduled to be undertaken during the 5 years. Gravity mapping of one 1:100 000 sheet will be carried out.

Goldfields palaeodrainage groundwater study: This work has been expanded to include a regional assessment of the groundwater in the Kalgoorlie region.

Tectonic framework, Phanerozoic basins: A new project designed to increase our understanding of the structural and thermal history of the Phanerozoic sedimentary basins will commence in 1988. The initial output will be a series of regional structural contour maps of selected horizons.

Coal resources

A study of the geology of the coal deposits in the Perth Basin will start this year. This will involve a preliminary assessment of the coal resources. A new project on coal resources modelling, to assess the State's coal resources according to the Australian code for reporting coal resources and reserves, will commence after completion of the geological reviews of coal in the Collie and Perth Basins.

OPERATIONS

Some of the more important projects undertaken are described in the following sections.

Basement, Minerals, and Geotechnics Branch: Precambrian Geology Section.

Second-edition coloured 1:250 000 geological maps of Newman and Robertson, and the accompanying explanatory notes were completed, and will be published together with the explanatory notes on Balfour Downs, Boorabbin, Widgiemooltha and Wyloo (maps printed in 1986-88).

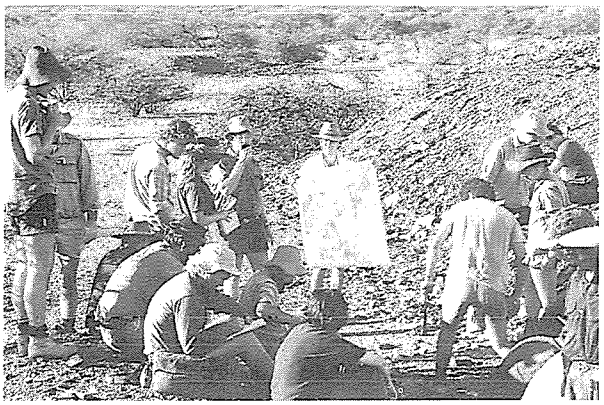
Mapping at 1:100 000 scale, in complex areas of economic importance continued. The Kalgoorlie, Yilmia, Cowan, and Lake Lefroy map sheets were printed and the accompanying reports were completed and await publication. These maps, incorporating new field observations, geophysical data, and available subsurface information from exploration activities, will be invaluable for mineral exploration in those areas. Mapping of Newman, Bardoc and Dunnsville was completed and is underway on Braeside, Davyhurst, Kanowna and Menzies.

The analysis of remote sensing data of the Kalgoorlie map sheet was undertaken at the Open University in the UK.

As a follow-up to the completed 1:250 000 first edition geological mapping, systematic investigation of individual tectonic and stratigraphic units are being carried out. Studies of the Ashburton Basin, Murchison Province and Sylvania Inlier - Ophthalmia fold belt were completed and await publication as Bulletins. The 1:500 000 scale maps relating to the Murchison study were printed and released. Similar studies are in progress on the Fortescue Group (Pilbara Region), the King Leopold Orogen (Kimberley Region), the eastern Bangemall and Savory Basins, and the north west part of the Yilgarn Craton.

Work in the north west part of the Yilgarn Craton has greatly extended the previously known limits of this important craton and revealed one of the largest known regions of the oldest rocks found on the planet, including the oldest known rocks in Australia.

A new State geological map at a scale of 1:2.5 million and a first edition 1:1 million scale map of the Albany sheet were completed and await publication.



Dr A Hickman, (holding the microphone) and Dr K Watson (holding the map) at one of 28 stops during the Murchison Excursion, one of two Centennial Geological Excursions during the year.

Mineral Resources Section

The Mineral Resources section was engaged to a substantial extent during the year on the preparation of material on mineral commodities for Memoir 3. As part of this project a new edition of the Mineral Deposits Map of Western Australia has been drafted. An indication of the mineral activity in the State since the last edition in 1980/81 is that more than 500 additions/changes to the last map have been necessary.

The boom in the mineral exploration industry has resulted in the section losing several of its professional staff during the year. All positions have now been filled, and the Senior Geologist (Mineral Economics) has returned after nearly two years secondment to the Royalties and Statistics branch of the Department.

The Economic Geology Sub-section completed a major study of mineralization (mainly gold) in the Murchison Province, and a summary of the results was presented during a field excursion and seminar in April, and at 'Gold '88', an international geological conference on gold held in Melbourne during May. Also presented at 'Gold '88' were the results of an investigation into the role of layered mafic/ultramafic intrusions as hosts to gold mineralization in the Eastern Goldfields. This study represents part of a broader investigation into metallogenetic controls of gold mineralization in the Menzies-Kambalda area.

The Bardoc 1:100 000 map sheet and accompanying report were completed, as was mapping of the Siberia section of the Davyhurst 1:100 000 sheet. A report and two accompanying 1:100 000 sheets on the geology and gold mineralization of the Bullfinch-Parker Range area will go to press shortly. Staff of the sub-section also commenced work on the Norseman and Menzies 1:100 000 sheets.

A study of Archaean volcanism in the Menzies-Norseman area was commenced. This will involve examining geochemical and volcanological variations with a view to obtaining petrogenetic information relevant to regional stratigraphy, crustal evolution, and economic geology.

A limited amount of work was done on the gypsum resources of Western Australia; secondment of a staff member to assist in the assessment of mineral potential of areas of particular conservation merit has curtailed progress on industrial minerals resource projects. Other

commitments related to microfilming of company reports and supply of technical information on industrial minerals to Government and members of the public, occupied most of the year.

The Mineral Economics sub-section was unmanned for part of the year, until the return of the Senior Geologist to the Survey in October. In addition to the preparation of the Mineral Deposits Map, the sub-section has been involved in updating and maintaining the reserves and resources inventories of all major commodities on the computer-based MININFORM system. Particular emphasis has been placed on maintaining an up-to-date situation on the rapidly changing gold scene, and some reappraisal has been undertaken of manganese ores, iron ores and heavy-mineral sands. With MININFORM and the commercial MINMET INFOPAC package (company and project-profiled database), work is being focussed to develop a timely information response system.

Considerable time and effort has been expended by the Mineral Economics and Evaluation sub-sections in support of the Mining Registration Division in the technical appraisal of exploration licence extension applications, expenditure exemption approvals, applications for special prospecting licences, and alienation of ground under the Lands Act and other legislation.

The Evaluation and Exploration Data sub-section received 2 929 new exploration reports in 1987-88, compared with 2 888 in the previous year bringing the total number of volumes to 23 186 relating to 6 123 projects. Of these 2 684 projects and 11 173 related volumes concern (wholly or in part) exploration for gold. During the year 1 125 volumes on 555 projects were filmed and released on microfiche. There were 147 industry requests for information from reports not yet microfilmed.

Engineering and Environmental Geology Section

The Engineering Geology sub-section has provided geological advice mainly for the Water Authority of WA and the Main Roads Department. Major projects included investigations of dam sites on the Harris, Quickup, Conjurunup and North Dandalup Rivers, quarry sites in the Kimberley and Pilbara, tank sites at Geraldton and Dongara, sewage treatment works at Jurien and road cuttings on the Toodyay Road and Albany Highway.

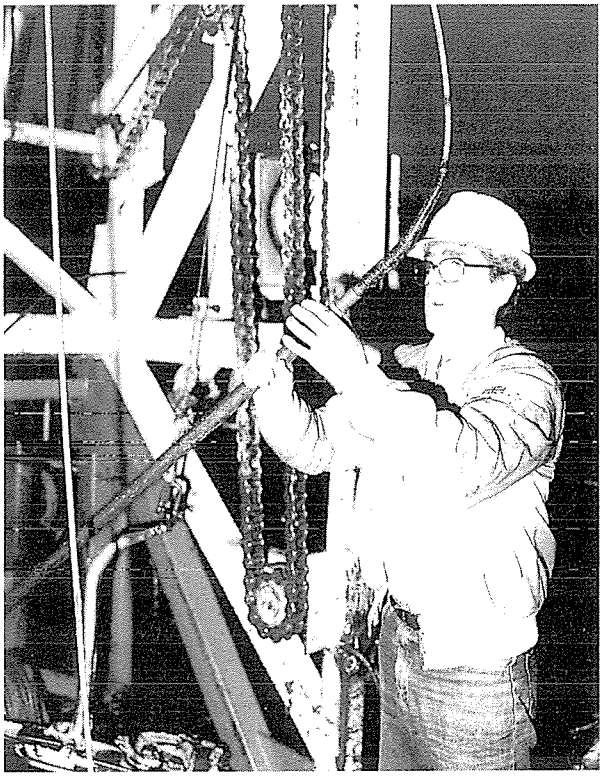
The Environmental Geology sub-section continued with its program of 1:50 000 environmental geology mapping. During the period the Busselton and Capel sheets were published; and fieldwork and map compilation were completed on Rottnest Island and Gleneagle. Work has been postponed on Jumperkine and Karragullen to allow an opportunity to handle the large volume of work entailed in the Interdepartmental Task Force on outstanding EPA Red Book recommendations. Work on the bauxite bulletin has continued but its completion has been delayed.

A major geomorphological mapping program has commenced in the Eastern Goldfields region of the State. The aim is to map in detail the regolith and other surficial deposits of the Yindarlgooda drainage system with a view to interpreting the Cainozoic geomorphological and geological development of the area. An integral part of the program will be the use of image processing of remotely sensed data. Work has commenced on the Dunnsville and Kalgoorlie 1:100 000 map sheets.

Further work on the bulletin describing the geology of Perth and its region continued.

A desk-top study was done on the Fitzgerald River National Park and a report on the geology and mineral resources of the park was prepared.

The sub-section also prepared detailed submissions on numerous reports and provided technical input for a variety of government environmental and land-use planning and management groups. This work continues to increase in response to State Government legislative and administrative initiatives.



Geophysical Technican, Dave Reid, with a drill rig at Nangarra, setting up for a gamma ray log in the late evening. These groundwater operations run 24 hours a day.

Petrology Section

During 1987-88 the activities of the Petrology section were affected by the absence of staff on long-service leave. Routine petrological examinations during the year resulted in the completion of 21 reports covering 621 samples.

One paper has been completed on the 'Alkaline Rocks of the Eastern Goldfields', for inclusion in Professional Papers, and a chapter on diatreme rocks - principally lamproites and kimberlites - has been written for Memoir 3. Mapping of the Kanowna and Gindalbi 1:100 000 sheets in the Eastern Goldfields is continuing, and a special petrological study of layered basic sills, particularly the Bulong Complex, has started.

Work in isotope geochronology has mainly been directed to writing up the results of completed projects.

Geochemistry Section

During the year papers (variously co-authored) on the Corunna Downs Batholith, the transition between the Hamersley and the Fortescue Groups, and a further paper on the geochemistry of the Pilbara Block have been published, and a paper on the Mount Clement mineralization (Ashburton Basin) has been submitted for publication.

A paper on the nature and origin of the gold-bearing laterite at Mount Gibson was presented at the Second International Conference on 'Prospecting in Arid Terrains' in Perth in April 1988. A final report on this project is being written.

Geochemical sampling has been undertaken in support of the geological program in the Fitzgerald River National Park and environs, and an assessment of company geochemical data obtained from the greenstone belt located between Broad Arrow and Lake Ballard is underway. Geochemical work for the Murchison Bulletin has been completed.

BASINS, FUELS, AND GROUNDWATER BRANCH

Hydrogeology Section

For the 12 month period to the end of June 1988, 129 bores with an aggregate depth of 14 204 m were drilled for groundwater resources assessment. Eight deep bores were drilled in the southern Perth Basin on the Cowaramup Line and this program is now completed.

The high level of gold mining activity in the Eastern Goldfields has raised questions about the location, quantity, and quality of groundwater resources in the area. The Goldfields Palaeodrainage groundwater project (Lake Ballard) was therefore commenced as a detailed study of the hydrodynamics and groundwater quality of part of a palaeodrainage system. A regional study has also been started to assess the groundwater resources of the Roe palaeodrainage within a 100 km radius of Kalgoorlie. Together these studies will increase our understanding of groundwater in the Eastern Goldfields.

The State 1:2.5 million hydrogeological map is due to be published late in 1988 and the first map of a 1:250 000 hydrogeological series covering different parts of Western Australia, will be published in 1989 with the appearance of the Perenjori Sheet. Compilation of the Broome Sheet is completed and compilation of the Derby Sheet is well advanced.

Investigations into the effects of bauxite mining and land salinization continue. Fourteen bores were drilled in the Cameron Central catchment in response to Alcoa's revised mining plan. Nine bores were drilled in the North Stirling area to provide hydrogeological data to assist selection of methods to reduce land salinization.

A large proportion of the work continued to be undertaken in association with the Water Authority. Throughout the year up to four hydrogeologists have been seconded to the Water Authority. The work has included water supply investigations at Perth, Condingup, Derby, Broome, Carnarvon and Sandstone; water supply wellfield development; groundwater scheme planning; reviews of groundwater scheme performance; groundwater resources assessment; and groundwater management.

John Watt, loading a hole for weathering spread seismic refraction survey, to investigate spillway site for North Dandalup dam site.

Recovering seismic cable.

Dave Reid and work experience assistant, conducting an electromagnetic survey to investigate groundwater pollution at the Nangarra Liquid Waste Disposal site.

In addition bore-site selection was carried out for the Main Roads Department and Public Health Department and reports were reviewed for the Department of Resources Development and Environmental Protection Authority. A considerable amount of work has been undertaken for the Department of Aboriginal Affairs and for Aboriginal Councils locating bore-sites and providing advice on groundwater resources for communities and outcamps. Drought in the wheatbelt has resulted in 55 inspections advising on groundwater prospects, and sites were selected in declared drought affected shires for the Drought Consultative Committee.

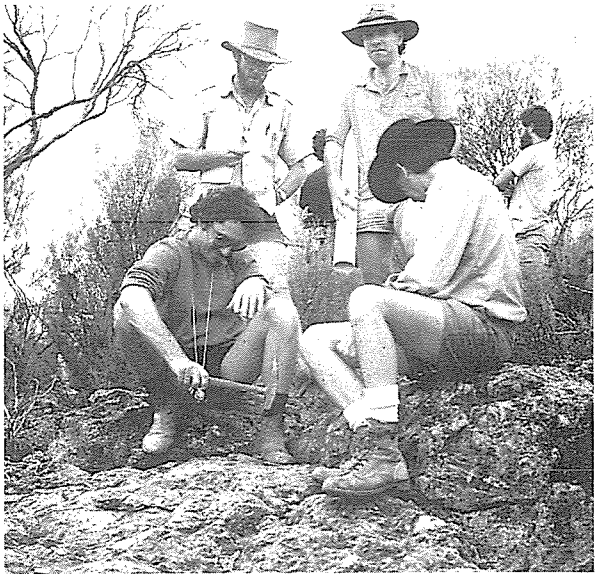
A significant undertaking during the year was the establishment of databases and interactive screens for the uptake of bore data records into the State Water Resources Information System (SWRIS). Trial uptake of data has commenced and depending on the availability of staff the data uptake should commence in 1988-89, and be completed within three years. This will allow ready access to the large volume of information held by the Geological Survey.

The isotope facility for determining carbon-14 and tritium in groundwater was transferred to the Chemistry Centre during the year.

Fossil Fuel Resources and Phanerozoic Geology Section

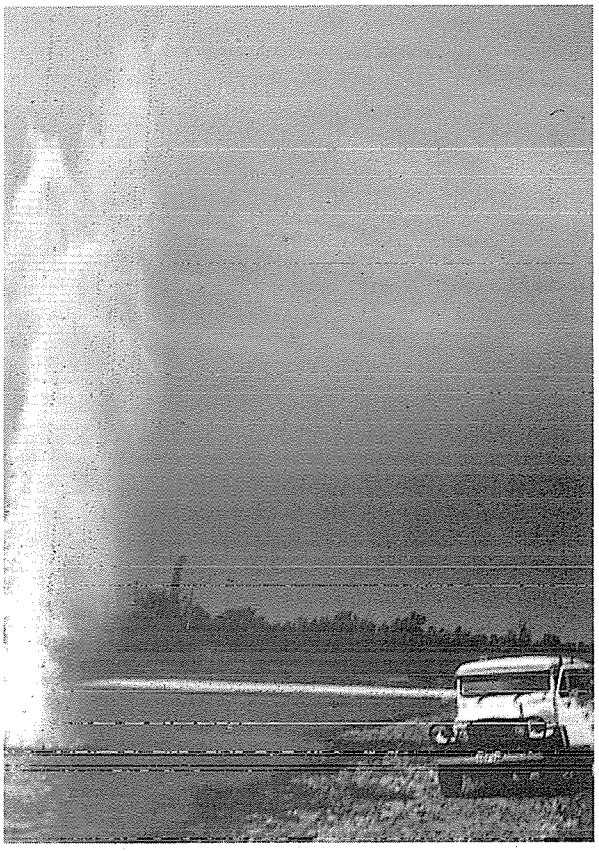
The Petroleum Resources sub-section continued to review and microform (microfilm and microfiche) data submitted by petroleum exploration companies and 3 060 microfiche were produced during the year. The contract with PI Energy Services for the sale of full-scale shot-point base maps, seismic sections and well logs continues, and has been found to be a most useful service for oil exploration companies.

The petroleum exploration database WAPEX has become a top priority project in the Department and during the year data capture and entry were initiated. The computer programs for the data base are still being developed and should be completed by the end of 1988. Approximately one quarter of the data had been captured by 30 June 1988 and data capture should be completed by mid 1989 when the system will become operational.



Some of the Geological Survey staff on the Centennial Murchison excursion: standing, Dr T Griffin and Dr K Watkins, seated Dr W Witt (with hammer) and Dr T Ahmat.

The geophysical synthesis of the southern Perth Basin has continued with the interpretation of seismic cross sections completed.



Seismic shot in a Fortescue waterhole during seismic refraction survey to investigate the structure of the lower Fortescue Valley.

The Basin Studies sub-section is continuing a major study of Cretaceous units in the southern North West Shelf to determining the geological setting of the known petroleum- productive beds. This is a co-operative project with the School of Geology and Geophysics at Curtin University of Technology and is a Minerals and Energy Research Institute of Western Australia (MERIWA) project.

A study of the tectonic framework of Phanerozoic basins in the State was started during the year. This project aims to develop a tectonic framework through the compilation of seismic horizon maps, temperature maps, and 3-D geohistory and thermal modelling.

In the Bonaparte Basin, offshore drilling data have been reviewed and the stratigraphy of the region revised. A geological history will be produced in the form of palaeogeographic maps. This project will assist in the regional evaluation of the petroleum potential of the area.

The Coal Resources sub-section monitors coal-related activities in the State and works in close association with the State Coal Mining Engineer. A geological study of the Collie Coalfield is proceeding. Data are being obtained from the companies on magnetic tape which will enable a more rapid manipulation of the large database which exists for the coalfield.

Geophysics Section

The regional gravity mapping of the southwest Yilgarn continued. The Bouguer anomaly map of the Bridgetown 1:100 000 map sheet was completed and published with explanatory notes. Gravity mapping of the Dinninup 1:100 000 map sheet commenced.

Seismic refraction surveys were conducted for the Water Authority at the North Dandalup dam site and for the Main Roads Department at proposed new road cuts near Arthur River.

In support of the 1:100 000 geological mapping of the Eastern Goldfields a composite aeromagnetic map of the Kanowna 1:100 000 sheet was completed using available open-file data.

A ground magnetic survey was carried out for the Water Authority at Northampton. The magnetic profiles located several dolerite dykes which have influence on groundwater movement. In collaboration with the Agriculture Department a ground electromagnetic survey consisting of 200 km detailed traverses at the Yornaning catchment was completed. The resultant contour map will be used in soil salinity and catchment management studies.

Geophysical logging of boreholes drilled for water continued; 69 boreholes were logged, and the aggregate depth of logs was 32 600 m.

Palaeontology Section

During the period 24 Palaeontological Reports were prepared, all but 4 on palynology. Three publications were released during the year, and three chapters were written for Memoir 3.

The palynological study of the Collie Basin was completed and work is now progressing on the Permian of the southern Perth Basin. A project on the Devonian miospores of the Lennard Shelf has been completed, and work will commence on stromatolites from the Middle Proterozoic Glengarry Group.

The updating of the Survey's fossil reference collection continues. During this period compilations on the Western Australian fossils of Ordovician, Devonian, Carboniferous and Triassic age were completed.

SUPPORT SERVICES BRANCH

Publications and Information Section

The Publications and Information section responded to numerous inquiries about geology, economic minerals, and related topics. Inquiries about gold declined somewhat, but there was an increase in the number of inquiries about platinum and diamonds. During the year 47 publications, including 28 maps, were released. At the end of the year 38 publications were being prepared for the printer.

The reserves and resources database, MININFORM, has been up-graded to FOCUS 3.0, and is now ready to be handed over to the Mineral Resources section, who will maintain it.

The booklet, 'An overview of mining in Western Australia', was updated and reprinted several times during the year.

Library

During 1987-1988, 4 013 members of the public visited the library of whom 1 171 used the microform reading and printing facilities. Staff loans totalled 1 120 and 382 Inter-Library Loans were arranged. The library sent 229 items on Inter-Library Loan to other libraries.

Heavy use of the WAMEX open-file exploration database has continued through the year including 42 computer searches being conducted for the public.

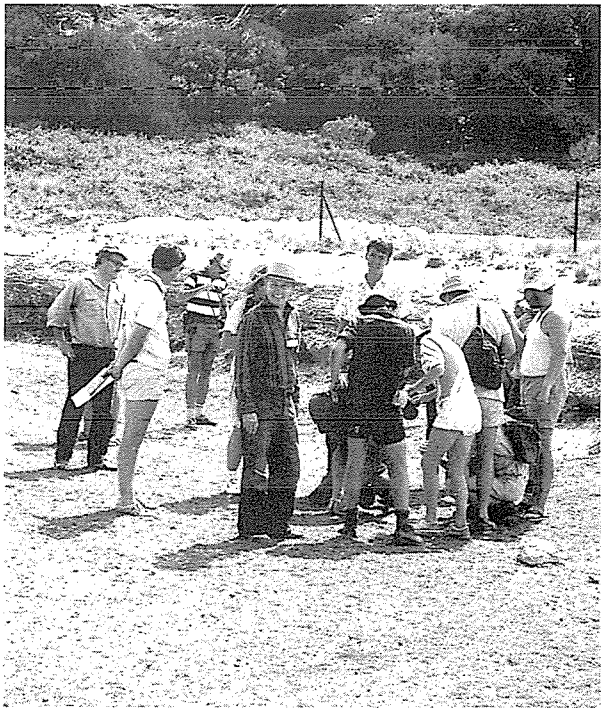
ORGANISATION

Staff

The approved staff strength during the year was 67 professional officers, 33 support staff and 7 wages staff.

Four professional staff, Mr L. Ranford (Deputy Director), Mr E. Leonhard (Engineering and Environmental Geology Section), Dr P. Morris and Dr P. McGoldrick (Mineral Resources Section) were appointed during the year. Mr T. Bestow (Assistant Director), and Mr R. Mather (Supervising Geologist, Engineering and Environmental Geology Section) retired and there were five resignations from the professional staff (Mr A Heath, Mr P Harrison, Mr S Lipple, Dr B Davies, and Mr A Deeney). At the end of the year there were 4 professional staff positions vacant.

There has been no further progress with the previously approved (1983) plans to expand the Geological Survey; the number of permanent officers is now only one more than in 1983. Considering the growth in demand for services since then all members of Geological Survey have maintained great effort, enthusiasm and productivity during the past 12 months.



The second Centennial Geological Excursion was the Rottnest Island Excursion, led by GS (WA) Director Dr P Playford. Here part of the group examines Mount Herschell Quarry, the type section of the Holocene Herschell Limestone.

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Bulletin 133, Geology of the Carnarvon Basin; by R M Hocking, H T Moors, and W J E van de Graaff.

Bulletin 135, Late Jurassic and Early Cretaceous palynology of the Perth Basin; by J Backhouse.

Report 21, Regional geology of the Kalgoorlie-Boulder gold mining district; by W Keats.

Report 22, Archaean geology of the Mount Narryer region; by I R Williams and J S Myers.

Report 23, Professional papers

A. Brachiopods and bivalves of the Kungurian (Late Early Permian) age from the top of the Coolkilya Sandstone, Carnarvon Basin, Western Australia; by N W Archbold and S K Skwarko.

B. Geology and exploration history of uraniferous and auriferous pyritic conglomerates in Western Australia; by J D Carter and R D Gee.

C. Geology and hydrogeology of the superficial formations and coastal lakes between Harvey and Leschenault Inlets (Lake Clifton project); by D P Commander.

D. Geochemical patterns in granitoids of the Corunna Downs Batholith, Western Australia; by R Davy.

E. The transition between the Hamersley and Fortescue Groups as evidenced in a drill core; by R Davy and A H Hickman.

Record 1987/3, Explanatory notes on the Wyloo 1:250 000 Geological Sheet, Western Australia (second edition); by A M Thorne, D B Seymour, and D F Blight.

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Record 1987/9, Information on industrial minerals, coastal plain between Fremantle and Bunbury; by J R Gozzard.

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Geological line compilation sheets for 1:100 000 scale: Cowan 3234, Kalgoorlie 3136, Lake Lefroy 3235, Yilmia 3135, Robertson 3151, and Newman 2851.

1:50 000 Environmental Geology Series: Mundaring (2134-2,2134-3), Lake Clifton-Hamel (2032-2,2032-3), Busselton (1930-1), and Capel (2030-4).

Special Geological Maps: Carnarvon Basin (3 sheets), Bonaparte and Ord Basins (3 sheets), Murchison Maps (3 sheets), State depth to basement map, Geological map of Western Australia (reprint), and wells drilled for petroleum exploration.

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MINING — PART OF OUR LIVING ENVIRONMENT

The history of mining is fundamental to the story of civilisation itself. The discovery, the use, and the mastery of metals was an essential factor in the rise of highly developed cultures and the domination of the planet by humankind. This rapid growth occurred in a remarkably short time, relative to the spectrum of evolution and prehistory.

In the last 300 000 years, emerging homo sapiens measured progress largely by the manner in which stone implements were prepared, and very slowly learned to become food producers rather than hunter-gatherers. The earliest 'mines' were excavations in limestone made to win superior flints for primitive implements.

With the discovery and development of the craft of metals, material progress became incredibly rapid. In the space of less than 130 years the Egyptians progressed from building mud brick tombs in the desert sands, to the great pyramid of Gizeh. The interminable 'stone age' was finally over, followed by the 'copper age', the 'bronze age', and the 'iron age', during which time humankind learned to master most of the physical environment.

We depend on mining, and the products derived from it, for our very existence. What were for a good many centuries the luxuries of the few, have now become the essentials of the many.

In this present age the levels of agricultural output which could be achieved without metals, fuels, and fertilisers would sustain only a small fraction of the world's population at subsistence level.

It is only in the latter half of this century that we have come to balance the necessity of mining with an awareness and care of the environment. Both can exist in harmony and that is how we must manage our future. The economic significance of mining to Western Australia is undisputed. In terms of environmental effects of mining activities upon the community, the mining industry utilized less than 0.1% of the land area of the State in 1987; generally as points of activity in remote areas. From this the industry produced minerals and petroleum to the value of $6946 million. By comparison, the other major primary producer, agriculture, used 44% of the land area to produce products worth $2579 million (1986/87).

In the face of, or more likely in ignorance of these realities, the community at large appears to maintain the negative view that mining damages the environment. In part this is due to the nature of the land disturbance, particularly with open cut and strip mining, which creates an 'un-natural' appearance. The more so when large scale pits remain a permanent feature of the landscape because it is impracticable and uneconomic to fill them.

However, many of these, especially the larger ones, become major tourist attractions because of historical significance and visual impact. The fact that the total area so disturbed is a small fraction of even the 0.1% of the total area affected by all mining activity, is generally not stated nor appreciated.

The effects of underground mining are usually less evident.

Overall, vastly greater areas will be disturbed by roads, power lines and urban development, than will ever be affected by mining, even with a level of mining activity as high as in Western Australia.

It is true that in the past there have been bad examples of environmental damage resulting from mining activities, which remain evident today. We learn from such experiences.

The Industry now operates within a framework of guidelines and accepted standards which will take it beyond the old 'reactive' mode of remedial action after avoidable damage was done, to systems based on a strategy of 'anticipate and prevent', which is more responsible, constructive and practical.

In this context, three philosophical statements by the United Nations World Commission on Environment and Development (the Brundtland Commission) are significant:

- "the environment does not exist as a sphere separate from human actions, ambitions and needs, and attempts to defend it in isolation from human concerns have given the very word 'environment' a connotation of naivety";
- "the word 'development' has been narrowed by some into a very limited focus along the lines of what poor nations should do to become richer, and thus again is automatically dismissed by many"; and
- "the environment is where all live, and development is what we all do in attempting to improve our lot within the abode. The two are inseparable".

The reality of the present day is that the mining industry in general has become extremely conscious of its community and environmental responsibilities, and the planning and development of new projects takes account of the necessary costs of both minimising environmental impacts and of effecting post-mining rehabiliation.

The industry continues to apply substantial resources to this aspect of its activities, and the success of these programs is demonstrable. Varied examples of beneficial post mining land use may be seen throughout Western Australia.

Application of reasonable and practicable strategies by the Department of Mines has already demonstrated that relatively simple but timely action can have a profound effect in terms of minimising environmental impact and improvement of the final visual effects. Basic examples are the rock wall armouring and covering of tailings dumps to avoid degradation and dispersal, and battering down waste dumps to allow for effective regeneration of vegetation on the slopes.

The Department plays an active part in promoting multiple land use planning, environmental management, and rehabilitation. The Mining Engineering division has a specialist section with particular responsibility for this area of activity. The group is able to draw also on expertise from other divisions, in carrying out the tasks.

Mining is the economic mainstay of Western Australia and all citizens benefit from this essential industry. A balanced view is needed on environmental issues. We must look at better understanding of all aspects and realistic resolution of them, thus enabling the long term maintenance of a vigorous, decentralised, and viable industry.

MINING ENGINEERING — ANNUAL REVIEW

Mr J M Torlach, BE(Min)
Director

With the completion of the second stage of its restructure during the past year, and the final phase already begun, the Division has been able to undertake a wide range of initiatives, and can plan with confidence for the achievement of longer term goals. Both the Perth and Karratha Inspectorates are fully staffed for the first time in many years.

Expansion of the industry has continued unabated, particularly in the gold mining sector, and new operations are still coming on stream at a rate of more than 30 per year. The division has received and reviewed during the year 83 new mining proposals, together with a further 15 proposals for major expansions of existing operations. 69 of the total of 98 are for gold ventures.

The first AXTAT report, titled 'Lost Time Injuries in Western Australian Mines - 1987' has been released, widely circulated and well received. The industry is making effective use of the information provided and the system has proved up to expectation as a valuable tool to the Inspectorate for monitoring trends and targetting problem areas.

The upgrading and extension of the long range radio network was completed during the year, with base stations installed at Karratha and Kalgoorlie. The provision of this facility has improved the field operating efficiency of the inspectorate and represents an added safety factor for inspectors travelling in remote and isolated areas.

Occupational health and safety initatives and other developments, including legislative amendments and additions, are described in the body of the report.

MINING ACTIVITIES

Some of the more significant events in the mining industry in 1987-88 are listed below.

Coal Mining

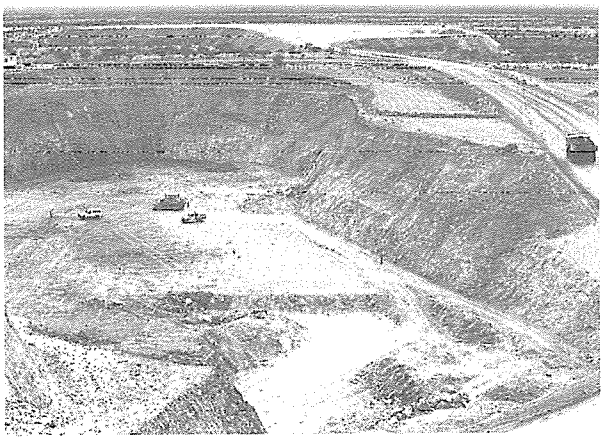
- The **Western No 3 Open Cut** development was brought to an advanced stage with the construction of infrastructure and haul roads. The mine now has considerable reserves of exposed coal, and full scale production can commence at any time. To-date, some 75,000 tonnes of coal have been mined to determine coal quality parameters.
- The Wirtgen 3000 SM machine on trial at **Western Collieries mines** is the first open cut continuous miner to operate in Australian coal mines, and trials to date are encouraging. The machine offers improved coal recovery with minimal floor dilution, the ability to mine the coal seams selectively, and the elimination of the need for shotfiring.
- At **Muja Open Cut,** the introduction of seven Cat 789 trucks and three Cat D109 Bulldozers provided significantly increased capacity to the fleet of heavy earth moving and haulage equipment. Muja commenced a three shift operation in October 1987.
- 'Stand alone' roof-bolting was established on a trial basis in several areas of the three underground collieries.
- Total extraction trials were successfully completed in the ACIRL Test Panel in **Western No 6 Colliery.** Additional Wongawilli system panels are being developed at the three Collieries.
- Radio controlled hydraulic breaker line supports were installed to improve working conditions, safety and coal extraction during fendering operations in the Wongawilli extraction area at **Western No 2 Colliery**

The sulphide ore processing plant at the Harbour Lights Gold Mine.

- New offices, workshops, change houses and ancillary areas and installations for **Western No 2 Colliery** were established at the Hille Headings, the new portal entry area at the Western extremity of the mine.
- New surface compressors were approved and are being installed at the collieries to provide for the ultimate replacement and withdrawal of underground compressors.

Other Mining

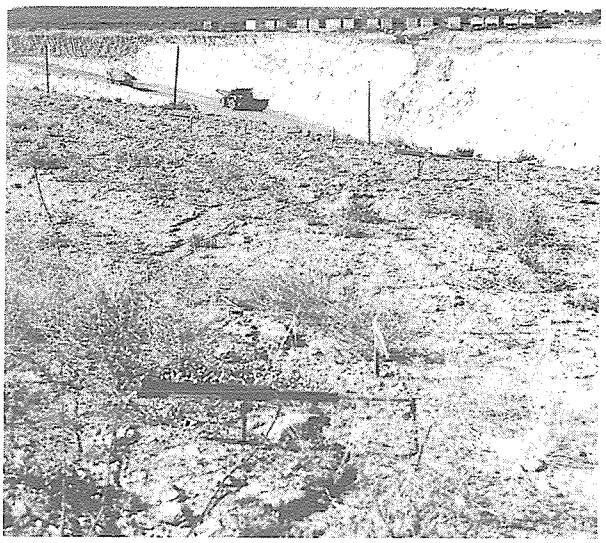
- At the Goldsworthy Mining **Finucane Island** iron ore facility, work commenced on the construction of a beneficiation plant. With a design capacity of 2 million tonnes per annum, the plant will increase the quality of the ore for shipment from 56-57% Fe to 62-63% Fe.
- Construction work at the Goldsworthy Mining **Nimingarra** minesite continued with the building of a crushing facility, stockpiling and conveyor systems, train loader workshop complex and a railway spur from the existing Shay Gap to Goldsworthy main line.
- At **Koolan Island,** iron ore production increased slightly over the previous year and the pit bottom reached a depth of 22 metres below sea level. The pit slope reinforcement programme continued and ground and sea water pressures were monitored.
- Mobile equipment has been removed from **Cockatoo Island** after the completion of preliminary and temporary rehabilitation works primarily aimed at ensuring the safety of persons on the island. The fixed plant will remain pending a final decision on the long-term future of the operation.
- **Channar Management Services,** a wholly owned subsidiary of **Hamersley Holdings Limited,** commenced initial construction work at their **Channar** minesite near Paraburdoo. The project involves the development of a complete new iron ore mine with associated crushing and service facilities. Crushed ore will be transported to Paraburdoo via a substantial overland conveyor consisting of two flights with a total length of some 21 kilometres. Channar ore will enter the existing Paraburdoo plant ore stream for screening and crushing, then be railed to the Dampier port facilities. Completion of the project is scheduled for the end of 1989. The mine will have an initial production rate of 3 million tonnes per annum and a peak rate of some 10 Mtpa.
- **Mt Newman Mining Company** undertook a major upgrading of services at the **Orebody 29** minesite at Newman. The project involved the construction of a crushing and screening plant, stockpile area, stacker and reclaimer, loadout tunnel, a rail spur and associated facilities. Completion of the project is scheduled for early 1989. This expansion, which will enable Orebody 29 production to be doubled, has been prompted by the securing of sales contracts for a discrete **Marra Mamba** ore product in addition to the material which is currently blended with **Mt Whaleback** ore.
- The year saw the major emphasis at **Mt Newman Mining** placed upon improving the operating efficiency of the mine and associated departments. In particular on the **Mt Whaleback** operation, the hours per shift worked by the major mining machinery including drills, shovels, and haul trucks has been the focus of attention.
- A new shiploading record for the port of **Dampier** was set on 9 April 1988 when 218 670 tonnes of ore were loaded on the 'Kazusa Maru'.
- The haulage fleet at **Paraburdoo** was upgraded by the acquisition of 12 Unit-Rig haul trucks of 192 tonne capacity. The last four of these trucks were commissioned in December 1987.
- Following major changes to industrial relations policy at **Robe River Iron Associates** operations there was some industrial disruption in August 1986 and January/ February 1987. Tonnage shipped during the period 1 April 1987 to 1 April 1988 exceeded 19 million tonnes. This surpassed previous record achievements by more than 20%. Mine and Plant production levels have also been high and have resulted in all stockpiles being maintained at high levels.
- At the **Eastern Deepdale** minesite at **Pannawonica,** Robe River Iron Associates proceeded with the development of Mesa 'K' to exploit a resource of some 67 million tonnes of 'blendable' ore. A 5.5 km haul road, 33kV/6.6kV powerline extension and water supply form part of this project.
- **Hancock Mining Limited** submitted an Environmental Notice of Intent and a proposal for the development of the **McCameys Monster** scree iron ore deposit at Wheelara Hill near Newman. The project will initially involve the mining by a contractor of scree ore sufficient to provide at least 750 000 tonnes per annum (after processing) of lump ore for sale to **Mt Newman Mining Company.**



The Aladdin pit excavation of Endeavour Resources at Nannine. Note the low profile waste dump adjacent to the pit.

- **BHP-Utah Minerals International** (Iron Ore) announced its wish to develop a new mining area at **Yandicoogina** (Marillana). A Public Environmental Report on the project was prepared during the year. The initial production rate is planned to be 2 million tonnes per annum.
- In the Halls Creek area at Brockman, **West Coast Holdings** and **Greater Pacific Investments** have identified a resource of some 4.3 million tonnes of ore containing niobium, tantalum, zirconium, hafnium, gallium, yttrium and heavy rare earths. A process for treating the ore from the **Brockman Project** has been developed and a patent application lodged. Feasibility studies including exploratory drilling and pilot-plant testing are planned along with environmental and social-impact studies.

- **Argyle Diamond Mines** continued operations at the **AK1 Pipe** near Kununurra and achieved its target in the second full year of production. A redesign of the mine has been undertaken to minimise the effects of movement in a slip-zone in the Revolver Creek Formation in the southwest corner of the pit. An increase in bench height from 10m to 15m was successfully implemented on an experimental basis during the year and higher benches have now been incorporated in future planning.
- The **Bow River** alluvial diamond project near the shores of Lake Argyle was commissioned by Freeport-McMoRan Australia Ltd and Gem Exploration and Minerals Ltd. Construction was substantially completed during the December quarter and mining operation in the pit were commenced by the contractor, Roche Bros. Production commenced during February 1988, more than six weeks ahead of schedule. Exploration work for extension to the diamantiferous gravels in the Bow River area was undertaken and preparations were made for bulk sampling of the Phillips Range diamond prospect (also in the Kimberley region).
- Pre-production development, concentrator construction and induction, and training of the work-force were completed by **BHP-Utah Minerals,** the managers of the **Cadjebut** lead/zinc mine near Fitzroy Crossing. The mine is a joint venture between **BHP** and **Billiton Australia** and is the first operation to commence in what may in future years become a significant base metal mining province. The mine is accessed by a decline and is equipped for the haulage of crushed ore from underground via conveyor. The operation is run on a fly-in/fly-out basis with the work force commuting by air from various regional centres. The mine has been authorised to work 12-hour underground shifts - the first such mining operation in the State.
- Production of solar salt continued throughout the year at **Leslie Salt Company** at Port Hedland and at the Dampier and Lake MacLeod operations of **Dampier Salt.**
- **Alcoa of Australia Ltd** continued to produce alumina from its mine sites at Jarrahdale/Kwinana, Del Park/ Huntly/Pinjarra and Willowdale/Wagerup as did **Worsley Alumina Pty Limited** from its Boddington Worsley site. Record prices for alumina towards the end of the year should ensure that a high level of activity continues into the next fiscal year.
- **Simto Resources Ltd** has served a Notice of Intent to commence a mineral sands operation early in the new year at Wonnerup. The Company plans to mine ore at the rate of 2.5 million tonnes per annum.
- **Z-Tech Pty Ltd** have established a zirconia treatment plant at Rockingham to produce high grade zirconia for use in the ceramics industry. Material for upgrading will initially be imported from the United States of America. In the long term local raw material will be used.
- TiO^2 a subsidiary of **Minproc Holdings Ltd** have indicated their intent to establish a mineral sands operation near Cataby.
- **Cable Sands Pty Limited** have established a new mine at Waroona South and are currently designing mining and treatment facilities for a planned new operation at Jangardup, south of Nannup.

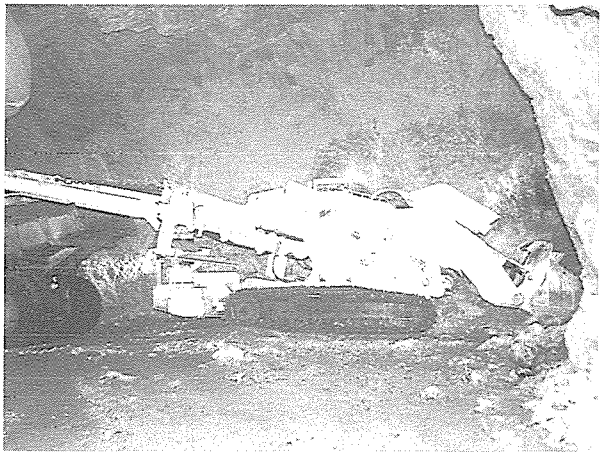


Crack detection monitors installed above a crack in the foot wall at the Harbour Lights Mine site.

- **Westralian Sands Limited** have commissioned a new monazite treatment plant at their Capel mine site.
- A gallium extraction plant is being built by **Rhone Poulenc Chimie Australia Pty Limited** adjacent to **Alcoa of Australia Ltd** alumina refinery at Pinjarra. Spent liquor from the refinery will provide the feed source for the plant.
- After considerable delay the **Barrack Silicon Project** has been given the go-ahead. The plant will now be established at Kemerton due to opposition from the residents of Picton to the original proposed location. Site works have commenced.
- An underground development and diamond drilling program took place on the 11 level of the **Agnew Nickel Mine** to establish additional information on the mine's ore reserves. At the completion of this work the mine again reverted to a care and maintenance status.
- **Western Mining Corporation** hauled its 6 millionth tonne of nickel ore to the surface from the **Otter-Juan** Decline at Kambalda. The mine has been in continuous production for 18 years.
- Underground mining continued at **WMC Fisher** Decline at Kambalda despite plans to close the operation earlier in the year.
- Record period production tonnages were achieved from **WMC Mt Windarra** decline following the suspension of development work at the mine. Plans to close down the decline have been delayed following the high price of nickel. The company has indicated that a decline is to be commenced from within the **South Windarra** pit.
- A decline was commenced at **WMC Wannaway** mine site south of Kambalda.
- Base metal mining received a boost when **Barrack Mine Management** commissioned a pilot copper concentrator at their **Horseshoe Lights** gold mine project to maximise returns from the gold-copper ore. It is anticipated 60 000 tonnes of copper concentrate will be produced each year and exported from the port of Geraldton.
- Talc continues to be mined at **Mount Seabrook** by **Thames Mining NL** and at **Three Springs** by **Western Mining Corporation Limited.**

Gold Mining

- A sulphide flotation plant for the treatment of supergene ore was commissioned at **Telfer** during the year. This plant produces a gold-rich copper concentrate (20% Cu, 120-150 gm/t Au) and is capable of a production rate of over 30 000 tonnes per annum of concentrate.
- Preparations are well advanced for the establishment of a 2 million tonne per annum capacity heap leach operation at **Telfer.** A 350m x 745m pad is being constructed on top of an existing waste dump and during the first four years of the project's life, it is expected that two 10m high lifts of heap leach ore will be placed on this pad. A detailed Notice of Intent for this project has been submitted.
- A decision on the future likelihood of underground mining at **Telfer** is expected in the early part of 1989. At present, data are still being collated and consultants reports are being prepared.
- At the **Bamboo Creek Gold Mine**, the decline was extended to exploit reserves to the 1134 metre level and driving of a new ventilation raise through to surface from this level was undertaken. A seismic event was reported from **Bamboo Creek** on 20 November 1987. A check with the Mundaring Observatory revealed that an event of magnitude 4 (Richter Scale) had been recorded at 0203 hours on that date. An inspection of the mine workings revealed no significant falls of ground or closure of excavations.
- The **Golden Spec Joint Venture** ceased operations at the **Blue Spec Mining Centre** near Nullagine during May 1988. The operators intend seeking an injection of capital from outside sources and hope to reopen the mine in early 1989.
- Mining operations continued off the **Golden Spec** shaft and development included winzing to confirm ore resources below the 7 level and a program of shaft deepening which followed this exploration. In addition, two new shallow shafts were sunk to exploit near surface reserves to the west of the Golden Spec shaft.
- The Anglo (Mulga) Shaft at the **Blue Spec** mine was dewatered and rehabilitated to allow new development to take place. Two new plats were excavated and access drives to the orebody from these were developed. The shaft and workings which had been under water since the 1970s were found to be in remarkably good condition.
- **Gould Pro Partners** completed shaft sinking and pre-production development at their **Norway mine** at the North Pole Mining Centre between Port Hedland and Marble Bar. A transportable headframe with electro-hydraulic hoist was installed. This company also took over operations at the former **Westmill State Battery** at Marble Bar and a vat-leach operation to process tailings has commenced.
- A number of small alluvial gold operations commenced in the Halls Creek area during the year. Of particular note are the operations of **Dry Creek Mining** and **Kilmorna Gold.** The latter company took over leases formerly held by **Maitland Mining** in the area and there is a possibility of a more significant operation being undertaken in the future.
- **Big Bell Mines Ltd** announced a major open cut mining project at Big Bell and currently treatment plant and ancillary facilities are under construction. Ore production for this project is expected to be at the rate of approximately 2 million tonnes per annum. Personnel for this project are being recruited from Geraldton and Perth and will operate on a fly-in-fly-out basis.



Trialling Voest Alpine Miner at Foster Decline, Kambalda. This is the first such machine in WA.

- **Dominion Gold Operations Pty Ltd** commenced operations at their **Gabanintha** mine site during the September quarter. Ore is mined at the rate of 400 000 tonnes per annum from three open cuts.
- **Metana Minerals NL** commissioned a new gold treatment plant at the **Mount Magnet** operations during April. The less efficient **Black Cat** plant was subsequently closed.
- **Western Mining Corporation Ltd** commissioned a gold recovery plant at their **Kwinana Nickel Refinery** site. This plant is extracting gold from by-products of the nickel refining process.
- **Whim Creek Consolidated NL** expanded their gold mining operations in the Meekatharra area. A new gold recovering plant was commissioned in the Paddys Flat area and this will run in conjunction with the existing **Haveluck** treatment plant and treat ores from open cuts adjacent to the Meekatharra townsite. The company is also developing its **Labouchere project** and this is expected to come on stream early in 1989.
- **Hill 50 Gold Mine NL** has served notice that it will expand its gold mining operations in the Mount Magnet area during 1988/89. The company will build a new treatment plant capable of treating in excess of 1 million tonnes per annum. Underground operations at the **Morning Star mine** will be slowly phased out to permit development of the open pit located in that area.
- **Australian Consolidated Minerals Ltd** commenced a decline from within their open cut at **Westonia** to enable development of gold ore structures below the planned depth of the pit.
- **Peko Gold Mines NL** commenced gold mining operations at **Peak Hill** during May. Planned production is in the order of 500 000 tonnes per annum.
- **Broken Hill Metals NL** commenced gold mining operations at their **Southern Cross mine** during March 1988. Ultimate production is expected to reach 1.5 million tonnes by mid 1988/89; current production is at the rate of about 700 000 tonnes per annum.

- **Quartz Reef Mining** at **Paynes Find** has had a stop-go-stop year and currently is under care and maintenance. A review of the operation is to be undertaken and subject to the location of further economic gold ore deposits the treatment plant may be re-opened.
- Open pit mining operations ceased at the **Croesus Mining NL Hannans South open pit, the Broad Arrow JV** operations, and the **Clackline Limited Montague Gold Mine** following the depletion of ore reserves.
- The **Kalgoorlie Mining Associates** Ivanhoe Shaft headframe has been dismantled and re-erected as a tourist attraction at the Golden Mile museum site in Hannan Street, Kalgoorlie.
- On 31 May 1988, the **Golden Fortune** mine at Mt Linden was put onto a care and maintenance basis until further notice.
- As of 1 June 1988, **Western Mining Corp Limited** ceased their role as managers of **Kalgoorlie Mining Associate.** This followed changes in ownership of the company.
- Guide ropes, winding ropes and conveyances have been installed at the **Foster Shaft**. The winding engine was commissioned to operate at creep speed until shaft and conveyance clearance are established.
- Final approval was granted for the $40 million **Kaltails** project at Kalgoorlie. The project is a joint venture between **Anglo American Pacific Limited** and **Gold Corp Australia.** Approximately 32.5 million tonnes of tailings located to the east of Boulder are to be reprocessed over a 12 year period. Approximately 12,000 tonnes of tailings per day will be treated.
- Construction of the **Gold Corp Australia** gold refinery and new carbon stripping plant was completed at the **Kalgoorlie Mint** complex.
- **Hampton Australia Limited** have advised their intention to expand the treatment plant at the **Jubilee mine** site to 1.25 million tonnes per annum. The cost of the extension is estimated to be $10 million.
- **Mawson Pacific Limited** submitted proposals to construct a new 1.2 million tonne per annum treatment plant costing an estimated $17 million at its **Marvel Loch** Gold Mine. Open pit mining commenced in January 1988 at the company's **Transvaal Mining Project** whilst at the Marvel Loch Gold Mine the **Exhibition** and **Undaunted** pits were joined to form one large pit.
- Shaft sinking operations were carried out at the north lode of **AUR NLs Mount Martin** gold mine site.
- Construction commenced at the **New Celebration Mine** managed by **Newmont Australia Limited** to upgrade the gold treatment plant to 1.6 million tonnes per annum at an estimated cost of $15 million.
- Decline mining commenced from within the perimeter of open pits at the **Queen Margaret Gold Mines NL - Bellevue Gold Mine, BHP Gold Limited - Gimlet South, West Coast Holdings Limited - Prince of Wales** mine site and **WMC Kalgoorlie Gold Operations - Lady Bountiful.**
- **Construction work commenced on additions to the WMC gold treatment plant at Mt Windarra.** The additions include additional leach tanks and the erection of a new roaster and stack. The estimated cost of the expansion is $30 million.
- A number of mines are now mining sulphide ores from their open cut operations. Commissioning of the sulphide concentrating plant took place at the **Harbour Lights Gold Mine** at Leonora. Construction of a sulphide flotation/regrind circuit was completed at **Paddington Gold Mine.**
- **Thames Mining NL** commenced a gold heap leach operation at **Parkers Range.** Initial ore reserves given for the project were 267 000 tonnes.
- Shaft rehabilitation was completed and mining commenced at **Golden Valley Mines NL - Frasers No 3** shaft at Southern Cross. The ore mined was treated at the companies **Radio Mine** treatment plant near Bullfinch.
- The **Callion Joint Venture** commenced open pit mining at the **Glasson** and **Callion** pits at Callion. Gold ore is to be transported to the **Broad Arrow Joint Venture** treatment plant.
- **Worsley Alumina Pty Ltd Boddington Gold** commenced operations in July 1987 mining at the rate of 3 million tonnes per annum. This rate is currently being expanded to 4.5 million tonnes per annum and a proposal has been received for a further expansion to 6 million tonnes per annum.
- **Alcoa of Australia Ltd** announced the go ahead for its **Hedges Gold** project near Boddington and the treatment plant facilities are currently under construction. When complete the plant will treat ore at the rate of two million tonnes per annum.

OCCUPATIONAL HEALTH, SAFETY AND INDUSTRIAL HYGIENE

Mine Safety

Increased mining activity in all Inspectorates resulted in a heavy work load being placed on inspection staff during 1987/88. This was aggravated at the District Inspector level following the resignation of two Inspectors; one in the first week of the reporting year. Despite this, the inspection frequency was maintained at mine sites.

The high level of mining activity in the Kalgoorlie Inspectorate resulted in 38 incidents involving a winder or heavy haulage vehicle being reported. Eleven of the 20 heavy vehicle incidents were rollovers and two concerned contact with electrical powerlines.

Of concern to the Collie Inspectorate were two underground fires, one on a conveyor belt and the other involving the electrical supply to a roadheader.

Underground diesel permits were issued for 186 diesels engines.

Ventilation

The appointment of ventilation staff during 1987/88 enabled the Division to operate at full strength in this important area. Widespread coverage of all mines resulted in more than 4000 samples being taken of atmospheric contaminants and conditions. Samples for dust totalled 1400 with a compliance factor of 93% relative to the standard of purity requirements.

Where areas of high dust levels were identified, discussion with the Managers concerned satisfactorily resolved such issues. Resampling following rectification is standard practice.

Noise and Vibration

The inspections for compliance with hearing conservation regulations progressed satisfactorily throughout the year. Forthcoming changes to the requirement for repeat noise surveys resulted in inspectors devoting more time to assessing the mining industry progress in noise control, as well as noise exposure levels due to altered work processes.

Good progress was made by the industry in reducing the number of blast induced complaints from members of the public. Several companies have successfully implemented changes to their blasting practices to further reduce the effects of noise and vibration.

Chris Kirvin measuring airblast/overpressures at Readymix Quarries, Gosnells.

Electrical

Special Inspectors of Mines (Electrical) Inspectors carried out 774 inspections of mining operations during the year, with 262 letters detailing defects being issued to mine managers.

A total of 184 submissions by mining companies, mainly relating to approval of electrical installations and appointment of electrical supervisors, were processed.

A total of 30 electrical incidents were reported and follow-up corrective action was directed where necessary. One fatal accident involved electricity.

There was one successful prosecution regarding unlicenced electrical installation work on a mining lease, and three warnings issued regarding unlicenced/ unauthorised and substandard electrical installation work on mining leases.

No fires were reported involving possible initiation from an electrical supply system.

Chemical

Chemical inspections were carried out in conjunction with the Chemistry Centre of WA at a number of mine sites in the Karratha Inspectorate. Particular attention was given to the storage together of incompatible chemicals, free standing high pressure gas cylinders, inadequate storage of respiratory protective equipment, cyanide storage conditions, provision and maintenance of safety showers, and the correct use of gloves and respiratory protective equipment when handling chemicals.

Areas of concern reported by all inspectorates, except Collie, include the satisfactory disposal of used cyanide drums and the use of incorrect types of respiratory protection and gloves when handling chlorinated solvents.

Railways

A new Special Inspector of Mines (Rail) was appointed following the retirement of the previous Special Inspector. Each railway operation received at least two inspection visits by Special Inspectors during the year.

Radiation

Routine auditing activities continued at all mineral sands mining and processing sites; 20 formal radiation inspections were conducted, by Special Inspectors of Mines (Radiation), at the five separation plant sites.

Investigative work at mineral sands separation plants included characterisation of particle size, evaluation of radon and thoron daughters, alternative analytical techniques for radionuclides and alpha self-absorption on filtered dust samples. Recent equipment acquisitions will allow this work and other work targetted for investigation (e.g. thoron emanation, equilibrium studies) to proceed in a more rigorous scientific fashion.

Monitoring of uranium exploration activities at **CRA's Kintyre** prospect continued, as did surveillance of the remedial clean-up work being conducted by Cable Sands at the Wonnerup site.

During the year, the Radiation section provided detailed input into the following important resource projects:

- **TiO^2** Corporations proposed mineral sands operations at Cooljarloo and Muchea.
- **Rhone-Poulenc's** proposed monazite processing facility at Pinjarra.
- **ICI's** proposed advanced ceramic plant at Kwinana.
- **West Coast Holding's** proposed rare earth mining and processing operations at Brockman in the Kimberleys.
- **The Health Department's** proposed radioactive waste disposal facility in the Goldfields region.

Close liaison with industry and government representatives continues to be an important function of the section. During the year a number of radiation protection guidelines were developed, in consultation with the industry and the Interim Mines Radiation Committee. New titles include:

- The Determination of Inhaled Gross Alpha Activities.
- Air Monitoring Strategies (Revised).
- Development of an Effective Respiratory Protection.
- Programme.
- Reporting Requirements.
- Pre-operational Monitoring Requirements.

The Executive Officer (Radiation) undertook a technical assessment tour of operating rare earth processing plants in France and the USA, and uranium treatment plants in France and Canada. The primary objective of the tour was to evaluate existing facilities, operating practices and procedures put in place for the control of occupational

radiation exposure at such plants. The visits were also used to ascertain the potential for optimisation of radiation exposure and to discuss regulatory aspects of radiation protection with relevant National and State agencies. The information gained on the tour will be used to formulate appropriate radiation protection strategies for similar projects in Western Australia, should they proceed.

Collie Mine Rescue Team training at Western Collieries.

Radiation Exposures Progress Report

In 1986, the Department of Mines introduced more restrictive standards for inhaled airborne radioactivity and a revised method of radiation dose assessment, based upon the additivity of internal and external radiation exposure pathways. These regulatory initiatives are in accord with international and national recommendations and result in a formal radiation protection system equal to the best in the world.

Since the introduction of these initiatives some sectors of the mineral sands industry have experienced some difficulty in complying with statutory radiation protection standards in some areas of their operations. Workers involved with dry separation plant operations are potentially at risk of receiving internal radiation exposures in excess of the annual intake limit, as assessed by the very conservative protocol which is currently in use.

The industry has significantly reduced exposures to external, or gamma, radiation over the last six to eight years. Now the major radiation protection issue confronting the industry is the control of radioactive dust. Over 90% of the total radiation dose received by 'designated radiation workers' derives from internal radiation exposure and specifically the inhalation of airborne radioactive dust; (alpha radiation exposure).

The mineral sands industry in Western Australia directly employs about 1000 workers and, based upon company radiation dose assessments, approximately 3% of these workers are presently recording doses in excess of the annual occupational dose limit (50 mSv/y). The average radiation exposure amongst the 300 designated workers (i.e. those workers with the potential to receive more than 10% of the annual limit) is 25 mSv/y. Such exposures underline the necessity for the industry to continue to pursue vigorously dust reduction programs.

In 1987, the Department of Mines formally requested the three most affected dry separation plant sites to submit time-scheduled compliance action plans for the management of dust exposure. These plans have been received and endorsed by the interim Mines Radiation Committee. The plans are based substantially on major engineering projects and will result in the expenditure of more than $3 million over the next two to three years. Linked with the capital works programme are optimisation investigations into the administration of radiation protection, allocation of monitoring resources and work or operational practices.

In considering the radiation protection issues currently confronting the industry there are two important points.

(i) Existing dry separation plants were built many years ago when dust reduction strategies were only given very cursory consideration in the design of such plants. New plants can be designed and constructed with much greater intrinsic radiation protection.

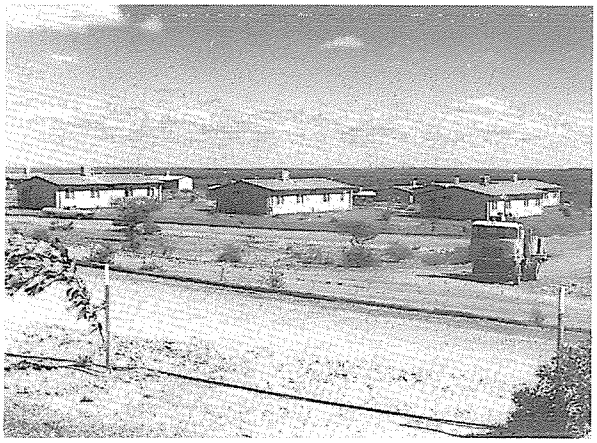
(ii) All of the designated radiation workers are those who are required to work in the dry separation plants; all other workers in the industry (i.e. those involved in mining, concentration, transport and technical/ administrative support) receive doses less than 10% of the annual occupational radiation dose limit.

With respect to progress over the last two years, the Department of Mines has been encouraged by the efforts of the industry in reducing internal exposures. At the start of 1987, 8% of workers exceeded the annual limit, whilst at the start of 1988 this figure had been reduced to 3%. The total collective dose, which is an important parameter in radiation protection, has also been reduced from 11.9 man-Sv in 1986 to 10.7 man-Sv in 1987, despite an increase of monazite throughput from 10000 tpa to greater than 12000 tpa over the same period. These significant reductions should continue to be maintained with the progressive phasing in of engineering controls and improved operational techniques. As a result, 100% compliance with statutory radiation protection standards should be achieved before 1990.

It is clear that the industry is now entering an evolutionary period where considerable changes to established and well proven industrial processes and practices are taking place. Challenging times lay ahead and a concerted effort will be required from all parties, the mineral sands companies, the workers and the regulators, to assure the industry's long-term compliance capability.

AXTAT

During the year, the Research and Technical Services Branch took over the management of the AXTAT Computerised Accident Recording System. The system contains information on all the accidents which resulted in work days being lost at mines in Western Australia since January 1987.



New mining village at Mount Morgans.

The Research and Technical Services Branch is using a statistical program installed on the IBM main frame computer to analyse and graphically present the information. This information is being published as 'Lost Time Injuries in Western Australian Mines'. The first edition covering the 1987 calender year was published in May 1988. The publication will be produced every six months and covers the previous 12 months.

CONTAM

The revised Contam system was developed and implemented as a line production system in October 1987. The system continues to monitor dust sampling with a much greater variety of summarised management information which enables trends of sampling levels to be more easily detected. A significant increase of 20% in sampling data has been recorded throughout the year. The increase was mainly attributed to detailed sampling of hydrogen cyanide levels in CIL-CIP plants. The Contam records now total over 90,000 samples. These also include data from the old Mindust system.

Prosecutions

Nine people were prosecuted during the year for offences against the Mining Act or Mining Registration Act and Regulations. Details of the offences are available in the Statistical Summary.

ENVIRONMENT AND REHABILITATION

Proposals were received and reviewed for a total of 83 new mining ventures, ranging from small scale alluvial gold operations to large scale gold and iron ore projects.

Added to this was a further 15 proposals for major expansions to existing operations.

The majority of the proposals were for gold operations as can be seen in the list below:

Gold	69
Mineral Sands	6
Silica and Lime Sands	5
Gypsum	4
Iron Ore	3
Nickel	2
Diamonds	1
Others	8
TOTAL	**98**

The Environmental Section continued to assess proposals and inspect operations at various stages to enable appropriate environmental protection conditions to be placed on tenements and to determine if tenement conditions were being adhered to.

Wonnerup Project

The clean up operation to remove mineral sands and tailings, with elevated radiation levels, from rural/ residential blocks of land at Wonnerup commenced in October 1987.

This operation is being carried out by Cable Sands (WA) Pty Limited acting as agents for the State and is planned to take approximately 3 years to complete.

The commencement of this project is a result of having involvement of the Division in discussions with the owners of the affected land, with Cable Sands, and with other State Government Departments to enable an agreement to be drawn up and signed by all parties. Progress of the operation is currently on schedule.

Golden Mile Mining Development

The Environmental and Rehabilitation Section was involved in the instigation and preparation of the Golden Mile Environmental Strategy document and is involved in the Golden Mile Mining Development Planning Committee.

Apart from a Conceptual Plan for the Golden Mile, the Section has commenced preparation of Conceptual Plans for the Mt Magnet and Yilgarn areas. It is also intended that similar plans be prepared for other major mining centres.

Tailings

The Research and Technical Services Branch is currently reviewing all aspects of tailings disposal. A questionnaire has been forwarded to mining companies with existing tailings disposal system in order to obtain relevant information on the systems used in the State. A response of 55% has been achieved to date. Australian Groundwater Consultants Pty Limited have been appointed to analyse the questionnaires and it is intended that an Industry Guidelines information circular on the subject will result.

Aboriginal Matters

Involvement by the Aboriginal Liasion Officer with Aboriginal groups likely to be affected by mining developments and mining industry representatives, has pre-empted potential conflicts and provided successful resolutions. Where conflict has existed the liaison position has been instrumental in maintaining communication channels and, by identifying areas of shared interest with the parties involved, succeeded in resolving these matters.

DRILLING BRANCH

In 1987-88 the Drilling Branch drilled 235 bores, totalling 14 917 metres, developed aquifers in most of the bores and controlled the construction of three multiport pollution monitoring bores by contractors. The previous highest meterage drilled by the Branch was 14 692.5m in 1986/87.

Rehabilitation trials on Chaffers Waste Dump at Kalgoorlie.

The work was mainly exploratory drilling to obtain basic data for assessment of State groundwater resources and stratigraphic information. Some work was for major region assessment but most was for specific mining projects (gold and bauxite) and land use projects such as land salinisation and drought relief.

Television camera scanning was carried out on 19 bores, seven bores were sidewall cored and seven bores were perforated by shaped charge explosives. Minor repair work was done on two existing bores to control artesian flows.

The Branch upgraded and extended the Departmental long range radio communication system which it operates. The system now has three fixed bases, 76 mobile units (previously 1 and 44), selective caller facilities and solar powered quiet receivers for the fixed bases.

A mudlogging/gas detection unit is being commissioned to detect hydrocarbons on a continuous basis while deep drilling, for data acquisition and safety reasons. Modifications carried out to the 'JACRO' drilling rig to increase its depth capacity from 250m to 500m proved very satisfactory.

GENERAL

Staff

Rehabilitation trials using smelter slag on the Chaffers Tailings Dump, Kalgoorlie.

The restructure of the Mining Engineering Division continued in 1987/88 with five additional staff being recruited under the second stage. The final stage in 1988/89 allows for an additional 11 positions, the majority of these being support staff.

The Department still has difficulty in recruiting mining engineers against the strong demand from the gold mining sector where premium salaries and attractive conditions are offered.

Personnel movements within the Division during the year included seven resignations and the appointment of 17 new officers, 12 of whom are professional/technical.

Personnel leaving the Division included two District Mining Engineers, two Assistant Drilling Supervisors, two Clerks, and the Manager - Environment and Rehabilitation; the latter being seconded to the staff of the Minister of Mines.

The two Assistant Drilling Supervisors to leave, J Young and W Genderson had 17 years and 18 years respectively with the Drilling Branch.

Environmental Committee group on inspection of a rehabilitated area.

Boards

Interim Mines Radiation Committee

Four meetings of the Interim Mines Radiation Committee were held during the year. The establishment of the Mines Radiation Safety Board has been subject to delay; the Draft Bill to establish the Board was assented to in November 1987 but membership is still being resolved.

Ventilation Board

The Board met on six occasions during the year to deal with a wide range of matters and to administer its responsibilities under the Mines Regulation Act.

Major activities of the board included:

- the establishment of a sub-committee to examine the philosophy and seek improvements in the sampling practice and reporting of atmospheric contaminatants form the CONTAM database;
- the preparation and circulation of instructions outlining the minimum respiratory protection requirements for atmospheres containing hydrogen cyanide;
- the approval of the document 'Code of Practice on Industrial Hygiene' for the Cadjebut Mine; and
- examining data from the atmospheric contaminant reporting system (CONTAM).

Management Boards

Western Australian Coal Industry Council

The Western Australian Coal Industry Council (WACIC), which was established in early 1987, met on four occasions during 1987/88. Three sub-committees have been established to enable detailed consideration of particular issues, a report on the Mines Resource subcommittee being included in this review.

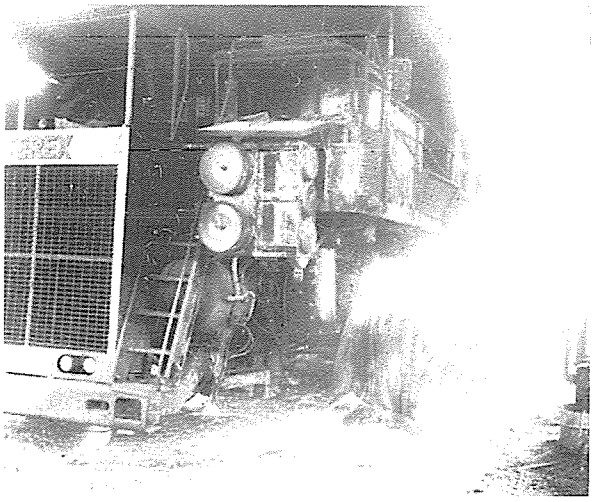
In October 1987, a WACIC delegation visited the United States, West Germany and Britain to study specific topics of these overseas coal mining industries. A report has been prepared and recommendations have been made to WACIC for consideration.

The Mines Rescue Sub-committee chaired by the District Coal Mining Engineer, had a total of 12 meetings and made three presentations to the Council, including building plans, operating and capital costs for a rescue station. Liaison with various parties is continuing towards achieving establishment of a satisfactory installation to service the needs of the coal mining and possibly the wider mining industry.

Board of Examiners (Metalliferous)

The Board of Examiners met nine times during the year with six meetings in Perth and three in Kalgoorlie.

A total of 401 candidates sat for various metalliferous mining certificates and of these 140 were interviewed by the Board of Examiners.



Burnt out mine Haul Truck following a tyre fire explosion.

Board of Examiners (Coal)

A total of 13 Certificates of Competency were issued by the Board in 1988/89. The Board met on four occasions.

Mine Survey Board

The Mine Survey Board met on four occasions during the year and issued 14 authorised Mine Surveyor's Certificates.

Statistical Details

Additional details relevant to the numerous Certificates issued by the Board of Examiners and Mine Survey Board are included in the Statistical Summary.

Information Initiatives

A seminar on Fires and Explosions in Large Earthmoving Tyres was held at Newman on 26/27 August, 1987. Response from the mining industry and other interested parties was exceptional and the seminar was attended by a total of 86 delegates. Delegates included representatives from all the major open cut mining operations in WA, mining companies in the Eastern States, tyre manufacturers and State and Federal Government Agencies (including the WA Fire Brigade and Department of Aviation).

The success of this seminar prompted the organiser, Brian Johnston the Machinery Inspector for the Karratha District, to arrange an equally successful rerun on 4/5 May 1988 in Kalgoorlie. This seminar was organised by the Regional Mining Engineer in Kalgoorlie and sponsored by the Department of Mines and the Chamber of Mines. Most of the speakers from the original seminar again participated, along with 60 other delegates.

A seminar on the ventilation aspects of surface mining operations was held at Paraburdoo in February, 1988. The seminar was attended by ventilation and occupational health representatives from most of the major iron-ore producers and other substantial open-cut mining operations in the Inspectorate, as well as representatives of suppliers to the industry. Papers were presented by Department of Mines staff and industry delegates. Of particular note were presentations on the use of chemical aids to dust suppression.

The Research and Technical Services Branch presented 10 cyanide seminars in gold mining areas, from Telfer to Southern Cross. 350 persons from industry attended these seminars. In June, a special cyanide seminar was given in Perth directed at designers and manufacturers of cyanide treatment plants for gold ores.

Also in June, in conjunction with staff from the Department of Occupational Health, Safety and Welfare, two successful Fire Assay Laboratory Safety seminars were held in Kalgoorlie with a total attendance of 120 delegates.

In September a Ventilation Officers Course was held in Kalgoorlie, with assistance provided by the West Australian School of Mines. 30 candidates attended both classroom and practical sessions in ventilation techniques. North Kalgurli Mines and Mt. Percy Mines allowed the practical sessions to be conducted at their plants.

CONTROLLING PESTICIDE RESIDUES

The discovery of excess organochlorine pesticide residues in Australian meat being exported to the United States received a great deal of publicity in 1987/88. These pesticides may take up to 20 years to degrade naturally and thus the long term effects are difficult to assess. Such pesticides are considered a potential health and environmental hazard, and the maximum permissable residue levels (MRLs) in foodstuffs are low.

Regular testing of both domestic and imported produce is conducted in most countries of the world to ensure these levels are not exceeded. It was during such routine testing in the USA that Australian meat was found to be in excess of the MRLs and thus not acceptable for that market.

This discovery threatened Australia's lucrative export markets in America and Japan. It was essential that effective remedial action be taken immediately, to minimise any negative effects on our export trade.

The Chemistry Centre has been involved in the pesticides crisis from the outset. Because of the Centre's long-standing involvement in the determination of residue levels in a wide variety of samples (including water, fruit, vegetables, air, surface swabs, urine, and fat) in connection with health and environmental work, its staff possess the necessary consultancy and analytical expertise to be of immediate assistance to the Department of Agriculture in assessing the situation.

The Agricultural Chemistry and Environmental Chemistry Laboratories of the Chemistry Centre have devoted much of their resources to this work; to the end of 1987/88 more than 18 000 soil, plant, and fat samples had been analysed to determine residue levels.

Chemistry Centre staff worked closely with the Department of Agriculture to survey farms suspected of being contaminated with excess pesticides. Soil samples were taken from farms and tested by the Agricultural Chemistry Laboratory. Animals absorb pesticides by grazing on pastures grown in contaminated soils, and through identification of contaminated paddocks farmers could isolate their cattle in safe areas.

For this survey the Agricultural Chemistry Laboratory had to establish a routine system for the determination of organochlorine residue levels in soil. Prior to the crisis this laboratory was not involved in such work, yet it was able to establish the operation within two months, including commissioning a new twin column capillary gas chromatograph. The workload reached a level of 500 samples per week, with a turnaround time of 24-48 hours. This work was vital to the success of the Department of Argiculture's soil survey.

The Environmental Chemistry Laboratory was involved in the analysis of biopsy fat samples and pasture. As the maximum residue levels for organochlorine pesticides in meat are set on a fat basis, such analyses make it possible to determine if an animal is contaminated. This work enabled herds to be assessed, and contaminated animals to be quarantined.

Pasture analysis was undertaken to determine the extent of contamination and correlate this with plant type, soil type, etc to enable suitable management techniques to be developed.

The result of this work was an efficient system to establish appropriate techniques for the management of quarantined herds in a minimum amount of time.

Chemistry Centre staff also worked closely with Department of Agriculture staff to establish the latter's new Bunbury laboratory which is predominantly involved in the analysis of fats. Advice was given regarding necessary equipment, appropriate analytical techniques, and Bunbury staff visited the Centre for short training courses. The Centre also plays a quality assurance role by monitoring the work of the Bunbury laboratory.

Chemistry Centre staff participated in state and national pesticide issue conferences and seminars. An officer of the Environmental Chemistry Laboratory was a representative at the State and Commonwealth meetings of analysts. This meeting was held by the Australian Quarantine Inspection Service (AQIS) to clarify the analytical requirements and standards applicable to this work. The Centre is also represented on the Department of Agriculture's 'Task Force on Chemical Residues' committee.

The volume and urgency of the pesticides work placed great demands on the resources of the Chemistry Centre. It was necessary for the Centre to receive additional technical assistance from Department of Agriculture staff placed at the Centre. Although their assistance has been invaluable, already cramped working conditions have become even more so. Delays in other projects were necessary as staff and resources were devoted to the pesticides issue.

Thanks to the efforts of the Department of Agriculture, the Chemistry Centre, and other government bodies, the pesticide crisis has been contained.

Problem areas have been identified and advice given on suitable management techniques. The Centre's involvement in this work is ongoing, with research aimed at further refining the management techniques applicable to farms, investigating alternative forms of agriculture, and investigating ways to accelerate the natural degradation of organochlorine pesticides.

As an example, the Chemistry Centre is involved in research into plant-soil and plant-animal relationships, work aimed at increasing the knowledge of the way these pesticides interact in the environment. This information is important for future farm management of the problems associated with these persistent organochlorine pesticide residues.

The pesticides crisis of 1987/88 was a situation to which the Chemistry Centre responded quickly and effectively, helping to defuse a problem which had the potential to severely damage Australia's export markets. The involvement of the Centre went beyond a pure analytical role, using the full gamut of staff expertise and experience. It is a clear example of the way the work of the Chemistry Centre is of great significance to Western Australia.

CHEMISTRY CENTRE (WA) — ANNUAL REVIEW

Dr J. Hosking MSc, PhD
Director

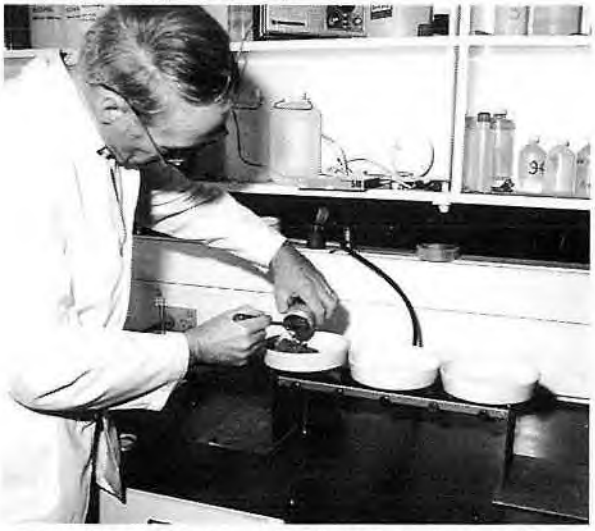
The 1987/88 year was one of great significance for the Chemistry Centre (WA), previously known as the Government Chemical Laboratories. The State Government decided, following reports from the Functional Review Committee, to retain the organisation as an integrated unit. Comprehensive restructuring has streamlined and enhanced the Chemistry Centre's many unique functions, and improved interaction with clients. Furthermore planning has commenced on relocating the Centre to a site adjacent to Curtin University.

As a result of the restructure the Chemistry Centre now comprises the following laboratories : Agricultural Chemistry; Environmental Chemistry; Forensic Science; Health Chemistry; Kalgoorlie Metallurgical; Mineral Processing; and Mineral Science. All senior positions were declared vacant and advertised. By the end of 1987/88, the positions of Director, Co-ordinator Agricultural and Mineral Development, Co-ordinator Forensic and Environmental Chemistry, and six of the seven Chief of Laboratory positions had been filled or an applicant recommended. Additionally, the administrative section of the Chemistry Centre was reviewed and reorganised to provide a more effective support service.

With the restructure near completion, plans for a new building in hand and the uncertainty over its future removed, the Chemistry Centre (WA) is now poised to consolidate its position as one of the foremost group of laboratories in Australia.

AGRICULTURAL CHEMISTRY LABORATORY

The demands on the services of the Agricultural Chemistry Laboratory increased dramatically during the 1987/88 year, compared with previous years. Receivals of plant materials, soil samples for nutrient analyses and soil samples for pesticide residue analyses totalled 72 800. Despite extremely crowded working conditions, staff maintained a high work output level.



Investigating soil chemistry; preparation of saturation extract.

Pesticide Residues in Soil

In response to the pesticide in beef emergency last year, the laboratory set up a capillary gas chromatography system to analyse soil samples from an extensive survey of affected properties. Staff were trained and the unit made operational within two months. This Laboratory analysed soils and plants, while the Environmental Chemistry Laboratory analysed fat samples.

By year's end 8 000 samples of soil from most of the contaminated properties had been analysed for the five main organochlorine residues. Stringent quality control kept the precision of the data within defined limits.

Research commenced into techniques to accelerate the removal of residues from the surface soils which are the main source of contamination of stock. An investigation is underway to assess the practical value of commercial immunochemical test kits for field use when testing for organochlorine pesticide residues.

Lupin Research

The lupin research program this year included the development of a spot test for alkaloid in plant sap which showed improved sensitivity over the Dagendorff test. The first stage of the investigation was completed on a pre-harvest test to enable very low alkaloid crops to be delivered into segregated storage for human consumption.

An ELISA test for lupin alkaloids being developed in conjunction with Curtin University made good progress with an indicated sensitivity of 1 part per million of alkaloid. Work was delayed by antibody recognition of the conjugate linkage but synthesis of new conjugates should resolve this problem.

This year the laboratory commenced a second five year study of alkaloid trends in commercial lupinseed which involved the analyses of a sample from each 5 000 tonne of seed delivered into storage.

Algal Pollution of WA Estuaries

An extensive soil testing program was conducted by the laboratory this year to define the movement of nutrients (mainly phosphorus from farm fertilizers) into waters of the Peel Harvey and Southern estuaries.

Five technical staff provided by the Agriculture Department commenced work in January and made a major contribution to the output of 34 000 analyses on the 5 761 soil samples from the surveys.

Bicentennial Project

Analytical work was completed on a Bicentennial funded project from the WA Branch of the Soil Science Society of Australia to characterise the soils from uncleared reference sites on major soil types in the South West.

The chemical information on these reference sites, which will be reserved in perpetuity, will be invaluable for future research into the changes imposed on the environment by agricultural and other forms of development.

Carotenoids in Salt Lake Alga

A newly installed HPLC system is being used to develop procedures for carotenoid analysis. The investigation is aimed at assisting industry develop a quality control/ quality assurance protocol to help solve problems related to the extraction and isolation of B-carotene.

Staff Movements

Chemist and Research Officer (P. Coates) undertook a six weeks consultancy mission to West Timor to investigate and advise on a regional laboratory service.

The Principal Chemist (B. Jeffery) and Chemist and Research Officer (G. Dellar) presented poster papers on their research into the soil chemistry of molybdenum and gypsum at the National Soils Conference held in Canberra in May.

Chemist and Research Officer (Dr D. Allen) commenced study leave in June for approximately six months to take up a Research Assistantship at the Australian National University. His project will involve the development of new chelating agents for the recovery of precious metals from dilute solutions. He also represented the Centre at a Soil Acidity Workshop at Wagga Wagga in October.

In June Chemist and Research Officer (Dr D. Harris) went to Poland to present several poster papers on lupin alkaloid research at the Fifth International Lupin Conference. After the Conference he will spend about six weeks visiting research institutions in Germany and the UK. The trip is being funded by a Grain Research Committee grant.

Patrica Lambert testing acidity of soil.

ENVIRONMENTAL CHEMISTRY LABORATORY

The work of the Environmental Chemistry Laboratory during 1987/88 has been dominated by three major projects.

Pesticide Residues

The discovery of excessive pesticide levels in meat exports to the USA created a huge demand for pesticide residue analysis. The pesticide section of this laboratory became extensively involved in work resulting in the quarantining of herds and properties, public health issues, research, and planning of additional facilities within both the Chemistry Centre and the Department of Agriculture, Bunbury.

Research into techniques for controlling organochlorine residues to within the applicable maximum residue limits has been undertaken. This work has enabled the Department of Agriculture to recommend new farm management strategies (such as grazing sheep rather than cattle in certain instances). An officer of this laboratory visited Queensland and New South Wales to assess equipment, research and management techniques.

Approximately 10 000 samples of soil, biopsy and abattoir fat, pasture and farm produce were received during the year. This required the employment of temporary staff and considerable overtime, and equipment often ran 24 hours per day. Even so, the laboratory had to accept delays on other projects due to the demands and urgency of this project.

Cyanide

With the increase in the gold price and resurgence of mining activities, the potential for cyanide pollution emerged from two main sources. The first was the possible environmental effects of waste cyanide leachates from tailings dams, and the second was the hazards associated with the transport of liquid cyanide in large quantities to minesites throughout the State.

The Environmental Chemistry Laboratory found in two interlaboratory studies that private laboratories had difficulty performing reliable cyanide analyses. This resulted in a huge increase in monitoring and investigational work being undertaken for private goldmining companies. The Environmental Chemistry Laboratory is part of a Chemistry Centre group currently consulting with industry and the funding organisation AMIRA, to develop a research project into the fate of cyanide and its movement in tailings dams and the environment.

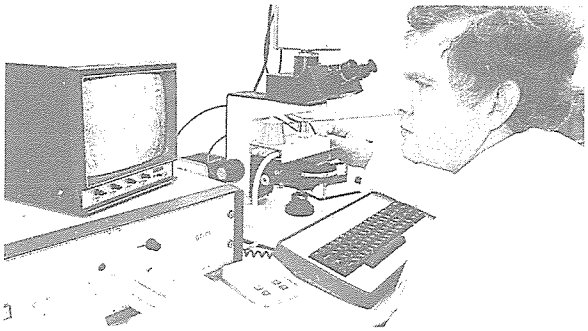
Income from mining companies for this work has been of the order of $100 000 for this year.

Projects for the destruction/neutralisation of cyanide in tailings liquors and concentrated solutions have been completed with some unexpected and previously undocumented discoveries. Further work is underway.

Estuarine Eutrophication

Problems experienced in the Peel-Harvey system for the past 10 years have now been discovered at early stages in other estuarine systems and have resulted in a large Environmental Protection Authority/Chemistry Centre investigation. New techniques of nitrogen and phosphorus analysis have been employed to analyse approximately 8 000 samples from these sources during the year.

Princess Royal Harbour, Albany, has been a site of major concern during the year because of an obvious decline in seagrass due to eutrophication. This has been found to be due in part to fertilizer runoff (as with the Peel-Harvey system) but also to industrial discharge and wharf practices. In the latter respect a massive potential for pollution has been discovered resulting from the unloading of fertilizer or rock phosphate cargoes. During these operations many tonnes of nutrient material is spilt or washed into the harbour.



Bernie Lynch with 'The GRIM' (Glass Refractive Index Measurement) in Forensic Science. This automatically measures the refractive index of glass samples. Used in motor vehicle accidents and other investigations.

FORENSIC SCIENCE LABORATORY

Spectrometry

The most critical technique employed by the laboratory is mass spectrometry. Almost 50 percent of all results depend on the technique for their ultimate validity.

In essence the mass spectrometer enables compounds such as drugs, poisons and environmental pollutants to be specifically identified at extremely low concentrations. When combined with other analytical techniques such as gas chromatography, this forms an extremely powerful analytical tool.

The technique has been in routine use in all aspects of the Forensic Science Laboratory operations for the past 10 years, however full exploitation has been limited as the instrumentation was restricted to small 'bench top' models interfaced to gas chromatographs. This restricted their use to volatile compounds. These instruments also had less than optimum sensitivity.

In September 1987 the laboratory installed a major mass spectrometer, the VG TS-250. The system design incorporates four sample inlet interfaces and enables the mass spectrometric analysis of solids, liquids and gases. The instrument is significantly more sophisticated than any other mass spectrometer in Western Australia and will result in the Chemistry Centre becoming the WA reference laboratory for mass spectrometry.

The VG TS-250 has already had considerable use in forensic chemistry, where it has solved previously intractable problems. The solid probe of the VG TS-250 can facilitate analyses of compounds which gas chromatographic techniques cannot accomplish. The VT TS-250 has also been extensively used by industrial hygiene and environmental chemists. In these applications the sensitivity of the system has enabled long standing analytical problems, such as sulphur interference in residue analyses, to be clarified.

Toxicology and Drugs

There was a 20% increase in casework submitted by the Police Coronial Inquiry section in connection with the investigation of unexplained sudden deaths during 1987/88. There was also a similar increase in exhibits submitted by the Prison Health Service in connection with the control of the problem of drug abuse in prisons.

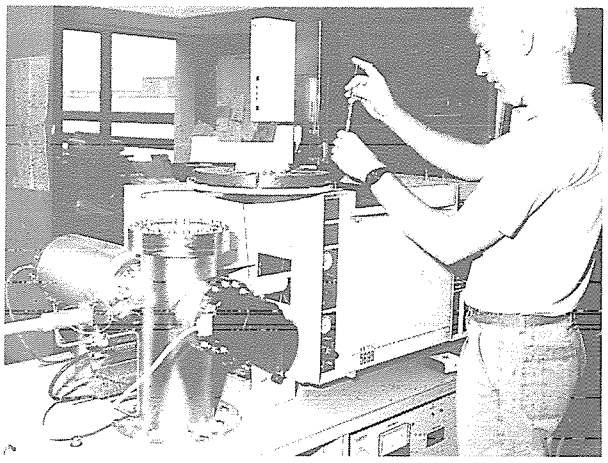
Work in these analytical programs has escalated at a rate far greater than could have been predicted by past trends and this has placed considerable stress on resources.

Physical Evidence

Significant developments have taken place in a number of areas in the physical evidence section. Particularly noteworthy are those in the areas of glass analysis and new pyrolysis capillary gas chromatography applications.

Forensic glass analysis benefited from the State Government's investment in the CSIRO electron microprobe at Floreat, and through the acquisition of the Automatic Glass Refractive Index Measurement system (GRIM). Research has established appropriate electron probe conditions for the measurement of sodium, aluminium, magnesium, silicon, potassium, calcium, iron, manganese, arsenic, barium, strontium, cobalt and titanium in glass. The probe is fully automated and large numbers of samples can be mounted for unattended analysis. This has great importance in economically generating 'frequency of occurrence' data.

The GRIM refractive index measurement system has greatly improved the acquisition of Refractive Index (RI) data. RI is probably the most useful and practical property for glass discrimination.

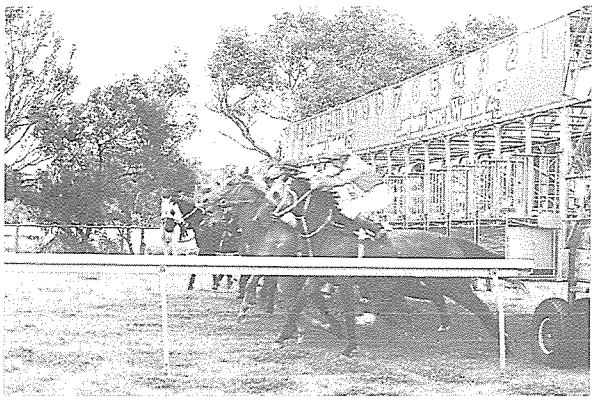


Greg Buck placing samples in the Mass Spectrometer in Racing Chemistry Lab.

A new pyrolysis capillary gas chromatography approach has been developed for the analysis of polar polymers such as alkyd paints, polyesters, acrylic resins, PVA latexes, adhesives and fatty acid compositions of fats and soaps. The procedure developed is a derivatisation process where polar pyrolysis products are simultaneously converted during pyrolysis to their methyl esters or methyl ethers. Improved access to mass spectroscopy facilities for pyrolysis work has enabled a much more sophisticated analytical insight for the technique. The pyrolysis derivatisation gas chromatography procedure has revealed structure and composition in the above material not previously directly detectable.

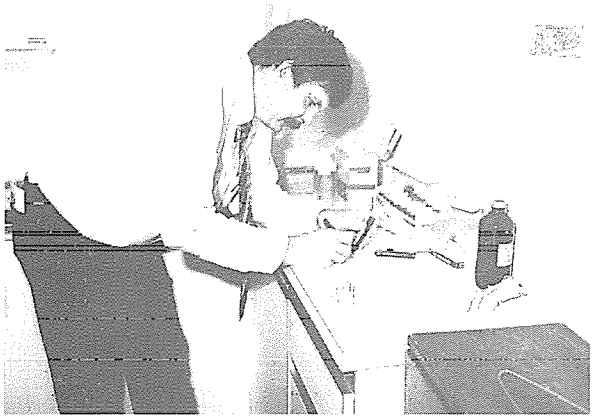
Racing Chemistry

Following on the etorphine scandal Cabinet made a $568 000 grant to upgrade the equipment and increase the staff of the Racing Chemistry section. These moves have enabled the section to test for a greater number of drugs at lower concentrations. In particular the narcotic analgesics have been targeted and new, extremely sensitive procedures have been instituted for their detection.



The Chemistry Centre's tests on horses have proven invaluable in minimising various ways of doping.

A meeting of the Principal Racing Clubs (Australia) in February 1988 decided to instruct their chemists to look for anabolic steroids in racing samples as of 1 August 1988. Previously, although covered in the rules of racing, anabolic steroids were ignored due to the costs involved in testing for this group of drugs. In conjunction with Murdoch University the Racing Chemistry section has been developing methods in preparation for this work.



Urine samples taken at the racecourse are labelled and sent to the Racing Chemistry Laboratory.

Urine samples undergo radio-immuno assay tests at the Racing Chemistry Lab.

HEALTH CHEMISTRY LABORATORY

The new Health Chemistry Laboratory was formed during the Chemistry Centre restructure to recognise the growing importance of health in the community. A great emphasis is placed on method development to help improve safety standards in the areas of occupational and public health. Applied research is also undertaken in conjunction with Government and commercial organisations to assist industry projects in the mining and agricultural areas.

Safety of Museum Exhibits

The WA Museum houses a large collection of animal, bird and reptile exhibits which have been collected over a period of years. Concern over treatment methods of various old exhibits resulted in laboratory staff visiting the Museum where they found some exhibits had been preserved with arsenic.

Subsequent checks were conducted on similar exhibits from country museums. The survey also examined the possibility of arsenic being transferred to the hands during routine handling. Assistance is being given to the Museum to help in determining if the arsenic level of treated specimens can be reduced. To date, the Museum has withdrawn several exhibits on the basis of early results. Work continues in this area.

Ord River Development Projects

A world-wide demand for high quality essential oils has resulted in interest from international dealers in the potential of the Kununurra area. The Health Chemistry Laboratory undertook taxonomic studies of lemongrass to identify commercial species by flavone analysis. As a result of this work selected species have been planted.

In associated trials with the Department of Agriculture and the Ord River Co-operative, trial crops of essential oil bearing plants are being assessed with regard to yield and oil quality. Production of high quality oil depends on factors such as rainfall, irrigation requirements, maturity at harvesting and distillation techniques. These and other factors are being studied in this long term project.

Safety in the Mining Industry

Laboratory staff visited the Goldfields and the Pilbara to participate in cyanide and fire assay laboratory seminars and also a ventilation officers course.

Chemical safety inspections of minesites and the investigation of specific incidents continued this year in conjunction with the Mining Engineering division.

Pyrolysis studies of construction material in underground conveyors and screens identified fumes released in combustion and charring. This was related to health effects, efficiency of respiratory protection and ventilation requirements.

New instrumentation has enabled specific analysis on sulphur based gas to be undertaken. Assistance was also given to the Mineral Processing Laboratory in identifying rotary kiln off gases collected during carbon regeneration trials.

KALGOORLIE METALLURGICAL LABORATORY

Staffing

Continuing increases in gold production throughout the State have contributed to the large amount of work received in the past year. The resignations of two senior professional staff and the delays in finding suitable

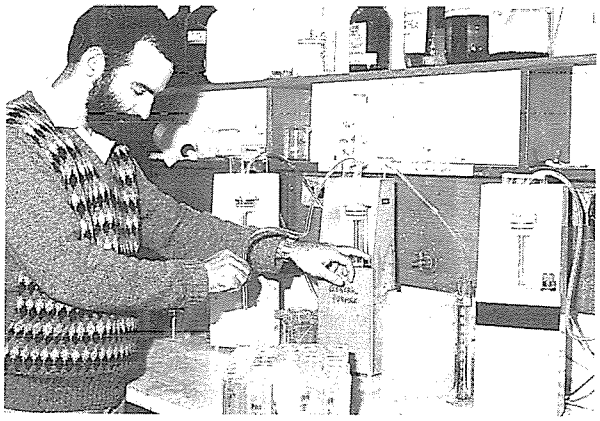
replacements has limited the amount of developmental work which could be carried out. Consequently the permanent staff have only been able to cope with client-sponsored work.

Three contract staff were employed at various times to assist with the workload. During the year, several professional officers from the Mineral Science and Mineral Processing Laboratories spent short periods of time as Acting Regional Metallurgist in Kalgoorlie. Late in the year Dr Vibhuti Misra was appointed Regional Metallurgist.

Analyses

There was a general trend towards more column leaching testwork compared with the standard bottle roll metallurgical evaluation of gold ores. This reflects the current interest in heap leaching of lower grade ore which has been stockpiled at most operating gold mines. Very few samples were received from single prospectors, indicating that the industry is now largely run by the bigger mining companies. Bullion analyses have continued to provide significant income with around 60-70 being handled each week. A computer system was installed to assist with bullion assay calculations and to allow standardisation of metallurgical reporting.

There is potential for expanding the Laboratory's activities in refractory ore treatment which is a growing problem for many of the open-pit gold mines in Western Australia. This will necessitate an internally funded research and development program and a closer link with the Mineral Processing Laboratory which already has some expertise in the area.



Greg Dellar measuring phosphorus absorption of soil.

Materials Science Laboratory

Public awareness of the availability of chemical expertise has caused an increase in contract work from WA small businesses. Clients involved in activities as diverse as mining, processing, formulation and manufacturing are consulting the Laboratory.

Potable Water

The Materials Science Laboratory is now involved at a national level in drafting an Australian Standard for material in contact with potable water. The working party will look at maximum levels of dissolved chemicals, methods of analysis and producing lists of prohibited raw materials and contaminants. Use of research grade instruments such as gas chromatography mass spectrophotometers is expected to be vital to the detection of low levels of organic chemicals.

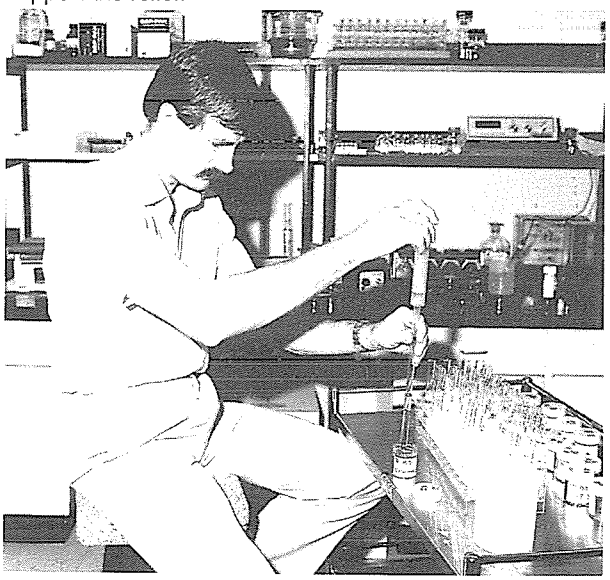
Restoration of Historical Buildings

Following on from earlier work to clean and restore natural stonework in Parliament House, the Materials Science Laboratory is involved in restoration of the Supreme Court Buildings. A variety of commercial acrylic, silicate and silicone treatments are being evaluated for use in the consolidation, strengthening and waterproofing of the natural stone and concrete of the Supreme Court. Recommendations for the cleaning of the accumulated dirt, and protection of the stonework against the acidic environment will be key focus points of this work.

Materials Conservation

Investigative work for the Conservation Department of Fremantle Maritime Museum has led to Dr G Richardson (Acting Chief) of the Materials Science Laboratory being appointed an Associate of the Museum (Curator Status). The work has predominantly involved analysis of artefacts from historical sites e.g. fat residues from whaling stations, resins on a stone axe, and boat filling compounds.

Characterisation of the materials used in the 'Tinworth' terra cotta relief, currently being restored by the Art Gallery, is underway. Iron oxide coloured backing plasters consolidated with a variety of natural gums support the relief.



Warren Ayliffe with one of the many urine tests required each week.

MINERAL PROCESSING LABORATORY

The year was notable for the increased level of activity in sponsored projects and the ability of the Laboratory to attract work from outside Western Australian. In addition to a large number of gold related projects the Laboratory carried out testwork on mineral sands, bauxite, gypsum, spodumene, tantalum, limesands, diatomaceous earth, peat, diamonds and copper. Greater utilisation was made of the pilot-scale facilities by clients, in particular the rotary kiln.

Gold Metallurgy

The Mineral Processing Laboratory's involvement in two collaborative research projects has generated considerable sponsored work from the Australian gold industry. Testwork carried out for clients included carbon activity measurements, electrowinning of gold from cyanide solutions, evaluation of the hardness of carbons, monitoring of CIP plant performance and cyanide destruction. An assessment was made of the fouling effect of a group of viscosity modifiers to be used at the Boddington gold mine.

Other Client Projects

Approximately 30 tonnes of bauxitic fines were processed through the rotary kiln for a large manufacturer. This project lasted 11 days and required operation of the kiln at 1430° C, a temperature much higher than previously experienced. Officers from other Laboratories in the Chemistry Centre were transferred to assist with the shift work requirements of the program. The kiln was also used for processing ore samples over a period of 36 hours.

A parcel of diatomite from the Hill River deposit in Western Australia was processed for a mining company. Several hundred kilograms of products were prepared by drying, pneumatic beneficiation and flux calcination at 1050° C. Two batches of product were tested for their suitability as a filter aid using the Laboratory's flow-test apparatus.

A copper concentrate was produced by flotation of a mixed copper oxide-sulphide ore from a gold mine. This project involved the operation of the ball mill grinding circuit and the continuous flotation plant. The client provided 900 kg of ore which yielded 31 kg of concentrate.

Testwork was carried out for another client to determine the feasibility of a low temperature molten salt route for converting spodumene from a tin mine to lithium carbonate. Low recovery of soluble lithium resulted in this processing method being rejected.

Ilmenite samples from different sources around Australia have been tested for their response to Becher upgrading. Small scale reductions were carried out in the Laboratory's electric furnace followed by aeration leaching to dissolve the metallic iron and produce synthetic rutile.

Departmental and Outside Research Projects

An ongoing research and development program is essential to maintain the Laboratory's expertise in current technology. Internally funded Departmental projects are the responsibility of individual officers to initiate and operate. Typical investigations include:

- Use of lime to capture sulphur during roasting of sulphides.
- Development of a slurry attrition test for activated carbon.
- Literature survey on solvent extraction of nickel, copper, tantalum and niobium.
- Commodity study of fluorite in Western Australia.

Collaborative research projects with Curtin and Murdoch Universities and CSIRO resulted in the presentation of several conference papers both in Australia and in the USA. The two projects are both related to gold; one is a general CIP investigation funded by AMIRA and the other, funded by MERIWA, is a study of roasting refractory concentrates. A new AMIRA project has been initiated within the Chemistry Centre on cyanide in tailings dams which, if acceptable to the gold industry, will involve the Mineral Science, Mineral Processing, and Environmental Chemistry Laboratories.

Workshop

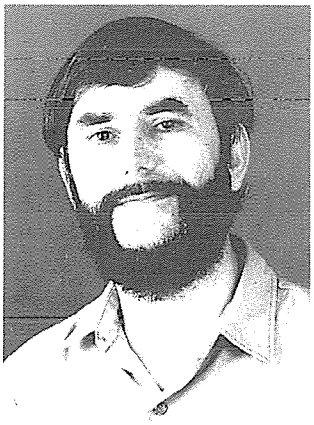
The Laboratory's extensive mechanical workshop facility was under some pressure to cope with the high workload experienced in this 12 month period. Considerable resources were allocated to modifications to the rotary kiln, flotation and grinding circuits to enable large scale testwork to proceed. Several one-off items of equipment were constructed for clients and a new fluidised bed roaster is nearing completion.

MINERAL SCIENCE LABORATORY

Laboratory Interaction

The value of maintaining the Chemistry Centre as an integral unit has been confirmed by the extensive interaction between individual laboratories during the year.

Among the joint projects set up have been the study of methods for the neutralisation of cyanide spills (with Environmental Chemistry), the assessment of health hazards associated with ceramic fibres (with Materials Science) and the general upgrading of mineral sands products and leaching of gold (with Mineral Processing).



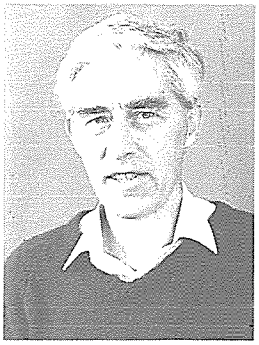
Mineralogist and Research Officer, Richard Clarke, an authority on asbestos and general fibre hazards.

Further to the work on ceramic fibres, a project was initiated to record the basic data of the commonly used types of man-made fibres as a reference document for occupational hygiene purposes.

A Mineralogist and Research Officer (R. Clarke) who has become an authority on the asbestos and general fibre hazard field, was co-opted to the National Working Party on Synthetic Mineral Fibres to review methods for fibre counting. A recommendation of appropriate methodology has been submitted for adoption by the National Occupational Health and Safety Commission. This work involved co-operation with officers from the Department of Occupational Health, Safety and Welfare and kindred officers from Commonwealth and State Departments.

Yanchep Caves

A Mineralogist and Research Officer (L. Bastian) who is also one of the State's most experienced speleologists, has undertaken the task of locating and documenting caves in the Yanchep National Park. The work, commissioned by the Department of Conservation and Land Management, has so far revealed a total of 23 caves and entrances, including one previously unknown cave.



Lex Bastian, Mineralogist and Research Officer, and expert Speleologist, currently documenting caves at the Yanchep National Park.

Stalactites and stalagmites in one of 23 caves in Bastian's study.

Quality Assurance

As part of the on-going program on quality assurance, the Laboratory took part in round-robin analyses of samples for gold set up by a private consultant laboratory, and of cement as part of a National Association of Testing Authorities program. The laboratory was also invited by the American Society for Testing Materials to assist in establishing recommended analytical figures for a new bauxite standard sample being prepared by the National Bureau of Standards (USA).

The results received regarding the gold revealed a wide spread of figures with the Chemistry Centre's results were positioned around the sample norm. No results have been received from the NATA program.

Support to Industry

As well as involvement with funded projects with the Mineral Processing Laboratory, the Mineralogy section has been in demand to carry out mineral investigational work by private mineral exploration companies.

Computer System

A personal computer installed in the laboratory during the year is being used to complete a number of administrative functions. The index to the Mineral Collection has been transferred to the computer system and has recently been extended by the addition of over 200 new specimens.

PUBLICATIONS AND LECTURES

The results of research and investigations conducted by the staff of the Chemistry Centre are published in a wide range of scientific journals as well as being presented at conferences and symposia.

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SOUTH PEPPER — NORTH HERALD

WESTERN MINING TEST NEW CONCEPTS IN DEVELOPING SMALL FIELDS

Originally discovered late in 1982, the South Pepper field was producing oil exactly five years later. In this regard the field is typical of many other offshore commercial oil fields found around the world but the similarity with these fields stops there.

South Pepper, and its smaller neighbour North Herald, collectively contain only six million barrels of recoverable oil and, therefore, must rank as the smallest oil fields developed independent of other existing facilities. An indication of the size of this project is that the fields will end up producing in four to five years as much oil as OPEC produces in eight hours.

While the development of these fields is a stand-alone project, the decision to develop was heavily influenced by the existence of other known oil accumulations in the area and the high prospectivity of the permit held by Western Mining Corporation (WMC). The decision also dictated that the fields should be developed in such a way as to ensure that facilities could be used for the development of these other known fields in the area and any future discoveries.

Accordingly, selection of the development plan was relatively easy despite the extensive study of alternative plans that had taken place during the previous three to four years. The scheme to develop Airlie Island with storage tanks and tanker loading facilities, while incurring a higher capital cost, was the only way in which other fields and future discoveries could benefit from the development of the South Pepper and North Herald fields.

Apart from being extremely small by offshore standards, these fields have also been difficult to appraise, as evidenced by the fact that only two of the four appraisal wells drilled in the South Pepper field encountered oil. In addition, the oil accumulation in the South Pepper field is a relatively thin column, making accurate assessment of expected recoveries almost impossible.

In an attempt to improve the recovery, drilling of horizontal wells has been part of the development scheme. The objective of these horizontal wells is to reduce the pressure drawdown in the reservoir and delay or retard the rate of gas and water coning. Prior to this programme two questions were unanswered:

(1) Could the wells be drilled with the required accuracy with the horizontal section of the well remaining at a certain true vertical depth plus or minus two metres.
(2) What improvement in recovery could be expected from the use of horizontal wells?

The first question has been effectively answered - horizontal wells can be drilled with the desired accuracy. Only time will answer the second and perhaps more important question.

Drilling of horizontal wells aside, the project used tried and proven techniques and equipment. While the use of a jack-up as a production platform is new to Australia, the practice is relatively common internationally and is becoming more common place.

In view of the small size of the project, strict control over costs had to be maintained. This was achieved through the use of lump sum, turnkey contracts and a very small management team, resulting in the project being completed on schedule and within budget.

While the success of this project in WMC's eyes must ultimately be measured in terms of recovery, of oil and profitability, the results to date and an important indicator for future WA development is that small offshore oil fields can certainly be developed commercially in WA.

A single well platform at North Herald is connected by a six inch flowline to the production facility (the jack-up rig "Vicksburg") situated in the South Pepper Field. A sub-sea completed well (South Pepper 4) is also connected to the production facility by a sub-sea 102 mm flowline and control umbilical.

The "Vicksburg" (on which production process facilities are located) is situated adjacent to the support structure which provides access to the three South Pepper well conductors plus several risers.

Crude from both the South Pepper and the North Herald fields is co-mingled on the "Vicksburg" processed and then pumped via a 152 mm trunkline to Airlie Island situated 25 kilometres to the south where it is stored in two 24,000 kL tanks. A 508 mm loading line to the tanker mooring terminal located two kilometres to the north of Airlie Island provides tanker loading facilities.

Project Schedule 1987

May 29	Project Approval.
June 22	Earthworks on Airlie Island commenced.
Oct 6	Vicksburg arrived at North Herald field.
Oct 26	North Herald jacket installed. Commenced drilling North Herald 3.
Oct 31	Installed production equipment on rig.
Nov 24	North Herald 3 completed. Rig moved to South Pepper location.
Dec 24	Completion of laying, tieing-in and hydro-testing a total of 6 pipelines totalling 42 kms.
Dec 27	First tank on Airlie Island ready to receive oil. Production from North Herald commenced.
1988	
Jan 1	South Pepper 5 commenced.
Jan 11	Tanker mooring terminal installed.
Jan 13	Second tank on Airlie Island commissioned.
Jan 16	South Pepper 6 completed.
Jan 28	Tanker arrives for first lifting.
Feb 1	South Pepper 7 completed.

Participants in the Project

- Western Mining Corporation Limited (operator)
- Pacific Oil and Gas Pty Ltd
- Petroz NL
- PPL Petroleum Ltd
- Command Petroleum NL
- Oge Limited
- Pan Pacific Petroleum NL

NOTE: *At the time of publication Petroz NL and PPL Petroleum Ltd are in the process of assigning their interests to Bridge Oil and Ampol Exploration Limited respectively.*

PETROLEUM DIVISION — ANNUAL REVIEW

Mr I Fraser, BSc (Hons)
Director

During 1987/88 the Petroleum Division continued its role of fostering the safe exploration, development and production of petroleum in Western Australia and its territorial waters, and acting on behalf of the Commonwealth in the adjacent Federal waters.

The year included processing of an increased number of applications for seismic surveys and well drilling in the State. The division collected some $600 000 in registration assessment fees. There were 17 new permits awarded and 26 new areas advertised; the highest number ever in one year.

The division was also active in promoting the 'drilling reservation concept', where prospectors are granted authority to drill over small areas without major financial commitments, for short tenancy periods, but with the right to a production licence should a discovery be made. This proposal received substantial industry support.

During the year Petroleum Division maintained its commitment to work safety in the petroleum industry by regular inspection of operations associated with seismic surveying, well drilling, pipeline laying, underwater diving, and production equipment installation and maintenance with regard to safety standards. The task of monitoring these activities was assisted by the appointment of three new officers; a Diving Inspector/Mechanical Engineer (M. Horlock); a Petroleum Engineer (T. Gouldie); and a Technical Officer (S. Medley).

Planning for another issue of 'PWA', Petroleum Division Director, Ian Fraser (right) and Assistant Director (Exploration) Keith Crank, compare notes for the next issue of 'Petroleum in Western Australia' which is published every 6 months.

State & Federal Legislation

Important matters covered in State and Federal Petroleum legislation include:

- issue of invitations to apply for exploration permits;
- issue of permits to successful applicants, and determination of conditions of title;
- renewal of permits and work programs in the renewal periods;
- granting of retention leases over presently non-commercial discoveries;
- granting of production and pipeline licences;
- approval of applications for farmouts and transfers of titles; and
- preparation and issue of regulations, directions, Special Prospecting Authorities, access authorities, authorities for Scientific Investigations, variations of title conditions, exemption from title commitments and cancellations of titles for non-compliance with the conditions of the title.

State exploration permits are issued under a work program system. In Federal areas, a work program system is generally used although a cash bidding system may be used in selected, highly prospective areas. The Joint Authority consisting of the Federal and State Mines and Energy Ministers is concerned mainly with important questions of titles in Federal areas. The State Minister is responsible for virtually all administrative details and surveillance of field operations in both State and Federal areas.

Operational Activities

Applications for operational activities (mainly seismic surveys and the drilling of wells) were received at a steady rate in 1987/88. The number of applications increased significantly on the previous year. This type of work has become increasingly complex because of the requirements under the new Environmental Protection Act and the greater interest being shown in the petroleum industry by conservation organisations.

Revenue Collection

In order to assess the royalty liability, the Petroleum Division ensured the accurate measurement of 1 916 150 kL of oil production, 1 174 600 kL of condensate production, and 3 915 573 x $10^3 m^3$ of sales gas production; with an aggregate royalty revenue of approximately $73 million.

In 1987/88 $1 530 000 was collected by way of rentals and other charges from the oil industry operating in Western Australia, of which $598,000 was the result of assessment of registration fees.

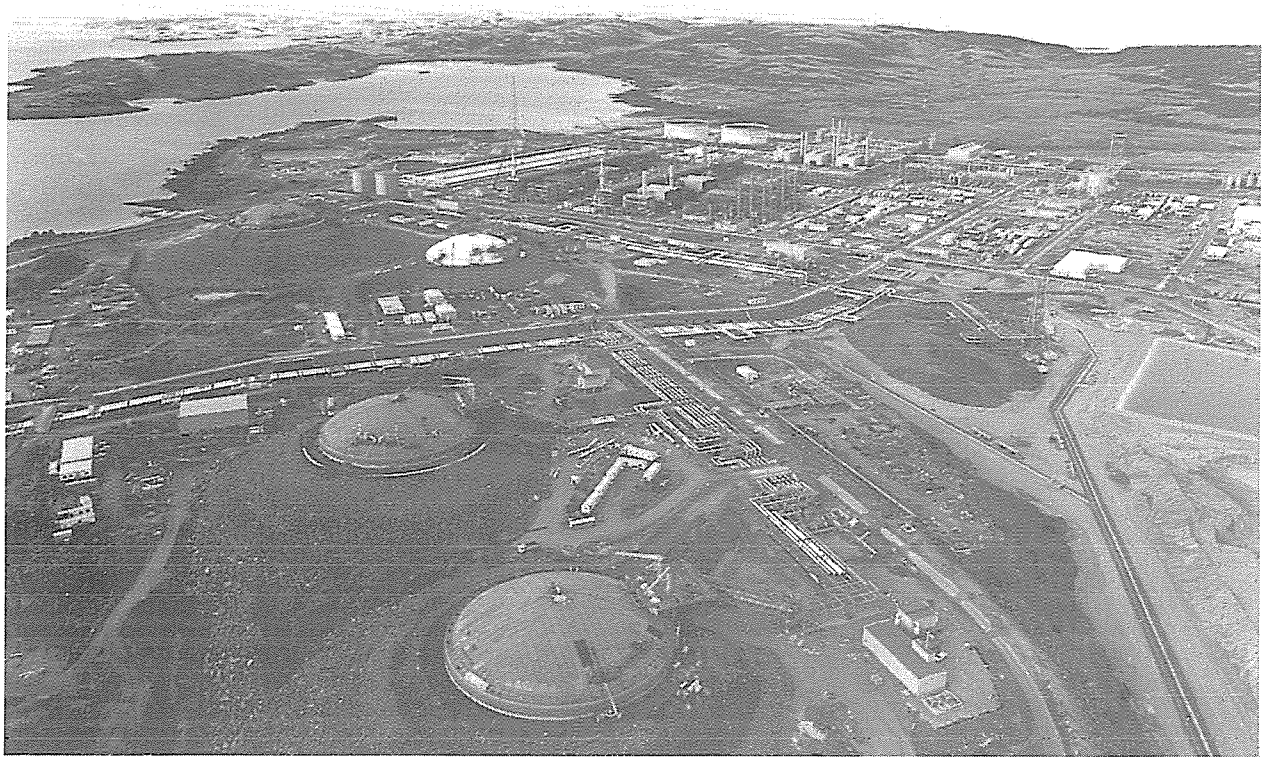
PETROLEUM EXPLORATION:

Petroleum Resources Branch

Overall drilling activity doubled compared to 1986/87 but seismic activity continued to drop, as it has done since 1985. To encourage exploration, particularly seismic, positive steps have been taken by promoting sole-risk seismic surveys, an exploration technique used successfully in many other countries.

During the year the first onshore speculative seismic survey was undertaken by Western Geophysical in a vacant area in the centre of the Canning Basin. This area was later offered as available for bidding, as 3 permits, with a closing date of 29 July 1988.

As part of the policy of promoting exploration during 1987/88, 17 new permits were awarded (7 offshore, 10 onshore) and 26 new areas were advertised as available



The massive Woodside Offshore plant to process natural gas and produce liquefied natural gas (LNG), nears completion on Burrup Peninsular in the Pilbara.

for application, the highest number ever advertised in one year.

New advertised areas are being promoted in the following ways:

- by previewing the proposed areas a year or more in advance of the gazettal date to allow more lead time for potential applicants to do meaningful studies;
- by encouraging sole-risk seismic surveys as has been done in the onshore Canning and offshore Carnarvon, Canning and Browse Basins; and
- in some cases, by publishing papers on areas to be advertised. This year a paper was prepared for inclusion in the North West Shelf Symposium held in Perth in August 1988. The release of several areas was timed to coincide with this symposium.

Drilling Reservations

Another concept being researched by the Division is a system of the Drilling Reservations whereby an authority to drill could be granted over a small area (say 1 or 4 blocks) without the encumbrance of a five year financial commitment. Tenancy is proposed for one year, renewable to two years, with the right to a Production Licence should a discovery result.

This proposal has been welcomed by the Industry and it is hoped that further development and refinement of the concept will lead to its incorporation in the onshore petroleum legislation in the near future.

Environmental Code for Seismic Surveys

The Petroleum Division is involved in the protection of the environment. For example, draft guidelines for a seismic survey environmental code have been prepared and submitted to a Work Party on Rehabilitation in the Mining and Petroleum Industry: Seismic Surveys, which is to meet during the latter part of 1988. The Assistant Director Exploration (K Crank) will act as Secretary for this committee. In addition the Director is a member of the new Bailey Committee studying petroleum exploration and development in nature reserves, a subject of considerable research by the Division during the past year.

Computer Records and Analysis

Considerable progress was made in the adaption of log analysis programs to the needs of the Division. These programs are essential to the efficient study of the reserves in the new fields coming on production over the next few years. Work program, permit and operational statistics data were incorporated into computer data bases and are now fully operational.

CURRENT PETROLEUM DEVELOPMENTS

Annual Production

Production for the year ending 30 June 1988 totalled 1 916 150 kL of crude oil, 3 915 573 x 10^3 cubic metres of sales of natural gas, and 1 174 600 kL of condensate. Oil was produced from Barrow Island, Blina, Sundown, West Terrace, Lloyd, Harriet, Dongara, North Herald-South Pepper, Rosette and Mt Horner fields; while gas and condensate were produced from the North Rankin, Dongara Mondarra, Yardarino and Woodada fields.

Petroleum Reserves at Year End

The main change since last year's report in the designation of petroleum reserves in the State is in the

use of a new standardised format based on a 90%, 50%, and 10% probability of confidence level.

Estimated recoverable reserves at 30 June 1988, based on 90% probability of recovery are shown in the following table, compared with similar figures for 1987.

Petroleum Reserves

	Crude Oil (10^6 kL)	Gas (10^9 m^3)	Condensate (10^6 kL)
	12.3	801.6	90.6
30 June 1988	20.3	859.2	90.0
Net increase/decrease	8.0	57.6	-0.6

The significant increase in crude oil reserves is mainly due to an upgrading of reserves in the Barrow Island and Harriet Fields plus the addition of Saladin and Egret reserves in the estimates.

Barrow Island Oil Field (West Australian Petroleum Pty Ltd)

Barrow Island field is located on a 233 square kilometre island, 88 kilometres north of Onslow. The first well was spudded in 1964 and since then 727 wells have been drilled. The field contains many reservoirs with the major production from the Windalia Sandstone. Production commenced in April 1967 and by 30 June 1988 cumulative production totalled 36 155 970 kL of oil. Total production for the Barrow Island field for the year to 30 June 1988 was 969 390 kL oil, and 97 729 x 10^3m^3 gas. Remaining reserves for the field are listed in the Statistical Summary.

Blina, Sundown, West Terrace and Lloyd Oil Fields (Petroleum Securities Group)

Blina field is located 105 kilometres southeast of Derby in the Canning Basin. Seven wells have been drilled in the field of which six are producing. Oil was discovered in the Blina-1 well in 1981 and production started on 30 September 1983. Production comes from two reservoirs, the Upper Devonian Nullara Limestone and the Lower Carboniferous Yellow Drum Formation, and totalled 21 537 kL for the year ending 30 June 1988.

The Sundown oil field, 26 kilometres northwest of Blina, produces from sandstones in the Permian Grant Formation. It commenced production in July 1984. Total production during the 12 months to 30 June 1988 was 2 872 kL.

The West Terrace field, discovered in June 1985 some 8 kilometres north of the Sundown field and also completed in the Grant Formation, produced 2 633 kL in the year ending 30 June 1988.

Lloyd-1 discovered oil in the previously unproductive Anderson Formation in July 1987. The field production to 30 June 1988 was 8 361 kL. An extension well Lloyd-2 failed to recover any hydrocarbons and was plugged and abandoned as a dry hole.

Overall oil production for the four fields in the Blina area for the year to 30 June 1988 was 35 403 kL.

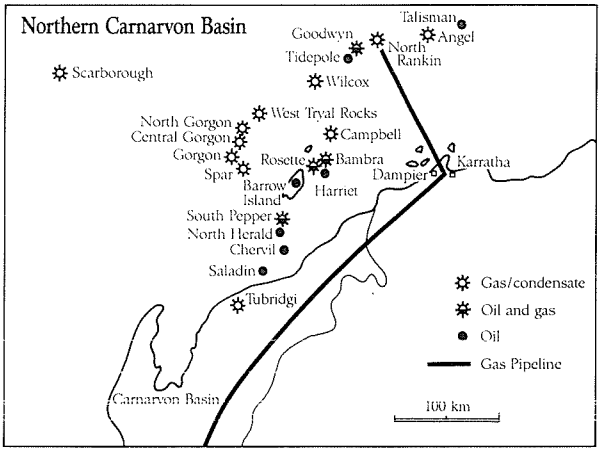
Dongara, Yardarino and Mondarra Oil and Gas Fields (West Australian Petroleum Pty Ltd)

These fields are located about 65 kilometres south of Geraldton. Production from the Dongara field began in 1971 and was followed by Mondarra in 1972 and Yardarino in 1978.

A total of 25 wells have been drilled in the Dongara field where gas, produced at a rate of about 275 000m^3 per day, is transported by pipeline from Dongara to Pinjarra via Perth and Kwinana.

The Mondarra field with two producing wells, and two plugged and abandoned, produced gas at a rate of 40 000m^3 per day. Yardarino field produces a small amount of gas from one well only. Oil production from Dongara averaged close to 20 kL per day during the first half of 1988.

Production of gas from the three fields totalled 256 x 10^6m^3 for the year ending 30 June 1988. During the same period 6 150 kL of Dongara oil was produced together with 935 kL of condensate. These fields produce from reservoirs in the Early Triassic and Permian.



Petroleum discoveries in the North West.

Mt Horner Oil Field (Barrack Energy Ltd)

The Mt Horner field is located about 380 kilometres north- northwest of Perth. The discovery well was drilled by WAPET in 1965 and since then 10 development/ extension tests have been completed. As of 30 June 1988 five wells are producing in the field. Production commenced in May 1984 and in the year ended 30 June 1988, 9 264 kL of oil was produced. The recently drilled Mt Horner-9 was completed as a producing well from a reservoir in the Cockleshell Gully Formation. Other producing reservoirs are the Kockatea Shale and basal Triassic sands.

Woodada Gas Field (Doral Resources N L)

Woodada field is 13 kilometres northwest of the township of Eneabba in the north Perth Basin. The discovery well was drilled in 1980 and since then 10 wells have been completed. Gas production commenced on 24 May 1982.

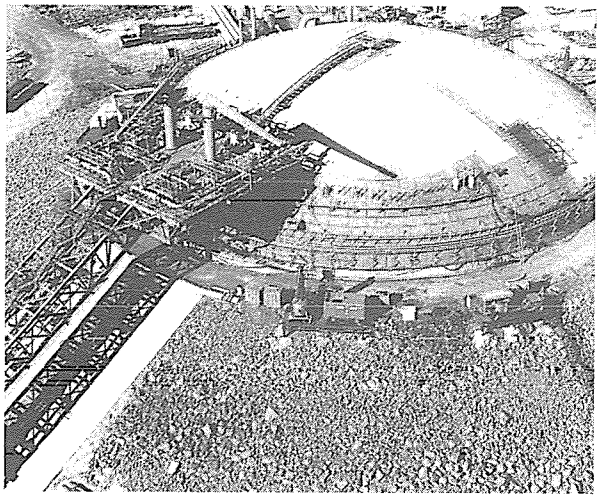
Early in 1987 the field was shut-in due to lack of available markets. Production re-commenced on 11 November 1987 and the field produces from six wells, on a rotational basis, with production limited initially to 250 000m^3 per week, until additional markets can be established.

The main reservoir for the field is in the Early Permian Carynginia Formation. Production for the year ended 30 June 1988 was 2 690 x 10^3m^3 gas, and 53 kL condensate.

Harriet and Rosette Oil Fields (Bond Corporation Pty Ltd)

Harriet field is located 20 kilometres northeast of Barrow Island and 120 kilometres west from Dampier, near the Lowendal Islands. Since the discovery well was drilled in 1983, 10 extension/development wells have been drilled with nine completed as producers and the other (Harriet-2) plugged and abandoned. Production commenced on 18 January 1986 and at 30 June 1988 a cumulative total of 1 391 506 kL oil had been produced. The reservoir is in Lower Cretaceous sandstones of the Upper Barrow Group. Oil is being produced at a rate of about 1 800 kL per day.

The Rosette field is currently undergoing extensive production testing. The field is located in the immediate vicinity of Varanus Island and was discovered by the directionally drilled Rosette-1 well drilled from the island, reaching total depth some 2000m offshore in October 1987.



One of three liquefied natural gas (LNG) storage tanks in the North West Shelf Development Project, to store refrigerated LNG for export to Japan.

North Rankin Gas Field (Woodside Offshore Petroleum Pty Ltd.)

North Rankin field is located 130 kilometres north-northwest of Karratha. The first well, North Rankin 1, was drilled in 1971 and production started in July 1984.

During the year ending 30 June 1988 3 651 x $10^6 m^3$ of gas and 1 173 611 kL of condensate were produced. The main reservoir is in the Upper Triassic Mungaroo Formation. Gas is currently being produced at a rate of about 23 x $10^6 m^3$ per day of which 13 x $10^6 m^3$ per day is reinjected into the reservoir.

The foundation improvement of the North Rankin A platform was completed satisfactorily and the Certifying Authority (Lloyd's Register) has issued a certificate verifying that the main platform and flare support structure is adequate for the 100 year storm design criteria.

In July 1987 gas recycling commenced on the North Rankin A platform and this has resulted in an increase in condensate production to approximately 3 250 kL per day. Work on the second stage LNG project is continuing and it is expected to come onstream in October 1989 with major LNG exports to Japan.

South Pepper/North Herald Oil Fields (Western Mining Corporation)

Western Mining Corporation completed the construction, installation, testing and commissioning work for its South Pepper/North Herald development facilities and production commenced on 28 December 1987.

The fields presently produce about 1 300 kL of oil per day. The development consists of two offshore wellhead platforms and a jack-up rig, used for accommodation and processing. Crude oil is then transported by submarine pipeline to storage and loading facilities on nearby Airlie Island.

The self-elevating jack-up drilling rig 'Vicksburg' arrived at Exmouth during October 1987 and assisted in the installation of the North Herald fixed platform and drilling of the North Herald No. 3 development well. The 'Vicksburg' was then towed to South Pepper where three production wells were drilled and production equipment was installed on the rig.

Future Developments

In addition to the Saladin project, the following petroleum developments are in various stages of planning.

Varanus Island LPG Plant

Bond Petroleum continued with its proposal to extract natural gas liquids from its fields in the Carnarvon Basin. The Company states that detailed design of the facilities and the award of contracts are progressing.

Talisman

Marathon Petroleum Australia has applied for a production licence for the Talisman oil field. The development plan is to install a subsea wellhead on the Talisman 1 well, with flexible flowlines to a moored tanker with production, storage and offloading facilities on board. The produced crude oil will then be transferred to a shuttle tanker for transportation to refineries.

Goodwyn

Woodside Offshore Petroleum Pty Ltd has made a submission for development of the Goodwyn field which is a condensate rich gas accumulation. The plan is initially to install an offshore platform with a 23 km long submarine pipeline to the North Rankin A platform.

Two contracts worth a total of $66 million have been let for the design of the Goodwyn A platform and work has commenced on the preliminary design. Topside work is expected to employ some 250 engineers and draftpersons, all in Perth.

OPERATIONS AND OCCUPATIONAL SAFETY:

Petroleum Engineering Branch

Safety is Paramount

The Petroleum Division has the responsibility of ensuring that operations having to do with petroleum exploration and development are carried out in a safe manner.

Safety standards established in Australia and overseas are required to be met or exceeded by the oil and gas

industry in the State. Legislation requiring adherence to these safety standards has been enacted and is reviewed and updated by the Petroleum Division as required.

Inspector Steve Walsh dons breathing apparatus and is lowered into a pressure production vessel to visually examine for defects or faults.

Safety Monitoring

Operations which are regularly monitored to ensure that procedures and equipment are up to safety standards are seismic surveying, well drilling, pipeline laying, underwater diving, production equipment installation and long term field development.

The prevention of oil and gas well blowouts is of primary concern. Standards for courses and blowout prevention certification have been established and industry participation in the courses is required. The division this year has formally accepted the course content and instruction staff of a Western Australian firm to teach blowout prevention theory and techniques to local industry workers. This new local course will probably allow a streamlining of current certification requirements and will improve blowout prevention understanding and awareness.

Foundation improvements to North Rankin A, the largest offshore platform in Australia, located off Karratha, has meant that demanning of the platform for safety reasons during cyclones or severe weather will no longer be required. Cyclone emergency action procedures were established by the platform operator and approved by the Petroleum division.

Daily reviews of applications to excavate near buried petroleum pipelines allow many activities, other than the piping of petroleum, to occur along pipeline easements within the Perth metropolitan area and in country areas.

The range of safety monitoring by the Petroleum division included the following:

- A summary report was developed concerning a fatal accident which occurred on the North Rankin A platform, the first fatility associated with petroleum exploration and production in WA in five years.
- Reports were submitted for all inspections, and appropriate correspondence entered into with the operating companies to rectify inadequacies in adhering to the requirements of the various Acts, Directions, and Schedules.
- A computer listing of field inspections performed was initiated this year, to provide a comprehensive summary of the particulars (date, inspector, location, purpose, etc) of inspections.
- A summary report was prepared on the results of an investigation into the circumstances surrounding the failure of the Fire and Gas System on the North Rankin A platform and actions taken by Woodside personnel during the course of this incident.
- Possible amendments to the Petroleum (Submerged Lands) Act concerning diving were reviewed, and a Code of Practice for Manned Submersibles was reviewed and returned to the Victorian Department of Industry, Technology and Resources.
- An incident concerning a decompression accident on the McDermott derrick barge DB-20 was investigated and a report prepared.
- Emergency and safety procedures and manuals which were submitted by permittees and licences were reviewed, modifications were requested where appropriate, and satisfactory manuals were approved for use.
- Random visits were made to check the calibration meter stations used for the sale of gas from the Dongara and North West Shelf gas fields. The loading and measurement of oil and condensate from storage facilities to tankers were also monitored for royalty purposes.

Special Projects and Continuing Operations

Work is continuing on the development of a comprehensive data management and problem solving micro-computer system which will allow the input and storage of most production, reservoir and geological data collected by the division. The system is entirely interactive, and is capable of preparing detailed management and engineering reports. Full reservoir engineering reports can be developed which calculate most formation and transient pressure parameters.

A draft of new WA Onshore Petroleum Production Directions was written and submitted to WA operators and to the South Australian Department of Mines and Energy for comments. A meeting in Adelaide to discuss uniform petroleum directions was undertaken. Approval for a re-alignment of the Dongara to Pinjarra pipe-line at East Perth was granted and field test work was witnessed.

Reserves and deliverability estimates for the Tubridgi onshore gas field were evaluated and checked against the information supplied by the operator.

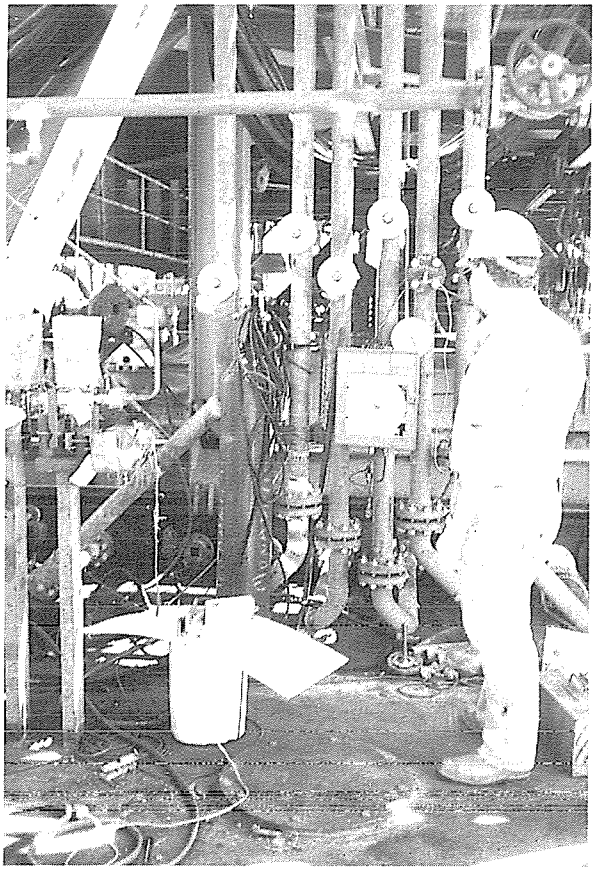
A material balance of produced petroleum through the installed production and metering systems at the Harriet field was reviewed and the operator's calculations were accepted.

A referral from the Environmental Protection Authority concerning the use of explosives underwater was researched and a response issued.

Reviews were undertaken of a draft copy of proposed onshore petroleum directions prepared by the South Australian Department of Mines and Energy. Also reviewed were the drafts of proposed codes on The Use of Electricity Underwater, The Operation of Manned

Submersible Craft, Underwater Air Breathing Operations, and Hyperbaric Evacuation.

The drillship 'Dan Duchess' was inspected in Singapore prior to its transfer into Australian waters.



Pressure testing production equipment. Calibrated gauges are used to monitor pressure testing of lines and vessels, witnessed by Inspector Mike Horlock.

Seminars and Conferences

Both the Production Geologist and the Exploration Geologist attended two courses in Perth; a computer training course and 'Oil and Gas Reserve Estimation' conducted by the Petroleum Exploration Society of Australia.

The Petroleum Engineer and the Petroleum Technologist each attended a five day Well Control and Blowout Prevention course at Curtin University in Perth, sponsored by the Oilwell Drilling Contractors Association of Australia and the University of Queensland.

The Diving Inspector/Mechanical Engineer and the Petroleum Engineer each attended a two day Sea Survival and Fire Fighting seminar sponsored by Woodside at Jervois Bay.

The Assistant Director Construction travelled to Singapore for the South East Asia Offshore Conference in February 1988.

The Petroleum Technologist attended an Australian Mineral Foundation course in Adelaide in February 1986, covering petroleum production operations, well completions, and stimulation techniques.

The Assistant Director Construction and the Petroleum Engineer attended and subsequently reported on several papers given at the Inter-national Conference on Calcareous Sediments in Perth in March 1988.

The Director attended the Australian Petroleum Exploration Association conference in Brisbane in March 1988.

The Assistant Director Construction, Petroleum Engineer and Diving Inspector/Mechanical Engineer took part in a seminar on measurement and measurement standards given by the National Standards Commission.

The Petroleum Engineer and Diving Inspector/ Mechanical Engineer completed Occupation First Aid Courses at the Red Cross centre in Perth.

SALADIN OILFIELD DEVELOPMENT

Joint venturers in WAPET's Saladin Oilfield Development, California Asiatic Oil Company, Texaco Oil Development Company, Ampol Exploration Limited, Shell Development (Australia) Pty Limited and Western Mining Corporation Limited, have given their approval for the project to proceed at a cost of $130 million.

At its maximum, the Saladin Field should produce about 9500 kilolitres, or 60 000 barrels of oil per day from the Early Cretaceous Flacourt Formation of the Barrow Group, at about 1020m sub-sea. Since reserves for the field are put at 30 to 40 million barrels, it is expected to have a life of at least six to seven years.

The engineering and project management contract for the project was awarded to the Perth based Dawson-Brown and Root joint venture after WAPET commissioned a feasibility study to look at various alternatives for the development of the field. It is anticipated that the Australian involvement in the contract will be in excess of 90%.

The field itself was discovered in 1985 after the Saladin 1 well successfully tested a seven metre perforated interval in the early Cretaceous Flacourt Formation. On drill stem test the well flowed at a rate of 875 kL, or 5500 barrels, per day.

Spurred on by this result, WAPET recorded 602km of seismic and teleseis in late 1985 and early 1986 within their exploration permit TP-3 in which the Saladin discovery was situated. Within this permit lies the most productive area of the field, approximately two thirds in waters up to 18 m deep, the remainder beneath the shoals surrounding Thevenard Island.

The next well in the field, Saladin 2, was drilled in November 1986, 1.5 km south-west of the first. The following February Saladin 3 was drilled a further 3 km to the south-west. Both were successful in encountering the same formation tested in Saladin 1, and flowed at a rate of 1745 and 1794 kL, or 10 976 and 11 284 barrels, of oil per day respectively. For single test intervals these wells had also recorded new maximum Australian drill stem test rates, considerable achievement given the maturity of the Australian offshore petroleum industry.

WAPET had understood the Saladin feature to be an elongated south-west to north-east trending structure closed against a north-westerly dipping normal fault on the upthrown side. Their appraisal program confirmed their interpretation. Barrow Group sand juxtapose impermeable Muderong shale providing a fault seal. The

first three Saladin wells have the same oil-water contact, indicative of a common reservoir.

It was after Saladin 3 that WAPET called on Dawson-Brown and Root to conduct design studies of the Thevenard Island development, and to report on costs accurately enough for decisions concerning the project to be made.

As required, WAPET also submitted an Environmental Review and Management Program for an assessment by the Environmental Protection Authority, whose report released in July 1987 found that the project was environmentally acceptable subject to certain conditions and recommendations. After a required public appeals period, a formal statement was issued in November 1987 by the Minister for Environment, endorsing the EPA's recommendations and conditions.

Detailed engineering design of the off-shore and on-shore facilities began immediately. Drilling re-commenced in late May 1987 with another offshore well, Saladin 7, 2 km southwest of Saladin 3 along the main fault, to further determine the southerly extension of the structure.

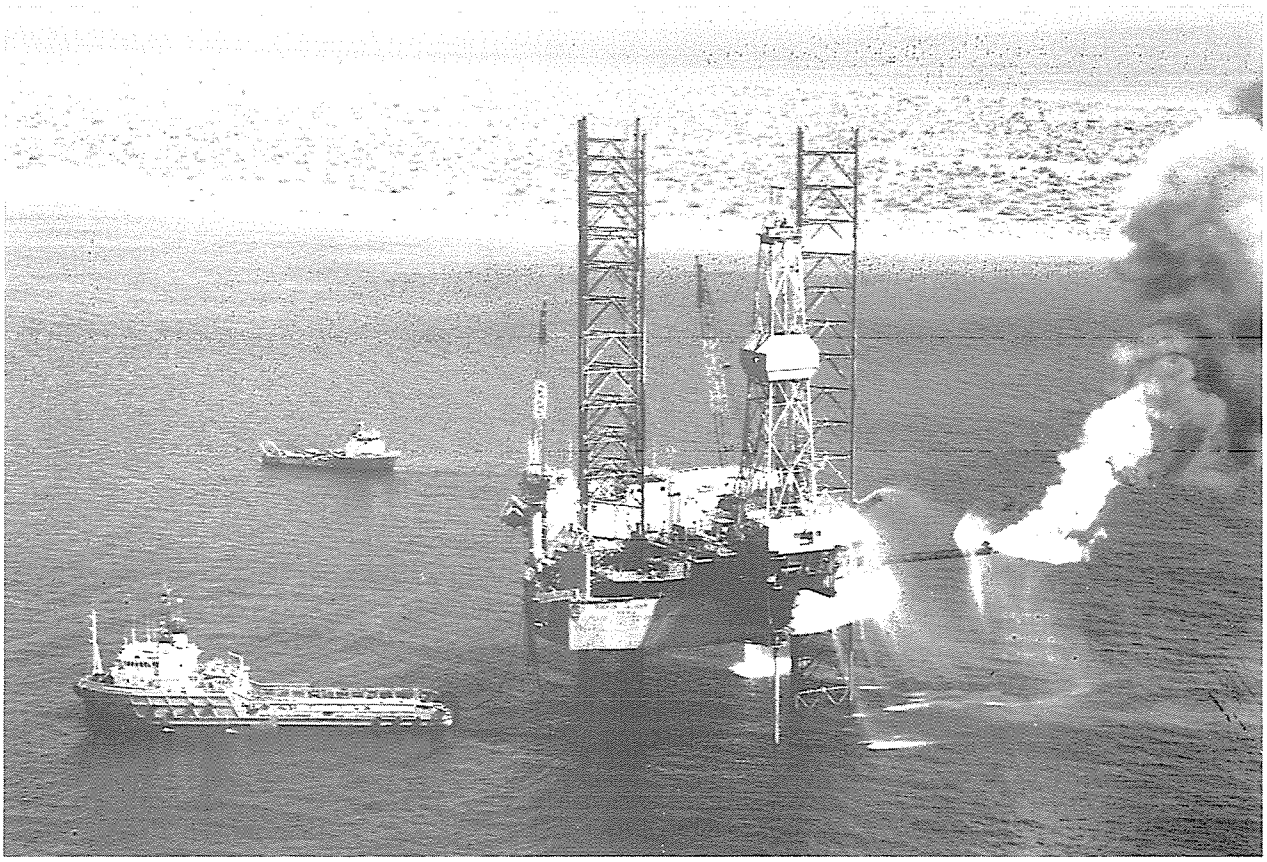
WAPET now plans to bring onto Thevenard Island a land rig to drill two directional wells from the Island out into the structure under the shoals area. The first will be aimed at a point between Saladin 2 and 3, and the second at a point to the south of Saladin 3. A third onshore well near Saladin 3 may be necessary depending on the results of the above wells and further reservoir engineering studies.

WAPET plans to install double deck topside platforms and three pile, three slot steel jackets over the Saladin 1, 2 and 7 locations.

Initial processing of hydrocarbons will occur at separation facilities on Thevenard Island after fluids are piped from the platforms along 150mm diameter subsea lines. The crude oil will then be separated and stabilised in three stages using a series of three phase pressure vessels and fixed roof tanks. Following this, the crude will be held in three 55,650 kl capacity floating roof tanks. Crude oil will then, via a 610mm pipe, be loaded onto tankers waiting 7 km offshore in a ten point spread mooring system.

Produced gas will be used as a fuel and instrument supply, and a ground flare has been designed to burn off excess gas. Special consideration has been given to the flare's design as regards the safety of personnel and indigenous wildlife. Later, as wells start producing water, this excess will be used under pressure for artificial lift of the remaining oil. Water used in the production process will be treated and then expelled to the sea beyond the shoals.

The construction workforce will be housed in Onslow near Beaden Creek and WAPET's existing shorebase will be used while construction on the project continues. Once production begins, the operational workforce will be camped on Thevenard Island itself. Actual onsite construction is to commence in the second half of 1988, and should be completed to enable production to begin in June 1989.



The jack-up rig 'Maersk Valiant' on location near Thevenard Island, testing Saladin Well No 3 for West Australian Petroleum Pty Ltd.

THE COOLGARDIE MAGAZINE EXPLOSION

The town of Coolgardie owes its existence to the discovery of alluvial gold in July 1892. The extent of the discovery turned the 'old camp' as it was known, into a bustling boom town and regional centre for the Eastern Goldfields.

As the surface gold deposits diminished, deep and hardrock mining continued in search of further deposits. An integral part of such mining is the use of explosives and to this end a Government Reserve for the storage of explosives had been set aside at the western end of Bayley Street.

As the townsite expanded to accommodate the population of Coolgardie, dwellings and business premises encroached upon the boundaries of the Explosives Reserve.

Several representations had been made by the Municipality of Coolgardie to have the magazines relocated but more for the sake of commercial interest rather than safety. During this period two Police Constables (PC Furlong and PC Chandler), were walking the 'beat' in Coolgardie at 3.45 on the morning of 19 May 1904.

PC Furlong reported that; "I was at Sylvester Street walking in a westerly direction, as I passed the fire station I noticed the sky suddenly become illuminated and about a minute afterwards, or perhaps a little less, I heard a noise of glass being smashed. I came to the conclusion that one of the magazines had exploded."

This conclusion was accurate as an immediate investigation of the Explosives Reserve revealed that a magazine owned by the National Explosives Company had exploded together with an associated detonator magazine. The extent of the explosion is revealed by the size of the crater where the magazine had been located. It was reported as an "inner crater 27 feet (8m) in diameter and 9 feet (2.7m) deep with an outer crater of 51 feet (15.5m) in diameter. The detonator magazine some 50 feet (15m) from the main magazine had disappeared altogether.

Stock records held by the explosives company's agent revealed that the main magazine had contained:

289 cases of Dynamite.
124 cases of Blasting Gelatin.
18 cases of Gelatin Dynamite.
251 cases of Gelignite.

The total of 682 cases equate to a little over 17 tonnes of nitroglycerine type explosives. The detonator magazine had contained 113,200 detonators of various sizes. Other magazines at the Reserve were slightly damaged but their contents had not been affected by the blast.

The most damage to any building appears to have been caused to a water condensing plant owned by a Mr McAlister and situated about 250 yards (228m) to the south of the magazine that had been destroyed.

McAlister lived on this site and was found by the investigating party soon after the explosion. The newpaper, **Coolgardie Miner**, of 19 May 1904 reveals the effect of the explosion upon McAlister and his camp in the following report:

"No lives were lost"
"McAlister who resides about 400 yards from the magazine was then looked up and in response to our call he came to the door.

"The wire fence which surrounded the building was strewn about in all directions and every tree in the neighborhood was stripped of its branches. Grave fears were at first felt for those known to be camped in the locality of the explosion.

"Mr McAlister had by no means recovered from the shock when the party found his camp. In the light of the several lamps it was seen that his escape was undoubtedly marvellous, for around his camp was strewn debris from the combustion. He emerged from the ruins of his domicile, with his face besmeared and he was considerably dazed.

The Chief Inspector of Explosives, Mr E A Mann, left Perth by train for Coolgardie on the day of the explosion and arrived the next morning. His investigation included interviews and statements from a range of people.

"Eliminating unnecessary hypothesis" he listed the probable causes as: lightning, deliberate or accidental human agency, or by spontaneous ignition due to chemical decomposition.

A Coronial Enquiry was called; the Chief Inspector, Mr Mann, drew attention to the fact that part of the magazine stock was old and had recently failed the 'heat test' applied to explosives to assess its sensitivity. This condition was not considered sufficient to contribute to spontaneous ignition.

The verdict of the jury was; "that the explosion of the National Explosives Co's magazine on May 19 was caused by fire in the interior of the main magazine, but from the evidence we are unable to decide how such fire was caused."

The jury added a rider; "that they are of the opinion that the magazines are too close to the town as evidenced by the damage done by the late explosion."

In confidential Departmental correspondence, the Chief Inspector disagreed with the rider, claiming that the relatively light damage from such a huge explosion proved that the magazines were correctly located in accordance with the Explosives Act and Regulations.

The matter was publicly aired for some time in the local press, mainly The Coolgardie Miner. Eventually the matter was "put under consideration" by the Under Secretary for Mines and a new site to the west of Coolgardie was selected and gazetted as an Explosives Reserve. On 28 June 1905, the Acting Chief Architect of the Department of Public Works informed the Under Secretary for Mines that the removal of the magazines from the old Reserve had been completed.

The Coolgardie explosion of May 1904 is considered of significant importance in the study and investigation of the causes and effects of large quantities of explosives and is reported in the 'History of Explosions' published by the Institute of Makers of Explosives.

In terms of the quantity involved, the accident ranks as about the 47th largest accidental explosion recorded in the 'History of Explosions'.

EXPLOSIVES & DANGEROUS GOODS DIVISION — ANNUAL REVIEW

Mr H Douglas, APTC (Chem), C Chem, ARACI
Director

The strong resource development sector in Western Australia has created the need for a professional and active Explosives and Dangerous Goods Division. With a greater involvement in hazards analysis and risk assessment the Inspectorate's role, though still that of an advisor and educator, has become one of safety auditor in maximising public safety in all matters concerning explosives and dangerous goods.

Acting on the recommendations of the North West Shelf Technical Safety Committee, Cabinet approved the appointment within the Explosives & Dangerous Goods Division of a Safety Co-ordinator who commenced duties in early 1988.

Accidents in 1987-88

An articulated tanker vehicle carrying in excess of 40,000 litres of petrol overturned. The cause was attributed to skid-plate design faults and resulted in the withdrawal of approval to operate such vehicles until the skid-plates of all similar tankers were approved by qualified design engineers.

Two other unusual accidents occurred during the year:

- A freak explosion which seriously injured a Curtin University geology post-graduate student during seismic survey operations at a Moora farming property.
- A violent explosion which wrecked an engineering shed when a cutting torch was applied to a tank which had not been gas freed.

Australian Dangerous Goods (ADG) Code

Prior to publication of the latest edition of the ADG Code discussions were held with Parliamentary Counsel to redraft sections of the Dangerous Goods (Road Transport) Regulations, to ensure continued conformity with the requirements of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code).

Kalgoorlie Reserve

Extensive development continued at Kalgoorlie during the year. There are now manufacturing plants at the Kalgoorlie Reserve, being operated by all the major explosives companies (CBS, Du Pont, ICI and Nitro Nobel) and these plants also support satellite plants distributed at various locations throughout the goldfields.

Liaison and Hazard Research

The Division carried out liaison work with Westrail, the EPA and CSBP, on the design and approval of tank containers and the rail/road transport of liquid sodium cyanide from the Kwinana manufacturing plant to operating mine sites.

Staff from Explosives and Dangerous Goods also worked closely with personnel from the British firm, Technica Pty Ltd, which specialises in quantitative risk analysis. Technica reviewed the hazardous aspects of shipments of Ammonium Nitrate from Bunbury.

Inspecting packaging and labelling prior to transportation.

Clerical Operations

The processing, issue and renewal of licences and permits prescribed under the regulations continued to be one of the major activities of the clerical section. These procedures have now been enhanced to some degree with the completion of a review and refinement of the computerised licensing system.

Facsimile equipment was upgraded during the year and this has enabled the Division to improve its communication links within Australia and overseas.

Although staff resources remained constant throughout the year there were several staff movements which required more time being allocated to staff training.

Authorisation of Explosives

During the year 14 new explosives were tested and authorised for use in Western Australia. Over the past 10 years numerous additions and deletions to the list of authorised explosives have occurred and action was subsequently taken to gazette a revised list.

Shotfirer Training

The increased level of mining activity in the State has, during the past few years, increased the need for experienced and qualified shotfirers in WA.

Qualified shotfirers are also employed in other areas of work - roadworks, construction projects, agriculture, and other specialised applications such as pyrotechnics (fireworks).

The Explosives and Dangerous Goods Division has been active in the running of shotfirer training courses since 1972. The courses are run on a full-time and part-time basis. The full-time courses are run over 5 days with 1 day dedicated to practical work. The part-time courses are run through TAFE (Technical and Further Education) over a 12 week period (3 hours/week) with 2 full days for practical work.

The full-time courses are run specifically to cater for the needs of the public sector - State Energy Commission, Main Roads Department, Water Authority of WA, City and Shire Councils, etc.

Prospective shotfirers are trained on the basics of safety fuse firing, electric firing, and detonating cord firing. The requirements of the Explosives Regulations 1963 with respect to the responsibilities of the shotfirer on the safe handling, use, transport and storage of explosives are also covered in the course.

Instructors organise field trips to farm sites or quarries for students to get practical experience with explosives. Working in groups of 3 or 4, students are given projects to work on e.g. removing a dead tree or stump, breaking a boulder, or blasting a trench.

Shotfirer's permits are issued to candidates who pass a written examination on the various aspects of shotfiring, and who do not have a criminal record.

Some seven or eight full-time/part-time courses are held in the metropolitan area and three or four part-time.Ecourses are held in the Kalgoorlie/South West region of the State. Courses ar also run in the North West region, depending one demand, at Colleges of Advanced Education.

During the past 16 years, approximately 2400 shotfirers have been trained through these courses.

Inspector Richard Bilman, (right) with police officer, inspecting road tanker.

Activities of the Safety Co-Ordinator

Public awareness of the inherent danger in the transport of dangerous goods, and demand for greater control of the major hazards involved in the hydrocarbon and chemical process industries, has increased in the last decade. A European community directive on the major accident hazards of certain industrial activities was adopted by the European community in June 1982, relating to this concern.

The directive has been a force to promote new legislation reflecting community concern, and to harmonise the approach by the various member States. Each State has developed its own regulations to achieve the intent of the directive. Typically these regulations apply to all sites where there is any activity involving specified quantities of certain hazardous substances; and also apply to off-site pipelines used for transferring quantities of hazardous substances.

The regulations which were primarily concerned with fixed land-based installations, also apply to inland waters. Thus jetties, stationary ships used for processing or storage and transferring equipment, are included. These regulations have also been applied to sites which are subject to other regulatory controls, such as explosives factories and mines.

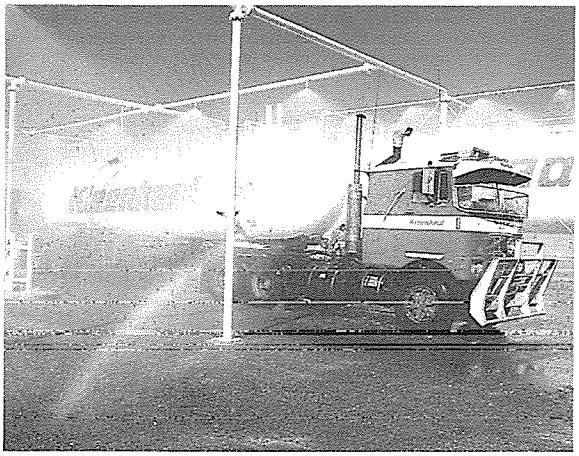
Similar Legislation in WA

A similar system of controls is being developed in Western Australia. There is no document equivalent to the European community directive but discussions take place between the various States to develop harmonised regulations. The major hazards policy unit within NSW is

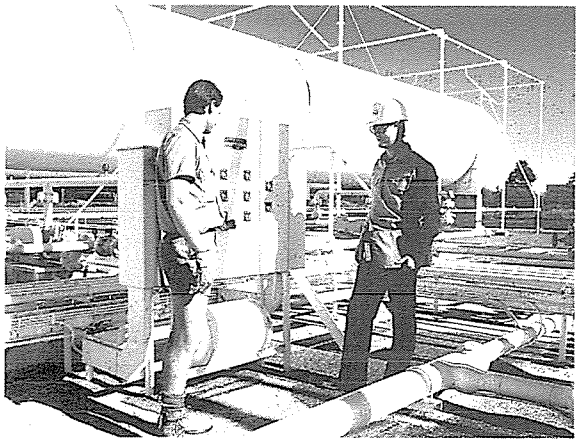
actively involved with the relevant departments in Victoria, South Australia, and Western Australia. With the rapid growth of WA companies processing gas from the North West Shelf, regulations and controls are timely and necessary.

The preparation of regulations forms only one side of the pyramid to control major hazards. The second 'side' is the interaction between Government and industry which deals with the avoidance, elimination and reduction of risk. The third is the interaction between the various regulatory authorities within Government, to ensure the application of an overall system of hazard identification and control.

A co-ordinating role has been set up within the Explosives and Dangerous Goods Division to develop, monitor, and coordinate the control of major hazards. Regulatory systems and auditing systems which have been successful overseas and interstate, will be evaluated and where appropriate incorporated in the control pyramid. The assessment and quantification of risk which



Loaded gas tanker being washed at LPG stripping plant.



Explosives and Dangerous Goods officer, Don Burgess (right) inspecting the same plant.

fills the centre of the pyramid requires considerable skilled manpower. The assessment provides a demonstration to Government that the hazards have been identified and practical measures taken for their control. Industry also benefits from this process as safer, more reliable plants, with lower operating costs, frequently result from the formal assessment and quantification of risks.

Packaged Dangerous Goods at Transport Yards

Early in 1986 the Division embarked on a campaign to check compliance with the packaging requirements of the Dangerous Goods (Road Transport) Regulations. In brief the regulations require packages to be of an approved standard and correctly labelled.

The first phase involved Inspectors attending the premises of all known consignors (manufacturers, formulators and distributors) of dangerous goods, over a six to nine month period. These premises are the source of the majority of packaged dangerous goods transported throughout the State and inspection and advice at the source simplified the operation. The Division had limited authority to take positive enforcement action (e.g. prosecute) since the regulations apply to the actual transport and offering for transport of dangerous goods.

At the conclusion of the initial phase it was obvious that another mode of operation would be required in order to achieve compliance in areas where problems existed. The second phase was attendance at despatch yards where transport companies (the prime contractors) had received goods from consignors to despatch (i.e. the dangerous goods had been offered for transport).

Preliminary work indicated a high level of support and co-operation from the prime contractors.

During 1987, Inspectors attended transport yards and inspected consignments of packaged dangerous goods and associated documentation. Consignments were detained wherever one or more items of non-compliance was observed with respect to either labelling requirements, package standard, or shipping documentation.

On being issued instructions not to forward the goods, the transport companies simply contacted the consignor and requested rectification of all deficiencies prior to movement of the goods. Consignors were then advised in writing of the interception and also warned that prosecution would follow if further breaches were encountered. Significant success was achieved through this method of operation, immediate compliance being effected and prosecution used only as a last resort.

The approaches used in ensuring compliance to this point had the desired effect, however problems still existed with goods arriving from other States and goods being delivered direct from consignor to user without consolidation at a transport yard. The only conceivable method of policing this area was in the interception of vehicles in transit. The Division does not have the authority to stop vehicles for roadside inspections except in the case of imminent danger so in late 1987 it was decided to conduct joint operations with Police.

Joint Police Operations

By working with police traffic officers, Inspectors are able to have vehicles carrying dangerous goods stopped using the authority of the police force. In this way vehicles in transit may be stopped safely and legally.

Once stopped, an inspection of the vehicle, the cargo, and the documentation is made by an Inspector. Any areas of non-compliance which are encountered are recorded and an infringement notice is then issued.

Department of Mines Inspector, Chris Howes (centre), in action during joint operations with WA Police, making roadside inspections of vehicles conveying dangerous goods.

All dangerous goods vehicles must carry emergency equipment relating to the nature of the dangerous goods e.g. breathing apparatus, protective clothing, face shields and fire extinguishers. All equipment is checked for its condition and date of servicing.

By stopping a vehicle in transit the inspection is of maximum value as various responsibilities of the consignor, prime contractor, and driver can be assessed at that instant and relevant information gathered for legal action if warranted.

A benefit from these joint operations was increased public awareness through major media coverage.

Conferences and Committees

The Director continued to chair the Competent Authorities Sub-committee (CAS) of the Advisory Committee on the Transport of Dangerous Goods. The CAS plays a critical role in assuring conformity in dangerous goods legislation across the nation.

The Deputy Director attended a conference in Washington D.C. run by the Hazardous Materials Advisory Council, delivering a paper on performance based packagings in Australia. This was followed by a conference in Chicago which included seminars on 'risk management' and the operation of dangerous goods facilities to prevent spills.

While in the United States the opportunity was taken to discuss matters of mutual interest with State and Federal regulatory authorities and industry groups. Subjects discussed included:

- the management of underground storage tanks and their potential problems following leakage;
- the transport and storage of Ammonium Nitrate;
- the conveyance of dangerous goods by road; and
- the storage and road transport of liquefied natural gas.

Complementary to this, the Deputy Director represented the State on a working group set up by the Australian Minerals and Energy Council to consider the development of uniform legislation for the LPG industry.

The Safety Co-ordinator attended a Major Hazards conference organised by the Institution of Chemical Engineers, in association with the American Institute of Chemical Engineers. The conference was concerned with preventing major chemical and related process accidents. Case histories were discussed including BHOPAL, SANDOZ and the Shell/Esso Mossmorran Development.

NEW COUNTER TO IMPROVE COMMUNICATION

The Department of Mines has always been conscious of its responsibility to communicate effectively with the mining industry and the general public, and is constantly looking for ways to improve all levels of communication.

Effective communication is needed in over-the-counter situations to provide prompt answers to enquiries and to supply adequate and appropriate information.

The Mining Registration Division's Outstation Mining Registrar's office has stood the test of time by providing prospectors and the industry with a complete mineral field informational centre at one counter.

The scope of service provided by Outstations at a single counter was, however, not available in Perth until this year. On 30 May 1988 the Department's Mining Information centre, a 'one stop counter', opened on Level 1 of the refurbished Mineral House. This centre, largely replaced the existing public counters of Mining Registration, Surveys and Mapping, and Geological Survey, all on different floors in the building.

Functions handled at the new Mining Information Centre include :

- perusal and sale of plans;
- sale of Acts and geological publications;
- receipt of tenement applications and dealings;
- tendex and search information;
- supply of microfilm reports; and
- payment of rentals and other Departmental accounts.

After some initial teething problems the operation of the Mining Tenement Information Centre has proved a success.

To help the Mining Registrars and their staff satisfy industry demands for the speedy transmission of documentation information, facsimile machines were installed in each Outstation office during 1987/88. Computer terminals are also being progressively installed to give each Registrar access to the Tendex mining tenement information system.

When this is completed, it will be possible for changes to the Tendex data base to be recorded by the Registrar virtually as documents are lodged. The result will be more current tenement information.

The Kalgoorlie office will be the first to carry out its own update of the Tendex database. Once this system is perfected other Outstations will progressively commence their own updates.

When these developments are complete it will be possible, by presenting oneself at any counter of this division, to obtain details of any mining tenement throughout the State, within hours of it being applied for if necessary.

The Division's Outstations are located at Broome, Carnarvon, Coolgardie, Kalgoorlie, Kununurra, Marble Bar, Leonora, Meekatharra, Mt Magnet, Norseman, and Southern Cross.

The new 'Mining Information Centre' on level 1 of the refurbished Mineral House Complex, replaced the Mining Registration, Surveys and Mapping, and Geological Survey Public Counters on different floors of the Building.

MINING REGISTRATION — ANNUAL REVIEW

Mr W Phillips, Dip Pub Admin
Director

As a result of the October 1987 Stockmarket crash the 1987/88 year was one of marked contrast for the division. The first quarter of the year continued the high levels of tenement applications experienced in 1986/87 which had made for a record number of applications in that year. After October the mining tenement applications fell to one third of the pre-market-crash levels. This situation is further illustrated in that 57% of all tenement applications received in the 1987/88 year were received in the first four months of the financial year to October.

Despite the fall in tenement applications the area covered by mining tenements at 30 June 1988, increased by 21% to 26 998 964 hectares, compared with 22 232 171 hectares at 30 June 1987. This is the largest area of the State ever covered by mining tenements. It exceeds by some 3 million hectares the area that was covered during the height of the nickel boom in 1970.

Existing staff resources were fully utilised to cope with a demanding year in all divisional activities.

Cashier Darren Sara receipts a customer on the ADS electronic cash register at the new Mining Information Centre.

Tenement Applications

Applications received for the year ending 30 June 1988 totalled 9276. The application types, and the comparative number for the previous two years were :

	1987/88	1986/87	1985/86
Prospecting Licences	5361	7045	4636
Exploration Licences	1671	1927	1075
Mining Leases	1838	1089	676
Other	406	255	147

Figure 1 shows tenement receivals (and areas) since 1 January 1982. The 1987/88 receivals represent some 18% of all applications lodged in this six and a half year period.

A table depicting mining tenements in force in each mineral field on 30 June 1988 appears in the Statistical Summary section.

During the year 8056 tenement applications were approved. This is 16% more than the number of tenements approved during 1986/87 and they encompass an area of 13 915 018 hectares, which is 25% more than the previous year.

Prospecting Licence Extensions

The number of extension applications received during 1987/88 was 2804, an increase of 37% over applications lodged during the previous 12 months. This increase is a natural flow-on from the high number of prospecting licences applied for and granted during previous years.

Director of Mining Registration, Bill Phillips, with Deputy Director, Roy Burton, during the final period before the new 'Super Counter' was opened.

Dealings

A total of 20 714 dealings were received in 1987/88; and increase of 19% compared with the number received during 1986/87. As in previous years the transfers, agreements and caveats continue to represent the major portion of dealings received, as illustrated in figure 2. The percentage of each type of dealing received during 1987/88 is similar to the percentages experienced during the previous year.

Tenement Surveillance - Reporting and Forfeitures

The Department received 14 914 reports on operations of mining tenements for 1987/88; an increase of 8% from the year previous. This is in line with the increased number of mining tenements now in force.

Applications for exemption from labour and expenditure conditions received for the same period increased 70% to 2954, compared with 1737 during 1986/87.

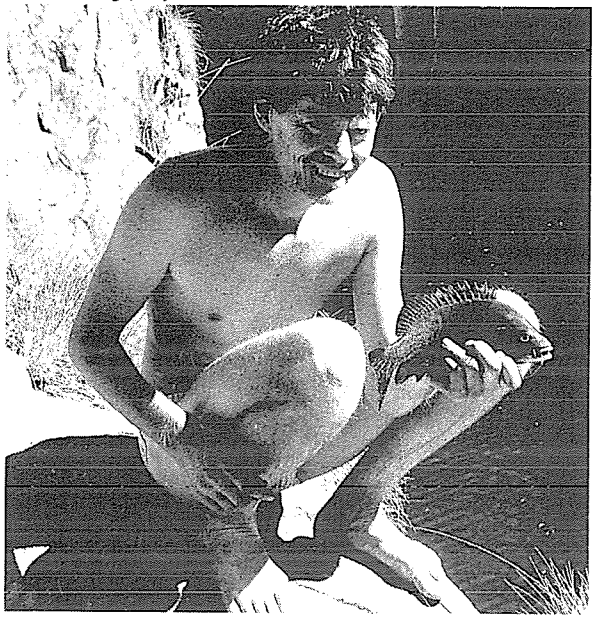
Monitoring of tenements for breach of rental or expenditure convenants continued throughout the year. The result was the issue of 1170 notices of intent to forfeit mining tenements. In general industry displayed an increasing awareness of the need to comply with expenditure obligations as reflected in the increasing number of exemption applications where expenditure shortfalls occurred.

Mining Information Centre

On 30 May 1988 the Mining Information Centre opened for business. This new facility will offer industry a 'one-stop' shop at Head Office with functions previously operated by the Mining Registration division, the Mapping Information Centre, and the Geological Survey public counter.

The Mining Information Centre provides services which include:

- mining tenement data via Tendex computerised database, manual registers and working map libraries;
- map and publications sales including geological and mining related maps;
- general advice on a spectrum of mining related enquiries and referrals to key Departmental officers as required; and
- community and general public enquiry services including project material.



Another view of Roy Burton, this time on the first Outdoor Challenge/Management Skills Development Course in the Kimberleys, sponsored by the Chamber of Mines WA, which involved groups of 8 in decision making based on the outdoors, and utilised survival rather than business oriented decision making process. This is the city executive Roy with the first of several fish he caught using grasshoppers as bait. Photo — West Australian Newspaper.

Tendex (Mining Tenement Information System)

This computerised information service, which became operational in November 1985, provides a productive tool for the Department and the mining industry.

Tendex is a computerised tenement index system, collating basic tenement and plan data, which generates reports for sale and provides the Department with the means to quickly update its plans.

By the end of 1988 Tendex facilities will have been installed in offices of the Mining Registrars at Leonora, Mt Magnet, Meekatharra and Kununurra, allowing prospectors and companies operating in these areas direct access to the system. It is planned to extend the Tendex network to a further three Mining Registrars' offices by the end of June 1989.

Work will commence in the last quarter of 1988 to further develop Tendex software to allow rental, expenditure and exemption details to be placed on the database, thus increasing the Tendex benefits.

Warden's Court

Due to the continuing high level of mining tenement applications over the last three years, Wardens' Courts remain under an extremely high workload. Some courts still have long lists of matters awaiting hearing, although since the stockmarket crash the situation has eased.

Warden's Court plaints lodged have fallen from 490 during 1986/87 to 247 in 1987/88. There were 1404 objections to tenement applications received during the same period.

Rationalisation of Outstations

The Mining Registrar's office in Cue was closed on 22 January 1988, and administration of the area transferred to Mt Magnet. This was done as a part of a regionalisation concept to allow for better use of the Department's limited resources.

Consolidated Mining Act

A consolidated reprint of the Mining Act and Regulations as at 1 August 1988 was issued. Although further legislative amendments are in the pipeline, the reprint is in great demand.

Illegal Mining

A number of successful prosecutions occurred during 1987/88, under the illegal mining provisions of the Mining Act 1978. The penalties presently provided for illegal mining in the Mining Act 1978 are to be substantially increased in the near future.

Amendments to Mining Act

Amendments to the Mining Act 1978 during the period under review are detailed in Appendix 2 'Changes to Legislation' in the Annual Report section.

Review of Fees and Charges

Application, rental and survey fees on mining tenements and dealings charges were reviewed and increased by 5.5% from 1 August 1988.

COMPUTER DERIVED PETROLEUM MAPS — THE FIRST STEPS

Maps have traditionally contained a wealth of information presented in both symbolic and visual form. Information and ready access to it, is one of the most important aspects of efficiency. As technology enables more and more information to be collated, the requirement is to make this information readily available and in a format which is easily recognised.

Ways of doing this better include looking at how to transform this information, how to reuse it, and how to merge it with other data. In this synthesised state, its usefulness is multiplied to meet the demand for more effective and concentrated information. Maps utilising cartographic principles are capable of communicating current, intelligent information, when closely interfaced with computer technology.

At present, the extent of petroleum exploration and development within the prospective sedimentary basins in Western Australia can easily be seen from the various permits and titles shown on the state Petroleum Tenements map at 1:2 500 000 scale. More detailed information can be obtained by referring to the 1:1 000 000 series of maps maintained on a daily basis to support the administration of petroleum titles by the Department of Mines.

A further indication of petroleum exploration activities can be determined from another 1:2 500 000 state map which shows the location and classification of the wells which have been drilled for petroleum exploration throughout the state.

These maps are maintained to support basic information required by the Department for record purposes as well as for use by the exploration industry and the general public. The maps all have a common function; to provide the means for easily relating these activities to the geography of the state.

However they lack the flexibility of being able to focus attention on one specific area of interest, and only bring together selected information relevant to a given project or user need. This is a limitation of all manual mapping systems.

The development in recent years of Geographic Information Systems (GIS) and Computer Aided Drafting (CAD), provide mapping organisations with powerful computer tools to store, process, and automatically output geographically related information tailored to suit specific user requirements. This technology also allows information from different sources to be combined for analytical or mapping purposes.

During 1987 Surveys and Mapping commenced work on a pilot project to create a GIS data base of petroleum tenements, wells, oil and gas field locations, and other related information to meet a number of Departmental needs. The project has been developed on an INTERGRAPH system which resides on a host VAX 11/785 computer to which the Department of Mines has limited on-line access.

The project has proved successful in providing a range of working map products at various scales for use by geoscientists and others. Examples of products which can be derived from any nominated geographic window within the state include:

- Tenements map showing all wells or wells selected by type.
- Wells location map.
- Map showing onshore, offshore, or territorial tenements only.

A typical application is relating geological or geophysical information received from different sources to existing well locations, oil or gas field locations, and exploration permit boundaries, all at a convenient working map scale. The Petroleum division has used base maps produced from the system to develop leads and prospects maps.

With development of a number of key computerised management information systems and data bases such as the petroleum exploration data base (WAPEX), the integration of some of these with a GIS will become an important factor in the Department's overall information technology strategy.

The effective use of GIS depends on the ability to build a soundly structured data base from which different maps can be derived, depending on what 'view' of the data is used. This is quite distinct from pure CAD in which the computer is used as a sophisticated drafting tool only, in the production of the map as a graphic product, not the storage and manipulation of the data contained within the map. In developing the Petroleum Mapping project much of the effort has been on the acquisition, validating, and processing of the source data required to build the supporting data base.

Further development is needed to customise the system to full production. This will enable visual information to be generated more easily than at present and will provide for sale of products to industry which are not available within our current range.

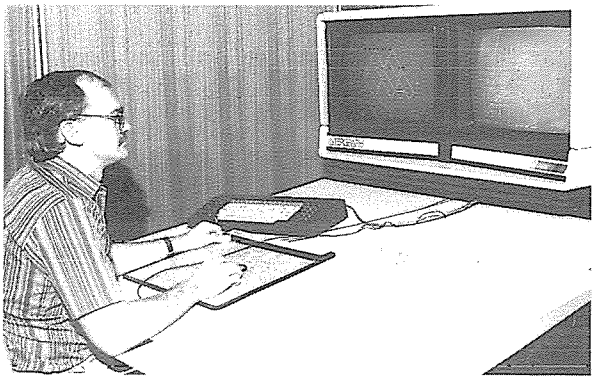
The development so far has been encouraging and is seen as only the first steps in making more effective use of visual integrated information. In the longer term the system will assist in streamlining the current petroleum mapping activities and will probably replace some of the manually produced products.

Mr W Moore, Dip Cart, MIS, MAIC, MIEMS
Director

During 1987/88 the elimination of tenement charting backlogs, improved receival processes and introduction of computer technology into geological map preparation, all provided benefits to the mining and petroleum industry.

Occupation of the new floors in Mineral House gave the division a better working environment, one with better functional facilities, particularly for the reprographic and graphic design laboratories and for public enquiries.

The identification and implementation of improved work procedures followed the divisional review in the Glover Report.



Cartographer Steve Bandy using the Intergraph system to produce a working map for use by geoscientists.

Staff

Increased demand for drafting and other services gave the division cause to employ up to nine people on a temporary basis during the year. Four of these officers were subsequently appointed to vacant positions within the division. An amount of $23 000 was expended upon employing contract drafting staff to assist with this increasing demand.

There were nine resignations and one retirement during the year. A new position of Senior Cartographic Draftsperson - Projects, was created to ease the administrative pressure on supervision of project work. The vacant Supervisor Mine Plans position was cancelled to maintain the approved staffing level.

The division has an approved staff list of 123; of which 74 are professional officers (cartographic); 30 drafting assistants; 10 technical officers and nine clerical officers. Two professional positions remained vacant at 30 June 1988.

Tenement Maps

The tenement maps produced by Surveys and Mapping are basic documents of the Department of Mines which provide a comprehensive series of maps showing the inter-relationship of all mining tenure and other land tenure. Due to the large increase in numbers of new tenements over the past few years many of these maps have reached the point at which they must be revised and replaced in order to remove voided tenements and other associated data.

Survey and Mapping Division's Director, Bill Moore (right) and Assistant Director, George Sharp (left) with consultant Graham Glover, during Glover's study of the Division prior to his Report.

Of the total 1331 tenement maps which cover the state many need replacement. Temporarily augmented resources allowed the division to replace 260 maps in 1987/88. It will not be able to sustain this rate and only some 220 are planned to be replaced in the next 12 months.

A strong demand continued from the mining industry for copies of tenement maps. These are sold to the mining industry and the public at the rate of 150 full maps per day, plus 51 photocopies of map portions per day. This equates to 21 maps per hour or one every three minutes, and in the case of map portions, seven portions each hour of the working day.

Review of the Division

The Glover Report was presented in August 1987. This document has far reaching possibilities for the future of the division. The review highlighted the work of the division, including the relevance to the work of the Department, and the systems and methods which were developed to handle the tasks.

As a result of the Glover recommendations the following activities have been implemented:

- The application receival process has been amended to provide a quicker transmittal of the application documents, from the date of receival to the receipt in Perth and entry into TENDEX, and to being plotted on the public plans. Most tenements now appear on plans within a week to two weeks of actual lodgement with only a few taking longer.
- The accumulated backlog of tenements to be plotted on plans was eliminated by suspending the map scale rationalisation program and directing resources to the charting process. The resources were then re-directed to renewing the public plans themselves. This was necessary in order to remove the old voided tenements, etc which had accumulated on many of the public plans.

- A pilot project to test the feasibility of geological map preparation using the SCITEX system was implemented for the Perenjori hydrogeological map.
- A new process for releasing ground following it having been compulsorily surrendered from an exploration licence, at the conclusion of its first five year term, was successfully implemented. This new method is more efficient, and at the same time provides an increased capacity to ensure confidentiality about the data and time of release of this much sought after ground.

Surveying

As in 1986-87 the number of mining leases which await survey increased. The main cause is the substantial numbers of prospecting licences being converted to mining leases following the expiry of their term.

505 tenements were surveyed, leaving a total of 2021 leases on which the survey of boundaries remains outstanding. The average area of tenements surveyed increased from 134 hectares in 1986-87 to 167 hectares in 1987-88. The average length of boundary per tenement increased marginally from 2.27 kilometres to 2.43.

New Costing Procedure for Surveying Mining Tenements

During the year Cabinet directed that the Department of Land Administration discontinue the practice of setting fees for payments to surveyors under its Regulations, in preference to the surveying profession establishing its own fee structure. The Department of Mines adopted the same procedure in February 1988, requiring competitive estimates to be obtained for all cadastral projects, which will subsequently be allocated at the discretion of the Department.

Subsequent to the introduction of this new system a number of areas in contention were discussed with the Association of Consulting Surveyors. Further consideration of these matters should result in a solution satisfactory to both parties.

Graticular Sections-Map Templates

To accommodate the planned introduction of graticular sections to facilitate definition of exploration licences, it has been necessary to generate a set of matching overlays showing the graticular sections which cover each public plan. The opportunity was also taken to extend this coverage to the offshore areas out to the edge of the continental shelf in anticipation of the planned Commonwealth and State offshore minerals legislation.

A contract to produce computer-generated maps showing the 1' x 1' grids was let and a total of 1329 maps were prepared.

AMG Overprints for Old Series Maps

Upon review, the number of non-AMG maps remaining in the system is more than was anticipated and it has been necessary to commence a program of rapid conversion by 'block-shift' to AMG coverage in order that these existing maps will be suitable for use with graticular sections when they are implemented.

Upgrading Mining Tenement Co-ordinate Data

The computer system (CADMAPS) currently in use by Surveys and Mapping for generating co-ordinates of surveyed mining tenements is being re-developed by the Department of Land Administration into a new system called SIGNET.

This system is designed to provide an improved route into a comprehensive land information system for the eventual capture of this type of data. Surveys and Mapping existing traverses must first be reviewed and redeveloped for SIGNET processing. All future traverses will be structured on a SIGNET basis. The new SIGNET in its final form is not expected to be available before 1989.

Mapping and Cartography

A high priority is given to disseminating geological information in the form of maps. The emphasis for geological mapping is now directed toward the 1:100 000 scale mapping in areas of economic potential covering the greenstone belts of the Eastern Goldfields. The first four maps of this series were printed.

A new activity being developed is a program of hydrogeological mapping at 1:250 000 scale over selected areas of the State. Preparation is in hand for the first map to be produced with the aid of computer assisted scanning technology known as the SCITEX system. Arrangements are currently proceeding for a part of this initial production to be contracted to an eastern states firm.

A major project of the Geological Survey in its Centennial Year was the production of Memoir III on the geology of Western Australia. This manuscript has generated a considerable number of monochromatic drawings and photos as well as the twelfth edition of the State Geological map, a State Hydrogeological map, and a revised edition of the Mineral Deposits map, all at a scale of 1:2 500 000.

A new publication titled 'Petroleum in Western Australia' was produced by the Petroleum division. A number of coloured figures and a centre lift-out map showing petroleum information and tenement holders were drafted for this magazine.

Contracting of some geological maps for preparation, either by conventional means or computerisation, will assume greater importance if Surveys and Mapping is to help achieve one of the objectives of the Geological Survey of Western Australia; to investigate, interpret and record the geology of Western Australia.

If the primary role of the Geological Survey in the next five years is to accelerate the geological mapping program then the Mapping branch will have to monitor priorities closely and consider alternative methods of map production.

State Map - 'Localities in Western Australia'

Production of the fourth edition of the Western Australian localities map at 1:2 500 000 scale came to fruition after many disruptions. A major benefit derived from the completion of this project is that it has enabled format material to be utilised in the preparation of other geologically oriented state maps. The result is a saving of time and resources.

Printing

A total of 19 coloured maps were printed in 1987-88. This figure includes reprinting of six maps of which stocks had become exhausted. The 13 new maps comprised 3 sheets at 1:250 000, 4 sheets at 1:100 000, 3 environmental maps at 1:50 000, 3 maps for the Murchison Province Bulletin, 2 Thematic maps in the 1:5 000 000 series (being the two six- monthly maps of Petroleum Tenements which were included in 'Petroleum in Western Australia') and the new fourth edition of the map of the state - 'Localities in Western Australia'.

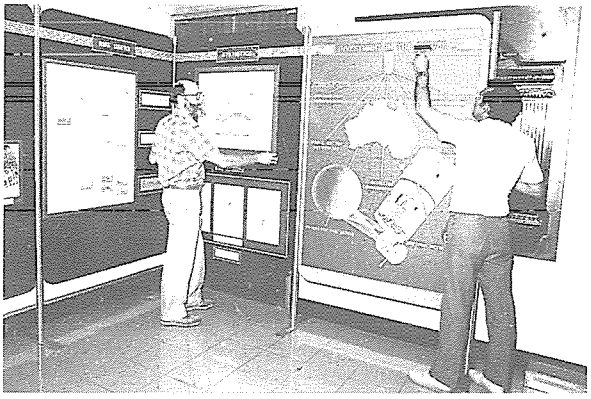
Publications

The major work from Geological Survey in 1987-88 was Memoir 3, a publication of more than 350 figures with a high priority rating.

Other significant publications either completed or in progress included Ord-Bonaparte Bulletin, North West Shelf Studies, Kalgoorlie Greenstones, Bauxite Deposits, Rottnest Report and Professional Papers. In addition many 35mm slides and overhead projection transparencies were prepared for all divisions for both local and overseas presentations.

The section utilised contract drafting services to support the increased demands of tight schedules.

A total of 501 diagrams, small maps, or figures, were prepared, together with 206 slides and 106 items of general art-work.



The Department's Graphic Designers, Trevor Dods and Dave Smart, with one of the numerous displays created during the year. This one outlining the RMS (Records Management System) system instigated by the Department.

Graphic Design

The graphic design section continued to fulfill the Department's requirements with respect to display posters and standing displays.

Nine major displays were mounted by the section, the highlight being the Geological Survey Centennial display at the Alexander Library, covering the history and present operations of the Geological Survey division. Other displays promoting the role of the Department included a Mining Overview, Environmental Geology, and AXTAT.

Displays prepared were:

- History of Geological Survey of Western Australia.
- Mining Overview.
- Environmental Geology.
- AXTAT.
- Cartography (in Mineral House Foyer).
- New maps and publications (in Mineral House Foyer).
- Chemistry Centre (Ministerial Visit).
- Careers Expo (at the Superdrome).
- Poster presentations for the Chemistry Centre on ultra-violet light.
- Soil Science (International).
- Agricultural science.

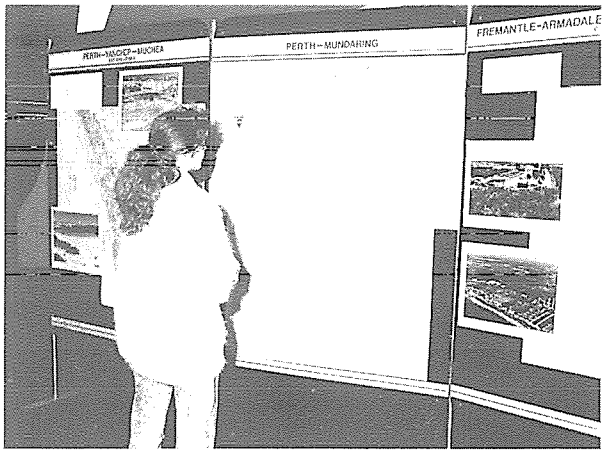
Reprographics

The Reprographic section's move into Mineral House Stage II has helped provide a better service because of the additional facilities. The unit now has separate rooms for each item of equipment. Despite experiencing some problems when the equipment was reassembled following the dismantling for moving, downtime was kept to a minimum.

Some heavy workload periods in 1987/88 required utilisation of outside bureaus, mainly for the fast photographic service.

Demand for all reprographic facilities increased in 1987/88, particularly in the area of conservation and environment, and engineering, where significant volumes of photographic and colour printing were ordered.

Several displays required substantial graphic material. Other reprographic services were provided to all divisions.



Environmental Geology Display — one of Geological Survey's Centennial celebrations.

Petroleum Mapping System

This system is being developed on the INTERGRAPH system at the Department of Land Administration (DOLA), Land Data Centre, using on-line access from the TEKTRONIX 4107 graphics terminal running under PSEUDOSTATION, as well as facilities at the above centre.

The purpose of the system is to produce computer derived maps at user nominated scales, showing various combinations of data related to petroleum tenement boundaries, petroleum wells and their attributes, oil and gas field locations, and major geological tectonic unit boundaries for any part of the State.

This system is now in 'semi-production' mode, in that most maps and printed reports designed to be produced by the system can be output, and it is being used to produce various types of plots on request by Petroleum and Geological Survey divisions.

Between August 1987 and May 1988 a total of 16 computer plots were requested from the system in order to display various combinations of data at scales ranging from 1:100 000 to 1:2 500 000.

The base sheet for updating the map showing wells drilled for 1987 was produced from the system.

CAD Activities

The TEKTRONIX 4054A graphics workstation facilities were used to produce a number of schematic diagrams showing computer hardware and system configurations.

Modifications have been made to part of the existing 2-D Drafting software package to allow users to plot from bearing and distance. This has been used to plot large or complex tenements as part of the process of revising standard plans or public plans.

Access to DOLA/WALIS Systems

Arrangements have been made for access to a number of systems via the Government IBM Computing network. Surveys and Mapping now has direct access from its IBM terminals to the Titles Remote Search System on the IBM System/38 Computer in Titles Office. One officer from each branch was selected for training and has access to the system. Two specified terminals within the Department also have access to the Western Australian Land Information System (WALIS), Gazetteer system on the DOLA IBM 3083 mainframe.

Professional Activities

Computer Graphics Seminar - Perth July 1987. A seminar conducted by Super Software; attended by the Senior Draftsman (P.Carroll).

13th International Cartographic Conference - Mexico October 1987. This conference was attended by Draftsman Special (P Walby) in a private capacity with assistance from the Department.

GIS Seminar CADCAM EXPO and WORKSHOPS - Perth 29 March 1988. A GEOVISION seminar which was attended by Deputy Director (G. Sharp) and another Senior Draftsman (P. Shaw).

Quality Awareness for Service Organisations - Perth 22 April 1988. This seminar, conducted by IBM's Quality Consultant, was attended by the Director (W Moore).

2nd Computer Assisted Cartography Workshop - Brisbane 6-7 June 1988. The Director, and Draftsman Special (B Cresswell) attended following recommendation by the Conference of Geological Cartographers.

Published Papers. Two articles prepared by the Director, published in 'Petroleum in WA', July 1988, were - 'Offshore Areas and the Territorial Sea - How the Law of the Sea Developed, and 'Establishing a Baseline for the Territorial Sea - The Australian Experience'.

Accommodation in Mineral House

The new Mineral House complex was occupied by most sections of the division in December 1987; the Surveys branch transferred from its external location to the new premises in July 1988. The areas now occupied provide a better facility for the functions of the division, with the reprographic laboratories and the graphic design studio in particular being a significant improvement.

New Departmental Public Counter

With the occupation of the new Mineral House complex and the refurbishment of Stage 1, a change in the handling of public enquiries was planned and introduced. Viewing of the tenement plans and the general tenement and map orders and sales have been passed to the Registration division. The 'in-depth' map and tenement information service has been consolidated with the existing Mine Plans and Research unit to form a new Map Information Services (MIS) group. As at the end of June 1988 the transitional changes and final implementation were under review.

MINERAL ROYALTIES - A FAIR RETURN TO THE COMMUNITY

In Western Australia the right to extract minerals (including petroleum) is granted to developers as a separate title from the usual land title. When these resources are extracted the State expects a return to the community for the loss of the resource and this return is referred to as a royalty.

A royalty differs from a tax as a tax is a compulsory extraction of money by a public authority for public purposes whereas a royalty is a payment for a good or a service.

Mineral royalties are important to the State; over the 10 year period to 1987 they constituted around 5% of total State revenue. Excluding funds received from the Commonwealth, mineral royalties constitute nearly 10% of the funds raised directly by the State.

Total royalty payments in 1987/88 were $211 million of which $46 million was paid to the Commonwealth under agreed revenue sharing arrangements.

The Department of Mines has a corporate objective of ensuring that the community receives a fair return from the exploitation of WA's mineral and petroleum resources.

A fair return to the community will take the following factors into account: the sale value; the cost of finding and extracting the resource; the benefit to the project developer; and the costs and benefits to the community.

The sales value of the resource depends upon its use, location, supply, and demand. It is a commonly held view that the return to the community should be greater for the higher valued product. It is therefore fundamental to consider resource value when assessing a royalty system.

While the sales value of a mineral will be determined by supply and demand and in most cases will be the same at the sale point for all producers, the cost of finding and extracting the resource will be different for every producer. This is obvious as mineral deposits come in all shapes, sizes, qualities and locations. The benefit to the developer will consequently vary considerably, not only from producers of one type of mineral to another, but also between producers of the same mineral product.

From the developers point of view the purchase price, or the royalty, which they are prepared to pay is implicitly dependent upon the net profit from extracting the resource. To be equitable to all producers it would be necessary to collect a similar share of the net return, rather than a share of the gross sale value.

In summary, desirable attributes of a royalty system include equity, fairness, economic efficiency, administrative efficiency, and predictability. Stability of revenue flow is also a desirable objective if the Government is to avoid substantial shifts in income and hence expenditure patterns. To take all these factors into account when assessing a fair return is a complex task.

There are three major types of royalty systems used in this State; specific rates, ad valorem rates, and profit based systems.

Specific rate royalties varying between 5 cents and $1.50 per tonne have been set in the Mining Act for generally low value products.

Ad-valorem royalties are those in which the royalty is expressed as a percentage of the gross value (the sale price). Virtually all of the royalty collected in Western Australia during 1987/88 was from ad-valorem royalties. The rates range from 2.5% for refined metals to 7.5% for roughly screened run of mine ore.

The philosophy behind the three level ad-valorem rates in the Mining Act is to achieve a 10% return to the community based on the value of the mineral at the mine site. As minerals are generally not sold in a run-of-mine form at the mine itself; for administrative simplicity, equivalent rates have been calculated for the common sale point and method of sale.

Thus for run of mine ore which is exported, the royalty is set at 7.5% of the value of the ore loaded onto a ship. For minerals sold in a concentrated form such as copper and mineral sands, the rate is 5% while for minerals sold as refined metals such as nickel and tin the rate is 2.5%. For petroleum products the royalty system calculates a "mine value" defined as the wellhead value to which a royalty of between 10% and 12.5% is applied.

For profit based royalties, the rate is expressed as a percentage of net value. Generally, the net value is defined as the return to the developer after all costs have been met for the extraction and sale of the resource. The two profit based royalties used in Western Australia apply to Barrow Island crude oil and Argyle diamonds.

Payments into the State Consolidated Revenue Fund (CRF) in 1987/88 totalled $166 million. The gross value of production estimated for this period was $6946 million, with royalty thus representing 2.4% of the total.

This return is not an accurate reflection of the community return from minerals and petroleum, as the gross value of production is a combination of run of mine ores and highly refined products such as gold, nickel, and alumina i.e. it includes value added during further processing for some commodities.

In an attempt to determine the community return for the minerals at the mine an estimate of the 'mined gross value' of mineral and petroleum production for the principal commodities has been calculated.

For 1987/88 the 'value' of the mined ore on which royalty was paid to the State was $4087 million. The $166 million royalty paid thus represented 4.0% of this value. The collection in 1987/88 thus appears to have fallen considerably short of the 10% level used as the foundation for the Mining Act royalty rates.

Reasons for the difference include: royalty exemption on gold production; the 'simplified' three level royalty system in the Mining Act which only approximates the 10% ex-mine principle; and low royalty rates in some special State Agreement Acts such as salt.

The most significant of these is the royalty exemption for gold. With the value of gold removed from 'mined gross value' the average rate of return would have been 5.9%.

Only the community can determine what is an appropriate level of return and whether the amount paid in 1987/88 was 'fair'. The level of return in that year is certainly lower than the underlying assumption of the Mining Act but a substantial part of the discrepency can be attributed to the royalty-free gold mining sector.

ROYALTIES AND STATISTICS BRANCH — ANNUAL REVIEW

Mr M L Meaton, BSc (Agric)(Hons), BEc
Manager

Staffing

Following a review by independent consultants and evaluation by the Department, the Royalties Branch was restructured and its role defined more clearly. The Branch has been divided into three operational groups covering royalty assessment and collection, systems development, and policy. These operational groups are designed to meet the Department's objective of "ensuring a fair return to the community from the exploitation of the State's mineral resources".

Staffing was increased with the appointment of a Royalties Manager, Senior Research Officer and an additional Royalties Officer. In line with the consultant's recommendation for economic or financial expertise, the first two appointments (Murray Meaton and Allan Teede) came from Treasury and the third (Vince de Angelo) from State Taxation. The appointments increased the effective staffing level to 10 and allowed the Branch to begin work on a backlog of outstanding royalty issues.

The year was a very active and productive one for the Branch. The co-operation given by other groups in the Department and by the industry was noteworthy. This helped the Branch to consolidate and improve the royalty assessment and collection process.

Royalties

In August 1987, the Minister for Minerals and Energy released the report of the Mineral Revenues Inquiry. Commissioned by the State Government the report was prepared following an independent inquiry by Professor Paul Bradley of the University of British Columbia. Although the government decided against implementing the report, Minister David Parker pointed out that it "was an extremely far reaching, interesting and useful document".

The report recommended the adoption of a profit based royalty system. This is not generally supported by the industry and the Chamber of Mines has expressed a preference for an ad-valorem royalty system based on 2.5% of ex-mine mineral value. This is considerably below the 10% ex-mine concept embodied in the Mining Act. Fortunately, the Royalties Branch and the Chamber have a very good working relationship which will ensure that the level and method of royalty collection will be discussed and developed in a sensible environment.

During the year significant changes to royalty rates or improvements in collection arrangements were made for

Smiles from the Royalties Branch: standing from the left; Vince D'Angelo, Kate Underwood, Michael Crouche, Graeme Rathman, Shelley Casey, Ross Ehlers (seated on desk), and Enzo Sisti. Seated from the left; David Norris, Murray Meaton (Manager), Allan Teede, and Kim Bowra. Missing; Lloyd Edwinson.

nickel, bauxite, coal, gallium, attapulgite and heavy mineral sands.

Fifteen Companies requested changes in royalty payments. Royalty Officers worked closely with the companies in evaluating their submissions and the industry co-operation shown is very pleasing to note. Generally, the mining sector understands the need to substantiate requests for variations to royalty payments and full disclosure to the Department of marketing and financial information is accepted as a necessary step in this process.

Following extensive consultation with mining industry groups, new regulations were introduced to assist in royalty collection and verification. These clarify the arrangements for producers and will make the collection process more efficient for all parties.

The contracts for provision of diamond valuation services were revised during the year with significant savings to government. The employment of a local diamond valuer has worked very well with benefits to both industry and the Royalties Branch.

The principal area of concern to the Branch is the increasing work-load in petroleum royalty collections. Royalties are based on the equivalent of "ex-mine" value with the valuation point defined as the "wellhead". Determination of "wellhead value" is set out in agreements negotiated between Government and the project partners. These Agreements take considerable effort to develop and administer as they are complex and require detailed auditing of project expenditure. To date only three projects have an Agreement on royalty payments with five projects operating on an interim royalty payment basis.

Staffing restrictions have limited the amount of auditing work undertaken and as a result external auditors have been contracted to carry out audit work on the North West Shelf project. With their assistance a very extensive "backload" audit was completed during the year for the period to August 1984. Records of project operations following this period should be audited during 1988-89 and work will also commence on other petroleum projects. The Department has recognised the problems being experienced by the Branch and staff levels are to be adjusted to overcome these problem areas.

Systems Development

The Senior Systems Development Officer (David Norris) appointed to develop royalty assessment, collection and verification systems was fully engaged during the year on activities in the petroleum royalty area.

A major portion of the year was spent on audit work associated with the North West Shelf project. Preparation of a draft verification manual was undertaken as a part of this process. The manual, to satisfy Commonwealth and State auditing requirements, will be completed when resources permit.

Another major activity involved modelling work to support negotiations with the Commonwealth over suitable revenue sharing arrangements for petroleum royalties collected under the Resource Rent Tax legislation (RRT).

Policy and Statistics

The Branch is increasingly involved in provision of policy advice to the Director General on a range of issues which have a wider economic framework than the royalty aspects. The appointment of a Senior Research Officer (Allan Teede) during the year has enhanced this activity which in the past was provided by other Government Departments. With the increasing complexity of mining industry concerns and the more sophisticated approach being taken by industry organisations, it is essential that the Department can contribute in a positive way to resolution of these issues. The policy group has an important role to play in this process.

Statistical Group

Three Statistical publications were prepared and released during the year.

Following a review of statistical collection procedures by an external statistician, work commenced on the development of a computerised system which will produce benefits through more rapid and accurate compilation. This is a long term project which will be developed and implemented as resources permit.

INFORMATION NETWORK — CORNERSTONE FOR FUTURE DEVELOPMENT

Following a review of information systems requirements in 1982, the Department committed itself to the development of integrated data bases in its primary business areas - with specific emphasis on mining exploration, mining titles, and petroleum exploration. The thrust of this initial computing strategy was to develop a series of starter systems in these key areas.

The most significant aspect of this strategy centred on the importance of developing usable stages of each system, as quickly as possible, with minimum resources. The Department was particularly successful in this regard and during the period 1985 to 1987 introduced a number of such service systems - the more important ones being those based on the Western Australian Minerals Exploration Database (WAMEX) and the Mining Tenement Information Database (TENDEX).

These and several other systems developed during the past four years have played a role in helping to achieve an improved information flow to industry and to other potential investors. During this period the Department improved its range of services to industry - particularly in the compilation of geological reports - through the application of word processing and personal computers.

Whilst these project systems were successful and encouraging, there was the need to put in place a strategy which would lay the foundations for a standard and consistent longer term information handling policy.

The essential elements of this policy were:

- To define true Departmental or corporate data and allocate ownership responsibilities for its collection, maintenance, and security. The Department has responsibility for a wide range of corporate data - eg. geology, mining tenements, mapping.
- To store and maintain all corporate information on one medium, thus eliminating duplication of effort and the additional costs in collecting and maintaining data on separate files.
- To provide Departmental offices and industry (where applicable) ready access to this information.
- To provide an overall hardware/software architecture to ensure that the business and technical requirements of the Department are being met in a consistent and cost effective manner.
- To provide a consistent framework of access (through a standard data network and multifunction workstations), to all corporate data.

The decision by the Western Australian Government in 1984, to proceed with construction/refurbishment of the Mineral House Complex, provided an opportunity to put into place a cornerstone in this architectual framework, the Data Network.

The Department was able to influence design aspects of Mineral House at a sufficiently early stage to ensure the provision of a standard but flexible cabling infrastructure. The proposed cabling infrastructure would be the future transport system for information across the Department and externally to industry and the public.

The Mineral House complex was thus designed to accommodate vertical and horizontal riser/ducting facilities to allow for the installation of the essential backbone or trunk cabling framework. Both utility wings of each floor were designed to accommodate cable cupboards and patch panel facilities. In addition suitable conduiting routes from the cable cupboards/patch panels were designed into the concrete floor slabs to carry the individual outlet cables to each outlet point.

The primary objective of this was to provide in-built flexibility for future information services and staff movement and to avoid the piecemeal and more costly development of sectional networks. The installation of the proposed network would ensure that all Departmental information could be accessed over a standard framework from virtually any workstation across the Department. The development of the proposed cabling network would also provide a solid foundation for future systems such as Local Area Networks (LANS), protect the investment made in these systems, and provide improved services to industry.

The proposed cabling network was approved and that planned refurbishment and cabling fitout of the Mineral House Complex is due for completion by the end of 1988.

The first phase of the new cabling network was commissioned during the second quarter of 1987/88, on the partial occupation of the new wing of Mineral House.

The complete installation of this cornerstone of the Department's information policy, will provide the capacity to further improve the range of services offered to industry and the public. This objective will be achieved through the progressive expansion of the information network during the next two years.

The principal areas of expansion will be:

- increasing use of computing work stations by staff in Mineral House - providing access to new or expanded Department data bases;
- increasing intra-departmental access through Department of Mines and WA Government network to specific information maintained by other agencies; and
- improved access facilities to the Department's regional offices.

These planned developments, together with the convergence of word processing, PC based office systems, and data processing into a common network accessing all data bases, will be significant tools for the Department to maintain current services and to monitor and promote the rapid progress of the mining and petroleum industries in Western Australia.

DEPARTMENT
OF MINES
WESTERN
AUSTRALIA

STATISTICAL SUMMARY 1987-88

SUPPLEMENT
TO THE
ANNUAL REVIEW

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LOST TIME INJURIES IN WESTERN AUSTRALIAN MINES 1987/88

MINES	NO OF EMPLOYEES	NO OF LTI'S	INCIDENCE	FREQUENCY	DURATION	INJURY INDEX	DAYS LOST
Metalliferous Surface	25 604	1 636	65	30	11.2	336	18 367
Metalliferous U/ground	2 420	288	120	65	14.0	910	4 030
METALLIFEROUS TOTAL	**28 024**	**1 924**	**70**	**33**	**11.6**	**383**	**22 397**
Coal Surface	893	178	208	126	8.1	1 021	1 434
Coal U/ground	323	143	441	301	11.4	3 431	1 628
TOTAL — COAL	**1 216**	**321**	**272**	**170**	**9.5**	**1 615**	**3 062**
TOTAL — MINING	**29 240**	**2 245**	**78**	**37**	**11.3**	**418**	**25 459**

Note: Duration in this table does not take into consideration the time lost after June 30, 1988 by persons still off work at the end of the financial year, or time lost from recurrent injuries.

SUMMARY OF FATAL AND SERIOUS ACCIDENTS IN 1987/88

MINERAL	NUMBER OF PERSONS EMPLOYED	ACCIDENTS		
		FATAL	SERIOUS	MINOR
Bauxite, Alumina	4 565		54	101
Coal	1 216		85	236
Diamond	733		17	53
Gold	7 924	2	221	487
Gold — Nickel	2 086	2	44	96
Mineral Sands	1 227	2	20	52
Iron	9 608		163	472
Nickel	673		4	6
Salt, Gypsum	496		6	28
Tin, Spodumene	159		4	19
Aggregate	201		6	28
Other Minerals	352	2	15	28
TOTALS	**29 240**	**8**	**639**	**1 606**

DESCRIPTION OF FATAL ACCIDENTS

Seven persons were killed in 1987/88 in separate accidents at metalliferous mines and one at an exploration site. There were no fatalities in coal mines.

- A miner was scaling rocks in an underground stope while standing on a steep rill. He lost his footing and fell striking his head on a rock.
- A diamond driller at a surface gold mine was struck on the chest while pulling drill rods from the hole.
- A mineral sands mobile plant operator was crushed when the rubber-tyred dozer he was operating ran off the road and over a bench landing on its cab.
- A technical assistant was electrocuted when he came into contact with a vehicle which had been made live by a faulty portable refrigerator. He was assisting a workmate who was in contact with the vehicle and in distress.
- A mineral sands plant operator was run over by a scraper while clearing rocks from a track over the hopper. It was thought he had moved from the area.
- A loader operator in a gold mine was scaling down a blockage in an ore bin when he fell and was suffocated in the moving fine ore.
- A dozer driver was fatally injured while clearing grid lines at an exploration site when a tree fell on the dozer he was operating.
- A timberman was digging sand to re-open an ore pass when the sand collapsed and he fell 45 metres down the pass.

PROSECUTIONS

Nine persons were prosecuted for offences against Mining Legislation.

Three miners were each found guilty of contravening Regulation 7.24(1) by failing to wash out and clean butts prior to drilling a face. Two were fined $50 with costs, and the third fined $80 with costs.

A truck driver was prosecuted for contravening Section 54 (three charges) and Regulation 6.2 by negligently endangering the safety of three people working inside a crusher by tipping a load of ore into the crusher contrary to a precautionary signal. He was fined $100 on each of the four charges and ordered to pay $1 450 costs.

An Underground Manager was prosecuted for contravening Regulations 3.24(2), 12.11 and Section 54 by failing to inspect a stope which had an entrance ladderway in a dangerous condition and positioned over an open ore pass thus endangering the safety of a workman working in the stope. The workman sustained a fatal injury when he fell down the open ore pass. The Underground Manager was fined $100, $75 and $100 respectively on each charge and ordered to pay costs of $120.

Two persons involved in the illegal mining of sand were fined $800 on each of four charges and ordered to pay $1 200 costs. The Police conducted this prosecution and the Registration Branch (Department of Mines) assisted in the preparation.

One person involved in illegal mining on a Flora and Fauna Reserve was prosecuted and found guilty. He was fined $400 with $32 costs. The Magistrate rejected a request for restitution of the gold and rehabilitation of the land, citing the Crown's ability to pursue each request in other Courts.

A Shift boss was prosecuted for contravening Regulation 3.25(1) for failing to ensure that a portion of his round was maintained in a safe condition. He was found guilty and fined $80 with $135.20 costs.

Prosecution proceedings or charges have been initiated in 6 other instances for offences against the Mines Regulation Act and Regulations.

SUMMARY OF DRILLING AND ASSSOCIATED WORK 1987/88
DRILLING BRANCH 1987/88

JOB NAME	PURPOSE	TYPE OF WORK	NO. OF BORES	METRES DRILLED
Cowaramup Cowaramup	Coal Investigation Groundwater Investigation	Wireline Coring Rotary Drilling	1 7	100.12 5 153.60
Lake Ballard	Groundwater Investigation	Wireline Coring	49	2 102.85
Derby Regional Groundwater Investigation/ Hydrogeological Mapping	Groundwater Investigation	Rotary Drilling	23	3 861.90
Great Southern Drought Relief	Drought Relief	Air/Mud Rotary Downhole Hammer	54	1 327.90
Cameron Central Catchment	Effects of Bauxite Mining on Groundwater	Wireline Coring	14	482.94
Lake Toolibin	Salinity Studies	Mud Rotary-Auger	27	320.07
North Stirlings	Salinity Studies	Mud Rotary	9	163.30
Kalgoorlie Regional Groundwater Ass'ment	Groundwater Investigation	Wireline Coring	51	1 404.40
Local Government	Pollution Monitoring	Contract Supervision	3	
Various	Groundwater Investigation	Bore Pumping Tests	29	
Various	Various	T.V. Borehole Scans	19	
TOTAL			**286**	**14 917.00**

METALLIFEROUS MINING CERTIFICATES OF COMPETENCY ISSUED 1987/88

FIRST CLASS MINE MANAGERS	Certificate Number
ANDERSON, B.F.	231
BOND, W.F.	232
KELLY, J.P.	233
SILVESTER, S.A.	234
GIBBS, D.A.	235
DUNCAN-KEMP, A.P.	236
BRADLEY, A.J.	237
TINKER, W.H.	238
MAGNUSSEN, J.G.	239
HARVEY, G.P.	240
GARNSEY, R.G.T.	241
COOPER, A.G.	242
BREMEN, S.B.	243
MURDOCH, R.J.	244
GRIJUSICH, I.F.	245
MARIBA, J.G.	246
BRAGHIERI, M.J.	247
BRADTKE, G.V.	248
CONLAN, G.R.	249
TOTH, T.M.	250
SAVY, G.R.	251
TURTON, A.D.	252
WOTHERSPOON, S.J.	253

UNDERGROUND SUPERVISORS	Certificate Number
REID, T.D.	A489*
GROW, G.W.	A490
SLATTERY, J.T.	A491
CLARK, D.M.	A492
MITT, P.S.	A493
JENNINGS, R.K.	A494
BURROWS, B.D.	A495
CASSERLY, D.R.	A496
MURRAY, G.R.	A497
PARSLOW, B.W.	A498
SIME, A.A.	A499
HONMAN, M.R.	A500
No certificate issued with this number	A501
ALMOND, M.A.	A502
BARGIEV, C.P.	A503
BEESON, G.W.	A504
CARR, R.S.	A505
CHEESEMAN, D.	A506*
COSTELLO, M.R.	A507
CARR, C.J.	A508
DAVIS, L.B.	A509
DAVIS, N.R.	A510
DREW, K.G.	A511
DUNCAN-KEMP, A.P.	A512
FITZROY, S.W.	A513
FREEMAN, L.C.	A514*

UNDERGROUND SUPERVISORS	Certificate Number
GILLMAN, G.A.	A515
GRAHAM, R.M.	A516
HAMPTON, G.E.	A517
HUNTER, G.K.	A518
JACKSON, G.	A519
KAULER, D.A.	A520
LUNARDI, P.	A521
McGINTY, H.J.	A522
PONIEWIERSKI, J.M.	A523
SLOAN, G.J.	A524
SPENCER, B.D.	A525
SULLIVAN, J.L.	A526
TONKIN, L.	A527
TWEEDIE, H.A.	A528
WALSH, J.R.M.	A529
JONES, M.J.	A530
KREITNER, S.	A531
HARTLEY, C.E.	A532
HASTIE, C.R.	A533
ADDINK, J.P.	A534
ATCHLEY, D.J.	A535
BECKWITH, J.M.	A536
BURKE, S.J.	A537
BELLINGHAM, A.A.	A538
CARNES, M.T.	A539
CHARLESTON, C.B.	A540
CUTTRISS, R.B.	A541
ESDALE, P.J.	A542
DE RUWE, A.L.	A543
EVANS, K.C.	A544
GLASTONBURY, A.J.	A545
GRAZZIADELLI, J.	A546
JOYCE, G.F.	A547
ROGERS-BENNETT, R.	A548
SMITH, A.M.C.	A549
COLE, R.L.	A550

*** Restricted Certificate**

QUARRY MANAGERS	Certificate Number
PLUME, C.E.	136
GAGELER, G.B.	137
PEARSON, A.J.	138
GORDON, B.A.	139*
DISCOMBE, M.B.	140
BAUMHAMMER, E.B.	141
ROGERS, S.J.	142
EASTERDAY, C.E.	143*
HATCH, B.G.	144
HALE, R.M.	145
DARVENIZA, P.	146
HATCH, D.F.	147
O'CONNELL, G.P.	148
ORELOW, S.	149
PITTS, K.	150
PREECE, D.T.	151
PASCALL, L.A.E.	152
SMITH, P.N.	153
FYFFE, B.R.	154
TURNER, M.B.	155
McGUCKIN, C.R.	156
BAILEY, M.E.	157
WILSON, S.	158
STEDMAN, R.	159
ROY, T.K.D.	160
GILLAM, T.A.	161
CLARKE, I.J.	162
BAKER, R.B.	163
CULLINAN, P.T.	164
MIDDENDORP, M.C.	165
SKINNER, C.F.	166
MacFARLANE, G.A.	167
NILSSON, K.K.	168
WILLIAMSON, G	169

*** Restricted Certificate**

RESTRICTED QUARRY MANAGERS	Certificate Number
RUBERY, D.J.	232
KNIGHT, L.P.	233
HENDERSON, M.H.	234*
HOLDEN, K.J.	235*
BIRD, J.C.	236
JERKOVIC, M.	237
VERITY, T.J.	238
BURMEISTER, D.F.	239
BEER, K.A.	240
HENDERSON, F.M.	241
TURNER, P.B.	242*
WEBB, A.P.	243
DICK, S.C.	244
O'GRADY, S.J.	245

*** Restricted Certificate**

RESTRICTED QUARRY MANAGERS	Certificate Number
FORBES, T.W.	217
SMEDLEY, P.G.	218
JONES, B.M.	219
ANDERSON, J.K.	220
TUCKER, B.	221
GELL, M.S.	222
GOSLING, A.G.	223
HARRISON, P.A.	224
MacKAY, J.D.	225
BAXTER, J.W.P.	226
BAARS, E.J.	227
BARBER, R.W.	228
JONES, S.W.	229
KEANE, J.M.	230
PARSONS, J.M.	231

COAL MINING CERTIFICATES OF COMPETENCY

FIRST CLASS MINE MANAGER	Certificate Number
HALL, C.D.	57*
WHITELEY, M.F.	58*
STAY, T.C.	59*

SECOND CLASS MINE MANAGER	Certificate Number
BAILEY, T.R.	26
MOLONEY, L.J.F.	27

THIRD CLASS (DEPUTY)	Certificate Number
BRANKOVIC, S.	120
DONOVAN, T.	121
HILL, P.W.	122
McCRYSTAL, B.D.	123

OPEN CUT MINE MANAGER	Certificate Number
MARTIN, S.T.	18*
EXTRACT, A.W.	19*
BROWN, I.R.	20**

DEPUTY (OPEN CUT)	Certificate Number
DAVIDSON, R.J.	29
SHANNON, I.J.	30

*** Reciprocal**
**** Mining Law and Oral**

AUTHORISED MINE SURVEYORS CERTIFICATE

	Certificate Number		Certificate Number
JAMIESON, J.A.	094	McMULLAN, M.	101
KASCHULL, H.J.	095	SCHABORT, B.J.	102
MERKLEY, D.I.	096	SMITH, J.J.	103
LEE, B.L.	097	COYLE, E.B.	104
BUDARICK, W.R.	098	GUETLICH, R.P.	105
COWCILL, M.L.	099	THOMAS, B.H.	106
LEGGE, B.A.	100		

SOURCE AND ALLOCATION OF WORK 1987 88

SOURCE	LABORATORY								
	AGRICULTURAL CHEMISTRY	ENGINEERING CHEMISTRY	FOOD AND INDUSTRIAL HYGIENE	FORENSIC SCIENCE	KALGOORLIE METALLURGICAL	MATERIALS SCIENCE	MINERAL SCIENCE	WATER SCIENCE	TOTAL SAMPLES
DEPARTMENT OR AUTHORITY									
Agriculture Department	71 618	6	9 990	4			16	199	81 833
Authority for the Intellectually Handicapped							1	25	26
Building Management Authority			2			19	11	34	66
Conservation & Land Management	3		82				1	70	156
Chemistry Centre (W.A.)	1 291	200	29	131		25	596	97	2 369
Department of Consumer Affairs			1	2		56	21	1	81
Dairy Industry Authority			29						29
Department of Occupational Health, Safety & Welfare			563			1	181	3	748
Education Department	35		2			5	5		47
Environmental Protection Authority	338		302			1	320	5 664	6 625
Fisheries Department			375			8		4	387
Geological Survey of WA							1 205	712	1 917
Health Department	59		3 515	136		7	15	217	3 949
Hospitals			23	19		2		1	45
Main Roads Department	9					1	81	6	97
Mines Department	4	4	106		228	5	601	13	961
Perth Mint				3			37		40
Police Department			8	6 142			55	2	6 207
Prisons Department			2	409		19			430
Swan River Management Authority								19	19
State Planning Commission								122	122
State Supply Division				23		80			103
WA Museum			219	19		14		1	253
Water Authority of WA	22		698			5	2	5 047	5 774
Waterways Commission			15					745	760
Other Departments	4		4	15		39	12	30	104
PUBLIC									
Pay	379	893	356	57	4 317	252	2 902	3 259	12 415
Equestrian Federation				8					8
Western Australian Greyhound Racing Association				296					296
Western Australian Trotting Association				796					796
Western Australian Turf Club				1 987					1 987
TOTAL	**73 762**	**1 103**	**16 321**	**10 047**	**4 545**	**539**	**6 062**	**16 271**	**128 650**

WELLS DRILLED FOR PETROLEUM FROM 1.7.87 to 30.6.88

WELL	COMPANY	TENEMENT	TYPE	LAT. (S) D	M	S	LONG. (E) D	M	S	ELEV. (M) GL/WD	RT	COMMENCE	RIG RELEASED	TD (M)	TD (IN)	STATUS ON 30.6.88
BONAPARTE BASIN																
DRAKE-1	BOND	WA-199-P	NFW	11	17	6	125	50	8	103	12	2.8.87	27.8.87	2 380	JURASSIC	P&A
													TOTAL:	**2 380m**		
CANNING BASIN																
LLOYD-1	HOME	EP-129	NFW	17	28	3	125	14	57	39	47	5.6.87	14.7.87	471	DEV	OIL
RUNTHROUGH-1	HOME	EP-129	NFW	17	29	23	124	11	56	50	57	6.6.87	24.7.87	1 025	CARB	P&A
DODONEA-2	WMC	EP-143	NFW	19	22	18	125	10	41	206	212	10.6.87	20.7.87	403	ORDOVICIAN	P&A
MELLANY-1	HOME	EP-129	NFW	17	24	6	124	17	17	31	38	18.6.87	5.8.87	1 074	PRE-CAMB	P&A
TWIN BUTTES-1	SANTOS	EP-142	NFW	18	30	42	122	56	42	209	217	26.6.87	15.7.87	1 137	ORDOVICIAN	P&A
HAROLD-1	HOME	EP-129	NFW	17	33	40	124	34	18	64	68	12.7.87	25.8.87	1 550	DEV	P&A
WEST TERRACE-2	HOME	L8	EXT	17	30	15	124	15	35	31	39	19.7.87	26.10.87	1 198	CARB	OIL
HILLTOP-1	BRIDGE	EP-114	NFW	18	17	36	122	17	18	32	38	20.7.87	11.8.87	1 770	PRE-CAMB	P&A
HIBISCUS-1/ST 1	WMC	EP-143	NFW	19	37	30	125	25	24	218	223	27.7.87	4.10.87	2 394	DEV	P&A
THOMPSONS-1	HOME	L6	NFW	17	36	41	124	12	33	80	84	4.8.87	19.10.87	1 800	DEV	P&A
JANPAM NORTH-1	HOME	EP-129	NFW	17	34	6	124	24	59	56	59	16.8.87	26.9.87	2 202	DEV	P&A
PADILPA-1	SANTOS	EP-104	NFW	17	1	7	123	11	36	45	52	17.8.87	24.9.87	2 184	DEV	P&A
OSCAR HILL-1	KUFPEC	EP-102	NFW	18	6	6	125	34	59	112	120	23.9.87	28.10.87	1 854	DEV	P&A
ANNA PLAINS-1	SOC	EP-142	NFW	19	20	19	121	28	2	5	9	12.10.87	4.11.87	1 160	ORD	P&A
BLINA-7	HOME	PL-6	EXT	17	37	30	124	30	0	58	62	28.10.87	14.11.87	1 391	DEV	P&A
NEEDLE EYE ROCKS-1	KUFPEC	EP-314	NFW	18	14	29	125	49	11	129	136	1.11.87	19.11.87	1 665	DEV	P&A
CALAMIA-1	OCA	EP-231	NFW	19	34	50	121	47	47	94	97	9.11.87	6.12.87	1 700	PRE-CAMB	P&A
LLOYD-2	HOME	L8	EXT	17	28	11	124	15	6	38	42	15.11.87	2.12.87	1 580	CARB	P&A
CRAB CREEK-1	BRIDGE	EP-114	NFW	18	1	11	122	31	22	6	13	30.11.87	23.12.87	1 831	DEV	P&A
PETALUMA-1	ULTRAMAR	EP-306	NFW	18	16	5	124	19	30	85	89	5.12.87	31.12.87	2 086	DEV	P&A
ANTARES-1	BRIDGE	EP-175	NFW	18	44	3	123	41	39	122	129	17.4.88	6.5.88	1 300	ORDOVICIAN	P&A
GAP CREEK-1	KUFPEC	EP-102	NFW	18	38	56	125	48	36	151	158	29.5.88	14.6.88	1 543	ORDOVICIAN	P&A
DARRIWELL-1	OCA	EP-231	NFW	19	35	24	122	6	15	93	97	8.6.88	1.7.88	1 600	ORDOVICIAN	P&A
PEGASUS-1	AMOCO	EP-316	NFW	20	5	55	123	57	4	263	270	21.6.88		1 000		
MARGARET-1	KUFPEC	EP-314	NFW	18	15	46	125	54	34	130	138	23.6.88	6.7.88	645	DEV	P&A
													TOTAL:	**36 563m**		
CARNARVON BASIN																
TALISMAN-4	MARATHON	WA-191-P	EXT	19	30	35	116	55	49	81	25	13.6.87	2.7.87	0	U.JUR	P&A
ROSETTE-1/ST 1	BOND	EP-307	NFW	20	39	24	115	34	26	5	12	8.7.87	5.11.87	3 279	U.JUR	O&G SUSP
PARROT HILL-1	AMPOL	EP-41	NFW	22	29	21	114	2	47	76	79	12.8.87	18.9.87	1 287	U.JUR	OIL SUSP
NORTH HERALD-3	WMC	TL-2	DEV	21	10	31	115	15	50	18	31	27.10.87	19.11.87	1 735	CRET	OIL
KYBRA-1	BOND	WA-192-P	NFW	20	51	52	115	46	9	19	35	15.11.87	15.12.87	2 562	PRE-PERM	P&A
SOUTH PEPPER-5	WMC	TL-2	DEV	21	7	29	115	16	13	18	31	27.11.87	12.12.87	1 300	CRET	OIL PROD
TALANDJI-1	PAN PACIFIC	EP-110	NFW	21	48	22	114	54	49	6	9	12.12.87	1.1.88	1 488	TRIAS/PERM	P&A
SOUTH PEPPER-6	WMC	TL-2	DEV	21	7	29	115	16	13	18	31	19.12.87	17.1.88	2 016	CRET	OIL PROD
SOUTH PEPPER-7	WMC	TL-2	DEV	21	7	29	115	16	13	18	31	20.12.87	1.2.88	2 022	CRET	OIL PROD
NICKOL BAY-1	ARCO	WA-202-P	NFW	20	3	26	116	34	43	58	34	3.4.88	25.5.88	2 739	TRIASSIC	P&A
ROBOT-1A	BP	WA-064-P	NFW	20	48	14	115	1	6	90	15	16.5.88		1 103		
SALADIN-7	WAPET	TP-3	EXT	21	28	51	115	0	25	8	32	28.5.88	22.6.88	1256	CRETACEOUS	OIL PROD
TRAP REEF-1	WAPET	TP-3	NFW	21	29	32	115	1	12	14	34	24.6.88	19.7.88	408	U.JUR	P&A
BARROW P18J	WAPET	PL-1H	NFW	20	46	20	115	25	44	37	41	28.6.88		281		
													TOTAL:	**21 476m**		
PERTH BASIN																
HORNER WEST-1	BARRACK	L7	NFW	29	8	11	115	2	34	95	98	2.6.87	12.7.87	103	PERMIAN	P&A
MOUNT HORNER-4a	BARRACK	L7	DEV	29	7	49	115	5	24	206	209	22.1.88	8.2.88	1 265	JURASSIC	OIL PROD
MOUNT HORNER-5a	BARRACK	L7	DEV	29	7	37	115	5	17	206	209	10.2.88	23.2.88	1 280	JURASSIC	OIL SUSP
MOUNT HORNER-8	BARRACK	L7	DEV	29	8	1	115	5	30	197	201	26.2.88	12.3.88	1 306	JURASSIC	OIL SUSP
MOUNT HORNER-9	BARRACK	L7	DEV	29	7	41	115	5	35	213	217	31.3.88	13.4.88	1 310	JURASSIC	OIL PROD
CONNOLLY-1	DORAL	EP-111	NFW	29	21	5	114	57	6	114	117	16.6.88	27.6.88	478	PRE-CAMB	P&A
CONDER-1	DORAL	EP-111	NFW	29	24	3	114	55	22	25	28	29.6.88	10.7.88	27	PRE-CAMB	P&A
													TOTAL:	**5 769m**		
													TOTAL FOR REPORT PERIOD:	**66 188m**		

LEGEND

TYPE	=	Well Type	PRE-PERM	=	Pre-Permian
NFW	=	New Field Wildcat	TRIAS	=	Triassic
EXT	=	Extension	GL	=	Ground Level
TD	=	Total Depth	WD	=	Water Depth
(m)	=	Metres	RT	=	Rotary Table
TD(IN)	=	Reached Total Depth In	P&A	=	Plugged and Abandoned
DEV	=	Devonian	OIL	=	Oil
CARB	=	Carboniferous	O&G SUSP	=	Oil & Gas Well Suspended
PRE-CAMB	=	Pre-Cambrian	OIL PROD	=	Oil Producer
U.JUR	=	Upper Jurassic			
CRED	=	Cretaceous			

SUMMARY COMPARISON OF EXPLORATION PERMIT DEALINGS 1987/88

	1987/88		1986/87	
	NO.	AREA (KM²)	NO.	AREA (KM²)
AREA ADVERTISED				
Onshore	14	32 503	4	26 210
Offshore	12	47 926	7	5 913
TOTALS	**26**	**80 429**	**11**	**32 113**
PERMITS GRANTED				
Onshore	10	46 017	3	13 790
Offshore	6	17 838 (*1 207)	5	8 804
TOTALS	**16**	**63 855**	**8**	**22 594**
PERMIT APPLICATIONS (pending at yr end)				
Onshore			4	
Offshore			2	
TOTALS			**6**	
PERMITS HELD				
Onshore	62	341 605	54	398 987
Offshore	32	143 562 (*7 658)	32	256 975
TOTALS	**94**	**485 167**	**86**	**655 962**
PERMITS SURRENDERED				
Onshore	3	34 352	4	46 738
Offshore	2	5 146	4	35 827
TOTALS	**5**	**39 498**	**8**	**82 565**
PERMIT RENEWALS				
Onshore	4	30 651	5	15 143
Offshore	4	10 702 (*2 011)	5	23 673
TOTALS	**8**	**41 353**	**10**	**38 816**
PERMITS CANCELLED				
Onshore			1	2 412
Offshore				
TOTALS			**1**	**2 412**
PERMITS EXPIRED				
Onshore	1	16 090		
Offshore	1	6 318	1	4 955
TOTALS	**2**	**22 408**	**1**	**4 955**

(* = km² included from territorial permits)

SUMMARY OF IDENTIFIED RECOVERABLE RESERVES AT JUNE 30, 1988

PROBABILITY OF RECOVERY	OIL C7+ (106kL)		GAS C1-C4 (109m³)		CONDENSATE C5 + C6 (106kL)	
	90%	50%	90%	50%	90%	50%
PROVED Developed						
Barrow Island	6.494	9.305	1.759	1.851	0.016	0.016
Blina	0.050	0.380				
Dongara#	0.019	0.019	1.019	1.019	0.004	0.004
Harriet	2.726	4.466	0.541	0.891		
Lloyd*	0.001	0.001				
Mt Horner*	0.494	0.494				
North Herald	0.081	0.271				
North Rankin			186.642	213.642	20.114	24.914
Rosette	0.099	0.319	0.477	0.937		
South Pepper	0.228	0.458				
Sundown	0.016	0.016				
West Terrace	0.014	0.046				
Woodada			1.324	2.684	0.002	0.006
TOTAL	**10.220**	**15.773**	**191.758**	**221.020**	**20.135**	**24.939**
PROVED Undeveloped						
Campbell			1.13	1.59		
Goodwyn Main	1.00	1.80	70.60	82.70	14.30	16.70
Goodwyn North			36.50	45.80	18.60	23.40
Goodwyn South	1.60	2.50				
North Rankin West			2.10	7.40	0.20	0.80
Saladin	4.65	7.73	0.37	0.62		
Tubridgi			2.14	2.16		
TOTAL	**7.25**	**12.03**	**112.84**	**140.27**	**33.10**	**40.90**
PROBABLE						
Angel			14.90	35.90	4.40	11.00
Bambara			0.57	0.88		
Brecknock			92.00	141.00	5.20	7.90
Brewster			0.00	23.50		
Central Gorgon			1.68	45.57	0.02	0.40
Dockrell	0.50	0.80				
Eaglehawk	0.20	0.20				
Egret	1.10	1.10				
Gorgon			4.69	57.19	0.01	0.16
North Gorgon			11.13	130.89	0.14	1.66
Rankin			5.50	5.50		
Scarborough			70.00	350.00		
Scott Reef			306.00	499.00	22.20	34.30
Spar			1.93	7.04	0.22	0.79
Tern			15.08	17.81		
Tidepole	1.00	1.10	12.80	14.80	1.60	1.70
West Tryal Rocks			11.30	80.77	0.55	3.94
Wilcox			7.00	9.50	2.40	3.40
TOTAL	**2.80**	**3.20**	**554.58**	**1 419.35**	**36.74**	**65.25**
TOTAL RESERVES	**20.27**	**31.00**	**859.18**	**1 780.64**	**89.98**	**131.09**

Table Two — Summary of Identified Recoverable Reserves at June 30, 1988
*** Interim Figures — Reserves currently being re-calculated.**
*** Includes Mondarra and Yardrino Reserves.**

LOST TIME ACCIDENT STATISTICS RELATING TO THE PETROLEUM EXPLORATION, PRODUCTION AND PIPELINE INDUSTRY

	YEAR ENDING JUNE 30, 1988			YEAR ENDING JUNE 30, 1987		
	ONSHORE	OFFSHORE	TOTAL	ONSHORE	OFFSHORE	TOTAL
Part of Body						
Eye	3	5	8	1	5	6
Ear				1		1
Face	1	2	3		1	1
Head, neck	1	7	8	5	1	6
Trunk	2	3	5	6	4	10
Spine		1	1	3	2	5
Internal organs						
Shoulder, upper arm	2	3	5	5	1	6
Elbow, lower arm	1	2	3	1	2	3
Wrist, hand, finger	5	7	12	3	7	10
Hip, thigh, groin	1	1	2	2	1	3
Leg, foot, toes	6	8	14	7	12	19
Skin					1	1
Multiple						
Other		3	3			
Nature of Injury						
Fractures	2	6	8	2	3	5
Dislocations				1		1
Strains/sprains	7	4	11	13	12	25
Concussion		2	2		3	3
Internal						
Amputation	1	2	3	2	2	4
Laceration/cuts	5	5	10	2	10	12
Superficial/bruising	1	2	3	4	3	7
Contusion/crushing	2	6	8	6	5	11
Burns					2	2
Multiple		1	1			
Unconsciousness						
Fumed						
Other	3	8	11	2	2	4
Agency of Injury						
Harmful contact	2	2	4		1	1
Chemicals	1		1		2	2
Slipping/falling	5	7	12	10	5	15
Falling objects		5	5	7	5	12
Mobile equipment	1	4	5		7	7
Stationary machinery	3	4	7		2	2
Hoisting		3	3		2	2
Manual handling	4	2	6	3	6	9
Vehicles				1	1	2
Explosions	1		1			
Fires						
Entrapment				1		1
Electricity						
Noxious gases				1	1	2
Other	8	7	15		1	1
Job Description						
Rig labour	14	21	35	16	54	70
Supervisor	1	2	3	3	5	8
Tradesman	6	11	17	4	10	14
Auxiliary services	5		5	2	2	4
Magnitude						
Minor	14	16	30	20	59	79
Serious	12	17	29	5	12	17
Fatal		1	1			
Time Factor						
Man—hours exposure	441 546	1 522 172	1 963 718	530 047	3 483 445	4 013 492
Man—hours lost	6 401	3 511*	9 912	3 848	4 765	8 613
Frequency Rate	58.88	22.34	30.55	47.17	20.38	23.92

*** According to Australian Standard CZ6—1966, a fatality should receive a scheduled charge of 6 000 days. This has not been included here as there is no mention of charges in the later edition (1885—1976) of the same standard.**

SEISMIC SURVEYS COMMENCED DURING 87/88

SURVEY NAME	COMPANY	TENEMENT	COMMENCED	COMPLETED	KILOMETRES RECORDED
		BONAPARTE BASIN			
SPA-1SL/87	GSI	Vacant	15.6.87	19.7.87	1 116
East Ningbing	Santos	EP-126	17.7.87	20.7.87	85
Cockatoo	Santos	EP-126	3.9.87	20.9.87	85
Sandra Marine	WMC	WA-128-P	15.10.87	23.10.87	235
		BROWSE BASIN			
BW 87 Marine	BHP	WA-34,35-P	6.8.87	18.8.87	1 071
Tex Marine	Ampol	WA-201-P	6.11.87	10.11.87	169
		CANNING BASIN			
Benfro Marine	Lasmo	WA-58-P	26.6.87	5.7.87	507
1987 Fitzroy Basin (Phase V)	Kufpec	EP-103	28.6.87	17.7.87	117
1987 Fitzroy Basin (Phase IV)	Kufpec	EP-101	19.7.87	28.8.87	305
Mingoo	WMC	EP-143,225	2.8.87	29.8.87	195
Meda	Home	EP-129	9.8.87	21.9.87	85
Ironstone Hill	OCA	EP-231	3.9.87	4.10.87	258
Rice Hill	Ultramar	EP-306	4.9.87	9.9.87	50
Moodoo	Command	EP-232,322	21.9.87	10.10.87	196
Lawford	ESP	EP-170	7.10.87	21.10.87	101
Great Sandy	SOC	EP-164	25.10.87	4.11.87	110
Mandora	Minora	EP-315	2.11.87	1.12.87	304
McLarty Block SPEC (SI 1/87-88)	Western	Vacant	9.11.87	7.12.87	366
Winifred 1988	Ampol	EP-114	5.6.88	30.6.88	210
		CARNARVON BASIN			
Barrow (451)	WAPET	PL-1H	7.4.87	9.8.87	231
SPA-3SL/87	GSI	Vacant	7.7.87	7.7.87	71
SPA-2SL/87	GSI	Vacant	18.7.87	20.7.87	74
SPA-4SL/87	GSI	Vacant	20.7.87	20.7.87	94
Koolinda 3 (453) Marine	WAPET	TP-3	3.8.87	28.8.87	316
Thevenard 2 (452)	WAPET	EP-65	10.8.87	14.8.87	16
Barrow 2 (454) Marine	WAPET	WA-23-P	29.8.87	7.9.87	139
B87 Marine	Bond	WA-192-P	9.9.87	16.9.87	177
Anita SW Marine	WMC	WA-149-P	19.9.87	7.10.87	324
Fishermans Point	Avon	EP-166	25.10.87	13.11.87	198
Peewar	Cape Range	EP-041	15.12.87	3.1.88	99
Whalebone Extension Marine	Ampol	EP-041	10.12.87	1.1.88	100
Whalebone Marine	Minora	EP-325	10.12.87	12.1.88	862
South Barrow Basin SI	GSI	Vacant	16.1.88	14.2.88	605
Helen Marine	WMC	TP-7	15.2.88	11.3.88	563
Madeleine Marine	Woodside	WA-028-P	18.3.88	20.3.88	168
88202P Marine	ARCO	WA-202-P	21.3.88	27.3.88	548
B 88 Marine	Bond	WA-192-P	30.3.88	6.4.88	64
Tubridgi	Pan Pac	L9	20.4.88	5.5.88	90
Wadawan	Pan Pac	EP-110	6.5.88	12.5.88	44
1988 Pre-detailed	Ampol	EP-41	30.5.88		160
		PERTH BASIN			
Goondaring	WMC	EP-023	10.2.88	25.2.88	60
Dongara Experimental	WAPET	L1 & L2	24.2.88	2.3.88	22
Cypress Hill	Ampol	EP-321	8.4.88	18.5.88	273

PETROLEUM PRODUCTION IN WESTERN AUSTRALIA 1987/88

FIELD	CRUDE OIL (kL)	CONDENSATE (kL)	NATURAL GAS (10^3 m^3)
Barrow Island	968 790		97 729.7
Blina	21 571.2		
Dongara	6 150.3	744.4	237 665.6
Harriet	654 049.2		109 245.0
Lloyd	8 318.2		
Mondarra		191.4	15 055.2
Mt Horner	7 216.7		
North Herald	141 827.7		
North Rankin		1 173 611.1	3 651 473.5
Rosette	684.0		2 966.0
South Pepper	102 028.3		
Sundown	2 876.9		
West Terrace	2 637.0		
Woodada		52.9	7 692.2
Yardarino			3 687.0
TOTAL	**1 916 149.5**	**1 174 599.8**	**4 125 514.2**

Table One: Production in Western Australia for the year ending June 30, 1988.

State of Western Australia
List of Permittee/Licensee/Lessee companies and titles held under the Petroleum Act, 1967, Petroleum Pipelines Act, 1969, Petroleum (Submerged) Lands Acts, 1967 and 1982 as at June 30, 1988

Notice to users: Issued for guidance and information purposes only. The legal status of the petroleum tenements listed may be verified by conducting a search of the register at the Petroleum Division.

Offshore	—	(A-1-P)	Exploration Permits
	—	(TP/1)	Territorial Sea Exploration Permits
	—	(WA-1-L)	Production Licences
	—	(TL/1)	Territorial Sea Production Licences
	—	(WA-1-PL)	Pipeline Licences
	—	(TPL/1)	Territorial Sea Pipeline Licences
	—	(WA-1-R)	Retention Lease
	—	(S)	Subsisting
Onshore	—	(L1H)	Petroleum Leases
	—	(EP 1)	Exploration Permits
	—	(L 1)	Production Licences
	—	(PL 1)	Pipeline Licences

*** denotes Operator Permittee/Lessee/Licensee**

Title holders	Titles
Agnew Clough Ltd	* EP 278
Perth WA.	* EP 321
273581 Alberta Ltd	EP 110
Calgary Alberta Canada.	L 9
Allender, James F.	EP 100
Unley SA.	L 9
Alliance Petroleum	WA-1-P
International Ltd	WA-18-P
Adelaide SA.	EP 126
	EP 175
Amoco Australia Petroleum Co	* EP 311
Houston Texas USA.	* EP 312
	* EP 313
	* EP 316
	* EP 331
	* EP 332
	* EP 333
	* EP 334
Ampol Exploration Ltd	WA-58-P
North Sydney NSW.	WA-147-P
	WA-155-P
	TP/6
	WA-191-P
	* WA-201-P
	* WA-203-P
	* WA-206-P
	WA-207-P
	* EP 41
	EP 101
	EP 102
	EP 103
	EP 314
	PL 1
	PL 2
	PL 3
	PL 4
	PL 5
Antarctic Petroleum Pty Ltd	EP 318
West Perth WA.	
ARCO Australia Ltd	* WA-202-P
West Perth WA.	
Armada Nominees Pty Ltd	EP 324
Nedlands WA.	
Austamax Operations Pty Ltd	EP 97
Melbourne Vic.	EP 101
	EP 102
	EP 314

Title holders	Titles
Australian Consolidated	EP 97
Minerals Ltd	EP 101
Perth WA.	
	EP 102
	EP 314
Australian Oil and Gas	EP 309
Corporation Ltd	
Sydney NSW.	
Avon Engineering Pty Ltd	* EP 328
West Perth WA.	* EP 329
Balmoral Resources NL	EP 114
South Perth.	
Barrack Energy Ltd	* EP 320
Perth WA.	* EP 323
	EP 325
	* EP 330
Basin Oil NL	EP 104
Melbourne Victoria.	
BHP Petroleum Pty Ltd	WA-1-P
Melbourne Vic.	WA-28-P
	WA-33-P
	* WA-34-P
	* WA-35-P
	WA-36-P
	* WA-155-P
	* WA-209-P
	* WA-210-P
	* TP/6
	WA-1-L
	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	WA-1-PL(S)
	WA-1-R
	PL 9
	EP 36
	* EP 175
BHP Petroleum (Australia) Pty	* WA-204-P
Ltd Melbourne Vic.	
Bligh International Inc	EP 175
Brisbane Qld.	
Bligh Oil and Minerals NL	EP 164
Brisbane Qld.	EP 175

Title holders	Titles
Bond Corporation Pty Ltd	* WA-192-P
Perth WA.	* WA-199-P
	* TP/1
	* TPL/1
	* TPL/2
	EP 100
	* EP 307
	L 4
	L 5
	PL 6
	* PL 12
BP Development Australia Ltd	WA-1-P
Melbourne Victoria.	WA-28-P
	WA-33-P
	WA-1-L
	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	WA-1-PL(S)
	PL 9
	EP 36
BP Petroleum Development	WA-36-P
Australia Pty Ltd	
Melbourne Victoria.	
BP Petroleum Development Ltd	EP 114
Melbourne Victoria.	
Bralorne International Inc	EP 137
Calgary Alberta Canada.	WA-58-P
Bridge Oil Ltd	WA-147-P
Sydney NSW.	WA-149-P
	WA-199-P
	WA-206-P
	* WA-207-P
	TP/7
	TP/2
	TPL/3
	TPL/4
	PL/14
	EP 101
	* EP 114
Brunswick Oil NL	EP 164
Claremont WA.	
Burns A.R. and V.W.	EP 100
Perth WA.	L 4
	L 5
	PL 6

Title holders	Titles
California Asiatic Oil Co	WA-1-P
Perth WA.	WA-28-P
	WA-33-P
	WA-34-P
	WA-1-L
	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	WA-1-PL(S)
	EP 36
	EP 41
	PL 1
	PL 2
	PL 3
	PL 4
	PL 5
	PL 9
Canning Basin Petroleum	EP 103
Pty Ltd	EP 314
Sydney NSW.	
Cape Range NL	EP 110
West Perth WA.	* EP 137
	L 9
Carnegie Oil NL	EP 326
Perth WA.	EP 327
	EP 328
	EP 329
Chapman Oil of Australia Inc	EP 142
Houston Texas USA.	
Charterhall Oil Australia Pty Ltd	WA-64-P
Melbourne Victoria.	WA-74-P
Churchill Resources NL	* EP 232
South Perth WA.	EP 328
	EP 329
Cliffs Western Australian	* PL 8
Mining Co Pty Ltd	
Perth WA.	
Clough L.T.	EP 137
Perth WA.	
Cochrane J.D. and S.A.	EP 137
West Perth WA.	
Command Petroleum NL	* WA-208-P
Sydney NSW.	EP 201
CNW Oil (Australia) Pty Ltd	WA-128-P
Sydney NSW.	TP/5
Connell L.R. and E.J.	EP 100
Perth WA.	L 4
	L 5
	PL 6
Conco Australia Ltd	WA-1-P
Perth WA.	
Consolidated Petroleum	WA-147-P
Australia NL	
Sydney NSW.	
CRA Exploration Pty Ltd	EP 114
Box Hill Victoria.	
Crocker, Hugh	EP 110
City Beach WA.	L 9
CSR Petroleum Operations	EP 101
Pty Ltd	EP 102
Brisbane Qld.	EP 314
CSX Oil and Gas (Australia)	EP 110
Corp	L 9
Melbourne Vic.	
Cultus Resources NL	WA-128-P
West Perth WA.	TP/5
Delta Petroleum Pty Ltd	EP 164
Belmont WA.	
Dominion Mining and Oil NL	EP 137
West Perth WA.	
Doral Resources NL	EP 23
West Perth WA.	* EP 100
	EP 170
	* L 4
	* L 5
	* PL 6
Eagle Corporation Ltd	EP 114
Perth WA.	EP 142
	EP 201

Title holders	Titles
East Hampstead Pty Ltd	EP 231
Perth WA.	
Elf Aquitaine Petroleum	* WA-18-P
Australia Pty Ltd	
North Sydney NSW.	
Energy Exploration Pty Ltd	EP 232
Belmont WA.	
ESP Interior Pty Ltd	* EP 170
Sydney NSW.	
Esso Exploration and Production	WA-128-P
Australian Inc	TP/5
Sydney NSW.	WA-147-P
	WA-155-P
	TP/6
	* WA-1-R
	EP 103
	L 9
FAI Natural Resources Pty Ltd	WA-192-P
Sydney NSW.	TP/8
	TPL/1
	TPL/2
	TL/1
	EP 307
	PL 12
First Australian Resources NL	EP 318
Perth WA.	EP 326
	EP 327
Forsayth NL	WA-58-P
Perth WA.	EP 309
Garda Pty Ltd	EP 318
Perth WA.	
Gascoine D.R. and J.E.	EP 100
Peppermint Grove WA.	L 4
	L 5
	PL 6
	EP 210
	EP 326
	EP 327
Gascoine D.R.	EP 318
Peppermint Grove WA.	EP 328
	EP 329
Geary J.K.	EP 100
Karrinyup WA.	L 4
	L 5
	PL 6
Geotechnics (Aust) Pty Ltd	EP 166
Fremantle WA.	
Giorno Pty Ltd	EP 325
Belmont WA.	EP 330
Global Oil Ltd	EP 175
Sydney NSW.	
Golden West Hydrocarbons	EP 137
Pty Ltd	
Claremont WA.	
Gulf Oil Australia Pty Ltd	EP 114
Perth WA.	
Hadson Petroleum International	
Ltd	WA-208-P
Oklahoma USA.	
Hallmark Minerals NL	WA-64-P
Perth WA.	
Haoma Petroleum Pty Ltd	EP 100
Perth WA.	L 4
	L 5
	PL 6
Heron Petroleum Pty Ltd	EP 318
Perth WA.	
Hill Minerals NL	EP 137
West Perth WA.	
Home Energy Co Ltd	WA-128-P
Perth WA.	TP/5
	* EP 129
	* L 6
	* L 8
	* PL 7
Hughes D.A. and D.J.	EP 100
Perth WA.	L 4
	L 5
	PL 6
International Oil Proprietary	* EP 126
Melbourne Victoria.	EP 164

Title holders	Titles
Japan Australia LNG (MIMI) Ltd	WA-1-L
Melbourne Victoria.	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	WA-1-PL(S)
	PL 9
Jervois Sulphates (NT) Ltd	* EP 111
Coburg Vic.	
Kimberley Oil and Gas NL	WA-147-P
Perth WA.	
Kalton Pty Ltd	EP 324
Allambie Heights NSW.	
Kufpec Australia Pty Ltd	* EP 97
Perth WA.	* EP 101
	* EP 102
	* EP 103
	* EP 314
	EP 322
	EP 323
Landsvale Oil and Gas Pty Ltd	EP 114
Perth WA.	EP 201
Lasmo Energy Australia Ltd	* WA-58-P
Brisbane Qld.	
Lasmo International Oil	WA-191-P
Development Ltd	
Brisbane Qld.	
Lassoc Pty Ltd	* EP 201
South Perth.	
Laurel Bay Petroleum Ltd	EP 101
North Sydney NSW.	EP 129
	L 6
Lennard Oil NL	WA-64-P
Perth WA.	EP 201
	EP 315
Marlin Oil NL	EP 137
West Perth.	
Marathon Petroleum Australia	* WA-191-P
Ltd	
Perth WA.	
Marvel Petroleum NL	EP 318
West Perth WA.	
Meda Petroleum NL	EP 166
Perth WA.	
Medcon Resources Inc	EP 164
Calgary Alberta Canada.	
Median Oil NL	* EP 318
Sydney NSW.	
Meridian Oil NL	EP 164
Belmont WA.	EP 232
	EP 322
Mid Eastern Oil Ltd	WA-1-P
Melbourne Victoria.	WA-28-P
	WA-33-P
	WA-36-P
	WA-1-PL(S)
	WA-1-L
	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	EP 36
	PL 9
Midland Brick Company Pty Ltd	EP 100
Perth WA.	L 4
	L 5
	PL 6
Minicorp Ltd	EP 201
Melbourne Victoria.	
Minicorp Natural Gas Pty Ltd	EP 100
Melbourne Victoria.	L 4
	L 5
	PL 6
Minora Oil NL	EP 41
Perth WA.	

Title holders	Titles
Minora Resources NL	WA-208-P
Perth WA.	* EP 315
	* EP 325
	EP 330
Mitsui Iron Ore Development Pty Ltd	PL 8
Mizen Af	EP 137
Perth WA.	
Moage Ltd	EP 315
Sydney NSW.	
Monarch Petroleum NL	WA-64-P
Perth WA.	EP 110
	EP 137
	* EP 166
	L 9
Monitor Exploration Pty Ltd	EP 318
Perth WA.	
Montauk Pty Ltd	WA-18-P
Belmont WA.	
Mt Isa Mines Ltd	WA-208-P
Brisbane Qld.	EP 322
The National Mutual Life Association of Australia Ltd	WA-18-P
Melbourne Victoria.	
New World Oil and	WA-192-P
Developments Pty Ltd	TP/8
Perth WA.	TPL/1
	TPL/2
	TL/1
	EP 129
	EP 307
	L 6
	L 8
	PL 12
Nippon Steel Australia Pty Ltd	PL 8
Perth WA.	
Nomeco-Command NL	WA-149-P
Sydney NSW.	WA-206-P
	WA-207-P
	TP/7
	TL/2
	TPL/3
	TPL/4
	PL 14
Noraust Investments Ltd	EP 126
Melbourne Victoria.	
Norcen Energy Australia Pty Ltd	WA-199-P
Sydney NSW.	
Norcen International Ltd	WA-209-P
Sydney NSW.	
Norlin W.K.	EP 100
Floreat Park WA.	L 4
	L 5
	PL 6
Northern Michigan	* EP 322
Exploration Company	
Sydney NSW.	
Oakbridge Ltd	EP 322
Sydney NSW.	
Ocean Resources NL	EP 328
Paddington NSW.	EP 329
Ocelot International Pty Ltd	EP 129
Perth WA.	L 6
	L 8
Offshore Oil (Far East) Ltd	WA-64-P
Sydney NSW.	
OGE Ltd	WA-149-P
Sydney NSW.	TP/7
	TP/2
	TPL/3
	TPL/4
	PL 14
Oil Company of Australia NL	EP 104
Sydney NSW.	EP 170
	* EP 231
Oil Investments Ltd	WA-18-P
Sydney NSW.	
Oil Venturers Pty Ltd	EP 318
Perth WA.	
Orca Petroleum NL	EP 309
North Sydney NSW.	

Title holders	Titles
Pacific Basin Exploration Pty Ltd	* EP 96
Perth WA.	* PL 7
Pacific Oil and Gas Pty Ltd	WA-149-P
Box Hill Vic.	TP/7
	TL/2
	TPL/3
	TPL/4
	PL 14
Pan Pacific Petroleum NL	WA-149-P
North Sydney NSW.	TP/7
	TL/2
	TPL/3
	TPL/4
	* EP 110
	EP 137
	EP 170
	EP 315
	* L 9
	PL 14
Peko Oil Ltd	WA-147-P
North Sydney NSW.	EP 232
Peko-Wallsend Operations Ltd	PL 8
Perth WA.	
Petro Energy Ltd	WA-192-P
West Perth WA.	WA-199-P
	TP/8
	TPL/1
	TPL/2
	TL/1
	EP 23
	EP 307
	PL 12
Petroz NL	* WA-64-P
Perth WA.	WA-79-P
	WA-199-P
	EP 170
Petroleum Engineering Services (Australia) Pty Ltd	EP 324
Coromandel Valley SA.	
Petroleum Royalties Pty Ltd	WA-64-P
Perth WA.	EP 137
Petroleum Securities Australia Ltd	EP 103
Sydney NSW.	
Petroleum Securities Pty Ltd	EP 129
Melbourne Victoria.	L 6
	L 8
Phoenix Oil and Gas NL	EP 231
Melbourne Victoria.	
Pioneer Concrete Service Ltd	WA-201-P
St Peters NSW.	
Pontella Nominees Pty Ltd	EP 164
West Perth WA.	
Pontoon NL	WA-74-P
Perth WA.	
Pontoon Oil (Australia) Ltd	EP 309
Perth WA.	
PPL Petroleum Ltd	WA-149-P
St Leonards NSW.	TP/7
	TL/2
	TPL/3
	TPL/4
	PL 14
Reading and Bates Australia	WA-192-P
Petroleum Co	TP/8
Tulsa Oklahoma USA.	TPL/1
	TPL/2
	TL/1
	EP 307
	PL 12
Reef Oil NL	EP 104
Perth WA.	EP 100
	L 4
	L 5
	L 6
Royal Resources Exploration Inc	EP 164
Perth WA.	EP 231
Roxburgh S.D.	EP 100
Melbourne Victoria.	L 4
	L 5
	PL 6

Title holders	Titles
Santos Ltd	WA-58-P
Adelaide SA.	WA-128-P
	WA-191-P
	WA-203-P
	TP/5
	* EP 104
	EP 170
The Shell Company of Australia Ltd	WA-204-P
Melbourne Victoria.	* EP 308
Shell Development (Australia)	WA-1-P
Pty Ltd	WA-28-P
Melbourne Victoria.	WA-33-P
	WA-35-P
	WA-36-P
	WA-1-L
	WA-2-L
	WA-3-L
	WA-4-L
	WA-5-L
	WA-6-L
	WA-1-PL(S)
	EP 36
	PL 1
	PL 2
	PL 3
	PL 4
	PL 5
	PL 9
Simian Pty Ltd	* EP 324
Nedlands WA.	
Socdet Production Pty Ltd	EP 104
Sydney.	
Southern Basins Petroleum NL	EP 232
Belmont WA.	
Southern Cross Exploration NL	EP 318
Sydney NSW.	
Southern Goldfields Ltd	EP 231
West Perth WA.	
Spedley Securities Ltd	EP 100
Perth WA.	L 4
	L 5
	PL 6
SRL Exploration Pty Ltd	WA-58-P
North Sydney NSW.	
Stellar Resources NL	EP 231
Sydney NSW.	
Stirling Petroleum NL	WA-58-P
Perth WA.	WA-64-P
Success Oil NL	* EP 326
Fremantle WA.	* EP 327
	EP 328
	EP 329
Sumitomo Metal Australia Pty Ltd	PL 8
Perth WA.	
Sydney Oil Company (164) Pty Ltd	* EP 164
Sydney NSW.	
TCPL Resources Ltd	WA-58-P
North Sydney NSW.	WA-206-P
	WA-207-P
Texaco Overseas Petroleum Co	PL 1
Sydney NSW.	PL 2
	PL 3
	PL 4
	PL 5
Texas Eastern Australia	WA-192-P
Development Pty Ltd	WA-199-P
Houston Texas USA.	TP/8
	TPL/1
	TPL/2
	TL/1
	EP 307
	PL 12
Texas Gas Exploration (Australia) Corporation	EP 137
Melbourne Victoria.	

Title holders	Titles
Texaco International Company Oklahoma USA.	WA-128-P WA-147-P TP/5
Timor Oil Ltd Sydney NSW.	EP 126
Tri-Arc Energy Ltd Sydney NSW.	WA-128-P TP/5
Trestate Pty Ltd Willoughby NSW.	EP 324
Tricentrol Exploration Overseas Ltd Victoria Park WA.	WA-191-P
Ultramar Australia Inc Sydney NSW.	EP 114
Vamgas Ltd Adelaide SA.	EP 101 EP 103 EP 129 EP 314 L 6 L 8
Varanus Pty Ltd Perth WA.	WA-192-P TP/8 TL/1 TPL/1 TPL/2 PL 12 EP 307 * EP 309
Venture Petroleum Pty Ltd Melbourne Victoria.	EP 201
Versatile Farm Equipment Pty Ltd	WA-58-P
Vancouver British Columbia Canada.	EP 137
Vigilant Oil NL West Perth WA.	EP 330
Wainoco International Inc Perth WA.	* EP 142
Weaver Oil and Gas Corporation Australia Perth WA.	EP 41
West Australian Onshore Oil NL Perth WA.	WA-58-P
West Australian Petroleum Pty Ltd Perth WA.	* WA-23-P * WA-24-P * WA-25-P * WA-205-P * TP/2 * TP/3 * EP 61 * EP 62 * EP 65 * EP 66 * L 1 * L 2 * L 1H * WA-7-L * TL/3 * L 10
Western Energy Pty Ltd Perth WA.	WA-58-P
Western Mining Corporation Ltd Perth WA.	* WA-128-P * WA-147-P * WA-149-P * TP/5 * TP/7 * TP/2 * TPL 3 * TPL 4 * EP 23 EP 41 EP 126 * EP 143 * EP 225 * PL 14
Westpet Pty Ltd Sydney NSW.	EP 325
Whitestone Petroleum Australia Ltd Houston Texas.	EP 97 EP 101 EP 102 EP 314
Whitewater Oil Inc Calgary Alberta Canada.	EP 110 L 9
Willara Petroleum Pty Ltd Perth WA.	EP 164
Winthrop Investments Ltd Sydney NSW.	EP 166
Winton Oil NL Melbourne Victoria.	EP 231
Woodside Oil Melbourne Victoria.	WA-1-P WA-28-P WA-33-P WA-36-P WA-1-PL(S) WA-1-L WA-2-L WA-3-L WA-4-L WA-5-L WA-6-L EP 36 PL 9
Woodside Petroleum Development Pty Ltd Perth WA.	* WA-1-P * WA-28-P * WA-33-P * WA-36-P * WA-1-PL(S) * WA-1-L * WA-2-L * WA-3-L * WA-4-L * WA-5-L * WA-6-L * EP 36 * PL 9
Yom Oil Ltd Athens Greece.	EP 97 EP 101 EP 102 EP 103 EP 314
York Resources NL Sydney NSW.	WA-128-P TP/5

MINING TENEMENTS IN FORCE AS AT JUNE 30, 1988

	MINERAL FIELD/DISTRICT	1978 MINING ACT			1904 MINING ACT
		PROSPECTING LICENCES	EXPLORATION LICENCES	MINING LEASES & OTHERS	MINERAL CLAIMS & OTHERS
01	Greenbushes			14	
04	West Kimberley	40	216	154	193
08	Ashburton	76	96	45	
09	Gascoyne	56	67	52	
12	Collie			121	
15	Coolgardie	978	71	901	
16	Kunanalling	541	26	95	
20	Cue	573	44	140	4
21	Day Dawn	185	8	34	9
24	Broad Arrow	716	21	289	
25	Bulong	334	25	96	
26	East Coolgardie	547	21	271	
27	Kanowna	353	26	110	
28	Kurnalpi	195	64	54	
29	Menzies	489	40	86	
30	Ularring	330	23	80	
31	Yerilla	532	25	96	
36	Lawlers	368	32	75	25
37	Mt Malcolm	1 519	55	180	
38	Mt Margaret	816	73	112	5
39	Mt Morgans	1 129	67	112	31
40	Niagara	445	15	63	10
45	Pilbara	699	270	310	10
46	Nullagine	367	32	89	
47	West Pilbara	261	113	153	5
51	Meekatharra	590	107	265	3
52	Peak Hill	197	139	117	
53	Wiluna	297	91	147	102
57	Black Range	268	73	83	13
58	Mt Magnet	310	36	164	9
59	Yalgoo	341	115	130	
63	Dundas	199	70	177	
66	Northampton	1			
69	Warburton	2	28		
70	South West	203	133	381	114
74	Phillips River	58	25	35	2
77	Yilgarn	771	130	304	
80	Kimberley	430	201	166	17
Special Agreement Act areas					
	TOTAL	**15 216**	**2 578**	**5 690**	**552**

Total Area of Mining Tenements in Force

As at	Area (hectares)
Dec '82	12 756 046
Dec '83	10 505 270
Dec '84	17 308 525
June '85	18 414 443
June '86	17 496 124
June '87	22 232 171
June '88	26 998 964

Abbreviations

cons. — concentrates
f.o.b. — free on board
f.o.r. — free on rail
f.o.t. — free on truck
n.a. — not available
n.ap. — not applicable

References

(a) Value based on the average Australian value of alumina as published by the Bureau of Mineral Resources in the Australian Mineral Industry Review.
(b) Value at works.
(c) Estimated f.o.b. value.
(d) Estimated ex-mine value.
(e) Metallic by-product of nickel mining.
(f) Estimated f.o.r. value.
(g) Estimated f.o.b. value based on the current price of nickel containing products.
(h) Delivered value.

UNITS AND CONVERSION FACTORS

	METRIC UNIT	SYMBOL	IMPERIAL UNIT	CONVERSION FACTORS	
				MULTIPLY IMPERIAL UNIT BY	MULTIPLY METRIC UNIT BY
Mass	gram	g	troy (fine) ounce (oz)	31.103522	0.032151
	kilogram	kg	pound (lb)	0.453592	2.204624
	tonne	t	long ton (2240 lbs)	1.016046	0.984207
	tonne	t	short ton (2000 lbs)	0.907185	1.102311
Volume	kilolitre	kl	barrel (bbl)	6.28981	0.158987
	kilolitre	kl	cubic metre (m^3)	1	
Energy	kilojoule	kj	British thermal unit (BTU)	1.05506	0.94781
	Typical natural gas		MJ/M^3	39	
Prefix	kilo (k)	10^3			
	mega (M)	10^6			
	giga (G)	10^9			
	tera (T)	10^{12}			

QUANTITY AND VALUE OF MINERALS REPORTED 1986/87 AND 1987/88

MINERAL	UNIT QUANTITY	1986/87 QUANTITY	1986/87 VALUE ($A)	1987/88 QUANTITY	1987/88 VALUE ($A)
Alumina	t	5 727 327	1 090 879 157	6 063 130	1 182 997 535
Barytes	t			9 669	1 160 280
Building Stone					
black granite	t	585	50 000		
quartz	t	1 861	83 755	294	13 210
Clay					
attapulgite	t	10 458	n.a.	11 387	n.a.
cement clay	t	23 991	59 969	22 679	56 698
fire clay	t	208 895	252 326	191 184	381 127
kaolin	t	7 460	241 564	185	11 187
white clay	t	72 176	209 528	1 697	20 364
Coal	t	3 795 055	141 742 231(r)	3 701 942	150 965 157
Cobalt	t	463	4 012 332	325	3 521 185
Construction Material					
aggregate	t	100 816	581 430	261 853	1 314 472
gravel	t	22 365	28 965	5 989	38 905
rock	t	116 222	187 560	315 395	3 265 965
sand	t	1 271 826	3 786 995	1 618 124	4 602 471
sandstone	t	20	40		
Copper	t	3 519	4 106 685	2 071	5 938 229
Diamond	ct	32 164 524	284 094 805	30 218 355	248 202 718
Diatomite	t	401	2 006	124	682
Dolomite	t	243	3 162	130	2 060
Emerald	g	200	1 784		
Felspar	t	4 405	68 814	9 602	387 558
Garnet Sand	t	12 122	427 334	17 890	630 044
Gold	kg	64 911	1 300 079 190	90 546	1 843 770 410
Gypsum	t	233 404	2 673 698	99 162	947 660
Iron ore	t	78 026 315	1 678 811 297(r)	95 177 702	1 867 172 034
Kyanite	t	955	153 220	826	114 799
Limestone	t	194 895	1 251 642	170 194	1 581 478
Mineral Beach Sand					
ilmenite	t	1 038 922	57 843 880(r)	946 494	63 934 291
reduced ilmenite	t	53	13 250(r)		
upgraded ilmenite	t	61 178	22 899 652(r)	195 504	69 996 495
leucoxene	t	12 606	5 140 988	10 882	4 581 114
monazite	t	12 407	8 417 755	9 705	6 960 550
rutile	t	82 462	46 089 968	85 078	51 168 571
xenotime	t	43	328 846		
zircon	t	310 576	56 297 397	366 053	97 148 148
Nickel Concentrate	t	406 321	264 726 489	388 964	391 749 276
Nickel Ore	t	59 257	10 065 723		
Palladium	kg	490	3 218 062	454	2 842 171
Peat	t	1 641	51 669	879	52 794
Petroleum Products					
condensate	kl	512 434	76 464 584(r)	1 140 514	169 911 500
crude oil	kl	1 574 655	262 843 620	1 932 597	304 355 749
natural gas	'000m^3	3 199 165	277 989 304	3 629 175	320 504 994
Platinum	kg	105	2 645 121	82	1 936 029
Salt	t	5 051 148	107 382 344	5 533 859	107 165 215
Semi-precious Stone					
amethyst	kg	51 000	195 500	51 000	195 500
Silica Sand	t	371 165	2 279 997(r)	402 995	2 985 987
Silver	kg	11 160	1 971 953	12 673	2 295 547
Spodumene	t	8 221	1 855 601	24 471	4 397 393
Talc	t	179 241	n.a.	169 612	n.a.
Tantalite	t	108	4 224 365	133	5 676 606
Tin Concentrate	t	731	4 882 698	434	2 855 928
Vermiculite	t	819	16 388	1 679	87 072
Zinc Concentrate	t			7 223	2 805 427
TOTAL VALUE			**5 855 841 549(r)**		**6 945 636 791**

Note: (r) Revised from previous edition

QUANTITY AND VALUE OF MINERALS SHOWING MINERAL FIELD AND METALLIC CONTENT

MINERAL	MINERAL FIELD	QUANTITY TONNES	METALLIC CONTENT	VALUE ($)	REF.
Alumina	South West	6 063 130		1 182 997 535	(a)
Building Stone					
— quartz rock	South West	294		13 210	(b)
Barytes	Pilbara	9 669		1 160 280	(c)
Clay					
— attapulgite	South West	11 387		n.a.	
— cement clay	South West	22 679		56 698)	
— fire clay	South West	191 184		381 127)	(b)
— kaolin	Greenbushes	185		11 187)	
— white clay	South West	1 697		20 364)	
Coal	Collie	3 701 942		150 965 157	(d)
Cobalt	Coolgardie		t 324.684	3 521 185	(c), (e)
Construction Materials					
— aggregate	East Coolgardie	227 795		957 328	
	Kimberley	6 526		26 104	
	Pilbara	19 447		256 900	
	West Kimberley	8 085		74 140	
		261 853		1 314 472	
— gravel	Coolgardie	3 309		16 545	
	West Pilbara	2 680		22 360	
		5 989		38 905	
— rock	South West	225 339		2 028 051	
	West Kimberley	35 892		610 174	
	West Pilbara	54 164		627 740	
		315 395		3 265 965	
— sand	Coolgardie	24 191		148 437	
	Mt Margaret	157		314	
	Peak Hill	14 912		82 376	
	Pilbara	13 302		77 021	
	South West	1 503 767		3 768 965	
	West Pilbara	61 795		525 358	
		1 618 124		4 602 471	
TOTAL CONSTRUCTION MATERIALS				**9 221 813**	**(b)**
Copper	Coolgardie		t 2 701.496	5 938 229	(c), (e)
Diamonds	Kimberley		ct 30 218 355	248 202 718	(c)
Diatomite	South West	124		682	(f)
Dolomite	South West	130		2 060	(f)
Felspar	South West	9 602		387 558	(f)
Garnet Sand	South West	17 890		630 044	(f)
Gold	State-wide	kg 90 545.779		1 843 770 410	
Gypsum	South West	71 396		794 319	(f)
	Yilgarn	27 766		153 341	(f)
TOTAL GYPSUM		**99 162**		**947 660**	
Iron Ore			Av. Assay Fe %		
Interstate					
— ore	Peak Hill	3 968 418	65.78	85 326 903	
	West Kimberley	1 479 040	66.50	16 266 460	
		5 447 458		101 593 363	

MINERAL	MINERAL FIELD	QUANTITY TONNES	METALLIC CONTENT	VALUE ($)	REF.
Exported					
— ore	Peak Hill	31 163 240	63.00	667 015 810	
	Pilbara	4 111 165	61.67	77 423 343	
	West Pilbara	51 812 871	61.19	967 284 020	
	West Kimberley	2 102 165	66.54	42 352 612	
		89 189 441		1 754 075 785	
— pellets	West Pilbara	540 803	63.26	11 502 886	
		89 730 244		1 765 578 671	
TOTAL IRON ORE		**95 177 702**		**1 867 172 034**	**(c)**
Kyanite	South West	826		114 799	(c)
Limestone	South West	126 828		1 294 978	
	West Pilbara	43 366		286 500	
TOTAL LIMESTONE		**170 194**		**1 581 478**	**(b)**
			Av. Assay TiO_2 %		
Mineral Beach Sands					
— ilmenite	South West	946 494	56.28)		
— upgraded ilmenite	South West	195 504	92.00)	133 930 786	
			TiO_2 t		
— leucoxene	South West	10 882	9 841	4 581 114	
			ThO_2 10kg units		
— monazite	South West	9 705	63 990	6 960 550	
			TiO_2 t		
— rutile	South West	85 078	80 822	51 168 571	
			ZrO_2 t		
— zircon	South West	366 053	239 976	97 148 148	
TOTAL MINERAL BEACH SANDS				**293 789 169**	**(c)**
			Av. Assay Ni %		
Nickel Concentrates	Coolgardie	278 265	11.40	288 087 264	
	East Coolgardie	32 573	11.70	34 630 549	
	Mt Margaret	78 126	9.57	69 031 463	
TOTAL NICKEL		**388 964**		**391 749 276**	**(g)**
			kg		
Palladium	Coolgardie		453.847	2 842 171	(c), (e)
Peat	South West	879		52 794	(b)
		kL			
Petroleum	Basin				
— condensate	Carnarvon	1 139 584		169 750 000	(c)
	Perth	930		161 500	(b)
		1 140 514		169 911 500	
— crude oil	Canning	41 968		6 721 774	
	Carnarvon	1 877 143		295 764 487	
	Perth	13 486		1 869 488	
		1 932 597		304 355 749	(c)
		$m^3 10^3$			
— natural gas	Carnarvon	3 372 291		294 385 000	(b)
	Perth	256 884		26 119 994	(h)
		3 629 175		320 504 994	(i)
TOTAL PETROLEUM				**794 772 243**	

MINERAL	MINERAL FIELD	QUANTITY TONNES	METALLIC CONTENT	VALUE ($)	REF.
Platinum	Coolgardie		kg 81.822	1 936 029	(c), (e)
Salt	Gascoyne	1 533 398		30 374 588	
	Pilbara	2 020 062		37 453 010	
	South West	250		6 250	
	West Pilbara	1 980 149		39 331 367	
TOTAL SALT		**5 533 859**		**107 165 215**	**(c)**
Semi-precious stones — amethyst	Gascoyne		t 51	195 500	(f)
Silica	Coolgardie	44 575		109 206	
	South West	358 420		2 876 781	
TOTAL SILICA		**402 995**		**2 985 987**	**(c)**
Silver	By-product of gold mining		kg 12 017.680	2 088 648	
	By-product of nickel mining		655.207	206 899	(c)
TOTAL SILVER			**12 672.887**	**2 295.547**	
Spodumene	Greenbushes	24 471		4 397 393	(c)
Talc	South West	169 612		n.a.	
Tantalite	Greenbushes	133	Ta_2O_5 kg 147 421	5 676 606	(c)
Tin	Greenbushes	434	Sn t 304	2 855 928	(c)
Vermiculite	Phillips River	1 679		87 072	(f)
Zinc	West Kimberley	7 223	Zn t 4 059	2 805 427	(c)
		Value of Gold		**1 843 770 410**	
		Value of Other Minerals		**5 101 866 381**	
		TOTAL VALUE OF ALL MINERALS		**6 945 636 791**	

QUANTITY OF GOLD (kg) AND ORE TREATED 1987/88 SHOWING MINERAL FIELD AND DISTRICT

	ALLUVIAL KILOGRAMS	DOLLIED SPECIMENS KILOGRAMS	MILLED OR SMELTERED		TAILING RETREATMENT KILOGRAMS	TOTAL GOLD KILOGRAMS
			ORE TREATED (TONNES)	GOLD THEREFROM KILOGRAMS		
Kimberley	**24.022**	**0.049**	**5**	**0.036**		**24.107**
West Kimberley						
Marble Bar	11.649	0.034	2 177 948	7 071.084	77.535	7 160.302
Nullagine	64.333	1.901	20 916	274.576		340.810
Pilbara	**75.982**	**1.935**	**2 198 864**	**7 345.660**	**77.535**	**7 501.112**
West Pilbara	**17.232**	**2.031**				**19.263**
Ashburton	**3.846**					**3.846**
Gascoyne	**2.095**	**0.677**	**352**	**4.347**		**7.119**
Peak Hill	**35.569**	**3.455**	**296 740**	**873.711**		**912.735**
Lawlers	6.207	0.809	1 310 020	3 868.822	99.643	3 975.481
Wiluna	0.067		1 152 423	3 684.961	482.228	4 167.256
Black Range	1.688	1.834	857 386	2 957.758	37.873	2 999.153
East Murchison	**7.962**	**2.643**	**3 319 829**	**10 511.541**	**619.744**	**11 141.890**
Cue	25.690	0.966	282 594	1 364.243	15.056	1 405.955
Meekatharra	5.285	0.121	1 970 410	4 757.053	3.270	4 765.729
Day Dawn	23.289	0.058	81 110	1 047.827	65.044	1 136.218
Mt Magnet	17.973	0.160	1 005 004	3 490.424	1.372	3 509.929
Murchison	**72.237**	**1.305**	**3 339 118**	**10 659.547**	**84.742**	**10 817.831**
Yalgoo	**1.010**	**0.114**	**699 241**	**1 798.234**		**1 799.358**
Mt Morgans	4.746		128 491	388.777	2.896	396.419
Mt Malcolm	3.160	0.744	1 502 714	4 886.380	750.362	5 640.646
Mt Margaret	10.387	1.475	578 458	1 636.557	137.826	1 786.245
Mt Margaret	**18.293**	**2.219**	**2 209 663**	**6 911.714**	**891.084**	**7 823.310**
Menzies	0.107		529 763	1 178.594	29.294	1 207.995
Ularring			175 069	459.425	14.202	473.627
Niagara	3.681	0.044	8 489	21.370	35.787	60.882
Yerilla			235 040	685.271	3.128	688.399
North Coolgardie	**3.788**	**0.044**	**948 361**	**2 344.660**	**82.411**	**2 430.903**
Broad Arrow	**0.189**		**3 016 695**	**8 130.898**	**113.507**	**8 244.594**
Kanowna	0.357	0.024	94 178	188.857	15.135	204.373
Kurnalpi	0.864		189 059	425.838		426.702
NE Coolgardie	**1.221**	**0.024**	**283 237**	**614.695**	**15.135**	**631.075**
East Coolgardie	0.987	0.034	5 415 377	16 402.232	452.050	16 855.303
Bulong	1.693		56	0.109		1.802
East Coolgardie	**2.680**	**0.034**	**5 415 433**	**16 402.341**	**452.050**	**16 857.105**
Coolgardie	4.570		2 001 002	5 587.578	57.834	5 649.982
Kunanalling	0.262		67 814	170.151	4.430	174.843
Coolgardie	**4.832**		**2 068 816**	**5 757.729**	**62.264**	**5 824.825**
Yilgarn	**6.098**	**0.507**	**3 884 904**	**6 745.423**	**38.292**	**6 790.320**
Dundas			**509 668**	**2 920.114**	**0.105**	**2 920.219**
Phillips River			**6 341**	**20.229**		**20.229**
South West			**2 228 402**	**6 775.938**		**6 775.938**
TOTAL	**277.056**	**15.037**	**30 425 669**	**87 816.817**	**2 436.869**	**90 545.779**

ROYALTY RECEIPTS 1986/87 AND 1987/88

MINERAL	1986/87 ($A)	1987/88 ($A)	VALUE ($A) VARIANCE	% UP (% DOWN)
Alumina	10 540 225	**12 132 983**	1 592 758	15
Building Stone	823	**298**	(525)	(64)
Clay	153 343	**331 800**	178 457	116
Coal	1 353 229	**1 520 155**	166 926	12
Cobalt	56 373	**24 772**	(31 601)	(56)
Construction Materials				
aggregate	19 797	**60 578**	40 781	206
gravel	10 088	**534**	(9 554)	(95)
rock	22 519	**84 622**	62 103	276
sand	250 568	**110 506**	(140 062)	(56)
sandstone		**25**	25	n.ap.
Copper	143 183	**106 883**	(36 300)	(25)
Diamond	13 109 395	**12 221 752**	(887 643)	7
Diatomite	173	**34**	(139)	(80)
Dolomite	18		(18)	(100)
Emerald	134		(134)	(100)
Felspar	3 195	**14 429**	11 234	352
Garnet sand	19 230	**32 261**	13 031	68
Gold	111 974	**122 814**	10 840	10
Gypsum	83 998	**31 677**	(52 321)	(62)
Iron ore	92 780 315	**94 807 770**	2 027 455	2
Kyanite	5 841	**8 347**	2 506	43
Limestone	90 641	**54 029**	(36 612)	(40)
Mineral beach sands				
ilmenite	1 462 769	**2 530 669**	1 067 900	73
leucoxene	137 980	**89 155**	(48 825)	(35)
monazite	252 178	**320 669**	68 491	27
rutile	1 038 150	**2 366 266**	1 328 116	128
xenotime	8 457		(8 457)	(100)
zircon	1 347 903	**3 685 866**	2 337 963	173
Nickel	4 315 281	**3 760 762**	(554 519)	(13)
Ochre	2 255		(2 255)	(100)
Palladium	24 567	**21 227**	(3 340)	14
Peat	2 740	**1 672**	(1 068)	(39)
Petroleum Products				
condensate	695 164 (r)	**1 284 015**	588 851	85
crude oil	21 917 124	**23 818 340**	1 901 216	8
natural gas	4 801 877 (r)	**4 941 808**	139 931	3
Platinum	24 567	**21 227**	(3 340)	(14)
Salt	747 615	**876 877**	129 261	17
Semi-precious Stones				
amethyst	6 375	**14 662**	8 287	130
Silica sand	165 339	**197 211**	31 872	19
Silver	87 238	**55 446**	(31 792)	(36)
Spodumene	72 632	**217 515**	144 883	199
Talc	88 874	**91 994**	3 120	4
Tantalite	109 428	**159 774**	50 346	46
Tin	143 601	**102 163**	(41 438)	(29)
Vermiculite	804	**2 402**	1 598	199
Zinc Concentrate	78 427		(78 427)	(100)
TOTAL VALUE	**156 286 407 (r)**	**166 225 989**	**9 939 582**	**6**

Note: (r) Revised from previous edition

NUMBER OF PERSONS EMPLOYED IN THE WESTERN AUSTRALIAN MINING INDUSTRY AS AT JUNE 1988

MINERAL COMPANY	LOCATION	1982 (a)	1987/88
ALUMINA			
Alcoa of Australia Ltd	Jarrahdale/Kwinana	1 676	1 574
	Del Park/Huntley/ Pinjarra	1 643	1 683
	Wagerup	103	500
	Administration	210	283
Worsley Alumina Pty Ltd	Worsley		876
		3 632	**4 916**
COAL			
Griffin Coal Mining Co. Ltd	Collie	421	493
Western Collieries Ltd	Collie	648	712
		1 069	**1 205**
COPPER-SILVER-ZINC			
Seltrust Mining Corporation Pty Ltd	Teutonic Bore	**148**	
DIAMOND			
Argyle Diamond Mines JV	Lake Argyle		677
Freeport Bow River Properties Ltd	Bow River		60
			737
GOLD			
AUR NL	Mt Martin		45
Australian Consolidated Minerals Ltd	Golden Crown		92
	Westonia		219
Australian Mine Mgmt Pty Ltd	Golden Kilometre		92
Australis Mining NL	Norseman		51
Austwhim Resources NL	Cork Tree Well		40
	Mt Morgans		52
BHP Minerals Ltd	Gimlet South/Orban JV		126
Bamboo Creek JV	Bamboo Creek		72
Bardoc Gold Pty Ltd	Bardoc		58
Barrack Mine Management	Horseshoe		119
	Wiluna		95
Boddington Gold Project	Boddington		265
Broken Hill Metals	Hopes Hill		121
Brunswick NL	Galtee Moore		52
Callion Mining Pty Ltd	Callion		44
Central Norseman Gold Corp. NL	Norseman	373	469
Consolidated Exploration Ltd	Lady Bountiful		66
	Davyhurst		35
Chevron Exploration Corp.	Mt Wilkinson		108
Cypress Minerals Aust. Co.	Gidgee		74
Eastmet Ltd	Youanmi		98
Edjudina Gold Mines Pty Ltd	Neda/Gawler		95
Endeavour Resources Ltd	Bluebird/Alladin		114
Forrest Gold Pty Ltd	Hannans South		21
	Tower Hill		55
Forsayth NL	Lawlers		82
	Mt Gibson		108
Freeport McMoran Australia Ltd	Karonie		65
Gabanintha Gold Mines	Gabanintha		72
Golden Valley Mines NL	Fraser		51
Goongarrie Gold Mines	Goongarrie		65
Great Victoria Gold Ltd	Gt Victoria		76
Hampton Australia Ltd	Jubilee		97
Harbour Lights Mining Pty Ltd	Leonora		112
Hill 50 Gold Mine NL	Mt Magnet	167	260
Hunter Resources Ltd	Mertondale		30
KLV-Kalgoorlie	Mt Charlotte	184	343
KLV-Fimiston	Perseverance	531	523
Kia Ora Gold Corp Ltd	Marvel Loch	50	175
Kunanalling Joint Venture	Gibraltar		45
Kurara JV	Kurara		62
Metana Minerals	Reedy		78
	Mt Magnet		120
Mincoa NL	Edwards Find		94
Mt Percy Project	Mt Percy		71
Nevoria JV	Nevoria		70
Newmont Holdings Pty Ltd	New Celebration		131
Norgold Ltd	Bottle Creek		75
North Kalgurli Mines Ltd	Fimiston	263	443

MINERAL COMPANY	LOCATION	1982 (a)	1987/88
GOLD CONTINUED			
Norseman Gold Mines NL	Ravensthorpe		74
Pancontinental Gold Mining Areas Pty Ltd	Paddington		143
Peak Hill Resources	Peak Hill		51
Queen Margaret Gold Mines	Bellevue		203
Sons of Gwalia NL	Gwalia		87
Sundowner Minerals NL	Mt Fisher		71
Telfer Project	Telfer	111	482
WMC-GT Boulder Holdings	Emu		128
	Kambalda	37	114
	Lancefield	75	100
	Sand King	10	53
Whim Creek Consolidated NL	Meekatharra	32	155
All Other Operators		1 182	1 257
TOTAL GOLD		**3 027**	**8 844**
IRON ORE			
BHP Minerals Pty Ltd	Koolyanobbing	77	
	Kwinana	418	
	Yampi	558	459
Goldsworthy Mining Ltd	Pilbara/Port Hedland	1 178	892
Hamersley Iron Pty Ltd	Tom Price-Paraburdoo/ Dampier	4 041	2 810
	Channar		25
Mt Newman Mining Co. Ltd	Newman/Port Hedland	3 794	3 769
Robe River Mining Co. Pty Ltd	Pannawonica/Cape Lambert	1 384	1 166
		11 450	**9 121**
MINERAL BEACH SAND			
Allied Eneabba Pty Ltd	Eneabba	204	363
Associated Minerals Cons. Ltd	Capel	122	177
	Eneabba/Narngulu	136	284
Cable Sands Pty Ltd	Capel	82	143
Westralian Sands Ltd	Capel	139	388
		683	**1 355**
NICKEL			
Agnew Mining Co. Pty Ltd	Leinster	288	20
Metals Exploration Ltd	Nepean	175	
Western Mining Corporation	Kalgoorlie	364	324
	Kambalda	1 476	1 618
	Kwinana Refinery	405	314
	Mt Windarra	348	530
		3 056	**2 806**
PETROLEUM PRODUCTS			
Bond Corporation Pty Ltd	Harriet		79
Home Energy Pty Ltd	Blina/Sundown		4
Barrack Energy Ltd	Mt Horner		3
Strata Oil NL	Woodada	45	4
West Australian Petroleum Pty Ltd	Barrow Island	133	183
	Dongara	9	11
Woodside Offshore Petroleum Pty Ltd	North Rankin A/Burrup Peninsula		1 343
		187	**1 627**
SALT			
Dampier Salt Ltd	Dampier	173	174
	Lake McLeod	117	90
Leslie Salt Co.	Port Hedland	49	116
Shark Bay Salt JV	Shark Bay	98	101
		437	**481**
ZINC CONCENTRATE			
BHP Minerals Ltd	Cadjebut		99
ALL OTHER MATERIALS (Including Rock Quarries)		683	724
TOTAL		**24 372**	**31 915**

(a) 1982/83 Employment statistics not available.