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THE OCCURRENCES OF GROUNDWATER IN THE ALICE SPRINGS TOWN BASIN.

by

T.Quinlan and D.R.Woolley.

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THE OCCURRENCE OF GROUNDWATER IN THE ALICE SPRINGS TOWN BASIN

SUMMARY

The Alice Springs Town Basin is a small alluvial basin with a surface of approximately three square miles. It contains a maximum thickness of seventy-five feet of fluviatile sediment, deposited by the Todd and Charles Rivers.

The lithology of the sediments is correlated with their postulated environments of deposition. The environments are alluvial fan, main graded channels, levee banks, flood plains, and back swamps. The occurrence of groundwater in the various types of sediments is discussed.

Contour maps of the piezometric surface, have been constructed for October 1957 and October 1961. Within this period there has been a fall in the surface of between three and ten feet.

The interpretation of the results of aquifer performance tests on bores 28 and 110 gave mutually consistent values for the aquifer constants within the zones of high permeability. The average values are T = 20,000 gallons per day per foot and S = 0.05. The constants computed for the test on bore 59/11 are inconsistent with the assumption of an isotropic, homogeneous aquifer.

INTRODUCTION

The Alice Springs Town Basin is a small alluvial basin with a maximum depth of approximately 75 feet and a surface area of approximately three square miles. Groundwater is withdrawn from the basin to provide a town water supply. The present annual withdrawal is approximately 250 million gallons of which approximately 200 million gallons is withdrawn by the town supply bores.

The resident geologists were requested by the Commonwealth Department of Works, in September 1959, to provide geological assistance in a programme of test drilling, the construction of eight production bores, and in long term tests to determine the aquifer constants. This programme is now nearing completion.

PREVIOUS INVESTIGATIONS

Test drilling of the Town Basin was commenced by the Australian Army in 1943, and was continued by the Department of Works from 1953 to the present.

Geological and hydrological studies have been made by Owen (1952 and 1954) and Jones (1957). Seismic and resistivity surveys were made by Dyson and Wiebenga (1957). The results and the conclusions made from the 1956-7 programme of test drilling, aquifer performance tests and stream gauging by the Department of Works are given by Wilson (1958).

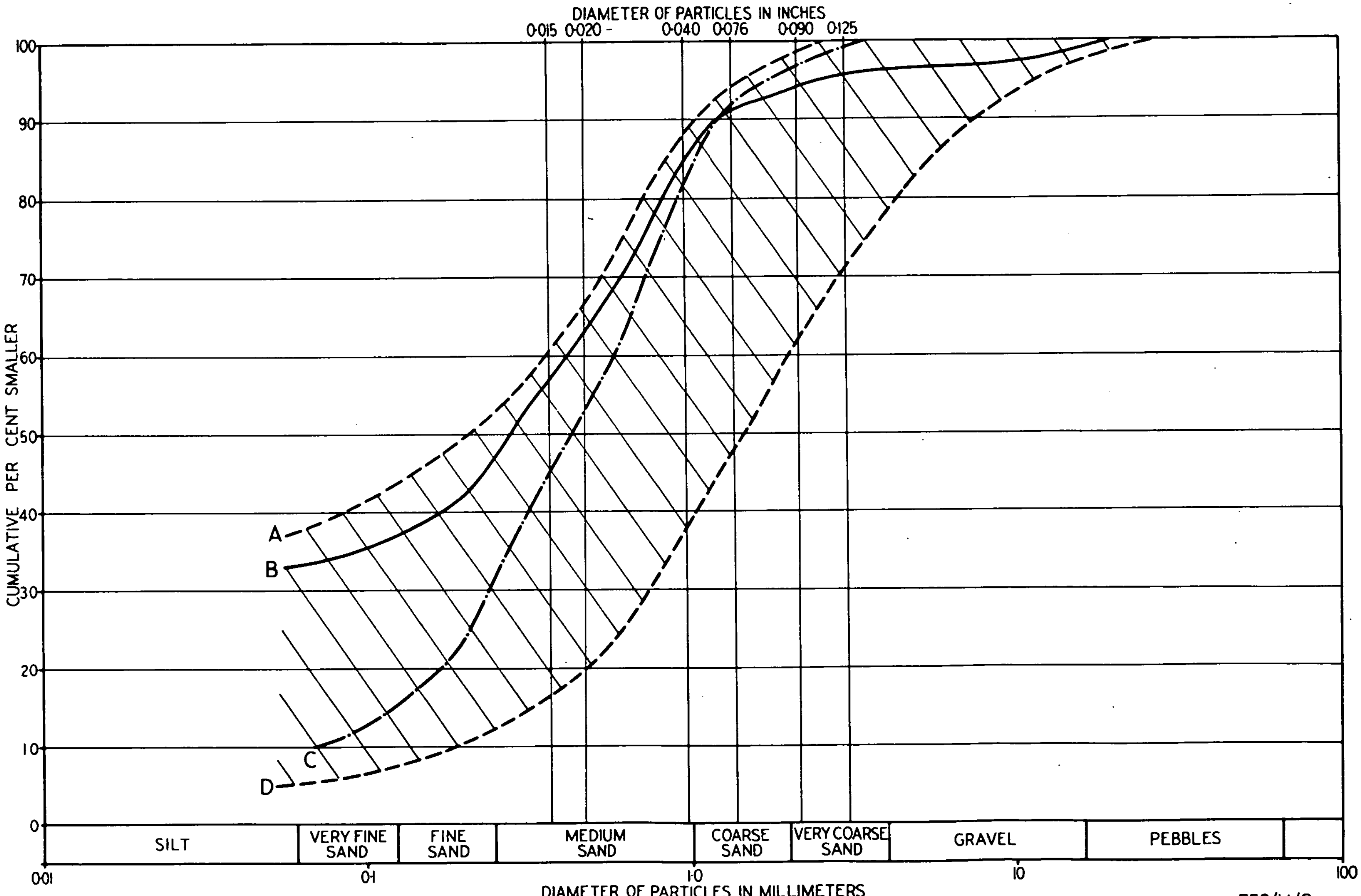

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Fig. 1 *Cumulative curves of size distribution by weight, illustrating textural character of the sand from bore 61/9 within the Alice Springs Town Basin. Curves A and D are the envelopes of size distribution curves. Curve B is a silty sand of low permeability at 19 feet. Curve C is a sand of good permeability at 18 feet.*

GEOLOGY

The fluviatile sediments of the Town Basin, which are thought to be of Pleistocene to Recent age, unconformably overlie metamorphic and igneous rocks of Precambrian age.

It is often difficult to determine the position of the contact between the alluvium and bedrock to the nearest two feet from bore samples. This is because of the presence of a regolith on the surface of the Precambrian rocks.

METAMORPHIC AND IGNEOUS ROCKS

The bedrock of the Town Basin consists of schist, gneiss, and granite, which have been intruded by dolerite and pegmatite dykes. These rocks form part of the Arunta Complex (Joklik, 1955) and are all of Precambrian age. Around the margin of the basin, the predominant trend of the foliation is north-west, although locally this trend is disturbed by minor folds and by faulting. The trend of the foliation is reflected in the trend of the bedrock "highs" within the basin (Plate 1).

SEDIMENTS

It is difficult to establish the stratigraphic succession in alluvium because of difficulty in correlating from bore to bore. This is because of the irregular shape of individual lithological units and because sudden changes in the channel of a river result in a cut and fill structure.

The fluviatile sediments consist of a mixture of detrital particles of gravel, sand, silt, and clay sizes. They can be divided into five main textural types.

1. Brown sand.
2. Brown and grey clayey sand.
3. Brown and grey silt and clay.
4. Regolith.
5. Colluvium.

The lithology of these units is discussed below:-

Brown Sand

The sieve analyses (Figure 1) show that the sand contains material from almost all grain size classes. Quartz is the dominant mineral, but some of the beds contain sufficient feldspar grains to warrant the use of the term arkose. Fragments of gneiss and schist as well as quartz aggregates are common; they range from sand to boulder size. The silt fraction consists mainly of quartz and mica. The sieve analyses of samples taken from closely spaced intervals in one bore show differences in the degree of sorting (figure 1) This is probably a reflection of the thin bedding (6 to 12 inches) in the sediments.

Test drilling has shown the beds of sand to be long, narrow bodies with a lenticular cross-section. The thickness of the bodies varies between 2 and 25 feet and they anastamose both vertically and horizontally through the body of alluvium (Plate 2). The sand bodies are concentrated in a zone underneath the present channel of the Todd River, and in a sinuous zone in the centre of the basin. The zones are referred to as the Eastern and Western Zones of high permeability (Plate 4).

This type of sediment forms approximately 15 percent of the total volume of the saturated alluvium.

Brown and grey clayey sand

The brown and grey clayey sand is similar in lithology to the brown sand, but contains much more matrix. In some cases the amount of silt and clay exceeds that of sand.

Brown and grey silty clay

The proportion of this type of sediment in the basin is large, probably 80 percent of the total volume. This type is a blue or grey silty clay very thinly interbedded or laminated with a brown clayey silt. Black laminae are common and are thought to contain carbonaceous material. It may contain variable but appreciable quantities of very fine to medium-grained sand. The clay content is estimated to range from 10 percent to 40 percent, and when it exceeds 30 percent the wet sediment is very greasy and plastic. The silt fraction mainly consists of mica flakes, and the sand fraction of sub-angular or sub-rounded quartz grains with variable amounts (as much as 20 percent) of angular grains of feldspar.

Regolith

Lithologically the regolith is a stiff blue sandy clay, with cobbles and boulders of both weathered and relatively fresh metamorphic and igneous rocks. In some bores there are thin lenses of brown, coarse-grained sand interbedded with the blue sandy clays. The sand-size material consists of angular grains of quartz and as much as 25 percent of sub-angular feldspar grains. Some of the cobbles, pebbles, and coarse sand grains are well rounded and water-worn. The sandy clay shows no sign of bedding or relict foliation.

It was standard practice to continue drilling and driving the casing, where possible, until the sample recovered consisted entirely of angular fragments of quartz, feldspar, schist, or weathered rock with a relict foliation.

Colluvium

The steeper slopes of outcrops of the igneous and metamorphic rocks and of the quartzite are commonly covered by coarse scree and rubble. Similar deposits are probably present on the steeper surfaces of the unconformity below the alluvium in the basin. They form only a small portion of the total volume of saturated alluvium, but may be an important source for the boulders and cobbles within the alluvium.

GEOMORPHIC DEVELOPMENT OF THE TOWN BASIN

The Town Basin is an alluvial basin which was excavated, and subsequently filled with alluvium to a maximum depth of 75 feet, during floods in the Todd and Charles Rivers.

The ages of the two phases, erosion and deposition, cannot yet be determined accurately. Some indication can be gained by the position of the basin in relation to the Tertiary surface of deep weathering. The latter is preserved as a broad regional dome which extends over the whole area of Central Australia (Quinlan, 1959). What are considered to be remnants of this surface are preserved on the north and south sides of Heavitree Range, approximately 500 to 600 feet above the present bed of the Todd River. Recent drilling in the area south of Heavitree Range has shown that the fluvial sediments unconformably overlie deeply weathered sediments of (?) Mesozoic age. It is possible then that both erosion and deposition occurred during the Pleistocene and Recent.

The processes of deposition are still active. Local residents point out that, within the last 20 years, the bed of the Todd River has risen between 5 and 10 feet. This is the result of the deposition of sand during periods of river flow. It is probable that the present rate of deposition is higher than would be the case if the catchment was not used for grazing.

Erosion to form the Town Basin

The form of the bedrock contours (Plate 1) indicates that the Town Basin was excavated by fluvial erosion, but little is known of the detailed sequence of events. Degradation was controlled by a local base level of erosion at Heavitree Gap, some 1800 feet above present sea-level, and the river was graded to a slope of approximately 17.5 feet per mile. The shape of the basin reflects the different mechanical strength of the igneous and metamorphic rocks, and of the Upper Proterozoic quartzite forming the Heavitree Range.

Deposition of alluvium in the Town Basin

It is difficult to infer the palaeoclimatic conditions which prevailed during the depositional phase. However, the texture of the sediments, and the spatial distribution of the lithological types, suggests that the sediments were deposited by an intermittent stream. It is probable that there has been no marked change in climate during this phase.

The five main lithological types of alluvium are thought to have been deposited in different environments as shown in Table 1.

TABLE 1.

Postulated environments of deposition of the five main types of sediment:

Lithological type of alluvium		Postulated environment
1. Brown sand	(a)	main river channels.
	(b)	braided channels on alluvial fans.
2. Brown and grey clayey sand		natural levee banks.
3. Brown and grey silty clay	(a)	backswamp areas and flood plains behind the natural levee banks.
	(b)	sheet flow deposits on the front of alluvial fans.
4. Regolith		surface of the metamorphic and igneous rocks.
5. Colluvium.		adjacent to steep slopes of bedrock outcrop.

The broad principles which are thought to control the deposition of material in the basin are discussed below. They are based on the assumption of deposition by an intermittent stream, scale model studies by Bain (1953), and on the spatial distribution of the lithologic units in the basin as inferred from the results of test drilling.

Material is deposited from the suspended and bed loads of a river as a result of a reduction in velocity. Initially it is deposited to form an alluvial fan at the head of the basin. The system of channels on the fan rapidly becomes graded with the drainage system in the catchment and the degradation - agradation boundary moves down stream.

Upstream from this boundary there is usually one major stream channel. Natural levees are built up when the stream overflows this channel and the bed load is deposited. The suspended load of clay and silt together with detrital material carried by tributaries from the edge of the basin are deposited in the back swamps and flood plains. The channel does not readily shift its position laterally, because it is confined by the levees or is entrenched into previous deposits. The channel sands are consequently thicker than sands on the face of the fan, and their margins are well defined.

Intermittent stream flow results in a variable degree of vertical sorting, but is responsible for very little improvement in sorting along the length of the channel. The amount of silt and clay matrix in the sand will be greater than that in the channel of a perennial stream. At low water stages the channel is not wholly occupied and the stream is deflected from one side to the other, depositing a layer of fine-textured material. A limited opportunity exists for resorting of the previously deposited sand at high water stages or during prolonged flow.

Downstream from the degradation-aggradation boundary the single channel is replaced by a system of braided channels. At high water stages sheet flow extends across the fan between the channels, depositing fine-textured material. The channel sands are thin and markedly lenticular in cross-section as the braided pattern may change with each flood stage.

The present grade of the Todd River is considered to be too steep for the formation of meanders.

These principles have been used to postulate a sequence of events. The main features of this sequence are shown in Plate 3 and are discussed below.

<u>Stage I</u>.

During this stage the channel of the Todd River occupied the deepest portion of the basin, and fluviatile sediments were deposited at the head of the basin to form an alluvial fan.

<u>Stage 2</u>

At the beginning of this stage the front of the alluvial fan had moved half way down the length of the basin. Upstream from the apex of the fan a graded channel had been developed, with natural levees along its length. It is assumed that at this time the external tributaries began to build up small fans on the margin of the basin. Back swamps developed where the levees of the main channel impounded the flood waters from the tributaries.

Stage 3

During stage 1 and 2 the alluvial fan had built up to a height of 30 feet above bedrock. At the start of stage 3 the front of the fan had passed through Heavitree Gap and the main channel, which had been developed on the top of the fan, was graded to a slope of approximately 20 feet per mile. The deposition of material from the suspended and bed loads in the main graded channel continued until the basin was filled to a level of approximately 1860 feet above present sea level at the junction of the Todd and Charles Rivers.

Stage 4

The beginning of stage 4 was marked by the sudden change in the position of the channel of the Todd River. It moved from the western channel to one which overlay the bedrock bars in the eastern portion of the basin (Plate 1). A large alluvial fan was built up at the change in gradient of the channel as it crossed the last bar. This fan was built up across the western channel because the amount of material carried by the Todd was greater than that carried by the Charles River. Fine grained sediment was deposited on the flood plain between the two channels.

Stage 5

This, the final stage in the sequence, has been adapted from Wright (1959), by interpretating his soil types in terms of the six types of fluviatile sediment. At the beginning of this stage the eastern channel was established through Heavitree Gap, and on top of the alluvial fan which had been formed in stage 4. Fine-grained sediment was deposited over large areas of the western and north-eastern portions of the basin. The western channel was covered by this sediment and the Charles River was diverted to join the Todd at the head of the basin.

HYDROLOGY

Groundwater is stored in the fluviatile sediments of the Town Basin. The low permeability of the Precambrian rocks and the presence of the regolith prevent leakage of groundwater from the saturated alluvium into the bedrock. Groundwater is lost from the basin by natural subsurface flow through Heavitree Gap, and is added to the basin by infiltration of part of the water which periodically flows in the Todd and Charles Rivers.

AVAILABILITY OF GROUNDWATER

Test drilling has shown that all the sediments below the water table are saturated but not all will readily yield water in significant quantities. A qualitative appraisal of the porosity and permeability of the main lithological types is made using the relative terms, low, moderate, and high.

Metamorphic and Igneous Rocks

The permeability and porosity of these rocks are low. A small quantity of groundwater may move into the town basin by way of fractured and weathered zones. These rocks will not provide substantial recharge to the basin.

Brown Sand

The thinly bedded brown sands of the main channels are the main aquifers in the basin. Their bulk permeability and porosity are both good, but variations can be expected from bed to bed, because of variations in texture (cf.Figure 1). The thin lenticular channel sands of the alluvial fans can be expected to have similar properties, but the alluvial fans as a whole may only have a moderate permeability.

Brown and grey clayey sand

Because of its texture this type of alluvium can be expected to have a low permeability and a low to moderate porosity. Significant quanities of water could probably be obtained from these sediments by long term drainage.

Brown and grey silt and clay

This type has a low to very low permeability, and a moderate to high porosity. It forms the bulk of the volume of alluvium in the western portion of the basin. The release of groundwater from storage in the silts and clays would be facilitated by vertical leakage to thin beds of sand which are connected with channel sands of the axial zone.

Regolith

The regolith is thought to have a very low permeability and a low to moderate porosity. Because of the small volume of the unit it cannot be expected to yield significant quantities of water.

Colluvium

The deposits of colluvium cannot be expected to yield significant quantities of water because of their small total volume. In certain circumstances their areas of outcrop may act as zones of good local recharge.

THE PIEZOMETRIC SURFACE.

Since 1957 measurements of the static water level have been made in various bores and wells at regular intervals by the Commonwealth Department of Works, by the Water Resources Branch of the Northern Territory Administration and by the Resident Geologists. Before 1957 water level records are sketchy.

These measurements have been used to construct contours on the piezometric surface. The contour maps for the 16th October 1957 and for the 14th October 1961 are shown on Plates 4 and 5. In this contouring :

1. Allowance was made for the change in transmissability across the boundaries of the zones of high permeability.

2. It was necessary to draw two sets of contours in the area between the Todd Bore and Bore No.28 to define the body of perched groundwater.

The contours shown on Plate 4 are typical of the period between 1953 and 1958. In this period the quantity of water which was lost from the basin by withdrawal and outflow was slightly greater than the quantity gained by recharge (cf.Figure 2). The contours illustrate the movement of groundwater through the basin following a period of recharge in June 1957. Within the four months to October the recharge mound had moved to the southern end of the basin. The withdrawal of groundwater from the Army No.2. and Town wells and the three East Side bores (Nos 27, 28, and 86) resulted in the dissipation of the mound in the western zone of high permeability and in the formation of a groundwater trough in this area. The steep gradients at the boundaries of the zones of high permeability which were formed by the recharge mounds, are quickly reversed in such circumstances. The shape of the contours indicates that the recharge mounds move relatively quickly through the zones of high permeability and that more groundwater moves through the eastern zone than the western zone. Withdrawal points were not constructed in the southern portion of the basin until 1958, and until then the recharge mounds moved through Heavitree Gap and the groundwater in them was lost as outflow.

The contours on the piezometric surface on 17th October 1961 are shown on Plate 5. For the period between 1957 and 1961 withdrawal and outflow was considerably greater than recharge, and the piezometric surface fell by 5 to 10 feet in the southern portion on the basin and between 3 and 5 feet in the northern portion. In this period Bores 59, 59/11. and 110 had been constructed in the southern portion, and withdrawal from them resulted in the extension of the groundwater trough in the western zone of high permeability. A similar trough was developed in the southern portion of the eastern zone. The extension of this trough to the north was prevented by a hydraulic boundary which was formed by the dewatering of the zone to the north of bore 110. As a result the recharge mound which was formed the previous April was preserved in the northern part of this zone. Elsewhere in the basin the mound had been destroyed. The shape of the contours indicates that much of the groundwater which was being pumped from the basin at this time was being withdrawn from storage within the areas of low permeability.

STORAGE AND WITHDRAWAL OF GROUNDWATER

Preliminary estimates have been made of the total volume of saturated alluvium in the basin during the period from 1953 to 1960. Figure 2 shows that the volume was reduced by a small amount during the years 1953 to 1958. Since then the quantity of water which has been withdrawn from the basin has considerably exceeded that gained from recharge and the volume of saturated alluvium has been decreased by 400 million cubic feet.

Groundwater is stored in beds and lenses of sand, silt, and clay under a combination of confined, leaky artesian, and water table conditions. The individual channel sands, because of their higher permeability, readily yield water to bores. Generally they do so until an equilibrium state is approached, when water is released from storage in the silts and clays, by gravity drainage or by vertical leakage to the channel sands. The long term withdrawal of groundwater from the basin can then be considered to occur under water table conditions.

AQUIFER PERFORMANCE TESTS

Seven aquifer performance tests have been conducted to date on the town supply bores, three of which are discussed in this paper. The aim of the tests was to investigate the hydraulic characteristics of the aquifers under water table conditions. The tests were run for periods as long as three months.

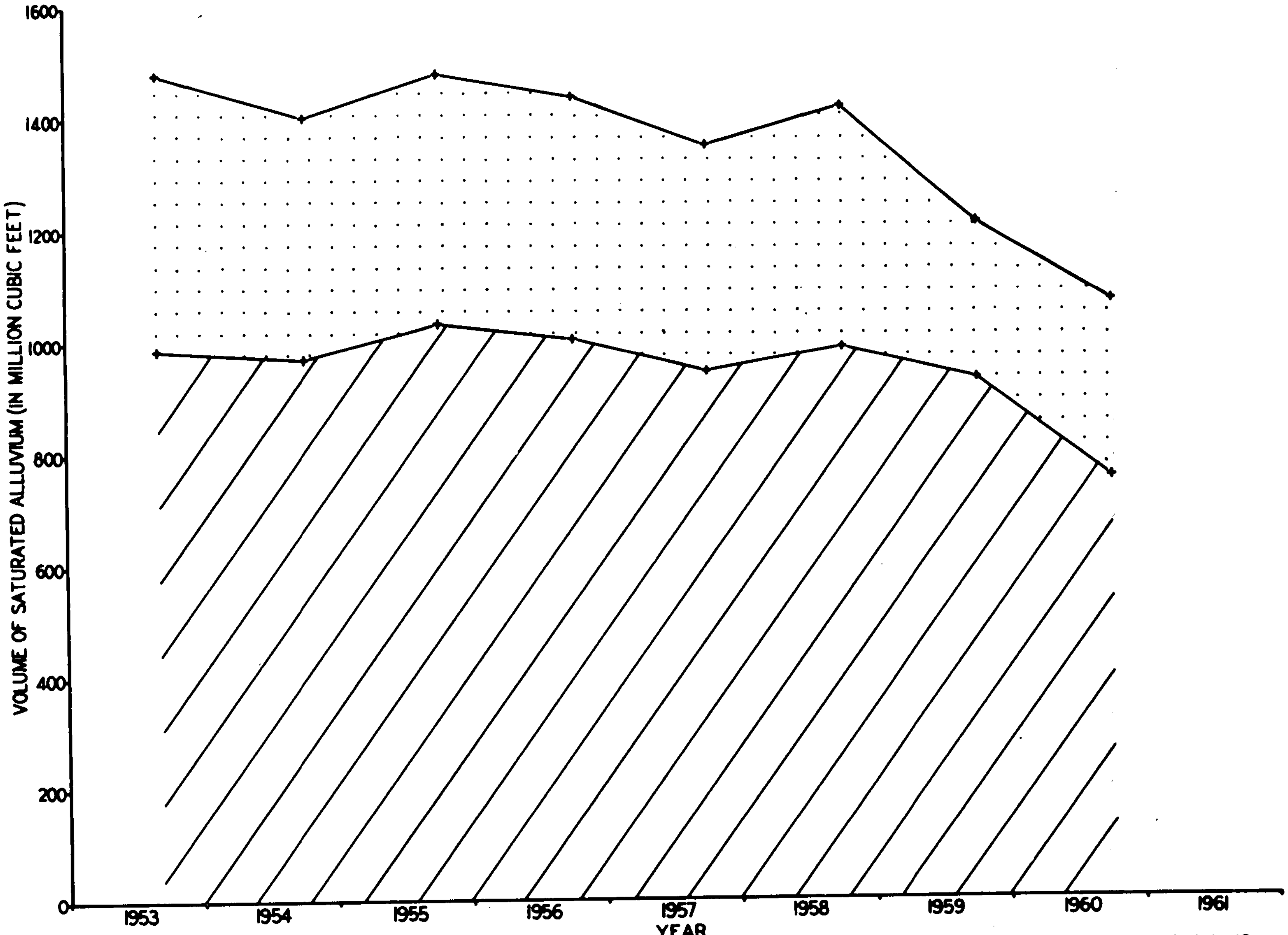

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Fig. 2 *Total volume of saturated alluvium in the Town Basin for the period 1953 - 1960*

Volume in the basin west of the western axial zone (dotted)

Volume in the basin to the east of and including the western axial zone (hatched)

Methods

The tests were conducted on bores which were pumping water for the town supply installation. This avoided the problems of special pump installations and disposal of discharge water. There are several practical difficulties which increase the probable error of the results.

1. Tests are possible only during the winter months when the fall in demand for water allows adjacent production bores to be shut down to avoid interference between bores. The time available for testing was seldom long enough to measure the recovery of water levels at the completion of pumping.

2. The discharge may fluctuate by 5 percent because of variations in head in the rising main.

3. The observed drawdowns were adjusted to allow for the natural fall in water levels between recharge periods. These corrections were obtained by extrapolation from long terms trends in water levels at observation points both inside and outside the area of influence.

Analysis of data

Because of the irregular distribution and the thickness of the channel sands it is not possible to treat them individually as confined aquifers, or more properly as leaky artesian aquifers.

It was shown above that on a long term basis the withdrawal of groundwater from the saturated alluvium can be considered to occur under water table conditions. The fluvial deposits, as a whole, could be considered as an anisotropic, non-homogeneous water table aquifer, but an exact solution to the differential equation which describes these conditions is difficult to obtain, and is of little practical value. It is expedient to first examine the drawdown data using the assumption that the saturated alluvium is an isotropic, homogeneous, water table aquifer of infinite lateral extent. The consistency of the results obtained from any one test can be taken as a indication of the differences between the ideal aquifer and the saturated alluvium.

The aquifer constants were calculated from the Theis formulae (Wenzel, 1942) which in non-dimensional form are:

$$s = \frac{Q}{4 \pi T} W(u)$$

$$u = \frac{r^2 S}{4 T t}$$

In terms of the units used for the aquifer tests the two equations may be written as:

$$s = \frac{1.91 \ Q}{T} W(u)$$

$$u = \frac{1.56 \ r^2 S}{T t}$$

where s = drawdown, in feet, as the observation point
- Q = the discharge of the bore in imperial gallons per hour.
- T = coefficient of transmissibility in imperial gallons per day per foot.
- W(u) = the well function
- r = radial distance in feet of the observation point from the pumped bore.
- S = coefficient of storage.
- t = time in days since pumping started.

Results

The Theis formula is applied by fitting a type curve for the well function W (u) to the drawdown information obtained from the tests.

The drawdown values and the matched curves of W(u) are shown on Plates 6 and 7, and the coefficients of transmissibility and storage computed from the curves are given in Table 2.

Interpretation of the Results

Bore 28

The drawdown curves are simple exponential curves which give mutually consistent values for the coefficients of transmissibility and storage.

Bore 110

The drawdown curves for observation bores 61/6 and 92 are simple exponential curves which give consistent values for the coefficients. The curve of W (u) was fitted initially to the early time portions of the drawdown curves for bores 49 and 50, and approximate values of the coefficients were T 125,000 gallons per foot per day and S = 0.003, values which are typical of confined conditions. The curve of W(u) was then matched with the later time portions of the curves, and the resultant values for the aquifer constants were consistent with those computed for the other two observation bores. These values were adopted.

Bore 59/11 - the shape of the drawdown curves indicates that vertical leakage to the developed aquifer through overlying aquicludes occurred at an approximate value of 10 for $\frac{r^2}{t}$.

The curve of W (u) was therefore fitted to the early time portions of the drawdown curves. The aquifer constants can be divided into two groups, the first with moderate coefficients of transmissibility and the second with low coefficients. The storage coefficients, as computed for confined conditions without leakage, are all low. The sharp increase in the drawdown on the tail of the curves was caused by interference from bore 59, which commenced pumping at this time.

TABLE 2

Coefficients of Transmissibility and Storage computed from the individual drawdown curves:

Aquifer test of Bore No:	Observation Bore No.	Coefficient of transmissibility	Coefficient of storage
28	9	22,000	0.045
	27	18,500	0.093
	Average:	20,000	0.07
110	49	24,000	0.018
	50	23,000	0.023
	61/6	22,500	0.013
	92	19,000	0.065
	Average:	22,000	0.03
59/11	59/9	42,000	0.0021
	59/8	25,000	0.0024
	Average:	33,000	0.0022
	Z^B	5,500	0.00011
	59/6	9,000	0.00009
	Average:	7,000	0.0001

Application of the Results to the Town Basin.

The application of the values of the coefficients in Table 2 to the saturated alluvium of the Town Basin in restricted by the nature of the fundamental assumptions used in the derivation of the Theis equation. The assumptions are (Wenzel, 1942)

i. The aquifer is confined.
ii. The aquifer is homogeneous, isotropic, and of infinite areal extent.
iii. The bore penetrates the entire thickness of the aquifer.
iv. The coefficient of transmissibility is constant in all places at all times.
v. The bore is of negligible diameter.
vi. The water removed from storage is discharged instantaneously with decline in head.

These assumptions are valid with the following qualifications:

1. The proposed mathematical model is for artesian conditions. However, Boulton (1951, 1954) has shown that providing sufficient time has elapsed and that the observation points are far enough from the pumping bore, then the exponential integral is an approximate solution to the differential equation which describes the water table case. These two qualifications were used in selecting the results for analysis.

The coefficients of storage and transmissibility computed for the tests of bores 28 and 110 are of the right order of magnitude for a water table aquifer. The coefficients of storage calculated for the test of bore 59/11 are small, and are typical of a confined aquifer.

ii. The saturated alluvium in the Town Basin is not a homogeneous, isotropic aquifer, nor is it of infinite areal extent.

However, "any case in which nonhomogeneity is so distributed that the flow field statistically fits the geometry of the mathematical model, the mathematical solution will provide a sound analysis" (Knowles, 1952). The results of the tests of bores 28 and 110 are consistent within the order of accuracy of the field measurements. This is not so for the test of bore 59/11.

The transmissibility of an anisotropic aquifer is a vector property with an elliptical law of addition. The values for the coefficient will then show a systematic and symmetrical variation in relation to two principle axes. The coefficients calculated for the observation bores about bore 110 show some systematic variation (figure 3) but more observation points are required to prove that the variations are symmetrical. Corrections for anisotropic conditions can be applied by distorting the dimensions of the mathematical model.

An aquifer may be regarded as being of infinite areal extent providing the drawdown curves have not been modified by vertical recharge or by reflections from a hydraulic boundary. Thus only the early time portion of the drawdown curves for the test of bore 59/11 were used. The shape of the drawdown curbes indicates that at the end of each test the cones of depression were still within an axial zone of high permeability.

iii. The thirteen bores were drilled to bedrock, and they were completed by different methods. The production bores 28 and 110 were completed with perforated casing, and water was withdrawn from the full thickness of saturated alluvium during the tests of these bores. Bore 59/11 was completed with sand screens set between reduced levels of 1804 and 1810 feet. The results for this test refer only to the interval between 1813 and 1803 feet. The observation bores Nos. ZB, 9, and 27 were completed with perforated casing, and bore 92 with blank 6 inch casing. The remainder were completed with perforated water pipe.

iv. The Theis type analysis is not strictly valid if water is released initially from elastic storage in a thin confined aquifer and subsequently released from the full thickness of saturated alluvium under water table conditions.

The drawdown curves of bores 49 and 50 (Plate 6) are thought to reflect this situation because of their shape.

This implies that bores 110, 49 and 50 intersect the same thin confined aquifer. The values calculated from the early time portion of the curve for bore 49 are T = 125,000 and S = 0.003, values which are characteristic of confined conditions.

The coefficients for the later time portion are T = 24,000 and S = 0.018; these are characteristic of water table conditions. It is probably necessary to adjust the values of the second set of coefficients to compensate for the change in conditions.

v. The diameters of the bores are negligible in relation to the radial distances.

vi. It is assumed that during the tests of bores 28 and 110 water is instantaneously released from storage with decline in head.

It is evident from the shape of the drawdown curves on Plate 7 that after a time t, defined by $\frac{r^2}{t} = 10^7$ additional quantities of groundwater were released from storage to bore 59/11 in response to the initial decline in head. Accordingly, the type curve was fitted to the early time portion of the drawdown curves (Knowles, 1952).

It is concluded that the average values of the coefficients obtained from the tests of bores 28 and 110 can be applied to the full thickness of saturated alluvium within the axial zone of high permeability about the respective bores. Additional information is required before a correction can be applied for possible anisotropic effects.

The values of the coefficients calculated from the drawdown curves for the test of bore 59/11 are inconsistent with the assumption of an isotropic, homogeneous water table aquifer. It is considered that bores with screens set opposite the lowest aquifers will withdraw groundwater under leaky artesian conditions. The specific capacity of such bores will always be lower than bores completed against all aquifers.

ACKNOWLEDGEMENTS

Much of the background information for this report, particularly with regard to water levels and bore logs, has been extracted from material collected by N.O. Jones, during his term as Resident Geologist from 1954 to 1959. E. Kingdom has assisted materially in the compilation of the aquifer test data and in the measurement of water levels.

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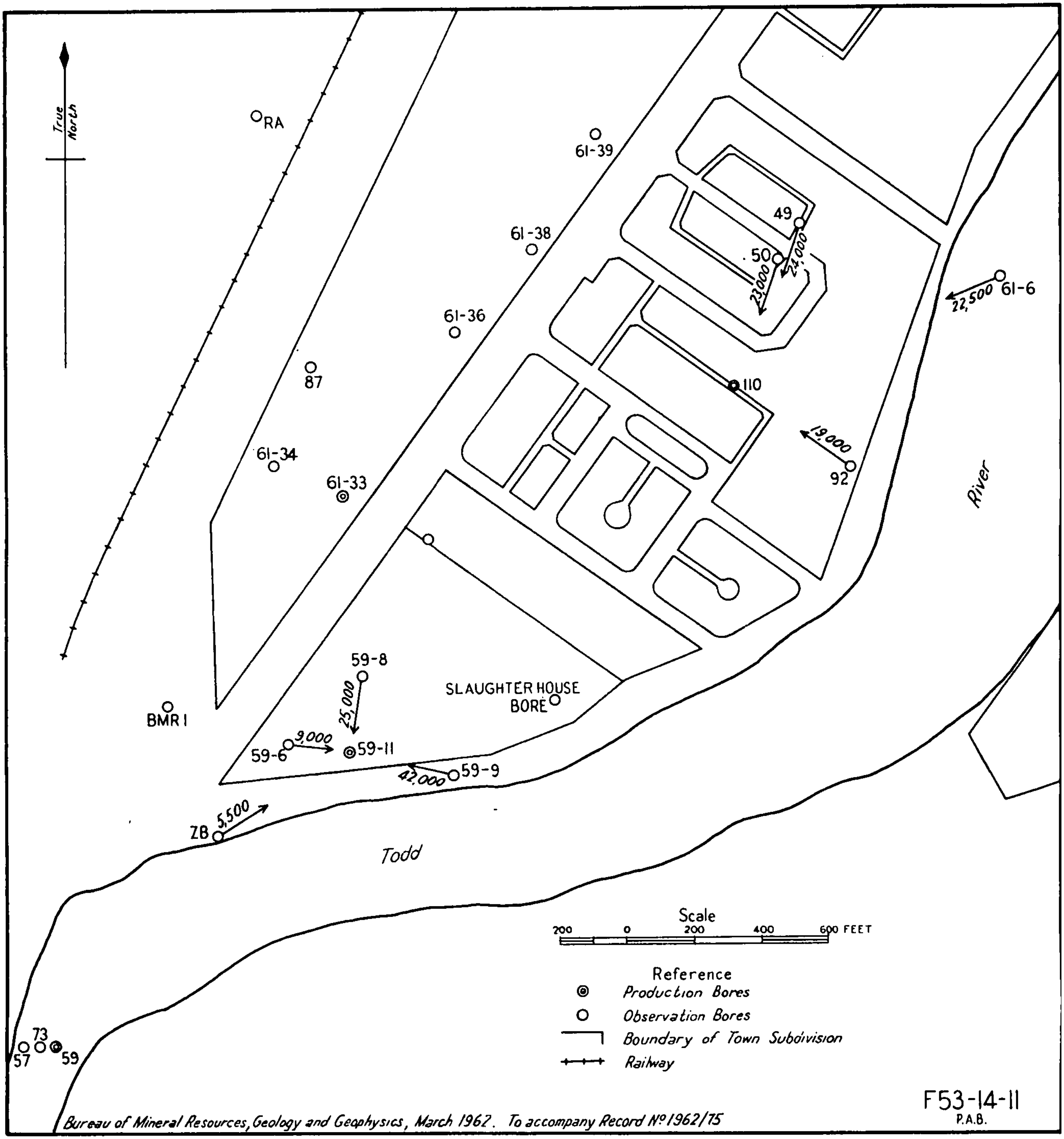

Fig. 3 *Alice Springs Town Basin. Location of observation bores and values of the coefficient of transmissibility for the aquifer tests of Bores 110 and 59/11*

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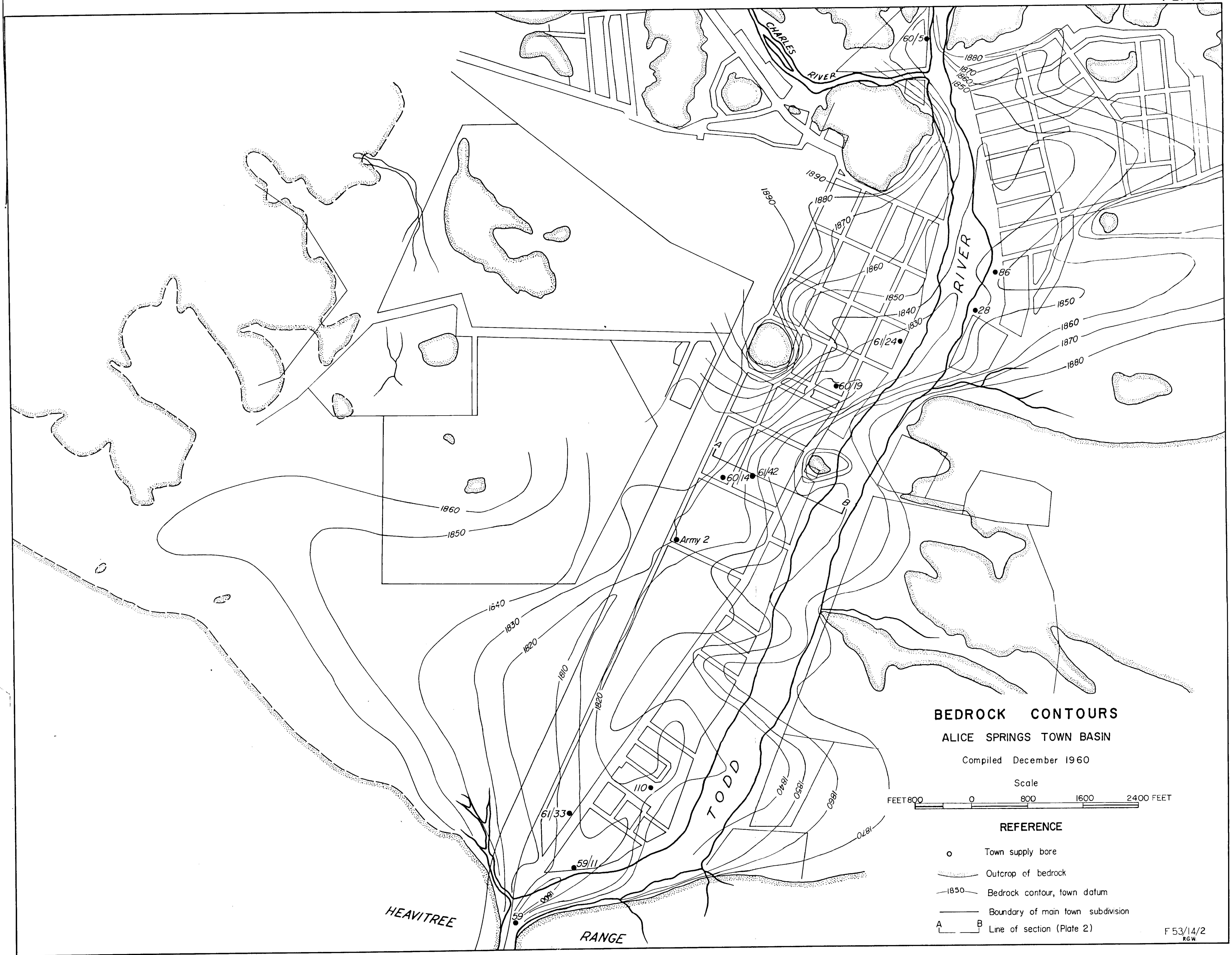

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PLATE 2

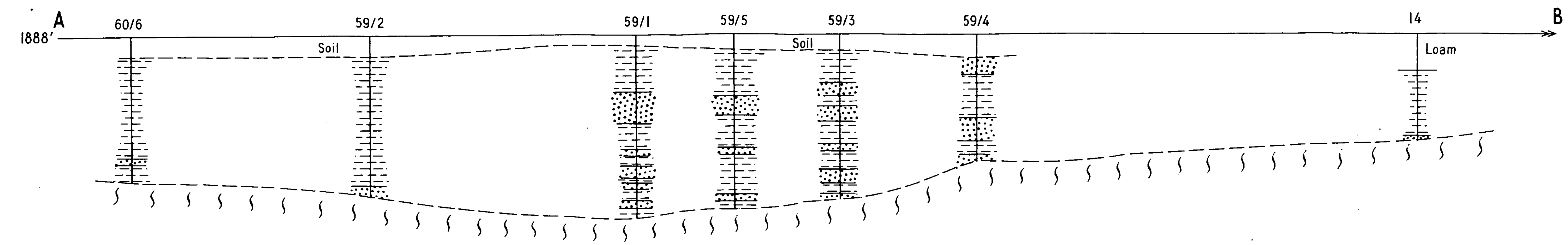
ALICE SPRINGS TOWN BASIN

CROSS SECTION A-B

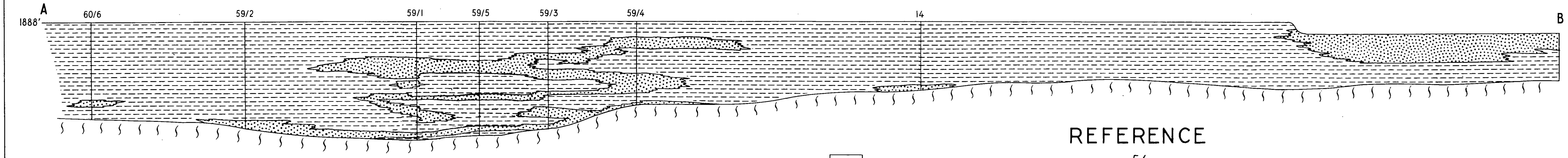
SHOWING

DRILLING RESULTS AND INTERPRETATION

DRILLING RESULTS



INTERPRETED CROSS SECTION



REFERENCE

Igneous and metamorphic rocks

Sand and gravel

Silt, clay, etc.

54 — *Borehole*

1888' *Height above sea level, town datum*

SCALES:
HORIZONTAL 100 50 0 100 200 FEET
VERTICAL 50 25 0 50 100 FEET

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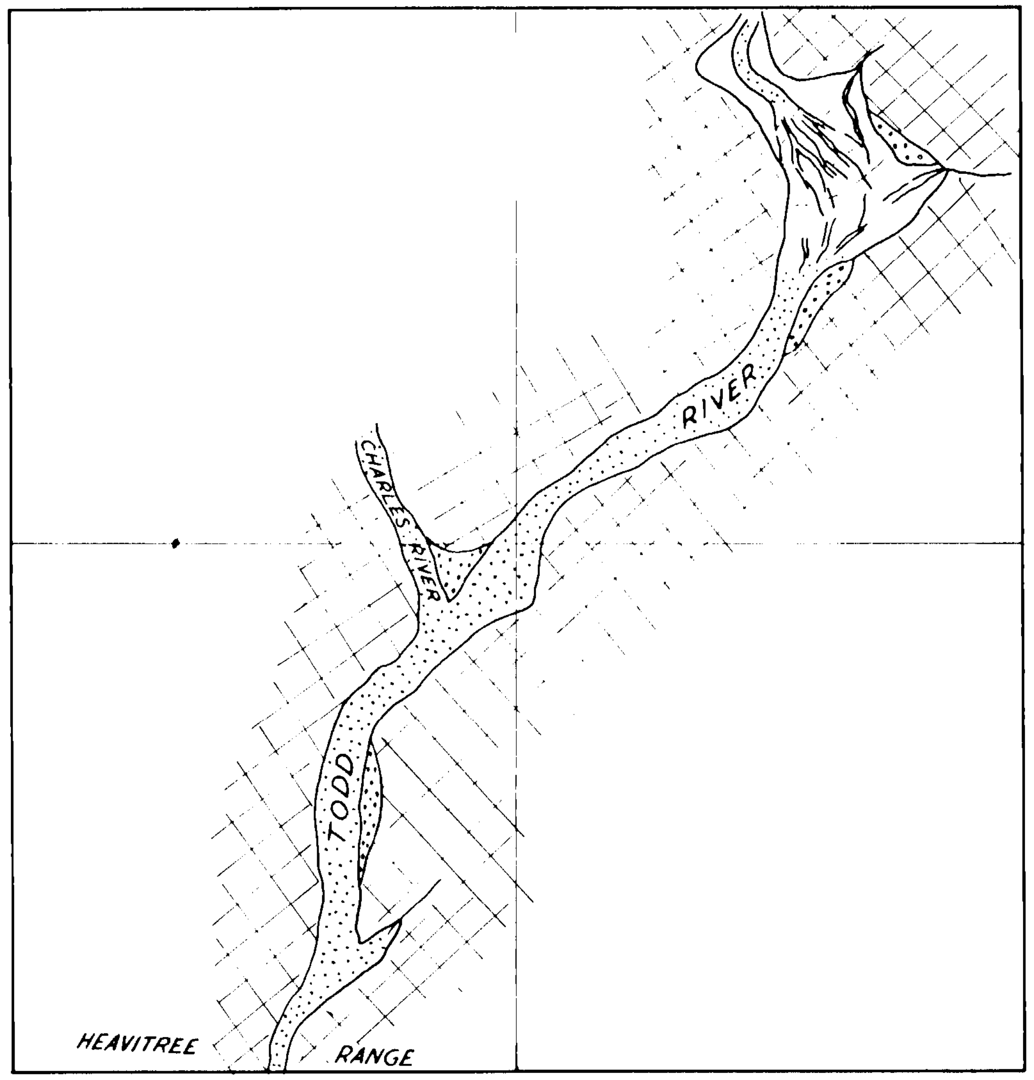
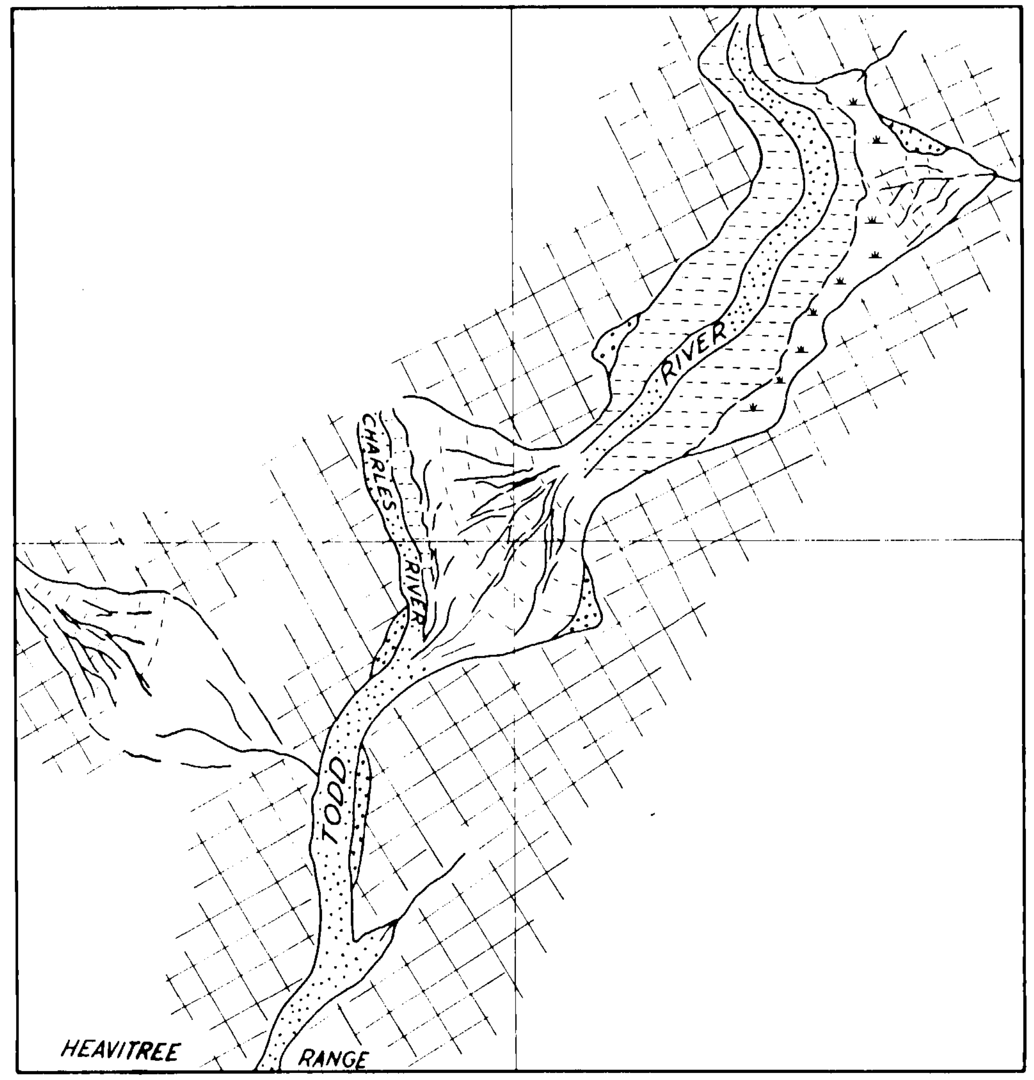
F 53-14-3

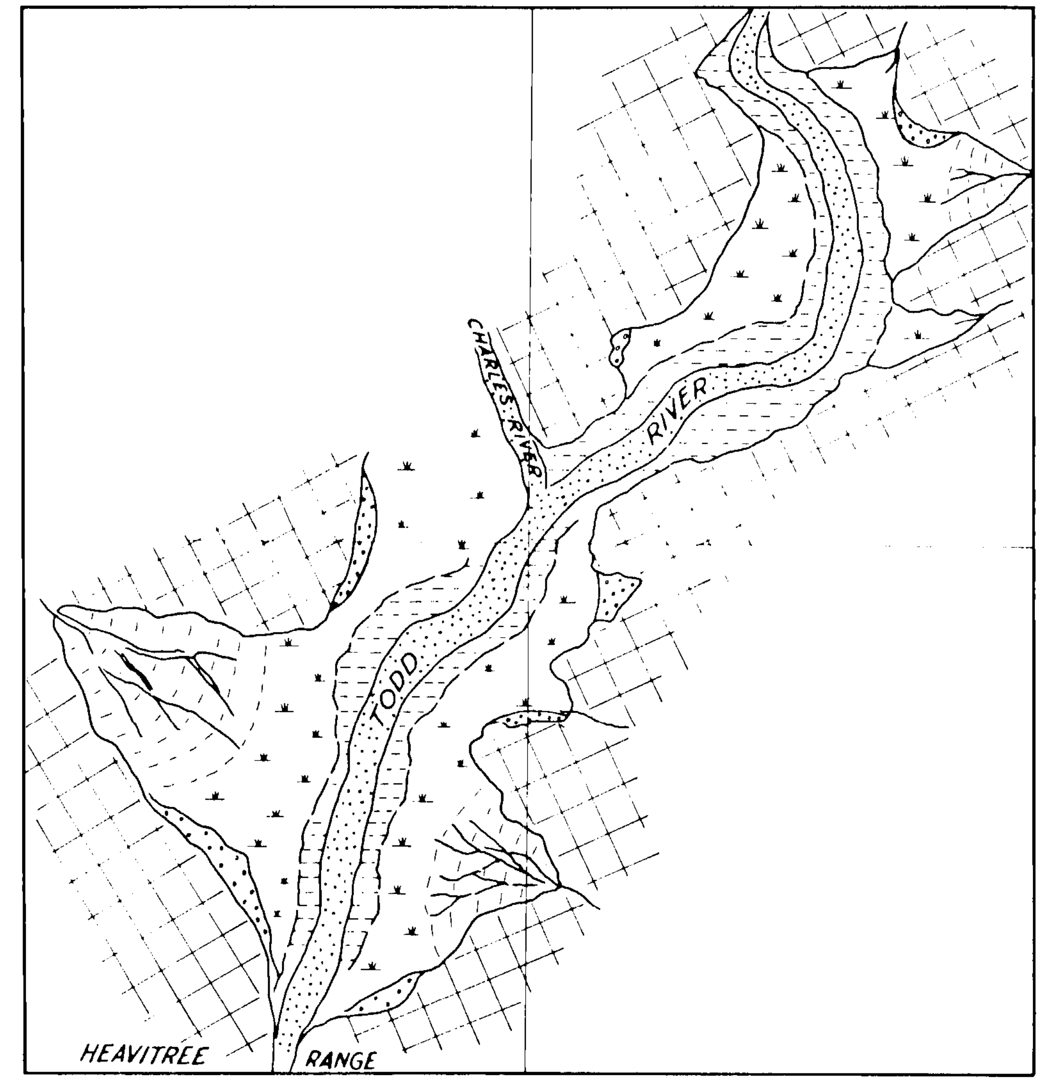
G.M.



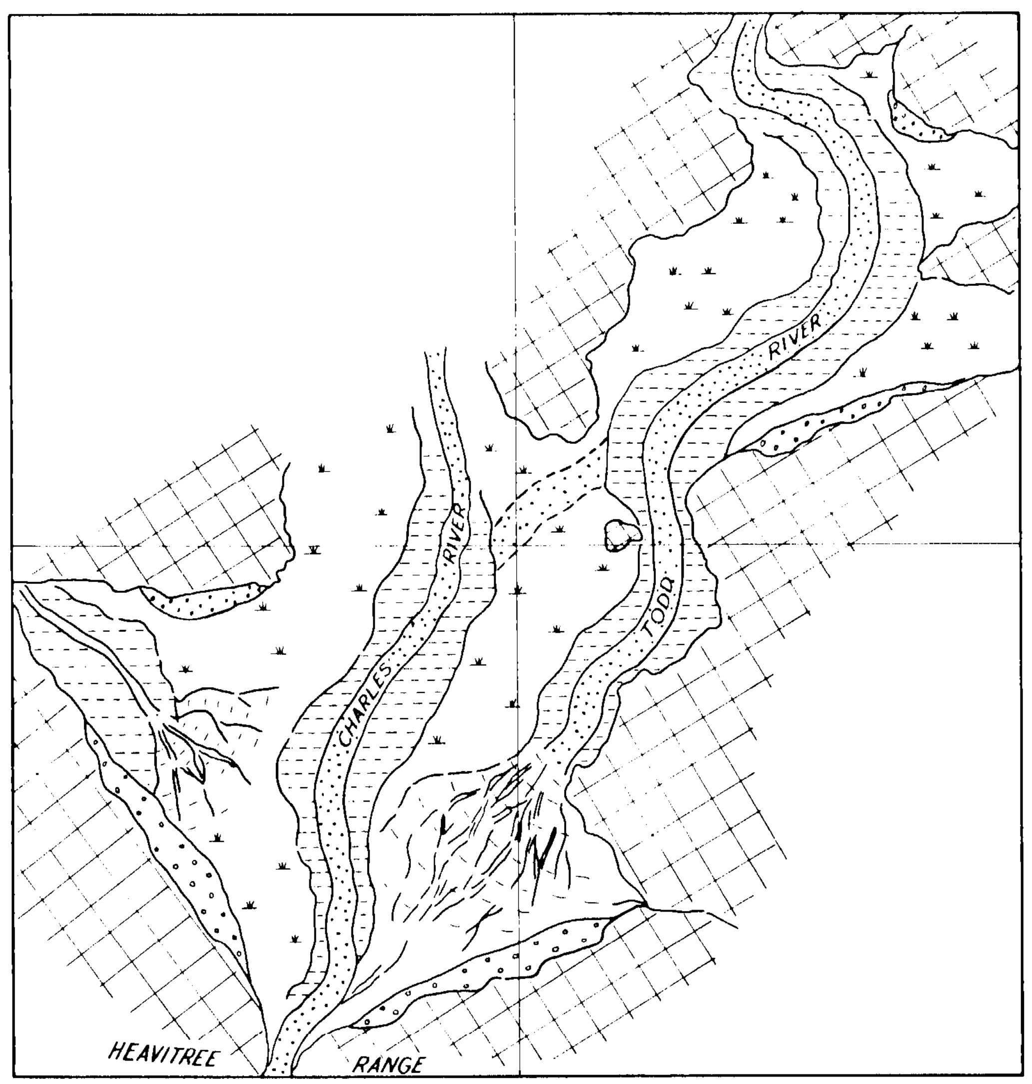
Stage 1: Deposition of alluvium at the head of the basin in an alluvial fan



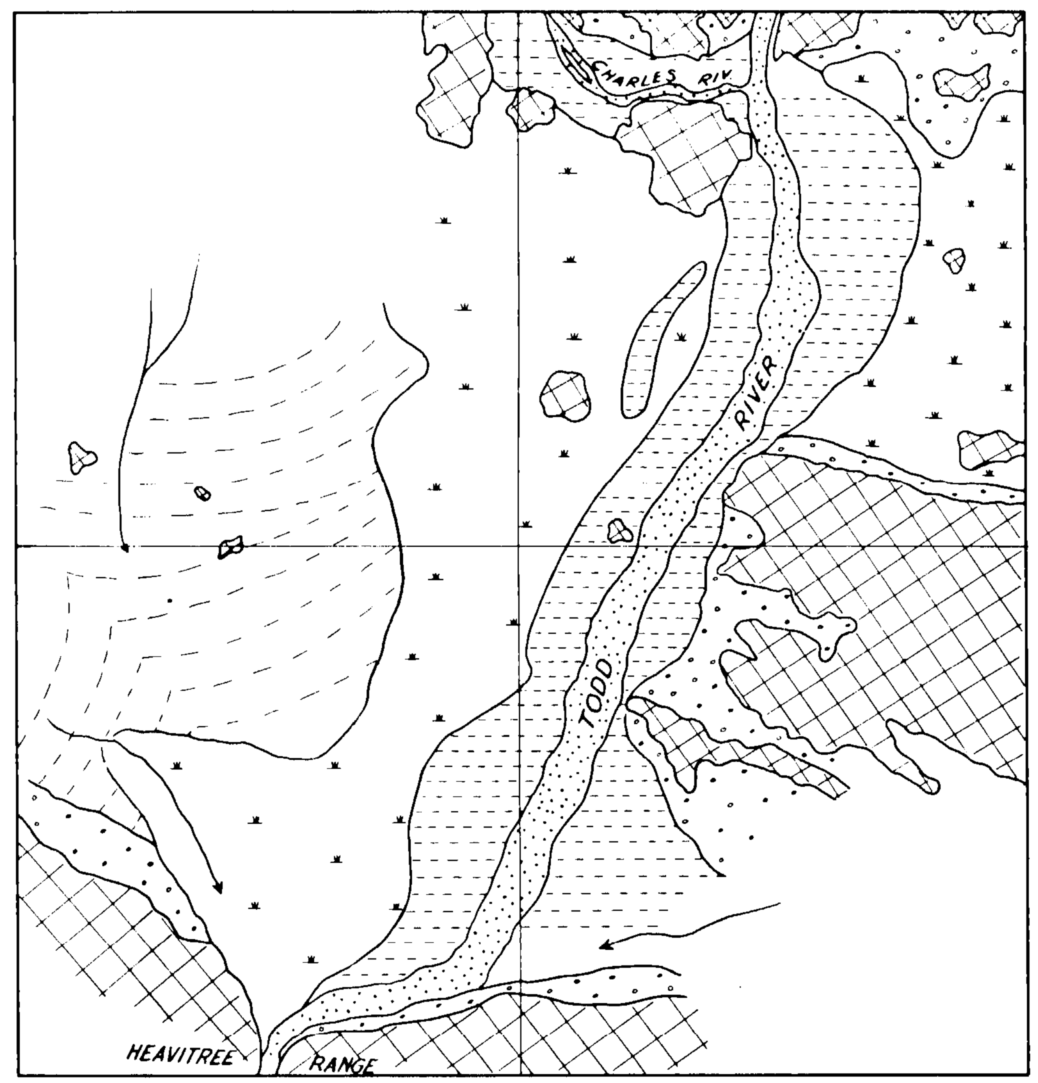
Stage 2: Movement downstream of the main alluvial fan and the establishment of a graded channel upstream. Commencement of deposition from external tributaries



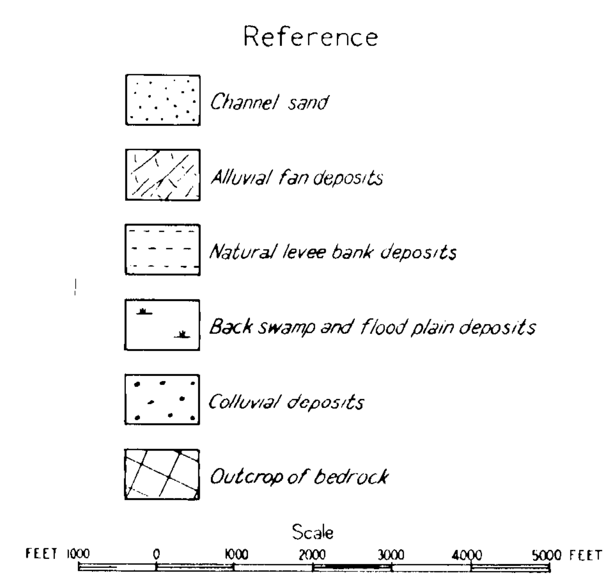
Stage 3: The establishment of the main graded channel through Heavitree Gap



Stage 4: Movement of the Todd River into the eastern channel with the development of an alluvial fan in the southern portion of the basin



Stage 5: Present distribution of the main lithological types of alluvium (modified from Wright 1959)



DEPOSITION OF ALLUVIUM IN THE TOWN BASIN
POSTULATED SEQUENCE OF EVENTS

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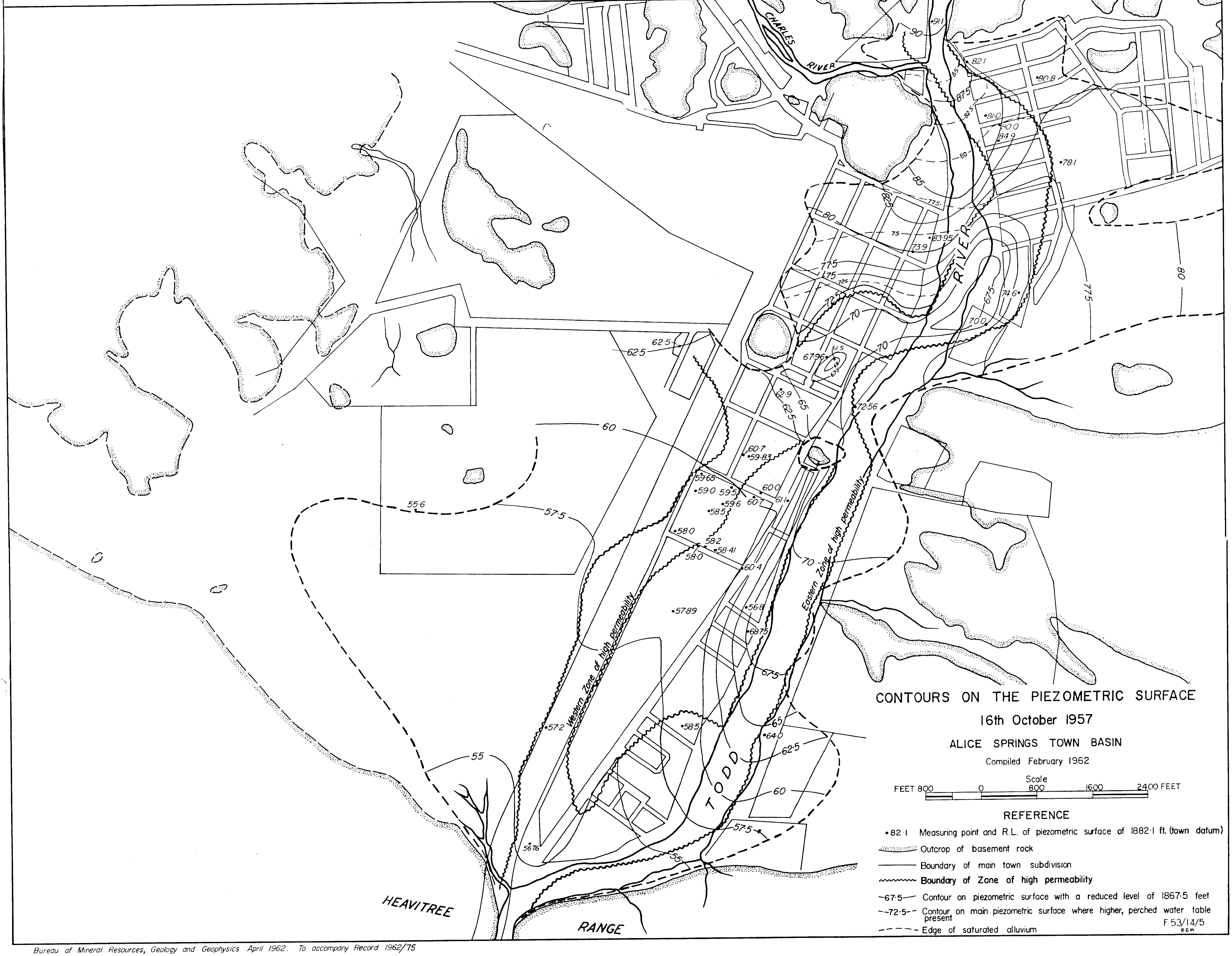
F53-14-4
PAB



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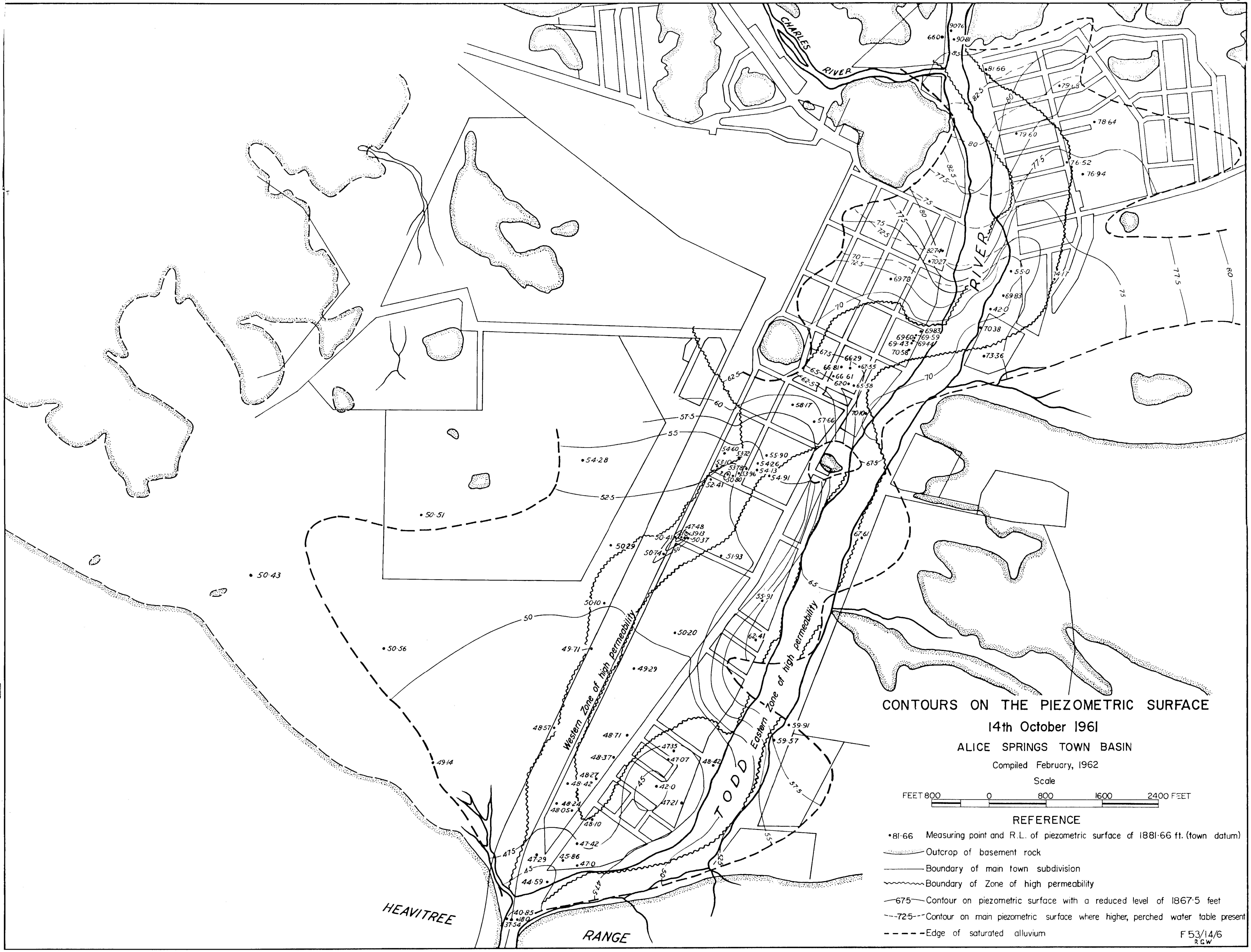
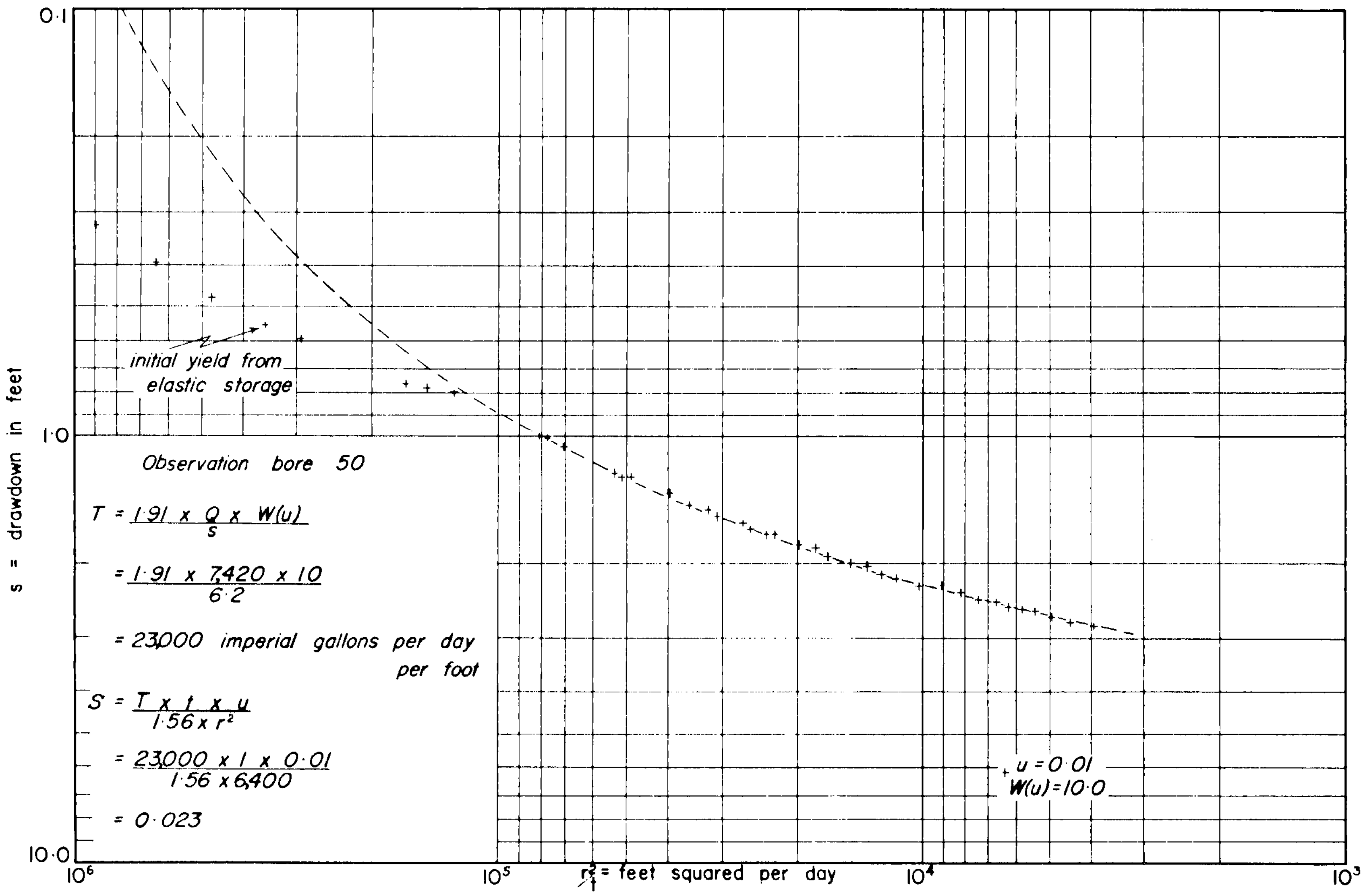
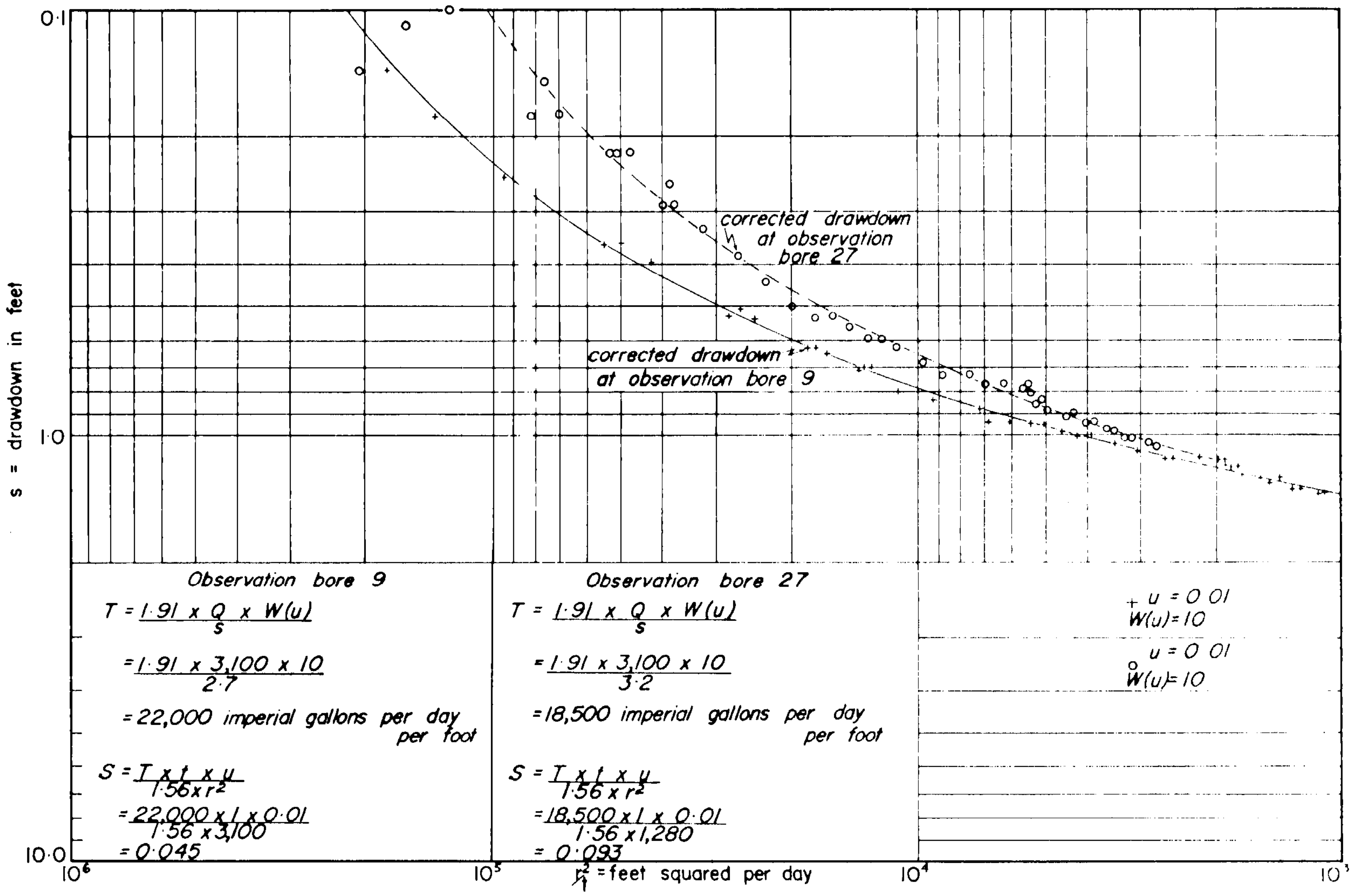


CONTOURS ON THE PIEZOMETRIC SURFACE
14th October 1961
ALICE SPRINGS TOWN BASIN
Compiled February, 1962

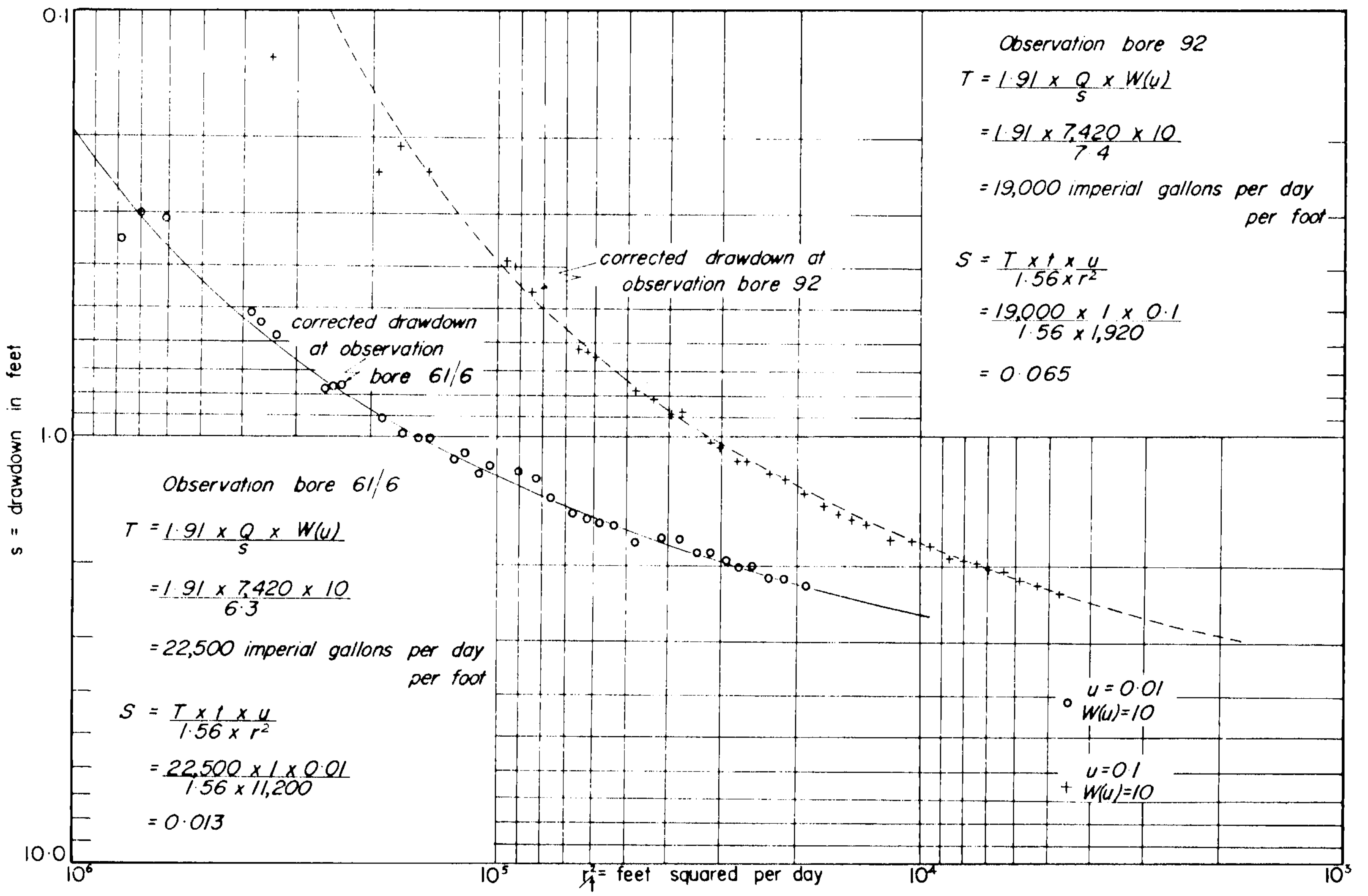
PLATE 6



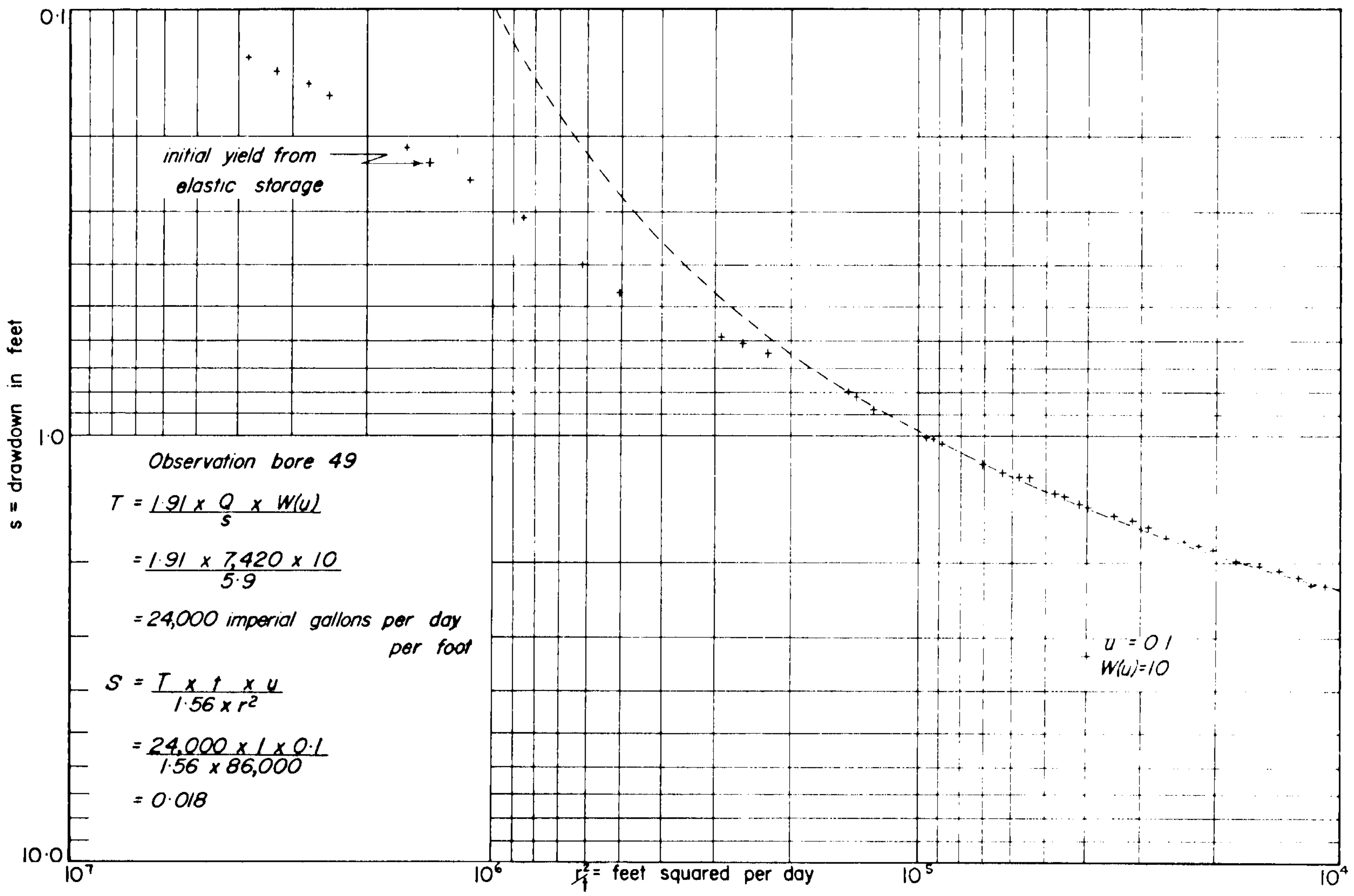
Drawdown curve at bore 50 for the aquifer test of bore 110



Drawdown curves at bores Nº 9 and 27 for the aquifer test of bore 28



Drawdown curves at bores 61/6 and 92 for the aquifer test of bore 110



Drawdown curve at bore 49 for the aquifer test of bore 110

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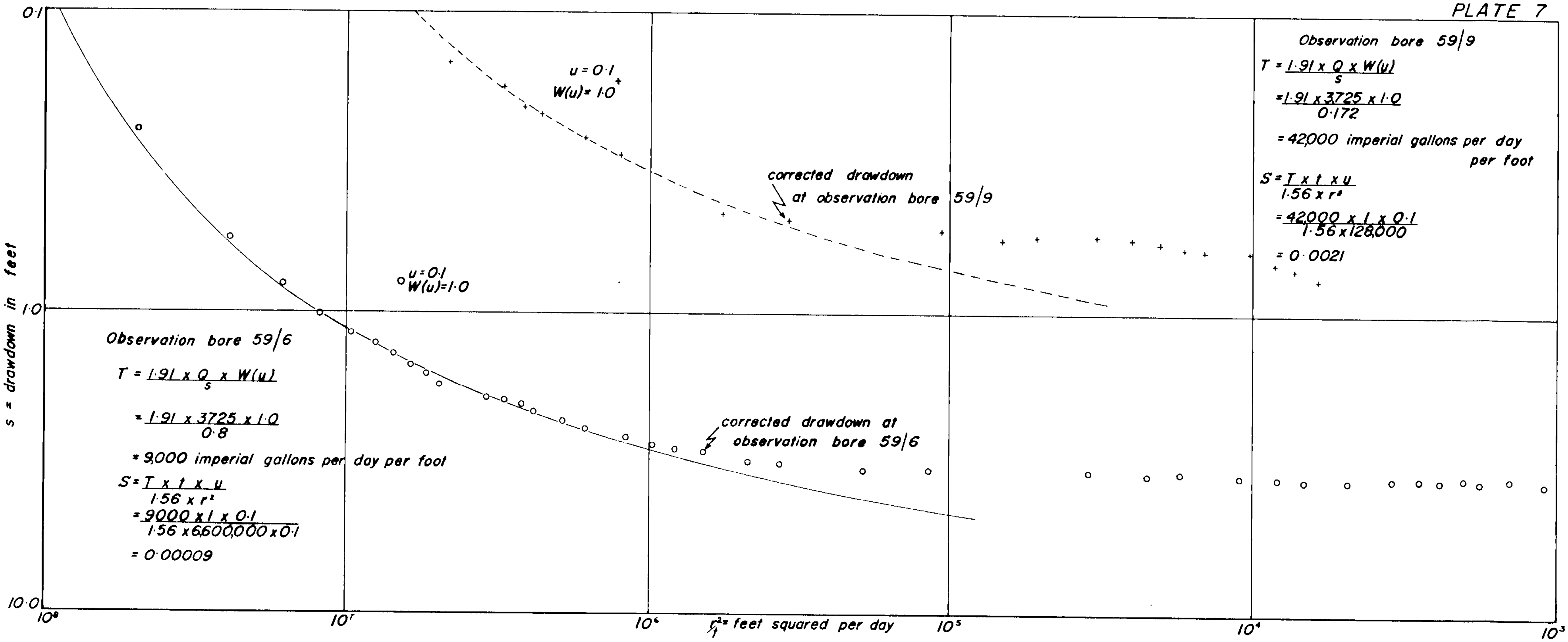
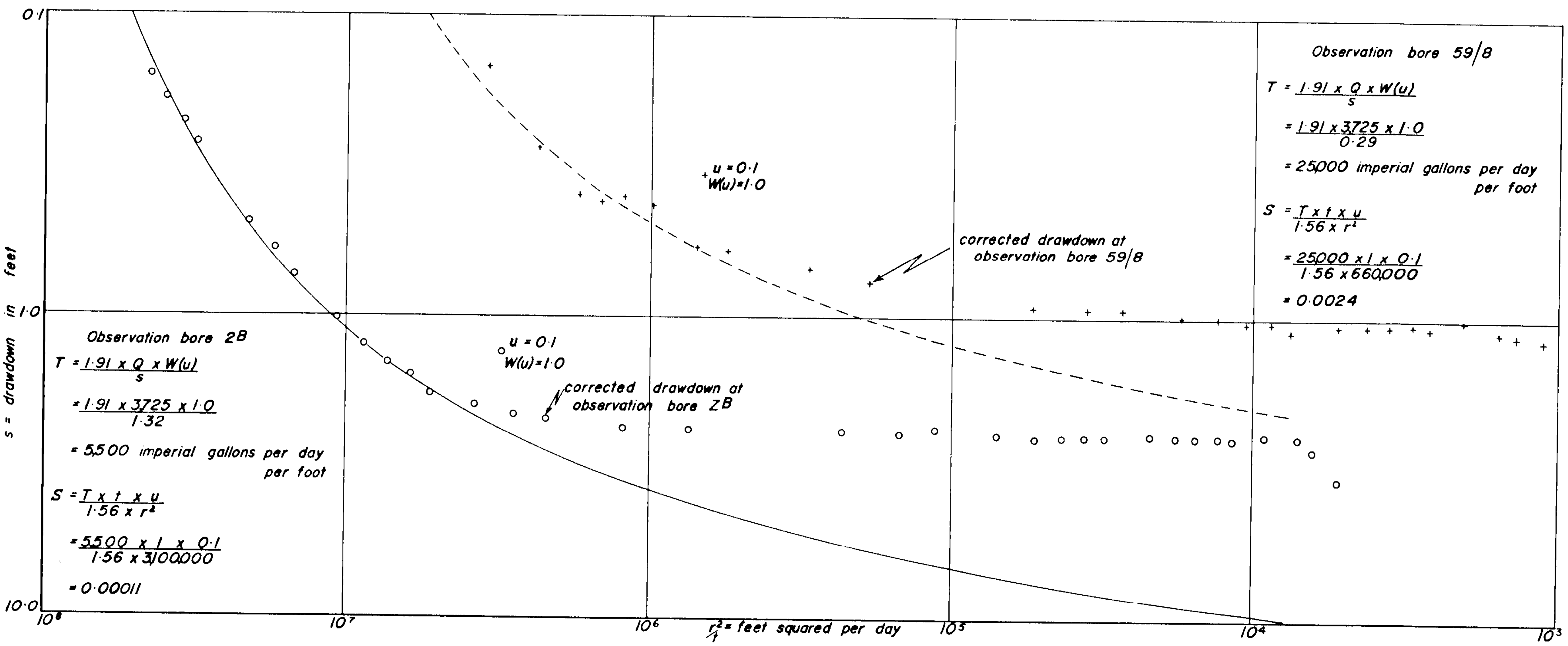
F53/14/7
RW



Drawdown curves at bores 59/6 and 59/9 for the aquifer test of bore 59/11



Drawdown curves at bores 2B and 59/8 for the aquifer test of bore 59/11