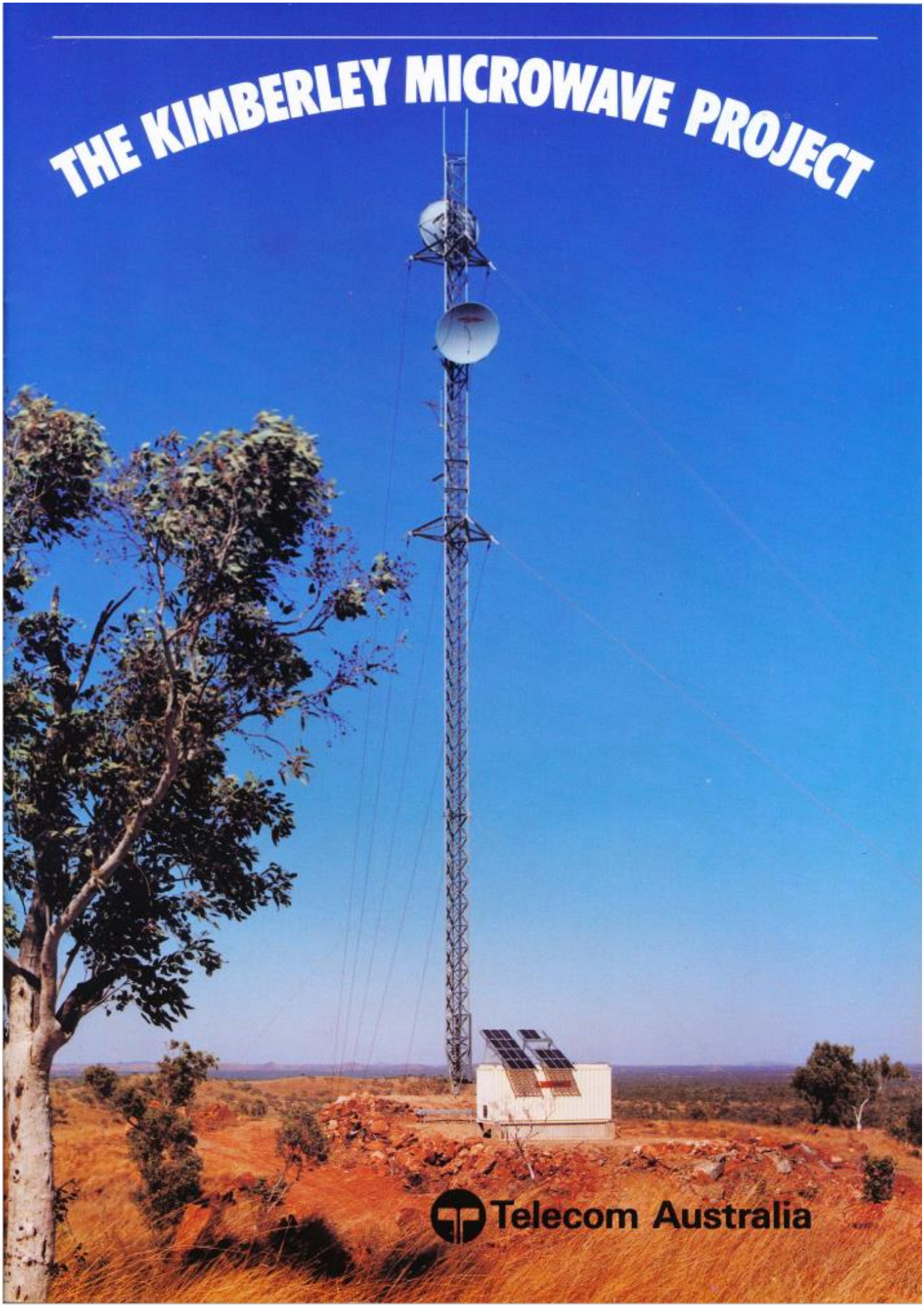
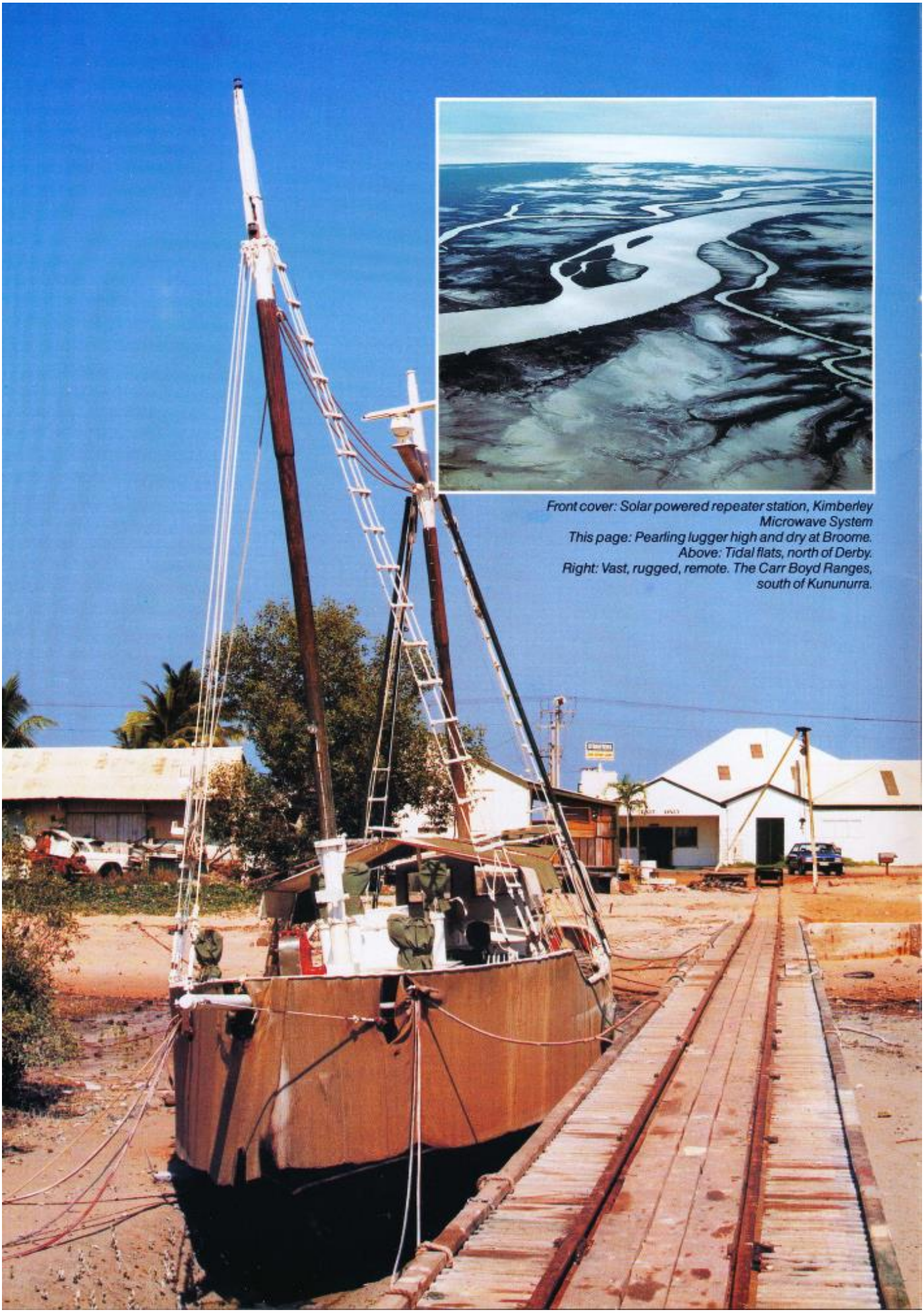
THE KIMBERLEY MICROWAVE PROJECT



Telecom Australia



Front cover: Solar powered repeater station, Kimberley Microwave System
This page: Pearling lugger high and dry at Broome.
Above: Tidal flats, north of Derby.
Right: Vast, rugged, remote. The Carr Boyd Ranges, south of Kununurra.

THE KIMBERLEY

Vast, rugged, remote, infinitely beautiful and colourful, arid in parts, densely tropical in others, the Kimberley is a unique area even for Australia.

Named in 1880 after the Earl of Kimberley, the then Secretary of State for the Colonies, the region lies above the 19th parallel in the north of Western Australia. In size it occupies an area of 421,451 square kilometres, three times as big as England.

The region is bounded by the Indian Ocean on the west, the Timor Sea in the north, the Northern Territory on the east and the Great Sandy Desert in the south.

Its coastline is one of the most treacherous in the world with many deep inlets and bays dotted with hundreds of islands. Tides rise and fall 12 metres and more.

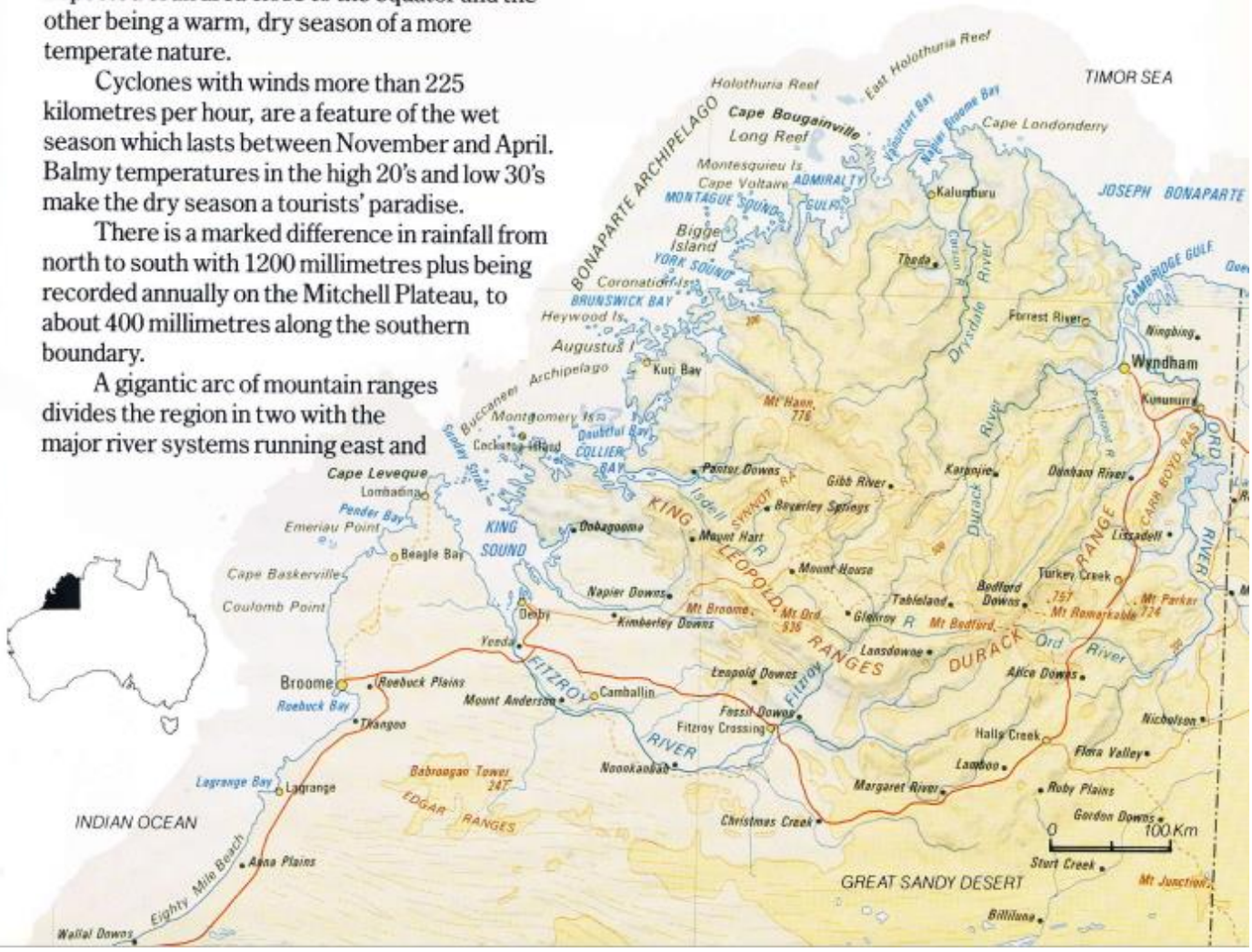
Climatically there are two distinct seasons, one reflecting the wet, tropical conditions expected of an area close to the equator and the other being a warm, dry season of a more temperate nature.

Cyclones with winds more than 225 kilometres per hour, are a feature of the wet season which lasts between November and April. Balmy temperatures in the high 20's and low 30's make the dry season a tourists' paradise.

There is a marked difference in rainfall from north to south with 1200 millimetres plus being recorded annually on the Mitchell Plateau, to about 400 millimetres along the southern boundary.

A gigantic arc of mountain ranges divides the region in two with the major river systems running east and

west. In the east, the damming of the Ord River in the Carr Boyd Ranges formed Lake Argyle, the greatest man-made lake in Australia having 9 times the capacity of Sydney Harbour.



In the west, the Fitzroy River flows into King Sound at Derby 1000 kilometres from its source. It has a catchment area of 85,000 square kilometres and in the wet season its normal flood rate is 32.4 million cubic metres of water per hour sufficient to fill Sydney Harbour in 25 hours.

Broome, Derby, Wyndham and Kununurra account for half the region's population; with the remainder being distributed between the smaller centres of Halls Creek and Fitzroy Crossing, and on pastoral stations.

The pastoral industry is one of the major primary resources with three quarters of a million head of cattle. The industry has experienced fluctuating fortunes in recent times and innovations to ensure stability are in hand.

The cultured pearl industry is the second largest export earner in the region. Operating out of Broome, the annual value of the industry is currently about $15 million.

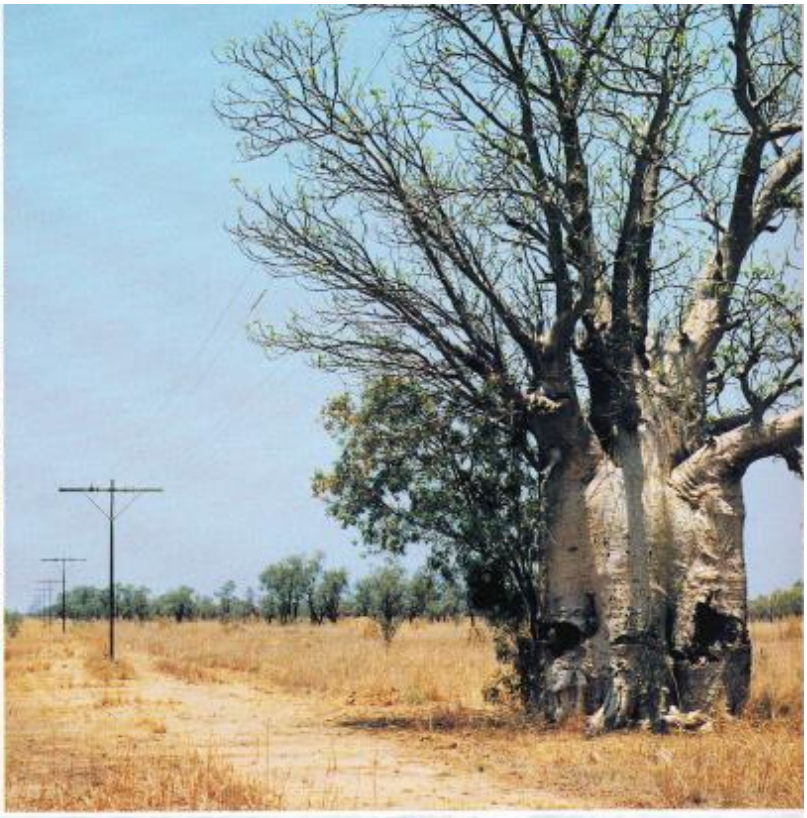
The East Kimberley, particularly Kununurra, is known for the Ord River Irrigation Project. Initially the project was devoted to growing cotton but after this failed in 1974 other crops were trialled. Experimental sugar cane yields have attracted much attention in recent years.

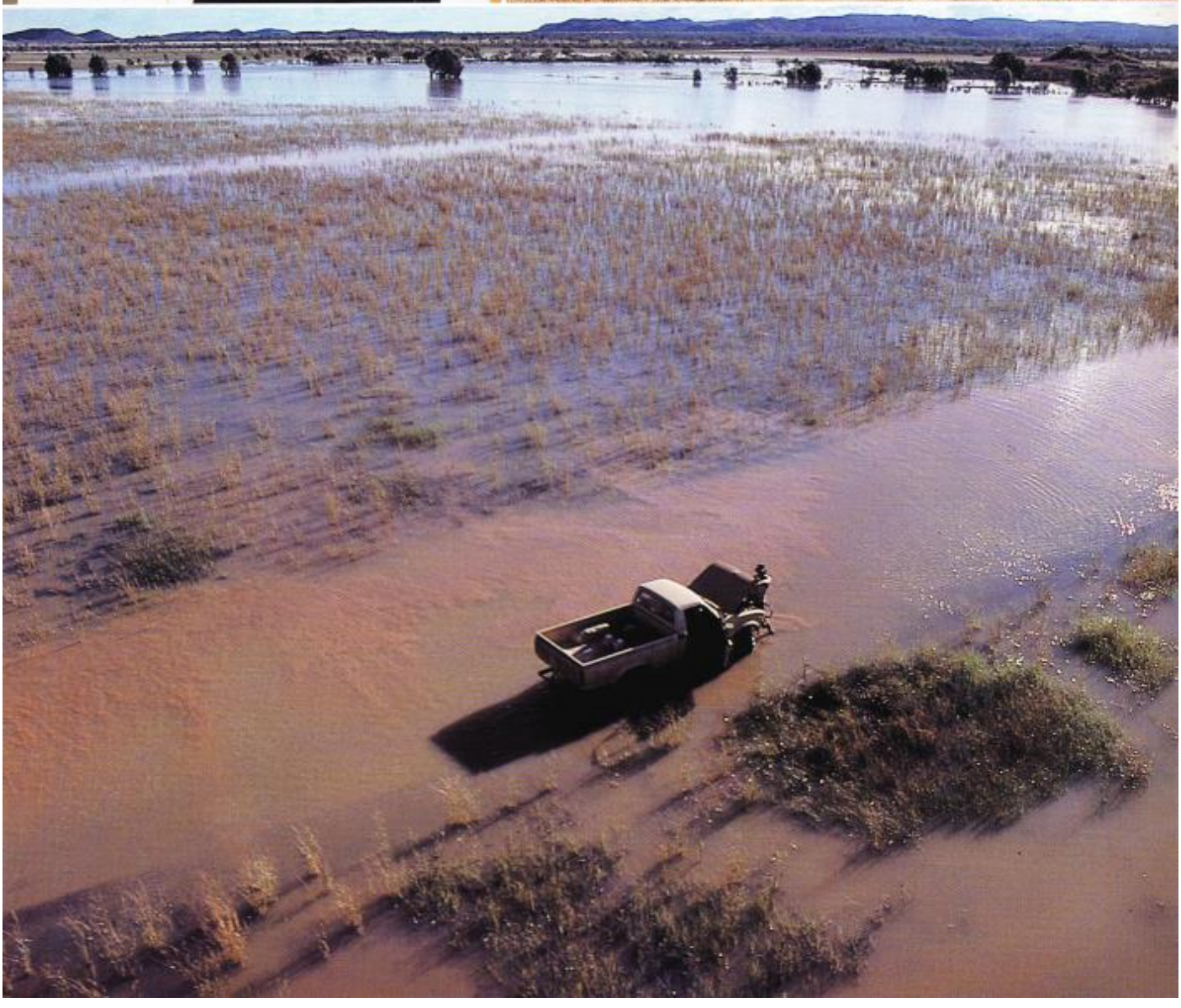
Diamond mining has added glamour to the region with claims being pegged at Ellendale, east of Derby and at Argyle, 110 kilometres south of Kununurra. It is estimated that Argyle possesses 50% of the world's supply of industrial diamonds. The Ellendale claim is currently dormant.

Iron ore has been mined by Broken Hill Proprietary Ltd at Cockatoo and Koolan Islands since 1951. Located in Yampi Sound, 140 kilometres north of Derby, the ore is some of the world's richest.

The search for oil in the north originally focussed on the Kimberley. The emphasis shifted offshore and further south to the Pilbara until the late 70's. In 1981, oil was discovered onshore in commercial quantities at Blina, about 100 kilometres east of Derby. Further exploration and development is continuing.

Above: Aboriginal communities will benefit from improved communications.
Below: Cattle mustering in the Kimberley.
Top right: Lake Argyle, Australia's greatest man-made lake.
Below: The Fitzroy River at Geike Gorge near Fitzroy Crossing.





COMMUNICATIONS DEVELOPMENT

Broome and Derby were established for different reasons in the early 1880's. Broome flourished from pearling while Derby served as a port for an infant pastoral industry in the West Kimberley.

In April 1889, the single wire telegraph line which connected Perth with northern ports reached both towns. At the same time a submarine telegraph cable from Java to Broome was opened for international traffic supplementing the already established route through Darwin.

With the discovery of gold at Halls Creek, the single wire telegraph line was extended to Fitzroy Crossing and Halls Creek in 1892. Extension of the line through to Wyndham, which had been established as a port for the East Kimberley, was completed in the following year.

Local manual telephone exchanges were opened in Broome (1908), Derby (1915), Wyndham (1920), and Fitzroy Crossing and Halls Creek (1925). These however were only designed to serve the local community and long distance communications remained the province of the telegraph.

Not until 1959, when the three channel Perth-Derby high frequency radio link was installed, could Broome and Derby talk to the south.

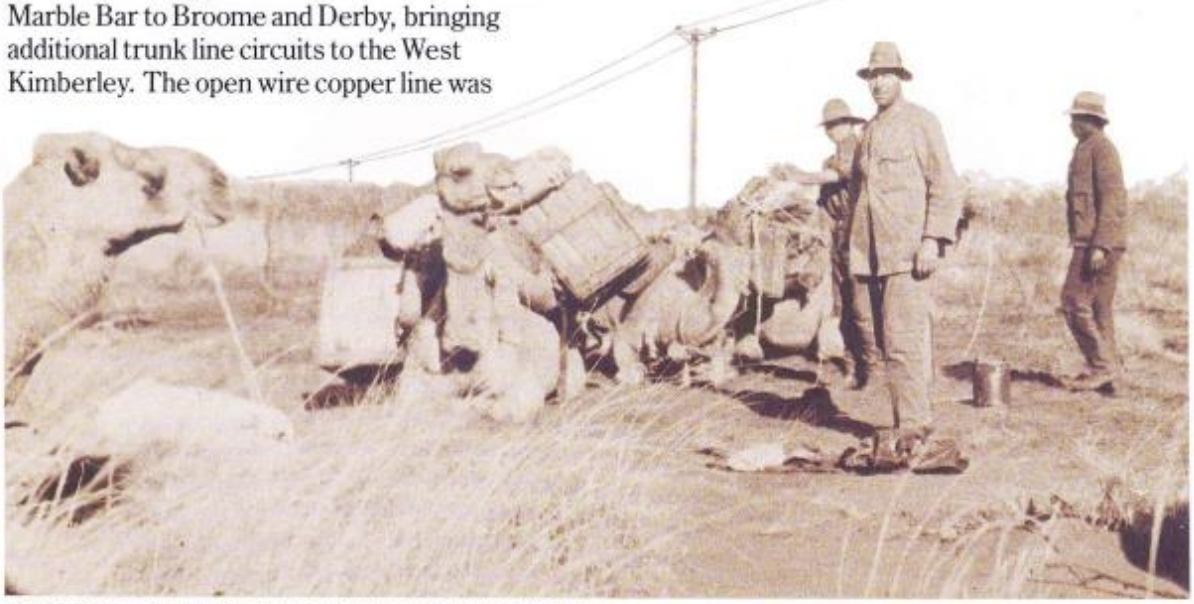
In 1965, copper wires were extended from Marble Bar to Broome and Derby, bringing additional trunk line circuits to the West Kimberley. The open wire copper line was extended through to Wyndham in 1968 to give Wyndham telephone access south.

Local telephone exchanges were converted to automatic working at Derby (1975), Wyndham (1976), Broome (1977). A manual telephone exchange had been installed in Kununurra in 1963 when the Ord River Irrigation Scheme got under way and this was converted to automatic in 1967.

Manual telephone exchanges remained in operation in Fitzroy Crossing and Halls Creek until both towns were connected to the new microwave communications system in July 1983.

During the seventies, further trunk circuits were added to the open wire system until it reached its maximum capacity. Prior to this, Telecom had looked at alternate methods of improving its facilities to the Kimberley. Telephone usage was increasing by 16% per annum and it had become necessary to programme the installation of a large capacity system.

Recent advances in telecommunications microwave technology had led to the miniaturisation, increased efficiency and improved reliability of new systems. Consequently, Telecom planners chose this technology to meet the Kimberley's needs. Planning commenced in 1978.



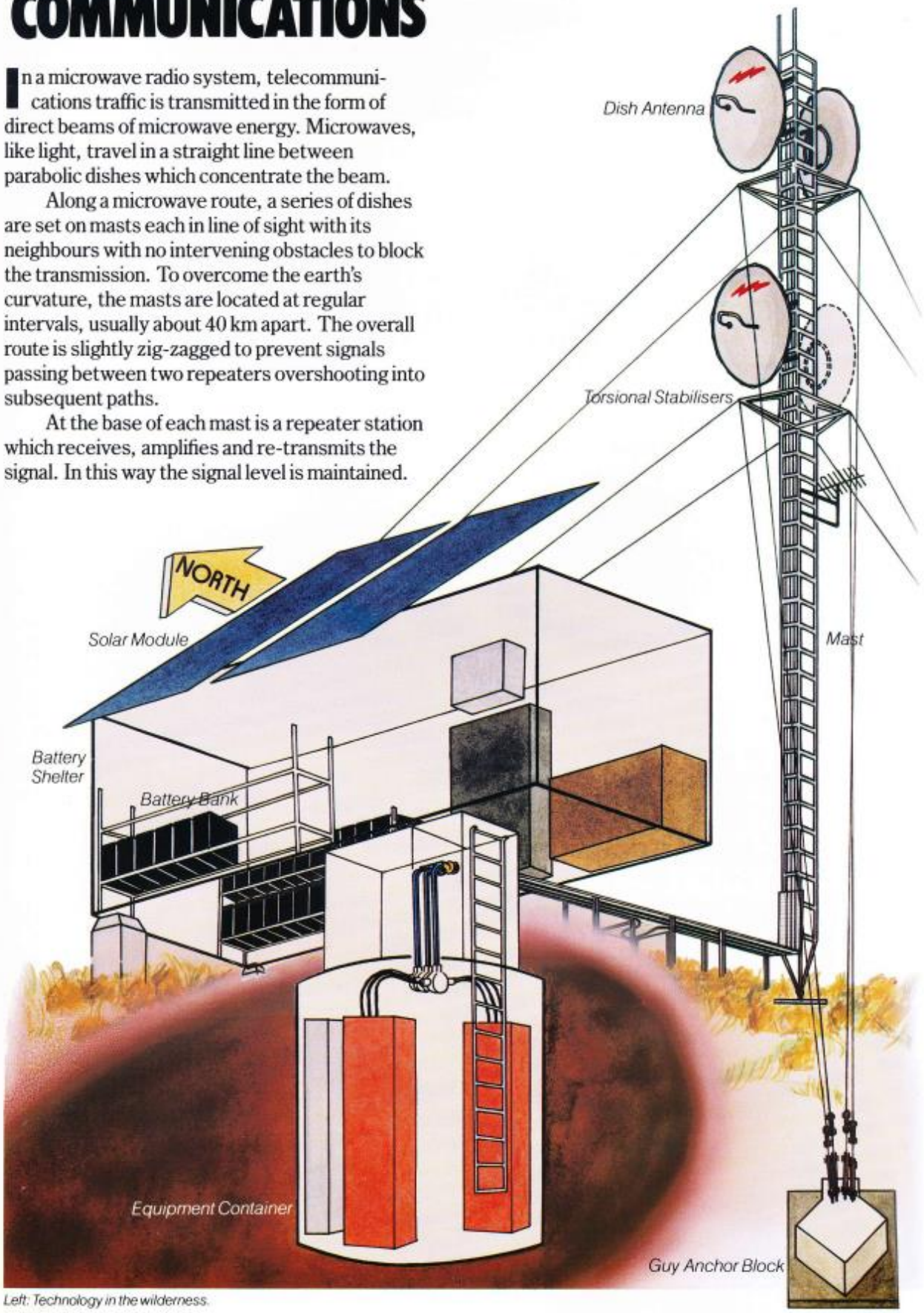
Top left: Broome telephonists connecting trunk calls prior to the microwave.
Top right: The old link. Open wire copper lines between Broome and Derby.
Left: Stranded in the wet. The Fitzroy River in Flood.
Above: Rebuilding the telegraph line across the Great Sandy Desert early this century.

MICROWAVE COMMUNICATIONS

In a microwave radio system, telecommunications traffic is transmitted in the form of direct beams of microwave energy. Microwaves, like light, travel in a straight line between parabolic dishes which concentrate the beam.

Along a microwave route, a series of dishes are set on masts each in line of sight with its neighbours with no intervening obstacles to block the transmission. To overcome the earth's curvature, the masts are located at regular intervals, usually about 40 km apart. The overall route is slightly zig-zagged to prevent signals passing between two repeaters overshooting into subsequent paths.

At the base of each mast is a repeater station which receives, amplifies and re-transmits the signal. In this way the signal level is maintained.



Left: Technology in the wilderness.

DESIGN PHASE

The design phase commenced with a survey of the route. Possible paths were plotted on a map and then checked by aerial and ground surveys.

The aerial survey was carried out using a helicopter fitted with a special computer to calculate and record the path profiles between repeater sites. The object was to select suitable paths free from obstructions between each repeater site.

Following this, details of a number of possible sites were submitted to the Western Australian Museum to ascertain the status of each site in terms of its historical, anthropological, archaeological or ethnographical significance in accordance with the Aboriginal Heritage Act. Some of the sites were considered sacred by local Aborigines and as a result these were not used.

Other sites were rejected because of the possibility of flooding or the difficulty of access.

Upon finalisation of the route, Telecom engineers commenced designing the system taking into account its ultimate capacity including provision for future expansion, and evaluating the latest microwave communication technology available.

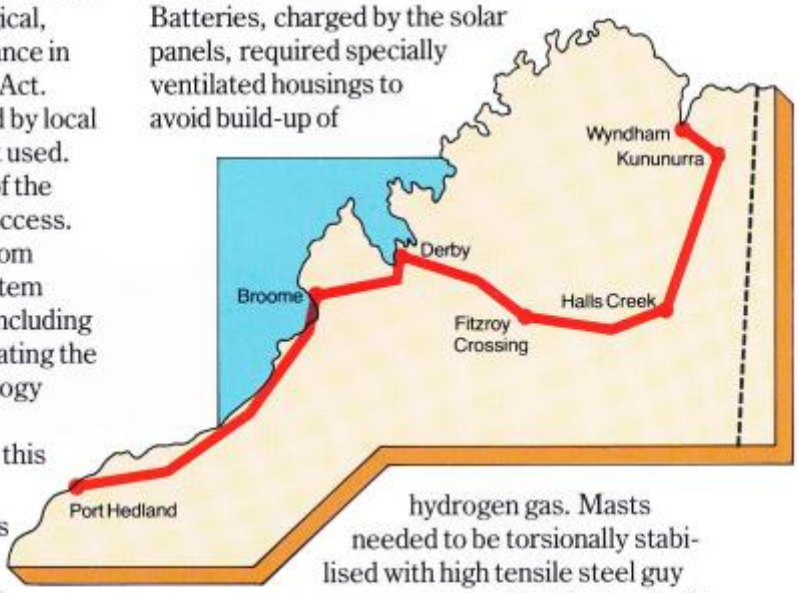
Three aspects became important at this stage:

a) the operational reliability of the various systems being manufactured;
b) the types of power sources available to operate the highly sophisticated equipment;
c) the method of construction to be used for the system installation.

All large microwave systems have a dual security mechanism which automatically switches standby equipment into operation should the mainstream circuitry fail, thus ensuring continuity of operation. However, the remoteness of many of the repeaters and the time required to effect repair of a breakdown, placed special emphasis on the need for a system possessing the highest standards of reliability.

Remoteness of locality also limited the choice of power supplies which could be used. A range of power supplies were examined and the solar supply, although a relatively new innovation, was chosen because of the specific climatic conditions of the region. Although a number of shorter solar powered microwave systems had been installed as part of the Australian telecommunications network, no system of the proposed magnitude had ever been designed in this country.

Stringent construction specifications imposed additional constraints. For example, the microwave equipment was to be housed in underground containers to maintain its operating temperature within close limits. Batteries, charged by the solar panels, required specially ventilated housings to avoid build-up of hydrogen gas. Masts needed to be torsionally stabilised with high tensile steel guy ropes to ensure that the parabolic dish antennas mounted on them did not twist "off beam" during cyclones with wind velocities up to 225 km per hour. The adjacent diagram gives details of the repeater station construction.



Following the evaluation of available microwave radio systems, a contract was awarded to NEC Australia Pty Ltd. The choice was based upon the low power consumption of the equipment and its extremely high reliability. Equipment components have a mean time between failure of 40 years.

The contracts for the provision and erection of the masts, installation of equipment housings, antennas and feeders for the complete system was won by the Melbourne based firm, Andrew Antennas.

Top left : Helicopter survey party selecting repeater site.
Left: Surveyor directing ground party from hilltop.

CONSTRUCTION

The Kimberley's climatic conditions played a big part in the construction of the system. In the wet season rain hampered operations, rivers flooded roads and access tracks, cyclones prevented mast erection and humidity sapped the energy of construction workers. As a result, work could only be effectively carried out in the dry.

To meet logistical constraints, construction was divided into two stages. The first stage involved the completion of the link between Port Hedland, Broome and Derby. The second stage extended the system through to Kununurra and Wyndham.

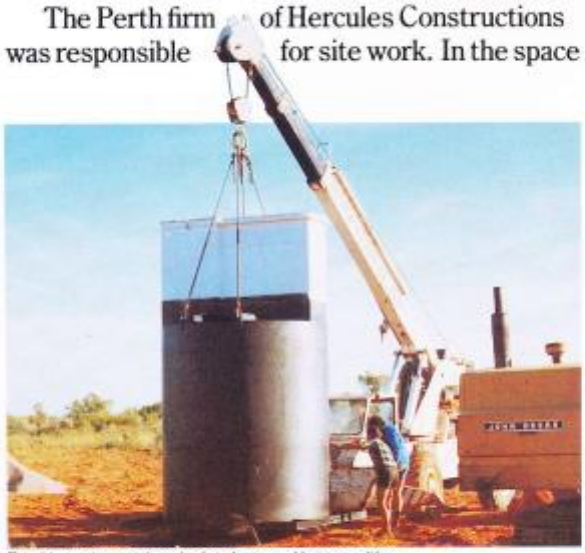
Construction commenced in March 1981 with the proposed completion of stage one planned for December 1982. Completion of stage two would follow 12 months later.

Initially, access roads had to be made to all sites. Once accessible, site work got under-way.

The Perth firm of Hercules Constructions was responsible for site work. In the space of a fortnight, its team would move in, prepare the site, carry out excavations for the underground equipment container and the mast foundations, bury the container, pour the foundations, mount a shelter above the equipment container and move to the next site. This was a remarkable effort considering that on average 360 tonnes of concrete were poured below ground at each site.

Modified shipping seatainers were used as shelters to house batteries and mount the solar arrays and locating one in position above the buried equipment container was a precision task.

Next followed Andrew Antennas' mast erection team. Across the 41 sites, masts varied in height from a short 18.3 metres to a tall 91.5 metres. Mast sections were pre-assembled on site prior to erection. Two to four dishes were mounted on each mast, depending upon path propagation conditions. Waveguide feeders were installed, and the antennas panned for maximum signal strength to ensure that they were exactly aligned to the next repeater.

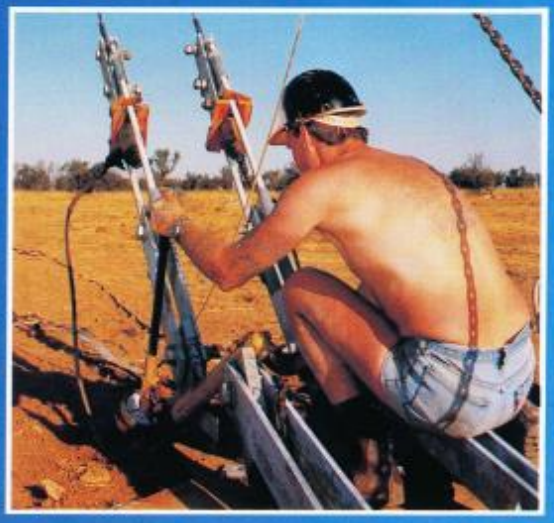


Equipment container being lowered into position.

Shelter mounting frame around container entry.

Unloading battery shelter.

Shelter in position.



Above: Completing the concrete pour on a guy anchor block.
Right: Tensioning steel guy ropes.
Below: Erecting mast section.

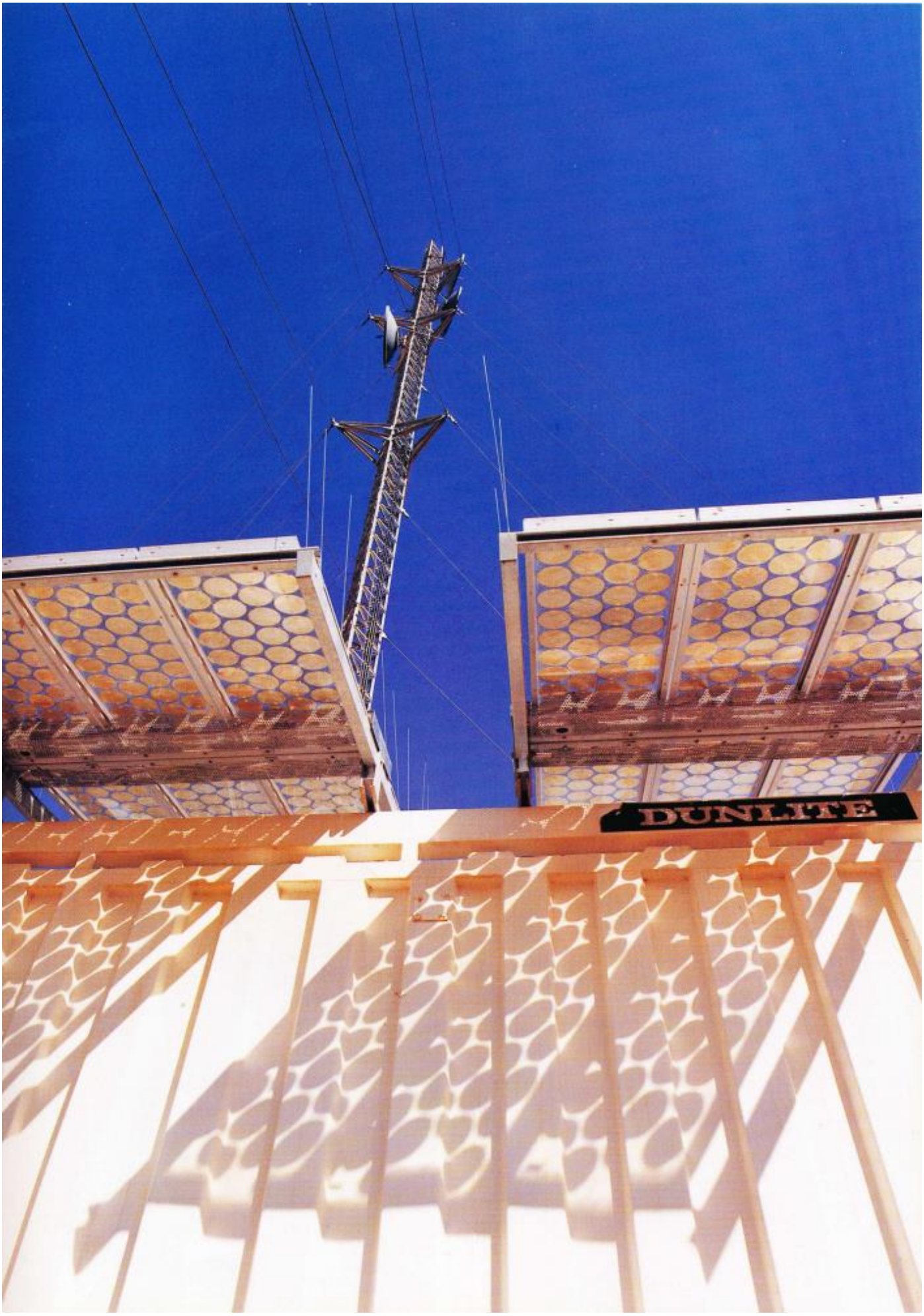
The installation of the power source was then undertaken by Telecom electricians. Firstly, the solar modules were mounted in arrays on top of the seatainer. Then banks of batteries with control equipment were installed inside.

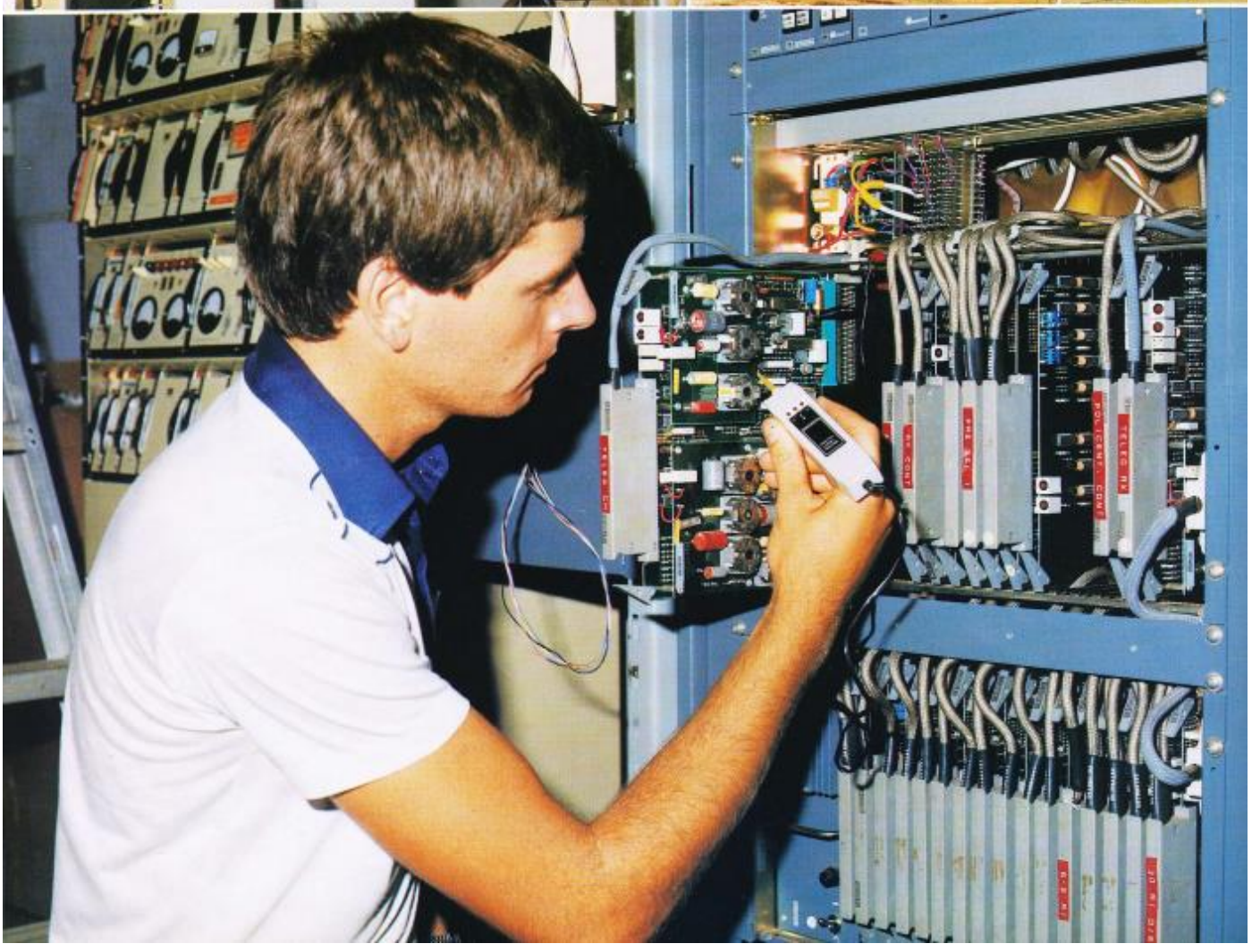
The batteries provide the power to operate the equipment and are charged by the solar cells. Design criteria ensured each repeater has enough battery capacity and solar modules to operate without sunlight for 12 days. Inspection of the batteries need only occur at intervals of six months or longer.

With everything else in position, the microwave equipment was then installed in the below ground container and connected to the antennas on the masts. This work was carried out by a team of Telecom technicians who were specially trained for the task.

Facilities were installed at a number of sites to provide telephone services to communities and pastoral stations situated up to 50 km either side of the route. These customers are known as "Waysiders."

Top left: Section of battery shelter.
Above: Checking repeater equipment inside container.
Right: Solar panels mounted on shelter.


DUNLITE



As a number of repeaters were installed, equipment testing commenced. In-station testing was carried out at each site to check the operation of the repeater. "Hop" tests were then carried out with adjacent repeaters. Finally, section testing checked complete operations between terminal stations. These were established at Port Hedland, Broome, Derby, Halls Creek, Kununurra, and Wyndham.

The first stage of the system from Port Hedland to Broome and Derby was completed on schedule and commissioned on 4 November 1982 giving both centres automatic access to the Australian and International telephone networks as well as telex, data and television bearer facilities.

The section from Derby to Halls Creek was brought into service on 3 July 1983. Earlier, in April, with installation still in progress, this section was pressed into partial operation to temporarily restore communications to the East Kimberley after major flooding had washed away 2 km of the open wire line.

Kununurra and Wyndham were connected to the system ahead of schedule on 11 September 1983 completing the construction of the world's longest solar powered microwave system in record time and on budget at a cost of $19 million.

This achievement is a tribute to the dedication of all those people who took part in the project.

Top left : Measuring signal levels on new equipment.
Top right : Kununurra Telecommunications Centre.
Below left: Testing equipment modules during installation.
Below: Sharing the moment. Broome calling its sister city Taiji Town, Japan.
Bottom: Derby, W.A. calls Derby, Kansas during official ceremony, 4 November 1982.

WAYSIDERS

The advent of wayside radio telephone services has brought many remote communities and cattle stations in touch with the outside world.

Prior to the completion of the system, some of these people had a very basic telephone service and some had nothing at all, except a Flying Doctor radio set for emergencies.

Those who had telephone services were usually connected to a long party line. The 250 km party line between Broome and Anna Plains served seven stations.

Other stations without a service had to undertake up to a 250 km return trip to make a telephone call. Sometimes when arriving in town in the wet season, they would find the open wire system out of order and would have to wait hours, or days, to make their call.

Some very large communities, such as the Aboriginal Community at Looma, near Liveringa, will now have telephone services and be able to contact other groups by telephone. Prior to the microwave system this was not possible.

The standard wayside service consists of a self-contained, solar powered radio system working directly to the nearest microwave repeater site. At the end of the project, 69 individual services and 5 communities with multiple services had been connected as waysiders.

Top left: Waysider, Jean Elecovich of Nita Downs Station, south of Broome.
Above: Tribal elders commemorate the arrival of the system in Fitzroy Crossing.
Right: In touch with the world.
Solar powered wayside radio system.
Back cover: Halls Creek Telecommunications Terminal at sunset.

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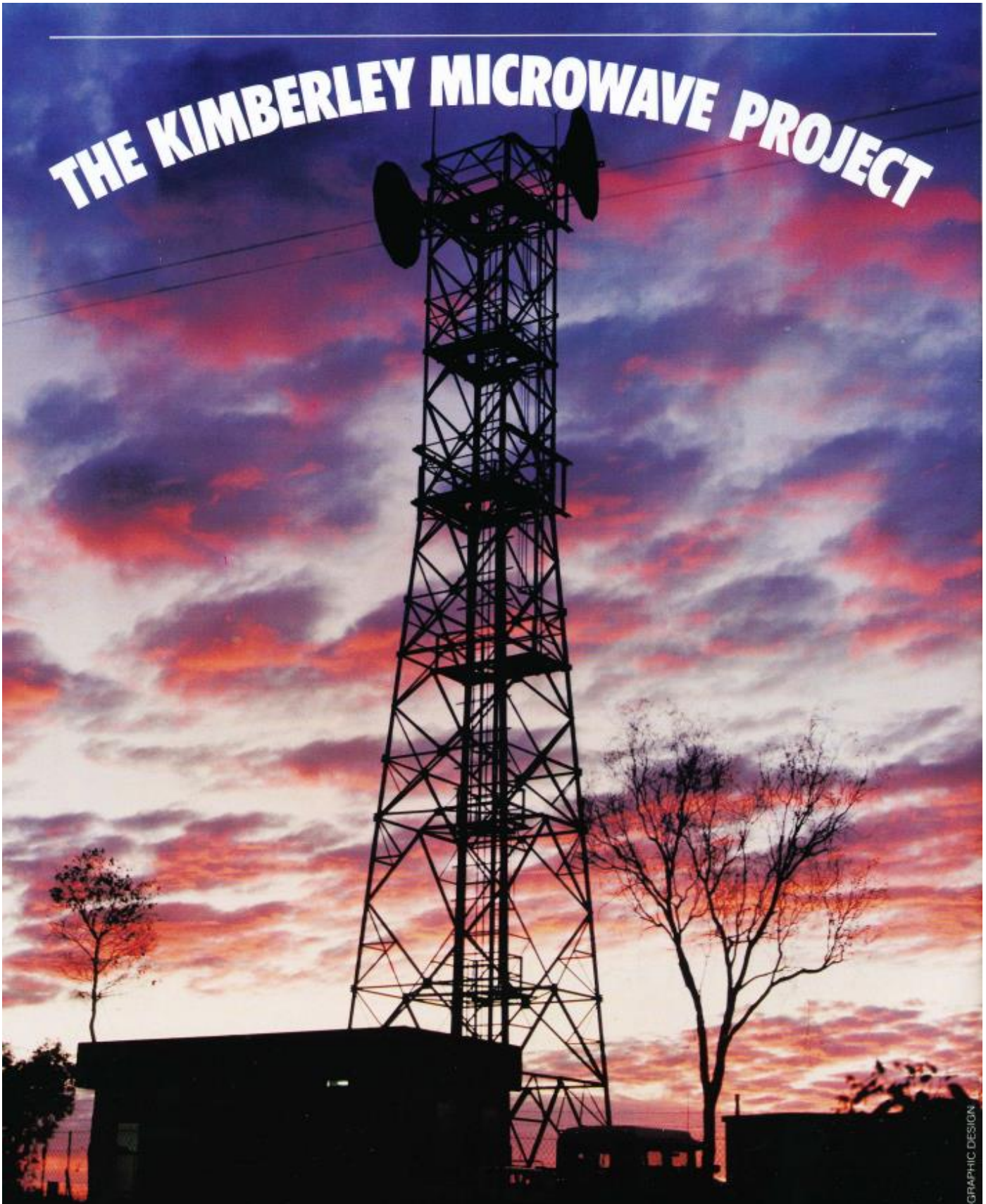

This booklet is dedicated to the people who planned and engineered the Kimberley Microwave System and to the people of the Kimberley who have awaited its arrival.

Telecom Australia
Produced by Public Relations Section, Perth

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