

INFRASTRUCTURE and GROUNDWATER

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Chapter 4

INFRASTRUCTURE

Transport links

The main road in the region is the sealed Stuart Highway which links Adelaide and Darwin (Fig. 4.1). Adelaide (population ~1 million) is 1000 km southeast of the Marla region by road. Alice Springs (population 27 500) is 550 km to the north by road. Port Bonython (740 km), and Thevenard near Ceduna (525 km), are the nearest State commercial deep sea ports; Whyalla (740 km) is the nearest privately operated deep sea port. Important towns in the region include Marla (population 243) and Coober Pedy (the main regional administrative centre, population ~4000).

The Central Australia Railway links Adelaide to Alice Springs (Fig. 4.1). The railway may eventually be extended to Darwin, where modern port facilities provide a link to southeast Asia. The nearest airport is Coober Pedy (sealed and gravel runways); a number of settlements and towns have airstrips, including Fregon (sand silt), Indulkana (silt clay), Marla (gravel), Granite Downs (silt clay) and Oodnadatta (Fig. 4.1).

Pipelines and production facilities

The Moomba Plant, operated by Santos Ltd ~660 km east of Marla (Fig. 4.2), produces sales gas for Adelaide and Sydney, and processes 25.4 million m³ (902 mmcf) of raw gas and 6 600 kL (42 000 bbl) of condensate and crude oil per day. Condensate, LPG, crude and some ethane are transported as a 'cocktail' via pipeline to Port Bonython where they are separated and marketed within Australia and overseas. The Port Bonython liquids plant, also operated by Santos, produces crude, naphtha, butane and propane.

A mini-refinery adjacent to the Port Bonython plant produces 95 kL/day (600 bbl/day) of gasoline by refining

naphtha feedstock from the liquids plant. The mini-refinery supplies the northern Spencer Gulf region.

The nearest pipelines in South Australia to Marla are the 659 km Moomba–Port Bonython Liquids Line and the 781 km Moomba–Adelaide Pipeline, operated by EPIC Energy (Fig. 4.2).

In the Northern Territory, ~550 km north of Marla, is the 1500 km Amadeus Basin–Darwin gas pipeline, completed in 1986 and operated by NT Gas Pty Ltd. This has a maximum daily capacity of 2.5 million m³ (87 mmcf), and *en route* supplies Northern Territory towns as well as several gold mines and a major lead–zinc mine at McArthur River. The capacity of the McArthur spur is 0.45 million m³/day (16 mmcf/day). The current Northern Territory market for gas is 15 PJ/year; a major potential market is the alumina refinery at Gove which would consume 20–25 PJ/year if converted from diesel.

The 270 km Mereenie–Alice Springs oil pipeline in the Northern Territory was constructed in 1985. It is operated by Santos Ltd and has a capacity of 1490 kL/day (9400 bbl/day); current throughput is 480 kL/day (3000 bbl/day). Oil is transported to a tankfarm and railhead at Brewer Estate, 20 km south of Alice Springs, where it is loaded into tank railcars on a spur line of the Central Australia Railway and transported 1500 km by rail to Port Adelaide. From here it is trucked to Port Stanvac refinery, 10 km south of Adelaide.



Airstrip in the Officer Basin. (Photo 40271)



Aerial view of Port Bonython tanker loading facilities. (Photo 40416)

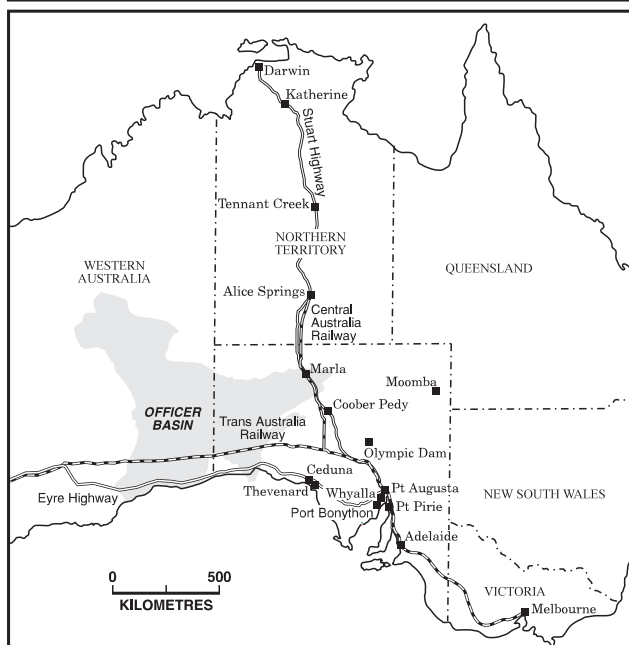
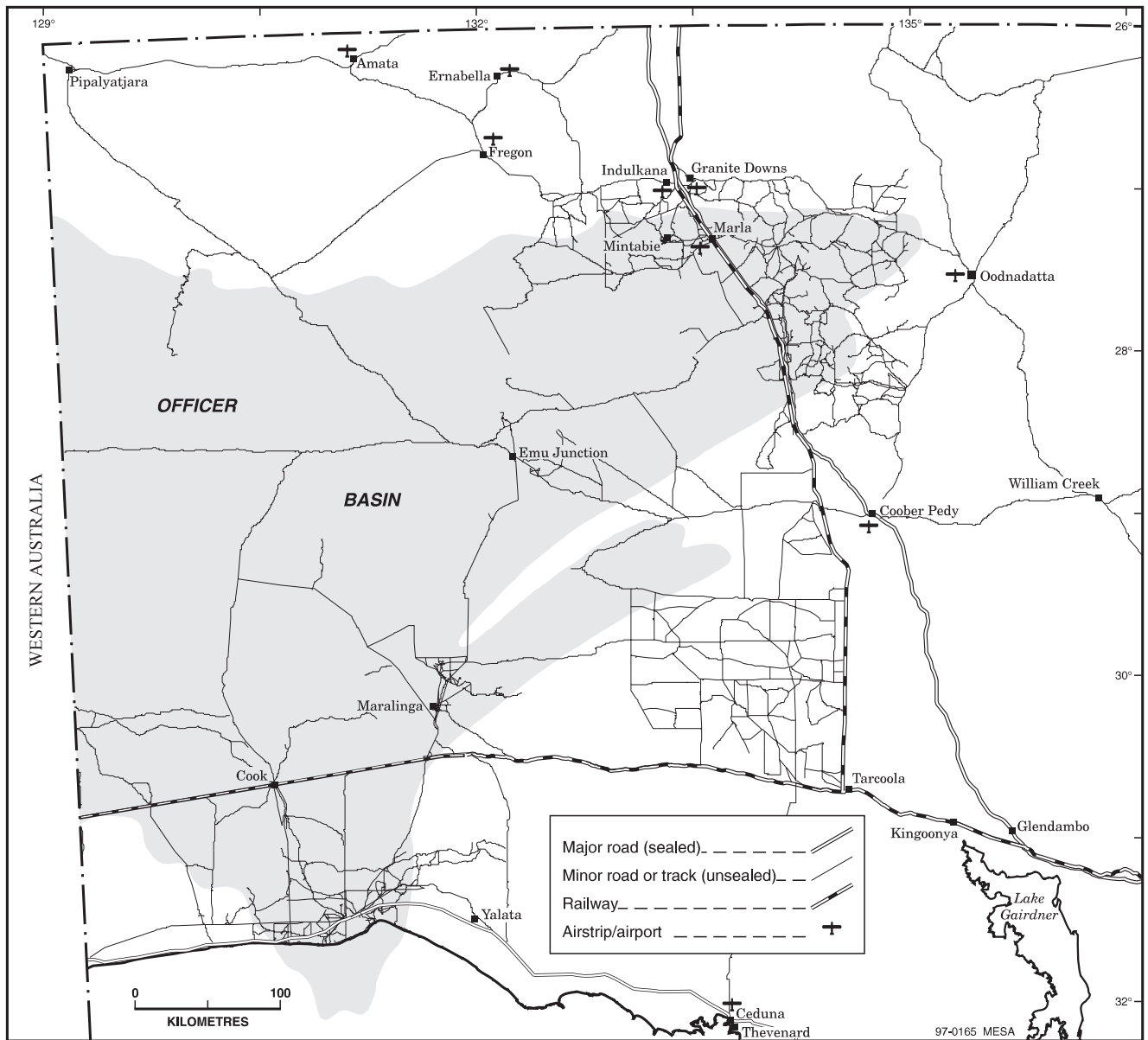


Fig. 4.1 Officer Basin infrastructure.

A transcontinental gas pipeline, linking gas reserves in the Northwest Shelf and Timor Sea to markets in southeastern Australia, is likely to be constructed in the next 10–20 years (Australian Gas Association, 1988). It is possible that such a pipeline would be routed through the Amadeus Basin to Moomba where it would link with the existing Moomba–Sydney gas pipeline. The economics of Officer Basin gas could be significantly improved if sufficient reserves were discovered prior to construction, and the pipeline routed via the basin.

Port Stanvac refines petroleum products mainly for the South Australian market. The refinery commenced operations in 1963 and the adjacent lubricating oil refinery came on stream in 1976. The main products are LPG, solvents, motor gasoline, jet fuel, kerosene, diesel (both automotive and industrial), lube oil basestocks for Australian and overseas markets, fuel oil and bitumen.

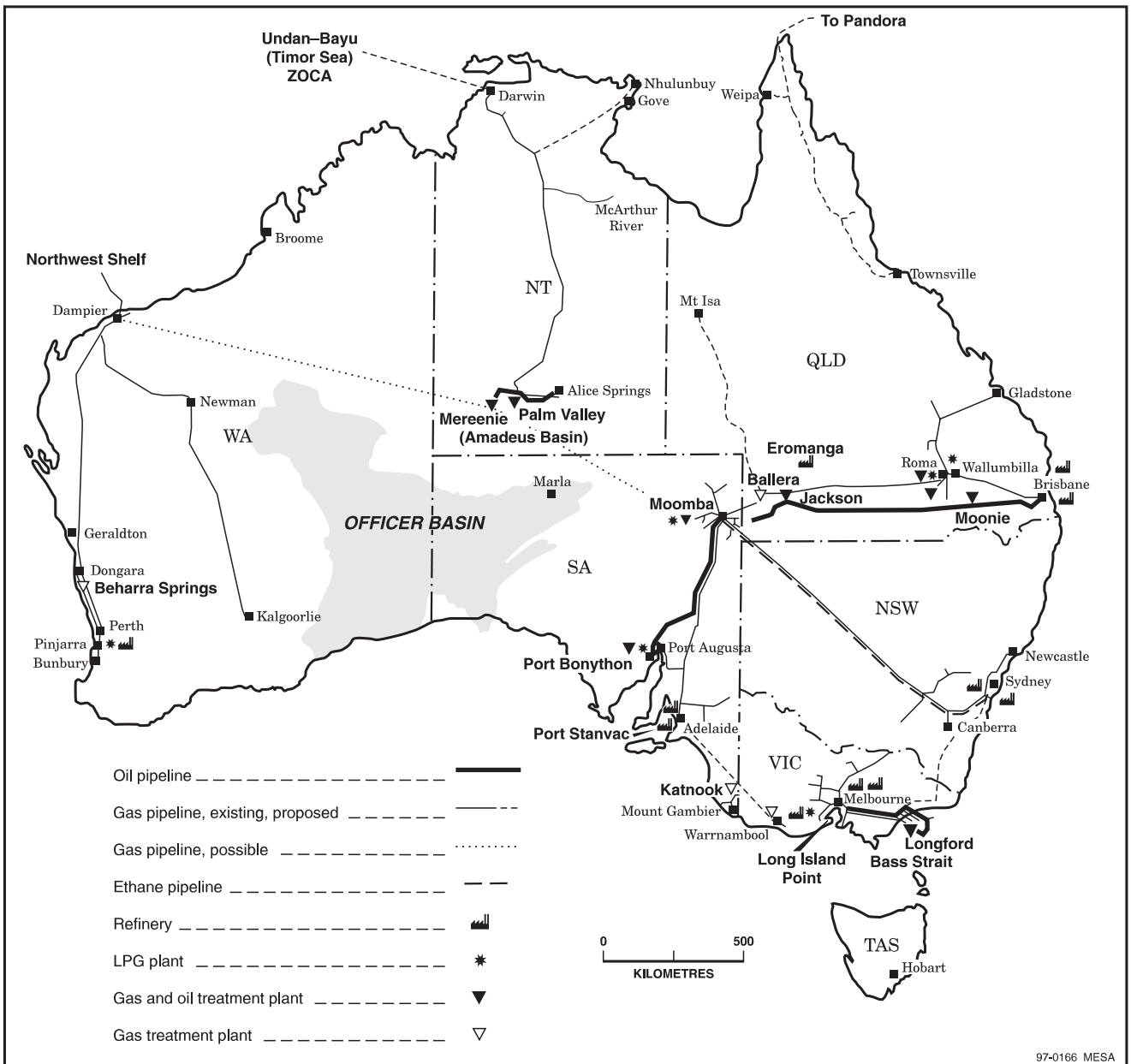


Fig. 4.2 Australian gas and liquids pipelines, treatment plants and refineries.

ACCESS TO POTENTIAL MARKETS

Industries in the region

The northern part of South Australia is sparsely populated and relatively undeveloped due to its remoteness and harsh climate. The main primary industry in the Officer Basin region is cattle, which are run on large pastoral leases. Tourism (including an eco-tourism venture by Anangu Pitjantjatjara) is a growing industry in the region. A large proportion of the world's opal is mined at Coober Pedy and Mintabie.

The Olympic Dam Mine, 480 km southeast of Marla, is the world's largest copper-uranium deposit. Western Mining Corporation is planning to more than double copper production from the current level of 85 000 t/year to ~200 000 t/year, together with associated uranium, gold and silver. The township of Roxby Downs supports the mine, and has a population of 2700 which will grow as the expansion

commences. Current energy usage is 30–40 MW/day (~1.5 PJ/year).

Extensive mineral exploration is currently underway on the Gawler Craton, south of the Officer Basin. High-grade gold intersections have been made at Challenger prospect and significant gold mineralisation has been discovered at other prospects (Campfire Bore and Golf Bore). The prospects for commercial gold developments in the region are rated very highly by the mineral exploration industry.

Extensive subeconomic Early Permian coal deposits (~15 billion tonnes) occur in the Arckaringa Basin, in the Coober Pedy region. The South Australian Steel and Energy (SASE) Project is investigating development of iron ore and coal resources south of Coober Pedy. The project plans to apply Ausmelt technology to produce pig iron. A pilot plant is being built at Whyalla.

Some of these projects may be potential users of natural gas.

Gas

Ex-field natural gas prices in South Australia are freely negotiated between buyer and seller, and the Commonwealth, States and Territories have agreed to remove impediments to across State borders trade in gas from July 1996. The rights of access to gas transmission and reticulation pipelines will be provided, and direct negotiations between consumers and producers facilitated.

Crude oil

A free market was introduced in 1988 for all oil and condensate produced in Australia. There is no restriction on imports or exports of crude oil or refined petroleum products. A similar regime has applied since 1991 for LPG. Markets for crude oil and condensate exist in South Australia and Australia, and low sulphur light crude oils find a ready domestic and overseas market.

GROUNDWATER

The Officer Basin occurs in an area of low rainfall and high evaporation. Surface water (ephemeral and permanent) is virtually non-existent, and groundwater, where present, is usually highly saline. Although data on groundwater are very sparse, it is unlikely that more extensive searching in this environment will yield any major resources of low salinity groundwater.

Surface water

There is little evidence of surface water in the Officer Basin region. The ephemeral streams of the Musgrave Block to the north and Eromanga Basin to the east vanish abruptly in the environment of higher permeability and porosity of the Palaeozoic sandstones in the Officer Basin, which result in faster penetration of water into the subsurface and a lower watertable. The ephemeral Officer Creek, which flows into the area from the north, extends into the basin ~50 km before being absorbed, but is by far the most persistent of such features. Other indications of the gathering of surface waters for recharge are very few and uncertain.

The only other evidence of surface water of any kind comprises the salt lakes around the southern edge of the basin outcrop at Serpentine Lakes, at Lakes Dey Dey and Maurice, at Wyola and Wilkinson Lakes, and north of Emu Junction. These highly saline environments, which occur along the southern boundary of the north-dipping Palaeozoic sediments of the basin, are interpreted as discharge zones (Fig. 4.3; Lau *et al.*, 1995a,b).

Aquifers

On the basis of the very sparse information that exists, Lau *et al.* (1995a,b) referred to all known groundwater as being interlinked in one unconfined system, with the Precambrian surface regarded as hydrogeological basement. While this may be a simplification, there is insufficient evidence to justify subdivision.

The system extends from surface in the discharge zones south of the basin to considerable depth in Birksgate 1, and

spans a host time range from Tertiary palaeochannel sediments to Cambrian Observatory Hill Formation. These sediments are highly variable in composition and are impossible to divide into aquifers and aquitards on the available information. Shale of the Observatory Hill Formation contains sand sequences, while the Trainor Hill Sandstone may be impermeable in parts. A major increase in the density of geological information is needed before there is any hope of mapping individual aquifers, if such exist.

Lau *et al.* also noted that there may well be perched aquifers in the palaeodrainage channels, hosted by Tertiary Hampton Sandstone or Pidinga Formation.

A confined or semi-confined aquifer may be present in the Murnaroo Formation, which is intersected in several holes in the southeastern part of the basin. This aquifer yielded saline water in the Tallaringa Trough and near Maralinga, and is probably recharged in the area of the Nawa Ridge where the formation is closest to surface and subcrops under Tertiary sediments.

Recharge

Subsurface water flow may occur through the Tertiary palaeochannels which extend southwards from the Musgrave Block over the full surface extent of the Officer Basin. While there is no firm evidence of such water movement, it must be expected on the basis of the proven water content in these features to the north, the permeability of the sediments, and the potentiometric gradient. Such waters would be expected to be saline.

Below the base of the Tertiary sediments, any southward flow of groundwater into the basin is expected to be blocked by the steep, fault-controlled northern edge of the basin and the steeply dipping Adelaidean sediments.

Movement of water from Western Australia eastwards into the South Australian portion of the Officer Basin is possible, but the potentiometric surface indicates that the major flow direction is to the south.

Thus, apart from surface flow, most recharge into the groundwater system of the Officer Basin is expected to come from local recharge.



Marla township showing groundwater recharge swamps, railway line and airstrip. (Photo T22004)

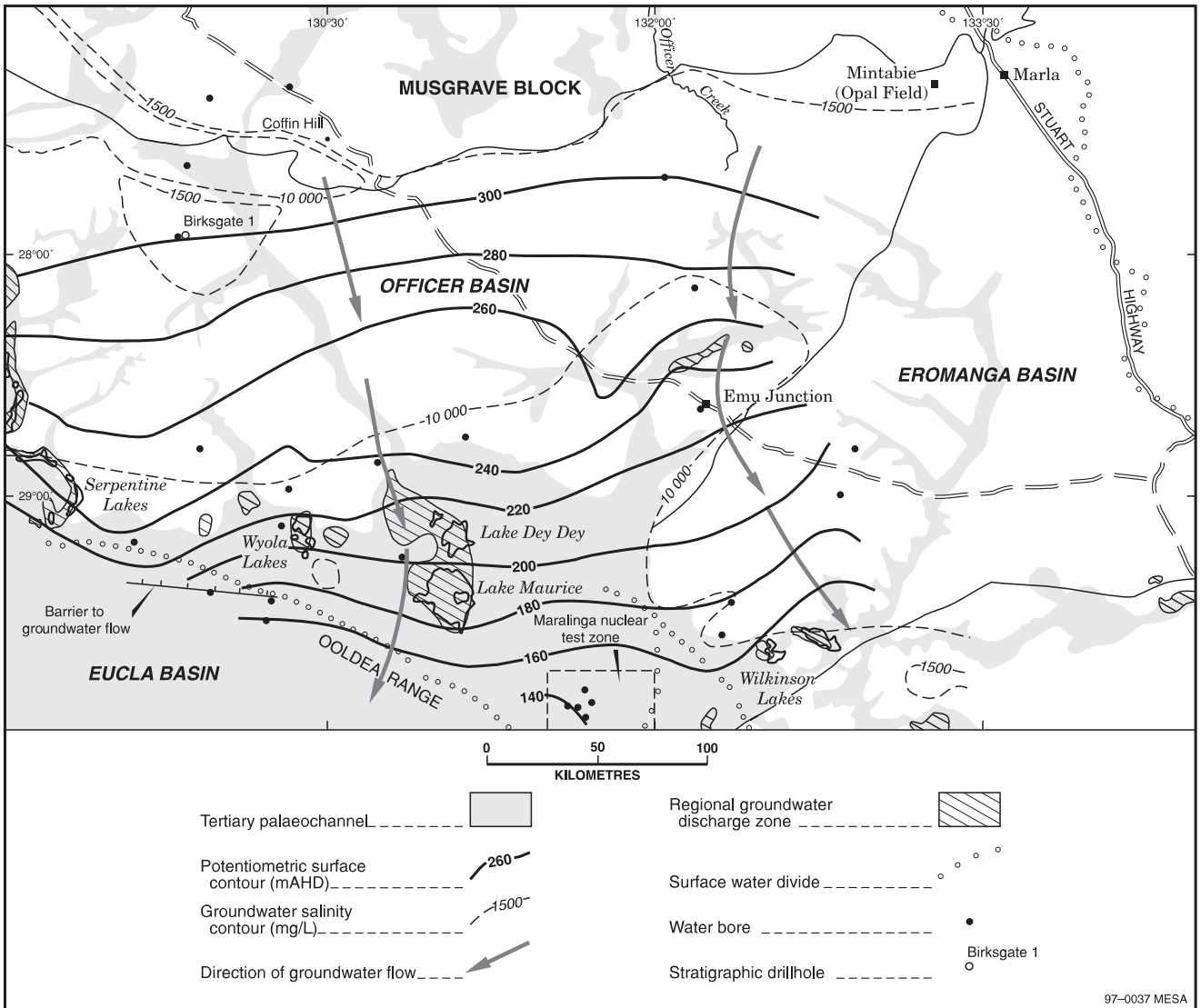


Fig. 4.3 Groundwater potentiometric surface and salinity (after Lau et al., 1995a,b).

Local recharge potential

While there are no statistics from the area of outcropping Officer Basin sediment, rainfall in the basin is expected to range from 150 mm in the south to no more than 250 mm in the ranges along the northern margin. This precipitation level is low by any standards and, when combined with high daytime temperatures and consequent high evapotranspiration rates, does not auger well for recharge.

According to Jacobson *et al.* (1994), the monthly rainfall in the arid zone must exceed 130 mm before there is any contribution to recharge. However, using the approximations implicit in Thornthwaite's equation (Thornthwaite and Mather, 1957), monthly rainfall and temperature figures for Ernabella which, while not in the Officer Basin is near enough to assist in such estimates, yield rather more optimistic figures, as shown on Figure 4.4. Combining the two estimates, and bearing in mind that the figures for potential recharge on Figure 4.4 usually require that the recharge occurs over one, or at most two months, it would appear that for this location significant recharge can be expected in at least 12 years of the 45 for which data are available, or one year in four on average. This is much better than the one year in 15–20 suggested by Jacobson *et al.*, but

their figure may well be more applicable for the Officer Basin itself, which has significantly lower rainfall than Ernabella in the Musgrave Ranges. The increased elevation and greater likelihood of monsoonal rains from the north increase the precipitation at Ernabella compared to that for the Officer Basin.

Whichever scenario is taken, it is clear that local recharge is a rare event in the Officer Basin and its surrounds, occurring on average every four to 15 years.

Discharge

The only evidence of surface discharge from Officer Basin aquifers is the salt lakes along the southern margin.

Subsurface discharge may occur into the overlying Eucla Basin to the south of the Ooldea Range, but this is speculative. Since the Officer Basin sediments dip gently northwards, and the base of the Cambrian is not deep below the Ooldea Range, the presence of impermeable 'Wirrildar beds' in seismic shotholes in this area may be a barrier to southward groundwater movement and may be partly responsible for the surface discharge in this area. Thus, there

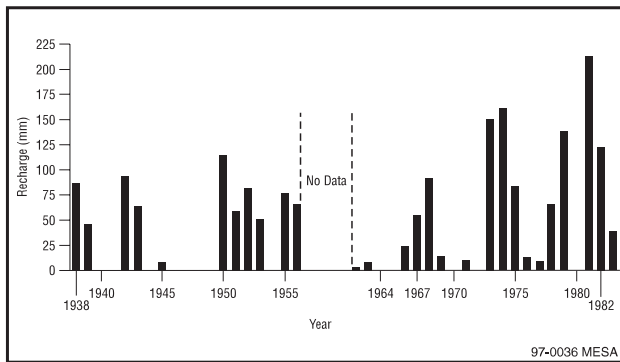


Fig. 4.4 Annual potential groundwater recharge at Ernabella. The monthly potential recharge (precipitation less potential evapotranspiration) is calculated from precipitation and temperature data. The annual potential recharge is the sum of positive monthly potential recharge figures.

continuous over this area but with little local recharge, so that there is little likelihood of lower salinity water other than very restricted, fragile supplies.

It is probable that the low salinity (<1 500 mg/L) supplies encountered at Birksgate 1 and near Coffin Hill in the BIRKSGATE map area are the result of local recharge. As such, they could be fragile and of limited extent. The low recharge potential of the area precludes large supplies of potable water.

may be little or no movement of water between the Officer and Eucla Basins.

It is presently thought that virtually all discharge from the Officer Basin sediments is through the salt lakes near the Ooldea Range.

Potentiometric surface

The potentiometric surface reflects the smoothed topographic surface, and confirms the general southward gradient (Fig. 4.3).

Water quality

Salinity contours indicate that groundwater is usually saline to very saline (Fig. 4.3). These contours give a general idea of what can be expected, but are much biased by a few samples, such as Birksgate 1 which is the only sample over a large area and could well be a more local anomaly tapping a small area of local recharge.

In the Musgrave Block to the north of the Officer Basin, it is common for groundwater to have nitrate and chlorine levels in excess of WHO approved limits. This could also apply to groundwater in the Officer Basin.

In the Maralinga area, groundwater in the Tertiary palaeochannels and possibly in the underlying Officer Basin sediments tends to be very acidic (pH ~4) and have a very high iron content (>200 mg/L). Similar impurities are found in palaeochannels in the Lake Maurice area. Such problem waters tend to be associated with water that has resided for a long time in the Tertiary Pidinga Formation sediments, which often contain pyrite and lignite. An undesirably high content of radioactive minerals is also common. Impurities such as these are not anticipated in the northern part of the Officer Basin, but are expected to become more prevalent to the south, paralleling the higher salinity.

The drilling of water wells in the western portion, particularly on NOORINNA and WELLS map areas, have generally been successful within 100 m of surface, with yields of 2–3 L/s being common. The salinity is reasonably high, ~10 000 mg/L, and becomes more saline to the south. It seems most likely that the unconfined aquifer is reasonably