DEPARTMENT OF MINES
SOUTH AUSTRALIA

HYDROLOGY OF THE GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA

- A PRELIMINARY REPORT -

by

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Geologist

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ABSTRACT

The Great Australian Artesian Basin within South Australia is discussed. New restricted limits based on the hydraulic continuity of the main aquifer are suggested, and the occurrence and extent of suspended and subsidiary associated basins is outlined. The geology as related to hydrology and as evidenced particularly from bore log information is also discussed. This includes hard rock Precambrian basement, Permian, Blythesdale, Cretaceous, and also Tertiary-Recent sediments. Special attention is given to the general hydrology, in quality and quantity of waters available, their intakes, natural outlets, and their chemistry.

The urgent need for reliable levels, selective flow and pressure tests, and proper regulated control of all flowing bores is emphasised. Evidence is submitted of the dilapidated condition of many bore heads and drains.

PART I

INTRODUCTION

At the beginning of the field season in 1961 a comprehensive preliminary hydrological survey of the South Australian portion of the Great Australian Artesian Basin was commenced. Water samples of all bores, springs and wells wherever available have been taken and submitted for full chemical analysis. Temperatures of flowing bores and the condition of boreheads and drains also were noted. In addition sludge samples wherever possible or considered advantageous were collected. As each station was visited all available hydrological information was sought and obtained from private records. All data has been incorporated into Departmental records and plotting on a grid basis for this area is in progress.

For the purposes of this report, the results of field work spread over two seasons has been used, together with existing Departmental records; for all but the north western portion of the basin in South Australia. Information and samples from Cordillo Downs were given by Dr. H. Wopfner, who has recently completed 4 mile mapping in that area.

The area covered by recent field work includes the whole of that enclosed by the currently accepted limits of the basin, excluding that area north of Mt. Willoughby and Anna Creek and west of Lake Eyre. The part included within the Frome Embayment has been covered and discussed in a separate report by the author; but the Lyndhurst and Cordillo suspended basins are also discussed. The whole southwest-lobe, an area including Kingoonya to Anna Creek and west to Mt. Clarence and Mabel Creek, is also described and further divided into two hydraulically separate basins.

Little new information is available from water bores in the deeper parts of the basin where drilling for artesian water has become uneconomic because of the increasing drilling costs compared with the arid nature and limited use of the country

which can be watered by it. In many places particularly around the marginal areas shallow ground water is available in sufficient quantity and quality for the watering of stock. The greatest amount of new bore information has come from marginal areas, also especially from those stations possessing their own boring plant. In many cases advice has been given orally to station managers as to groundwater prospects, based on information gained as a result of the survey and from existing Departmental records.

LOCATION & TOPOGRAPHY

The Great Australian Artesian Basin in South Australia occupies 119,820 square miles, taking up the whole of the north eastern portion of the State. The boundary, as set down in the Report of the Interstate Conference on Artesian Water in 1928, extends as far south as Kingoonya, Marree and Lake Frome. This includes, as inliers, the Peake and Denison Ranges and the Mt. Woods areas. The Basin is situated almost solely in remote, sparsely populated parts of this state in areas suitable for only light sheep and cattle grazing. Topography is generally monotonously flat and broken only by dissected table lands and residual erosional mesas and buttes. Much of the area is covered by moving sand dunes, their orientation being dependent on the prevailing winds, and much by desolate crab hole gypsum country, and stony deserts.

The principle drainage pattern is controlled by the large, low-lying depression of Lake Eyre, which is fed by such major channels as the Diamentina and the Cooper from the northeast, and the Macumba-Finke drainage system from the northwest. Stuarts Range provides a water divide between subsidiary drainage systems such as the Lake Cadibarrawirracanna, and the Lake Phillipsen-Lake Woorong System, both west of the Peake and Denison Ranges. Lake Frome takes much of the drainage south of

the Cooper and provides a further local base level and evaporation pan. Without accurate reduced levels it is difficult to determine gradients of drainage, but generally they can be considered so low that Lake Eyre rarely receives any appreciable intake resulting from any distant run-off. The evaporation rate on Lake Eyre has been estimated by Benython (19) at 80" - 90" per annum.

CLIMATE AND VEGETATION

Most of the Great Artesian Basin in South Australia lies within the 5" isohyet and is hence in semi-arid country. The fringe areas on the west and south and also on the eastern part of the State are between the 5" - 6" rainfall zone. However the distribution of this rainfall is extremely erratic and long droughts lasting several years can follow a good season.

Great extremes in temperature are common. Summer shade temperatures soar to an occasional 120°F or more, with numerous typical duststorms, but the winters are mild and calm and comparatively pleasant.

The vegetation reflects such a severe climate by its sparseness. Mulga bush and other shrubs together with saltbush, bluebush, spinifex and a brief seasonal growth of grasses provide the essential vegetation over most of the basin. Gum trees are restricted largely either to higher rainfall areas or along major water courses. Extensive bare stony table land or gypsiferous flats are quite common in many parts of the Basin.

GEOLOGY & HYDROLOGY

The basin in South Australia has been described hydrologically by many previous workers notably Jack (1923) and Ward (1946). It is not a simple sedimentary or hydrological basin bounded on all sides by crystalline bedrock or with distinct water-sheds. It is rather an extensive sedimentary basin limited in some places by outcropping Proterozoic rocks, and in others

by the shallow occurrence or outcrop of a mature Archaean granite landscape.

Precambrian

The Flinders Ranges, the Willouran and Peake and Denison Ranges, provide practically continuous Proterozoic basement rock outcrop. From Stuarts Range Station to the Peake and Denison Ranges it is suspected that shallow Precambrian basement in the form of flaggy quartzites form a continuous hydraulic barrier to underground water movement. Permian shales may also occur in the area and form a barrier. Although not continuous there are outcrops of flaggy quartzites well beyond the bulk of the Willouran Range towards the upper reaches of Stuarts Creek. These together with the presence of a strong northwest-southeast lineation in younger cover sediments - suggest a structural barrier to the flow of groundwater or pressure water.

On a good deal of its western margins of the basin the sands of the Blythesdale Group thin and shelve onto Permian carbonaceous shales. This is the case in the Lake Phillipson area and also further north on Mabel Creek Station. Similarly this is almost undoubtedly the case on a good deal of Anna Creek Station especially to the south of Lake Cadibarrawirracanna. In the south western lobe of the larger limits of the basin north of Kingeenya, the marginal zone is determined by the occasional Archaean outcrop of quartzites or conglomerate, but more often by the occurrence of granite. Only in a few places does this massive ex-foliated granite outcrop along what has previously been determined the marginal limits of the Great Artesian Basin. However it is often easily recognized in sludge cuttings or well diggings, from shallow depths. Where either solid granite or weathered but obviously untransported granite debris occurs at depths shallower than the natural water table of 100 - 150 ft., then this criterion has been used as a useful means for defining the outer effective hydrological limits of the main basin or sub-basins described. In some areas where the limits of the

transported weathered granite debris are indefinite the variation in water quality is sometimes used to decide the continuity of an aquifer. The occasional granite outcrops in the Mt. Woods vicinity are regarded as inliers although these and shallow sub-surface hard rocks are suspected as controlling the hydrology over a quite considerable area.

Permian

Several deep bores in the west and south western portions of the basin have intersected Permian sediments. In and around the Lake Phillipson area a black lignite of lower Artinskian to Upper Sakmarian age is a distinctive Permian formation. This low grade coal has been further recognized in shallow bores on a good deal of the southern portion of Mabel Creek Station, on the northern boundary of Ingomar Station and more recently outcropping at Mt. Toondina (I. Freytag, 1962). Deep bores such as Margaret Creek, Coorie Appa, Anna Creek, Boorthanna, Stuarts Ranges No. 1 and 2 and L. Phillipson bores, have been described and correlated by Ludbrook (1961). Lower Sakmarian glacigenes have been described from Lake Phillipson, Coorie Appa, and Margaret Creek bores, while glacigene sediments containing striated boulders outcrop on the western side of the Peake and Denison Ranges and in the Finke area in the Northern Territory.

It is expected that the distribution of Permian sediments is considerably more widespread than initially thought. The indistinguishable nature of Permian blue shale with Cretaceous blue shale in hand specimen, makes field recognition difficult and virtually impossible without stratigraphic evidence. On Billa Kalina Station the southern part of Mt. Eba, Ben Ben and Mt. Vivian Stations, a suspected pre Jurassic chocolate and sometimes purplish shale unlike the blue shale has been recognised and sampled. This may well prove to be Permian in age. Without further palaeontological work on sludge samples submitted it is difficult to say, but there is reason to suspect that blue shale

which underlies much of this southwest area is Permian in age. Definite Permian is described from Stuarts Range No. 1 and 2 and from Anna Creek bores, and is almost certainly present on Anna Creek Station two miles south of Kumetha Dam. As Blythesdale equivalent sediments are found outcropping on the south of Anna Creek Station, and deep blue shale occurs to the north of Millers Creek, it is probable that these sediments are pre-Blythesdale and most likely Permian. Black shale has been described in the logs of some of the old bores in Millers Creek and Beetram Downs, and it may be that this is the equivalent of the Lake Phillipson coal. At present there is insufficient evidence for a useful continuous or predictable aquifer within the Permian sediments, and for this reason hydrologically speaking they can generally be regarded as basement rocks. Few bores apart from oil bores in the north east of the State have penetrated sediments older than Blythesdale, and hence it is not known how extensive the Permian sediments are within the main portion of the basin. However 260 ft. of (?) Upper Permian stringers of coal interbedded in coarse sands and grits have been recognized in the Immamincka No. 1 well from 6750-7010 feet, hence suggesting the possibility of a very great regional extent of Permian sediments within the Artesian Basin.

Blythesdale Group and Equivalents

This formation, consisting of fresh water conglomerates and sands of all grades provides a very extensive continuous horizon within the main portion of the Great Artesian Basin and constitutes the main pressure aquifer. In addition, these sands, which grade into grits with fragments of weathered granite in the southwest and western portions of the basin, form a discontinuous mantle over a wide area of shallow crystalline basement. An effort has been made to delineate the continuous from the discontinuous extension of this formation, particularly where this has application to the hydrology.

Although in most parts of the basin proper in South Australia the Blythesdale is covered by varying thicknesses of Cretaceous and younger sediments, southwest of the Marree - Alice Springs railway line and south of the Peake and Denison Ranges, there are many places where it is either very thinly veneered by Cretaceous, or exposed. An aerial photographic interpretation by Forbes and Coats (1961) of the Coober Pedy Lake Eyre region, has been useful in delineating these areas of exposure.

Only rarely are macro fossils found in bore sludges from this fresh water formation. The occurrence of weathered Gawler Range type porphyry boulders of all sizes rounded and with the feldspar phenocrysts mostly removed, is thought to indicate the upper portion of the Blythesdale (pers. comm. Wopfner). This criterion has been useful in their recognition where the sands are shallow and have been cut by wells, as on Anna Creek. Elsewhere where Blythesdale is recognised in unsilicified form it is a highly felspathic sometimes micaceous white grey or pinkish well rounded quartz grit. Where it is found at some distance from residual deposits the rounded grit or pebbly sand is usually freer of large micas and has felspar associated with it. It is normally a porous bed ideally suited for the passage of underground water. In the more central portions of the basin the Blythesdale is represented by a fine micaceous felspathic quartz sand.

Where recognised in outcrop around the Peake and Denison, Willouran and Flinders Ranges, the formation is often cross bedded and sometimes silicified. Often there is differential weathering in outcrop creating cavernous and characteristic peck mark effects.

Thicknesses of the Blythesdale Group are quite variable. In the main and deeper portions of the basin the thickness is largely untested except in the case of oil bores. In O.P.S. Innamincka No. 1 well the thickness of the three upper units

is 530 feet. Most bores that have been drilled for water alone have not penetrated the full thickness of the Blythesdale Group being unnecessary in tapping the pressure water.

Evidence of more extensive Blythesdale at one time is seen from erosional remnants of their sands on the northern Flinders Ranges. Outcrops on Mt. Babbage and near Mt. Neil indicate levels 800-1000 ft. above present plain level due to post Cretaceous uplift of the Flinders Ranges.

Reference is made to the current work of Wopfner and co-workers in the Oodnadatta region where type areas for the Blythesdale equivalent sequences in South Australia are being worked out.

Cretaceous

Predominantly comprised of marine blue shale these relatively impermeable sediments provide a sealing aquiclude for the pressure water of the main portion of the basin. While the Cretaceous is subdivided on fossil evidence these divisions were not distinguishable lithologically in bore sludges examined. Nor is their age distinction often important hydrologically.

A secondary formed leached mottled horizon is associated with the duricrust formation in mid Tertiary times and this is not a stratigraphic unit. It is more permeable than the unleached horizon below hence will sometimes increase the downward percolation and accumulation of water at the leached-unleached contact. In the southwestern areas the leached mottled zone is up to 150 feet thick and is of more importance hydrologically than the marine blue shale.

Whereas in the southwest lobe of the basin around Ben Ben, Mt. Eba and Mt. Vivian Stations, this leached zone is a very pallid and lightly mottled siliceous clay shale the Stuarts Range equivalent is composed of a rather opalised clay shale conglomeratic in nature and with gypsum seams within it.

In the Gosses Range on Ben Ben Station large rounded cross bedded quartzite boulders have been found imbedded within

this light clay shale. On much of the surrounding country these quartzite boulders occur as floaters. It is considered that these are restricted to the Aptian (pers. comm. Wopfner). Their origin is somewhat obscure although they appear to be typical of marginal facies and hence probably come from bedrock, or possibly basal Blythesdale.

While the Cretaceous is predominantly comprised of blue shale in places silty, limey or carbonaceous, occasional sandy horizons occur, and are of sufficient thickness and extent to be important hydrologically. However no continuous aquifer in the Cretaceous is known and it is suspected that these sandy horizons are only lenses.

In parts of the basin it is known that either the base of the Cretaceous or the upper portion of the Blythesdale is represented by a hard pyritic bar often sufficient to separate two horizons of water. In addition the weathered outcrop of blue shale and mottled leached shale is often associated with abundant gypsum. These are two possible sources of the sulphates so predominant in the waters west of Lake Eyre.

Tertiary and Recent

Although of less importance hydrologically than older formations, being much thinner or absent in central portions of the basin, the occurrence of Tertiary and Recent sediments in many parts of the basin should be noted. The greatest thickness in the main basin might be 300-400 feet and in the northeast portion of the State useful supplies of water are obtained from them in the form of a suspended basin. The effect of the northern Barrier Range is felt south of Cordillo Downs on the New South Wales border where stock water is often obtained at the base of the Tertiary.

Tertiary limestones are characteristic of the areas west of Marree to the Oodnadatta area and also on Murnpeowie and upper parts of the Birdsville track and north of Innamincka.

The base of the Tertiary sediments is often recognised by an agate conglomerate or boulder bed, or simply a coarse

sand. This is overlain by shales and sands often cross bedded. A duricrust formation followed by a laterite profile with possible time breaks all underlie Mio-Pliocene Etadunna and equivalent fresh water limestones and more recent sand and gypsite deposits. The duricrust horizon is estimated as being of Mid Tertiary Oligocene-Miocene age as the overlying Etadunna formation is not affected by it. (pers. comm. Wopfner).

The Tertiary - Pleistocene deposits are generally thicker in the southeastern parts of the basin extending into the Frome Embayment especially between Lake Frome and the Flinders Ranges, and south of the Lake in the Border and Siccus Basin, of R.L. Jack (1925). In these areas they assume much greater importance hydrologically being often less uniform in nature and having several aquifers.

Recent deposits of swamp sand and gypsite are of no major importance hydrologically except in the location of limited seakages.

HYDROLOGY - AQUIFERS

Pre Cambrian

Only brief mention will be made of the water available from the hard basement rocks as they do not constitute part of the sedimentary basin. Suitable rock types and specific conditions are required for the occurrence of useable groundwater. Dolomites and quartzites are the principle rock types in which good quality water is stored. In the weathered granite mantle water is only found where there is a basement hollow and filled with a few feet of residual grit. Where intake is local and water has moved over a very short distance, the quality is often excellent. These conditions exist especially on parts of Coondambo, North Well Bulgunnia and McDonall Peak Stations.

Where solid granite is intersected at shallow depths without an appreciable weathered zone, groundwater is usually either absent, in small supply or highly saline.

On the west of Parakylia Station chocolate laminated micaceous Marinoan shales were encountered in wells and bores but it is considered that the ground water was found in sands above these.

Within the Frome Embayment useable groundwater is obtained from sediments believed to be Proterozoic. In most places supplies were generally limited and the quality only just tolerable for sheep.

Permian

Insufficient evidence is available to indicate whether a reliable and useful aquifer exists in the South Australian portion of the Great Artesian Basin within Permian sediments. In critical areas hydrological information is usually inadequate or suspect. Stuarts Range bore No. 2 is the only bore, in the area of the Great Artesian Basin covered, which is reported as giving a useful water supply from Permian sediments. Even this report is suspect in the light of a regional study in which it is seen that water of similar quality from the Blythesdale equivalent sands could be expected in this area. Highly saline water has been reported from many horizons in the Lower Permian, but supplies and the extent of these are in doubt. Some deep dry bores have been drilled in Permian e.g. a 600 ft. hole on Anna Creek Station just south of Kunoths Dam. On Millers Creek Station a number of deep bores drilled, in the northern part of the property were initial failures and others have become saline with use. If, as suspected, these were in Permian sediments, the lack of outcrop and hence intake is reflected in poor water quality, and a connate origin seems likely. Because of the general lack of outcrop resulting in poor intake conditions, the Permian sediments, are not considered to be a useful aquifer in the western portion of the Great Artesian Basin or its fringe areas in South Australia.

Blythesdale Group and Equivalents

As this Group is the main pressure aquifer for the Great Artesian Basin it has the greatest importance hydrologically.

The extent of pressure water occurrence is controlled, firstly by the continuous distribution of these sands; secondly by the extent of the Cretaceous shale cover; and thirdly by the relative differences in elevation of intake and aquifer at any point. The hydraulic flow of this pressure water can be hampered by occurrence, at shallow depth below the surface, of an effective basement high acting as a barrier. Lack of accurate levels and pressure data within the basin prevents the drawing up of isopotentials which could enable true direction of water movement to be determined. Isohalsines, however, show that the intakes for the main portion of the basin are in the northeast from Queensland and New South Wales, but with subsidiary intakes from the northwest. Only for zones where the piezometric surface is below the base of the blue Cretaceous shale is intake noted to be at all effective in freshening on the western margins. The sands of the Blythesdale Group also extend as an aquifer, outside the limits of the main pressure water. In the southwestern areas north of Kingoonya, this horizon provides an unconfined aquifer over the southern parts of Bon Bon, Mt. Vivian, Mt. Eba, Millers Creek, The Twins and North Well Stations. In places these sands and grits are directly overlain by relatively permeable white siliceous leached mottled clay shale. Where the sands and grits contain free groundwater, whether or not covered by the mottled shale, there is usually a fresh skin of water overlying more saline water. The supplies of fresh water available depend on the degree of local intake available. In the immediate vicinity of watercourses and swamps potable water can be obtainable. Highly saline water however occurs in places of ineffective intake and where the downward percolation of fresh waters cannot reach the ground waters contained in confined aquifers. Good examples of this are found in the Coober Pedy area. In areas where these sands and grits are only thinly veneering bedrock they contain extremely saline water. These conditions exist on most of the areas of Ingomar and Lake Wirrida Stations and

on Mt. Penrhyn blocks.

Where sands and grits of the Blythesdale Group overlie shallow granite they often grade down into weathered bedrock and are not easily distinguishable. Under these conditions, where the groundwater is not hydraulically connected but rather in pockets and bedrock depressions, quality and supplies of the perched water table are extremely variable.

Cretaceous

No new information regarding the use of Cretaceous aquifers has been received in the course of this survey. Saline water has been obtained in several of the deep artesian bores from near the base of the Cretaceous. Lake Harry, Clayton, Dulkaninna, Koppermanna and Mt. Gason bores on the Birdsville Track Stock route are reported as having struck reasonable quality stock water from sands within the blue shale formation. Similarly Coonanna bore had a flowing supply of not analised but good quality water from 970 - 985 ft. (total depth 2030 ft.) from within the Cretaceous shales. In addition several old bores on the east of the basin, north of Lake Frome, Woolatchi, Jerilla, Lake Crossing and Montecollina showed the presence of a pressure aquifer containing stock water within the Cretaceous sediments. Of these Yerilla and Lake Crossing were discontinued before reaching the Blythesdale Group.

Upper Cretaceous non-marine shale and sandy beds are important in the northeast of the State where they are of greatest thickness. Artesian water from these beds was obtained from Patchawarra bore, and sub-artesian water has been developed at other places to the south adjacent to the New South Wales border. Good use is also made of this aquifer at Cordillo Downs.

Local horizons of good quality water have been developed on the Stuarts Range notably on Mt. Willoughby Station where weathered permeable mottled Lower Cretaceous shales overlie impermeable unweathered blue shale. However, these supplies are strictly limited to areas of local intake derived from swamps and creeks. Further to the south on the Twins Homestead, useful

groundwater has also been obtained at the same contact.

Tertiary - Recent

The importance of these sediments which are undifferentiated for hydrological purposes are most clearly seen in the adjacent areas of the Great Artesian Basin and in the north east of the State. The Frome Embayment previously described by the author (1962) contains several aquifers within these formations. Both here and around the northern end of the Flinders, and in the Lyndhurst basin shallow water is derived from Tertiary-Recent sediments as a result of intake from the adjacent Ranges.

On Cordillo Downs and in the Innamincka vicinity a favourable horizon for water is at the contact of lateritic and underlying duricrust where at shallow depth good quality water is often obtained, Wopfner, (1961). This horizon is effective on the limbs of domes and anticlines, and natural springs are recorded in some places where this contact is exposed.

No other significant Tertiary-Recent aquifers are recorded, although the fresh water limestones may be worth exploring where they are of sufficient thickness and where they overlie an impermeable shale horizon.

MARGINS AND SUBDIVISIONS OF GREAT ARTESIAN BASIN, SUBSIDIARY AND SUSPENDED BASINS

The Great Artesian Basin in South Australia lends itself to subdivision hydrologically. Previous workers have often used the all encompassing boundary which includes areas not hydrologically or hydraulically connected with the basin.

The subdivisions made in this hydrological survey are shown on an accompanying plan '63-393). The main division is the limiting and separating of the main pressure basin from its subsidiary adjacent basins because of hydraulic discontinuity. Previous boundaries hold for the south east and southern portions as far as Stuarts Creek, where Blythesdale abuts Precambrian and springs exist, providing good evidence for the edge of the Mesozoic sedimentation and water movement.

Hamilton Springs located six miles north of Stuart Creek Homestead and on the track to Anna Creek Homestead produce ample evidence of the limiting westward movement of pressure waters. These springs are situated on streng lineaments orientated northwest-southeast where Proterozoic and Permian sediments are at shallow depth. Springs on the eastern side of the Peake and Denison Ranges and these on the western side, though out from the Ranges, do appear to line up with the Lake Cadibarrawirracanna Springs, providing similar evidence of the limitations to west and southwesterly movements of pressure water. From Giddi Giddinna springs westwards to Stuarts Range No. 2 bore and Rock Hole bore on Mt. Clarence, the elevation of the Blythesdale Group Sands is probably too high to allow an appreciable rise in water levels even though this aquifer is almost definitely hydraulically connected with Raspberry Creek bore on Mt. Barry Station to the north. In these bores and in Southern Cross, Salty and Bedouri bores on Mabel Creek, the piezometric surface is below the base of the blue Cretaceous shale.

North of a line from Bedouri bore to Rock Hill bore on Mabel Creek and Mt. Clarence Stations, non pressure or low pressure water occurs beneath blue shale. The relative uniform quality of the groundwater in bores over a wide area extending into Mt. Willoughby Station indicate a continuous hydraulically connected aquifer. This aquifer has every indication of being part of the main pressure basin to the north. Beyond the limits of the blue Cretaceous shale where the Blythesdale Group sands are thick enough, good quality water is often to be found as a result of local downward percolation and intake. This situation continues well out into the unoccupied country west of Mabel Creek Station. Seismic evidence indicates crystalline bedrock at about 800 ft. depth about ten miles out from Gordons Corner Bore being on the western boundary of Mabel Creek Station. As the area is largely untested by boring and the limits of the blue shale cover on Mt. Willoughby are not known, the outer boundary of the Great Artesian Basin in this area and to the

north is at present very inaccurately defined.

The effects of intake from the west as seen by water qualities is variable but in places appears to be reasonably extensive. While the lack of pressure permits intake into the aquifer, the thin blue shale cover and possible outlier nature of it appears to allow absorption and some runoff assisting in local intake. It is not considered that there is a marked trough in the piezometric surface in this area.

SUBSIDIARY BASINS

South Western Area

The southwest lobe of the Great Artesian Basin as described and included by previous workers is on new evidence considered hydraulically isolated. It is a shallow hydrological sub-basin with little or no exterior means of intake or replenishment. In all probability most of it is underlain by Permian blue shales which are in hand specimen and sludge material usually difficult to distinguish lithologically from the Cretaceous. As no uniform aquifer within the suspected Permian has been recognised, it seems fit that the Blythesdale Group grit or equivalent form the water bearing bed in this isolated hydrological basin.

From Kingoonya north this subsidiary basin has been defined on the basis of the extent of obviously transported sediments as opposed to residual weathered granite and basal grits. Outcrops and shallow occurrences of quartzites and conglomerate of presumed Archaean age are used as the basis for a southerly boundary on North Well and Ben Ben Stations. Granite outcrop and residual granite sheddings on Bulgunnia, McDouall Peak and Ingomar Stations north of the Mt. Penrhyn block provides for the most part a definite westerly boundary well inside that of R.L. Jack's original more generous margin. Near Fitzgerald's Dam on Mt. Penrhyn southeast to south of Balta Baltana and Mt. Woods, granite bedrock appears sufficiently shallow to act

as a barrier for groundwater movement. From Mt. Woods north to Lake Cadibarrawirracanna and east to the southern end of the Peake & Denison Ranges, a vast area of shallow Blythesdale overlies suspected Permian blue shales, and is in turn partly overlain by Cretaceous blue shales. Only where the Cretaceous blue shale is eroded and is absent while intake conditions are favourable good quality water is available from the Blythesdale sands. These conditions exist along many creek beds and at canegrass swamps, but there is no evidence for a suspended groundwater basin on much of Anna Creek station. South of Anna Creek station and west of a line from Cerrie Appa bore to Billa-Kalina homestead, and northwest of a line from north Parakylia to East Wells on Coondambo station conditions are variable. The occurrence of good quality water depends on the thickness of the sands overlying the possible Permian blue shale and the occurrence of Cretaceous blue shale affects the quality of the groundwater considerably. One Ben Ben, Mt. Vivian and much of Coondambo stations where the Cretaceous blue shale is absent conditions for groundwater are more uniform and useful stock supplies are available. This area bounded to the south by a line from East Wells to just north of Kingeonya is not uniform and not hydraulically connected throughout, but does form a shallow unit in itself.

Coober Pedy Area

The area around Coober Pedy, defined as saline by Ward (1946) is hydraulically isolated with little or no intake either laterally or vertically, and hence contains aquifers with stagnant and saline water. It is considered that shallow Permian and granite occurring south of Rock Hill bore, the shallow granites of the Mt. Woods area and that lying north of the abandoned Sabina bore form barriers to ground water movement from the north and east respectively. A similar barrier to the south restricts the movement of groundwaters toward the north. To the west shallow Permian occurs in the Lake Phillipson area and the Blythesdale is thought to shelve shallowly onto this.

The area is thus hydraulically isolated and the saline groundwater contained in the Permian sediments is regarded to be connate.

Frome Embayment

The Frome Embayment has been described previously in a separate publication by the author (Rep. GS. No. 2497). This is a complex area comprised of four basins, the Siccus Basin, the Border Basin, Wirrealpa Intermontane Basin, and the area between the Flinders Ranges and Lake Frome, which is adjacent to and partly superimposed on, the southeast fringes of the main Artesian Basin, but they are all in Tertiary - Recent sediments.

Mt. Lyndhurst Basin

This is another area containing an adjacent hydrological basin. Mt. Lyndhurst Basin is enclosed by the Proterozoic bedrock to the south, east and west extending north to Meekawarinna bore on Murnpeowie and is described by Ward (1946). Both groundwater and sub-pressure waters exist, but quality is quite variable and depending on distance from and conditions of intake. The occurrence of more than one aquifer within this area could explain the considerable variation in depth of bores over comparatively short distances. These aquifers have not been differentiated within the basin apart from the obviously shallow seakages, and bores which penetrated basement rocks on the southern edge, generally the deeper aquifers contain better quality water, deteriorating away from outcrop, e.g. recharge areas.

Cordillo Downs Basin

This area has not been visited by the author but an examination of the hydrology shows that water can be obtained from the Upper Cretaceous and in addition from Tertiary sediments above the duricrust horizon in particular areas on anticlines and domes. (Wopfner 1961). Generally the deeper aquifers contain only stock quality water though potable water is obtainable from shallow bores and wells penetrating the Tertiary sediments.

South of Cordillo Downs there is a suspended basin from which stock water can be obtained from varying depths normally less than 500 ft. The three bores on the Innamincka stock route penetrated an aquifer which may be basal Tertiary or Upper Cretaceous. This aquifer probably derives its intake partly from Grey Ranges in New South Wales, and partly from outcrops on the Cooper and Strzelecki Creeks.

WATER QUALITY

Isohalsine plan (63-391) shows a deteriorating quality in the pressure water from the main basin in a southwest direction towards the natural outlets or mound springs. Birdsville bore of 35.1 grains per gallon total salt content and Geyders Lagoon bore of 42 grains per gallon in the northeast of the State contain the best quality pressure waters. Salinities of springs sampled around the southern and southwestern edge of the basin are often misleading due to evaporation and concentration. But samples from shallow bores near these springs indicate an increase in salinity away from intake. Reference is made to an isohalsine plan which has been drawn for the pressure water in these parts of the basin where bore density warrants it. Water quality in the main aquifer is remarkably uniform over wide areas in the parts of the basin away from the fringes. The water qualities show clearly that in the Lakes Crossing area on the Strzelecki Track a different aquifer occurs. The analysis of these anomalous bores are not similar in themselves and vary from 70 - 700 grains per gallon total salts from Petermorra to Lakes Crossing bores suggesting the presence of a separate upper aquifer. Similarly in the Mt. Lyndhurst basin, salinities are too variable to suggest any hydraulic connection with the main pressure basin.

Salinities in the south western areas north of Kingoonya reflect some local intake where Cretaceous shale is absent and certainly regional isolation from the main pressure basin occurs. Regional isolation without areas of intake are

reflected in the high salinities of water in Blythesdale in the Coober Pedy area. Yet 12 miles to the north there is a particularly uniform water quality in what is undoubtedly part of the main basin.

Outside the limits of blue Cretaceous shale on Mabel Creek and Mt. Willoughby, good quality water is obtainable in an area of local downward percolation of rainwater and runoff. The same sweetening effect occurs around the southern part of the Peake and Denison Ranges where pressure water does not surface as at Anna Creek homestead. Little or no effective sweetening or intake can occur where the edge of the basin is marked by a line of springs.

On fringes of the sub-basins the water qualities are sometimes potable locally, but the quality of ten fluctuates seasonally. This is notably true of the Kingoonya town water supply where a good heavy rain two years ago sweetened very effectively an area which had become saline. In areas of unconfined aquifers saline water is often found to underlie fresh usable water layers which vary in thickness seasonally and is dependent on the topography.

In the main basin and in the western areas, the quality of the water is adequately indicated by the chemical characteristics - the grainsper gallon may well give a misleading impression. While a high carbonate content in the eastern parts provides soft water which is suitable domestically but is often considered unsuitable for irrigation, the sulphate waters to the west normally have highly corrosive properties and are too hard for all domestic use. Only in areas where the piezometric surface of the pressure waters is below the surface and where local intake gives rise to refresh the groundwaters is domestic quality water available in the western areas from the main basin.

INTAKES AND OUTLETS - MOUND SPRINGS

The main intakes to the Great Artesian Basin have already been determined as being from the western margins of the

Queensland - New South Wales Great Dividing Range. A study of an isohalsine plan indicates the gradual southwesterly deterioration in water quality in the main portion of the basin in South Australia. The quality deteriorates further to the southwest towards the natural outlets - the mound springs where, except for high surface evaporation resulting in concentration of the salts, the water is still of good stock quality. Bores adjacent to the mound springs give a better picture of the water quality in any particular region.

No intake is possible where pressure water surfaces as at mound springs. The salinities of the artesian water show no improvement in quality westwards of the main zone of mound springs. Only where groundwater in the Blythesdale Group sands is not under pressure or the water level is below the base of the overlying shales is local intake possible. Obvious effects of local intake resulting in the occurrence of fresh water are reported from areas west and south of the mound springs, where Johnson and Greenfield's bores on the Mudla block are good examples. Similarly long ago established fresh water wells in the Blythesdale Group sands south of Lake Cadibarrawirracanna on Anna Creek reflect local intake. No great effect of intake is noticed west of Mabel Creek and on Mt. Willoughby station where the piezometric surface is well below the base of the overlying shales being absent in places. Water qualities reflect some improvement westerly from Mabel Creek homestead and similarly on the southwest of Mt. Willoughby. An increase in salinity is noticeable where the effect of this westerly intake is limited by the lower levels of the piezometric surface and where the non-pressure water becomes low pressure water, but the limits of this effect are not always clearly defined. Such increases in the salinity were found on Evelyn Downs and Copper Hills Stations. Lack of local intake is shown in some areas by higher salinities along fringe areas e.g. from Bedouri bore on Mabel Creek to Rock Hill bore on Mt. Clarence. Other areas of intakes outside the main portion of the basin occur on the

westerly parts of Mulgunnia and Wilgena West and on Coondambo from the south. Intake through internal drainage is possible over large areas where there is no effective aquiclude as on Ben Ben, Mt. Eba and Mt. Vivian Stations. Further to the north where the main aquifer contains no pressure waters it is refreshened similarly. Examples of these features were found on the western part of Anna Creek Station and west of the line of mound springs lying between the Peake and Denisen Ranges and Willochra Ranges.

Leakage of pressure waters forms numerous springs on the edges of basement rock outcrop of the northern Flinders Ranges, Willouran Hill and Peake and Denison Ranges. The water levels in the bores to the west of these do not suggest that groundwater moves easterly to these springs. In addition the almost continuous high of Proterozoic rocks and Permian sediments would bar any easterly groundwater flow.

Mound springs together with other springs within the basin provide the only natural escape for pressure waters. The present generation of mound springs are at a much lower elevation than the older extinct springs which form a prominent feature of the landscape in the Coward Springs - Beresford - Strangeways area and further to the north. The older springs now 100 -120 ft. above plain level reflect a period of much higher groundwater pressure of the aquifer than the present one. Although the recent springs are at lower elevation they yield no large supplies but are mostly seakages. The mounds of the old springs mostly consist of travertinous material while some of the more active recent ones have only a thin surface coating of limestone but the main body of these is composed of sand and mud.

The mound springs east of the Peake and Denisen Ranges, the Flinders Ranges and Willouran Ranges are associated with outcropping or suspected shallow occurrences of Proterozoic rocks. They are also formed where shallow Permian shales are present. The Lake Frome, Lake Callabonna, Lake Eyre and possibly Dalhousie Springs are most likely related to structural lineaments and zones of weaknesses.

MOVEMENT OF WATERS

Although undoubtedly there is movement of the pressure waters towards the mound springs it is considered that the extent of the easterly movement of water originating on the western and northwestern margins of the basin have been exaggerated by previous workers. R.L. Jack has drawn approximate isopotentials for the basin but it is not known on what basis these were constructed as no reliable levels are available apart from the railway line. Undoubtedly there is some easterly movement from a western origin and probably more at present than in the past before the pressure declined partly owing to increasing utilisation.

There can be little doubt that, because of the uniformity and general gradual deterioration of quality in the main portion of the basin, the movement is to the southwest. Without an accurate isopotential plan it is impossible to estimate the extent of the movement of westerly originated waters. The regional isohalsine pattern, though confused over a wide area, does show a distinct movement from the northwest with a probable zone of mixing north of the Peake and Denison Ranges. However in the areas southwest of the Alice Springs railway line and the neighbouring mound springs, there is no regional movement of groundwater. Further to the southwest isopotentials drawn for the Mt. Eba region and they indicate also no regional groundwater movement.

CHEMICAL CHARACTERISTICS OF THE BLYTHESDALE WATERS

Much has been written on the chemical character of the artesian water and its significance. Although the sulphate waters are always assumed to originate from the intake on the west and carbonate waters from intake on the east, no satisfactory solution to the problem of the origin of the sulphate has been suggested. The sulphate waters to the west and southwest of Lake Eyre north are an anomaly to this assumption. It has been established that there is no possible intake to this area from the southwest. Nor

is any southerly movement of water likely south of the numerous springs situated east of Peake and Denison Ranges. The only intake to this area would appear to be from the east or southeast, yet the waters are sulphate.

The origin of carbonate waters from the east must be related to limestones and dolomites and possibly the basalts. In additionrapid intakes as probably occur must favour adsorption of atmospheric carbon dioxide. As far as western sulphate water is concerned, gypsum and pyrites would appear to be the obvious sources of the sulphate radical.

PART II

ECONOMIC ASPECTS OF THE GREAT ARTESIAN BASIN

No recent flow or pressure measurements have been made within the basin in South Australia. However, it can easily be seen by anyone visiting these bores that only a small percentage of the flowing water is being used profitably. Water from artesian bores is nowhereeconomically used, a small portion of the flows is consumed by stock. Depending on the number of stock per bore and on the yield the percentage of flow used would probably vary from 1% - 2%. It cannot be emphasised too strongly that the water flowing through the drains does not return to the main aquifer but is lost by evaporation and percolation and is dissipated in shales and sands lying at shallow depth below the surface. Many bore heads and drains are in a deplorable condition such that the surroundings have become extremely boggy and treacherous to stock and vehicles alike. The stock losses are considerably around these and also in the vicinity of some natural springs. There are some bores such as old Mulcha, Culberta, Old Koppermanna bores which were abandoned because of lack of proper care in upkeep. This has in some cases necessitated expensive replacements while such monies could have been used more profitably by drilling new bores in other areas suitable for further development. Cement around the casing

should be kept in proper condition and bore heads should be equipped with control valves so that the flow can be regulated to requirements. Leaking bore heads only aggravate erosion of the top casing and hence further deterioration.

There are many places within the Great Artesian Basin where the quality of water is good enough for at least limited irrigation. Mulka bore of 54 grains per gallon will support grass, tomatoes and other vegetables. The detrimental effect on soil structure by the carbonate waters could be partially offset by the addition of gypsum. Alternatively if different plots are cultivated each year, there appears no reason why greater horticultural use cannot be made of the carbonate artesian water. It is understood that very little has been done by the Agriculture Department in these areas where great scope exists for ecological experimentation and research. It is also felt that the stock carrying capacity could be greatly increased for vast areas of the Great Artesian Basin with supplementary and even limited lucerne growing using a rotating system of cultivated plots if necessary. Hay and other dry feed transported to outback stations at times of drought is expensive and is a limiting factor in carrying capacity at dry times.

The resources of water available and the degree of diminution in pressure cannot be assessed without flow and pressure tests. That such diminution is occurring is apparent from reports of smaller flows from springs on the edges of the basin. The advantages of flowing water over non pressure water, which requires equipping in these areas, is considerable and should be actively guarded.

STATIONS WHOSE BOUNDARIES LIE ENTIRELY WITHIN THE MAIN GREAT ARTESIAN BASIN

The accompanying plans show the stations underlain by the aquifer containing pressure water. They will not be discussed separately as their regional description has been given in the previous chapter, page . This together with the bore details gives a full account on the pressure water potentials. Generally the shallow ground waters obtainable on these properties are unpredictable and depend entirely on local conditions for intake and recharge.

GROUNDWATER PROSPECTS ON STATIONS WITHIN THE GREAT ARTESIAN AND ADJACENT AND SUSPENDED BASINS

Anna Creek Station:

Pressure water on this large holding is limited to the eastern portion except for the small remote parts north of the springs around Lake Cadibarrawirracanna. A line drawn from Sampfire Swamp on Mudla north to Francis Swamp and Anna Creek homestead indicates the westerly limit of the pressure water. North of Anna Creek homestead, outcrop and shallow basement rock of the Peake and Denisen Ranges control the occurrences of springs and the pressure water movement. Several new flowing bores have been drilled where it has been economically possible, generally to depths not exceeding 1200 ft. The quality of the pressure water shows a general deterioration in a west and south westerly direction and reach their maximum of 400 to 500 grains per gallon just east of the shelving of the Blythesdale Group sands on to Permian or Precambrian.

To the west of the shallow basement rocks, highly saline shallow water occurs even where there is a thin covering of Cretaceous blue shale. Usable water is obtained only along water courses and in areas where there is a sufficient thickness of Jurassic sands without shale cover. West of Anna Creek homestead to the Lake a series of old wells, some of which are still used, fulfil these conditions. The southerly limits of pressure water

north of Lake Cadibarrawirracanna must occur somewhere about a line from salt springs at Ceeree Appa Crossing and Warragarrina Springs on Nilpina Station. Two deep water bores have been drilled south of the lake into presumed Permian sediments, but apparently without being successful.

Bores drilled in Precambrian rocks of the Peake and Denison Ranges show varying salinities and supplies according to the rock types penetrated but seasonally good quality water is present in creek alluvium and Blythesdale Group sand not covered with impermeable beds.

Callanna Station:

Springs along the foothills continue west from Beerlee to Welcome and Wanganna Springs, all of which are reported as yielding appreciably smaller supply over the last few years. Beerlee, Callanna and Cooryanna bores all show that artesian water is available north of this line of springs. Analyses show a deterioration in the groundwater quality from 92 in Beerlee bore to 175 grains per gallon in Cooryanna bore.

Water is obtained from wells constructed in the hard rocks east of the homestead, but on this station no useful non pressure water is thought to overlie the comparatively shallow pressure water within the basin.

Finniss Springs Station:

The edge of the artesian basin is well defined following the limit of hard rock outcropping from Davenport to Venable Springs. Numerous springs surround Hermit Hill which is a basement rock monadnock. Smiths and Gosses Springs are minor, but flowing, mound springs though not related to the proximity of basement but possibly to the northwest - southeast lineation and structural weakness. Charles Angas and Morris Creek bores prove the existence of the anticipated pressure water and northwards deepening of the artesian basin.

Variable supplies and salinities of water are obtained from the hard rocks and from alluvium on the south of the block. No potable or domestic water has been found, but limited supplies of stock water do exist at selective sites. As can be expected, the water table drops to a very low level during extended drought periods and wells must be over 100 ft. deep to be permanent. The homestead well in 1961 had not only lost supply but had also become saline, indicating that only a thin horizon of fresh water overlies saline groundwaters below.

Mabel Creek Station:

West of Southern Cross on Mt. Clarence the division line between saline water to the south and good usable stock water to the north runs almost through Pflaums and Bell Bird bores. Shelving Blythesdale Group sands on to Permian sediments at shallow depth to the south causes the marked difference in groundwater quality. Occasional good quality water is found south of this line at Coronation and Clean Skin bore but only where sufficient thickness of sands overlie Permian shales in areas of suitable intake such as large swamps. The salinity pattern of the connected though non pressure waters north of Bedouri and Pflaums and Bell Bird bores, reflects the presence or absence of overlying Cretaceous blue shale. The irregularity in salinity east of the suggested margins may be a result of some intake being possible through the thinning or possible local absence of the Cretaceous shale. Certainly the best quality water is obtained to the north west of the station from Gordons Corner to Paragon bores. Further west into unoccupied land, Blythesdale Group Sands are sufficiently thick to provide a useful aquifer and they are not covered with impermeable shale so that even better quality water and in good supplies could be expected.

Mt. Clarence Station:

North of a line from Giddi Giddimma Springs, Stuarts Range No. 2 and Rock Hill bore to Southern Cross bore abundant useful stock water is obtained. The groundwater is still considered hydraulically part of the artesian basin. Abundant pumping supplies are available from the gently northward sloping aquifer being at 250 ft. depth in the south and 350 ft. in the north. The salinity though rather high in a narrow zone near the afore mentioned line of bores, rapidly improves northwards from 500 - 750 grains per gallon to 250 - 300 grains. South of this a hydraulic barrier prevents free circulation of groundwater and greatly increased salinities of 1200+ grains per gallon result as in the Coober Pedy township region. The occurrence of shallow Permian and Precambrian further to the south of Coober Pedy precludes the availability of any useful groundwater.

Very limited local supplies of fresh potable water are obtained at depths of 150 ft. from the base of the leached and mottled opalised shales comprising the Stuarts Range escarpment. Such water is obtained from Willow bore and from Mt. Clarence homestead bore, but the benched aquifers are likely to be limited in extent and limited in yield. Similar aquifers exist in areas west of the escarpment and at favourable points on the drainage lines, also good quality water is obtained.

Mt. Willoughby Station:

The westerly limit of the hydraulically connected though non pressure water is indefinite through lack of drilling. Hard rock, poormangie and Leslie bores, all of excellent quality stock waters reflect westerly and north westerly intake. Abundant pumping supplies of good stock water from depths not exceeding 350-400 ft. should be available from anywhere on the station. Any rise in water levels is only likely on the north east of the Station.

In addition to this uniform deeper aquifer, there is a further favourable horizon for groundwater at depths about 150 ft. at the contact of weathered leached and mottled shale overlying impermeable blue shale. Only there where favourable conditions of intake exist are useful supplies likely to be encountered. The areas in the vicinity of Boomerang Mathesons C.B. and Big Swamp bores are good examples. Generally the quality of groundwater from this aquifer is very good and often potable.

Moolawatana Station:

Situated on the north eastern extremity of the Flinders Ranges, most of this station is expected to be within the Great Artesian Basin. The pressure water surfaces against basement rocks by a series of springs along the foot of the Range west of the homestead and small following bores such as Gunpowder bore exist adjacent to these. A small flowing low pressure bore near the homestead is at slightly lower elevation than the non-flowing woolshed bore where Blythesdale Group grits outcrop. To the east the basin deepens rapidly as evidenced by the 1872 ft. deep Woolatchi flowing bore, but either faulting or folding in the sediments must occur between here and Moolawatana No. 2 bore of 1432 ft. depth near Salt Creek and much further to the east. The main artesian water is not penetrated along Hamilton Creek to the south-east because shallow aquifers replenished by run-off from the Ranges suffices requirements and is of good quality for some distance toward Salt Creek. Box bore and Marks bore have potable water while New bore and Neds bore contain water still of good stock quality. The quality of the pressure water on this station is of the order of 100 - 120 grains per gallon being of the high sodium carbonate type.

Murnpeowie Station:

All but the very southern portion of this large station is within the limits of the artesian basin. Because

of the comparatively shallow and relatively uniform depths of the aquifer over wide areas, the basin has been fairly systematically drilled. A subsidary suspended aquifer above the main Blythesdale aquifer exists in the eastern areas from Petermorra, Mt. Hopeless, Yerilla, to Lakes Crossing bores. Their waters are also under pressure but is of poor quality increasing in salinity eastwards and north eastwards from Petermorra bore of 76.7 grains per gallon to Lake Crossing bore of 739.1 grains per gallon total salt content.

The southern edge of the basin is well defined at Catt and Chimney Springs, but is less definite west of these. However, it must lie south of Murnpeowie homestead and include Clayton Dam bore, although it is probably not so far south as Mookawarrina bore. Except from Quartpot to Meteor bores the basin deepens generally to the north and north east. Although the quality of the pressure water is almost uniform on Murnpeowie, there is a southerly deterioration in quality from 70 - 90 grains per gallon. Saline Mound springs on the north west corner of Lake Blanche are small, though significant in location.

Drilling of shallow bores in unweathered blue shale which outcrops over wide areas of the station has not been successful. All the successful bores and wells e.g. Boundary Redbanks and Lygnum are located on major streams and obtained water in sediments above the unweathered Cretaceous blue shale.

<u>Mudla Block</u>:

Billa Kalina and these springs around Campfire Swamp mark the southwesterly limits of pressure water. In this area water quality has increased in salinity to over 300 grains per gallon total salts.

South west of these springs as at Coorie Appa, Blythesdale Group sands occur at shallow depth and are not overlain by Cretaceous shale in some areas. On major water courses, therefore, potable non pressure water is sometimes obtained as at Johnsons and Greenfields bores. This non pressure water on

the south-west corner of the block deteriorates in quality as the Cretaceous shale cover thickens, and local recharge decreases.

Mundowdna Station:

The edge of the basin is marked clearly from Wirringinma Springs to the homestead and further on to the Four Mile bore and by the shallow depths to the main aquifer in Clarks bore. The margin of the aquifer must occur somewhere just south of this. Apart from Lake Billy and Well Creek bore, the artesian water on Mundowdna Station has not been developed further northward. Artesian water could be obtained anywhere north of the afore mentioned line of springs and bores, and the water should be of better quality northeast from the springs where it is 150 grains per gallon. Difficulty is likely to be encountered in finding water south of this line or, in fact, any shallow useful non-pressure water on the property.

St. Stephens Ponds:

The edge of the Great Artesian Basin follows from somewhere south of Four Mile bore on Mundowdna hard rock outcrop north of Decoys Hill, across the Beerlee Springs on Callanna station. Bores with a small flow containing 150 grains water of Marree are a sign of proximity to the margins. However, on the north of Stephens Ponds only salt water has been obtained in a bore on Sandy Creek. Bransoms bore of 1005 ft. depth yields a very poor supply of water which has deteriorated in quality from 95 to 132 grains per gallon. Just why this area is devoid of good pressure water is obscure, but is possibly owing to a facies change in the sedimentation where the sand beds thin out or are absent over limited areas.

Shallow water in Marree is much more saline than the pressure water and is limited in supply.

Stuarts Creek Station:

The southern edge of the artesian basin can easily

be

be traced from Venable Springs south of New Year Gift bore to Bull Paddock Springs. A deep pressure saline bore half way between Stuarts Creek homestead and Curdimurka must be within the basin. No springs or bores are recorded west and north west of the homestead and east of Margaret Creek. A line of outcrop of flaggy quartzites can be traced along Chambers or Stuarts Creek, and again just north west of Mt. Morgan on Mudla. A series of waterholes in Stuarts Creek proper may be due to pressure water leakage from the north, but more likely to depressions in hard rock, and areas where the water table of the creeks underflow lies above the alluvium in the creek bed. A large area north of Stuarts Creek is undeveloped and untested for water prospects. Pressure water should be available in the country north of line from Bull Paddock Spring and Billa Kalina Springs. The line of springs and bores from Fred Springs to Anna Springs and Beresford Springs are not considered marking the edge of the pressure water and therefore of another type than Billa Kalina Springs suggest. The springs just south of the Marree-Alice Springs railway are on a north west to south east lineation and are thought to be a result of structural weakness.

The pressure water is of stock quality deteriorating generally to the south west. Bores associated with the springs along the railway line vary from 250 to 300 grains per gallon, although salinity increases southwards to 642 grains at Bull Paddock Spring. New Year's Gift bore is an exception with 155 grains.

Drilling of only two bores has been attempted in hard rocks south of the homestead both without success. Shallow groundwater prospects are likely to vary greatly outside the basin with local conditions of drainage and rock type.

Woolatchi Station:

The whole of this block is likely to be underlain by Blythesdale Group sands, the 1872 ft. deep Woolatchi bore shows them to be at fairly deep levels at least in some parts.

Probably the basin would be shallower east of this bore nearer Salt Creek and the salt lakes, and also to the west north of Moolawatana homestead. Skeleton and Fossils bores show that useable shallow stock water is available with deteriorating quality away from the Ranges. However, this shallower water does not appear to be of useful quality or to be extensive on the western areas where several unsuccessful attempts have been made to depths of 350 ft.

Mound Springs on the edge of Lake Callabonna are capable of supporting a limited number of stock. The springs reflect a possible disruption in the deeper sediments as suggested by lineations in the drainage pattern or else the occurrence of a bedrock high resulting in leakage from the artesian aquifer.

Wilpoorinna Station:

Only on the extreme north west of this property is artesian water likely to be found. The chances of obtaining this decrease in southerly direction towards the Frome.

Shallow water is obtainable on major water courses but it is generally salty and only of doubtful quality. Even on the Frome, salt water was encountered in the alluvium. Most of the station is underlain at shallow depth by mottled highly weathered shales and sandy shales not favouring the accumulation of good groundwater.

WATER PROSPECTS ON STATIONS IN THE SOUTHWEST AREA.

Balta Baltana Block:

Only three bores have been drilled on the southern part of this station. All were dry and one penetrated granite at 410 ft. In view of the known occurrence to the north of granite outcrop in the Mt. Woods area, it is considered that

there is a poor chance of finding groundwater on this block.

Ben Ben Station:

Conditions are rather similar here as they are on Mt. Vivian. A great number of bores have been drilled, many of which were unsuccessful, especially to the south. The shallow quarts grit is again the main aquifer in which the groundwater quality is dependant partly on topography. Blue shale is thought to underlie most of the station and may be equivalent to the reddish and purplish shale which is encountered in old bores such as Leaks bore on the southern parts. Precambrian outcrop marks the edge of this south western sub-basin south of Wallabyng Range in the south west of the station.

Potable water is obtainable in wells and bores located near swamps and in depressions, but a number of wells are saline. Generally depths are shallow, as water is often obtained at less than 100 ft. It is not expected that a deeper aquifer is likely to be present, although its occurrence has not been tested on Ben Ben Station.

Billa Kalina Station:

As on Millers Creek, useful stock water is obtained from Blythesdale equivalent sands outcropping on Mudla Creek on the north west corner of the property. To the southward where these sands are overlain by Cretaceous shales the groundwater deterierates rapidly. Potable water has been found in Blythesdale equivalent sand below sandy blue shales just north of the home-stead. Within half a mile of the homestead is a 100ft. scarp fresh water limestones of Pliocene age and exposed. It is believed that they thinly overly the cretaceous sandy shales and Blythesdale equivalent sands, and are a good medium for intake. Therefore, they may well assist in the refreshing of the groundwater to such extent that it becomes potable. South of the homestead these conditions do not exist and the aquifer contains groundwater too saline for stock. Some of the bores containing highly saline water were abandoned when cattle raising replaced

the sheep raising. Probably the water is stored in sands of Blythesdale Group, equivalent below Cretaceous shale, although the erratics in the Devils Playground bore and occurrences of reddish and purplish shales in wells suggest that the sediments are possibly of Permian age. If these sediments belong to the Blythesdale and Cretaceous, then they must shelve out to the east. Material seen in earth tanks and outcrops in the central portions of the property, west of Angle Swamp and near South Hidden Swamp suggest this shelving effect as (?) Permian sediments directly underlie the sandhills adjacent and west of Precambrian outcrop.

The groundwater prospects on the whole central and eastern parts of the property are not considered good. Useful water may be obtained from favourable types of hard rock, and there is some evidence that dolomites do occur on the Parakylia boundary fence. Limited supplies of groundwater may be obtained in interdune flats large sandhills, but quality and quantity may fluctuate seasonably.

Bulgunnia Station:

Only the area east of about 134°30' was surveyed, to delineate the areas continuously connected with the south west sub-basin. It was found that west of a line from Giffens, Lewis and Bulgunnia homestead and Quarry bores, sediments are residual and closely related to weathered granite. Although several good bores to the west of this exist, they are quite variable in supply and quality, depending on the local conditions. It is therefore not surprising that bores have been unsuccessful. To the east, however, the occurrence of groundwater is more uniform and, although quality fluctuates with the intake potential, few bores are failures, and the comparatively abundant waters available are all suitable for stock.

Coondambo Station:

While the southern part of this station south of

the railway has undulating rounded rises which are part of an old granite surface, now veneered with thin residual grits, the northern portions gradually plunges to the north with thickening unconsolidated sediments consisting of residual grits, and, further to the north, transported material.

Some potable water is obtained from bores and wells in favourable drainage areas on the shallow granite and associated residual grits, but the supply and extent of occurrence are usually limited.

On the north part of the property, water quality is very variable, often with saline water at depths overlain by a fresh water horizon of varying thickness. Most bores are not deep and the presence of many wells shows clearly that better supplies are obtainable from these.

Ingomar Station:

Examination of bore sludges show the limit of residual sediments to be west of a line running north and east of Tea Tree Well, Birthday Swamp and Burntiltaby Wells. West of this bedrock occurs at varying depths covered by typical yellow, reddish sand. Rarely is useful water found on these basement rocks in this areas, although numerous shallow bores have been drilled on Ingomar and the Lake Wirrida blocks. Some bores intersected granite without finding water, and some encountered highly saline water.

On this station, even where the sediments are thicker on the eastern side, no successful bores have been drilled, although many attempts to varying depths of up to 350 ft. have been made. It is considered that this is an area hydraulically isolated owing to the occurrence of hard rocks and Permian blue shale at shallow depth, on the north, east and west.

McDouall Peak Station:

Like Bulgunnia, McDouall Peak Station can be divided by a line from east of Robert's Well to the homestead to just west of Woolingee bore. West of this line, residual weathered

granite or solid granite is encountered at shallow depths. Several bores or wells exist in this area and some, mainly in depressions, provide potable water, for example at nuns and Werth Jacob's bores. Elsewhere especially in the north western corner, insufficient permeable weathered material and residual sediments overlies the shallow granite. Thus a suitable aquifer does not exist explaining the failure bores.

On the east of this line, sediments gradually thicken, and blue shale, possibly Cretaceous, was cut in a new bore two miles south of New Year well and bore, but intakes to these sediments are limited, perhaps owing to the blue shale cover. Only at New Year bore and the new bore just south, and at old Peak bore, has useful water been developed. Abandoned wells and bores bear testimony to the unreliability of the water supply in the eastern portion of McDouall Peak even in areas where the sediment cover on basement rocks is thicker. It is considered that the chances of obtaining water in the north east corner are poor in view of the failure bores drilled on the adjacent stations Ingemar and the Twins.

Millers Creek Station:

Blythesdale equivalent sands outcrop in the extreme north east corner of the station on the Mudla Creek. Good water is available here where intake is unimpeded, but the quality quickly deteriorates upstream. South of Mudla bore, however, the salinity increases but less rapidly. The Blythesdale equivalents from which the successful bores obtain moderate to large supplies occur usually at depth much less than 350 ft. over most of the station, although in one bore they have been penetrated at 350 ft. The salinities vary widely and apart from Mudla bore range from 110 grains per gallon to 900 grains of total dissolved salts. Generally the water on the south of the station block is poor as several failure bores prove. At the head of Mudla Creek and the north west portion of the property, this aquifer contains groundwater either too saline for use or

is practically non existent. Apparently some intake refreshes the aquifer along Miller's Creek, which explains the improved groundwater quality near the homestead.

Deeper bores drilled on the north west corner have probably intersected Permian sediments containing saline and mostly unusable water. The 506 feet deep No. 17 bore, 8 miles southwest of the homestead, cut water at 486 feet. It is abandoned, as the groundwater salinity was 886 grains per gallon.

It is believed that this bore penetrated also Permian sediments.

Pt. Miller's Creek - Bentrem Downs:

The same shallow aquifer in isolated areas in which good water is available in small supply at the base of the weathered mottled shales exists on this block. Such waters are penetrated at Nickels Well. In some cases, it is suspected that the Blythesdale equivalent is covered by only the mottled weathered zone. Where these conditions exist, good usable stock waters are available in reasonable supply as at Clay Pan bore, Sleans bore and No. 12 bore to the south of Miller's Creek.

In addition, several deep bores up to 600 feet have been drilled on this block at various locations. Some have been abandoned before encountering water and ending in blue shale. Many have obtained initially either extremely saline water or water whose quality has become too saline for use. There is a strong possibility that these bores have penetrated Permian sediments. The probability of the occurrence of Permian sediments and the saline water expected, suggests that further deep drilling for groundwater supplies will not be successful.

Mt. Eba Station:

On much of Mt. Eba, especially the north and central portions, the Blythesdale equivalent is overlain by Cretaceous blue shale. The water quality from this horizon is variable though in most cases is useful for stock. A study of iso-

potentials indicates that local intake is possible even when blue shale thinly overlies the sands.

In some areas, it has not been necessary to drill to this horizon where there is a shallower aquifer at the base of the weathered and mottled shales. In this case, potable water though very limited in quantity, is sometimes obtained as for example at Mt. Eba homestead. The deeper waters are often of lesser quality and only suitable for stock. It is suspected that Permian blue shales wholly underlie the station and that these were intersected in bores to the south of the homestead at Cavanaghs, Corkscrew, Birthday and Buckleys bores; and similarly to the north at Gundaloo bore. As no useful reliable aquifer has been found to exist within these shales, further attempts to obtain water supplies by means of drilling are expected to be unsuccessful.

Mt. Penrhyn Block:

Nowhere on this block has useful groundwater been obtained. Very small supplies of good groundwater were obtained on top of granite just north of Fitzgerald Dam, but this has now been exhausted. North on the block, salt water is encountered because there is little or no effective intake and replenishment of the Blythesdale equivalent aquifer. To the east and south, comparatively shallow bedrock precludes any effective reservoir within the aquifer.

On the south west, Blythesdale group sands overlie shallow Permian carbonaceous shales. If the sands are thick enough, water is encountered above the black shales, but it is nearly always saline.

Mt. Vivian Station:

Shallow unconfined coarse quartz grits probably in Blythesdale equivalents occur over most of this property at 100 to 200 feet depth. Although of greatly varying quality, groundwater occurs over a wide area. Generally, the better quality

water is found where owing to the topography local intake replenishes the unconfined aquifer. Many successful bores intersected salt water which commonly directly underlies fresh water beds of varying thicknesses. Many abandoned bores in the Vivian Well region penetrated saline water, stored in blue shale probably of Permian age. No deep drilling into the lower Cretaceous blue shale has been attempted to test the possible occurrence of a second aquifer with the exception of Clemens bore. Here a second aquifer consisting of quartz grit was encountered at 240 feet depth lying within or below blue shale. It is not known as yet just how extensive this water bearing horizon is.

North Well Station:

Only the eastern portion of North Well was surveyed in an endeavour to determine the continuation of the quartz grit as an aquifer. The 20 miles long outcrop of basement rock north of Wallabyng Range along the Bon Bon boundary separates the areas adjacent to Lake Labyrinth from the basin to the east. However, the north eastern corner of North Well Station bounded by a line from Whymlett Well to Mentor Well does include a basin of useful though varying quality water in unconfined quartz grits. Potable water exists at Mentor and Whymlett Wells in low-lying areas. Away from this area, the occurrence of water is less reliable and is controlled by favourable rock types on local hollows in granite basement.

Parakylie Station:

Only the western margins of this station were covered by field survey. Purple micaceous laminated Marinean shales were encountered in Lock's Well and Butchers Well. The water which varies greatly in quality probably occurs in grits above these shales. Useful stock water was encountered above basement rocks in bores on the extreme northwest of the station. Elsewhere in favourable hard rock types, successful bores have been drilled. Sandstones and grits thicken to the west on the station, which

they have been successfully drilled, in three places, near the western boundary.

Twins Station

Water is obtainable at two horizons. The contact between weathered leached shales and impermeable blue shale provides a favourable shallow horizon for accumulation of water if intake is available. This type of aquifer is tapped at the Twins homestead and limited supplies of potable water are obtained. The supply and quality is likely to fluctuate seasonally, but the yield has been proved sufficient for domestic needs even in the driest times.

The Blythesdale equivalent covered by Cretaceous shales provides water of useful quality and quantity, except in the extreme south west of the property. The salinities vary from 372 grains per gallon in Horse bore to 853 grains in Jacobs bore. It is suspected that the black shale encountered below the aquifer in many bores is of Permian age. As no reliable aquifer is known to exist within this formation, further drilling in these tight sediments is expected to be unsuccessful.

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Geologist.

DSK:AGK.AWK.MIP
30/9/63

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Schedule of Bores, Wells and Springs referred to in the Hydrological report of "The Great Australian Artesian Basin," - survey by D. Ker, Geologist.

(To accompany Report and Plan No.63-~~464~~ 392).

NAME OF BORE, etc.	LOCATION		PASTORAL STATION
	GRID.REF.	BORE NO.	
Anna Creek Bore (New)	H/4	56	Anna Creek Station
Anna Springs	H/4	36	Sturt's Creek Station
Beresford Springs	H/4	9	" " "
Bedouri Bore	F/4	127	Mabel Creek Station
Bell Bird Bore	E/4	1	" " "
Birthday Bore	G/5	278	Mt. Eba Station
Birthday Swamp Bore	F/4	148	Ingomar Station
Birthday Swamp Well	F/4	103	" "
Big Swamp Bore	F/3	34	Mt. Willoughby Station
Birdsville Township Bore, Queensland			Queensland
Box Bore	K/3	25	Moolawatana Station
Boomerang Bore	E/3	4	Mt. Willoughby Station
Boorloo Bore	J/4	74	Callanna Station
Boorloo Springs	J/4	73	" "
Boorthanna Bore	G/3	35	Nilpinna Station
Bore 2 miles south of New Year Well 4 Bore	G/4	53	McDouall Peak Stn.
Bore (One of Three Bores)	G/4	38	Balta Baltanna Blk.
Bore (One of Three Bores)	G/4	39	" " "
Bore (One of Three Bores)	G/4	40	" " "
Boundary Bore	K/4	83	Murnpeowie Station
Branson's Bore	J/4	9	St.Stephens Ponds Stn.
Bucklands Bore (New)	G/5	264	Mt. Eba Station
Bulgunnia H/stead Well	F/5	101	Bulgunnia Station
Bull Paddock Springs	I/4	48	Stuarts Creek Station

NAME OF BORE etc.	LOCATION		PASTORAL STATION
	GRID.REF.	BORE NO.	
Burntiltably Bore	F/4	102	Ingomar Station
Butchers Well	H/5	31	Parakylia Station
Callamma Bore	I/4	26	Callamma Station
Campfire Swamp Springs or Billa Kalina Springs	H/4	20	Mudla Blk. Station
Catt Springs	K/4	18 & 19	Murnpeowie Stn.
Cavanaugh Well	G/5	36	Mt. Eba Stn.
Cavanaugh Bore	G/5	274	" " "
Charles Angus Bore	I/4	18	Finnies Springs Stn.
Chimney Springs	K/4	21	Murnpeowie Stn.
Clark's Bore	J/4	65	Mundowdna Stn.
Clay Pan	G/5	356	Miller's Creek Stn.
Clayton Bore	J/53	2	Peacharwarinna Stn.
Clayton Dam Bore	J/4	35	Murnpeowie Stn.
Clean Skin Swamp Bore No. 2	F/4	8	Mabel Creek Stn.
Clemen's Bore	G/5	211	Mt. Vivian Stn.
Coolingee Bore	F/4	167	Ingomo Stn.
Coonanna Bore	L/4	7	Tilcha Stn.
Coorie Appie Bore	H/4	21	Mudla Blk. Stn.
Cooryann Bore	I/4	25	Callanna Stn.
Corkscrew Bore	G/5	277	Mt. Eba Stn.
Coronation Bore	F/4	10	Mable Creek Stn.
Culberta Bore	L/5	19	Quinyambie Stn.
C.B. Bore	F/5	35	Mt. Willoughby Stn.
Davenport Springs	I/4	44	Finnies Springs Stn.
Dulkaninna Bore	J/4	4	Dulkaninna Stn.
East Wells	H/5	92 & 93	Coondambo Stn.
Fossils Bore	L/4	10	Woolatchi Stn.
Four Mile Bore	J/4	26	Mundowdna Stn.
Francis Swamp	H/4	3	Anna Creek Stn.
Fred Springs	I/4	12	Stuarts Creek Stn.

NAME OF BORE etc.	LOCATION		PASTORAL STATION
	GRID REF.	BORE NO.	
Giddi Giddinna Springs	G/3	41	Anna Creek Stn.
Giffen's Bore	F/5	96	Bulgunnia Stn.
Gendaloo Bore	G/5	265	Mt. Eba Stn.
Gerden's Corner Bore	E/3	1	Mabel Creek Stn.
Geese Springs Bore	I/4	14	Finnies Springs Stn.
Goyders Lagoon Bore	J/2	1	Clifton Hills Stn.
Greenfield's Bore	H/4	43	Mudla Blk. Stn.
Gunpowder Bore	K/4	50	Moolawatana Stn.
Halfway Bore (between Sturt's Ck. H/Stead & Curdimurka Rly.Stn.	I/4	47	Stuarts Creek Stn.
Homestead Bore	G/5	258	The Twins Stn.
Homestead Bore (abandoned)	G/5	259	The Twins Stn.
Homestead Well (Finnis Springs Stn.)	I/4	45	Finnis Springs Stn.
Horse Bore	G/4	16	The Twins Stn.
Innamincka Oil Bore No.1	L/2	11	Innamincka Stn.
Jacob's Bore	G/4	10	The Twins Stn.
Johnson Bore	H/4	42	Mudla Blk. Stn.
Kopperamanna Bore (New)	J/3	8	Kopperamanna Stn.
Kopperamanna Bore (Old)	J/3	9	" "
600' Hole Sth of Kunloth's Dam	H/4	58	Anna Creek Stn.
Lake Billy Bore	J/4	21	Mundowdna Stn.
Lake Cadibarrawirracanna Springs	G/3	42	Anna Creek Stn.
Lake Crossing Bore	K/4	25	Murnpeowie Stn.
Lake Harry Bore	J/4	7	Lake Harry Stn.
Lake Phillipson Bore	F/4	42	Mabel Creek Stn.
Leak's Bore (New)	G/5	338	Bon Bon Stn.
Leak's Bore (Old)	G/5	160	Bon Bon Stn.
Leslies Bore	F/3	32	Mt. Willoughby Stn.
Lewis Bore	F/5	92	Bulgunnia Stn.
Lock's Well	H/5	33	Parakylia Stn.
Lygnum New Bore	K/4	72	Murnpeowie Stn.

NAME OF BORE etc.	LOCATION		PASTORAL STATION
	GRID REF.	BORE NO.	
Lygnum Old Bore	K/4	28	Murnpeowie Stn.
Margaret Creek Bore	H/4	19	Mudla Blk Stn.
Mark's Bore	K/4	56	Moolawatana Stn.
Matheson's Bore	F/3	36	Mt.Willoughby Stn.
Mentor Well	F/5	131	Wilgena Stn.
Meteor Bore	K/4	9	Murnpeowie Stn.
Montecollinna Bore	K/4	3	Adjacent Murnpeowie Stn.
Mookawarinna Bore	J/4	40	Murnpeowie Stn.
Moolawatanna No.2 Bore	L/5	6	Muloowurtina Stn.
Morris Creek Bore	I/4	17	Finnis Springs Stn.
Mound Springs (edge of Lake Callabonna)	K/4	32	Woolatchi Stn.
Mt. Clarence Homestead Bore	F/3	13	Mt. Clarence Stn.
Mt. Gason Bore	J/2	2	Clifton Hills Stn.
Mt. Hopeless Bore (New)	K/4	59	Murnpeowie Stn.
Mt. Hopeless Bore (Old)	K/4	24	" "
Mudla Bore	H/4	39	Miller's Creek Stn.
Mulka Bore	J/3	6	Mulka Stn.
Neds Bore	K/5	135	Moolawatana Stn.
New Year Bore	G/4	49	McDouall Peak Stn.
New Year Gift Bore	I/4	13	Stuarts Creek Stn.
New Bore	K/5	26	Moolawatana Stn.
Nickells Well	G/4	41	Miller's Creek Stn.
North Jacob's Bore	F/4	170	McDouall Peak Stn.
Nun's Bore	F/4	120	" " "
No. 12 Bore	G/4	31	Miller's Creek Stn.
No. 17 Bore	G/5	175	" " "
Paragon Bore	E/3	2	Mabel Creek Stn.
Patchawarra Bore (New)	L/2	8	Innamincka Stn.
Patchawarra Bore (Old)	L/2	9	" "
Peak Old Bore	G/4	50	McDouall Peak Stn.
Petermorro Bore	K/4	23	Murnpeowie Stn.

NAME OF BORE etc.	LOCATION		PASTORAL STATION
	GRID REF.	BORE NO.	
Pflaum's Bore	F/4	125	Mabel Creek Stn.
Poorèmingie Bore	F/3	31	Mt. Willoughby Stn.
Quartpot Bore	K/4	17	Murnpeowie Stn.
Quarry Bore	G/5	372	Bulgunnia Stn.
Raspberry Creek Bore	G/3	1	Mt. Barry Stn.
Red Banks Bore	K/4	8	Murnpeowie Stn.
Roberts Well	F/4	121	McDonall Peak Stn.
Rock Hill Bore	F/3	22	Mt. Clarence Stn.
Sabrina Bore	F/3	24	Adjacent Mt.Clarence Stn
Sandy Creek Failure Bore	J/4	10	Mundowdna Stn.
Salty Bore	F/4	43	Mt. Clarence Stn.
Skelton Bore	K/4	34	Woolatchi Stn.
Smith's Springs Bore	I/4	15	Finniss Springs Stn.
Southern Cross Bore	F/4	179	Mabel Creek Stn.
Stern's Bore	G/5	357	Miller's Creek Stn.
Sturts Range No.1 Bore	F/3	26	Mt.Clarence Stn.
Sturts Range No.2 Bore	F/3	27	Adjacent Mt.Clarence Stn
Tee Tree Well	F/4	104	Ingomar Stn.
Tilcha Old Bore	L/4	5	Tilcha Stn.
Two Bores Sth. of Sturts Creek H/Stead	H/5	100 & 101	Stuarts Creek Stn.
Venable Springs Bore	I/4	24	Finniss Springs Stn.
Wangranna Springs	I/4	28	Callanna Stn.
Warragarrana Springs	G/3	31	Nilpinna Stn.
Welcome Springs	I/4	27	Callanna Stn.
Well Creek Bore	J/4	20	Mundowdna Stn.
Whymlett Well	G/5	64	Wilgena Stn.
Willow Bore	F/3	28	Mt. Clarence Stn.
Wirringinna Springs	J/4	66	Mundowdna Stn.
Woolatchie Bore	K/4	33	Woolatchi Stn.
Yerilla Bore	K/4	26	Murnpeowie Stn.

"GREAT AUSTRALIAN ARTESIAN BASIN" SURVEY

SCHEDULE OF BORE AND WELL SPOIL SAMPLES OBTAINED BY D. KER DURING RECENT FIELD SURVEYS

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	FIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
E/3	(28°-29° 133°-134°)	2	Paragon Bore	4	203	F12/63	
		4	Boomerang Bore	4	239		
"	"	6	Watchercallen Bore	4	205	F11/63	
E/4	(29°-30°	1	Bell Bird Bore	4	213		
"	133°-134°)	2	Corkscrew Bore	4	212	F13/63	
F/2	(27°-28°	9	Timothy Bore	4	254	F16/63	
"	134°-135°)	8	Patricia Bore	4	248	F15/63	
"	"	5	No. 2 Bore (Copper Hill Stn.)	4	258	F14/63	
F/3	(28°-29°	6	No. 3 Bore	4	201		
"	134°-135°)	10	No. 5 Bore	4	197	F17/63	
"	"	14	Mt. Clarence H/B (Deep Bore)	4	186	F18/63	
"	"	18	Sputnick Bore	4	174	F19/63	
"	"	20	No. 4 Bore	4	184		
"	"	31	Poorawingie	4	232	F20/63	
"	"	35	C.B. Bore	4	237		
"	"	34	Big Swamp Bore	4	238		
"	"	40	Giddy Giddina Bore	4	212	F21/63	
"	"	32	Lealey's Bore	4	231	F22/63	
"	"	44	Craigs Bore	4	210	F23/63	
"	"	45	West Point Bore	4	209	F24/63(A) F25/63(B)	
"	"	56	Hard Rock Bore	4	233		
"	"	58	Broken Bit Bore	4	235	F26/63	
"	"	47	Dead Finish Bore	4	244	F27/63	
"	"	52	Bridget Bore	4	251	F28/63	
"	"	16	Yellow Bulluch Bore	4	188	F29/63	
"	"	29	Willow No. 3 Bore	4	172	F30/63	
"	"	41	Abandoned Bore H/B	4	195	F31/63	
F/4	(29°-30°	129	Box Hole Bore	4	177	F53/63	
	134°-135°)	131	Abandoned Bore	4	180	F51/63	
"	"	12	Abandoned Bore	4	219	F52/63) F57/63)	Green Sand Blue Shale
"	"	38	Abandoned Bore	4	221	F55/63	
"	"	4	No. 2 Bore	4	222	F56/63	
"	"	166	Darbies Bore	4	119		
"	"	152	Abandoned Well	4	151	F50/63	
"	"	136	" "	4	161		
"	"	11		4	220	F54/63	

MAP LOCATION		BORE REF. NO.	NAME OF BORE OF WELL ETC.	FIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
F/4	(29°-30° / 134°-135°)	3	Aband. Bedoura Bore	4	225	F32/63	
"	"	130	Abend. Bore	4	179	F49/63	
"	"	135	Abend. Bore	4	162	F48/63	
"	"	147	Abend. Bore	4	149	F47/63	
"	"	180	Ping Pong Bore	4	226	F46/63	
F/5	(30°-31° / 134°-135°)	76	Shallow abend. Bore	4	74		
"	"	93	Glynn Bore	4	87	F61/63	
"	"	75	Abend. Bore	4	74	F60/63	
"	"	94	Bertabyng Well	4	85	F59/63	
"	"	133	New Bore East 34 Pdk.	4	24	F58/63	
G/4	(29°-30° / 135°-136°)	12	DofWks. Miriniti	2	262	F69/63	
"	"	15	Darbies Bore	2	265	F71/63	
"	"	18	Coronation Bore	2	269	F70/63	
"	"	34	No. 6 Bore	3	112	F67/63	
"	"	42	Blue Duck Well	3	116	F72/63	
"	"	26	Beetrem Downs No. 1	3	117	F68/63	
"	"	60	Pagna Well No. 2	5	10	F73/63	
"	"	7	New Year Well	4	113	F64/73	
"	"	30	Beetrem Downs No. 4 Bore	3	115A	F65/63	
"	"	32	No. 15 Bore	3	119	F66/63	
"	"	45	Abend. Well	4	150	F63/63	
"	"	53	New Bore	4	111	F62/63	
G/5	(30°-31° / 135°-136°)	211	Clemen's Bore	3	21	F96/63	
"	"	274	Cavanaugh Bore(2)	2	224	F90/63	
"	"	278	Birthday Bore	2	231	F91/63	
"	"	253	Backlands Bore(Old)	2	251	F100/63	
"	"	264	Backlands Bore(New)	2	250	F87/63	
"	"	265	Abend. Gondalloo Bore (Old)	2	247	F88/63	
"	"	279	Buckley Bore	2	239	F92/63	
"	"	61	Abandoned Bore	2	239	F94/63	
"	"	57	Paisley Well	2	242	F109/63	
"	"	56	Russell Bore	2	245	F101/63	
"	"	40	Gondalloo Bore(New)	2	249	F93/63	
"	"	257	Banjo Bore	2	266	F89/63	
"	"	258	Twins Stn. Bore	2	271	F108/63	
"	"	14	Nth. Twins Old Well	2	272		
"	"	191	Bore No. 2	3	3	F107/63	
"	"	310	"	3	4A		
"	"	309	"	3	4		
"	"	308	"	3	5A	F106/63	
"	"	181	Abandoned Bore(Nth. Vivian Well Hut)	3	5	F95/63	

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	YIELD LEDGER REF.		PALARO. SAMPLE NO.	REMARKS
Grid Ref.	Lat, Long.			Book No.	Page No.		
G/3	(30°-31° / 135°-136°)	297	Abandoned Bore	3	6	P105/63	
"		305	" "	3	8		
"		315	Abandoned Bore	3	9A	P103/63	
"	"	317	Deep Bore	3	9	P99/63	
"	"	314	Abandoned Bore	3	10	P104/63	
"	"	215	Abandoned Bore	3	12A		
"	"	293	Bore	3	12		
"	"	295	Adj. to Pyramid Bore	3	16	P98/63	
"	"	221	Karona Bore	3	17		
"	"	294	Klan's Bore	3	18A		
"	"	220	McCalthey Bore	3	20		
"	"	292	Nth. of McCalthey Bore	3	21A		
"	"	210	Rankin Bore	3	22A		
"	"	202	Hudson Well	3	22		
"	"	237	Abandoned Well (McKinnon's Dam)	3	70	P85/63	
"	"	200	Fishe's Well & Bore	3	23A		
"	"	198	Sth. Vivian Bore	3	23		
"	"	290	Swamps Well	3	24A		
"	"	291	Sister's Bore	3	25A		
"	"	206	North Well	3	25		
"	"	212	Willow Well	3	26A		
"	"	204	Southern Cross Well	3	27	P110/63	
"	"	187	Virjilpin Bore	3	29A(?)		
"	"	177	Bluff Paddock Bore	3	31A	P97/63	
"	"	154	Sludge	3	32A	P86/63	
"	"	?	Police Camp Paddock	3	33	P102/63	
"	"	17	Crombie's Bore	2	95	P111/63	
"	"	19	Bald Hill Salt Bore	2	201	P112/63	
"	"	24	Jacob's Bore	2	227	P113/63	
"	"	26	Sundown Bore	2	228	P114/63	
"	"	27	Mintabyng Bore	2	229	P115/63	
"	"	28	Cheadles Bore	2	230	P116/63	
"	"	57	Laurie Hill Bore	-	-	P117/63	

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	FIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
G/5	(Lat. 30°-31° Long. 135°-136°)	53	Central Bore	2	237	F118/63	
"	"	55	Corkscrew Well	2	233	F119/63	
"	"	62	No. 1 Pd'k Bore	4	14	F120/63	
"	"	255	Dump Bore	3	80A	F121/63	
"	"	259	Twins N/S Bores	2	273	F122/63	
"	"	261	Abandoned Bore	2	197	F123/63	
"	"	262	Matheson's Bore	2	204	F124/63	
"	"	263	New Saltash Bore	2	199	F125/63	
"	"	269	Paisley Bore	2	243	F126/63	
"	"	272	Boolka Bore	2	226	F127/63	
"	"	273	Cavanagh's Bore(1)	2	225	F128/63	
"	"	349	Mungillio Bore	3	91	F129/63	
"	"	356	Claypan Bore	3	114	F130/63	
"	"	357	Sloem's Bore	3	114A	F131/63	
"	"	358	No. 17 Bore	3	111A	F132/63	
"	"	359	Aband. Bore	3	110	F133/63	
G/6	(31°-32° 135°-136°)	8	Two Wells	3	60A		
H/5	(28°-29° 136°-137°)	48	Stn. Well	4	262		
"		57	Cormies Bore	4	266	F36/63	
"	"	53	No. 4 Bore on Umbum Ck.	4	268	F35/63	
"	"	54	Sunny Crk. Bore	4	273	F33/63	
"	"	58	Nancy Bore	4	276	F34/63	
H/4	(29°-30° 136°-137°)	11	Welcome Bore	2	178		
"	"	58	600' Hole Sth. of Kunoth Dam	4	284	F75/63	
"	"	41	Willow Bore	3	118	F71/63	
"	"	29	No. 7 Bore	3	120A	F76/63	
"	"	48	Abandoned Bore	3	125	F79/63	
"	"	27	Crown Wells	3	133	F78/63	
"	"	50	No. 8 Watercourse Bore	3	135A	F74/63	
"	"	60	One Tree Bore	5	7	F37/63	
"	"	64	Aband. Bore on Terpena Ck.	5	6	F38/63 F39/63	

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	YIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
H/4	(29°-30° / 136°-137°)	38	Coward Springs	2	172	F124/62	
"	"	28	5 Mile Well	3	125	F80/63	
"	"	33	No. 1 Bore	3	122	F81/63	
"	"	51	H/Stn. Bores (Billa Kalina)	3	133A	F82/63	
"	"	53	Abandoned Well	3	131	F83/63	
"	"	54	Abandoned Bore(1)	3	129	F84/63	
H/5	(30°-31° / 136°-137°)	101	Sth. of Start Crk. H/Stn.	2	163	F126/62	
"	"	33	Lock's Well	3	100A		
"	"	31	Butcher's Well	3	98		
"	"	3	Woodlampie Bore	3	106	F134/63	
"	"	1	No. 8 Bore	3	107		
"	"	110	Abandoned Bore	3	130	F136/63	
"	"	7	Night March Bore	3	131A	F135/63	
"	"	9	Cuddlewiddy? Well	3	135		
"	"	107	No. 8 Bore	3	107	F137/63	
"	"	108	No. 20 Bore Sludge	3	109A	F138/63	
"	"	109	Aband. Bore	3	130A	F139/63	
"	"	111	Woodamulla Bore	3	132	F140/63	
I/4	(29°-30° / 137°-138°)	11	Jacob's Well Spring & Bore	2	174		
"	"	12	Fred Springs	2	175	F110/62	
"	"	14	Goose Springs Bore	2	156	F107/62	
"	"	19	Finnis Bore	2	148	F106/62	
"	"	24	Venable Bore	2	147		
"	"	28	Wangeanna Springs	2	139	F99/62	
"	"	48	Bull Pd'k. Spring & Bore	2	161	(F115/62) (F114/62)	
"	"	49	Walgarina Spring	2	164	F113/62	
J/2	(27°-28° / 138°-139°)	10	Abandoned Bore	3	46	F40/63	
"	"	13	Aband. Dry Bore	3	48A	F41/63	
"	"	15	Twins Wells, Well	3	49	F42/63	

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	FIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
J/3	(28°-29° 138°-139°)	10	Ntaduma Well	3	129		
"	"	13	Koppercamanna Mission	3	48A		
"	"	23	Apatcongannie Well	3	41A	PA3/63	
J/4	(29°-30° 138°-139°)	3	Tarkaninna Well & Bore	2	111	P81/62	
"	"	25	H/Stead Spring	2	95		
"	"	41	Hagan's Well	2	87	P97/62	
"	"	42	Old Well	2	81	P79/62	
"	"	48	Apollinna Well	2	64		
"	"	61	Mulga Bore	2	56		
"	"	64	Hanley's Well	2	84	P96/62	
"	"	68	Peachawarrinna Bore & Well	2	107	P78/62	
"	"	71	Bore	2	126		
"	"	73	Beerloo Springs	2	134		
"	"	67	White Well	2	101		
"	"	11	Bore 4 Miles N-W of Marree	2	130		
J/5	(30°-31° 138°-139°)	217	Maggie Pd'k. Bore	2	63	P93/62	
K/4	(29°-30° 139°-140°)	5	Toonootchen Bore	2	39	P48/62	
"	"	21	Chimney Springs	2	23		
"	"	33	Woolatchie Artesian Bore	1	264		
"	"	65	Woolatchie No. 1 Bore	1	265	P9/62	
"	"	67	Mulligan Bore	1	267		
"	"	72	Lignum Bore	2	22		
"	"	80	Bore on Emu Creek	2	44	P41/62	
"	"	81	Abend. Bore on Emu Ck.	2	45	P50/62	
"	"	82	Abend. Bore	2	59	P2/62	
"	"	76	Bore	2	35		
"	"	78	Bore	2	40	P51/62	
"	"	69	Yerila Bore	2	15		

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	FIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
K/4	(29°-30° 139°-140°)	75	Baldy or Black Water Springs	2	52	F44/62	
"	"	79	Mt. Springs (Lake Blanche)	2	42		
"	"	83	New Bore - Murnpeowie	2	75	F34/62	
"	"	66	Woolatchie New Bore	1	266	F6/62 @(100') F8/62 @(260')	
K/5	(30°-31° 139°-140°)	144	Shepherds Pd'k Bore	1	187	F14/62	
"	"	137	Paralana House Bore	1	197		
"	"	32	Yadglin Pd'k Bore	1	203	F23/62 F15/62	
K/6	(31°-32° 139°-140°)	13	Abandoned Bore	1	54	F70/61	
"	"	70	Nth.West Pd'k. Bore	1	73	F28/62	
"	"	22	Well in Creek Bed	1	75		
"	"	12	Bore - Millaroo West Stn.	1	91	F4/62	
"	"	11	Perseverance Bore	1	96	F25/62	
"	"	10	Beulah Bore	1	97	F13/62	
"	"	9	No. 4 Govt. Bore	1	102	F20/62	
"	"	55	McKenzie Bore	1	105	(F56/62) (F55/62)	
"	"	61	Bull Corner Bore	1	136		
"	"	77	Coffin Bore	1	157	(F21/62) (F3/62)	
"	"	93	Gravity Bore	1	161	F67/62	
"	"	94	Dry Well	1	162	F64/62	
"	"	96	Bore near Brenton Crk.	1	162		
"	"	80A	Red Banks New Bore	1	147	F142/63) Sands	
"	"	80A	" " " "	"	"	F143/63) Clay	
K/6 Co.Derby	(31°-32° 139°-140°)	9	Drennan's No. 2	3	53A	F141/63	
"	"	74	Lake Ashby Bore	1	28	F64/61	
"	"	25	Toolaby Bore	1	62		
"	"	78	Muntering Pd'k.Bore	1	64		

MAP LOCATION		BORE REF. NO.	NAME OF BORE OR WELL ETC.	YIELD LEDGER REF.		PALAEO. SAMPLE NO.	REMARKS
Grid Ref.	Lat. Long.			Book No.	Page No.		
L/5	(30°-31° 140°-141°)	20	Kelly's Bore	2	13	F10/62	
L/6	(31°-32° 140°-141°)	13	Catch & Trial Bore	1	4	F60,65, 66/61.	
"	"	73	Furlough Bore No.4	1	18	F62/61	
"	"	25	Pioneer Bore	1	92	F18/62	
"	"	24	Confidence Bore	1	93	F26/62	
"	"	69	Lucky Hit Bore	1	95	F12/62	
Surface Spoil Samples from Dams & Outcrops etc., not plotted							
		-	½ mile SSW of Nunyerenie H/S (Shale)			F44/63	
		-	4 miles N.East Giddi Giddina Bore on Mt. Clarence			F45/63	
			Brennan's Dam Spoil - Billa Kalina Stn.			F144/63	
			Paleo. No. 1 Sample - Billa Kalina Stn.			F145/63	
			Billa Kalina H/Station Dam Spoil			F146/63	
			Rankin's Dam Spoil - Lake Phillipson Blk.			F147/63	

PLATE 1

The Diamentina River in flood at Birdsville, Queensland, indicating potential intake to shallow aquifers.

PLATE 2

Cross bedded quartzite boulder erratic in pallid weathered Cretaceous clay shale. Gosses Range, Ben Ben Station.

PLATE 3

Reedy Springs near Blanchewater Murnpeowie Station Springs at Tertiary - Cretaceous interface.

PLATE 4

Public House Springs Murnpeowie Station. Blythesdale sandstones on right gently dipping to the north, and outcropping against Precambrian rocks on left Northern Flinders Ranges.

PLATE 5

Blanchecup Mound Spring near Coward Springs

PLATE 6

Coward Springs railway bore with casing completely eroded and disappeared. Bore continues to flow as a natural spring.

PLATE 7

Cooryanna Bore Murnpeowie Station.
Temp. 133° +F. Approx. flow 1 mill. gals/day
Water to depth 6-8 ft. around corroded borehead.

PLATE 8

Jewellery Bore Murnpeowie Station. Originally flowed at 1¼ mill. gals/day - now at 450 gals/hr. due to blockage. Note quagmire conditions around poorly drained bore head.

PLATE 9

Meteor Bore Murnpeowie Station. Note - no bore head at all hence no possible flow control, and pressure leakage in subsurface casing causing swamp conditions.

PLATE 10

Kepperamanna Old Bore, Etadunna Station. Bore ceased to flow until new bore was drilled close by when flow was restored. Note lack of maintenance to borehead.

PLATE 11

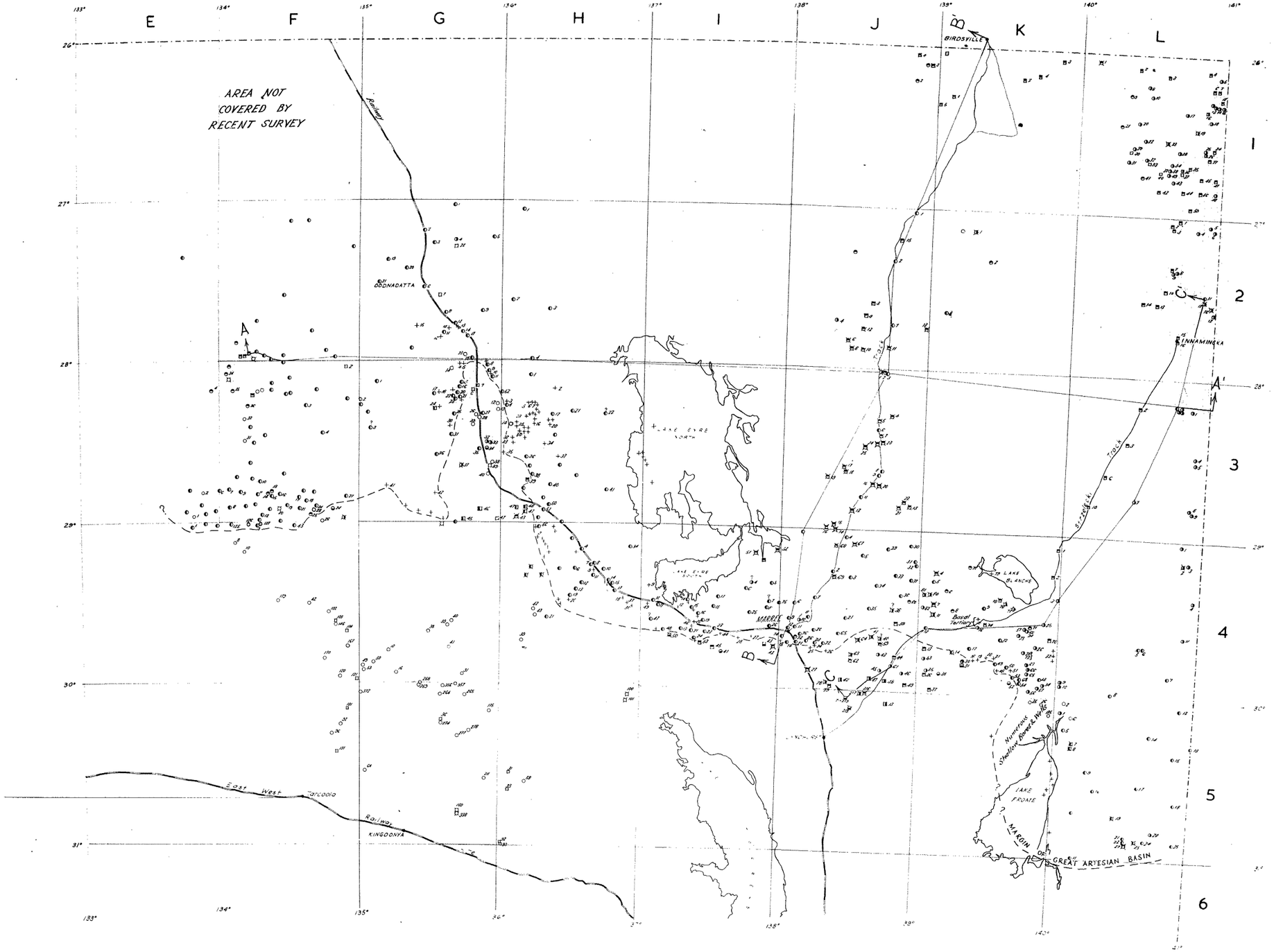
Crows Nest bore Muloorina Station showing further disregard for the preservation of casing against undue corrosion.

PLATE 12

Big Lake Lotty Bore was used to generate electricity Used to water over 400 sq. miles of country.

PLATE 13

Mungeranie Bore, Birdsville track stock route bore. Showing provision on borehead which could be used in pressure test measurements. A typical double gate artesian bore head.



SCALE

MILES 20 10 0 20 40 60 80 100 MILES

LEGEND

Spring or Mound Spring	+	Blythesdale
Bore or Well	● ■	Blythesdale Aquifer
" " "	● ■	Cretaceous - Recent Aquifer - probably Regional
" " "	● ■	Recent - Soakages - not Regional
" " "	● ■	Hard Basement Aquifer
" " "	○ □	Aquifer - type not known
" " "	⊠ ⊠	Abandoned
" " "	○17 □18	With Grid Reference where currently allocated
A ——	—— A'	Section Line

To accompany report by D.Mer.

S.A. DEPT. OF MINES

GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA

BORE LOCATION & AQUIFER CLASSIFICATION PLAN

Associated Drawing No. | No. Amendment Exd. Date

Req. No.
D.M.
Compiled from

Approved Passed

Director of Mines

Drn
Tcd
Chd
Exd.

Scale 20 miles to 1 inch.

63-392
BC

Date 26-3-63

E F G H I J K L

133° 134° 135° 136° 137° 138° 139° 140° 141°

26° 27° 28° 29° 30° 31°

1 2 3 4 5 6

AREA NOT COVERED BY RECENT SURVEY

BIRDSVILLE

INNAMINCKA

MARREE

LYNDHURST

OODNADATTA

DEEP PRESSURE WATER

LAKE EYRE NORTH

LAKE EYRE SOUTH

LAKE BLANCHE

LAKE GREGORY

LAKE FROME

Birdsville Track

Strzelecki Track

Useful Shallow Waters

Useful Suspended Aquifers With Stock Waters

Poor Stock Waters

Some Potable Wells

Useful Stock Shallow Waters

Frome Embayment See Previous Report

UNTESTED

Shallow Cretaceous Local Intake Occasional Potable Water

Low Pressure Blythesdale Stock Quality Water

Low Pressure Blythesdale Water Stock Quality

Good Stock Water ?

Saline Blythesdale

Occasional shallow Stock Water Local intake in Blythesdale Sands

Saline Area

Saline Shallow Permian

Saline

Local Potable Water in Shallow Granite Hollows

Stock Water

Saline (Permian?)

Stock Cretaceous Water Poor-Saline Blythesdale

Locally Potable

Shallow Bedrock

Shallow Residual Grits

Good Stock Waters in unconfined Grits

Shallow Hard Rock Basement

Local Intake Variable Quality Waters

Shallow Hard Rock Basement

Local Potable Water in Shallow Subsurface Granite Hollows

East West Transcale

RAILWAY KINGOONYA

SCALE

Miles 20 0 20 40 60 80 100 Miles

LEGEND

- Edge Hydraulically Connected Artesian Basin Recommended Basin Margin.
- Cambrian – Precambrian Basement Rock Outcrops.
- Limits of subsidiary Basin Based on Shallow Occurrence of Residual Grits or Bedrock.
- Approximate Limit of Extent of occurrence of Blue Unweathered Cretaceous Shale in Bores.
- Approximate Limit of Pressure Water in Blythesdale Sands.
- Boundaries of Subsidiary or Suspended Basins.
- Original Accepted Boundary of Great Artesian Basin.

To accompany report by D. Ker.

S.A. DEPT. OF MINES

GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA SHOWING ADJACENT AND SUSPENDED BASINS

Associated Drawing	No.	No.	Amendment	Exd.	Date

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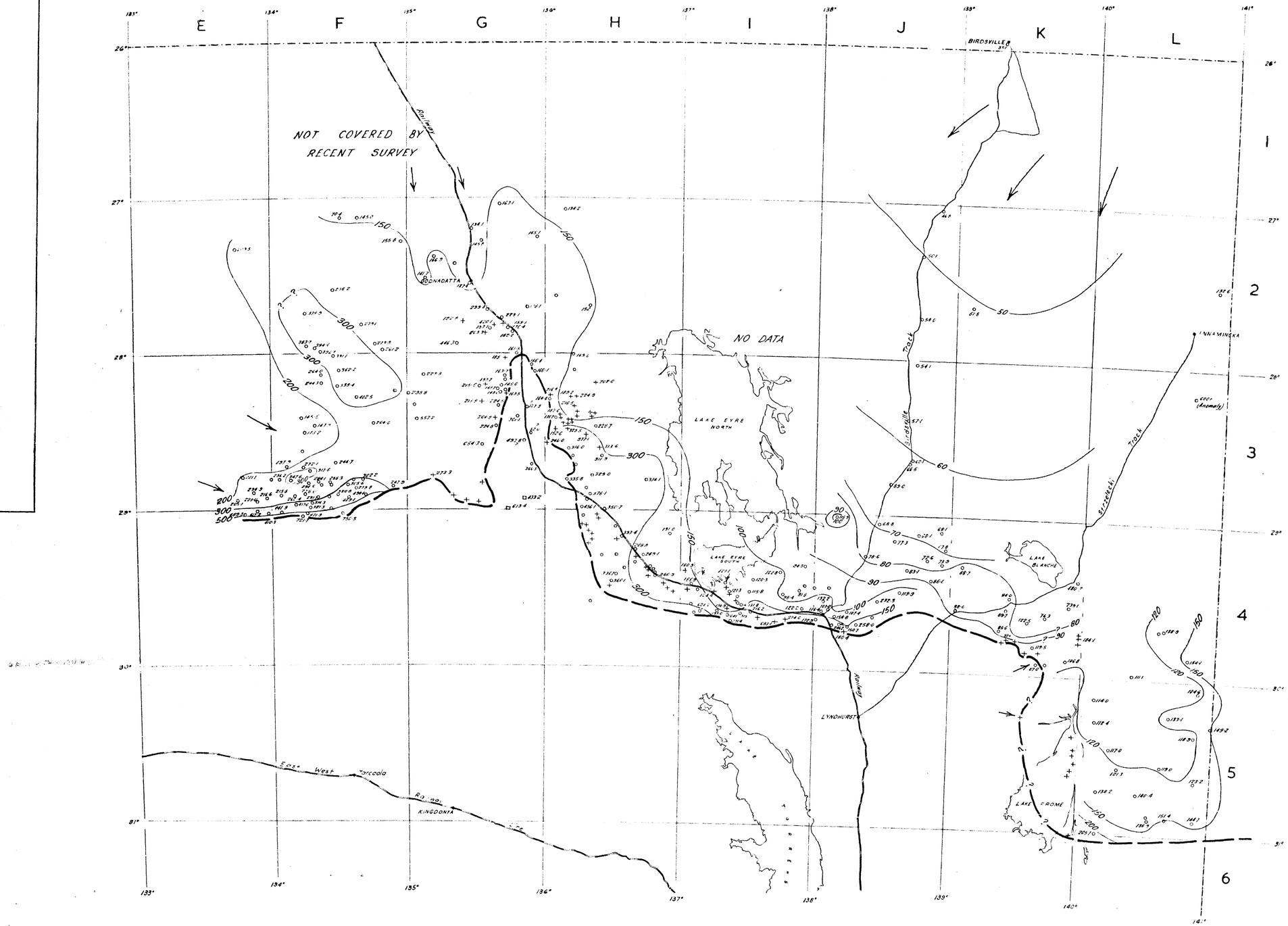
Exd

Scale: As above.
63-393
Date 26-3-63 B.C.



To accompany report by D Ker

S.A. DEPT. OF MINES

GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA
ISOHALSINE PLAN OF AREAS CONSIDERED
TO BE HYDRAULICALLY CONNECTED

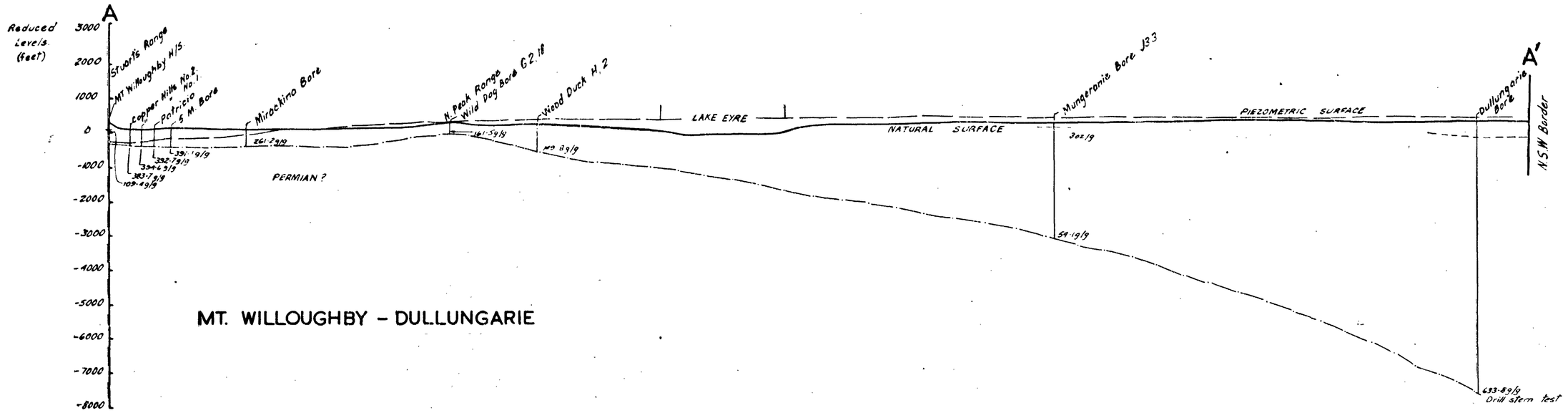
Req. No.
D.M.
Compiled from

Associated Drawing No. | No. Amendment Exd. Date

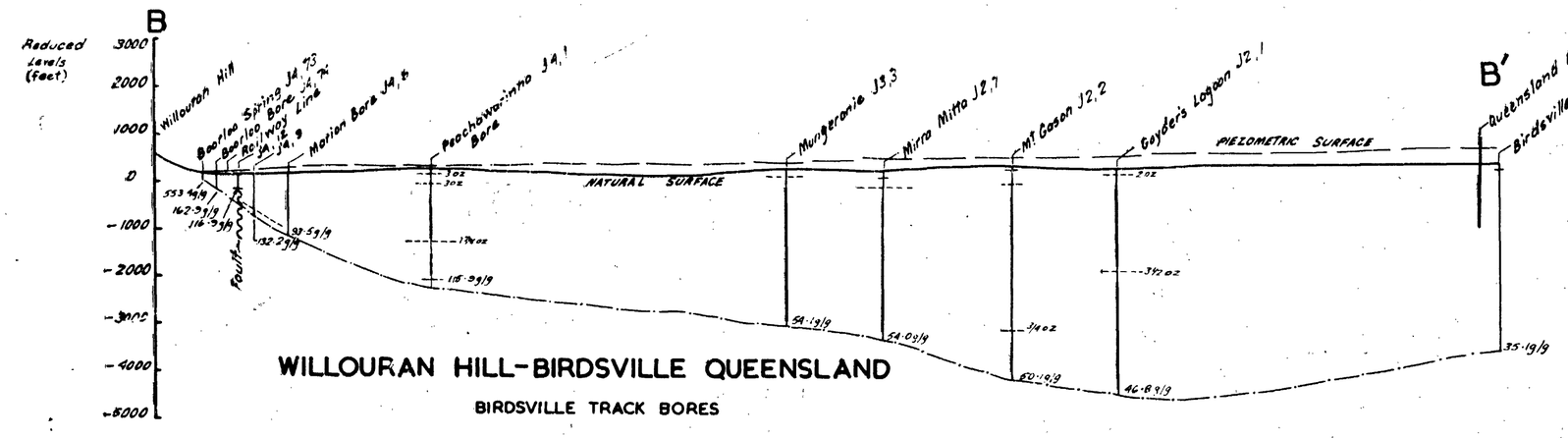
Approved Passed
Director of Mines

Drn.
Tcd. M&L
Ckd.
Exd.

Scale: 20 miles to 1 inch.
63-391
BC
Date 26 3 63

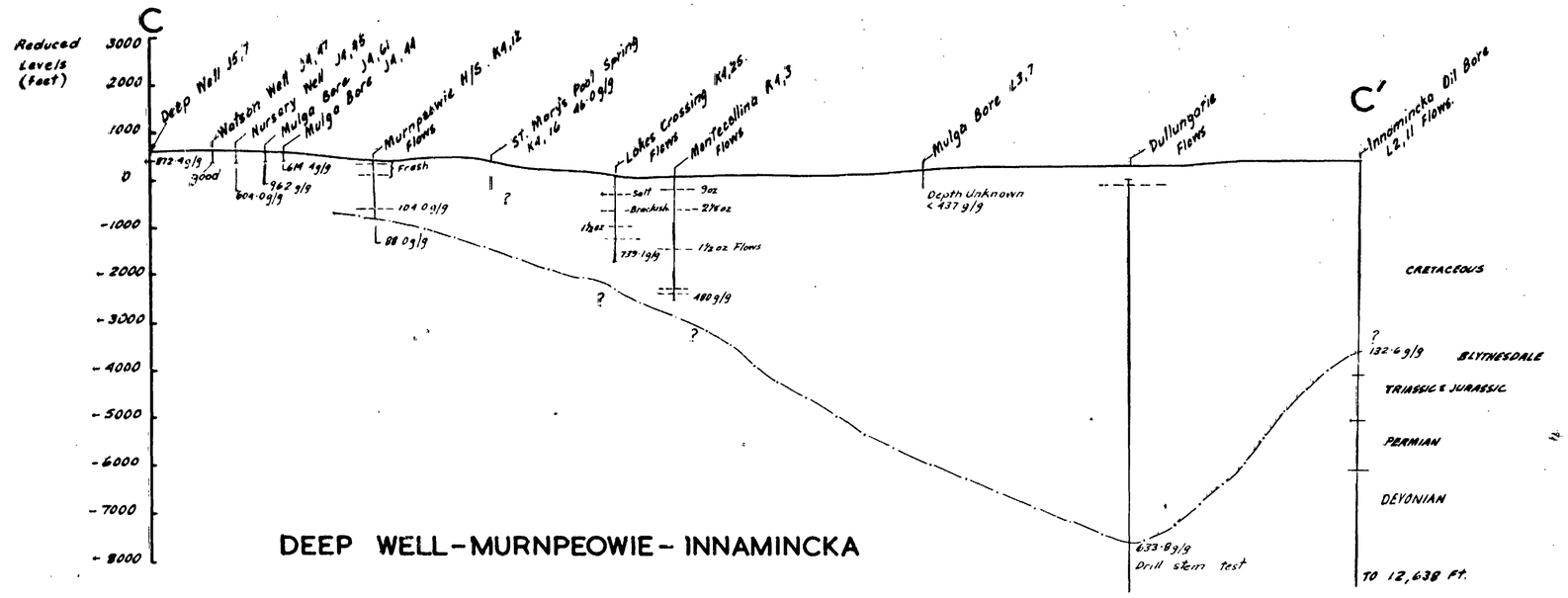


MT. WILLOUGHBY – DULLUNGARIE



WILLOURAN HILL-BIRDSVILLE QUEENSLAND

BIRDSVILLE TRACK BORES



DEEP WELL-MURNPEOWIE- INNAMINCKA

LEGEND

AQUIFERS

- – – Tertiary, Cretaceous Aquifer
- -·- Blythesdale Aquifer

GEOLOGY

- Weathered Cretaceous
- Cretaceous
- -·- Blythesdale
- Permian ?
- Precambrian

319·1 g/g = Salinity in grains/gallon.
N.B. No surface level control.

To accompany report by D. Ker.

S.A. DEPT. OF MINES

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA
CROSS SECTIONS A-A' B-B' C-C'

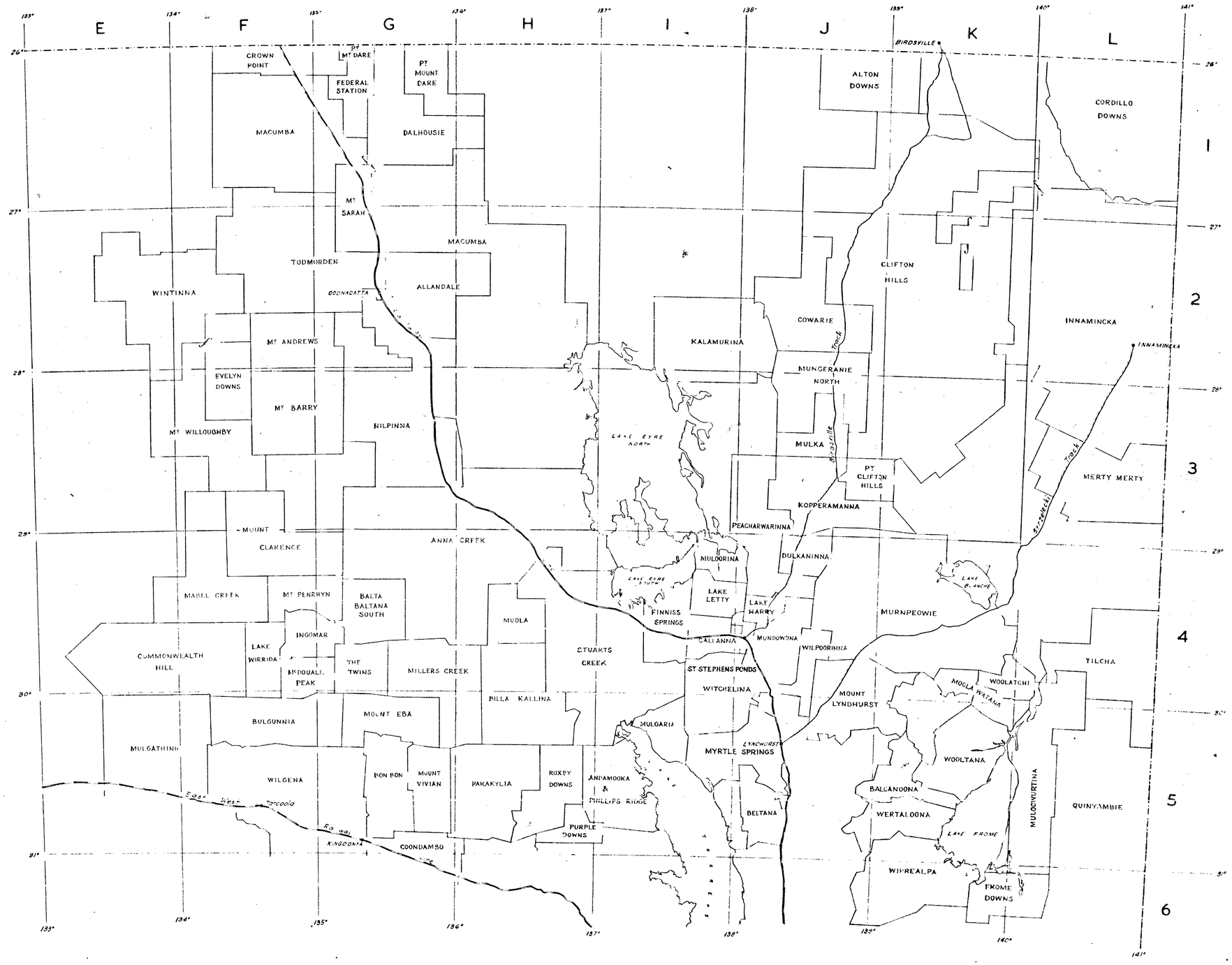
Approved	Passed	
Director of Mines		Drn. / Tcd. B.L.G. / Ckd. / Exd.

Scale : Hor 20 Miles to 1"

63-399

994·2/3

Date 28-3-63.



To accompany report by D. Ker.

S.A. DEPT. OF MINES

GREAT AUSTRALIAN ARTESIAN BASIN IN SOUTH AUSTRALIA

PLAN OF PASTORAL STATIONS

Req. No.
D.M
Compiled from

Associated Drawing No.

No. Amendment Exd. Date

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Director of Mines

Drn.
Tcd.
Ckd
Exd.

Scale: 20 miles to 1 inch

63-404
Bc
Date 29-3-63