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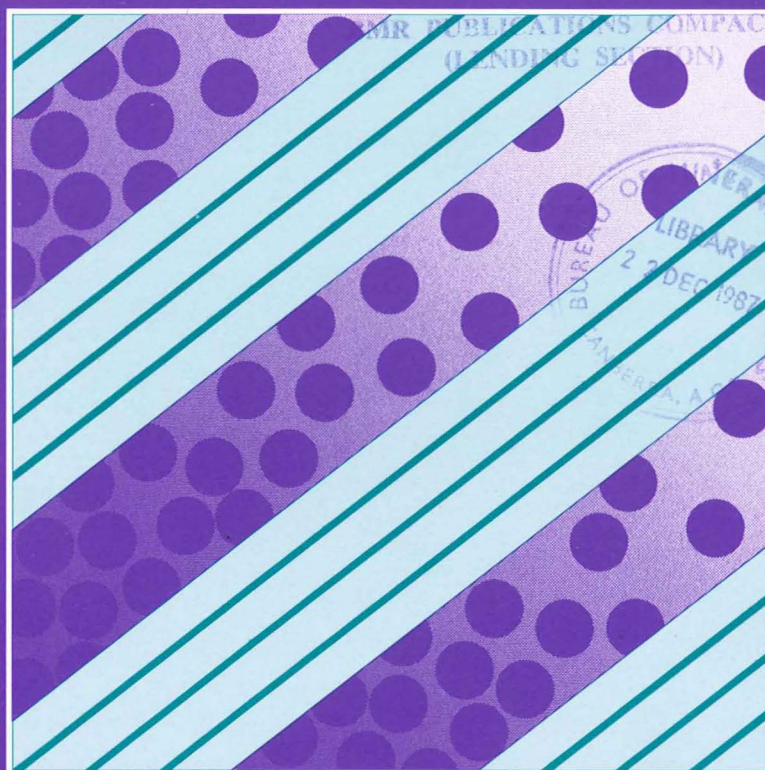
GROUNDWATER

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Studies in Hydrogeology



MURRAY BASIN HYDROGEOLOGICAL PROJECT PROGRESS REPORT 17 FOR HALF YEAR ENDING 31 MARCH 1987



1987/55

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BUREAU OF MINERAL RESOURCES,
GEOLOGY & GEOPHYSICS

DIVISION OF CONTINENTAL GEOLOGY

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MURRAY BASIN HYDROGEOLOGICAL PROJECT

PROGRESS REPORT 17

for half year ending 31 March 1987

compiled by

G.E. Wilford



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SOUTH AUSTRALIAN DEPARTMENT OF MINES & ENERGY

The Mallee water level observation network is about to be rationalized further after 3.5 years of monitoring and a downturn in the amount of irrigation. Under the Border sharing Agreement with Victoria, selected observation wells in the 20 km border zone will be sampled for salinity testing, in addition to those already selected for water level monitoring.

On the Cooke Plains-Comandook area, some 150 ha of grazing land below the 10 m AHD contour has been affected by rising shallow water tables over the last two years in response to clearing of the natural Mallee scrub. Recently drilled observation wells and several private wells will be monitored from now on. Sketchy historical data suggests water table rises of up to 5 metres over the last 30-40 years in the Coastal Plain area (see map).

The three layer computer model of the Mallee area has been used to calculate increases in saline groundwater inflows to the River Murray in response to the clearing of natural vegetation throughout the area. Using MURKEY and SACOST models, the actual increase in river salinity and the cost to the community of SA has been estimated e.g. 50 years after the increased recharge reaches the water table between Mildura and Tailem Bend, salt inflows will increase by 50%, resulting in an increase in salinity at Morgan of 70ECm which will cost SA \$4.7 million. Various mitigation strategies incorporating re-vegetation have been modelled and recommendations on banning of further clearing have been sent to the Native Vegetation Advisory Committee. Further investigations will refine the model and establish when the pulse of increased recharge will reach the water table.

The Mallee model is also being used to predict the effects of the maximum allowable withdrawals from the Mallee and Border Zone Proclaimed Regions.

A slice model of the Murray River alluvial flood plain is being established to assist with enquiries on the effect of groundwater inflows to the Murray of irrigation on the high-land south of Morgan and excavations on the flood-plain e.g. marinas. However, the main application will be to

determine the effect of groundwater accession from bank storage on the falling limb of a flood as part of a larger study in salinity source processes.

A long term pumping trial for the Woolpunda Interception scheme has been in progress for almost 6 months. Pump corrosion and chemical deposition has been minimal. Interestingly, some of the deposition has been in the form of native sulphur. Consultants have been engaged for the final design of the interception scheme.

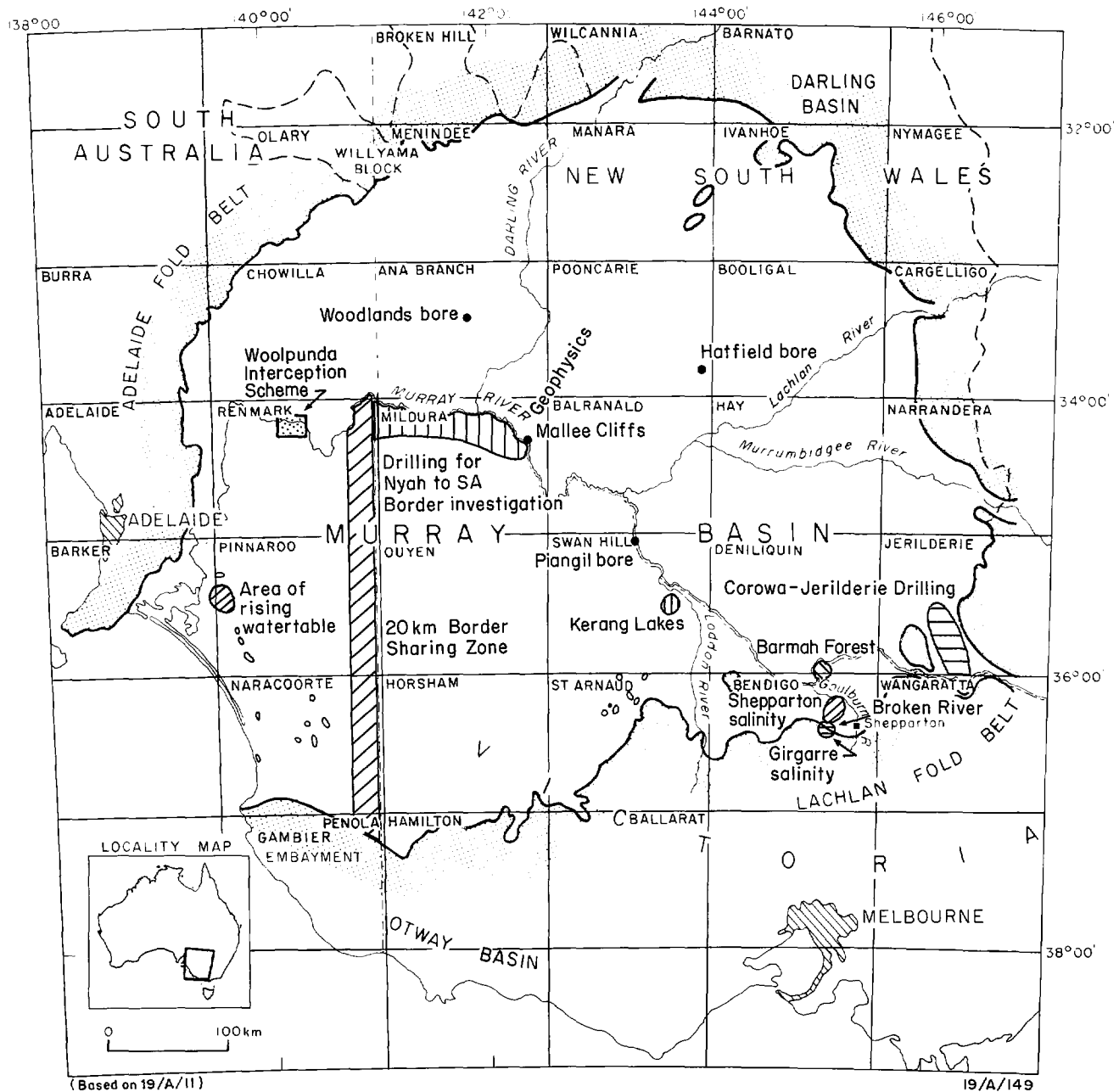


Figure 1. Locality Map

WATER RESOURCES COMMISSION OF NEW SOUTH WALES

by
D. Woolley

Drilling

Drilling was completed at the Woodlands and Hatfield sites for the Joint BMR/DWR Drilling Project. A total of 12 sites has now been completed. Another 7 sites are proposed for this project for 1987.

Drilling in the area of the Oaklands Sub-Basin for the Corowa - Jerilderie Groundwater Investigation recommenced in March, with 1 site being completed during that month. The new drilling is in addition to the 6 sites which were drilled in late 1985 and early 1986. A total of 11 sites is proposed for this area.

Monitoring

Monitoring of groundwater levels throughout the Murray Basin is continuing. Additional sites are being incorporated into the network upon completion of bores in the Joint/BMR/DWR Drilling Project in the western part of the basin and the Corowa - Jerilderie Groundwater Investigation.

Geophysics

Seismic refraction and gravity surveys provided further information on pre-Tertiary basement structure in the western part of the basin.

Completion of the Euston - Balranald Line revealed the northern extension of the Tyrrell Fault with a vertical throw of about 230 metres. The Windomal Line, to the south of Balranald, is still to be completed.

The DWR seismic crew undertook seismic survey work in Victoria under contract to DITR, with a total traverse length of about 50 km. A series of ridge and trough features with relief of 100 to 150 metres occurs in the Wilga Road section to the south-southeast of Mildura. Survey levelling of the Wemem section was undertaken during the half year period and at the

time of writing, the completed seismic profile revealed a gently sloping basement surface rising eastwards towards the upthrown side of the Tyrrell Fault.

Statistics

Seismic Refraction:	Euston-Balranald	11 km
	Windomal	5 km
	Wilga Road	27 km
	Wemem (survey levelling)	15 km
Survey Levelling for BMR Gravity:	Menindee	80 km
	Karadoc-Bottle Bend	11 km

GEOLOGICAL SURVEY OF NEW SOUTH WALES

by

H.N. Ray

1. COAL EXPLORATION - OAKLANDS BASIN

Coal Cliff Collieries Pty Ltd (CRA) have submitted a report on their Oaklands South exploration area (A207, A250) for the six months to March 1987. No further drilling has taken place.

Coal reserves have been assessed and detailed mine planning is continuing.

The Coal Geology Branch of this Department has completed and submitted a report on the geology and coal resources of the Oaklands Basin for inclusion in the proposed Coal Bicentenary Volume to be published by the BMR.

2. PETROLEUM EXPLORATION

No petroleum exploration has taken place since the completion of three wells by Claremont Petroleum (PEL 212) in the half year ended March 1986.

The only petroleum exploration activity proposed within the next twelve

months is a 75 km seismic survey planned by Meekatharra Minerals Australia Pty Ltd in PL273 in the Oaklands Basin.

3. MINERAL EXPLORATION

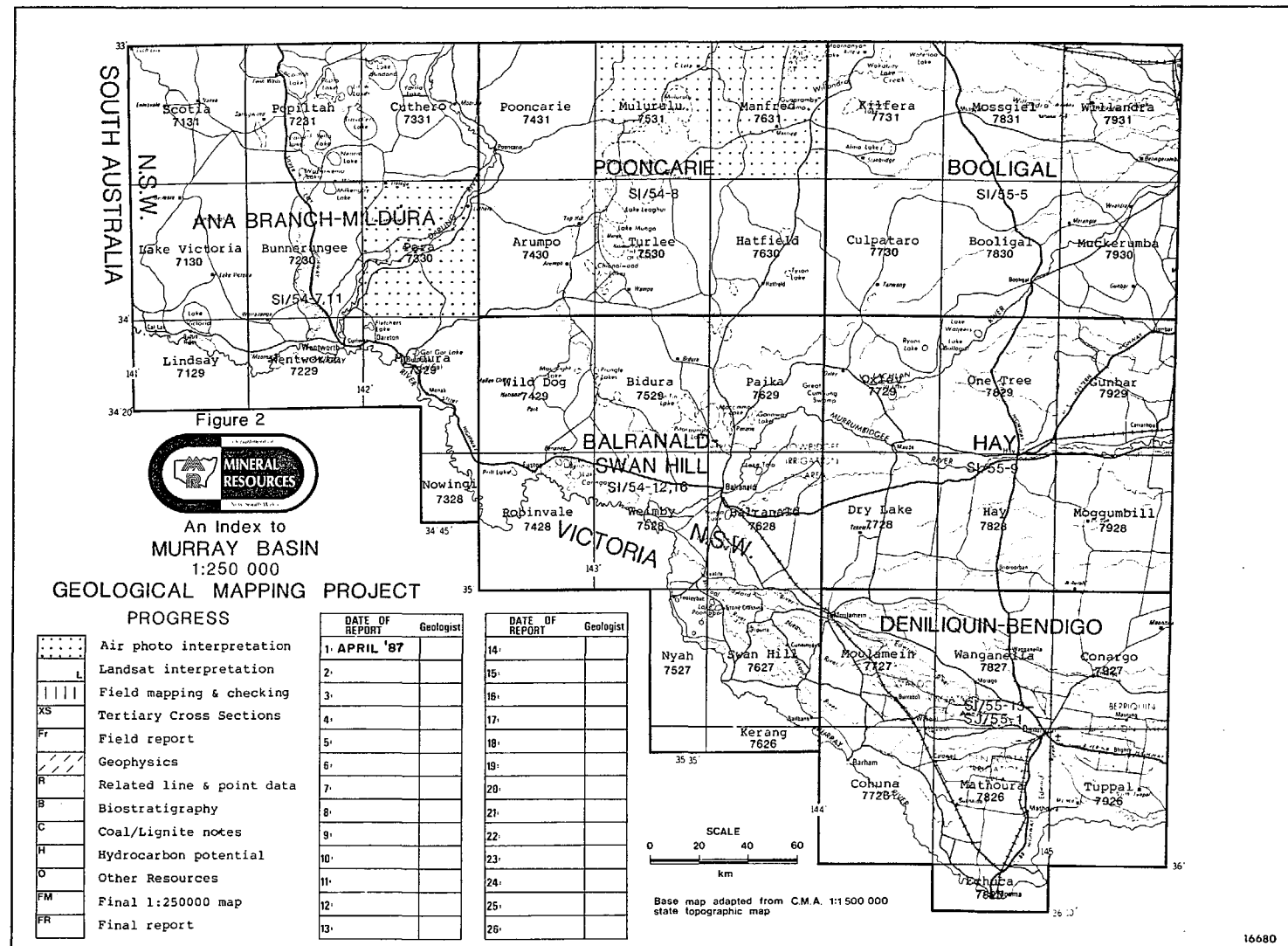
The exploration licences for gypsum held by CSR Ltd in the Ana Branch area have been relinquished and final reports are now available on open file.

CRA is currently exploring for heavy mineral sands in an area mainly to the east of the Darling River. The area held under exploration licences has been reduced but final reports on the relinquished areas have not yet become available.

4. GEOLOGICAL MAPPING

1:250 000 scale mapping of the New South Wales portion of the Murray Basin has commenced. Air photo interpretation and field checking are currently underway in the Ana Branch and Poongcarie 1:250 000 sheet areas (figure 2). By the end of 1987, preliminary (unpublished) geological maps and brief notes should become available for the Bunnerungee, Para, Mulurulu, and Manfred 1:100 000 sheet areas.

Figure 2. Geological mapping areas, NSW



RURAL WATER COMMISSION OF VICTORIA

BY

R. EVANS

The Rural Water Commission of Victoria has engaged in the following hydrogeological studies in the Murray Basin.

1. NYAH TO SOUTH AUSTRALIAN BORDER HYDROGEOLOGICAL PROJECT

- . 12 section line bores drilled, mostly in the Mildura area and West of Mildura.
- . 6 deeper bores penetrated the Parilla Sand aquifer.
- . 6 pumping test bores were constructed, plus associated observation bores
- . 4 pumping tests were carried out, some of which were designed to increase the vertical hydraulic conductivity.
- . Riverbank sections were mapped in detail at the end of 6 section lines
- . 6 slug tests were carried out.
- . Groundwater sampling of 12 bores was completed.
- . Borehole EM probe readings were commenced.
- . Groundwater flow modelling at Boundary Bend was commenced using a two layer quasi 3D finite element model.

2. SHEPPARTON REGION SALINITY OPTIONS STUDY - MODELLING ASPECTS

A two layer quasi 3D finite element flow model has been developed over a 30,000 ha irrigated region in the Toolamba - Tatura - Mooroopna - Ardmona area. The model is being used to establish combinations of recharge and discharge values which will satisfy the observed groundwater behaviour over the period from 1980 to 1986. The model incorporates two layers in the Upper Shepparton Formation and allows for seepage from the underlying aquifers. The model has an average element size of 70 ha and uses 3 monthly time steps.

3. GIRGARRE SALINITY INVESTIGATION

- . Construction of an evaporation basin at Girgarre has begun.
- . Monitoring of existing pump performance continued, including the effects of disposal to the drainage system.

4. BARMAN FOREST

- . Monitoring of water table levels continued with the aim of establishing the relationship between tree health and groundwater levels.
- . Extra drilling has commenced in the forest to establish an extensive monitoring grid.

5. SHEPPARTON REGIONAL INVESTIGATIONS

- . Drilling work continued on the Punt Road - Arcadia - Broken River Section to examine the Shepparton formation sequence as it overlaps Siluro-Devonian bedrock, south east of Shepparton. Eleven (11) holes were drilled for the period, for a total of 399 metres.

Studies continued of the stratigraphy, lithology and hydrochemistry of intermediate level Shepparton Formation aquifers in the Rochester Area.

- . Hydrogeological maps at a scale of 1:100,000 of the Upper Shepparton Formation covering the Murray, Goulburn and Campaspe Valleys are being prepared. A report to accompany the maps will include relevant geological cross sections.
- . A geological section between Kyabram and Congupna of the Upper Shepparton Formation was completed. The section indicates the extent of prior stream activity in the area.
- . Groundwater flow models have been or are being developed for three small areas (100 to 5000 ha) within the region. A single layer finite difference model has been calibrated over a 3 year period

for an area at Girgarre. A two layer model has been developed for an area at Tongala and calibration has just commenced. Bore data have been collected but model development has not yet commenced. The areas modelled include some parts which have high uncontrolled water tables and others which have water tables effectively controlled by groundwater pumping.

- . A map of depths to water table throughout the Shepparton Region was produced for August 1986. Similar maps have been produced in August of 1982 and 1984. The basic map is prepared at a scale of 1:100,000 and provides a good regional picture of water table levels and allows broad regional trends to be identified.
- . Major long term pumping trials are in progress in the Campaspe Irrigation District and at Girgarre.

6. FARM EXPLORATORY DRILLING SERVICE

Assistance is continuing to be provided to farmers to locate shallow aquifers which could be pumped to supplement surface water supplies and also to assist in lowering water tables.

Proposals were prepared for investigation programmes on 12 properties in the Shepparton Region, and field work carried out on 11 properties. Aquifers capable of yielding more than 1 megalitre/day of water of a quality less than 2500 EC, were delineated in two cases.

In the north west Mooroopna area, 50 line kilometres of electro-magnetic surveys (Geonics EM 34-3) were completed with follow up drilling to a depth of 25 metres on 7 sites, to aid interpretation.

7. ACCESSIONS PROJECT

Techniques for assessing rates of water table accession are being evaluated. A borehole induction probe (EM 39) is being hired to test whether it can be used in monitoring changes in salinity profiles and hence measuring accession rates.

8. SUBSURFACE DATABASE MANAGER'S SYSTEM

The Water Commission has begun the development of a comprehensive computer based groundwater data base. Currently data is stored in a variety of forms. The proposed system will systematise all storage procedures and, most importantly, allow ready access to all data. Data on the RWC 7,000 observation bores and 27,000 private bores will be stored. Over the previous 6 months, detailed specifications have been written and data preparation prior to loading has been accelerated.

9. MILDURA WEIR WITHDRAWAL MONITORING

An investigation was undertaken to study the effects of the withdrawal of the Mildura Weir in June 1986 on groundwater levels and salt accessions to the River Murray. Daily monitoring of river flows and river salinities at 3 locations and groundwater levels for up to 168 bores was carried out. Analysis of the monitoring results is almost completed.

10. KERANG LAKES STUDY

The objective of this new study is to develop land and water management plan for the area around the Kerang Lakes and Torrumbarry Irrigation System, having regard to agricultural production, water quality and quantity, conservation values, recreation and tourism. A consultant has been reviewing the most appropriate surface water and groundwater modelling programmes available, and some of the technical issues to be addressed in the study. This study is expected to be actively underway by late 1987.

11. MALLEE CLIFFS GROUNDWATER INTERCEPTION INVESTIGATION

A stage 2 consultancy has just been let by DWRNSW to further investigate possible evaporation basin sites and other aspects of the hydrogeology of the interception scheme. This is under the control of an RMC steering committee. This work is expected to take approximately 4 months and will involve several months drilling.

12. SOUTH AUSTRALIAN/VICTORIAN BORDER GROUNDWATER SHARING AGREEMENT

Two more meetings of the Border Review Committee have been carried out, including a field excursion on the Victorian side of the southern half of the border zone. This new legislation established a legal framework for the equitable distribution of the groundwater resources of a 40 km wide zone running along the S.A./Vic. border. A review by the Engineering and Water Supply Department of South Australia of the actual groundwater usage in several of the zones in South Australia indicates significantly greater usage than previously estimated. An assessment of groundwater usage in several zones in Victoria is underway. A number of studies are being planned which will be used to refine the most appropriate groundwater management policy for the region.

DEPARTMENT OF INDUSTRY, TECHNOLOGY AND RESOURCES, VICTORIA

by

C.R. Lawrence

Four major documents have been recently prepared in Victoria with respect to salinity problems. They are:

SALT ACTION: Victoria's strategy for managing the salinity of land and water resources. Natural Resources and Environment Committee of Cabinet. This report is a draft strategy for public comment.

The strategy defines salinity control regimes, and provides guidelines for the preparation of the salinity management plans.

Action programs include:

- . regional planning
- . farm improvement and assistance
- . revegetation
- . improved water use

- . drainage and salt disposal
- . environmental protection and improvement
- . education and participation
- . research and investigation

SALINITY CONTROL IN VICTORIA: Physical Options - Department of Water Resources (P Macumber and C Fitzpatrick).

This report summarizes the present state of understanding of the salinity problem throughout the State. Technically feasible salinity control options for affected areas are discussed and presented in the form of a Salinity Management Option Three (SMOT). Research and investigation requirements for further evaluation of these options are identified.

There are a large number of options which may be used to control salinity. However, particular options will only be technically feasible in areas with specific physical characteristics. Accordingly, Victoria has been divided into 14 salinity provinces distinguished by distinct hydrogeological and geomorphic characteristics. Each province has its own small range of technically feasible control options. Additional salinity provinces may be defined in the future as more information is collected.

The State is divided into dryland and irrigation provinces since there are fundamental differences in the operation to salinity control in each instance. The dryland areas are further subdivided on the basis of the nature of the groundwater flow system.

Control of local groundwater flow systems can in some instances be achieved, fairly quickly. However, for the regional systems, salinity control may take many generations to achieve and in some cases may be virtually unattainable. Over 80% of the dryland areas have regional flow systems. For most of the dryland provinces the only economically viable options are agronomic/agroforestry and perhaps on-farm options, aimed at reducing groundwater accessions. Irrigation provinces are divided along catchment lines but also differ according to the character of the underlying groundwater bodies.

Riverine Plain Groundwater Investigation 1986 Goulburn/Broken Region, Bore completion reports DITR (J.G. Bartley and M.A. Reid)

Areas of data deficiency in terms of geology and hydrogeology for groundwater modelling purposes in the Riverine Plain were identified. To overcome these deficiencies DITR accelerated its drilling program in the Goulburn/Broken and Murray Valleys.

Using contractors 30 holes were drilled and constructed as groundwater observation bores, 7 monitor bedrock aquifers, 22 monitor the Calivil/Renmark aquifer and 1 monitors the basal Shepparton Formation aquifer.

Location, construction, lithologic, stratigraphic, geophysical logging, water level and construction details are catalogued for all bores.

Preliminary results from this drilling indicate that:

- . The occurrence of high water tables in the Shepparton Region tends to coincide with the presence of relatively shallow bedrock overlain by Shepparton Formation with little or no Calivil/Renmark aquifer present.
- . Monitoring of the new bores during 1986, including a wet period from July to October, reinforces the observed general rise in pressures throughout the Riverine Plain. This demonstrates quite clearly the dramatic effect that a few wet months can have on the system (even in areas of substantial groundwater pumping) in what was a year of only slightly above average rainfall.
- . In the Shepparton/Arcadia area a significant lower Shepparton Formation aquifer is present at about 50 to 60 cm which contains water of 1 000 to 1 500 mg/l TDS.
- . The freshest groundwater encountered at a number of the deep sites was at an intermediate level, either in the lower Shepparton Formation or in the upper zone of the Calivil/Renmark aquifer. The

proximity of these sites to a major stream suggests that there is substantial hydraulic connection between streams.

- . Confirmation of the existence of a groundwater divide, probably structurally controlled, in the Dunbulbalane-Drumanure area which separates the Goulburn and Broken Creek flow systems in the Katandra-Uouanmite area, southeasterly towards Waggarandall, is actually opposite to the northwesterly regional groundwater flow trend.
- . Significant recharge into the Broken Creek deep lead is occurring in the Katandra-Invergordon irrigation area and also via the Cambrian rocks of the Dookie Hills.
- . Water tables, currently between 5 and 15 m are rising steadily in the area of the Goulburn/Broken Creek groundwater divide. In this area the shallow water is between 6 000 and 18 000 mg/l TDS.
- . Considerable variations or transitions in water qualities were recorded within the Calivil Formation and, to a lesser extent, the Renmark Group at some sites north of Shepparton.
- . Very high bedrock pressures exist immediately to the north of the Waranga Basin, confirming that there must be substantial leakage from the Basin through the fractured rock.

Riverine Plain Salinity investigation and assessment. Progress Report 1 (1986). DITR edited by R. Lakey (contributions, J. Nolan, L. Murphy, J. Bartley, A. Lane, A. Moodie and A. Aitkins Consultants).

pursuing the objectives of the Salinity investigation of the Riverine Plain DITR has used consultants, private drilling contractors and vacation students to expedite the program. This has included collation, vetting and preparation of the geological, hydrological and geophysical data for the Riverine Plain and the storage of this information in a systematic and readily accessible data base. A formidable amount of hydrologic data for the Riverine Plain had already been collected by government agencies notably DITR, RWC, DCFL and DARA, but it was in an incompatible format.

This task although not yet completed, has put in place a sound data base

for regional and sub-regional numerical modelling projects which together with the field investigation program will be the focus of the groups endeavour throughout 1987/88.

DITR has been assisted in this task by the New South Wales Department of Water Resources and the Bureau of Mineral Resources. The Riverine Plain Regional Model includes the Victorian Riverine Plain and an adjoining section of southern NSW and is being developed jointly by DITR and the NSW Department of Water Resources.

The project data base includes:

- . stratigraphic subdivision of the deeper bores
- . percentage sand for the Shepparton Formation and the Calivil/Renmark Unit
- . water levels of observation bores
- . licensed groundwater conditions
- . irrigation deliveries
- . meteorological data
- . stream gauging data
- . soil parameters

The modelling exercise is principally to quantitatively predict salinity incidences as such on a broad scale and to evaluate alternate control measures.

The numerical model selected is the USGS 3D finite-difference model (McDonald and Harbough).

For this study the project area has been developed into cells 7.5 km x 7.5 km. Three layers are used - namely the Shepparton Formation to the east and Parilla Sand to the west, the Shepparton Formation and to the west the Parilla Sand underlain by the Geera Clay, and the Calivil/Renmark Unit. The model calibration phase is from 1970 to 1980 and verified from 1980 to 1985.

Three sub-regional models to be commenced in 1987 are:

Shepparton, Loddon-Avoca and Kerang Lakes.

BUREAU OF MINERAL RESOURCES

by

Ray Evans & Jim Kellett

Joint BMR-WRC Drilling Program:

The HATFIELD fully-cored borehole was completed in February. Total depth of the hole was 433 m. It intersected 42 m of high-yielding coarse sands at the base of the lower Renmark Group before striking granite basement at 427 m. Groundwater salinities ranged from 15300 mg/l TDS in the Pliocene aquifers to 4700 mg/l in the lower Renmark Group.

All piezometers put down in 1986 have now been pumped for chemical analyses, and all cores and cuttings have been sampled for palynological analyses.

Sites have been pegged at KYALITE, PEREKERTON, WALDAIRA, GREAT CUMBUNG SWAMP and TCHELERY in the Western Riverine Plain, and at EUSTON and ANABRANCH for the 1986/87 program.

GEERA AQUITARD STUDY

A hole was drilled 8 km west of Piangil, Victoria, in conjunction with DITR, as a contribution to the Geera Aquitard Study. Total depth of the hole was 392 m, striking diorite at about 380 m. The fine-grained marine units were continuously cored, 80-235 m. The hole was completed as a lower Renmark Group observation bore. Renmark Group salinity is 2700 mg/l and SWL is 6m above ground surface.

Samples of the core material have been taken for pore water analysis. A contractor, Dr B. Radke, was engaged to provide a report detailing the

diagenesis and paragenesis of the cored sequence. His report will be made available as soon as practicable.

APPENDIX

MURRAY BASIN HYDROGEOLOGICAL PROJECT

Description and status

This project is a long-term study which is being undertaken jointly by South Australian, Victorian and New South Wales geological surveys and water authorities and by the Commonwealth Bureau of Mineral Resources, Geology and Geophysics. It is coordinated by a Steering Committee comprising members of those organisations.

The Murray Basin is a geological structure with an areal extent of some 300 000 km². In each of the three States, the basin sediments contain very large groundwater reserves. Where the groundwater has a low salinity it is increasingly being used for irrigation and town water supply purposes. In much of the basin, the water is suitable only for stock use and is extensively used for this purpose. In other parts of the basin, the groundwater is too saline for any use. There is a complex interaction between groundwater and surface water which may be beneficial, as in recharge areas in some parts of the basin, or harmful as in areas of saline groundwater discharge to rivers. In recent years, the states involved have stepped up the rate of assessment of the groundwater regime in the basin.

The primary aim of the Project is to improve the understanding of the groundwater regime of the basin by examining it as a single entity, unencumbered by State boundaries. Since a knowledge of the geology of an area is basic to the understanding of groundwater occurrence, a geological study of the basin is an essential part of the Project and, as a consequence, it will also be possible to make an assessment of other mineral resources.

The project was planned initially to last five years and is organised in five phases:

- (1) Geological synthesis, using all available geological and geophysical data.
- (2) Hydrogeological assessment, on the basis of available data.
- (3) Documentation of deficiencies in geological and hydrogeological information and formulation of proposals for appropriate work programs.
- (4) Additional work as approved which could include stratigraphic drilling, aquifer testing, biostratigraphic analysis and isotype hydrology studies.
- (5) Development of numerical model(s), if found to be appropriate in the light of the data then available.

The geological synthesis is nearing completion, and a draft document reporting results, with accompanying 1:1 scale geological maps, is expected to be finished by late 1986.

Phase 2 began at BMR in 1983. Hydrogeological data available from the BMR data base designed for the project: BMR and State workers will prepare a report assessing these data, and the results will be illustrated on several maps including the following:

1:1 million scale maps showing water table, potential contours and salinity variations for the three or four most important hydrostratigraphic units;

1:2 million scale maps showing (i) amount of water abstracted-added per unit area (ii) recharge-discharge areas, distribution of aquifer parameters for a 7 layers hydrogeological model. (Both Victoria and South Australia have tested the feasibility of making a preliminary model of the basin as a whole based on a coarse (75 km) rectangular grid).

The hydrogeological assessment and phase 3, the documentation of deficiencies in geological and hydrogeological information, are scheduled

for completion in 1986.

Additional work required in Phase 4 (e.g. stratigraphic drilling, geophysical investigations) may be conducted by BMR or by appropriate State authorities. The development of numerical model (Phase 5), if found to be feasible, may be undertaken by BMR or by State authorities. The Project will depend on the close co-operation of staff from all organisations involved, and some movement of staff between organisations for short periods will be necessary. Throughout the study, individuals and organisations will be encouraged to publish results of various aspects of the work. Results of the overall Project will be incorporated into joint publications.