ENGINEERS AUSTRALIA
Western Australia Division

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NOMINATION OF

ORD RIVER DIVERSION DAM

FOR AN
ENGINEERING HERITAGE AUSTRALIA HERITAGE RECOGNITION AWARD

Diversion Dam and Lake Kununurra on July 20, 1963

PREPARED BY ENGINEERING HERITAGE WESTERN AUSTRALIA
ENGINEERS AUSTRALIA
WESTERN AUSTRALIA DIVISION

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Cover page photo courtesy of Kununurra Historical Society.

1. INTRODUCTION

The potential of the East Kimberley Ord River basin was first noted by explorer Alexander Forrest during his exploratory journey through the Kimberley in 1879, during which he named the Ord River after the Governor of Western Australia, Sir Harry Ord. He subsequently set himself up as a land agent and encouraged graziers to take up pastoral leases in the area. Alexander's brother, John – later the State's first Premier, in 1883 also led a party which re-examined parts of the Kimberley district previously explored by Alexander. The most notable pastoralists to accept the challenge were the Durack, Emanuel and Kilfoyle families. Having read Forrest's report in early 1881, brothers Patsy and Michael Durack made the long sea voyage from Brisbane to Albany, then overland to Perth to meet Forrest who elaborated on the favourable impression of the country given in his initial report. In 1881 and 1882 the Duracks, Emanuels and Kilfoyles organised an expedition to examine the area themselves. Led by Stumpy Michael Durack, and including Sydney Emanuel and Tom Kilfoyle, they left Queensland in July 1882 and travelled by ship from Brisbane to Cambridge Gulf, then overland to investigate the land Forrest had allocated to them along the Ord River valley. The party then made the arduous journey south and west to Beagle Bay where they had to wait over three weeks for the delayed arrival of the schooner *Mary Smith,* which should have been waiting for them when they reached the pickup point. They then sailed for Fremantle, arriving on 1 January 1883 and made the sea journey to Brisbane. In the first half of 1883 the Duracks and Kilfoyle mustered 7250 head of cattle and 200 horses and left Queensland mid 1883 to drive the cattle 4800 kms overland to the Ord River valley, arriving in September 1885. Less than half the cattle survived the epic journey and were used to stock holdings at Argyle, Lissadell, Rosewood and Newry stations. Ivanhoe station was established some years later. The Emanuels settled in the Fitzroy river valley.

In 1941 the newly appointed Western Australian Director of Works and Buildings, Russell Dumas, was requested by his Minister to make a special study of the north of the state, in order to become familiar with its problems. In August and September of that year he spent three weeks investigating the country in the north-east Kimberley and along the Ord River to its source near Hall's Creek. He was impressed by the potential of the area to grow crops and he recommended that a small experimental area be established. Later that year the Ord River Experimental Station was set up on the banks of the river at Carlton Reach by Kim Durack, with assistance from the WA Public Works and Agricultural Departments. This location was adjacent to one of the largest waterholes in the Kimberley, the riverbanks being alluvial loam. This establishment was moved 16 kms downstream in 1946, to the black soil plains, on which most of the irrigable area lies, and became the Kimberley Research Station, a joint Commonwealth – State venture. After twelve years of research, results indicated that sugar, rice, cotton, safflower and various other oil seeds were likely to succeed, if adequate water was available.

Work then began on planning an irrigation scheme to harness the huge volume of water flowing down the Ord during the monsoon (wet) season. Irrigation of the fertile plains along the river's lower reaches would allow development of a productive agricultural industry and create a food bowl for Western Australia and overseas.

Following the Commonwealth Government's 1959 decision to provide funding for the establishment of the town of Kununurra, the construction of the Ord River Diversion Dam and the irrigation channels, irrigated farming could commence in 1963. The first two figures in the Appendix show a general plan of the greater Ord River region (Fig. A1) and a general plan of

the dam-site area (Fig A2), both dating to 1959. The third figure is a plan of Ord Irrigation Project showing the first five farms.

2. STATEMENT OF SIGNIFICANCE

The construction of the Ord River Diversion Dam was a highly significant event in the development of the East Kimberley region in Western Australia.

The Ord River Valley had been a pastoral area since the late 1880's but the declining importance of the area for the cattle industry paved the way for the establishment of an irrigated farm development on the black soil plains of the lower Ord valley in the early 1960s.

The first stage of the Ord River Irrigation Project included the Ord River Diversion Dam, a well planned barrage at a strategic location across the river at Bandicoot Bar, providing gravity flow to the main irrigation channel serving the first irrigated farm lots.

The diversion dam was a significant successful technical and logistical achievement, overcoming multiple difficulties such as an extremely remote site, basic transport and communication facilities and adverse seasonal climatic conditions.

The successful completion of the dam was a credit to the planners, designers, offsite suppliers and manufacturers and contractors involved.

3. LOCATION

The locations of Kununurra and the Diversion Dam are shown on satellite images in Figures 1-3 below. Figure 2 highlights the northern region of the State, identifying the nearby port of Wyndham, through which much of the material for construction of the dam was transported.

Figure 1. Satellite image of Western Australia (Courtesy Google Earth)

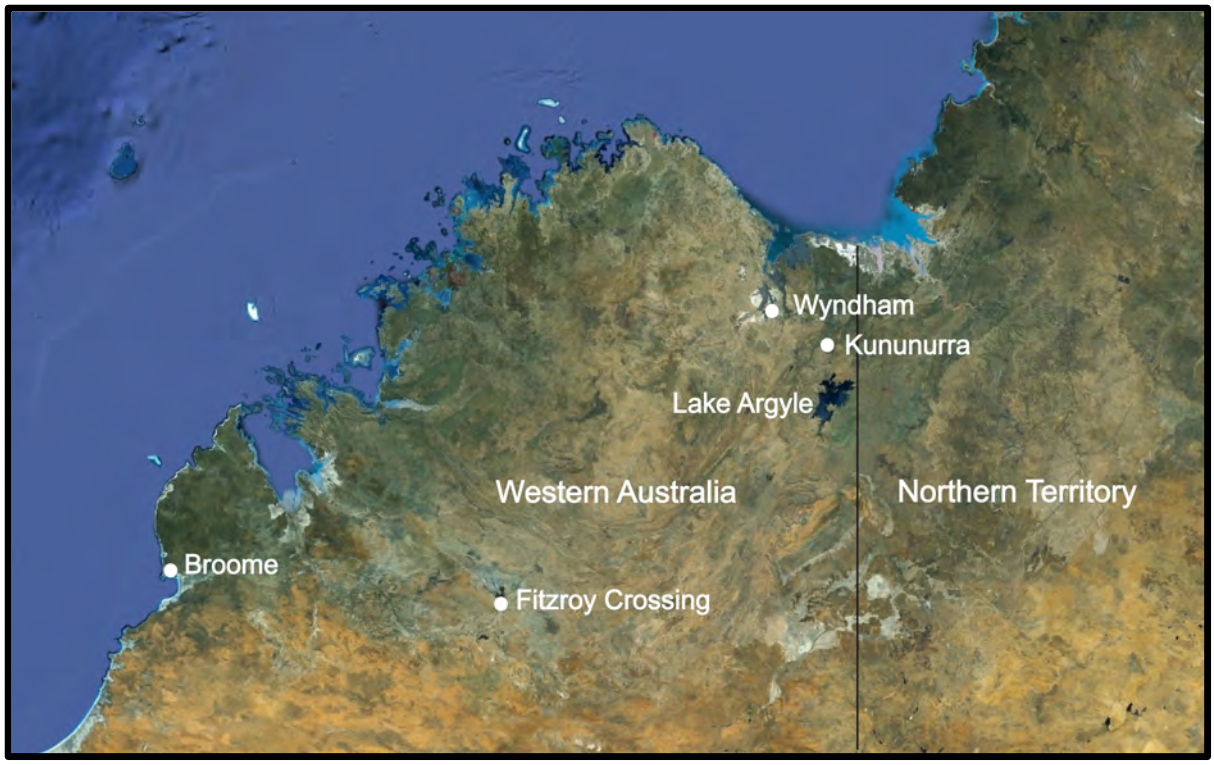


Figure 2. Satellite image of northern Western Australia (Courtesy Google Earth)

Figure 3. Satellite view of the Kununurra region (Courtesy Google Earth)

4. HERITAGE RECOGNITION NOMINATION FORM

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: ***ORD RIVER DIVERSION DAM***

The above-mentioned work is nominated to be awarded a

Engineering Heritage Recognition Award

Location, including address and map grid reference:

This nomination refers to the Ord River Diversion Dam located at Bandicoot Bar on the Ord River, near the town of Kununurra in northern Western Australia. See Figures 1-3.

Latitude: $15^0$47'32.31" S

Longitude: $128^0$41'40.76"E

Owner (name & address): Water Corporation of Western Australia, PO Box 100, Leederville, WA 6902

The owner has been advised of this nomination and a letter of agreement is attached.

Access to site: The dam is readily accessible by road or foot.

Nominating Body: Engineering Heritage Western Australia, Engineers Australia, Western Australia Division

Mark Bush

Professor Mark Bush, Chair EHWA
Date: 14 March, 2013

5. OWNER'S LETTER OF AGREEMENT

watercorporation.com.au

629 Newcastle Street
Leederville WA 6007

PO Box 100
Leederville WA 6902

T (08) 9420 2420
F (08) 9420 3626

WATER CORPORATION

Water Corporation Letter of Agreement

Dr David McCarthy
Administrator
Engineering Heritage Australia
Engineers Australia
11 National Circuit
BARTON ACT 2600

Dear Dr McCarthy,

Ord River Diversion Dam
Nomination for Engineering Heritage Recognition
Owner's Letter of Agreement

This letter accompanies the nomination by Engineering Heritage WA to Engineering Heritage Australia of the Ord River Diversion Dam for a heritage recognition award.

The Water Corporation is very pleased to support this initiative of Engineering Heritage WA and, if the nomination is successful, the Corporation would be agreeable to sponsor the manufacture of an interpretation panel and assist with the organisation of a commemoration ceremony at Kununurra on Saturday, July 20, the 50th anniversary of the official opening by the then Prime Minister, Sir Robert Menzies.

If you have any queries please contact Terry Murphy on 08 9420 2420 or Terry.Murphy@watercorporation.com.au

Yours sincerely

Catherine Ferrari
General Manager Communications

ABN 28 003 434 917

6. HISTORICAL SUMMARY

The Western Australian Government submitted its first proposal to the Commonwealth Government in 1949 for financial assistance to build a diversion dam on the Ord River. This approach was not successful nor was a request for funding for a revised scheme for a larger project submitted in 1956.

However in the campaign leading up to the 1958 Federal election, Prime Minister Menzies announced a £5,000,000 grant to Western Australia for northern development. Details of the proposed Ord River Irrigation scheme were subsequently submitted to the Commonwealth in May 1959.

In August 1959 the Commonwealth Government approved the £5,000,000 grant to assist with the development of the first stage of the project; the construction of a diversion dam or barrage across the river at Bandicoot Bar, irrigation and drainage channels, pumping and power stations, protective levees, and the nearby township of Kununurra. The dam would store 97.4 million cubic metres for the dry season. The lake created by the dam was subsequently named Lake Kununurra.

Three additional stages were envisaged at the inception of the scheme: Stage 2 was to be the construction of the main Ord Dam without crest gates and an auxiliary spillway, having storage of approximately 740 million cubic metres; Stage 3 would have crest gates added to the main dam and auxiliary spillway, and a 10,000 KW hydro-electric power plant at the main dam site; and Stage 4 included an additional 10,000 KW of hydro power, if required. The scopes of the later stages were subsequently modified.

The total cost of the four stages was estimated to be over £16,000,000.

The overall responsibility for planning and supervision of the scheme was entrusted to the Public Works Department of Western Australia with survey work and investigation being carried out by the Department and Lands and Surveys in conjunction with the Public Works Department.

Kununurra townsite

The town of Kununurra came into existence in the late 1950s as a support centre for the Ord River Irrigation Scheme. Initially it provided administrative and social facilities for the Public Works, Contractors and support staff, and the dam construction workforce. It was well planned and subsequently schools, hospitals, retail outlets and tourist accommodation units were established for the permanent residents who included the farmers who took up the farm lots.

The opening of the diversion dam in 1963 enabled the development of a major agricultural industry in the region, accompanied by the growth of towns and communities. It led to important decentralisation of agricultural production in the state, reducing the reliance on produce delivered to northern districts from the south-west or imported from other states, and enhanced the quality, variety and quantity of produce available to the high population centres in the south. The irrigation scheme was further enhanced with the completion in 1971 of the Ord River Dam, further upstream, which produced the massive storage reservoir Lake Argyle (see Fig. 2).

7. BASIC DATA

Project Name : Ord River Diversion Dam

Owner : Water Corporation of Western Australia

Location : Across the Ord River, at Bandicoot Bar, near Kununurra, Western Australia, Latitude 15º47'32.31" S, Longitude 128º41' 40.76 E,

State : Western Australia

Local Government Area : Shire of Wyndham East Kimberley

Designer : Public Works Department, Western Australia

Year Commenced : 1959

Year Completed : 1963

Constructor : Christiani & Nielsen Clough

Physical Description :

The dam consists of a barrage with a concrete spillway approximately 335 metres long keyed onto a quartzite bar in the river bed. The barrage has 20 steel radial gates, each 15 metres wide and 11.3 metres high, and weighing 95 tonnes, prefabricated in Perth, erected between 1.8 metres thick reinforced concrete piers and abutments anchored on to a concrete sill. The gate arms are supported on trunnions fitted to anchor girders supported on and stressed horizontally to the piers and abutments by 64 no. 28.6 mm dia. Macalloy high tensile steel bars, each set developing a force of 2500 tons to resist the water pressure against the gates. There is a precast, prestressed beam bridge spanning over the spillway supporting a 6.7 metres wide two-lane roadway. Automatically controlled electrically powered radial gates hoisting winches are supported on precast beams as is a 20 tonne capacity moveable gantry used to place stop logs upstream of the gates to permit maintenance. 41,000 cubic metres of concrete was used in the dam construction and approximately 350,000 cubic metres of earth fill was required to construct a total of 4.8 km of levee banks linking the concrete structure to the adjacent river banks and providing flood protection for the irrigation area.

Physical Condition :

The structure is in good physical condition.

Heritage Listings : Nil

8. DESCRIPTION OF THE PROJECT

When the Commonwealth Government formally advised the Western Australian Government in August 1959 of its intention to provide funding for the Ord irrigation scheme the state government departments concerned were well advanced in planning for its construction

8.1 Hydraulic Design Considerations

The Public Works Department of WA investigations prior to the detailed design of the dam, which were based on limited stream gauging, concluded that a flood flow of 2,000,000 cubic feet per second (56,700 cubic metres per second) could be expected. The topography at the dam site is a flat alluvial plain almost devoid of rock outcrops, with the Ord River meandering through the plain on a fairly fixed course at a grade of approximately 1:2500. The site selected was primarily related to the existence of a quartzite outcrop across the river at a location known as Bandicoot Bar. Figure 4 shown an outline plan of dam superimposed on aerial photograph of the river.

Figure 4. Outline of proposed dam superimposed on an aerial photograph of the river (Photo courtesy John Lewis)

The bar was conveniently located with respect to the irrigation area to be served from the diversion dam. However the proposed position of the dam on a bend of the river and the slightly oblique angle imposed some difficulties in the layout of the spillway. Another consideration was that it was unusual to build a diversion dam prior to, and without the protection of, a main storage dam.

Accordingly it was decided to carry out laboratory model studies. Two and three dimensional models were built at the Department's hydraulics laboratory in Perth. A series of tests were carried out to optimise the orientation of the structure, determine coefficients of discharge for various numbers of gates, measure water profiles at various discharges, study the debris problem which results from heavy river floods, and sundry other hydraulic considerations which needed to be taken into account in the detailed dam design. The studies proved most useful in solving problems not amenable to mathematical analysis and in confirming various design assumptions about which there had been some uncertainty. The wing walls to the abutments were added to prevent flood flows from bypassing the Diversion Dam.

The final design provided for the gates to pass a flood of 1,5000,00 cubic feet per second (42,500 cubic metres per second), with excess water to pass over the dam's western levee bank, remote from the irrigation area.

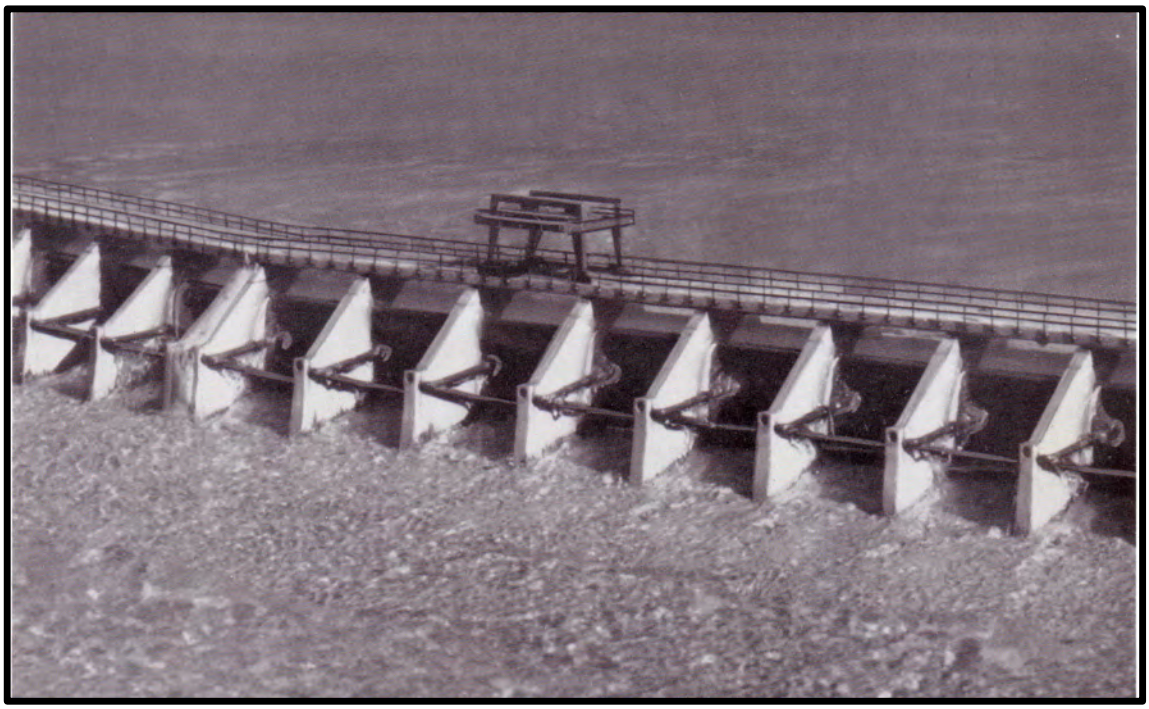


Figure 5. Scale model of dam in PWD Hydraulics Laboratory, Perth (Photo courtesy John Lewis)

8.2 Design of Radial Gates and Concrete Works

A key feature of the diversion dam operation was the radial gates to be used for storage and flood control purposes. John Lewis, who was the PWD WA Engineer in Charge of Planning, Design and Investigation, had in 1952 visited the Canyon Ferry Dam on the Missouri River in the state of Montana, USA, when on a University of WA Gledden Fellowship. This dam has four radial gates. The designers, the US Bureau of Reclamation subsequently generously supplied the drawings of the gates to the Public Works Department at no cost. The same design information was also provided free of charge to the State Rivers and Irrigation Commission of NSW for the Keepit Dam, on the Namoi River. The Keepit Dam, completed in 1961, has six radial gates. The Canyon Ferry dam gates used riveted construction and the PWD WA, concerned that using a welded design could cause distortion and built in stresses which could possibly lead to failure by cracking, opted to stay with riveted construction.

The majority of the detailed design of the dam's concrete, earthworks, mechanical and electrical engineering works was carried out in the Perth office of the PWD WA. The Main Roads Department of WA was responsible for the design of the roadway over the spillway.

Figures A4 and A5 (Appendix) show the general arrangement drawing and a cross-section of the Diversion Dam.

8.3 Site Mobilisation and Award of Major Construction Contracts

Tenders were called in the first half of 1960 for the major site contract, the construction of the concrete spillway, abutments, piers and roadway, the erection of the radial gates, and the construction of levee banks. Eight bids were received and the successful tenderer was the Christiani and Nielsen Clough (CNC) joint venture, which was awarded a £2,900,000 contract in July 1960. Contract completion was to be 30 November 1962. The other major contract, valued at £763,000, was awarded to Perth firm Vickers Hoskins Pty Ltd in a joint venture, for the prefabrication and trial assembly of the radial gates and associated equipment.

Prior to the mobilisation of the contractor PWD WA had commenced the establishment of the town of Kununurra, 4 km from the dam, site access roads, a town water supply, a power station and an airstrip suitable for a De Havilland Dove aircraft.

Construction work in the river bed was generally not possible during the December to March wet season so in the period July 1960 to March 1961 CNC concentrated on the establishment of its staff housing and workforce accommodation, administrative buildings, recreational facilities, erection of aggregate screening and washing plants and the concrete batching plant and the erection of stores and workshops. Mobilisation of plant and equipment also took place over the summer period. However a start was made on the rock excavation for the sill which was curtailed in December when the river began to flow. The site prior to excavation is shown in Figure 6.

Since Kununurra was connected to Perth by 3000 kms of mainly unsealed roads most construction materials except concrete aggregates were shipped from Fremantle to the port of Wyndham, then transported by road 100 kms to the site.

Figure 6. Bandicoot Bar at commencement of excavation (Photo courtesy John Lewis)

8.4 Bulk Transport of Cement

The transport of cement in bulk, which appeared to be the correct solution from a technical and economic point of view, presented a problem as bulk transport by ship had not previously been attempted in Australia. The design of the specialised plant necessary for off-loading cement from the ship and the road transport from Wyndham to the construction site was studied in the Central Design Offices of Christiani & Nielsen in Copenhagen in close consultation with the Swedish specialist firm *Interconsult* which was subsequently commissioned to manufacture and supply the required equipment. The Western Australian State Shipping Service designed and made alterations to the holds of the *S.S Dulverton* to allow the vessel to transport up to 1400 tonnes of bulk cement on each voyage. Cement was delivered by Cockburn Cement to Fremantle wharf by low loaders carrying up to three cylindrical containers each carrying 7 tonnes of cement. The containers were lifted by dock cranes, positioned over the holds, and aerated cement was discharged. At the port of Wyndham the cement was extracted from the ship's holds by a unique vacuum system developed by *Interconsult.* The aerated cement was sucked through 6 inch pipes from a number of points in the holds to a cylindrical vertical reloader from which it was, in turn, blown by compressed air into 6 tonne capacity spherical containers supported on dockside located semi trailer trucks. The cement was then transported to, and blown into, shore based silos with a capacity of 1500 tonnes, and finally by 30 tonne capacity semitrailers carrying four 6 tonne spherical containers to the site where the silo capacity was 750 tonnes. Over the project duration a total of 15,000 tonnes of cement was transported by the *Dulverton*. Figures 7 and 8 show the loading of bulk cement into SS Dulverton at Fremantle wharf and unloading at Wyndham wharf.

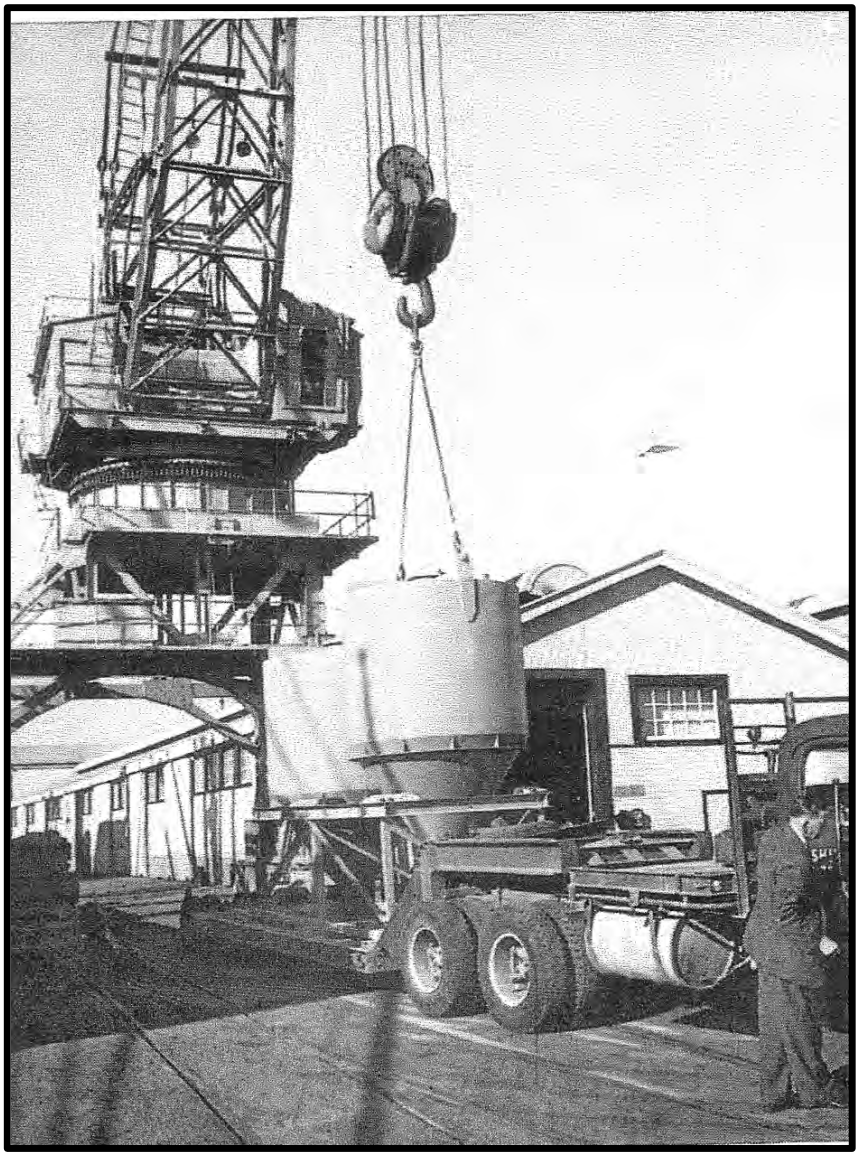


Figure 7. Transferring bulk cement into *SS Dulverton* at Fremantle wharf (Photo courtesy Christiani & Nielsen)

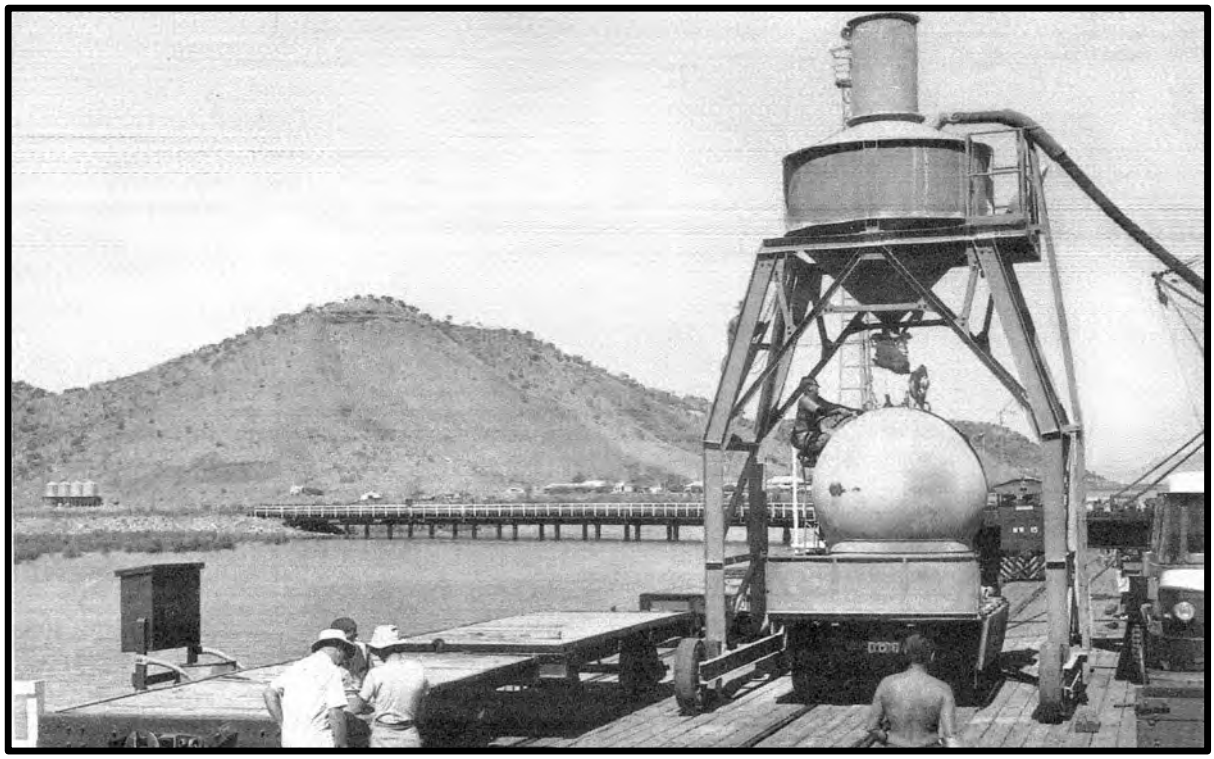


Figure 8. Pumping bulk cement into cylindrical container on Wyndham wharf for transfer to shore storage silos visible at left (Photo courtesy Christiani & Nielsen)

8.5 Site Construction

Prior to construction work commencing near the end of the 1960 – 1961 wet season CNC's earthworks subcontractor, D F D Rhodes Pty Ltd, built a temporary levee upstream of the dam to give protection against minor river flows which could occur and to provide a source of water for earthworks compaction.

Concrete production plant, comprising a washing, screening and classifying plant to process river aggregates available from downstream of the dam site; aggregate and cement storage bins; and a 1600 litre turbine concrete mixer were established at the beginning of the project. Aggregates, cement and water were measured by automatic registration equipment and the plant was capable of mixing 45 cm per hour. Chilled water was used when required. Concrete was transported to the site in 1.5 cm kibbles on 7 tonne flat top trucks.

The dam construction work proper commenced in early 1961 with the removal of excess rock down to foundation level, the drilling of grout holes and the pressure cement grouting of the underlying rock to form a grout curtain and to seal any fractures. These were minimal and only 10% of the volume of cement expected to be required was actually used. The rock surface was then thoroughly cleaned before concrete was placed between plywood-faced formwork in the sill sections. Figures 9 and 10 show the Excavation at Bandicoot bar and concreting spillway sections under construction.

Figure 9. Rock excavation at Bandicoot Bar, protected by temporary upstream levee (Photo courtesy Christiani & Nielsen)

Figure 10. Concreting spillway sections (Photo courtesy Christiani & Nielsen)

Plywood formwork was also used for the concrete pier construction. The piers were anchored to the sill with reinforcing bars and concrete cast in horizontal layers. Vertical holding down

bolts for the gate anchor girders were cast into the piers. Horizontal ducts for the anchor girder Macalloy post tensioning bars were also accurately located at the appropriate level. Each girder is held by 64 Macalloy bars 28.5 mm dia developing a total force of 2500 tonnes. Figure 11 shows the concrete piers and erected gate anchor girders. In Figure 12 shows the blockouts on the concrete to allow stressing of Macalloy bars, and the gantries for placing precast roadway beams.

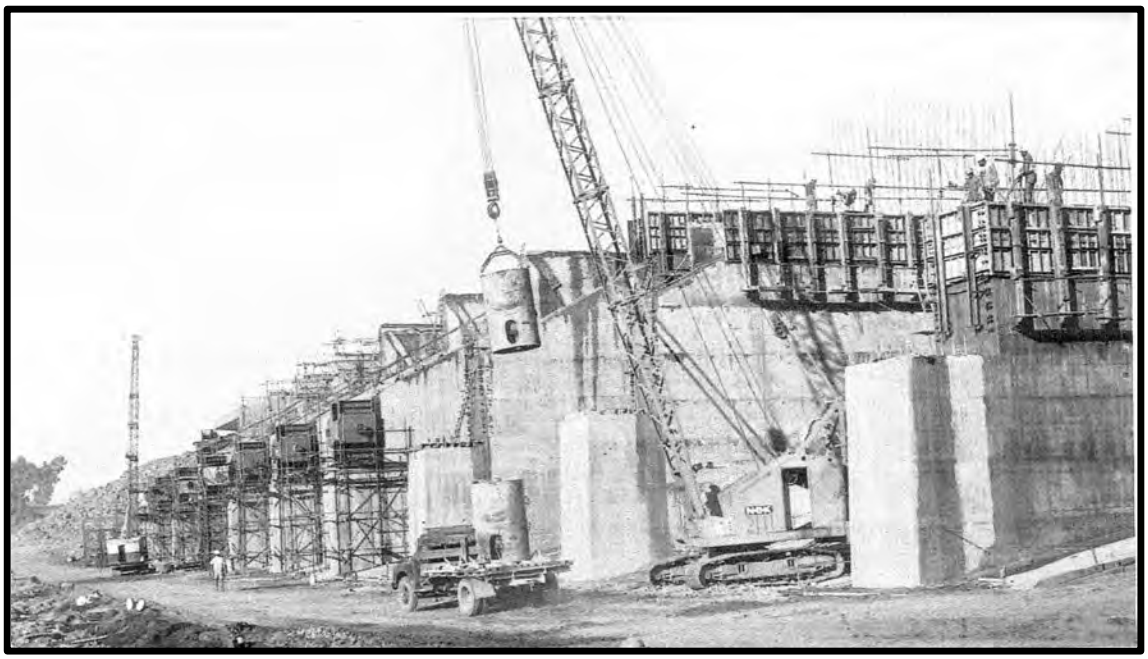


Figure 11. Concreting piers, erected gate anchor girders in background (Photo courtesy Christiani & Nielsen)

Site cranage consisted of five crawler mounted units and two smaller rubber tyred cranes.

A total of 41,000 cubic metres of concrete, 650 tonnes of reinforcing steel and 240 tonnes of Macalloy bars were used in the dam construction.

The post tensioned roadway, hoist and gantry support beams and diaphragms were precast in a casting yard adjacent to the concrete batching plant. The beams also were post-tensioned with Macalloy bars. The beams and diaphragms were erected by purpose made wheeled gantries which were moved from pier to pier on lattice girders which were placed and moved by the crawler mounted cranes. One beam in each span is loose so that it can be lifted out by a permanent gantry if it becomes necessary to place and remove stop logs which are placed in front of the gates if they need servicing.

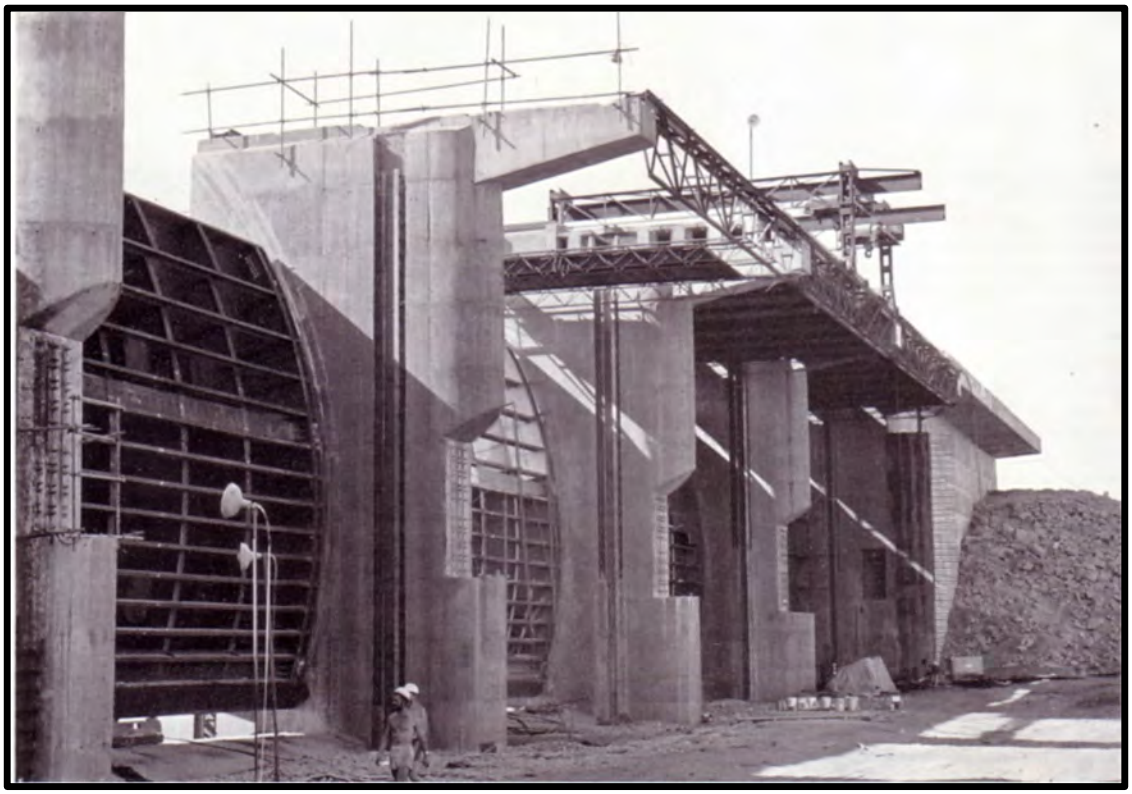


Figure. 12 Concrete piers showing block outs to allow stressing of Macalloy bars and temporary gantries erecting precast roadway beams (Photo courtesy Christiani & Nielsen)

The erection of the radial gates was a major undertaking carried out by the CNC workforce. Each gate weighed 95 tonnes. Initially the anchor girders for gates were accurately positioned then bolted and stressed into position, The radial gate arms were then fitted to the girder trunnions and the intermediate members erected allowing the gate skin plates to be riveted into position. Progress was slow due to the difficulty in recruiting workers with riveting experience and a high rejection rate. A painting subcontractor was used to apply the protective coating. The specification called for sand blasting to white metal and the application of a five coat vinyl system inside the gates and a seven coat system externally. The grit blasting required 3,500 tonnes of sand and 16,000 gallons (73,000 litres) of paint.

The radial gates are operated automatically by means of a sophisticated control system which senses not only the level of the upstream water, but also the rate and direction of variations, thus being able to anticipate the correct opening and closing of individual gates. This equipment is installed in a control tower located near the east abutment.

Figure 13 shows the radial gates being trial assembled in Vickers Hoskins' Perth workshop and Figure 14 shows a radial gate being erected in the field.

Figure 13. Radial gates being trial assembled in Vickers Hoskins' Perth workshop (Photo courtesy Water Corporation of WA)

The concrete work was completed by the contract date of 30 November 1962 but the gates were not completed until early 1963, mainly due to delays resulting from industrial action by the metal trades. However final work on the gates was completed during the 1962 – 1963 wet season by placing stop logs in the slots upstream of the gates thus allowing work to continue on individual gates although the dam was storing water.

The gates were fully completed on 8 March 1963 and dam was officially opened by the Prime Minister of Australia, the Right Honourable Sir Robert Menzies, on 20 July, 1963. However there was a preliminary 'opening ceremony' when Queen Elizabeth and Prince Phillip visited the site on March 17, 1963 (See Appendix Figures A7- A10).

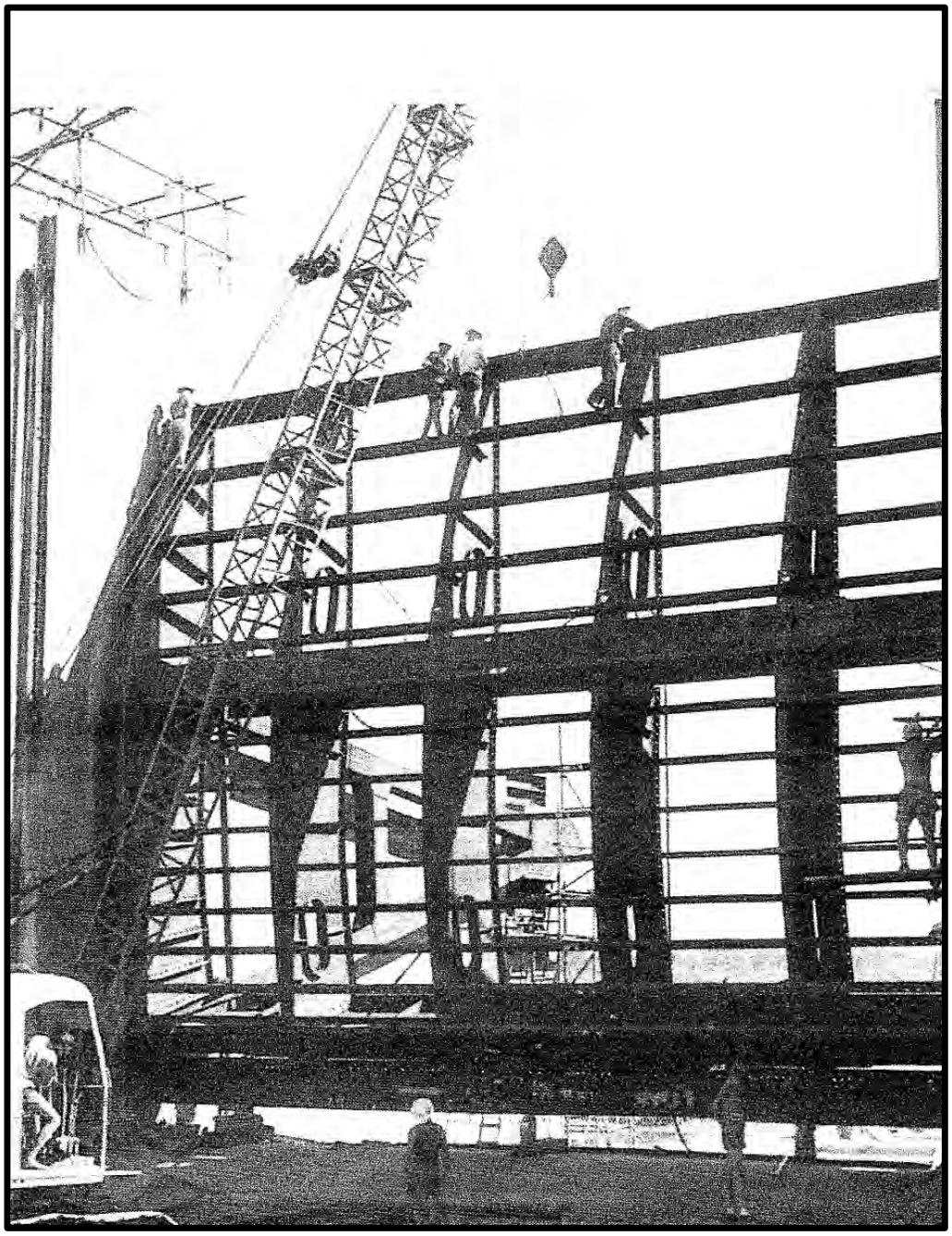


Figure. 14 Radial gate being erected in the field (Photo courtesy Christiani and Nielsen)

9. EMINENT PERSONS ASSOCIATED WITH THE PROJECT

Donald Campbell Munro BE FIEAUST ISO (1909 – 2009)

Donald Campbell Munro was born in Fremantle on September 7, 1909. He grew up in Fremantle and East Fremantle and was educated at Fremantle Boy's School and Perth Modern School. He was an engineering cadet with the Public Works Department and studied engineering at the University of Western Australia. In 1927 he was awarded the Lynn Scholarship at UWA. Whilst at UWA he co-designed the University Engineers Club Crest. He completed his five year engineering course in 1931.

In 1932 he joined the Hydraulic Engineering Branch of the PWD, working on the construction of Canning and Wellington Dams. In 1934 he transferred to the Metropolitan Water Supply, Sewerage and Drainage Department when supervision of the Canning Dam came under that department. He became Resident Engineer at Canning from 1938 to its completion in 1940. He also worked on the Samson Brook and Stirling dams becoming Resident Engineer on the latter in 1941.

In 1942 −1945 he served in the Royal Australian Engineers reaching the rank of Major.

After the war he rejoined the PWD as Principal Assistant Hydraulic Engineer and was Project Engineer for the raising of Mundaring Weir, which commenced in 1946. He became PWD Hydraulic Engineer in 1966, Deputy Chief Engineer in1962 and Chief Engineer of the PWD in 1965, a position he held until 1968.

Don Munro worked on the first proposals for the Ord River Scheme in 1949, and was Project Engineer for the Diversion Dam 1961−1963. He successfully advocated an earth and rock-fill dam for the Main Ord Dam, as opposed to the concrete dam proposed by the former Director of Works and Buildings, Sir Russell Dumas.

In 1969 he succeeded Sir John Parker as Director of Engineering at the Public Works Department, becoming the first West Australian born Director of Engineering, holding that post until 1972 when he became Head of the Department of Development and Decentralisation.

He became Chairman of SECWA in 1972 holding the position to 1975. During this time he was also a member of the Metropolitan Regional Planning Authority (1972-1978) and a member of the Metropolitan Water Supply, Sewerage and Drainage Board (1973-1980) and the State Electricity Commission (1969−79, Chairman 1974−75).

Roy Albert Hamilton BE, FIEAUST , FAIM, JP OAM (1925 – 2004)

Roy Albert Hamilton was born in Perth on 19 February 1925 the son of school teacher Charles Stuart Hamilton and his wife Gladys Sarah Hamilton (nee Robertson). He grew up in Gillingarra, Derby and the Wheatbelt where his father was teaching.

His primary school education from 1932 was at Derby and then he attended Northam High School.

In 1947 he graduated with a four year Bachelor of Engineering degree with honours and joined the Public Works Department.

He was the District Engineer Pilbara from 1947 to 1953 and then was appointed Resident Engineer for the Wellington Dam Hydro Station and the raising of Wellington Dam (1953-1960).

From 1960 to 1963 he was Resident Engineer on the Ord River Diversion Dam. After the Ord assignment in 1963 he became a Senior Engineer in the PWD Construction, Major Hydraulics Branch, rising to become by 1970 a Principal Assistant Engineer. In 1970 he returned to the Kimberley as the Kimberley Regional Manager.

In 1973 he was appointed Director of the Office of the North West retiring in 1983 and moving to Kununurra to develop a 12.5ha mango plantation.

In 1988 he was awarded the Medal of the Order of Australia for services to the community of Kununurra and for fostering industrial and agricultural development. He was also awarded a Centenary Medal in 2001 for services to the community of Kununurra.

Roy died on June 12, 2004 aged 79.

Sir Charles Walter Michael Court AK, KCMG, OBE (1911 − 2007)

Charles Court was born in Crawley, Sussex, UK and came to Western Australia as an infant.

He qualified as a chartered accountant in 1933 and became a foundation partner of Hendry, Rae and Court, accountants, in 1938. He served in the Australian Army in World War 2, enlisting as a Private in 1940 and rose to the rank of Lt-Colonel by the end of the war.

He entered the Western Australian State Parliament as Liberal MLA for Nedlands in 1953 and held the seat until he retired in 1982. When the Liberal Government under David Brand was elected in 1959 Charles Court became Minister for the North West and also Minister for Industrial Development. During his tenure he had an important influence on the mineral and energy developments in the North- West and on other rural and mineral developments. He coordinated and was actively involved in the first stages of Ord River irrigated farm development and the establishment of the town of Kununurra, following the signing of the 1959

joint funding agreement between Commonwealth and State Governments to establish an irrigation scheme in the Kimberley region of WA.

He was Minister for Railways from 1959 to 1967 during which time the standard gauge railway was initiated and substantially completed.

During the Tonkin Labour Government (1971-1974) he became Leader of the Opposition and subsequently served as Liberal Premier from 1974-1982. In 1972 he was knighted for his services to state and national development.

Sir David Brand KCMG (1912 – 1979)

David Brand was born in Dongara, Western Australia and educated at Mullewa State School WA.

He joined the AIF in 1939 and was wounded when serving in Greece in 1941. After his discharge from active service in 1942 he served as a sergeant in the Volunteer Defence Corps until the end of the war in 1945.

He joined the Liberal Party in 1944 and won the State seat of Greenough in a 1945 by-election, holding the seat until he retired thirty years later in 1975.

In April 1950 he became Minister for Works, Water Supply and Housing in the McLarty Liberal – Country Party Coalition Government. After the defeat of the coalition in 1953 he became deputy leader of the Opposition and, on McLarty's retirement, Opposition Leader from March 1957. When the Coalition regained power in 1959 he became Premier, Treasurer and Minister for Tourism, positions he held until March 1971. His eleven years, eleven months and one day as Premier exceeded by more than one year Sir John Forrest's record. He was appointed a KCMG in 1969.

David Brand presided over one of the most exciting periods of development in Western Australia's history. His partnership with the then Minister for Industrial Development, Charles Court, proved exceptionally successful. In 1959 the State and Commonwealth Governments commenced the construction of the Ord River Irrigation Project. In 1960 the Commonwealth lifted its embargo on the export of iron ore, enabling exploitation of large deposits in the Pilbara.

However in later life he described his work with Sir Russell Dumas to secure the 1952 agreement with Anglo – Iranian Oil Company to establishment the Kwinana refinery as the highlight of his career.

His Government was narrowly defeated at the polls in 1971, Sir David stepped down as Leader of the Opposition in 1972 and he retired from Parliament on 21 August 1975. He died on 15 April 1979.

H.E (Harold) Hunt BE FIEAUST (1917 − 2006)

Harold Hunt was born in Cottesloe, Western Australia in 1917. He received his primary and secondary education at Buckland State School, Geraldton District High School and Perth Modern School. He was awarded an engineering cadetship with the Public Works Department of WA in 1935, and commenced engineering studies at the University of WA. On graduation he joined the Departments' Hydraulic Engineering branch and supervised the construction through hard rock of the diversion tunnels for the Stirling and Samson Brook irrigation dams.

Harold joined the Australian Army Engineers in 1941 and for most of WW2 was Captain in command of Light Aid Detachments (mobile repair workshops) including ones operating in Bougainville and Wewak, New Guinea. On demobilisation he rejoined the PWD and from 1946 to 1951 he was Resident Engineer for the raising of Mundaring Weir. During the 1950s he was construction engineer for over 15 major dams providing water supplies to towns in the south-west and mid-west of WA. During the late 1950s and early 1960s he was responsible for the construction of the first major hydraulic works in the Kimberley region, including the Camballin Scheme on the Fitzroy River and the Ord River Irrigation Scheme, which included the Ord River Diversion Dam and associated irrigation channels and farmland earthworks. During the course of this work he was responsible for introducing into the Department the contract system for the construction of major works.

In 1970 he was appointed Chief Engineer for the Public Works Department under D C Munro. In 1972 he transferred to the Metropolitan Water Board (MWB) as its Chief Engineer. The MWB was responsible for all water supply, sewerage and main drainage within the Perth Metropolitan Area, and in the early 1970s it was engaged in a major expansion program. This program included the development of metropolitan ground water resources, an infill sewerage program and the development of two new major sewerage treatment plants.

Harold was Chairman of the Regional Zone Development Committees for Albany and the South-West (1964−72). He was a member of the Metropolitan Region Planning Authority (1972−81) and also of the EPA Conservation Through Reserves Committee for System 6 Darling Range. He was also Chairman of the Darling Range Salinities Studies Committee (1974−80) and the Western Australian Quality of Water Committee (1972− 80).

Harold was a member of Engineers Australia Division Committee from 1967−1974 and Chairman in 1974. His publications include: 'The Raising of Mundaring Weir' and 'Perth's Early Water Supplies'.

J.G.(John) Lewis BE Hons, FIEAUST (1925 −)

Engineer for Planning, Design and Investigation, Hydraulics Section, Public Works Department of Western Australia 1954 – 1964.

John Lewis was born in London in 1925 and migrated to Australia with his parents in 1927. The family initially lived in the country of Western Australia hence his initial primary education was by correspondence followed by primary and secondary education at Quairading and North Perth primary schools. He won a scholarship to Perth Modern School in 1938 but did not complete his secondary education at PMS, leaving in 1941 to join the Public Works Department as a cadet. He studied at night to matriculate before entering the University of WA in 1945, graduating in 1948 with First Class Honours in Civil Engineering.

He won a University of WA Gledden Fellowship in 1951 and did post graduate engineering study at Imperial College, London, specialising in earth and rockfill dams and hydraulic structures. He studied various dams and hydroelectric power plants in USA for three months in 1952 during his Fellowship. He returned to Perth in 1954 to take up his appointment again with the Public Works Department of WA.

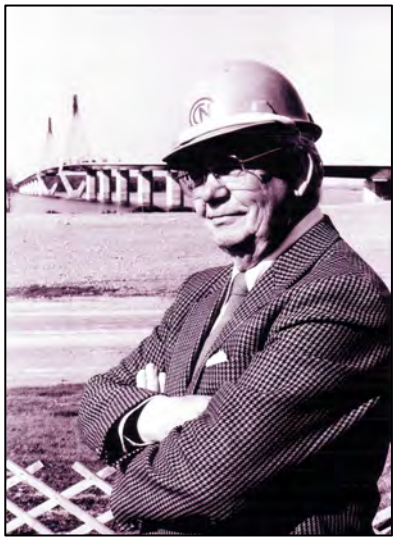
During his sixteen years as an engineer with the PWD WA he led design teams on four large earth dams and three major concrete ones. They included

- Raising Mundaring Weir by 10 metres
- Raising Wellington Dam by 15 metres
- Logue Brook Dam [45 m high]
- Waroona Dam [39 m high]
- Ord River Diversion Dam
- Fitzroy River Weir
- Ord Main Dam and Spillway – site location, conceptual design
- Planning and Layout of the Ord River Area including Kununurra Township

John was responsible for setting up the PWD's Engineering Research Station which provided a special knowledge of hydraulic models, coastal erosion, engineering properties of soils and foundations, corrosion protection and durability of soils. In 1960 John visited India and Pakistan studying problems of flood and sediment control, subsequently submitting a report to the IEAUST on those subjects. In 1961 he attended the Congress on Large Dams in Rome, the Conference on Soil Mechanics and Foundation Engineering in Paris and represented Australia at the International Irrigation and Drainage Commission meeting in Moscow. He then studied various large works in the central States of Soviet Russia.

He resigned from the PWD in 1964 to join an engineering consulting practice concerned with water supply, railway and port structures for the developing mining industry.

Leif Ott Nilsen MSc.Eng, DIF, FIEAust (1918 – 1991)



Manager, Christiani & Nielsen (Aust) 1959 – 1970.
Leif Ott Nilsen was born on 16 December 1918 in Copenhagen, Denmark. He was educated at Efterslaegtsselskabets School in Copenhagen and at the Technical University of Denmark, where he was awarded the degree Master of Science in Civil and Structural Engineering with first class honours in the autumn of 1942.

In 1946 he applied for work with Christiani & Nielsen A/S in Denmark, with a view to working overseas. His application was successful and later that year he sailed to Durban, South Africa with his wife Ida.

From 1948 to 1950 he worked for Christiani & Nielsen in Lorenco Marques (Maputo), Mozambique. Projects completed during this period included the Matola River Bridge and an extension to the piled wharf and warehouse foundations. In 1950 he was transferred back to South Africa to work on projects in Durban and Cape Town. From 1953 to 1955 he supervised the construction of the Ellis Brown viaduct (Umgeni River Bridge), a long prestressed concrete bridge in Durban. This bridge was the first large prestressed concrete bridge built in South Africa. In 1956 Leif Ott Nilsen was appointed Branch Manager, responsible for the activities of Christiani & Nielsen in Cape Town.

In 1957 Christiani & Nielsen, in a joint Venture with J. O Clough & Son, won an international tender to construct the Narrows Bridge in Perth Western Australia. In May 1957 Leif Ott Nilsen was appointed Agent for the construction of the Narrows Bridge. On completion of the Narrows Bridge in 1959, a decision was made by Christiani & Nielsen to establish a branch of the company in Perth, Western Australia.

Larger projects undertaken by Christiani & Nielsen from 1959 to 1970 in Western Australia included the construction of the Ord River Diversion Dam, a joint venture with J.O. Clough & Son. Other projects included the construction of jetty No 2 for Australian Iron and Steel Pty Ltd, a cooling water intake structure for State Electricity Commission, also at Kwinana, and ten concrete bridges of various lengths on Western Australia's Standard Gauge Railway project.

In 1970 Leif Ott Nilsen, together with his wife Ida returned to Denmark. During the period from 1970 to 1980, he completed many complex administrative tasks for Christiani & Nielsen A/S in Denmark and abroad, most notably, projects in Norway and Libya where Gadaffi had nationalised the company's assets during the construction of a wharf for BP in Benghazi.

In July 1980 he was appointed manager for the supervision of the construction of the Faroe Bridges in Denmark by Christiani & Nielsen A/S on behalf of the Road Directorate, Danish Ministry of Transport.

On 15 May 1985, Queen Margrethe II of Denmark awarded the Order of the Dannebro, Knight, to Leif Ott Nilsen for meritorious service. The Faroe bridges were officially opened by Queen Margrethe II of Denmark on 4 July 1985.

Leif Ott Nilsen retired on 1 September 1985.

Other Engineers who were closely involved with the project

PWD Perth office staff involved with design of the project were K Webster, 2IC to John Lewis and lead civil engineer; D Rickman, responsible for Mechanical and Electrical Services; K Ehrenfeld; M Corboy; J Grey; P Hill and R Pritchard.

PWD site staff included Brigadier F Hussey, deputy Resident Engineer; B Sharpless, R Bulstrode; A Henryon; P Davies; D Lawson and E Shelton. C Ion was responsible for surveying.

Christiani Nielsen Clough site staff included J Huusom, Project Manager; U B Hansen, Deputy Project Manager 1960 − 1961; D Young, Deputy Project Manager 1961 – 1962; B Ludvigsen; P Knight and J Turner.

The dam control equipment was supplied and installed by Adelaide firm F R Mayfield, supervised by D Larkin.

10. HERITAGE ASSESSMENT

Historical Significance

The Ord River Diversion Dam is historically significant because its construction, harnessing the wet season flood waters of the Ord River, was a prerequisite for the commencement of Stage 1 of the Ord River Irrigation Scheme, a joint State and Commonwealth initiative to develop an agricultural industry in what had been for long a marginal pastoral area. The town of Kununurra was established to initially serve the new development and subsequently became the administrative centre for the East Kimberly region. The construction of new sealed roads in the area as a consequence of the scheme resulted in a large escalation in tourist activity and, with the impending commencement of Stage 2 of the irrigation scheme, the full potential of region will be realised.

Technical Achievement

Considering the remoteness of the site, limited available site investigation data, basic transport and communication facilities (no telephone link to the south), lack of nearby infrastructure and difficult seasonal climatic conditions, the construction of the diversion dam was a significant technical achievement. The dam was constructed at a time before the commencement of the major iron ore and gas development projects in the Pilbara region. These developments generated a large expansion of specialised manufacturing, contracting, subcontracting and service industries which would have been of significant benefit if available in the early 1960s.

Social

The implementation of Stage 1 of the Ord Irrigation Scheme, made possible by the construction of the diversion dam, created a working environment for a new group of pioneers (and those who supported them) who took up irrigated farm lots.

Rarity

The Ord River Diversion Dam was the first major barrage with radial gates built in Australia at the time of its construction in the early 1960s. It was also the first major civil engineering project constructed by private enterprise for the Public Works Department of Western Australia.

Representativeness

The diversion dam is an excellent example of a barrage across a shallow river bed, located and designed to store water to gravity flow into an irrigation area as well as coping with exceptional seasonal river flows.

Integrity/Intactness

The diversion dam is intact and still functioning as intended when designed and constructed fifty years ago.

11. INTERPRETATION PLAN AND BUDGET

11.1 50TH Anniversary of Official Opening of Ord Irrigation Project

The Ord River Irrigation Project was officially opened by the Prime Minister of Australia, The Right Honourable Sir R. G. Menzies, at a ceremony at the Diversion Dam site on 20 July 1963.

If this nomination is successful it is proposed to hold an engineering heritage recognition ceremony for the Ord River Diversion Dam, in Kununurra, at a location to be agreed, on Saturday, July 20, 2013, the 50th anniversary of the original opening of the project.

At least ten former employees, who were involved in the design or construction of the diversion dam, with the PWD WA or the Contractor CNC, with partners, have made preliminary arrangements to travel to Kununurra for the ceremony. The Chairman of the Board of the Water Corporation, and the CEO, have advised that they will attend the ceremony. In addition a number of relatives of people who were involved with the original scheme (but are now deceased), are likely to attend the ceremony.

The Kununurra Historical Society, a very active body in the town, is very supportive of EHWA's initiative, and has been assisting EHWA with locating and providing information to prepare this nomination.

11.2 Probable Themes of the Interpretation Panel

- A brief history of the origins of the scheme
- Diagrams of the region, area and first five farms location
- Photographs of the dam site before construction
- Progress construction photographs
- Photographs and brief description of roles of eminent persons involved
- Photographs of the near to complete and completed dam
- Photographs of the official opening ceremony and plaque

11.3 Panel Design

The panel will be similar to the one provided for the NASA Carnarvon Space Tracking Station, ie. with a EHA 300 mm diameter disk mounted on a strut between the legs of the panel.

Ongoing maintenance of the panel will be the responsibility of the owner.

11.4 Budget

Quotations for design and production of the interpretation panel have been obtained. The budget includes the potential cost of 2xPVC mockups of the panel to be used at an indoor ceremony in Kununurra, one PVC panel to be subsequently donated to the Kununurra Historical Society for their museum, the other to be installed by WaterCorp at the John Tonkin Water Centre in Perth as part of a new permanent display featuring the Ord River Irrigation Scheme.

The budget also includes the cost of two travel and accommodation in Kununurra for two members of EHWA to attend the ceremony.

ITEM	NOTES	BUDGET
Nomination Production Costs	Photocopy Costs, estimated	$50.00
Panel Design	Quote received	$528.00
Panel/Frame Manufacture	Quote received	$2,557.50
Panel Delivery	Estimated	$300.00
Panel Install Costs	To installed by WaterCorp	unknown
2x PVC Panels		$352.00
Travel Costs	2 x $1361 (airfare + 2 night accomm)	$2,722.00
Ceremony Costs		unknown
	TOTAL COST (known amounts):	$6,509.50

It is anticipated that the Water Corporation (owner) will meet the costs of the panel and frame manufacture, and installation. We will also propose that the Water Corporation, in conjunction with the Shire of Wyndham East Kimberley, meet the costs and organise the ceremony. The issue of invitations and registering of RSVPs will be done by the EA WA Office staff.

12. ACKNOWLEDGEMENTS

The author wishes to thank the following for their assistance in preparing this nomination.

Mr John Lewis, PWD WA Engineer in Charge of Planning, Design and Investigation at the time of the Ord River Irrigation Project was being planned.

Mr Uffe B Hansen, Deputy Project Manager for Christiani Nielsen Clough 1960 – 1961

Mr Birger Ott Nilsen, son of Leif Ott Nilsen

Mr Andrew Barker, President, Kununurra Historical Society, 2012 – 2013

Mr Terry Murphy, Water Corporation of WA

Professor Mark Bush, Chairman, Engineering Heritage WA

Mr Mike Taylor, Secretary, Engineering Heritage WA

13. REFERENCES

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Nomination prepared for Engineering Heritage Western Australia by Don Young, March 2013.

APPENDIX - ADDITIONAL HISTORICAL PHOTOGRAPHS AND DIAGRAMS

Except where indicated, all photographs and diagrams in this Appendix are by courtesy of the Water Corporation of WA.

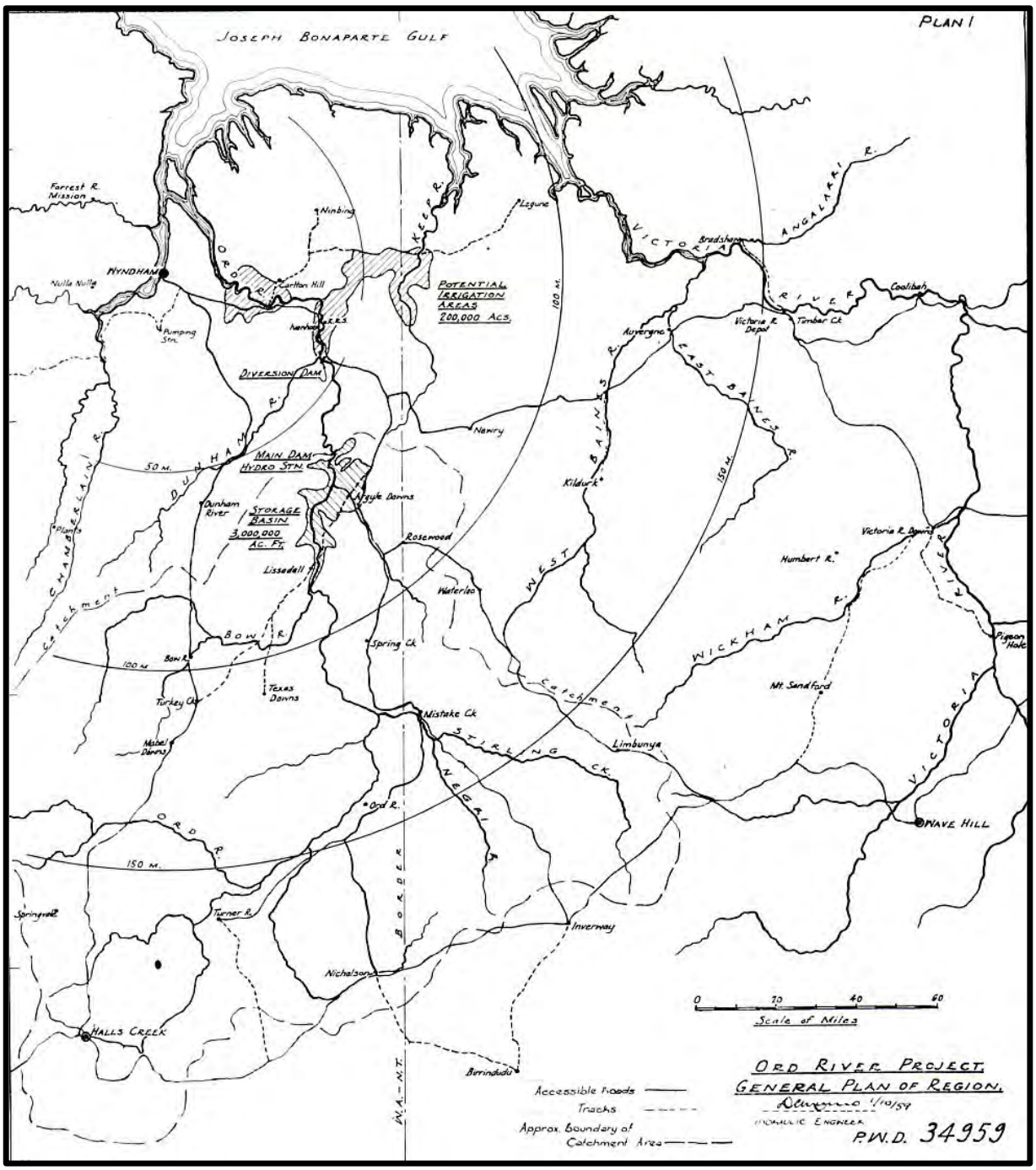

Figure A1. General Plan of Region October 1959

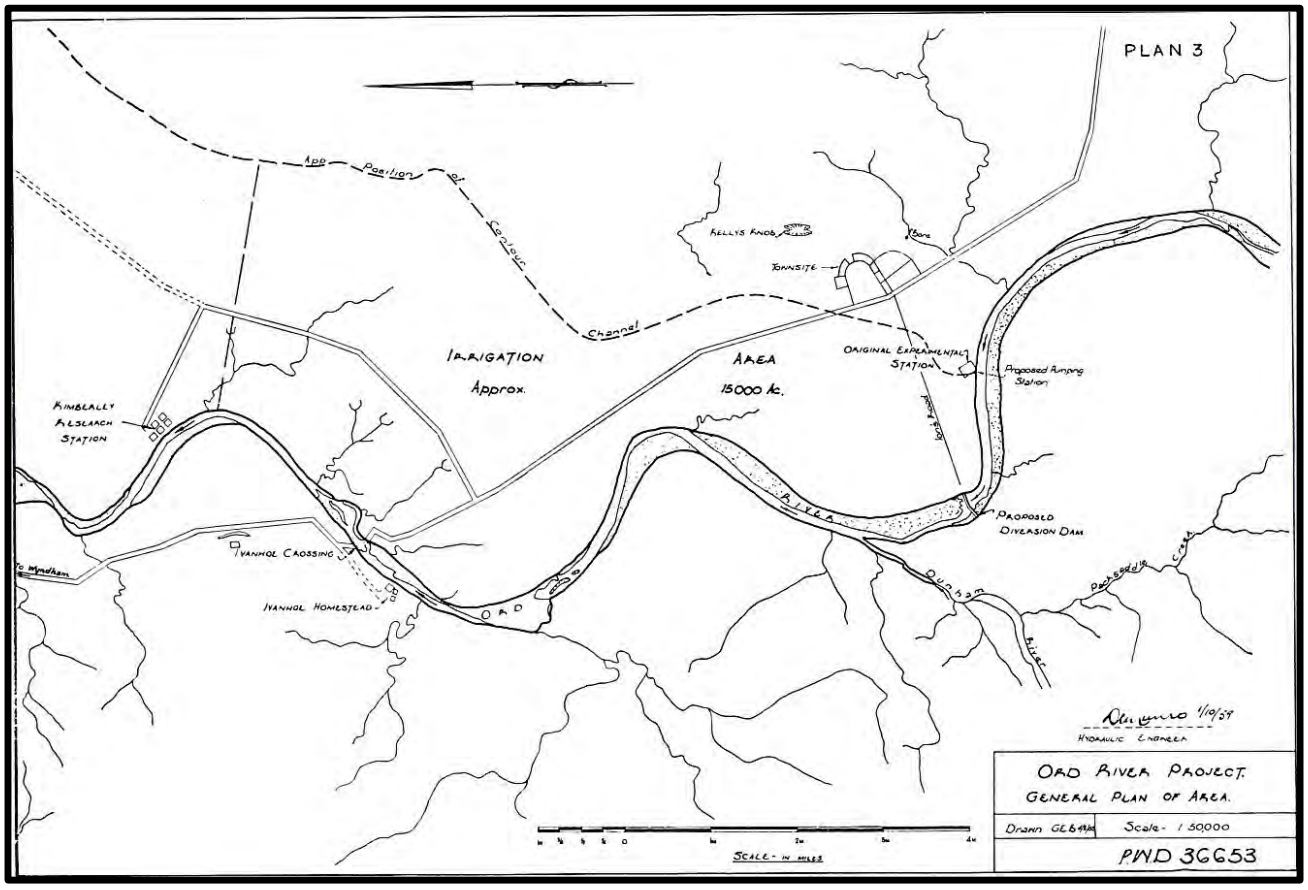

Figure A2. General plan of the area October 1959

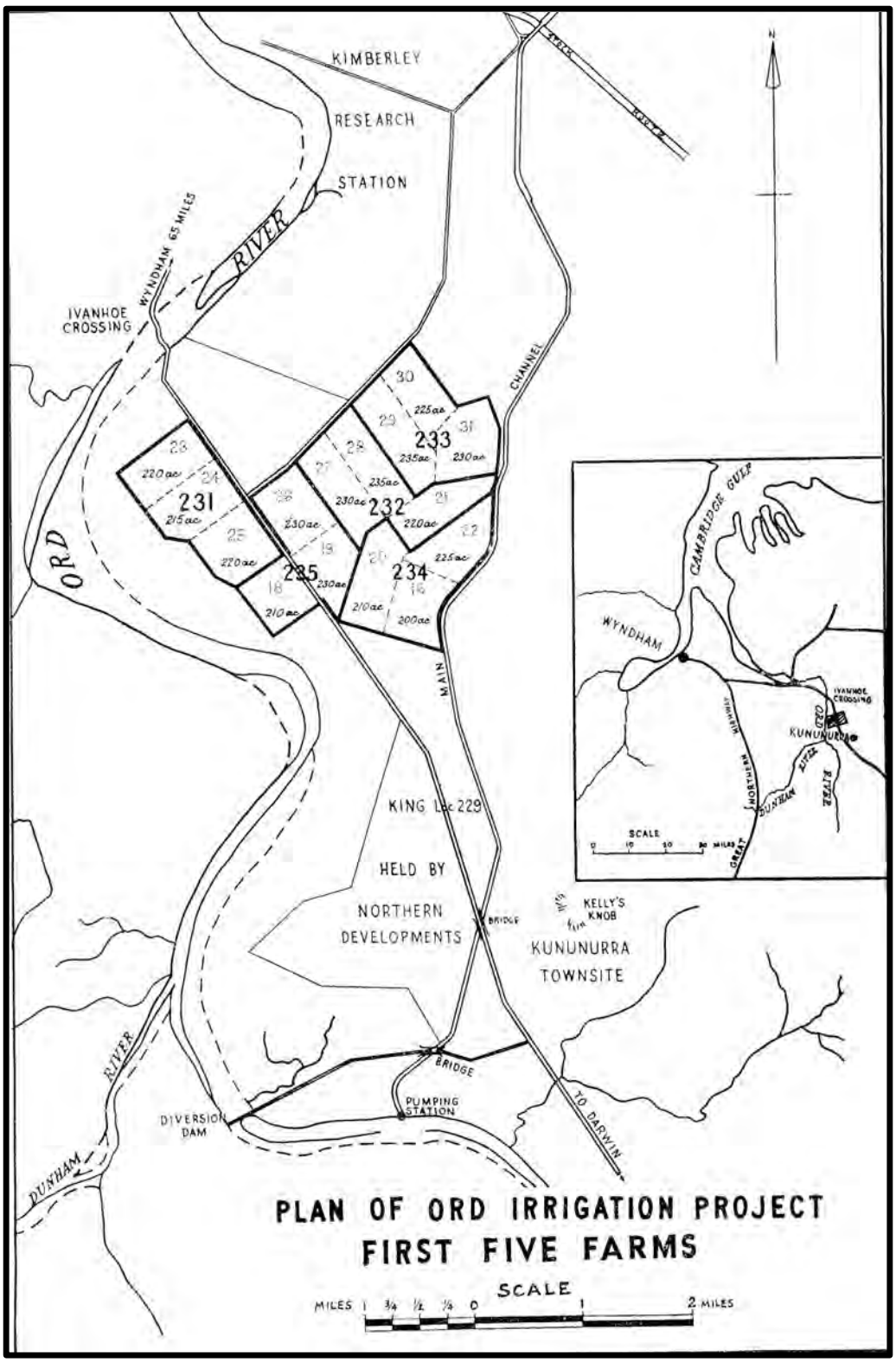

Figure A3. Plan of Ord Irrigation Area, First Five Farms.

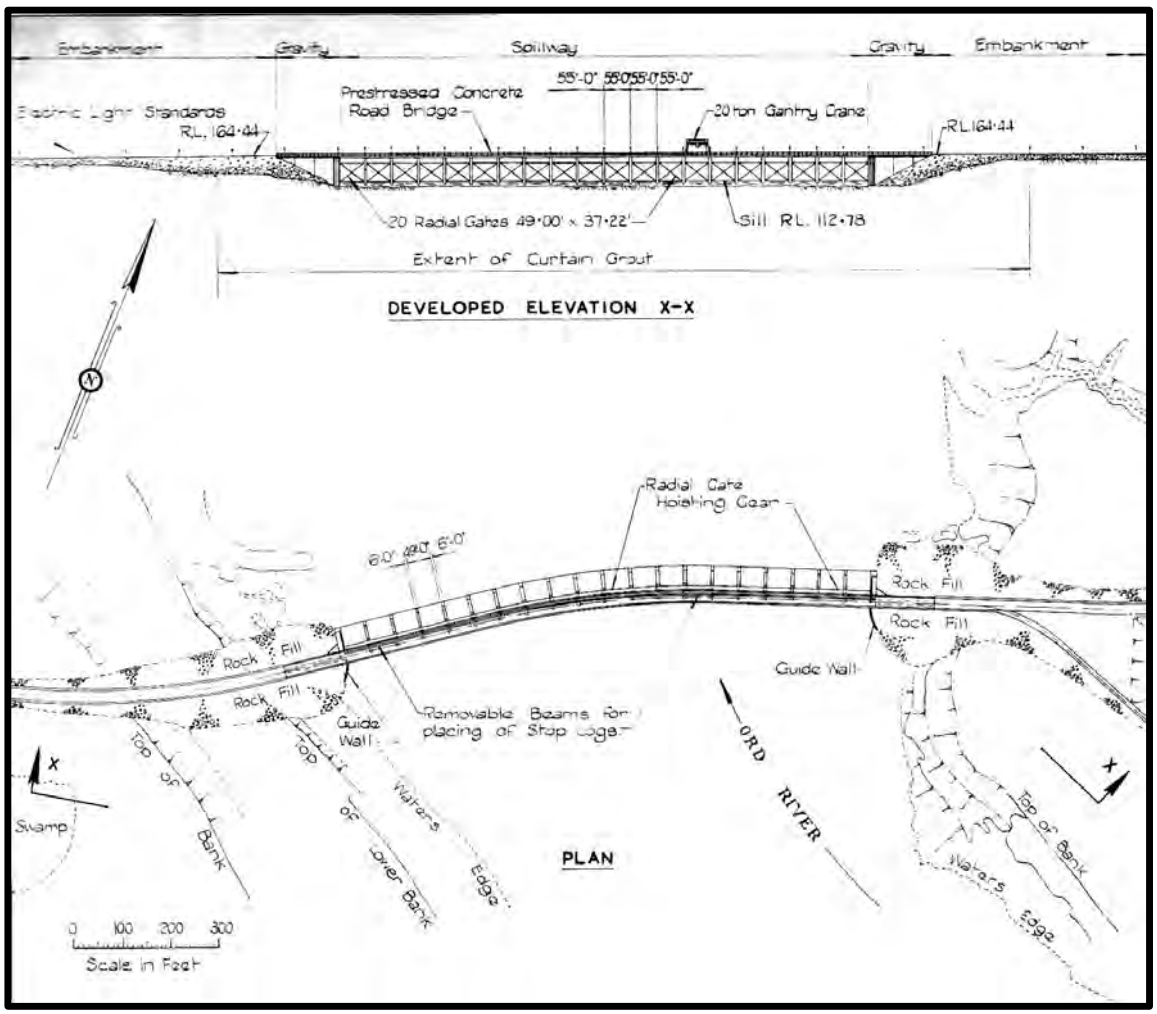

Figure A4. General arrangement drawing of Diversion Dam

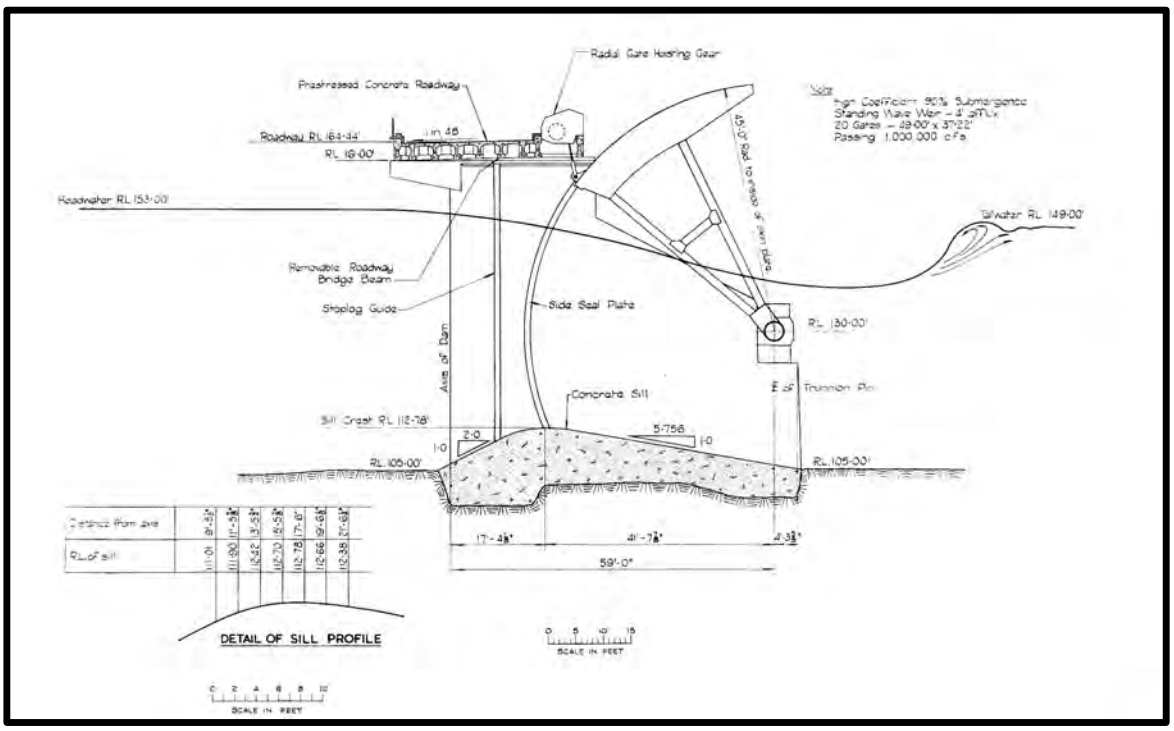

Figure A5. Cross-section of Diversion Dam.

Figure A6. Ord Diversion Dam in early 1963 (Photo courtesy Kununurra Historical Society).

Figure A7. Royal Party arriving at Kununurra airfield, 17 March 1963 (Photo courtesy Kununurra Historical Society).

Figure A8. Queen Elizabeth addresses audience at Kununurra Club, 17 March 1963 (Photo courtesy Kununurra Historical Society)

Figure A9. Prime Minister Menzies speaking at opening ceremony, 20 July 1963 (Photo courtesy Kununurra Historical Society).

Figure A10. Plaque Recording the official opening, 20 July 1963 (Photo courtesy Kununurra Historical Society).