QUEENSLAND
IRRIGATION AND WATER SUPPLY COMMISSION

REPORT

ON

BOWEN-BROKEN IRRIGATION SCHEME

OCTOBER 1967

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QUEENSLAND

IRRIGATION AND WATER SUPPLY COMMISSION

OUTLINE

OF

REPORT

ON

BOWEN/BROKEN IRRIGATION PROJECT

(OCTOBER, 1967)

PURPOSE:

This report sets out an outline of a proposal for the conservation of the waters of the Broken River and for their use in the development of an irrigation project astride the Broken and Bowen Rivers in the vicinity of Collinsville at an estimated cost of $22,520,000.

ORIGIN:

Following the decision to proceed with the construction of a thermal generating station at Collinsville in October, 1962, with water supply for such station to be drawn from the Bowen River, preliminary investigations were undertaken to determine:

(a) The best location for a single purpose structure to provide water supply for power generation and urban use only;

(b) Possibility of a dual purpose storage to provide water for power generation, urban use and some irrigation; and

(c) Possibilities of major water conservation works and irrigation.

Arising from these investigations it was decided to proceed with the construction of Eungella Dam at 44.6M on the Broken River with a capacity of 105,000 acre feet and capable of providing a total annual supply of 40,000 acre feet.

The investigation also confirmed that prospects for much larger water conservation works on the Broken River were favourable as were the possibilities of using supply from such works for irrigation development in the large area of attractive agricultural soils available on both banks of the river in the vicinity of Collinsville.

SCOPE OF INVESTIGATIONS:

The investigation covered by this report covers -

Agricultural Aspects:

A reconnaissance soil survey of the project area.

An evaluation of the available soil for irrigation production.

A preliminary study of possible farming enterprises.

An assessment of existing and possible production from the area.

Engineering Aspects:

Preliminary topographic surveys of the main dam site and reservoirs, diversion dam site and proposed irrigation area.

Assessment of supply available for proposed reservoirs.

Preliminary designs and estimates of cost of the main dam and diversion dam.

Preliminary layout of main channel system and estimates of capital cost of irrigation, drainage, road and other works including resumptions, surveys, etc.

Estimates of annual cost of operation and maintenance and likely income from the project.

OUTLINE OF SCHEME:

The proposed scheme would comprise:

(a) Urannah Dam at 22.4M on the Broken River with a storage capacity of 350,000 acre feet.
432,000 mc

(b) A diversion dam at 3M on the Broken River to raise the level of water released downstream from the main storage for diversion by gravity into a channel reticulation system.

(c) Main channel system serving a small area of land on the left bank between the diversion dam and about 59.4M on the Bowen River and thence distribution on both banks of the Bowen River to as much of the attractive agricultural soils in this general area as would be required for the establishment of some 138 farms, each with not less than 450 acres of land suitable for irrigation.

(d) Surface drainage and road works throughout the area.

The proposed locations of the Urannah Dam, the diversion dam and main channels are shown on Fig. 2 (Sheets 1 and 2).

DETAILS OF PROPOSED WORKS:

Urannah Dam - 22.4M Broken River:

Name of Site -

This site, which is located $1\frac{1}{2}$ miles downstream of the confluence of Urannah Creek and the Broken River, has been named Urannah Dam.

Catchment Area -

The catchment area above the site is 425 square miles and includes three important tributaries, Bee, Massey and Urannah Creeks, which together with the Broken River itself, rise in the Clarke Range. The elevation of the catchment rises from R. L. 716 feet at the dam site to a general level of about 2,600 feet along the Range with peaks in the Range rising to over 4,000 feet.

Mean annual isohyets over the catchment, estimated from rather meagre data, are shown on Fig. 1 and range from approximately 27 inches near the site to nearly 90 inches on the Clarke Range with the average being estimated at 55 inches.

No stream gauging records are available in the vicinity of the dam site and stream flow data has been derived by approximate methods using a comparison with the Herbert River catchment believed to be hydrologically similar.

Stream flows are now being obtained by automatic gauging stations installed in 1962.

Average annual flow at the Urannah site is estimated to be 276,000 acre feet.

Geology -

No diamond drilling has been carried out on the site but geological inspections indicate that the site and reservoir area appear to be satisfactory for the construction of a large dam and storage.

Surface geology consists of granite and diorite rock types with partial cover of alluvium. Granite rocks which are predominantly of granite porphyry have been intruded by the diorite and related porphyritic modifications.

Outcrops of very hard fresh rock occur over most of the bed with small areas of shallow sand cover and narrow low level alluvial terraces along both banks. Depth to sound rock on the sides of the site is expected to be small.

Possible Storage Capacity and Yield -

Topography of the site and reservoir area is such that a storage capacity of up to 500,000 acre feet, or even greater, could be provided.

At this stage preliminary designs for storages at this site have only been made for capacities of 200,000 and 350,000 acre feet because of the unreliability of data on stream flow and the limited nature of the investigation.

It appears, however, that with a catchment area of 425 square miles; a probable average annual rainfall over the catchment of 55 inches; and potential storage capacities up to at least 500,000 acre feet, that a substantially larger storage than 350,000 acre feet capacity would be practicable. Details of the required height, yield at the dam site and estimated costs determined from these preliminary investigations of storages of 200,000 and 350,000 acre feet capacities, are set out in Table 1.

TABLE 1

CAPACITIES, YIELDS AND COSTS OF STORAGES AT URANNAH DAM SITE

Height (ft.)	Capacity (ac. ft.)	Annual Yield at Dam (ac. ft.)	Estimated Capital Cost as at June, 1963 Total ($M)	Per ac. ft. Storage ($)	Per ac. ft. Yield ($)
139	247,000 mL 200,000	107,000 mL 87,000	9.2	46	106
166.5	432,000 350,000	160,000 mL 130,000	10.4	30	80

Preliminary Designs -

Preliminary designs have only considered a rockfill dam with reinforced concrete upstream face slab and a side spillway. This design has been adopted because of doubt about the availability of suitable earthfill material for a central or sloping earth core.

Two alternative designs of spillway have been examined - an open spillway and a spillway with automatic spillway gates.

In each case the normal reservoir level would be some 166.5 feet above bed level to provide a capacity of 350,000 acre feet with the maximum height of bank 192.5 feet for the open spillway design and 179.5 feet for the gated spillway.

Preliminary estimate of cost for each structure is $10.4 million.

The preliminary design and layout for the dam with gated spillway is shown in Fig. 3.

Flood Mitigation -

With the open spillway arrangements, the favourable storage characteristics of the Urannah site provide significant flood mitigation along the Broken and Bowen Rivers.

A preliminary assessment shows that reduction in flood peak of approximately 70% could be obtained for flood inflows of 165,000 to 350,000 cusecs, as indicated in Table 2.

TABLE 2

URANNAH DAM SITE FLOOD MITIGATION EFFECT - OPEN SPILLWAY DAM

Maximum Inflow (cusecs)	Myer Rating	Maximum Outflow (cusecs)	Reduction of Peak Flow (%)
350,000	17,000	119,000	66
247,000	12,000	80,000	67
165,000	8,000	49,000	70

The peak flow of the 1958 flood at 8.5M on the Broken River has been estimated to have been approximately 360,000 cusecs, equivalent to a Myer Rating of 13,500.

It is estimated that with a storage of 105,000 acre feet at Eungella and 350,000 acre feet at Urannah Dam, reduction in this flood peak would have been some 120,000 cusecs.

This indicates that in future consideration of the Urannah dam site, special attention should be given to the provision for flood mitigation, either by the use of an open spillway storage or the provision of some additional storage specifically for flood mitigation.

Diversion Dam:

Two locations have been examined for the diversion dam site, 59.4M on the Bowen River and 3M on the Broken River. The Broken River site has been selected because a structure on the Bowen River sufficiently high to permit diversion at R.L. 450 feet would cost at least $12 million.

137m

At 3M on the Broken River, the catchment area is some 875 square miles and the maximum possible flood is in the vicinity of 500,000 cusecs. Under these circumstances and in view of favourable foundation conditions, only a mass concrete gravity dam with overshop spillway has been considered.

The investigations have been restricted to a height of dam investigated for the purposes of power supply and urban requirements at Collinsville only, i.e. a structure with spillway crest at R.L. 543.5 feet, or 71.5 feet above bed level.

River Bed 472 ft.

This would enable diversion at approximately R.L. 520 feet which levels have shown would be high enough to command sufficient of the soils suitable for irrigation downstream of the 59.4M site on either bank of the river to provide for complete utilisation of the water that would be available from the two storages considered.

Preliminary design and layout of the dam is shown in Fig. 5.

The estimated cost of this structure is $3.34 million.

It is possible to build a significantly higher structure at this site and it is likely that if the scheme were proceeded with, it would be found desirable to increase the height of the structure by some 20 to 30 feet to provide for a higher diversion level and also a storage of at least 20,000 acre feet above diversion level.

A limited amount of foundation investigation has been carried out at this site.

Main Channels:

The possible location of a main channel system from the diversion dam, serving lands on both sides of the river downstream of 59.4M on the Bowen River is shown on Fig. 2. This is approximate only, having been determined from only a few lines of levels through the area, supplemented by the use of photogrammetry.

The channel system indicated is more extensive than would be required for the water that would be available from the storages proposed but would allow careful selection of the area to be developed somewhere within the system indicated.

Approximate estimates of cost have been prepared on the basis of experience in other areas.

335,000 m/c for even 12" Rain
60" = 1.675 m m/c
72" = 2.01 m m/c

SUPPLY AVAILABLE AT DIVERSION DAM:

Between Urannah Dam (22.4M) and the diversion dam (3.0M) the catchment area increases from 425 to 875 square miles and the additional catchment includes two major tributaries, Emu and Grant Creeks, which rise in regions of 50 inch to 60 inch rainfall. Although no actual stream flow data are available for these streams it is obvious that the additional catchment will contribute a significant further inflow into the Broken River.

No allowance has been made for any additional regulated supply at the diversion dam from these streams but it has been assumed that their contribution will offset any stream losses in the release of water down the 19 miles of stream channel between Urannah dam site and the 3M diversion dam site.

432,000 m/c

With Eungella Dam built to a capacity of 105,000 acre feet and Urannah Dam 350,000 acre feet, it is estimated that an assured supply of 200,000 acre feet per annum would be available at the diversion dam.

247,000 m (includes Eungella Dam)

It is expected that with the availability of more precise hydrological data, the annual supply available from a larger storage at the diversion site could be increased considerably over the above figures.

Assuming that the available yield from Eungella Dam of 40,000 acre feet will be reserved for power generation and urban supply at Collinsville and supplementation of irrigation supplies in the Lower Burdekin River, the net yield available for additional irrigation development is 160,000 acre feet.

197,000 m

SOILS, LAND USE, FARM SIZES AND WATER REQUIREMENTS:

Soils:

The major soil groups in the area were mapped by Isbell (Bureau of Investigation) as part of a reconnaissance survey of the Nebo-Collinsville Area in 1954 and subsequently re-examined and extended over the balance of the area likely to be served by the scheme in 1962. Details of soils areas are indicated in Fig. 2 (Sheets 1 and 2).

Table 3 sets out the areas of the various soil types which would be commanded by the main channel system.

TABLE 3

COMMANDED SOILS AREAS

Bank	Section	Soils suitable for Irrigation							Unsuitable Soils
		1	3	7	12	16	17	Total	
Left bank	Bowen River to Glenmore Creek	10,820	2,250	-	11,750	9,630	7,080	41,530	18,470
Right bank	59.4M to Strathmore Ck.	20,500	2,240	12,180	290	34,500	1,150	70,860	17,320
	Strathmore Ck. to end	-	-	1,040	-	33,410	-	34,450	14,750
	TOTAL:	31,320 12528 HA	4,490	13,220	12,040 ×	77,540 × 40,000 HA	8,230 ×	146,840 60,000 HA	50,540

In selecting the areas for development, it would appear desirable at this stage to concentrate as far as possible on types 12, 16 and 17 and those sections of Type 1 (alluvium) above flood level and free from nut grass.

Land Use:

Although it is possible that cotton and other agricultural crops may be grown satisfactorily in the area, it is not considered desirable at this stage to plan on these crops with the possible exception of maize or grain sorghum for bulk export to Japan.

In view of the predominance of the beef industry in the surrounding country and the availability of meatworks at Bowen, the area would be best suited to production of irrigated lucerne, pastures and other fodders for production of hay for sale to the surrounding area and/or for use under direct grazing for cattle fattening.

Farm Sizes:

For the purpose of this preliminary investigation a farm size of 450 acres of irrigable land as determined for the Emerald Project has been adopted.

To allow for a significantly larger area of permanent cropping, pastures or lucerne in this area a basic allocation of 750 acre feet per farm, as compared with 600 acre feet per farm for Emerald, is proposed.

Water Requirements:

No factual information is available on the water requirements of crops in this area. An examination of actual average rainfalls and estimated monthly evapo-transpiration for Collinsville and Havilah indicates an average annual water requirement of 32 to 34 inches to reach maximum growth.

Water requirements for various crops adopted for this investigation were as follows:

Permanent Pasture	3.0 acre feet/acre
Lucerne	3.0 acre feet/acre
Sorghum	1.0 acre feet/acre

FARM PRODUCTION:

Tentative farm studies have been made for several alternative enterprise patterns as follows:

1. Lucerne/Sorghum
2. Pasture/Beef and Dryland Sorghum
3. Pasture/Hay/Beef and Dryland Sorghum

Yields and returns adopted for the tentative study are set out in Table 4.

TABLE 4

YIELDS AND RETURN FOR ALTERNATIVE FARM STUDIES

Enterprise	Cropping	Area (acres)	Adopted Yields (per acre)	Returns
Lucerne/ Sorghum	Lucerne	180	7.5 tons	$28 per ton
	Irrigated Sorghum	250	80 bus.	$28 per ton
Pasture/Beef and Dry Sorghum	Irrigated Pasture	250	800lb. beef	$20 per 100lb.
	Dryland Sorghum	150	20 bus.	$28 per ton
Pasture, Hay and Beef and Dry Sorghum	Irrigated Pasture	250	580 lb. beef	$20 per 100 lb.
			2 tons hay	$28 per ton
	Dryland Sorghum	150	20 bus.	$28 per ton

Table 5 sets out information on the financial situation of farms engaging in the various alternative enterprises.

TABLE 5

FINANCIAL SITUATION OF ALTERNATIVE LAND USE PATTERNS

Item		Alternative Land Use Patterns		
		Lucerne/ Sorghum	Pastures/Beef and Dryland Sorghum	Pastures/Hay/ Beef and Dryland Sorghum
Capital Outlay	($)	50,000	42,000	50,000
Gross Income	($)	50,500	42,300	45,300
Total Costs	($)	20,100	30,100	31,100
Net Income	($)	30,400	12,200	14,200
Return on Capital	(%)	61.0	28.9	28.4

The above alternative enterprise patterns are believed to indicate the upper and lower levels of productivity on farms established in this area.

POSSIBLE DEVELOPMENT:

Extent of Area to be Developed:

197,000 ML

On the basis of an available supply of 160,000 acre feet per annum, an average use of 750 acre feet per farm and a distribution efficiency of 65% (as assumed for Emerald Project) some 138 farms could be developed. Such farms would have a total farm area of some 62,500 acres and would require a gross area of development of some 78,000 acres. 25000 HA.

= 31,200 HA.

Location of Development:

Having regard to the apparent suitability of soils for irrigation commanded by the main channel system and subject to detailed soil survey an adequate area appears to be available on the right bank of the Bowen River between 59.4M and Strathmore Creek and for the purpose of this investigation this area has been adopted.

However, in any further examination of the proposals consideration should be given to partial development on both banks to take advantage of the substantial area of Soil Groups 12 and 17 on the left bank between 59.4M and Cockatoo Creek.

ESTIMATED CAPITAL AND ANNUAL COSTS AND REVENUE:

Capital Costs:

A preliminary estimate of cost for the project as at October, 1963 is set out below:

	($)	($)
Storages -		
Urannah Dam	10,400,000	
Diversion Dam	3,340,000	13,740,000
Irrigation Works -		
Main channel system	6,060,000	
Distribution channels, drainage works, roads, land resumptions	2,720,000	8,780,000
TOTAL:		$22,520,000

Annual Costs:

Estimates of annual costs of operation and maintenance of the project are as follows:

	($)
Storage - operation and maintenance	10,000
Water distribution and maintenance of irrigation works	100,000
Maintenance of drainage works	28,000
Maintenance of other installations	6,000
TOTAL:	$144,000

Revenue:

Annual revenue would be derived from charges for irrigation water, for supply to Collinsville, drainage rates and land rentals.

Charges proposed for this area would be:

Irrigation Water	$3.50 per acre foot
Drainage Rate	$0.70 per acre
Land Rental	$0.25 per acre

Using the above charges the estimated annual revnue would be as follows:

		($)
Irrigation Charges	- 104,000 acre feet at $3.50	364,000
Drainage Rates	- 62,500 acres at $0.70	43,750
Land Rentals	- 62,500 acres at $0.25	15,625
TOTAL:		$423,375

The net annual revenue (i.e. surplus income over expenditure) is some $279,400 or 1.24% of the capital cost or sufficient to cover the debt service charges on $5,070,000 of the capital cost of $22,520,000.

General:

In the above calculations no allowance has been made for costs or returns associated with Eungella Dam and the water which this dam provides for irrigation in the Lower Burdekin River or to the Collinsville Power Station, it being assumed that such supply is fully committed prior to the larger scheme being undertaken.

PRODUCTION FROM SCHEME:

Overall:

Assuming all farms adopted one of three enterprises set out earlier the range of overall areas irrigated, volume and value of production would be as set out in Table 6.

Increased Value:

Production from the area under existing conditions is estimated at $152,000 and the increased value of production for the various enterprises is as follows:

Lucerne/Sorghum Enterprise	$6,718,000
Pastures/Beef/Dryland Sorghum Enterprise	$5,681,000
Pastures/Hay/Beef/Dryland Sorghum Enterprise	$6,001,000

BENEFITS:

Benefits from the Irrigation Area would comprise a small direct return on the capital investment in excess of operation and maintenance costs and a substantial increase in the net value of production from the area.

Benefits external from the Irrigation Area would comprise substantial gains to the grazing industry within, and for some distance outside, the Bowen/Broken Basin from the availability of supplementary and drought fodder; increased output from and the prospect of year round operation of the meatworks at Bowen; increased use of facilities such as the Collinsville-Bowen Railway and the Port of Bowen; and increased population and business activity in the Collinsville and Bowen areas.

Direct Revenue:

The net annual direct revenue from water charges, drainage rates and land rentals of $279,400 is equivalent to 1.24% on the total capital cost of the scheme or sufficient to cover debt service charges on $5,070,000 of the capital cost.

Increased Production:

Table 7 sets out for the various enterprises the increased gross value of production from the scheme and the ratio of such increased value of production to the unserviced portion of the capital cost of the scheme, i.e. after deducting the $5,070,000 serviced by the direct revenue surplus.

TABLE 6

AREAS CROPPED, VOLUME AND VALUE OF PRODUCTION

Enterprise	Cropping				Volume of Production		Value of Production	
	Irrigated		Dryland		Product	Quantity	Item	Total
	Crop	Area (acs.)	Crop	Area (acs.)		(tons)	($)	($)
ıcerne/Sorghum	Lucerne	24,800	-	-	Hay	186,300	5,216,000	
	Sorghum	28,980	-	-	Sorghum	62,652	1,754,000	6,970,000
ıstures/Beef and Dryland Sorghum	Pastures	34,500	Sorghum	13,800	Fat Beef	12,300	5,520,000	
					Sorghum	11,178	313,000	5,833,000
ıstures/Hay/ Beef and Dryland Sorghum	Pastures	34,500	Sorghum	13,800	Fat Beef	8,920	4,000,000	
					Pasture Hay	69,000	1,930,000	
					Sorghum	11,178	313,000	6,243,000

TABLE 7

INCREASED VALUE OF PRODUCTION AND RATIO

Enterprise	Increased Gross Value of Production ($)	Ratio Increased Value of Production to Unserviced Capital Cost (%)
Lucerne/Sorghum	6,718,000	38.5
Pastures/Beef/Dryland Sorghum	5,681,000	32.5
Pastures/Hay/Beef/ Dryland Sorghum	6,001,000	34.4

Effect on Surrounding Cattle Breeding Areas:

The benefits to be derived from the project would not be restricted to the effects on production in the immediate Irrigation Area but could substantially improve output from the surrounding beef producing area, as follows:

(i) Hay production for the lucerne/sorghum enterprise from 24,800 acres of irrigated lucerne could provide supplementary feed for in excess of 750,000 breeders and 750,000 weaners in the dry season with a resultant significant decrease in breeder mortality and an increase in branding.

(ii) Alternatively an area of 34,500 acres of irrigated pastures for fattening could provide an assured market for up to 240,000 head of young store stock per annum from surrounding breeding areas. Year round turnoff could provide continuous operation for the Bowen meatworks, avoiding the present disabilities of seasonal operation and employment.

(iii) Alternatively hay production of 69,000 tons and fattening of some 172,000 head of beef cattle per annum could provide supplementary fodder for in excess of 200,000 breeders and 200,000 weaners in the dry season as well as providing a significant boost in output from the Bowen meatworks.

Population and Business Activity:

As each of the irrigated farms would be a two-unit farm, i.e. the owner plus one permanent hand at least, the farm population in the area would be some 1,100 people and a further increase of 1,100 could be expected in Collinsville and Bowen with corresponding increases in business activity.

FURTHER INVESTIGATIONS REQUIRED:

Further investigations are required before a more detailed examination of this project can be attempted. Particular investigations are required on the following:

(a) More detailed engineering investigations of Urannah Dam, the Diversion Dam, irrigation works and the possibility of storages on other streams including the Bowen River, Emu and Grant Creeks.

(b) More intensive irrigation trials such as have been initiated on Birralee Station.

(c) Examination of the relative merits of either -

(i) use of water by gravity supply to land astride the Bowen River in the Collinsville area; or

(ii) pumped supply (with power generation at Urannah Dam) to lands on the right bank of the Burdekin River upstream of and to the south of Home Hill along the coastal strip.

These investigations have been commenced with the assistance of the Snowy Mountains Hydro-Electric Authority. It is expected that these will be completed together with a more detailed assessment of production potential and value in approximately twelve months.