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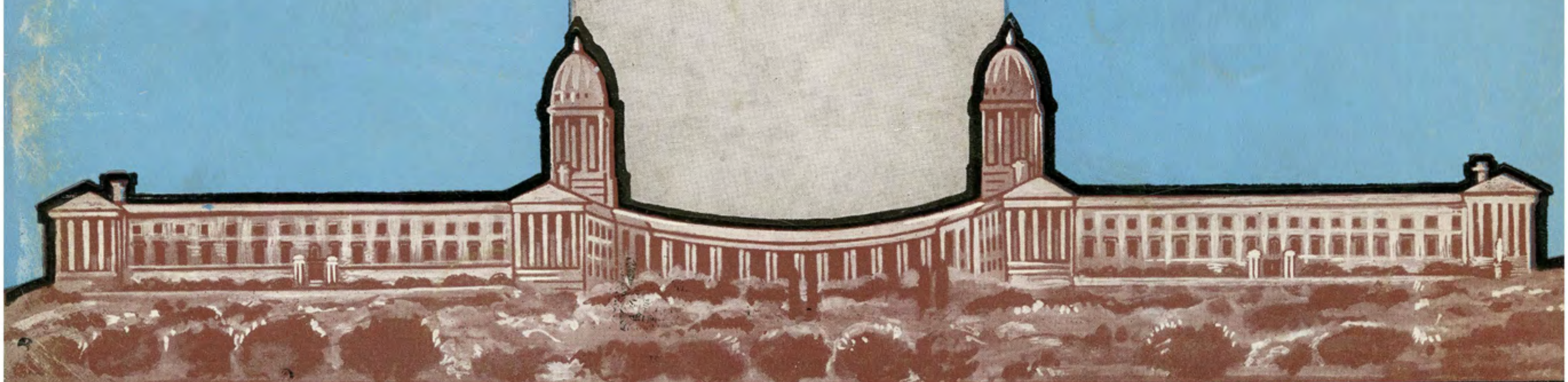
PUBLIC WORKS OF SOUTH AFRICA



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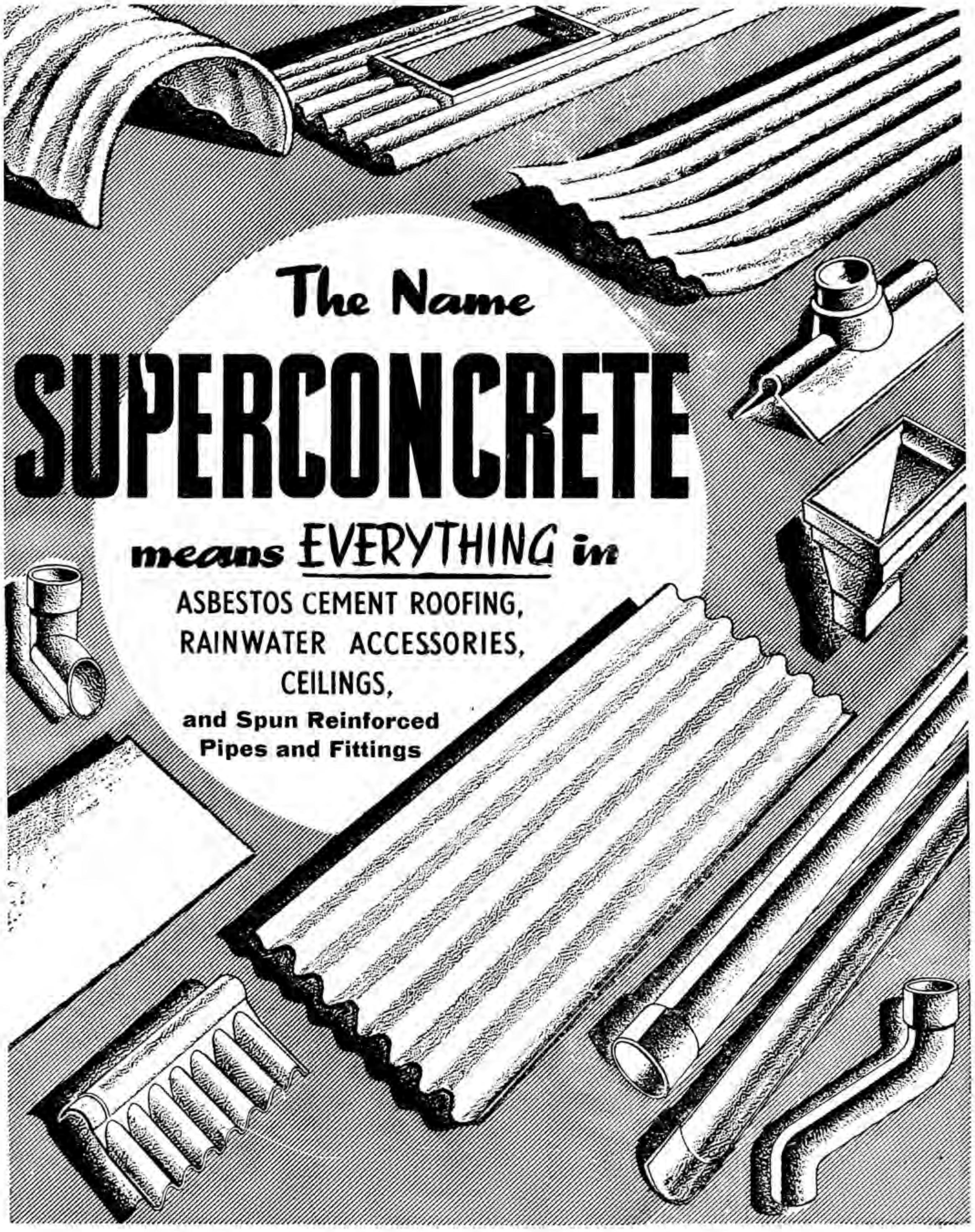
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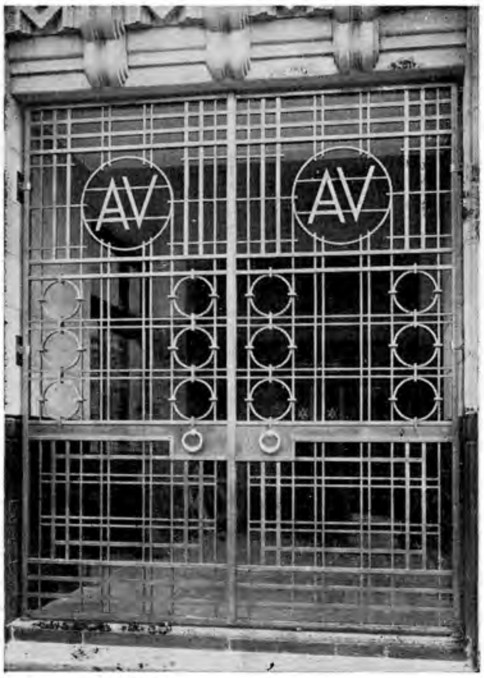

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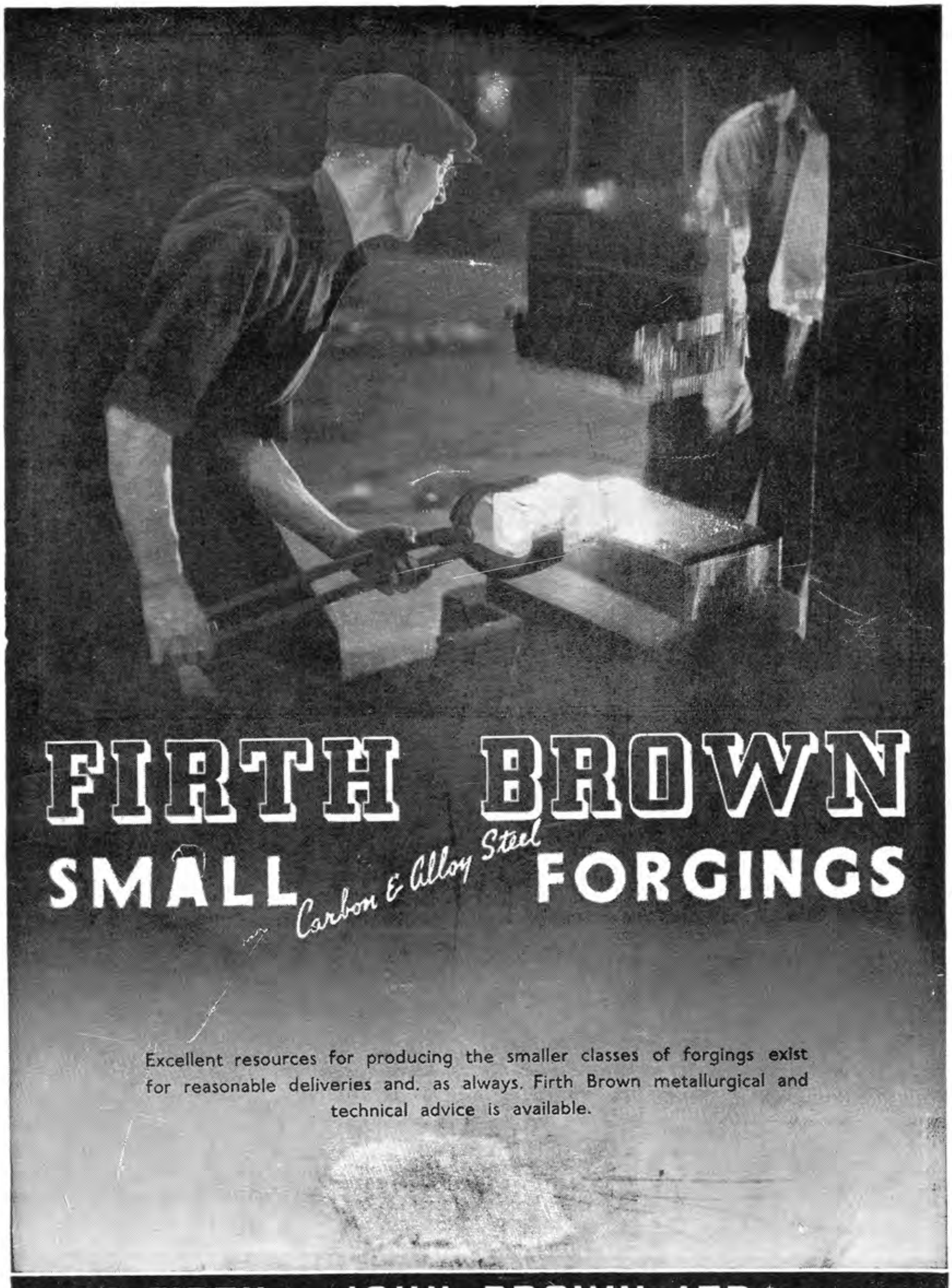
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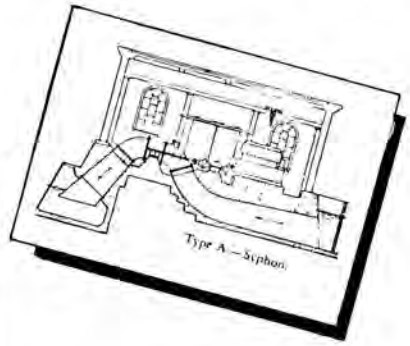

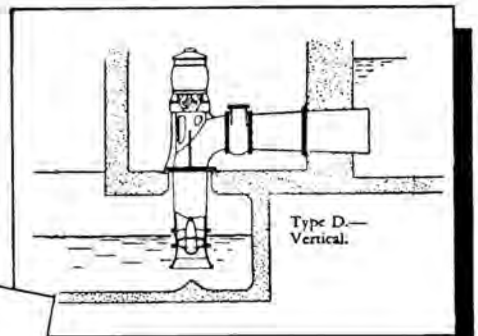

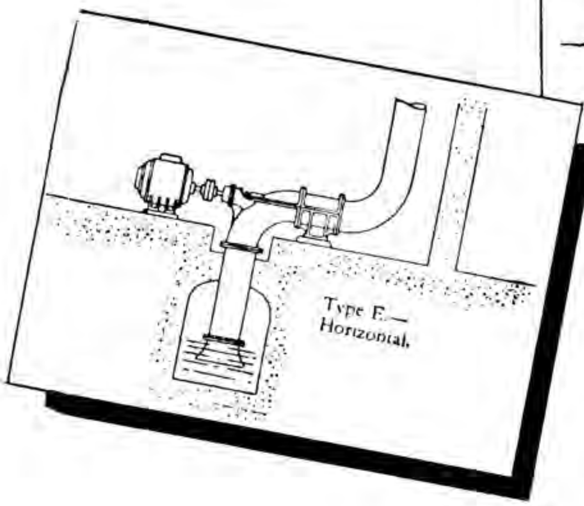

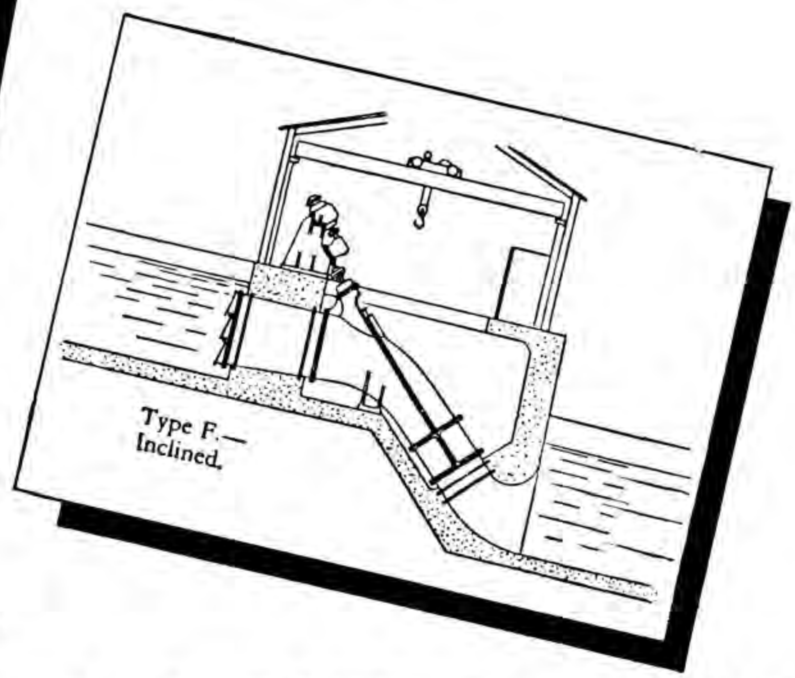

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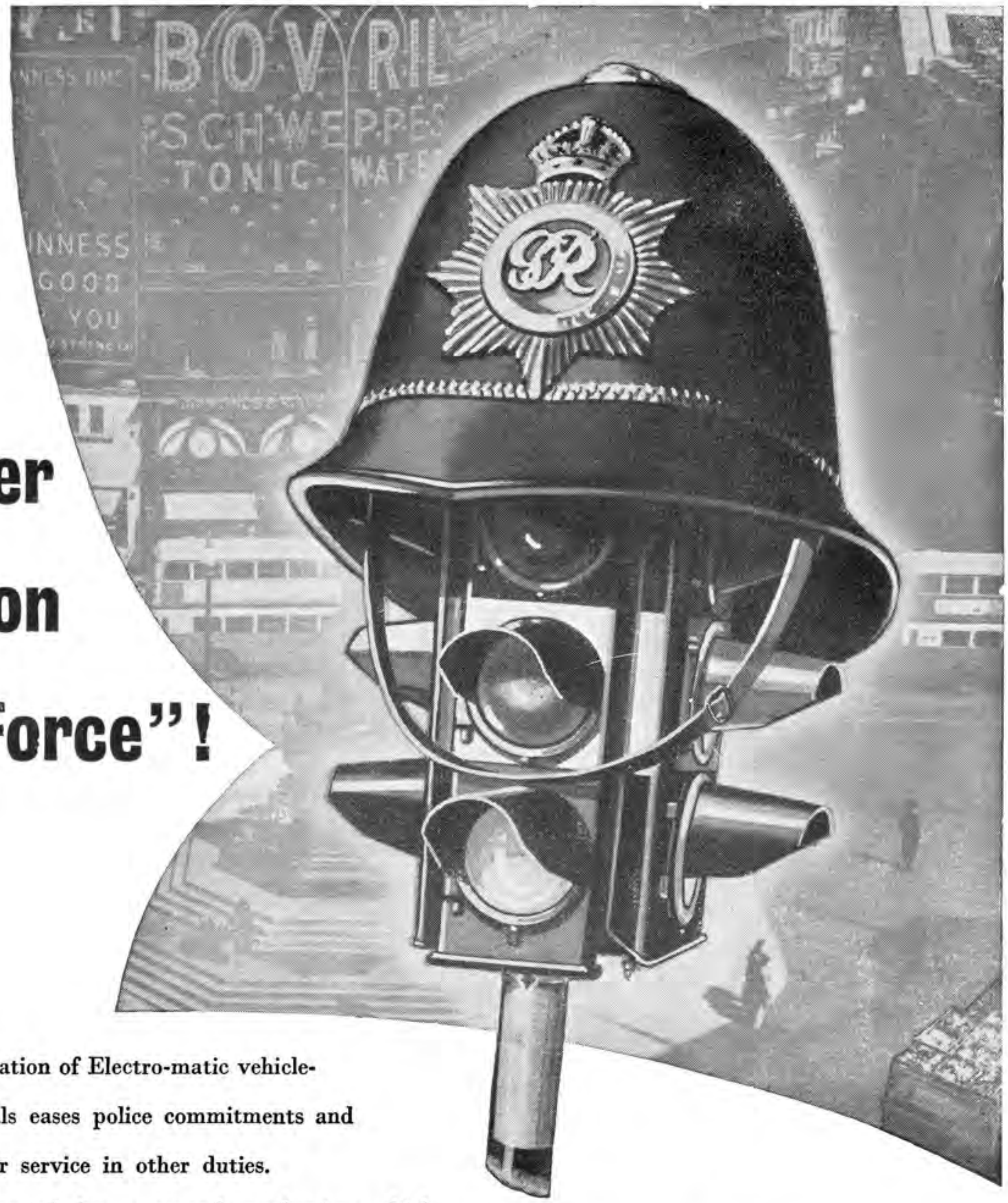

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PUBLIC WORKS OF SOUTH AFRICA, which is published monthly, is intended to keep the public up-to-date in regard to the engineering and building projects of the Central Government, the Provincial and Municipal Governments of Southern Africa and activities overseas.

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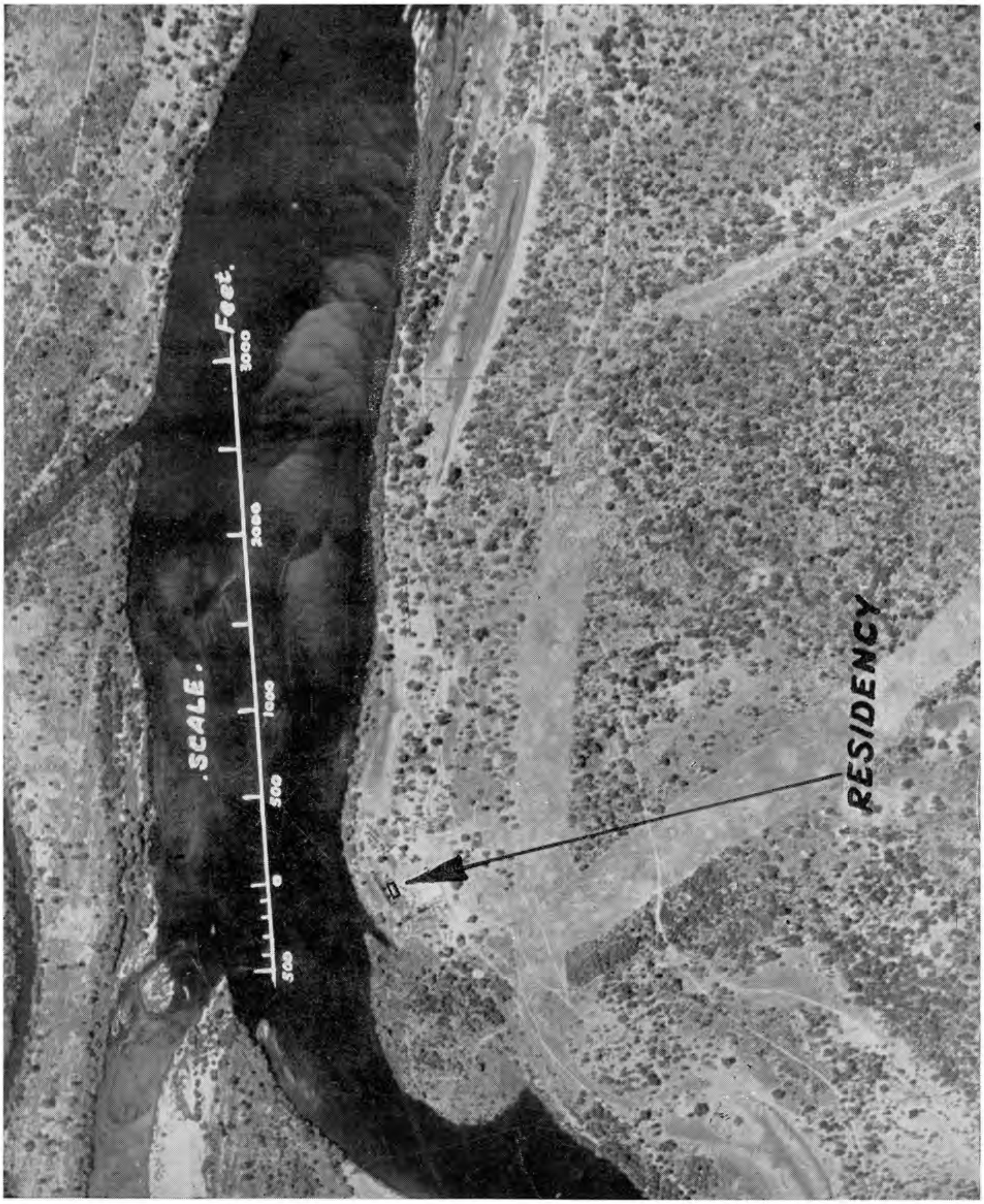


Aerial view of the Katima Mulilo site on the banks of the Zambesi River.

ADMINISTRATIVE CENTRE FOR NATIVE AFFAIRS DEPARTMENT AT KATIMA MULILO

A. D. MACKAY, B.Sc., A.M.I.C.E.,
District Representative, Public Works Department, Pretoria

THE Caprivi Strip is a tongue of land stretching easwtards from the north-eastern extremity of South-West Africa. For reasons of convenience the eastern section of the Caprivi Strip is controlled by the Native Affairs Department of the Union Government. The area thus administered is bounded on the north by the Zambesi River and Northern Rhodesia, and on the south by the Chobe River. The Chobe joins the Zambesi at a point some 50 miles upstream of the Victoria Falls.

The administrative settlement is at Katima Mulilo, situated on the southern bank of the Zambesi River and some 120 miles to the west of Victoria Falls. "Katima Mulilo" means "Quench the Fire," and the name is reputed to have originated in the following manner: The Zambesi River natives used to carry a lighted brazier in their dug-out canoes; the rapids at Katima Mulilo are somewhat treacherous and their negotiation looks simpler than it really is, with the result that, more often than not, the canoes were swamped, and the precious fires quenched.

The confluence of the Chobe with the Zambesi is interesting in that four territories meet at a point there, namely, Northern Rhodesia, Southern Rhodesia, Bechuanaland and South West Africa (the eastern tip of the Caprivi Strip).

The climate of the Eastern Caprivi is sub-tropical to tropical and the country is typical African bushveld, interspersed with glades, grassy plains and areas of dense forest. The terrain is a level sandy plain and it is doubtful if there is a difference of level exceeding twenty feet over the whole area.

The Union Government decided in 1943 to rebuild the Native Commissioner's residence, which was in an advanced state of disrepair and was threatened by flood waters from

The Court House with the open Magistrate's Court on the right.

the Zambesi. At the same time, provision was made for the erection of an administrative block, store rooms, a lock-up, and improved native staff quarters. To invite tenders would have been futile, as there would have been no response. It was decided, therefore, to undertake the work departmentally from the Pretoria District Office, Public Works Department.

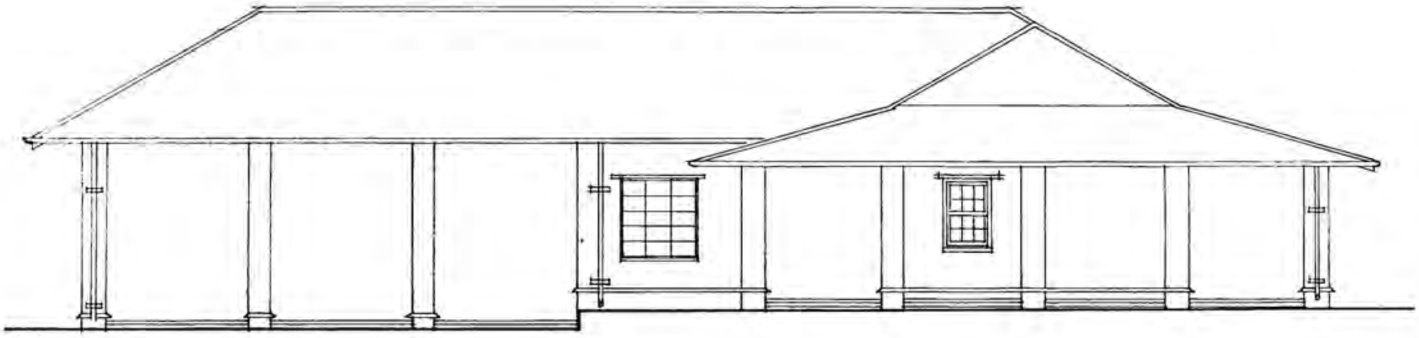
Design Problems

The first problem was that of design, more particularly for the Residency. Climatic conditions, combined with the remoteness of the locality, meant that the amenities usually associated with even the most isolated centres in the Union, were entirely absent. The aim, therefore, was to secure the most comfortable living conditions possible. The living rooms were made large and amply provided with windows. A feature was the broad, mosquito-proofed verandah completely surrounding the building, a most valuable amenity, serving more often than not, as dining, sitting and bedroom. The kitchen was planned as a separate unit, connected to the main building, by a mosquito-proofed covered way. This has proved most satisfactory for the heat, noise and odour, as well as the chatter of the domestic staff, are thus effectively isolated.

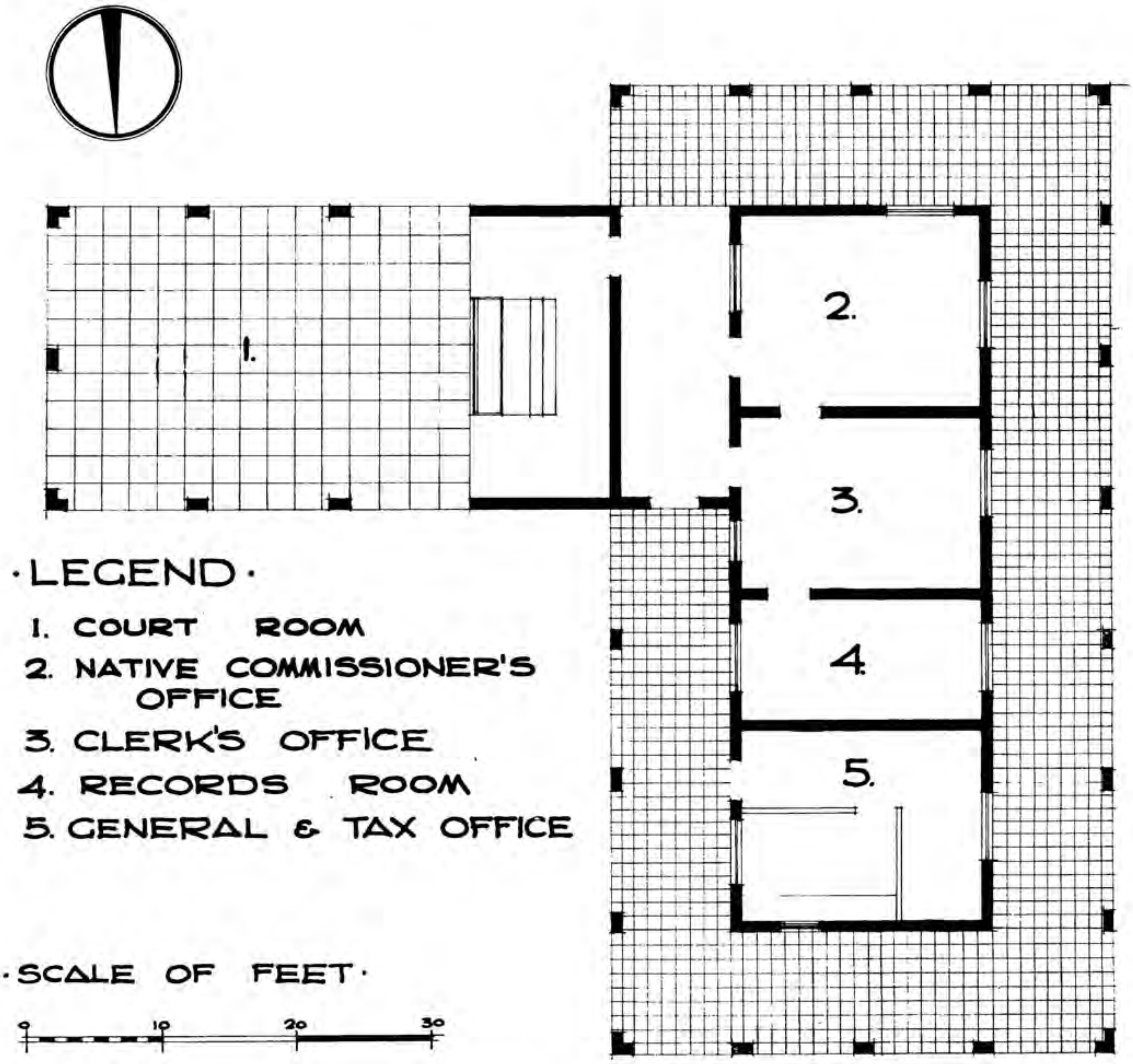
Owing to the prevalence of termites, effective ant-proofing had to be devised and the method adopted in Northern Rhodesia was employed. A strip of flat iron was built into all walls about 3" above floor level, and projecting about 2" *inside* the rooms. This has proved entirely satisfactory. At the moment a house is being erected at Katima Mulilo for an additional officer to be stationed there and, as an extra precaution against termites, the site has been treated with pentachlorophenal.

(Continued on page 21)

A closer view of the open-air court, with the magistrate's desk in the far corner and space for the litigants to sit on the floor in front.



WEST ELEVATION



PLAN

The Court House at Katima Mulilo.

The house was completely mosquito-proofed, including all small openings such as air bricks, louvred ventilators, beneath the eaves, and so on. A neat mosquito trap was devised within the main living room and combined effectively with the front door. A second mosquito-trap was incorporated in the covered-way leading to the kitchen. The corrugated iron roof was so constructed as to allow a free current of air to pass through from openings beneath the eaves. In the house now under construction, the roof will, in addition, be provided with a lantern type of ridging, thus allowing of an even freer movement of air. Windows and the western aspects of verandahs were liberally equipped with venetian blinds.

In the administrative block there is an open air type of courtroom, consisting of concrete floor where Native dependants, witnesses and litigants can be seated and a corrugated iron roof carried on piers. The Magistrate's bench is on a raised dais at the office end of the Court.

The materials used were concrete foundations and floors, of which the Residency lounge was finished in parquet, and the remainder in granolithic. The walls were of locally-made bricks, plastered internally and externally. All the windows were made of steel in wood frames, while doors and frames were constructed in wood. In the house, now in course of erection, steel frames are being used for all doors and windows. The ceilings throughout were of hardboard.

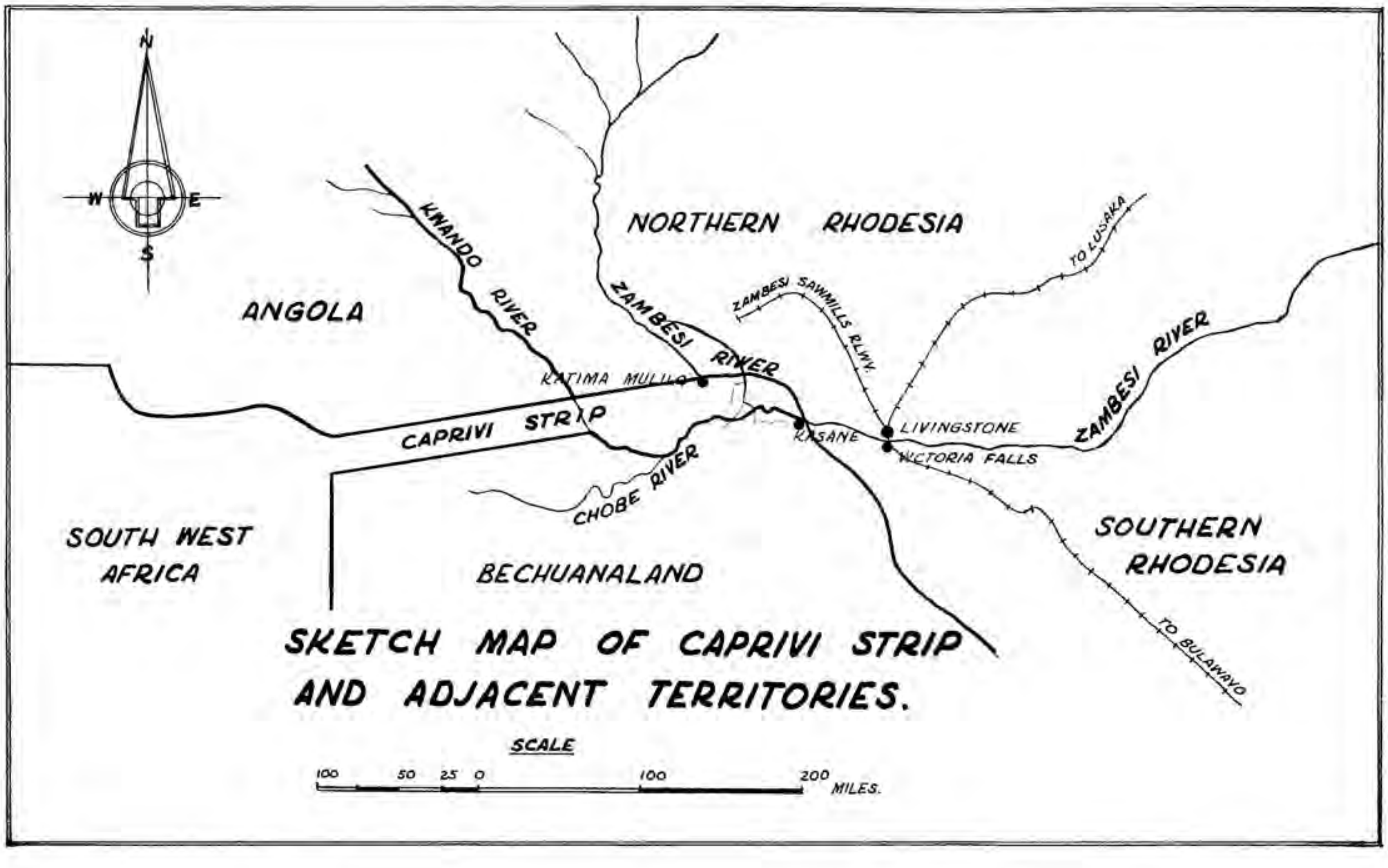
Transport Difficulties

Having settled on the designs of the various buildings, the practical problems of construction had to be investigated and solved. The first of these was transport. Fortunately, a privately-owned standard gauge railway, operated by the Zambesi Sawmills, with its terminus at Livingstone, runs in a north-westerly direction, and the management provided every facility for the carrying of material over this line. In 1944, a spur of this railway terminated at a point some 28 miles to the north of Katima Mulilo, and goods could be consigned from Pretoria to this railhead; from this point the loads were transferred to motor lorries which ran to the north bank of the Zambesi opposite Katima Mulilo. All goods then had to be ferried over the river, about half a mile at low water and four times this distance when the river was high, in boats or barges and on rafts. The 28-mile lorry route, over execrable tracks, took some four hours and the drivers, apart from negotiating incredible obstacles, had to be constantly on the look-out for elephants. These animals, which are dangerous, have to be treated with far greater respect than that accorded to any other wild creatures in the "bundu."

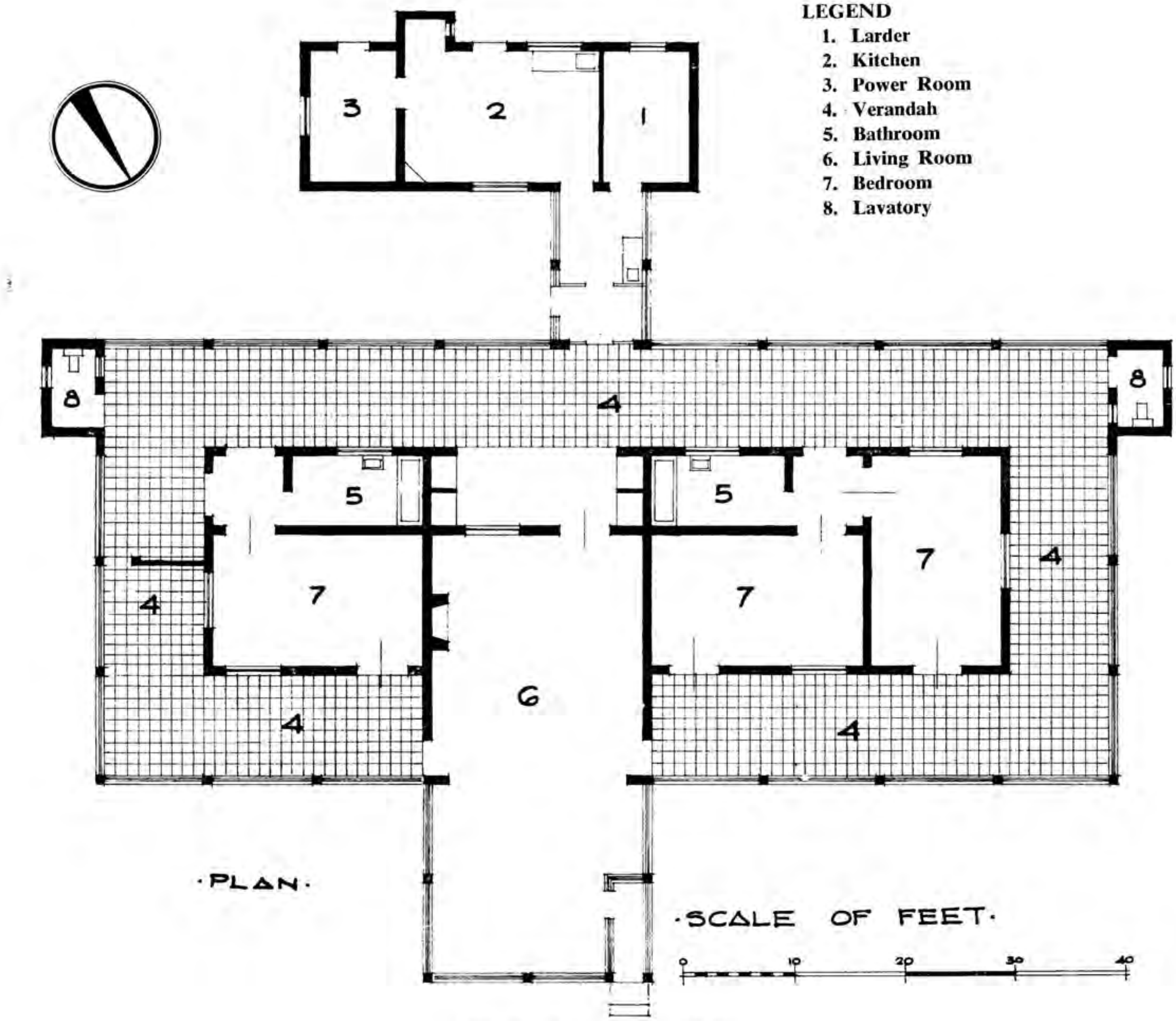
The railway spur north of Katima Mulilo now no longer exists and, for the operations now in progress, the Zambesi Sawmills railway terminus at Masese has to be used. Masese is some 56 miles from the site and the trip by motor lorry takes 5 to 6 hours. The lorries are Government garage vehicles sent from Pretoria.

River transport to Katima Mulilo is available from Kasane, near the confluence of the Chobe with the Zambesi. This transport is operated by the Witwatersrand Native Labour Association, who have a fleet of powerful motor-driven barges, suitable for passengers and non-bulky packages. Before boarding the river boats, however, a road journey of some 40 miles from Victoria Falls to Kasane has to be undertaken, rapids interrupting the river passage between Kasane and the Victoria Falls.

(Continued on page 23)



SKETCH MAP OF CAPRIVI STRIP AND ADJACENT TERRITORIES.



The Residency, Katima Mulilo.

A corner of the Residency.

Grateful acknowledgments are due to the Zambesi Sawmills and to the Witwatersrand Native Labour Association for their very ready help and advice in all phases of the work at all times.

Materials and Labour

Before construction could start materials had to be collected and delivered and care had to be taken that nothing essential was omitted as otherwise precious weeks, or even months, would have been wasted. One could not resort to ringing up a merchant from Katima Mulilo for some essential, but missing, article! Stone was obtained from the bank of the Zambesi River, but only at low water, and only at one point, this being the sole occurrence of rock outcrop in the vicinity. All stone was hard-knapped by locally recruited native labour. Sand was available in unlimited quantities but, unfortunately, of rather too fine texture for concrete. However, it had to be used. Cement and lime were sent from Pretoria.

Bricks were burnt in the vicinity and the quality was very poor, as no satisfactory raw material existed. All timber was obtained from the Zambesi Sawmills, who also made all the joinery from their various hardwood forest products. All other materials, e.g. roof iron, plumbing, painting and electrical goods, were sent from Pretoria.

European artisans were not available. Building in the "bundu" is done by native tradesmen, and as can be readily appreciated the standard of workmanship is not of a very high order. Native bricklayers, carpenters and painters were recruited with difficulty, and a good working foreman was sent from Pretoria. In the later stages of the work, a plumber and an electrician from the Pretoria departmental staff augmented the skilled labour force. Local natives provided the unskilled labour, and the maintaining of a sufficient number of labourers was always a source of difficulty. One little complication was that due to the practice of paying partly in money and partly in maize meal. The collection and storage of a sufficient quantity of maize had to be organised months ahead.

Water Supply

The Zambesi River water is always crystal clear and is potable in its raw state, being chemically and bacteriologically remarkably pure. It is quite satisfactory, for example, for topping up batteries. The problem of water supply, therefore, resolved itself into one of pumping from the river, delivery into storage tanks and reticulating. As the maximum rise and fall of the river is about 30 feet and the elevation at Katima Mulilo is in the vicinity of 3,500 feet above sea level, special provision had to be made to ensure trouble-free pumping at all times. The equipment, inherited from the South-West Africa Administration, consisted of a vertical shaft sunk on the river bank to a depth of low water level. At the base of the shaft there was a rotary pump and the 2″ intake pipe was taken through the bank and for a few feet along the bed of the river. The pump was belt-driven from a $6\frac{1}{2}$ H.P. Lister engine in a pumphouse at the top of the shaft. This engine also drove the dynamo for the electric light system.

During unprecedented floods early in 1948, the river rose to within 4″ of the floor of the pumphouse; a few more inches rise would have flooded the pump shaft, and the pumping system would have been put out of action. At remote and isolated centres, the failure of essential services cannot be viewed with equanimity. It was decided, therefore, to install a more satisfactory system. A 2 H.P. Jacuzzi Pumping Unit (an injector type pump), delivering 20 to 25 gallons per minute, driven by a $3\frac{1}{2}$ H.P. Lister petrol-paraffin engine, has been installed, and is giving every satisfaction.

(Concluded on page 24)

Even the magistrate's convenience has not been allowed to spoil one of the principal features of the site, this fine old baobab tree.

Sewerage

Owing to the sandy, porous nature of the soil, the disposal of waste water and sewage presents no difficulties. French drains deal with the former. Each W.C. pan is connected to a simple soakage pit constructed of two or three petrol or oil drums. So far, their functioning has been perfect.

Lighting Equipment

The present electric lighting system comprises a 2 kW 32/65 volt generator driven by the 6½ H.P. Lister engine mentioned above, charging a bank of 9 car batteries. While this installation has given satisfactory service for the past four or five years, it is felt that something more effective should be provided, especially as additional residential buildings are now being erected. It has, therefore, been decided to install a 3 kW, 230 volt, 60 cycle, remote start Onan Lighting Plant, with automatic control panel. This compact and neat little plant will provide for some fifty or sixty light points, and will permit the use of domestic appliances, such as refrigerators, radios, kettles, irons, toasters and so forth. It is not difficult to imagine what a boon these amenities will be to the wives of officials stationed at Katima Mulilo. The remote starting device, which simply means that when a switch is put on, the plant starts up and when the last switch is turned off, the plant shuts down, is a feature of the greatest importance at this isolated spot.

In conclusion, I would emphasise that the object of the Public Works Department has been to provide facilities, conveniences and amenities which are, as far as humanly possible, fool-proof. Less than half-a-dozen Europeans, the Government's servants and their families, have to live at this administrative post where, if anything goes wrong, it may take a month or six weeks for a plumber, a fitter or electrician, with equipment and spare parts, to reach them. It is not without a considerable feeling of pride on the part of the P.W.D. officials concerned, that the Residency at Katima Mulilo has earned the title of the "Show Place of Northern Rhodesia."

TORNADO DAMAGE AT ROODEPOORT

By

CHAS. A. RIGBY, M.Sc. (C.E.),

(Principal Research Officer, Engineering Division: National Building Research Institute).

THE severe storm which struck Roodepoort on the evening of the 26th November, 1948, killing three people and causing £200,000 worth of damage to buildings, has raised two questions: (1) What was the nature of the storm and (2) what steps can be taken to minimize the damage and loss of life sustained from storms in the future?

Nature of a Tornado

From a study of the damage and eye witness' accounts it is obvious that this storm *was* a tornado. Before we can consider whether there are any steps we can take to minimize the damage sustained by buildings and to reduce or prevent the loss of life in such storms let us briefly consider the nature of a tornado.

Briefly stated, a tornado is a very intense, progressive whirl, having a diameter of only a few hundred feet, with inflowing winds which increase tremendously in velocity as they near the centre, developing there a vorticular ascensional movement whose violence exceeds that of any other known storm. From the violently-agitated main cloud mass above there usually hangs a writhing funnel-shaped cloud, swinging to and fro, and rising and descending. The forward speed of the whirl is usually of the order of 20-40 miles per hour or more; its path of destruction is usually less than a quarter of a mile wide; its total life a matter of perhaps an hour or so. In dim light, accompanied or closely followed by torrential rain, and perhaps hail, and usually with lightning and thunder, the tornado suddenly strikes with almost irresistible force.

It is one of the most remarkable things about a tornado that even the lightest object may be wholly undisturbed a very short distance, perhaps only a few yards, from the area of complete destruction close to the vortex. The central low-pressure core of the tornado is surrounded by radially inflowing winds of moderate strength, and then closer to the centre, by spiralling and ascending winds of terrific violence. The surface winds which take part in the vorticular inflow and ascent seem to be chiefly responsible for the damage and loss of life. However, the central "core" surrounded by its whirling winds, has its pressure greatly reduced by the centrifugal force of the whirl; this causes the nearby air within buildings or other enclosed spaces which is at normal atmospheric pressure, to exhibit a powerful explosive effect which may also cause considerable damage to buildings.

Types of Damage Encountered

Summarizing, then we have three sources of damage in a tornado:—

(1) That resulting from the violence of the surface winds;
(2) That resulting from the uprushing air movement close around the central vortex;
(3) that resulting from the explosive action due to the drop of pressure in the central core.

(Continued on page 26)

Photograph by Johansons Portrait Studio, Springs.

Picture B, showing the damage which occurred in the north-eastern part of Roodepoort where the greatest destruction was experienced.

Photograph by Johansons Portrait Studio, Springs.

Picture A. Damage done to houses in the vicinity of the Durban Roodepoort Deep Mine.

Path of the Storm

The damage at Roodepoort was inspected by officers of this institution (including the writer), while the path of the storm, throughout its entire length, was surveyed by Messrs. J. A. King and A. J. Dreyer of the Meteorological Office, Pretoria. The accompanying map, showing the path followed by the storm was kindly supplied by Mr. King.

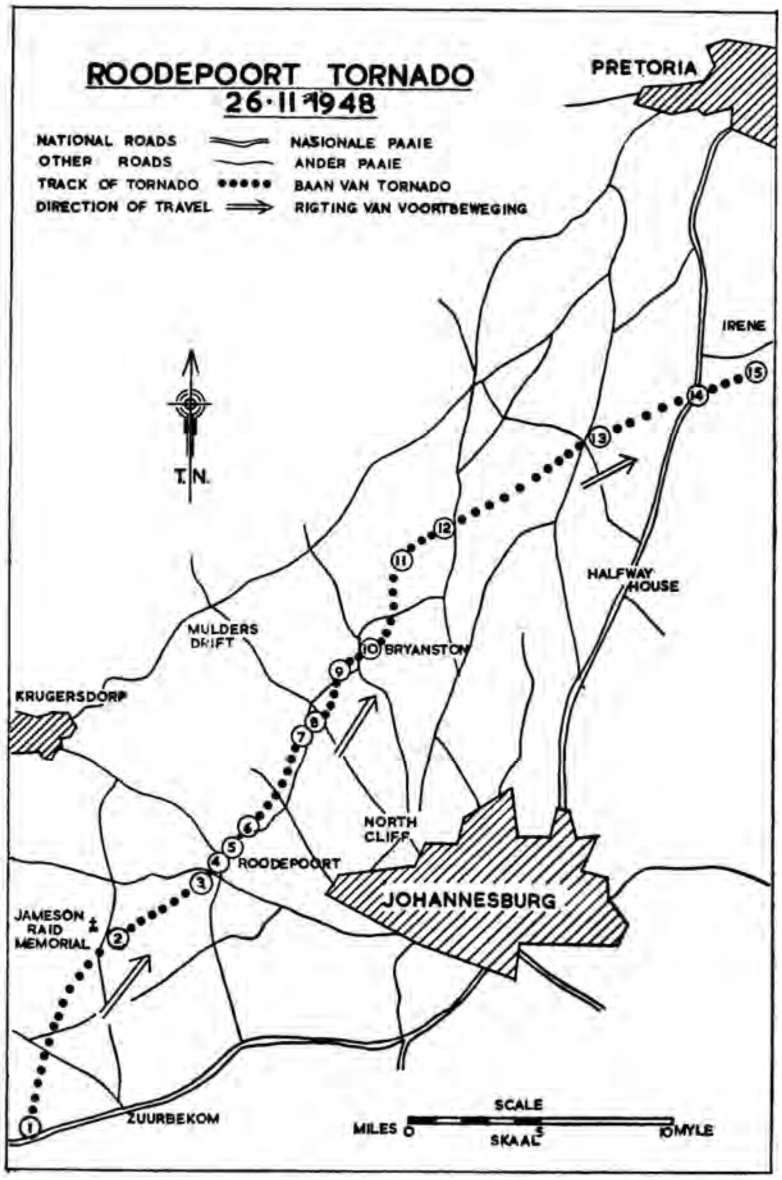
The path was first located at a point 4 miles west of Zuurbekom (Point 1) on the main Johannesburg-Potchefstroom road where it is reported to have struck at 5.15 p.m. Here hailstones 2″ in diameter fell and nearby observers saw a funnel-shaped cloud well above the ground surface.

At Durban Deep Mine, Roodepoort (Point 3) a mine headgear was damaged; trees were uprooted and some houses of very sound construction were severely damaged. Picture A shows the damage caused to some of these houses. Six identical houses which had been very well built stood on the street shown in the foreground. The one on the left, out of the picture, was slightly damaged, the next three were badly damaged as shown, while the two on the right were practically unscathed. The direction of travel of the storm was approximately diagonally across the picture from the lower right hand corner to the top left hand corner.

The path of the storm then passed through a residential area in the North-Eastern part of Roodepoort (Point 5) and it was here that the greatest destruction occurred (see picture B). At this point the path was about 300 yards wide with fairly well defined edges. Within this width the damage showed a very haphazard pattern, a house which showed no evidence of being better constructed than its neighbours would be practically unscathed while five or six houses on either side would be roofless and, in many cases, very badly damaged. This random nature of the damage was observed throughout the area. Evidence of the rotational effect was sought but very little was found here. However, at the Durban Deep Mine the fall of the trees suggested a clockwise rotation while on the outskirts of Roodepoort the roof of a cowshed (see picture C) which had been supported on stone pillars about 2 feet above the general wall level was rotated in a clockwise direction through a small angle. The sidewalls of a nearby roofless cowshed collapsed toward the centre of the storm's path. No evidence of the explosive action, caused by the drop in pressure, such as walls or windows falling outwards, could be found although it was reported that the plate-glass windows of a garage "blew-out" into the street. Ceilings which had risen were fairly common but in these cases the roof was either completely gone or was missing on the leeward side, and it might have been the uplift caused by the wind on the leeward side that was responsible for the raising of the ceiling. It was observed in practically all cases where only part of the roof was missing that the missing part was on the leeward side of the buildings showing that uplift is the predominant cause of failure of roofs.

Sheets of galvanised iron roofing and other debris were scattered over a wide area of the veld on the upward slope of the hill beyond Roodepoort. An avenue of trees (Point 6) on the brow of the hill was badly damaged and several of these trees had sheets of galvanised iron wrapped round them several feet above the ground. The trees in the centre had collapsed in the direction of the storm, but the ones on the left hand edge had fallen towards the centre.

The storm followed the path indicated and uprooted 40 blue-gums over a width of 200 yards at milestone 13 on the main Johannesburg-Pretoria road (Point 14). The last trace of damage was observed near Irene (Point 15), where more blue-gums were uprooted. There are conflicting reports of the time it reached here, but the most reliable put the time at about 7 p.m. The total length of the tornado path traced was about 41 miles, and the rate of travel, according to reports of the times when the tornado passed various points on the route, was 22-28 miles per hour.



Symptoms of the Storm

In their report Messrs. King and Dreyer conclude that this storm was a tornado of the type commonly known in the central southern states of the U.S.A. in that :—

(1) A writhing funnel-shaped cloud was observed below the main cloud base.

(2) Damage occurred intermittently along the track of the storm and was confined to a width in no case more than 300 yards.

(3) The storm was accompanied by hail and severe thunder. Both are indications of extreme atmospheric instability.

(Continued on page 27)

Photograph by Johansons Portrait Studio, Springs.

Picture C. Partially rotated cowshed roof.

(4) Damage occurred in valleys and on hills on both upward and downward slopes without showing any preference for locality.

(5) No damage occurred even on short distances outside the track.

(6) The evidence obtained indicates a cyclonic (clockwise) direction of rotation.

(7) The storm was short but intense in its duration where it touched the ground.

(8) There was considerable variation in intensity at the points of damage located.

Excessive Cost of Preventative Construction

In regard to the protection of property certain conclusions are fairly clear. Tornadoes cannot possibly be prevented, and no building, certainly none of any practical nature, can be built to withstand the violence of the wind in the vortex of a well-developed tornado. Costly preventative construction is not recommended for two reasons: (i) it is not likely to be effective if the full force of a tornado should strike the building; and (ii) the tornadoes are, fortunately, rare in South Africa and cover such a limited area that the chances of any particular house being struck are very remote indeed, and therefore any large additional expense is not justified. However, the intensity of the tornado violence and the velocity of the surface winds vary greatly and the damage done by the less violent components will depend on the type of buildings and excellence of construction. Obviously buildings of good, sound construction should be less liable to sustain damage than those less soundly constructed.

Previous Tornadoes in the Union

The records of tornadoes which have occurred in South Africa since the turn of the century are by no means complete and it is possible that a number have occurred in remote parts of the country and have not been reported. Those which have done the most damage are listed below:—

(a) Malmesbury, C.P., 29th September, 1905; path about 300 yards wide by $\frac{1}{2}$ mile long; killed 7 people and damaged 75 to 80 buildings.

(b) Turffontein, Johannesburg, 6th October, 1929; path about 300 yards wide by 7 miles long; no casualties; estimated 200 buildings damaged.

(c) Roodepoort, 26th November, 1948; path 300 yards wide; 3 people killed and 425 buildings damaged.

It is interesting to note that in each case the path is reported as being 300 yards wide.

The most complete records found were those for the period December, 1923, to December, 1929, when twelve tornadoes were reported from such widely scattered points as Pietermaritzburg, Delarey, East Griqualand, Kokstad, Newcastle, Pietersburg, Umtata, Volksrust and Turffontein.

No record of the number of buildings damaged by these storms could be found, however, but an estimate of 130 was made (omitting Turffontein) on the basis of the value of the damage done and the size of the town involved. Due to natural growth many of the smaller towns in the Union now cover a larger area and are more densely built up than during the period under review; so it may be expected that more buildings will be damaged by tornadoes in a similar period of time in the future. A 50 per cent. increase should be more than ample to allow for this factor. With this adjustment an average of 33 buildings damaged per year can be expected. Although the records do not cover a long enough period to give an accurate probability figure, those that are available show that a tornado may be expected to strike some larger centre once in 20 years. It is unlikely that the damage sustained will be more severe than that at Roodepoort as the storm passed through a thickly built-up area. Assuming the Roodepoort figure as the probable loss, another 22 buildings annually is added giving a total expectancy of 55 buildings damaged per annum. It is assumed that there are about 750,000 buildings in South Africa of the class reported as damaged in the records, which gives a probability figure of 1 in 13,600 of any building being damaged in any one year. It is believed that the actual risk is much less than this.

Roof Construction Weaknesses Found

An examination of the damage at Roodepoort has shown up certain weaknesses in roof construction which could be improved at very little additional expense. Had these details been taken care of there is no doubt that the damage sustained would have been much smaller. One of the weaknesses noted was the practice of fastening the rafters down to the walls with a single strand of galvanized wire embedded at one end

(Concluded on page 28)

Photograph by Johansons Portrait Studio, Springs.

Picture D. Wall plate anchored to top of wall.

in the brickwork, passed over the rafter and twisted around itself below the rafter. Where the rafters had been thus fastened down, and the roof had been lifted off by the storm, in nearly all cases the fastening had failed because the wire had straightened out or had broken where it had been twisted around itself, and not because the wire had pulled out of the brickwork. If double wires or strap-iron anchors, securely built into the brickwork and anchored to the rafters had been employed, it is very probable that some of these roofs would have remained in place.

It was also noted that in some cases a wall plate had been anchored to the top of the wall and the truss rafters nailed down to this (see picture D): this detail develops very little strength and it is recommended that the rafters should in all cases be anchored directly to the wall. In a number of cases where the trusses had been properly anchored they remained firm but the corrugated iron roofing was missing (see pictures D, E and F). It was observed that in these cases the purlins had been carried away with the roofing, indicating that the fastening of the purlins to the trusses is weaker than the fastening of the iron to the purlins. In most of these cases the purlins had been fastened to the rafters by nails which developed very little resistance to lifting. If the purlins had been strapped down to the rafters with hoop iron or angle irons a much stronger joint would have resulted. Failing this a bolted joint could be employed to advantage. In general it was considered that the members of the trusses themselves were adequate but that the method of fastening the truss down and the joint details, both of truss members to each other and to the purlins, were the weak links. Improvement of these details would not be costly and would, no doubt, materially reduce damage done by the less violent elements of a tornado.

No cases were observed where a wall had collapsed when the roof had remained in place. In cases where one or more walls of a building had collapsed, and witnesses or victims could be interviewed, they were unanimous in stating that the roof had gone before the wall or walls collapsed. Hence it is apparent that improvement in the roof details and anchorage, if it is effective, will reduce the damage to walls and danger to life, as well as reducing roof loss. It seems prudent therefore to carry out the suggested improvement in roof details.

Photograph by Johansons Portrait Studio, Springs.

Picture F. Part of Roof retained.

Photograph by Johansons Portrait Studio, Springs.

Picture E. Purlins carried away with roofing.

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HOUSING STANDARDS

Extracts from Part II of a Symposium presented to the South African Health Congress, on behalf of the National Housing and Planning Commission.

By

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IN our March issue we published extracts from the first part of Mr. Connell's paper. In this second part he deals with standards of services, structures, comfort and architectural design.

Sanitation Standards

WITH regard to sanitation services, it appears that the question as to whether each dwelling should have its own individual latrine as opposed to the provision of communal latrines (possibly of a better standard) is of more importance than the question of whether or not to provide water-borne sewerage. It is generally held that individual latrines should be provided in all cases, and in consequence it will be recommended that a private closet be installed with every dwelling, and that schemes relying on communal sanitary facilities will in future fall below the minimum standard.

As to the type of sanitary system to be provided it is hardly practicable in this country to insist on a water-borne system as the minimum acceptable standard, although the advantages of this system are so great that no effort should be spared to provide this form of sanitation wherever possible. In fact, this system should be installed in all cases except those in which there exists some physical obstacle to its provision, such as an inadequate water supply. Even rocky subsoil should not be regarded as an insuperable obstacle in this regard, in the sense that greater care expended on the choice of sites for housing schemes would preclude their being constructed on such unsuitable ground, and so remove this oft-quoted reason for dispensing with water-borne sanitation.

Water Supply

Where a piped supply exists the question to be decided is whether, in the interests of health and hygiene, the street standpipe serving a number of dwellings is adequate, or whether the supply should be carried direct to each dwelling. The Research Committee inclines to the latter view, in the light of the fact that reticulation to street standpipes itself uses up a high proportion of the piping that would be necessary to supply each dwelling. As a minimum standard, one water-point in each dwelling should suffice.

Heat Services

The heat services normally provided with the dwelling include some means of cooking food, heating water and some provision for space heating, generally in that order of importance. All these functions can be satisfactorily combined in one relatively simple appliance, or the first two alone, where the heat given off from the stove would be undesirable.

At the lowest level, as in the kraal, cooking is performed over an open fire placed either out of doors or in an open hearth indoors, and water heating is performed in receptacles placed over the fire. Despite the romantic associations of the camp fire, this method is thermally inefficient in the extreme. In consequence it is found that considerable amounts are spent on fuel for very little return by way of heat services. In fact, a survey carried out last year among Native householders living in locations on the Witwatersrand, revealed that the average Native family spends more per month on fuel than the average working-class family spends in England — a cold country — on a vastly higher standard of heat services. And this in a hot country like South Africa! It is considered desirable that more suitable types of cooking stoves should be designed and installed even in houses for the lowest income groups. Stoves of this type should incorporate within their design a low-pressure boiler capable of providing economically a small reserve of hot water. Something approaching this is in fact available, but the types obtainable from present designs do not provide sufficient control to prevent wasteful combustion; with a very little modification, however, they could be brought into line with the suggested standard.

The question of alternative types of appliance — electrical or gas burning — need not concern us here, the important point being that adequate provision for economical cooking and water heating must be provided in every dwelling.

The requirements for space-heating will vary in different parts of the country. Nowhere, however, does this requirement become a ruling condition in South Africa, where intermittent heating is all that is required. In most dwellings the cooking stove, if properly placed, will suffice for this purpose. Alternatively, a small open fireplace or an electric or gas heater may be provided in the living room; this is particularly suitable in areas which have relatively long periods of cold weather. The main object in making some definite provision for space heating is, of course, to put an end to the use of the brazier inside dwellings.

External Services

It is in the external services that there exists the possibility of far-reaching reductions in cost, without endangering the public health or well-being. Whilst it is true that the conventional standards of street and footway construction, complete with kerbing, storm water drainage and so on, represent the desirable standard, there is no doubt that very often much less elaborate facilities would suffice in all but the main estate roads in housing schemes. Provision should be made, of course, for the full eventual road width between opposite fences, but in times of stringency like the present it is not necessary to do more than lay down a carriageway of the minimum possible width, having wide grassed verges without kerbs, and doing away in most cases with paved footways. This may entail a little inconvenience to the occasional motorist — of minor importance in residential streets — and it may cause the pedestrian to get his feet wet or his shoes dusty but no permanent disadvantages are likely to accrue from such a reduction in standards; but great savings in cost would result if such a policy were to be consistently carried out.

It has been noticed, too, that a great deal of unnecessary expenditure goes into the construction of suburban residential roads of excessive width. This practice is not only expensive in construction costs, but is also extremely wasteful in land-

Decentralising London: a trench-digging machine being used in the first stages of the development of Chippingfield, near Harlow. Within the next 20 years an area of 6,300 acres is expected to house 60,000 present day residents of London's northern and north-eastern suburbs.

use, tending to reduce densities, increase the total area of the scheme and hence throw up its total cost.

Communal Services

Additional communal services such as health clinics, crêches, community centres and the like, which are at present provided for under the formula referred to by the previous speaker, are very necessary elements in the housing estate, particularly in poorer districts, where they may play an important part in combating anti-social tendencies. Sites should be set aside for these facilities, but their provision should properly be made out of social welfare or health funds rather than out of diminished housing funds.

STRUCTURAL STANDARDS

It was not considered the task of the Research Committee on Minimum Standards of Accommodation to lay down minimum structural standards for dwellings, but it is probable that therein lies one of the most promising directions in which costs may be reduced.

About two years ago a well-known authority, speaking about urban native housing, made the statement that, at that time, the cost of the average dwelling was roughly £350, and of its services £150. Thus of the total cost, 70% was expended on the dwelling and 30% on the services.

Cost Analysis

In a study of a number of small, relatively low-cost houses in the economic class intended for occupation by Europeans, the following average distribution of costs was found to apply :—

Total cost of **structure** = 100.

Foundations	6%	Flues	2½%
Walls	17%	Plastering	5%
Floors	12%	Painting	5%
Roof	10%	Plumbing	9%
Ceiling	4%	Sanitation	3%
Windows	4%	Electrical	5%
Doors	10%	Miscellaneous	7½%

No accurate figures are at present available for the type of house commonly erected in urban native locations. The proportions would vary somewhat; that expended on walls tending to be slightly higher, whilst that spent on finishes, doors and electrical installation would tend to be lower. Due to the smaller size of the dwelling, the proportions would not be vastly different from those given.

It is clear at once that drastic reductions in cost can never be made, and, that if the cost of building is to be effectively reduced at all, this can be accomplished only by seeking ways and means of lowering the cost of each element in turn. One way of reducing costs which suggests itself, therefore, lies in the minute study of building methods, which will embrace the manufacture and distribution to the trade of the constituent materials in order to seek ways of lowering their initial cost, the methods and processes employed in building them into the structure, the problems of process efficiency, lost time and falling off in the efficiency of workers due to fatigue and similar causes. Minute gains all along the line in each of these aspects would be likely to add up to considerable savings in the cost of the dwelling as a whole; multiplied over a large number of units, the savings would release funds for many more dwellings.

It should never be forgotten that the housing situation in South Africa has reached a state of crisis; the fact that this has been so for some time and that we are getting used to being reminded of it does not alter the fact itself. Conservative estimates have been made which place the extent of the housing shortage at roughly 300,000 dwelling units, of which the great majority will be required for natives. Naturally, the provision of so many dwellings must be spread over a number of years, but nevertheless a very determined effort will have to be made very soon if the country wishes to insure itself against the more disruptive effects of bad housing conditions. It is this urgent need for speed which prompts the suggestion that more latitude may have to be allowed in the matter of the structural standards of dwellings, at any rate for a time.

In view of the emergency measures and temporary expedients which will have to be resorted to, necessarily, to supplement even a greatly accelerated output of permanent houses, advantage should be taken of this fact to permit the construction of a certain amount of housing the structural standard of which may be below that of the conventionally accepted and time-honoured methods of construction.

Types of Housing

It is suggested that there are three classes of housing in which the structural standards may be different; these are as follows :—

(a) Emergency subsistence housing.

(b) Transitional and rehabilitation housing.

(c) Permanent (40 year loan) housing.

In South Africa, almost all housing effort in the past has concentrated on the last category and little attention has been given to the other two; in the future it is almost certain that very much more attention will have to be given to these two types of housing accommodation.

Subsistence housing, which should be permitted only where a grave emergency exists, as at Moroka, for instance, or in places where new and rapid developments are taking place in hitherto remote places, such as new pioneer settlements or construction sites, would represent the lowest level of housing accommodation for which funds are provided. Housing of this sort should be regarded as a gift or as a form of short-term social insurance rather than as an investment and it should be destined for a short life, followed by total demolition at the end of a fixed period. In this sort of housing the lowest constructional standards consistent with health requirements will suffice; indeed it is of vital importance in this class of work that the structure should be incapable of surviving the calculated useful life of the buildings, otherwise the tendency will be towards permanent occupation.

Owing to the fact that it offers no real solution to the housing shortage, but is only a local emergency measure, subsistence housing should never be allowed too large a part in the total housing plans of the nation.

The second group, transitional and rehabilitation housing, may represent a much larger proportion of the total and should play a bigger part in future housing plans than it has done hitherto. Housing of this type takes two forms: first, housing constructed to structural standards lower than the conventional (e.g. 4½" external walls without floors or ceilings) to meet an immediate need and intended for later conversion to permanent standards; second, housing intended for the temporary occupation of ex-slum dwellers and people in a transitional state of culture, for rehabilitation purposes prior to their eventual transfer to permanent houses. In both cases the intention is permanent occupation of the site, and the temporary buildings are constructed in their final positions in the layout. Consequently permanent standards of estate planning are called for from the outset. In regard to the dwellings themselves, reduced structural standards, ranging from a mere lowering of the standard of finish to general reductions in the structure itself, may be permitted according to circumstances.

Houses intended as permanent dwellings (i.e. having a life of half a century or so), fall into the class which occupied the attention of most housing authorities in the past. Faced with rising costs and in many cases with lowered efficiency, it has been suggested that careful observation and study of the various building processes covering every element in the structure of dwellings will open the door to reduced costs, increased efficiency and hence ultimately to greater productive capacity in the field of traditional housing construction.

New Methods of Construction

There have been many attempts in South Africa, some of them extremely successful, to evolve methods of construction which will provide low-cost housing of an adequate standard at a price below that of traditional construction. Most of these systems, which were evolved mainly for use in native house construction, make use of an extreme degree of rationalization, involving the careful detailing of the structure, the simplification of all processes and the thorough organization of the sequence of operations to avoid lost time and wasted effort. A number of these systems have succeeded in reducing the cost of dwellings to less than one-half the cost of similar dwellings constructed on traditional lines; one or two types have achieved even greater reductions. Not all of them, however, are built to the same structural standard as is provided by traditional construction, and the question arises as to how much can these promising methods be employed for permanent house construction on the forty year loan basis? It is linked with other questions which are being raised, such as whether half-brick external walls could be used in house-construction, or whether soil-cement or pisê-de-terne construction is permissible in permanent housing.

Unfortunately there exist no convenient accelerated tests whereby the performance of a new material or building method can be quickly checked against that of traditional construction.

The traditional structural standard will continue to be the norm, its performance being known by experience, and the question of the widespread use of alternative systems of construction will remain a matter for assessment on the merits of each case.

It is certain that a great deal more latitude in the choice of constructional methods for assisted housing projects will have to be permitted in future if the provision of dwellings is to go ahead at a pace consistent with the urgency of the housing problem. It is logical to recommend that the work of the Research Committee on Minimum Standards of Accommodation, now nearing the end of its first study of this problem, should be followed immediately by the setting up of a competent research committee to study the question of structural standards.

A permanent prefabricated aluminium primary school, the first of its kind, built at Lockleaze, near Bristol. This view depicts a corridor with cloakroom recess on the right.

COMFORT STANDARDS

The Research Committee on Minimum Standards of Accommodation has prepared a series of reports dealing with comfort standards in dwellings. These cover the heating, cooling and ventilation of buildings, their natural and artificial lighting and the reduction of noise in dwellings.

Heating, Cooling and Ventilation

It has been found that the greater portion of discomfort results from heat penetration through the roof or roof-ceiling combination, due to the high solar radiation conditions in South Africa. Consequently it will be recommended that the practice of providing dwellings with unceiled roofs should be discontinued. With the provision of ceilings, together with adequate ventilation, it becomes possible to lower their minimum height above floor level. This will provide some partial compensation for the additional cost of the ceiling.

Lighting and Noise

Minimum standards of daylighting and artificial lighting have as their object the care and protection of sight, and the elimination of eyestrain. The physical conditions for good lighting are well known, and the problem is simply to set a standard that will provide these conditions within the dwelling.

The Research Committee has found that the traditional method of fixing minimum window sizes by reference to a fixed percentage of the floor area does not in all cases give rise to satisfactory conditions, particularly in living rooms and kitchens. Consequently a recommendation will be made that a new method of utilising the "daylight factor," which gives rise to standards in conformity with the theoretical requirements should supersede the present method in all future work.

The importance of correct siting and orientation in relation both to the cooling, daylighting and sun penetration of dwellings cannot be too strongly emphasised. This is largely a matter of design and cannot conveniently be laid down in a schedule of minimum standards.

Recommendations will be made in respect of the minimum standards of noise reduction in dwellings. Good standards of noise reduction are of particular importance in combined and multiple dwellings, such as terraces, flats and hotels.

Standards of Architectural Design

The partial reduction of standards which may be found advisable for economic reasons, need not necessarily mean a poor residential environment, either within or outside the dwelling, provided a high standard of architectural design is insisted upon at all stages of the work. It is difficult, if not impossible, to define standards of design, or to include them in a schedule of minimum standards, but good design standards are no less vital to the success of any housing scheme than are the mandatary and conventional standards which preserve its social and economic validity, and nowhere is the importance of good design more vital than in schemes where some of these standards have had to be reduced.

Architectural standards apply not only to the planning and design of dwellings themselves but to the visual relationships between buildings as seen together in the open air, and to the design of the environment as a whole. This includes the question of skilful study of the site, the planting of trees and grassing of open spaces and the design of all the ancillary details such as street lamps and nameplates. The visual relationships between dwellings becomes of supreme importance in areas of high density development, such as may be expected to become more common in our cities as time goes on. We are unused to this type of development — involving the use of terraces, flatted dwellings and flats — but there is no reason to suppose that its appearance need be a calamity. In many countries high standards of architectural design applied to housing, have succeeded in resolving the planning and visual problems of high-density urban development, often with very great success.

The idea of carrying good design into every detail of the home and the housing estate is not yet commonly-accepted practice in South Africa, but this idea has much to commend it, for it will provide a defence against the air of sordidness and mediocrity which has too often characterized low-cost housing schemes constructed in the past without due regard to good standards of architectural design. Architectural design can thus be regarded as a first-class morale-builder. The converse is true: if the environment is sordid and ugly, it will inevitably have a depressive effect on the national morale.

THE UNION'S WATER RESOURCES

By

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IN our February issue we published an account of the activities of the Rand Water Board. Here, this vital question of water supplies is discussed on the national plane.

This important, factual and candid paper formed the subject of Mr. Mackenzie's recent Presidential Address to the South African Institute of Civil Engineers in Cape Town. After pleading for new water legislation, the author surveys agricultural possibilities, underground supplies, irrigation and soil conservation. Our next issue, which will conclude the paper, will give his remarks on industrial and mining development, river pollution, hydro-electric and electrical development, municipal water supplies and regional development.

THE whole of our future economy and development is so bound up with our water resources, that it is high time we took stock of our meagre supplies and tried to base their use on what we, as a nation are aspiring to achieve, namely self-sufficiency.

Water is the one commodity which is essential to the existence of mankind, animals and plants, so that its study is not confined merely to the hydraulic and hydrographic engineer, but to all of us in some degree or other.

The engineer is concerned with its conservation, control and use, the chemist in its composition and purity, the farmer in its application to the soil, and so on until we finally reach the man in the street who looks forward to his daily bath.

We are all familiar with the protagonists of this and that theory for the solution of our country's water problems, but how few people realise that these well-meaning folk unfortunately seldom, if ever, consider if their facts are correct and never ascertain whether our local conditions permit of their ideas being carried out or not.

South Africa is a land of great contrasts — geographically, climatically, geologically and in practically every way; so much so, that the adoption of overseas methods and practice can only be made if these are so modified that they fit in with our local conditions, otherwise they should be left alone.

The use of water has been based so much upon European conditions, instead of adapting practice to local conditions, that now, when we are on the eve of great expansion we find ourselves up against past precedents and vested interests, as for instance in our water laws.

Water Legislation

Under our present water legislation freedom of action is very restricted on account of the vested interests of riparian owners and in consequence development is being hampered owing to the lengthy legal processes that have to be overcome before any headway can be made.

When the original Water Act* was brought into being in 1912, it was not fully realised then how rapid our mining and industrial development would be, and the Act in consequence dealt primarily with irrigation.

Amendments have been introduced from time to time to meet the changing conditions, but these have never gone far enough and the only solution to the problem would be to scrap the whole Act, redraft a new one to meet our present-day conditions and in some measure try to anticipate the probable requirements of future development.

By this it is not to be inferred that a new Act should ruthlessly deprive present owners of their vested rights but rather should aim at bringing about a more balanced distribution of our water resources between all sections of the community.

Water is a commodity which is in very short supply and will be increasingly so as time goes on. If stricter control is to be introduced then it should be in the hands of the State which has the interests of all sections at heart.

Responsible opinion amongst the more enlightened sections of the public has made repeated requests for the abolition of our present water code and the substitution therefor of an Act which is simpler in operation, more in keeping with our present development and suitable to our future requirements. The sooner this is done the better for all concerned.

Agricultural Possibilities

In comparison with other countries South Africa is agriculturally a poor country and if we consider its climate and physiography the reason is not far to seek, for we have a low average rainfall of about 18 inches per annum which is irregular and erratic both seasonally and in its distribution.

Climatic conditions being what they are, and there is no reason to expect any alteration despite the numerous theories put forward, the production of crops is dependent upon a sufficiency of rainfall, and if this is lacking irrigation must be introduced to make up the requirements of plant growth.

Of a total area of nearly half a million square miles which comprises the Union, it has been stated that only about 20 million morgen are arable and it is doubtful whether, except under very favourable conditions, we will have one million morgen of land under irrigation in any one season.

Fortunately we have areas like the Cape coastal area where crops can be grown without the use of irrigation water, as for example the wheat areas. In the Transvaal and Orange Free State highveld, maize and wheat can also be grown without irrigation, but the continual cropping of all these areas has given rise to depleted yields and in some instances laid the surface open to the ravages of wind and water, with resulting soil erosion.

In Natal, along the coastal belt, sugar-cane is also grown without the aid of applied water but it is becoming very clear, to those who have given the matter any thought that, if irrigation could be introduced into this industry, it would result in greater yields and more stabilised results.

We are so subject to the menace of periodical droughts that the farmer who has a reasonable and assured supply of water at all times can regard himself as blessed and it is therefore essential to nearly all our farming operations that there should be a good supply of water available at all times and seasons.

The Hartebeestpoort Dam, completed in 1922, has a capacity of 33,550 million gallons.

South Africa is primarily a pastoral country and any departure from this into the agricultural field can only be made where there is a sufficiency of rainfall or where irrigation water is available to make up the deficiency. Farmers should face up to this fact and not indulge in a lot of wishful thinking.

Underground Supplies

South Africa possesses practically no artesian basins or aquifers of any magnitude. There are a few areas in the Union where waters from dolomitic formations have been of great service to farmers and townsmen, as for example the Mooi River basin at Potchefstroom and the well-known source at Fountains at Pretoria, while other dolomitic sources are to be found at Zuurbekom, Kuruman, Ottoshoop, Mafeking, etc., but the quantity of water, though useful, is not great and full use is being made of it.

If we study a rainfall distribution map we see that about half the area of the Union has a mean annual rainfall of 15 inches or less and owing to the relatively low humidity of the area the evaporation is correspondingly high.

Along the south and east coastal belt the gross evaporation factor varies from 50 to 60 inches per annum while towards the north-western Cape it is as much as 110 inches.

Under these conditions it is not to be wondered at that we have no surface waters, except rivers passing through the area which derive their water from more distant sources of higher rainfall as, for example, the Orange River which originates in the Basutoland highlands.

Having little or no surface water run-off of its own this low rainfall area is dependent upon underground supplies brought to the surface by means of drilling, and many of these boreholes are drilled to a depth of as much as 500 feet below the surface.

In some of these areas the water was laid down in geological times and, as it receives no replenishment from surface infiltration, the farmers are virtually drawing upon capital, which means that in time lack of water will make successful farming quite impossible in those regions.

In a recent survey of our underground water resources (Geological Survey Memoir No. 1) Dr. Bond has shewn that

* "The Irrigation and Conservation of Waters Act," No. 8 of 1912.

the Union is further handicapped in that very little of our underground water is fresh, some is potable but a great deal has such a salinity as to be quite unfit for consumption.

Some indication is given of the extent to which use is made of our underground supplies by the fact that government drills have put down some 35,000 holes to date which have yielded on test the equivalent of nearly 700,000 acre-feet per annum. To date the sum of £4,580,000 has been spent on drilling for farmers.

If we include the drilling done by private enterprise it will be realised that, but for this source of supply, a very large area of our country would not be populated at all and it has always been a source of wonder that man and beast can survive on so little water and this should be an object lesson to the average townsman in the economical use of water.

These supplies, so hardly wrested from Nature, are the mainstay of our wool and meat production, which in turn contribute largely to our national economy.

It is, however, a great pity that the ignorant exploitation of this branch of farming has contributed so much to the speeding up of the processes of dessication through over-stocking, and unless checked in time, may result in national disaster.

Irrigation

Irrigation has taken place along our rivers since the early advent of the European and the influence of the Huguenots is to be seen in the viticulture practised in the Cape Western Province.

As civilisation spread up north from the south, so the early pioneers settled themselves along all the rivers and streams that gave any indication of perennial flow, and throughout the length and breadth of the land the fertile alluvium of the river banks has been utilised for the production of crops under water.

Initial private enterprise was followed by communal effort when the problem became too large for the individual and later the government came forward with land settlement schemes under irrigation.

To-day we have the following areas under irrigation :—

(a) Government controlled schemes	90,000	morgen
(b) Board operated schemes	140,000	,,
(c) Small owners and others	70,000	,,
Total	300,000	,,

When we consider the vast areas under irrigation in Egypt, India and America it will be appreciated that we have actually done very little, but this is only because our natural resources are so limited.

Most of our rivers have little or no perennial flow and what surface run-off we do get is irregular and in the most cases flashy. Heavy thunderstorms, with short but intense precipitation, are the order of the day in the summer rainfall area which comprises about 85 per cent. of the Union.

Under these conditions and bearing in mind the vexed question of overgrazing, it is not to be wondered at that, where the topography is steep, any heavy run-off must be accompanied by soil erosion and resultant silt, which finds its way into the natural drainage lines of our rivers.

Roughly reviewing the Union and treating it on provincial lines, it may be stated that there is room for considerable irrigation development in Natal, particularly along the coastal belt from the Portuguese border south through Zululand to Durban. New areas could be put under cultivation and the sugar-growing industry would greatly benefit by applying water to the raising of cane.

In the north-western portion of this Province lie great possibilities in the way of industrial development on account of the coal measures there.

Following the coastal belt southwards from Durban we have an area which has been given over to winter holiday resorts and no large-scale irrigation is likely nor desirable.

In the Transvaal, we find that practically all the headwaters of the Limpopo River have been dammed up for irrigation and here future development is limited.

Along the north-eastern escarpment, from the Zoutpansberg south, there are a number of rivers draining to the east where, under semi-tropical conditions, a number of diversion schemes have been built. Seasonal fluctuations of flow in the winter months have now made it almost essential that storage should be provided to balance the flow and to make new development possible.

Generally speaking further large-scale development is not possible in this Province but a fair number of smaller projects will in time be built.

In the Cape, considerable development has taken place but, unfortunately, the silt problem has reduced the storage capacity of a number of old schemes and expensive remedial measures will have to be applied to restore them to their former usefulness, as for example Fish and Sundays Rivers.

When it can be shewn that soil conservation can be effectively carried out, a number of new projects might be tackled later, but it would be suicidal policy to try and develop them to-day as potential storage sites would be ruined for all time due to siltation.

In the Orange Free State some development has taken place but it is doubtful, in view of the probable needs of the gold industry, whether any new major irrigation will be possible, although however there is scope for certain minor works on some of the tributary rivers of the Vaal and Orange Rivers.

Coming to the Orange River and its major tributaries the Caledon and the Vaal, we find that these three rivers account

Van Ryneveld's Pass Dam near Graaff Reinet.

for one-third of the mean annual run-off of the Union amounting to about ten million acre-feet per annum.

In the case of the Caledon River there is little prospect of irrigation along its banks and its future use will be to augment the water of the Sand, Vet and Modder Rivers in the Orange Free State by taking its waters through tunnels into the headwaters of these rivers.

The Orange River, with its comparatively heavy silt load, does not at this stage lend itself to storage, but proposals are afoot to divert some of its water, after desiltation, at Bethulie, through a tunnel some 50 miles in length, into the headwaters of the Fish River, in order to rejuvenate this valley and also that of the Sundays River. In addition an added acreage will be obtained of about 50,000 morgen.

The further use of the balance of the water of this river is at present being investigated but it would be somewhat premature to make any comments at this stage, beyond saying that there appear to be possibilities, if barrage type structures are built, to control the flood waters, which at present only serve some 25,000 morgen of alluvial soil from the Buchuberg Weir to the Aughrabies Falls, the rest finding its way to the sea.

It must be appreciated that whatever scheme is undertaken to harness the waters of the Orange it will be very expensive, and until large-scale soil conservation has proved effective, storage is not desirable, unless we are prepared to face up to an annual loss in storage capacity of about 60,000 acre-feet, which is the computed silt burden of the river to-day.

Limits of Irrigation

Against this somewhat black background and omitting for the moment the other possibilities of water use, we may well ask if irrigation has any further role in our future economy? The reply is in the affirmative, provided we do not try to go one better than Nature intended us to go.

It is obvious that we have large areas which are entirely pastoral and not agricultural in character with very small supplies of surface water, augmented only by underground supplies which should only be used for grazing herds and flocks.

The farmers in such areas must accept this hard fact and instead of clamouring for impossible and foredoomed storage schemes they should adapt their farming practice to their environment and concentrate on the care and protection of the local vegetal cover.

Vaal-hartz weir four miles above Fourteen Streams bridge

In similar arid and semi-arid areas where the surface run-off is known to be erratic and intermittent in character, with an occasional heavyy flood, storage on any scale is also seldom possibsle or desirable, and, if carried out, invariably leads to loss of storage capacity due to heavy siltation and in a lesser degree from evaporation.

Where schemes have been built in these areas they have been failures and even highly expensive remedial measures will bring no alleviation, for the simple reason that the water resources are wholly inadequate and cannot support the increased population.

It is difficult to resist appeals from these areas but in the national as well as the individual interest quite apart from grounds of economy, sentiment should be set aside and a more practical stand taken.

The proper solution would be the removal of some of the population to areas better suited to irrigation and this would be in the interests of the State as well as the individual, who now merely ekes out an existence and can never rise above his present hard environment.

Just as "one swallow does not make a summer" so an occasional flood in a river does not justify the building of a storage dam.

It is essential for successful irrigation farming that the irrigated area should be kept well within the limitations of the available water supply and if there are any known factors which prevent this, then in the interests of all parties concerned the amount of development should be restricted.

If we are to bear in mind the water requirements of our mines and industries, it is evident that most of our future schemes will have to be studied in relation to how far they are likely to come into competition with these activities for the use of water and when built will have to be made complementary.

Strange as it may seem in this land of water shortage, it is a fact that one of the greatest evils on many of our existing irrigation schemes is over-irrigation. Excessive use of water brings with it water-logging of the soil and, bearing in mind the generally high evaporation factor in the more arid areas, the next stage is the rendering unfit of the soil, through "brack" or alkali from the dissolved salts drawn up by capillary action.

If we are to retain the fertility of the soil this evil calls for the closest co-operation between the engineer and the soil chemist, who in turn must educate the farmer into better ways and methods of preserving the soil and conserving the water.

Past mistakes and errors must give way to proved and more scientific methods otherwise the results will be ruinous to the individual concerned and the country as a whole.

There is much to be desired in our general agricultural set-up, particularly in regard to irrigation, and it is hoped that with the recent introduction of the Soil Conservation Act our scientific colleagues who have to advise the farmers on these matters will co-operate with us in planning more correct land use.

Soil Conservation

Reference has been made to the menace of silt in our rivers and as engineers we are all fully alive to this vital problem, which militates against all successful attempts to

Kamanassie Dam, fifteen miles north-east of Oudtshoorn.

store surplus water. In fact, there is not a single river in South Africa which does not in some degree or other carry its quota of silt.

The annual loss of capital expenditure through loss of storage in our dams is enormous, and with each successive raising, we not only lose storage but the increasing shallowness of the basins renders them useless through excessive evaporation.

Geological dessication over the ages has shaped the earth's crust and will continue to do so despite all our puny attempts to stop this process, but we can, however, slow down the process if we try to work in harmony with Nature.

Man, by his exploitation of the earths' surface, be it bad farming methods or slipshod engineering practice, has hastened the process, and it is in the latter regard that we can assist in the general scheme of things as engineers.

The public has been made soil conscious by a good deal of press propaganda and is looking for spectacular results, but it will be rather disappointed, as the crux of the matter lies in better soil use and the protection of the vegetal cover of the earth's surface and not in vast and expensive engineering works.

There are many difficulties to be overcome and not the least of these is the problem of what to do with the human and animal populations of certain areas which have to be tackled.

In the building of a new road or the restoration of an old one, the engineer is generally able to divert the traffic to a temporary deviation while the new work is under construction, but when we deal with human beings, such an expedient, however desirable, is not always practicable on a large scale.

The public, especially the farmers, will have to face up to the fact that in some very badly eroded areas no restoration work can be done unless the human and animal populations are at least temporarily removed to some other area to allow the restoration work to be proceeded with and, returning to the road analogy, the restored area, like the new road, will then be capable of carrying a greatly increased traffic.

Much good work has been done but until adequate staffs and funds are made available the tempo will be slow.

The conservation of our soil is so bound up with the conservation of our water resources that unless we tackle these two problems concurrently, we cannot hope to be able to support our ever increasing population.

LIBRARY ACCESSIONS

C.S.I.R. Information, in its present form, is a list of accessions to the Library and Information Division of the South African Council for Scientific and Industrial Research. Many of the publications were received from the Union's Scientific Liaison Offices in London and Washington.

The arrangement of the accessions list is alphabetical under subject headings. As far as practicable these headings have been kept uniform with those used in the **Industrial Arts Index,** a publication familiar to most searchers for technical information. The classification numbers follow the Universal Decimal Classification. Short annotations or abstracts have been added when the titles are not self-explanatory. Certain documents have already been handed on to institutions which have built up collections covering highly specialised fields. In such cases the name of the institution is given in this list, as the document in question is located there. Applications to borrow such items should be sent direct to the institute named, not to the C.S.I.R. Library.

Publications not in constant use by the departments of the C.S.I.R. may be borrowed through the post. **Enquirers should quote the number at the left-hand side of each item (e.g. 34/21)** and address their letters to :—

Library and Information Division,
South African Council for Scientific and Industrial Research,
P.O. Box 395, Pretoria.

Documents should be returned to the Library by **registered post, packed flat.**

AIR CONDITIONING.

34/2 AMERICAN society of heating and ventilating engineers, New York.
Heating and ventilating air conditioning guide, 1947 . . . containing a technical data section . . . the roll of membership of the society . . . complete indexes . . . vol. 25. New York, American society of heating and ventilating engineers (c1947).
xxiv, 1282+128 p. illus., tables, diagrs. (i set loose in envelope).
(Not available on loan.)
628.8(058)

34/3 HERKIMER, Herbert and Harold Herkimer.
Air conditioning . . . New York, Chemical publishing co., inc., 1947.
ix, 692p. tables, diagrs.
628.84

ARCHES.

34/9 ILLINOIS. University. Engineering experiment station.
. . . Dependability of the theory of concrete arches, by Hardy Cross. Urbana, University of Illinois, 1930. (Bulletin vol. 27, no. 29, March ; Engineering experiment station, bulletin no. 203).
34 p. tables, diagrs.
(In National Building Research Institute.)
Pam. 624.624.001.1

34/10 ILLINOIS. University. Engineering experiment station.
. . . Laboratory tests of reinforced concrete arch ribs, by Wilbur M. Wilson. Urbana, University of Illinois, 1930. (Bulletin vol. 27, no. 26, February 25, 1930 ; Engineering experiment station, bulletin no. 202).
102 p. illus., tables, diagrs.

34/11 ILLINOIS. University. Engineering experiment station.
. . . Laboratory tests of reinforced concrete arches with decks, by Wilbur M. Wilson. Urbana, University of Illinois, 1931. (Bulletin vol. 28, no. 34, April 21, 1931 ; Engineering experiment station, bulletin no. 226).
100 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.624 : 620.178

ARCHITECTURE.

34/12 PILCHER, Donald.
The regency style, 1800 to 1830 . . . London, B.T. Batsford ltd. (1947).
viii, 120 p. front. (col.), 138 plates, diagrs.
This study of regency architecture is divided into the following main sections: The "man of taste"; the landscape garden and its influence ; taste and technique ; towards a regency style ; town and countryside.
72.034(42).

BATH, England.

34/17 ISON, Walter.
The Georgian buildings of Bath, from 1700 to 1830. London, Faber and Faber (1948).
211 p. 136 plates, diagrs., folding plan.
Main sections: An historical survey of the Georgian development of Bath ; the planning of the Georgian city ; the public buildings ; the domestic buildings ; interior decoration.
72.034(423.8)

BEAMS.

34/18 ILLINOIS. University. Engineering experiment station.
. . . Flexural fatigue strength of steel beams, by Wilbur M. Wilson. Urbana, University of Illinois, 1948.
(Bulletin vol. 45, no. 33, January 22, 1948 ; Engineering experiment station, bulletin series no. 377).
34 p. tables, diagrs.
(In National Building Research Institute.)
Pam. 624.072.2 :669.14] :620.178.3

34/20 ILLINOIS. University. Engineering experiment station.
. . . Tests of composite timber and concrete beams, by Frank E. Richardt . . . and Clarence B. Williams, Jr. . . . Urbana, University of Illinois, 1943 (Bulletin vol. 40, no. 38, May 11, 1943 ; Engineering experiment station, bulletin no. 343).
62 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.21.072.2 :[624.011.1+624.012.3] :620.17

34/21 ILLINOIS. University. Engineering experiment station.
. . . Ultimate strength of reinforced concrete beams as related to the plasticity ratio of concrete . . . by Vernon P. Jensen. Urbana, University of Illinois, 1934 (Bulletin, 40, no. 44, June 22, 1943 ; Engineering experiment station, bulletin series no. 345).
62 p. tables, diagrs.
"The hypothesis is advanced that the stress-strain diagram for concrete under short-time loading consists of two linear parts, one representing elastic behaviour and the other representing plastic behaviour. The former is measured by the "modular ratio," which is defined as the ratio of the modulus of elasticity of steel to the initial modulus of elasticity of concrete. The latter is measured by the "plasticity ratio," which is defined herein as the ratio of the plastic strain to the total strain at rupture of the concrete. Furthermore, the hypothesis is advanced that the plasticity ratio, like the modular ratio, is the function of the compressive strength of the concrete. Based on these hypotheses, formulas are derived for the ultimate strength of beams reinforced in tension only. Comparisons are made with the results of tests which have been reported by various investigators."
(In National Building Research Institute.)
Pam. 624.21.072.2 :624.012.4] :620.17

BRIDGES.

34/25 ILLINOIS. University. Engineering experiment station.
. . . An investigation of rigid frame bridges ; part I, tests of reinforced concrete knee frames and bakelite models . . . by Frank E. Richart . . . Thomas J. Dolan . . . and Tilford A. Olson . . . Urbana, University of Illinois, 1938. (Bulletin vol. 36, no. 23, November 15, 1938 ; Engineering experiment station bulletin no. 307).
48 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.21.072.33 :620.172.224

34/26 ILLINOIS. University. Engineering experiment station.
. . . Highway slab-bridges with curbs: laboratory tests and proposed design method . . . by Vernon P. Jensen . . . Ralph W. Kluge . . . and Clarence B. Williams, Jr. Urbana, University of Illinois, 1942. (Bulletin vol. 40, no. 46, July 6, 1943 ; Engineering experiment station, bulletin series no. 346).
88 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.21.073 :625.745.1] :620.17

34/27 ILLINOIS. University. Engineering experiment station.
. . . Laboratory tests of three-span bridges with decks on slender piers . . . by Wilbur M. Wilson and Ralph W. Kluge. Urbana, University of Illinois, 1934.
(Bulletin vol. 32, no. 15, December 11, 1934 ; Engineering experiment station, bulletin no. 270).
134 p. tables, diagrs. (one folding).
(In National Building Research Institute.)
Pam. 624.624 :620.178

34/28 ILLINOIS. University. Engineering experiment station.
. . . Moments in I-beam bridges . . . by Nathan M. Newmark and Chester P. Siess. Urbana, University of Illinois, 1942 (Bulletin vol. 39, no. 44, June 23, 1942 ; Engineering experiment station, bulletin series no. 336).
148 tables, diagrs.
(In National Building Research Institute.)
Pam. 624.21.072.2

34/29 ILLINOIS. University. Engineering experiment station.
. . . Studies of slab and beam highway bridges; part I, tests of simplespan right I-beam bridges . . . by Nathan M. Newmark . . . Chester P. Siess . . . and Robert R. Penman. Urbana, University of Illinois, 1946. (Bulletin vol 43, no. 42, March 8, 1946 ; Engineering experiment station, bulletin series no. 363).
132 p. illus., tables, diagrs.
Pam. 624.21.072/.073 :625.745.1] :620.178

34/30 ILLINOIS. University. Engineering experiment station.
. . . Studies of slab and beam highway bridges ; part II, tests of simple-span skew I-beam bridges . . . by Nathan M. Newmark . . . Chester P. Siess . . . and Warren M. Peckham. Urbana, University of Illinois, 1948. (Bulletin vol. 45, no. 31, January 12, 1948 ; Engineering experiment station, bulletin series no. 375).
62 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.21.072/.073 :625.745.1] :620.178

BRIDGES, Military.

34/31 JOINT intelligence objectives sub-committee.
German military bridges: J-bridging equipage, J-42 and J-43: German "S" bridge; German "N" bridge; German "R" bridge; Grosshohlbaustein system of bridge construction; German pontoon bridge M-26; target evaluation report on German bridges; Czechoslovakian emergency bridge Skoda-Faltus. London, H.M. Stationery office [1946 ?]
(JIOA final report no. 47).
424 p. illus., photos., diagrs. (some folding).
(Copy also in Commerce and Industries.)
624.21 :623.6](43)

BUILDING.

34/32 SEARS, John, Editor.
The architects' and builders' compendium, 1948 . . . . London, Compendium publishing co., ltd., 1948.
915 p. illus.
(Not available on loan.)
72+69(058)

34/33 STÜSSI, Fritz.
Vorlesung über Baustatik: erster Band . . . Basel, Birkhaüser, 1946.
ix, 368 p. illus., diagrs.

693

BUILDING MATERIALS. Distribution.

34/34 GREAT Britain. Ministry of works. Committee of enquiry into the distribution of building materials and components.
The distribution of building materials and components: report of the Committee of enquiry appointed by the Minister of works. London, H.M. Stationery office, 1948.
144 p. tables.
Chairman: Lord Simon of Wythenshawe.
Main sections: The place of distribution in the building industry; The builders' merchants; Alternative channels of distribution; Trade associations; Restrictive practices in distribution; an analysis of the cost of distribution through builders' merchants; Scope and adequacy of builders' merchants; Advantages and disadvantages of alternative channels of distribution; Distribution and the changing nature of demand.
Pam. 691 :339.8](047)

BUILDING RESEARCH.

34/35 BRITISH intelligence objectives sub-committee.
Housing research of the Institut für technische Physik, Technische Hochschule, Stuttgart; reported by . . . G. J. Thiessen . . . CIOS item no. 22 . . . London, H.M. Stationery office [1946?] (BIOS final report no. 237, item no. 22)
9, 33 p. illus. diagrs., tables. Mimeographed.
The main section of this report covers heating (a. Heating transmission of walls. b. Cooling characteristics of outside walls. c. Temperature distribution in different rooms. d. Effect of moisture content on wall conductivity — drying rates. e. Relative heat loss of different parts of building). An appendix reproduces a publication by Wilhelm Bausch called "Schalldämmungs-messungen im Laboratorium und in fertigen Gebäuden." (Measurements of acoustic insulation in the laboratory and in finished buildings).
(Copy also in Commerce and Industries.)
Pam. 697.133+699.844.1](43)

CHILDREN. Physique.

34/45 CLUVER, E. H., and others.
. . . The physique of American, Canadian, English and South African school children, by E. H. Cluver, E. Jokl and P. R. Rorich . . . Pretoria, National advisory council for physical education, 1946.
pp. 45-49. tables, diagrs.
Reprinted from South African journal of medical science, 1946, no. 11.
Pam. 572.512.1/.4.029

CLAY.

34/46 ILLINOIS. University. Engineering experiment station.
. . . The bonding action of clays; part 1 — clays in green molding sand . . . by Ralph E. Grim . . . and F. Leicester Cuthbert. Urbana, University of Illinois, 1945 (Bulletin vol. 42, no. 50, July 31, 1946; Engineering experiment station bulletin series no. 357).
64 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 533.611

CLIMATOLOGY.

34/47 CONRAD, V.
Fundamentals of physical climatology . . . Cambridge, Massachusetts, Harvard university press, for Blue Hill Meteorological observatory (c1942).
vii, 121 p. illus., maps, diagrs.
551.58

COLOUR.

34/49 EVANS, Ralph M.
An introduction to color . . . New York, John Wiley and sons, inc., 1948.
x, 340 p. illus. (some col.), tables, diagrs.
535.6

CONSTANTS. Physical.

34/50 GEOLOGICAL society of America, Washington.
. . . Handbook of physical constants; edited by Francis Birch . . . J. F. Schaider and H. Cecil Spicer. [Washington], Geological society of America, 1942. (Special papers no 36).
ix, 325 p. tables, diagrs.
(Not available on loan).
53.081.6 : 55

CONSTANTS. Physical and chemical.

34/51 KAYE, G. W. C. and T. H. Laby.
Tables of physical and chemical constants and some mathematical functions . . . tenth edition . . . London, Longmans, Green and co., 1948.
vii, 194 p. tables.
(Not available on loan).
53.081.6+54.081.6

COLUMNS.

34/52 ILLINOIS. University. Engineering experiment station.
. . . The effect of eccentric loading, protective shells, slenderness ratios, and other variables in reinforced concrete columns, by Frank E. Richart and others. Urbana, University of Illinois, 1947. (Bulletin vol. 45, no. 22, November 28, 1947; Engineering experiment station, bulletin series no. 368).
130 p. illus., tables, diagrs.
(In National Building Research Institute.)
Pam. 624.075.2 : 624.012.4] : 620.17

34/53 ILLINOIS. University. Engineering experiment station.
. . . The strength of thin cylindrical shells as columns . . . by Wilbur M. Wilson and Nathan M. Newmark. Urbana, University of Illinois, 1933. (Bulletin vol. 30, no. 26, February 28, 1933; Engineering experiment station, bulletin no. 255).
48 p. illus., tables, diagrs.
(In National Building Research Institute).
Pam. 624.075.2 : 620.17

TENDERS INVITED

THE following are particulars of the more important tenders which have been invited up to the time of going to press for public works by Government Departments, Provincial Administrations and Municipalities. In each case the date by which the tender must be submitted is given. While every endeavour will be made to maintain accuracy in these columns it is pointed out that readers using this information do so entirely at their own risk.

NOTE: S.A.R. & H. Tender Board address is: 715, P.F.A.C. Building, 15, de Villiers Street, Johannesburg.

ELECTRICAL EQUIPMENT, ETC.:

Bulawayo Municipality: 25 M.V.A. air-break circuit breakers and L.T. switch and fuse gear. Contract E. 51/1939. City Electrical Engineer, Bulawayo. Due, 17/5/49.

Johannesburg Municipality: Copper wire. Contract C.37. Due, 19/5/49; Electric motors and control gear. Contract C.248. Due, 2/6/49; Flue switch gear. Contract C.144. Due, 2/6/49; Electrical material. Contract C.143. Due, 2/6/49.
S.A. Railways Tender Board, 715, P.F.A.C. Building, 15, De Villiers Street, Johannesburg.

ENGINEERING EQUIPMENT, ETC.:

The Government Mining Engineer, P.O. Box 883, Salisbury, offers for the purchase of the following: (1) One 50 h.p. Davey Paxman loco type boiler complete with all mountings and Penberthy injector. Re-tubed and tested; (2) One 30 h.p. Nicholson loco-type boiler complete with all mountings. Re-tubed and tested; (3) One 16 h.p. Marshall loco-type boiler complete with all mountings and feed-pump; (4) 27 spare boiler tubes (new). The above may be inspected at the Government Mining Engineer's workshop and stores, Siding 157, Salisbury.

POWER PLANT, ETC.:

Mafeking Municipality: Offers for the purchase of power station plant consisting of Babcock & Wilcox boilers, engines and turbine-driven alternators, circulating water system, switch gear, transformers and an cillary plant, which will become available for disposal by the Council when the Council takes a supply of electricity in bulk from the Rand Mines Power Supply Co., Ltd. It is anticipated the items for disposal will become available in approximately 9 months from date hereof. Contractors will be required to dismantle and take delivery of the equipment at the Power Station, Mafeking. (Deposit £3-3-0 — extra copies £1-0-0 per copy). Specification M.6/1948. Conditions of contract and schedule of equipment available for disposal in due course can be obtained from the Council's consulting engineer: J. S. Clinton, P.O. Box 4648, Johannesburg. Due, 18/5/49.

ROADS, ETC.:

The execution of certain road works amounting to some 125,000 yards super within the township of Umtali. Contract C.28/1948. Due, 23/5/49. (Deposit of £4-4-0 — extra copies of documents at £2-2-0 each). Town Engineer, Umtali.

SEWERAGE, ETC.:

Queenstown Municipality: Section 1. Pumping Plant; Section 2. Equipment for sprinkling filters; Section 3. Equipment for rapid gravity sand filters; Section 4. Electrical equipment. Contract S3/1949. Town Clerk, Queenstown. Extended to 20/5/49.

TELEPHONES, ETC.:

Johannesburg Municipality: Telephone cable and wire. Contract C.154. Due 2/6/49. S.A. Railways Tender Board, 715, P.F.A.C. Building, 15, De Villiers Street, Johannesburg.

WATER:

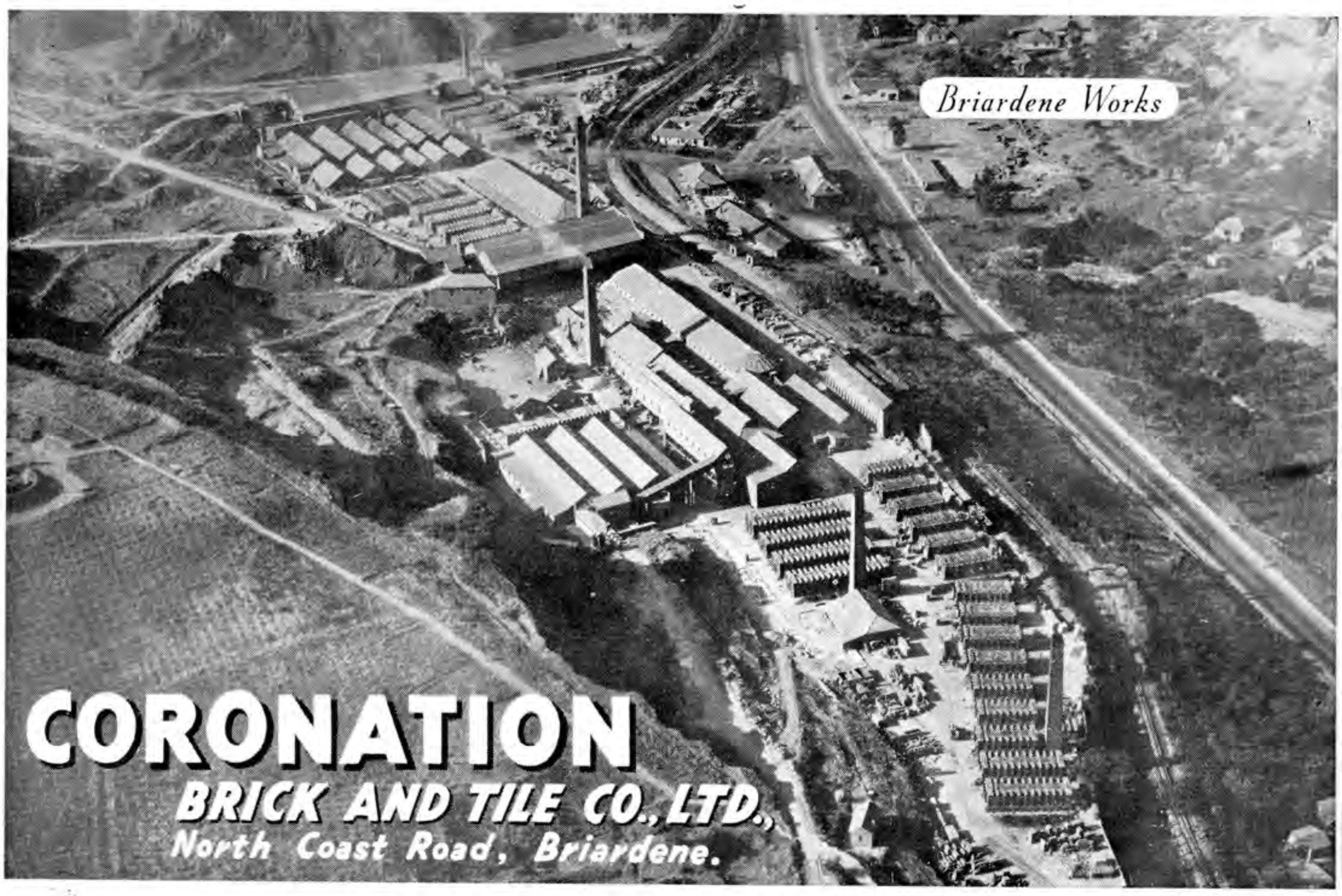
Nelspruit Municipality: Hydro-electric plant, penstock and transmission equipment. Contract E.3/1948. Town Clerk, Nelspruit. Extended. Due, 6/7/49.

Pretoria Municipality: Manila drilling cable. Contract Irr. 467. Due, 19/5/49. 3 neutral earthing compensators; Contract Irr. 526. Due, 19/5/49. Controller of Stores, Irrigation Department, P.O. Box 277, Pretoria.

Ceres Municipality: Hydro-electric scheme. Steel pipes, valves and fittings. Contract 3/1949. (Deposit of £5-0-0). Consulting Engineer: Ninham Shand, 806, Groot Kerk Building, Cape Town. Due, 30/5/49.

Ceres Municipality: Hydro-electric scheme: (a) The erection of hydro-electric station buildings; (b) Hydro-electric plant; (c) Removal and erection of Diesel-electric plant and auxiliaries; (d) Overhead line material. Contract E.2/1949. (Deposit of £2-2-0—spare complete copies of documents on payment of £1-1-0 each). Electrical Engineer, Ceres. Due, 30/5/49.

Despatch, Eastern Province, Cape, Municipality: Water Supply Scheme: Pipes and fittings, 2″ to 9″ diameter; water meters; pumping plant; galvanised iron tank and stand; cast iron surface boxes; valves, 2″ to 9″ diameter. Contract No. 1. (Deposit of £5-5-0 — extra copies of documents at £1-1-0 per copy). Consulting Civil Engineers: Hawkins, Jeffares & Green, Great North House, 36, Siemert Road, New Doornfontein Johannesburg. Due, 16/5/49.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