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MINISTRY OF WORKS AND DEVELOPMENT

DUNEDIN

IDA VALLEY IRRIGATION SCHEME

RE-ASSESSMENT

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INDEX

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1 INTRODUCTION

The Ida Valley Irrigation Scheme was the first Government-initiated scheme in Otago, and was developed essentially by using and extending a race system that had supplied water for sluicing in gold mining sites near Galloway and Poolburn. While it has now been operating for 62 years, the scheme's major weakness still remains - the water supply in most years is not sufficient to meet full quotas on the area under agreement and the necessity for frequent water rationing has been a matter of concern for a number of years.

Methods of improving the water resource for the area have mainly involved the diversion of Hopes Creek run-off either to the Upper Manorburn Reservoir or directly into the distribution system via the Upper Bonanza Race.

This re-assessment is a result of the irrigators' renewed interest in the development of Hopes Creek and also to look at the scheme in view of the need to reduce or at least contain running costs.

2 HISTORY

Information contained in this chapter has been obtained from correspondence on the following files:

15/2	Ida Valley Irrigation Scheme
15/2/1	Manorburn Dam
15/2/13	Poolburn Dam
15/26	Irrigation General.

To avoid confusion with this historical data, British Units have not been converted to the SI system in this chapter, but metric units are used for the remainder of the report. The following units are given for reference:

1 sq mile = 2.59 km^2

1 acre = 0.405 ha

1 dayhead (cusec-day) = 2 acre-feet = 2.45 Ml

1 cusec = 100 m^3/h.

2.1 Scheme Development (refer map 1)

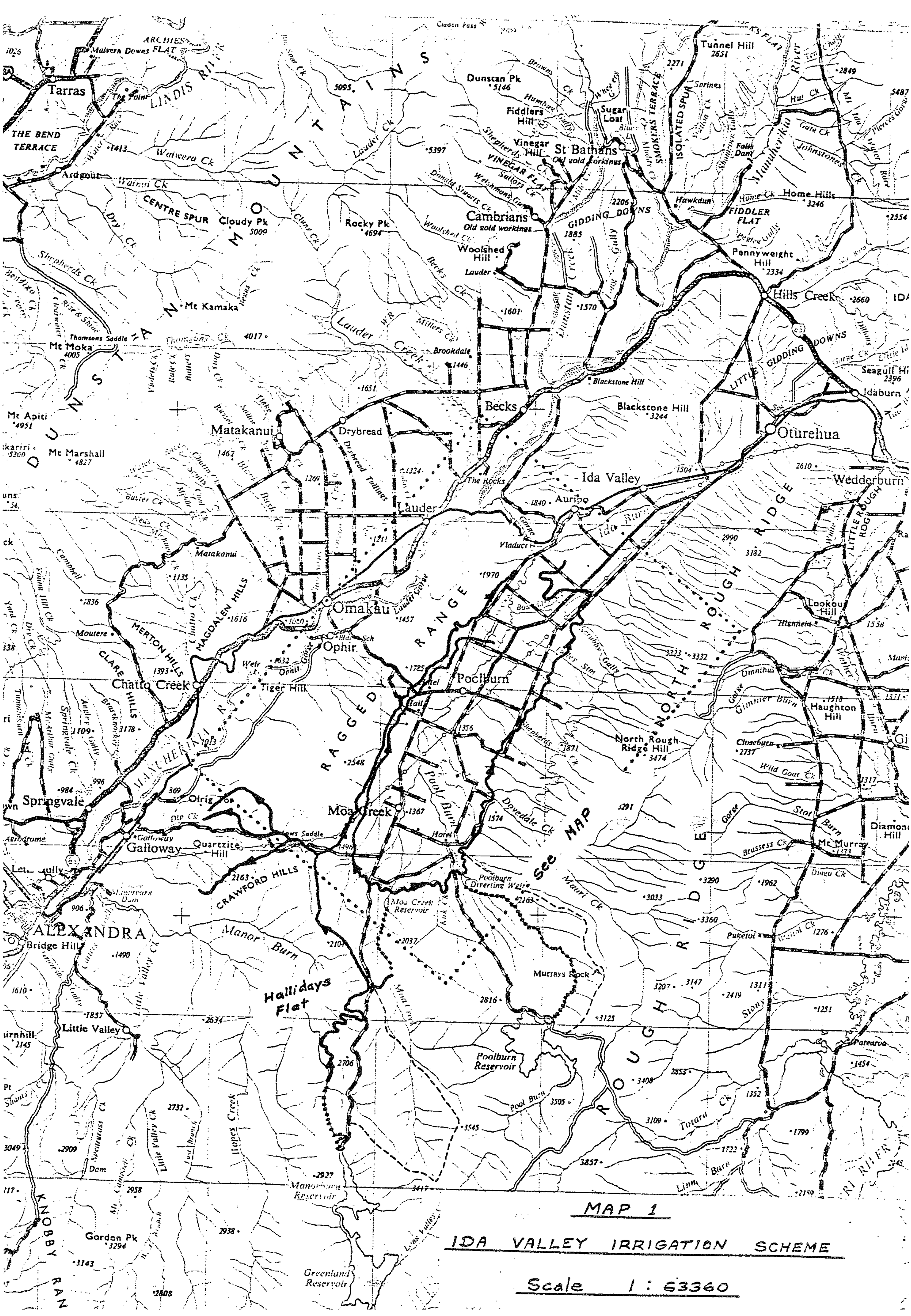
The Greenland Reservoir, together with a network of water races, enabled Manorburn water to be used for mining purposes from 1865 until about 1908, by which time the gold mining days were effectively over and the whole system lay idle.

Under the direction of Mr F W Furkert (District Engineer, PWD, Dunedin, 1908-12) an investigation into the feasibility of combining this resource with an irrigation scheme for Ida Valley was carried out by the department. This resulted in the construction of the Upper Manorburn Reservoir (completed 1914) to replace the Greenland Reservoir and provide equalisation of flow for irrigating 12 000 acres. The other main features involved the enlargement of the Upper Bonanza Race between the dam and Hallidays Flat from where water could be fed into Moa Creek, the enlargement of the Lower Bonanza, Syndicate and Blacks No. 3 races, the extension of Blacks No. 3 race back to Moa Creek, the construction of diversion weirs in Moa Creek and the Poolburn, and a new race from Moa Creek to the Poolburn continuing along the east or German Hills side of the valley. The scheme was built between 1912 and 1916 and the first water supplied in 1917.

There was a lack of interest in irrigation among some of the Ida Valley farmers during the first two years of operation, so in 1920 it was decided to divert some of the Manorburn water to the Galloway area via Lows Saddle, rather than taking a more costly supply to that area from the Manuherikia Scheme.

The irrigated land in both areas had grown to 5000 acres by the 1922/23 season, and up to 13 169 acres by 1926/27. In view of the original figure of 12 000 acres that could be supplied, by 1928 some doubts had arisen as to whether this 13 169 acres was not too great for safety, as gains from creeks had not proved to be as good as originally estimated. These doubts were confirmed by the 1929/30 and 1931/32 seasons when some rationing had to be applied, but nevertheless, the area being irrigated in 1931/32 had risen to 13 754 acres.

Additional storage sites had been sought for a number of years, and the Poolburn Dam was completed in 1931. It was anticipated that an average supply of 4980 dayheads would be available from this reservoir, but later results proved this expectation to be too high. In fact the Poolburn supply, after two seasons, was 3450 dayheads and it was apparent by this time that Poolburn run-off per square mile was not as good as that of the adjacent Manorburn catchment.



MAP 1

IDA VALLEY IRRIGATION SCHEME

Scale 1 : 63360

In 1934 diversion of Totara Creek, a tributary of the Taieri River, to the Poolburn catchment was completed by building a 2.7 mile race, and this provided about 500 dayheads per season.

While the Poolburn catchment of 16.9 square miles is 45% of the Manorburn catchment (37.5 square miles), the Poolburn net gains as a percentage of Manorburn net gains are given as 23.1%, 27.9%, 31.8%, 25% and 25.8% for the seasons 1932/33 to 1936/37. Some of this variation could have been due to varying supplies from Totara Creek.

The Lower Manorburn Dam was built largely as relief work in 1934, the water from this supply being used in the Galloway area. The saving of Upper Manorburn water through this new reservoir was estimated at 600 dayheads.

Petitions from farmers were received in 1932 (10 farmers, 2410 acres) and 1936 (11 farmers, 4300 acres) for extending the scheme as it then existed to include land immediately above the German Hills Race, and referred in particular to diversion of Hopes Creek as the source of water supply (also pointed out around this time was the possibility of bringing in about 4000 acres in Crawford Hills and further Crown land overlooking Ophir). Authority for a survey was approved in January 1937.

This was the first mention on file 15/2 on supply from Hopes Creek although earlier investigations involving a tunnel to Manorburn were reported on in 1923 (refer file 15/26). A complete account of Hopes Creek diversion proposals follows in Section 7

Moderate rationing was again necessary in 1941/42 but normal operation then continued until the end of the 1946/47 season. At this stage, the rationing of water on only three occasions in the 30 years of the scheme's operation caused no great concern to either the farmers or to the department, as a balance between good farm production and safe operation had proved reasonable. Farmers had become quite prosperous and national benefits had been achieved with the greatly increased production of wool and fat lambs. Overall the scheme was considered to be completely successful.

There followed however, beginning in 1947/48 when supplies were reduced by 15%, a succession of seasons of very low run-off, and although both reservoirs were full in 1945, rather severe rationing had to be applied for the next 10 seasons (see Section 4.4). This prolonged period of rationing resulted in great losses in both production and farm earnings, as well as the reduction of valuable flocks, and caused farmers to lose confidence in the scheme.

In the 1957/58 season ample water was at last available, with both dams filling to spill, and no real shortage has occurred since; the incentive to conserve water by a reduction in charges according to the amount each farmer saves has, however, remained in force.

Understandably, thoughts of augmenting the water supply for the scheme and perhaps increasing the irrigated area have frequently arisen over the last 30 years or so. Much work has been put into investigations of Hopes Creek, the adjacent catchment west of Manorburn, in an endeavour to find a method of obtaining this additional supply at a reasonable cost.

2.2 Areas and Charges

The area under agreement in the Ida Valley is 12 357 acres of which 7237 acres are covered by the No. 1 agreement and the remaining 5120 acres by the No. 2 agreement.

35 irrigators on the No. 1 scheme had signed agreements for water at 10/- per acre per year for a period of 42 years with expiry date 31 August 1974. A charge of 14/- per acre applied to the 39 No. 2 agreement irrigators, these agreements having an expiry date of 31 August 1945. Some farmers have irrigated areas under each of these agreements, but the quota for both is 18 inches (460 mm).

In 1951, approval had been given for Hopes Creek diversion to Manorburn with a stipulation for a voluntary increase of 3/- per acre on the No. 1 scheme, and a requirement for the No. 2 irrigators to sign new agreements allowing a 3/3 per acre increase. Irrigators were circularised about these new charges but because of the lack of support, Hopes Creek diversion did not proceed.

A report in September 1966 outlined Government policy regarding financing of new schemes, and updated costs of Hopes Creek (now £409 000) indicated an annual running cost of £18 000 requiring 30/- per acre per year over the 12 357 acres under agreement and a total development cost of £54 per acre.

A revised report in September 1964, on the same basis as above, gave an operating cost of £21 450 per year (annual cost 35/- per acre) and development cost of £78 500 or £64 per acre.

At a meeting in November 1965, irrigators were advised of the above figures, and it was reported by the DCW Dunedin that a cost of 35/7 per acre per year was not queried, and this represented a substantial increase over the existing rates of 10/- and 14/- per acre. It was emphasised by the farmers that an assured 18 in quota would give a substantial increase in production as it would be essential for them to carry additional stock to meet the higher charges and maintain present living conditions.

2.3 Hopes Creek Investigations

The first full report on the various Hopes Creek diversion proposals was completed in May 1937. Several dam sites were investigated, the best providing 1347 dayheads storage with a 90 ft structure costing £33 000. Three supply proposals, feeding into the Upper Bonanza Race and including costs of the German Hills Race, were outlined as follows:

(a) Dam and 20 cusec race providing about 2330 dayheads for irrigating 3500 acres at a cost of £80 000.

(b) 20 cusec race would provide 1200 dayheads for 1600 acres at a cost of £40 000.

(c) 40 cusec race would provide 1630 dayheads for 2000 acres at £64 000.

A suggestion that Galloway could be supplied by open race directly from Hopes Creek was ruled out in August 1937 due to the very broken nature of the country.

Following a more detailed survey, a further report on the above proposal was received in December 1937. The dam as proposed proved to be much less favourable, with 12 000 cu yd of concrete required to store 134 dayheads at a cost of £60 000 (cf £33 000). The best proposal by this time was a 25 cusec race diverting 1400 dayheads per season into the Upper Bonanza Race costing £19 000, plus a new race above the existing German Hills Race, 13.5 miles long, costing £23 000, ie, a total cost of £42 000. An average charge of 13/6 would have provided revenue of £1215 and 1.66% on full capital. In May 1938, authority was given for spending £36 250 on this work. Due to non-commencement of work, however, the authorities were cancelled in March 1939.

In September 1944, diversion proposals were re-examined as a result of a head office request. The 25 cusec race scheme of 1937 was again referred to, the estimated cost now being £57 000 to be covered by 2000 acres at an annual charge of 14/-. The scheme was turned down, however, as the farmers were not prepared to agree to a land sub-division scheme for efficient water utilisation - a stipulation of the Minister of Works.

A further report in October 1947, following a petition and request earlier the same month, gave details much the same as in September 1944, with the total cost of diversion and the German Hills extension now being £65 000.

Further consideration continued over the next 12 months, resulting in the Minister of Works not approving construction of the German Hills extension as he considered that Hopes Creek would not be capable of providing water for the extension area as well as supplementing supplies for the present irrigated area. The possibility of supplying the Galloway-Crawford Hills area arose again, and a report on this instead of the German Hills extension was requested.

A full report and plan of five diversion proposals for Hopes Creek was completed in May 1949. The most favourable of these was considered to be a 90 ft dam near the Stone Hut Flat, and a tunnel and race conservatively estimated as being able to supply 5000 dayheads to a relocated Bonanza Race for use in the Crawford Hills-Galloway area and the higher German Hills land at a total cost of £242 500.

With reference to the above report, comments and suggestions were received from head office, resulting in a supplementary report in June 1949. An additional dam on the Manorburn, and a larger dam at the Stone Hut Flat on Hopes Creek were investigated, but the proposal of the May 1949 report was still viewed as being the most favourable.

Hopes Creek diversion to the Crawford Hills - Galloway area was reported on in March 1951, but the deep broken gorge would require long lengths of tunnels and syphons. To cover 3650 acres, including the 1400 acres at present supplied from the Manorburn Reservoir, 4000 dayheads would have to be provided. The estimated minimum cost for 1.75 miles of tunnel, 2500 ft of syphon, and the race and dam was £230 000.

Submissions were made to the Ministers of Works and Finance in July 1951 pointing out that Hopes Creek was the only additional source of supply, and recommended £55 000 be provided for construction of a dam in Hopes Creek and race to the Upper Bonanza Race, plus £20 000 for repairs to this race. Treasury agreed, subject to charges being increased to a reasonable level, and in particular that the farmers agree to a contribution towards the above of 3/- per acre annually. Cabinet approval was received on 11 July 1951, but the farmers rejected these proposals in December 1952. Resolutions were passed by the Irrigation Advisory Council for full investigation of two tunnel proposals, indicating farmer preference for a more major scheme.

Irrigators petitioned the Minister of Works in March 1954 asking for a dam in Hopes Creek, a tunnel to Manorburn and extension of the scheme along German Hills, for which they were willing to pay an additional charge of 3/4 per acre annually. The Minister asked for an up to date report and whether sufficient water would be available to cover a further 2000 acres.

In June 1954, J D Watt (Resident Engineer, Alexandra) reported on the general course of negotiations since Cabinet approval in 1951, and the farmers' present requirements, and indicated that an annual average Hopes Creek yield at the Stone Hut site, from four years of record, was 6070 dayheads.

A full report on Hopes Creek hydrology and diversion proposals, with costs, was prepared by J D Watt in 1955. Basically, the general findings of this report were that Hopes Creek could be diverted to augment the Manorburn supply (at a cost of £409 000) to ensure an 18 in quota each season, but there would not be sufficient water to guarantee a supply to allow any extension of the existing irrigated area.

There was a revival of this whole matter in May 1960 with another petition, from 18 farmers with 6000 acres, asking for an extension to the Ida Valley Scheme with supply from Hopes Creek, being presented to the Minister. The RE, Alexandra, suggested that no action should be taken until the results of field trials being conducted by the DSIR and Department of Agriculture became known.

In 1963, Federated Farmers stated that 18 in of water was required, a further request was made for the diversion of Hopes Creek to be looked at again. This followed on from a further report on the trials when it was suggested that at least 17 in annually was necessary. The Inter-departmental Committee considered that 17 - 18 in be accepted as the quota and asked for further directions on any detailed investigations required.

On the basis of an 18 in quota, a re-assessment of advantages of bringing in Hopes Creek resulted in a report in August 1965 and the general findings were similar to those in the Watt Report of 1955. The cost as at August 1955 was assessed at £515 000, requiring an annual charge of 35/7 per acre to cover costs of any new works plus those for upgrading the existing system. It was also found that present water supplies would provide a full 18 in quota to about 85% of the area under agreement so that the effect of bringing in Hopes Creek would be to provide full irrigation to the remaining 15%, ie, to about 2100 acres at a capital cost of about £240 per acre. The Minister of Works advised that such expenditure was quite uneconomic and that he could not even consider recommending the proposal to Government.

The final result of the above report was that a meeting of irrigators was held in November 1965, and they were advised of the situation. At this meeting it was decided that likely costs be assessed yet again, and that an agricultural survey be carried out to determine the likely increase in production with the augmented supply.

A report completed in November 1966 examined scheme water supplies and usage as well as giving a detailed analysis of Hopes Creek runoff, and also re-assessed all aspects of the alternatives related to Hopes Creek diversion.

Following on from the irrigators meeting of November 1965 and the report of November 1966, an engineering assessment of the Ida Valley Scheme was requested. This was completed by October 1971 and an agricultural assessment resulting from a farm-by-farm survey of Ida Valley properties was compiled between 1972 and 1976.

Having this information in hand has resulted in this re-assessment of the whole scheme including the various proposals for the diversion of Hopes Creek.

3 IDA VALLEY DESCRIPTION

3.1 Topography and Geology

Ida Valley is another of the relatively depressed intermontane basins that are typical of the Central Otago region. It is aligned NE-SW, and is bounded on the north-western and south-eastern sides by Raggedy Range and Rough Ridge respectively, both of which are schist blocks. The valley ranges in width from 4-7 km over its length of about 50 km and is closed by the greywacke Hawkdun Range and Idaburn Hills at its northern end, and the rocky schist uplands adjacent to the Crawford Hills in the south.

An area of downlands around Oturehua, the only township in the valley, rises about 50 m above the valley floor and effectively separates the whole valley into two parts, the southern part being the region covered by the Ida Valley Irrigation Scheme and therefore the area with which this report is concerned.

The floor of this area is of low relief and is composed of tertiary deposits of sands, clays and gravels covered in most places with alluvium, sloping gradually from the foothills of Rough Ridge and Raggedy Range down the terraces and fans to the central floodplain of the Poolburn.

The main streams are the Idaburn which enters the valley from the north, and the Poolburn from the south; their confluence is about 15 km south-east of Oturehua. The combined waters then flow through a deep gorge through Raggedy Range to join the Manuherikia River near Lauder. Many tributaries from the surrounding hills reach the Poolburn after flowing down wide flat valleys with the result that numerous old stream beds exist around this southern border. Water from practically all these tributaries is fed into the water races which traverse the foothills, thereby conserving as much as possible the supplies held in the Manorburn and Poolburn reservoirs.

A number of small ponds dot this area and are caused by the presence of sub-soil fans or by the impervious tertiary clays.

3.2 Climate

The southern part of Ida Valley has a semi-arid climate with hot, dry summers and cold winters typical of the climate in many of the Central Otago valleys.

The mean annual rainfall for the period 1917-1978 as recorded at Moa Creek (Met. No. I59162) is 400 mm, but this can vary widely from year to year, eg, a maximum of 581 mm and a minimum of 268 mm have been recorded in 1935 and 1959 respectively. There is also a marked seasonal variation that becomes evident from mean monthly figures - 134 mm for December, January and February in comparison to only 62 mm for June, July and August.

Records from a climatological station at Moa Creek from 1958-69 indicate the high temperature ranges experienced in the south of the valley. The mean temperature for January is given as 14.5°C while that for July is only 0.5°C.

Wind direction data were also recorded at Moa Creek over a period of 10 years and show that the prevailing wind is from the north-west (average 60 days/year), usually strong and warm, and causing high soil moisture losses. South-west winds occur about half as often, and these bring most of the rain to the valley.

Ground frosts occur on about 180 days/year, and McCraw (1) states that soils are frozen to a depth of up to 8 in (200 mm) for at least two months each year. Hoar frosts often lasting for several days are experienced in winter.

3.3 Soils

From the southern end of Ida Valley north to the Idaburn, the soils are brown-grey earths, this reflecting the low rainfall that occurs here.

Linnburn soils on the intermediate terraces, Pigburn soils on the intermediate fans and Drybread soils on the highest terraces and fans are the main soil types, and it is essentially these that are at present irrigated.

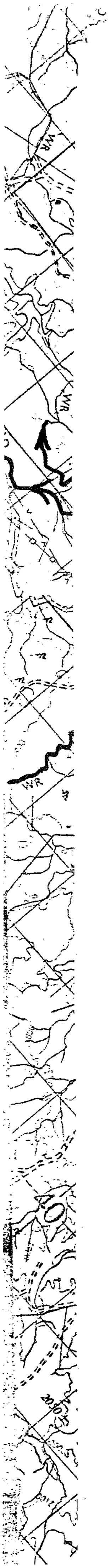
Pans exist on both levels, being relatively thin gravel-clay layers on the intermediate terraces, but they are more massive with firmly cemented gravel about 0.5 m thick on the higher terraces.

For a full description of soil classification, profiles, etc, see the report by McCraw which, as well as the paper by Cossens and Rickard (2), detail many of the factors such as salinity and groundwater involved with Ida Valley irrigation. Some of the major findings of these studies are, for ease of reference, repeated in the following paragraphs:

Of the 11 300 ha commanded by the water races around the margin of the southern part of the valley, it is estimated that about 4500 ha are waterlogged, 3200 ha of this being attributable to irrigation with the remaining 1300 ha having a naturally high water-table. McCraw also considers that 6% of these commanded soils are moderately salty, while more than 40% are slightly salty. Much of the salt contamination has been caused by excess irrigation water seeping down from the high terrace salty soils to the previously salt-free soils on the intermediate terrace.

Cossens and Rickard state that all surface waters have relatively low salinity values, but there is great variance in ground water salinity which can be a problem where the water-table is less than 1.5 m from the ground surface. This is particularly so on the fan and high terrace soils, but the deeper Linnburn soils in the centre of the valley are not badly affected at present.

Both waterlogging and salinity problems could be controlled by maintaining a low water-table, this being effected by more efficient irrigation methods (such as spray, border-dyking or contour ditches) than the present application which is largely by wild flooding, and also the installation of drains where the presence of fans and salty soils may require them.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4 EXISTING IRRIGATION SCHEME

4.1 Description (refer to maps 1 and 2)

Water for the Ida Valley Scheme is supplied essentially by the Manorburn and Poolburn Reservoirs, but provision exists for diverting flows, when available, from the many streams into the races that cross them.

The Upper Manorburn Dam is of the concrete arch type, 27 m high and 118 m crest length, and impounds a lake of 51 000 Ml at a maximum area of 700 ha. The Poolburn Dam is a similar structure 25 m high and 163 m long, forming a 25 700 Ml reservoir having a maximum area of 450 ha.

Water released from the Manorburn Reservoir is carried by the Upper Bonanza Race down to Hallidays Flat. A bifurcation here results in the commencement of the Lower Bonanza Race taking water on to Lows Saddle, with the Upper Bonanza Race continuing on until it feeds into Moa Creek.

Both Ida Valley and the Galloway area are commanded by Lows Saddle, from where the former is supplied along its western side by the Syndicate Race, and the latter via Dip Creek which also includes supply to the Crawford Hills Race.

Diversion weirs in Moa Creek and the Poolburn have capacities of 38 Ml and 60 Ml respectively, and are used for day to day regulation. The Moa Creek weir supplies the Blacks No. 3 race along the western side of Ida Valley, but a lower level than the Syndicate Race; it is also connected to the Poolburn weir (via the Poolburn Race) from where the German Hills Race along the eastern side of the valley commences.

4.2 Water Requirement

During a normal year, the area at present irrigated from the Upper Manorburn and Poolburn Reservoirs is 5000 ha in Ida Valley where the quota is 460 mm, and 600 ha in the Crawford Hills - Galloway area where the quota varies between 500 mm and 760 mm.

The portion of the valley served by the Poolburn Reservoir is 1950 ha, ie, a requirement of 9000 Ml for the full quota. There is provision, however, for Manorburn water to be diverted to this area, if required, via the Poolburn Race.

This leaves 3050 ha in the valley to be supplied from the Upper Manorburn Reservoir, or a net requirement of 14 000 Ml; the water requirement from the same source for the Crawford Hills - Galloway area is given as 3700 Ml (3).

The average annual net requirement of the scheme ~~is~~ therefore 26 700 Ml, while that to satisfy the 1 in 20 year demand is 37 500 Ml (640 mm quota).

(These quotas are adopted from studies carried out by G G Cossens and P D Fitzgerald (3)).

4.3 Race Losses

Race losses throughout the Ida Valley distribution system have been analysed for the 1972/73 - 76/77 seasons only, as remedial works being carried out each year tend to make any long term assessment somewhat irrelevant. With an average supply of 28 200 Ml per season over this period, losses have averaged 6700 Ml as follows:

TABLE 1

Race	Loss	
	(Ml)	%
Upper Bonanza	2140	32.0
Lower Bonanza	1100	16.4
Crawford Hills	190	2.3
Syndicate	550	8.2
Poolburn	370	5.5
Blacks No. 3	570	8.5
Blacks No. 3 distributaries	190	2.8
German Hills	1300	19.5
German Hills distributaries	290	4.3
	6700	

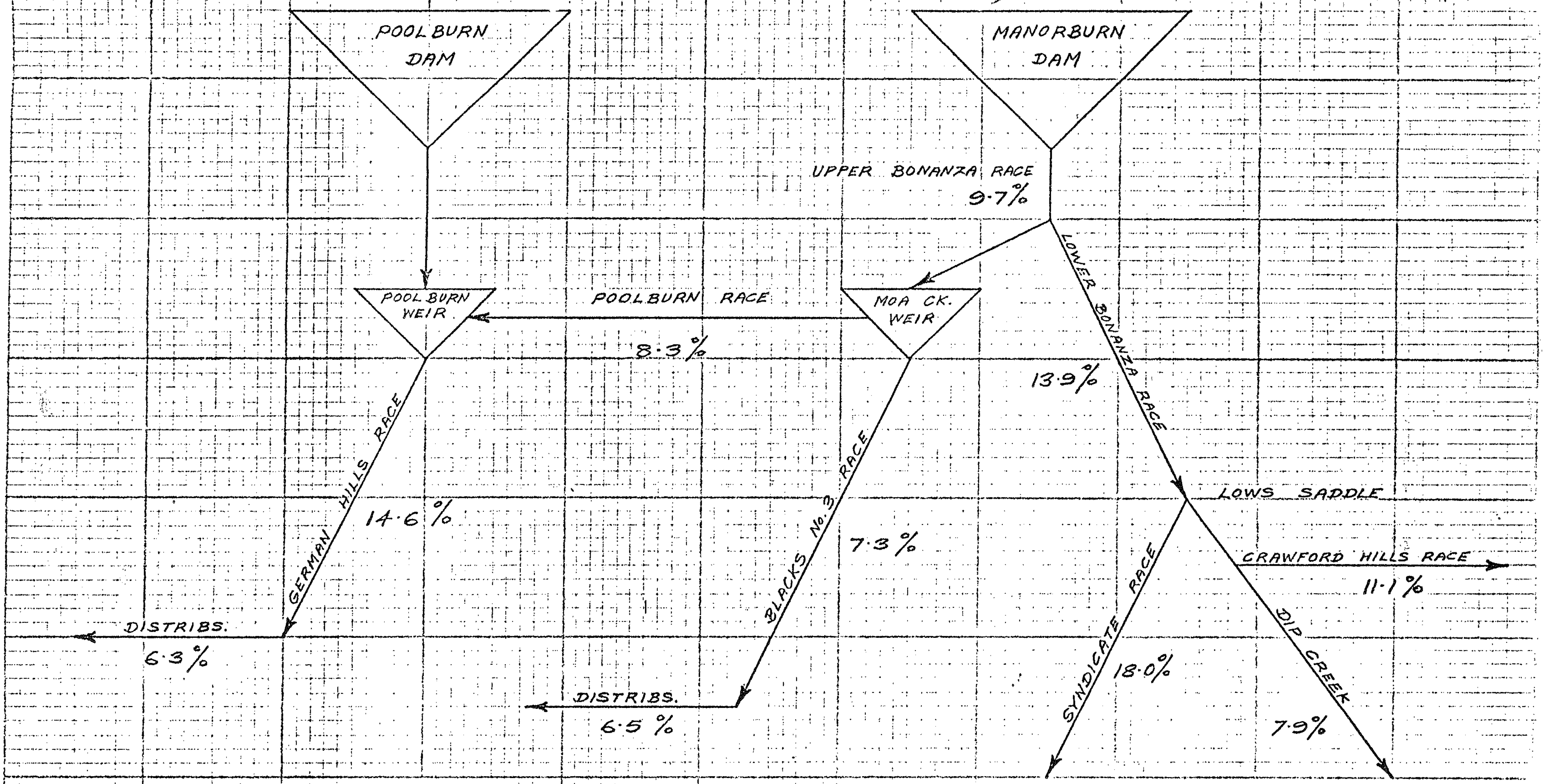


FIG. 1 DIAGRAMMATIC LAYOUT of RACE SYSTEM.

LOSSES SHOWN AS %AGE OF INPUT

The first impression from the above figures is that the Upper Bonanza Race is the main cause of losses being about 24% of all water released from the Manorburn and Poolburn Reservoirs. However, this is not the case when regarding efficiencies of races.

Figure 1 shows a diagrammatic layout of the water distribution system and losses expressed as a percentage of input are also given. This clearly shows that the Upper Bonanza Race is now far from being the most inefficient water-race in the system. In the past, seasonal losses averaging about 13% of the water released from the Manorburn Reservoir were experienced, but the expenditure of $90 000 during the last five years to substantially upgrade parts of this race where leakage has been most severe has obviously been effective; the present average loss having dropped to 9.7% represents a saving of 650 Ml per season. Further savings will probably be effected by continuing the current renewal and maintenance programme, but the need for an expensive pipeline or concrete-lined channel to replace parts of the Upper Bonanza Race, which has previously been considered inevitable, is unlikely to achieve any worthwhile benefits. Losses in this as well as the other races will always be present, but if they represent 10% or less of the input there seems little justification for major works to achieve only minimal savings.

In terms of water distribution efficiency, the biggest reduction in losses could be obtained by upgrading the German Hills, Lower Bonanza and Syndicate Races. Assuming that with relatively minor works these could be reduced to what is considered an acceptable level of 10%, overall losses would decrease from 24% to 20% of supply from the reservoirs.

It is therefore accepted in this report that 20% of water released from the Manorburn and Poolburn Reservoirs will be lost within the race system, so the water requirement at the source of supply to give full quota to the area under agreement is about 32 000 Ml per season.

4.4 <u>Supply and Demand</u>

The amount of water each irrigator receives during a season is dependent more on the storage available in the reservoirs at the beginning of the season rather than on agreed water quotas. That is, farmers can usually only be advised sometime during August what percentage of full supply, hence their quotas, will be available for the following season.

Distribution of water, and race patrol and maintenance, are handled by six racemen under the control of a head raceman, these seven men being employed all year round with additional labour for race cleaning contracted when required during the off-season. With 130 km of main races and 65 km of distributary races to maintain, reconstruction works progressively carried out over the years now mean that only parts of the Syndicate, Crawford Hills and Bonanza Races are not suitable for machine cleaning.

Race flows are controlled by gates and measured by weirs throughout the system, and water is supplied to individual farmers by means of measuring boxes set in the race banks. Supply is on an on-demand basis with irrigators informing the head raceman of their requirements at least 36 hours in advance.

The very nature of the scheme therefore means that considerable skill in management of water distribution is required to ensure losses are kept to a minimum, and this accounts for the high ratio of racemen - one per 750 ha - that are necessary. Manual adjustments to numerous check gates and measuring boxes have to be made continuously as farmers water requirements change during the season, and the racemen do a commendable job in that water sold averages about 76% of that released from storage.

Except for the moderate rationing that was necessary in the 1929/30, 1930/31 and 1941/42 seasons, the water supply from the Manorburn and Poolburn catchments had been sufficient to satisfy all demands up until the 1945/46 season. The net average seasonal yields of the Manorburn and Poolburn catchments, up to this time, had been 24 500 Ml (27 years record) and 7500 Ml (14 years record) respectively, ie, sufficient to maintain the full quota, including race losses, without considering any gains from streams below the reservoirs.

The off-season of 1946 was a very poor period for run-off, with the result that large withdrawals from the reservoirs (which were both full at the start of the 1945/46 season) were necessary to meet the 1946/47 season requirements.

A succession of droughty years followed, and quite severe rationing reaching a peak in 1950/51 had to be applied for the next ten seasons as follows:

1947/48	supplies reduced by 15 percent
1948/49	supplies reduced by 54 percent
1949/50	supplies reduced by 32 percent
1950/51	supplies reduced by 83 percent
1951/52	supplies reduced by 18 percent
1952/53	supplies reduced by 33 percent

1953/54	supplies reduced by 21 percent
1954/55	supplies reduced by 66 percent
1955/56	supplies reduced by 25 percent
1956/57	supplies reduced by 60 percent.

Run-off improved during 1957 and both dams had filled to spill by the beginning of the 1958/59 season. However, with the average annual yields from 1947 to 1957 for Manorburn and Poolburn having been only 15 900 Ml and 4900 Ml respectively (with race losses, estimated average annual net yield of 18 000 Ml), the farmers' faith in the ability of the water supply to meet requirements was considerably shaken. An incentive to conserve water by a reduction in charges according to the amount each farmer saved was therefore instituted, and has remained in force to the present time.

Over recent years, individual farmers have been given a 50% rebate on their unused quota when the full quota was offered, and 100% rebate on water not used when low storage levels have meant restrictions have had to be applied.

A graph showing the quantity of water in storage at the beginning and end of each season, together with the seasonal supply from each reservoir, is shown in Figure 2; these data are also tabulated below.

Remembering that the gross seasonal requirement is 32 000 Ml, the following points should be noted:

(a) The precarious storage position that existed from April 1947 through to April 1957, when total storage at the start of each season ranged from a minimum of 20% to a maximum of 108% of the average seasonal requirement. The average supply during this period was 22 000 Ml, ie, 68% of requirement.

(b) The much improved storage situation since 1958, but the average seasonal supply rising to only 26 000 Ml (82% of requirement) probably reflects the farmers' desirability to conserve supplies.

For table see next page

Season	Supply (Ml)			Quota (3)		Remarks
	Manorburn	Poolburn	Total	Offer	Drawn	
	51 000					In storage 29.9.45
		25 700				In storage 20.11.45
1945/46	23 800	6 500	30 300	-		
46/47	30 150	10 550	40 700	-		
47/48	24 560	8 650	33 200	85		
48/49	13 450	5 050	18 500	46		
49/50	21 800	7 100	28 900	68		
50/51	7 350	1 400	8 750	17		
51/52	24 400	5 300	29 700	82		
52/53	18 750	6 500	25 250	67		
53/54	21 500	7 750	29 250	79		
54/55	12 050	3 600	15 650	34		
55/56	18 600	7 650	26 250	75		
56/57	8 650	2 700	11 350	40		
57/58	11 000	2 450	13 450	100	46	M'burn spilled 16 000 Ml
58/59	23 450	9 500	32 950	100	93	
59/60	21 700	9 400	31 100	100	94	
60/61	13 850	5 700	19 550	75	58	
61/62	19 900	8 300	28 200	100	86	
62/63	19 300	8 500	27 800	100	88	
63/64	19 550	4 650	24 200	75	74	
64/65	16 500	3 200	19 700	75	66	
65/66	20 650	5 750	26 400	100	84	
66/67	25 850	7 400	33 250	100		
	21 300					In storage 14.9.67
		4 550				In storage 30.10.67
	No records for 1967/68 and 68/69 seasons.					
	38 650					In storage 9.10.69
		13 600				In storage 14.10.69
1969/70	23 450	7 500	30 950	100	88	
70/71	23 300	7 150	30 450	85	84	
71/72	17 900	5 050	22 950	65	62	
72/73	21 750	7 450	29 200	80	80	
73/74	20 250	6 900	27 150	90	78	
74/75	21 850	6 300	28 150	85	78	
75/76	25 800	6 650	32 450			
76/77	18 150	5 900	24 050			
	46 000	22 000				In storage 10/77 In storage 10/77
TOTAL	583 000	178 000				
MEAN (30 YEARS)	19 400	5 900				

TABLE 2

4.5 Manorburn and Poolburn Yields

From 1945 until the end of the 1976/77 irrigation season, and excluding the 1967/68 and 1968/69 seasons for which no records are available, a total of 589 000 Ml was drawn from the Manorburn Reservoir (excluding approximately 16 000 Ml spilled during the winter months of 1958), and 191 000 Ml from the Poolburn Reservoir. Also over this period Manorburn and Poolburn storage decreased by 22 000 Ml and 13 000 Ml respectively.

The net catchment yields over the 1945-77 period are therefore as follows:

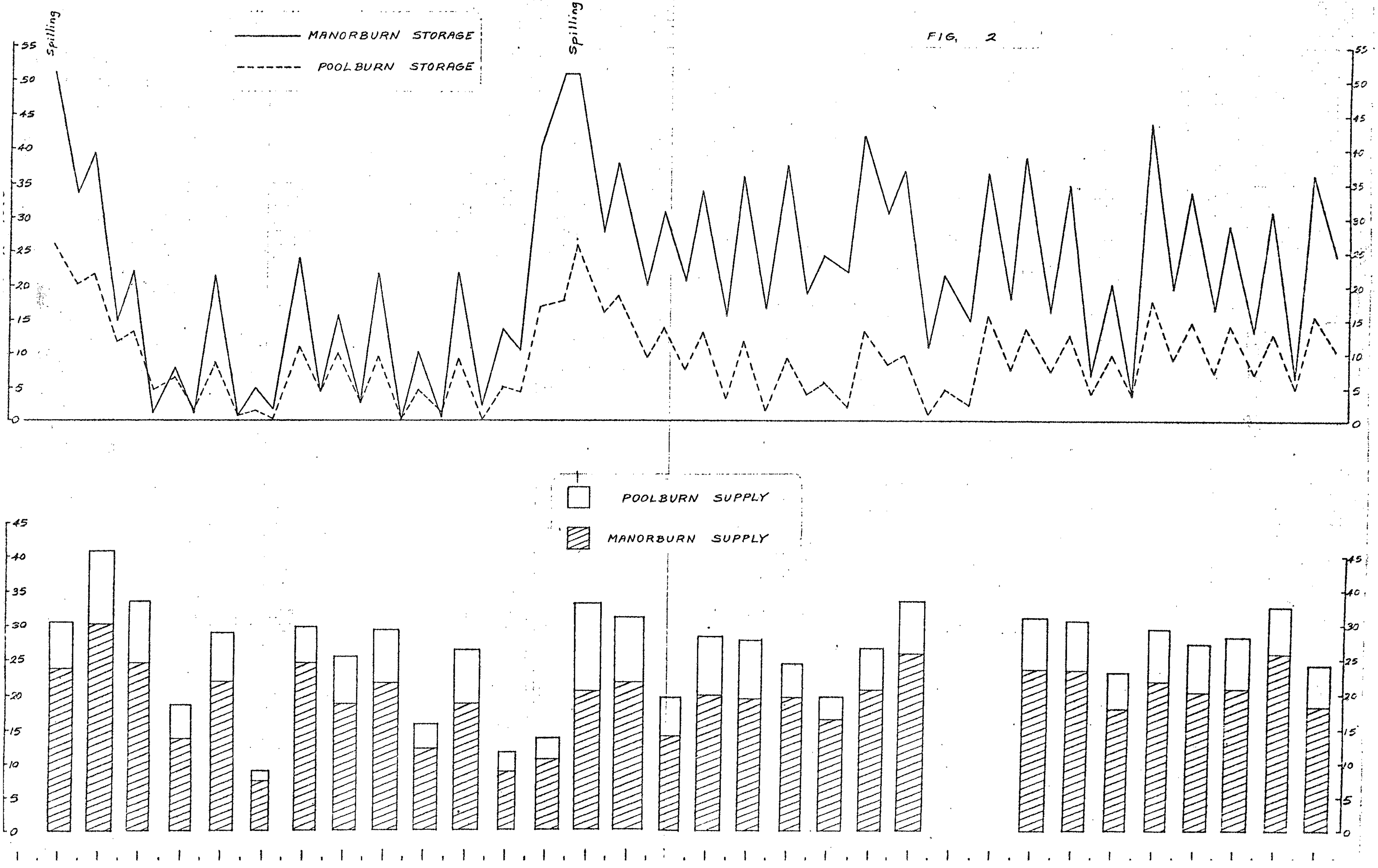
Manorburn 583 000 Ml or 19 400 Ml per year

Poolburn 178 000 Ml or 5 900 Ml per year

(compare average of 24 500 Ml and 7500 Ml respectively up to 1945).

This combined annual yield of 25 300 Ml is therefore 6700 Ml or 21% less than the requirement necessary to supply the full quota.

FIG. 2



Spilling
Spilling
MANORBURN STORAGE
POOLBURN STORAGE
POOLBURN SUPPLY
MANORBURN SUPPLY

The long term average annual yield of the Manorburn Reservoir (1918-77) is 21 800 Ml and for the Poolburn Reservoir (1931-77) it is 6400 Ml, ie, a total of 28 200 Ml. However, due to the low run-off in the catchments that was sustained over ten successive years (see Section 4.4) it is considered that the use of long term averages, particularly with regard to incorporating Hopes Creek run-off into the supply system, could be too optimistic in estimating what the Hopes Creek contribution to the scheme might be.

In this report, therefore, the water resource assessment is based on records collected from 1945-77, a period which includes not only the very wet 1957/58 period when both dams filled to capacity, but also the prolonged very dry period previously referred to.

4.6 Stream Gains

While the flows of many streams are absorbed into the race system when water is available, their contributions cannot really be quantified. It is appreciated that worthwhile flows are available for use early in the season, particularly from Dovedale and Maori Creeks, but most usable streams have dried up by December or January when the scheme becomes totally dependent on the Manorburn and Poolburn Reservoirs for its water supply.

A race from Totara Creek (a tributary of the Taieri River) provides a valuable supply of about 1000 Ml per year to the Poolburn Reservoir.

4.7 Operating Costs and Scheme Charges

The labour content required to run the scheme has been referred to previously and it is a very significant factor in operating costs that are currently running at about $70 000 per year, ie, mainly racemen's wages and vehicle running costs.

A renewal fund as such does not exist and major construction works are carried out as funds are made available. For example, just over $100 000 was spent between 1974-77 when extensive repairs to the Upper Bonanza Race were carried out. While the amount spent on construction varies from year to year, minor repairs and/or renewals added to operation and maintenance costs mean that the annual cost of running the scheme is currently about $75 000.

Charges equivalent to $1 and $1.40 per acre ($2.47/ha and $3.46/ha) for the No. 1 and No. 2 agreements respectively were set in 1924 and remained in force until the 1972/73 season. From 1973/74 until the 1975/76 season, 20% per year increases were approved with the aim of eventually meeting all running costs out of revenue (depending on the agreement, charges should now stand at $5.63/ha and $9.46/ha).

However, with rebates being applied on unused quotas, annual revenue varies according to water availability and demand, and bears little resemblance to charges on a per hectare basis.

A summary of running costs (excluding major construction and repairs) and income from water sales over recent years is given below:

Season	Operation and Maintenance	Receipts
1968/69	$30 492	$13 572
1969/70	28 880	13 584
1970/71	35 311	11 971
1971/72	37 338	9 004
1972/73	38 026	11 544
1973/74	44 449	11 838
1974/75	48 180	14 866
1975/76	60 012	17 193
1976/77	54 669	16 434

TABLE 3

The above indicates that not only is revenue from water sales about 30% of the cost incurred in delivering that water, but also that operation and normal maintenance costs have virtually doubled since 1970. These costs will continue to rise steadily each year, and together with the fluctuations in receipts as a result of the rebate system for unused water, will result in ever-increasing operating losses until the present water resource is augmented from Hopes Creek and/or the existing scheme is re-examined with a view to its being upgraded and being treated in all aspects as a new scheme.

As at 31 March 1978 the capital value of existing scheme works was $703 000 and the accumulated losses over the life of the scheme amounted to $2 111 000.

5 AGRICULTURAL ASSESSMENT

5.1 General

As part of an overall assessment of irrigation schemes in and around the Manuherikia Valley, an agricultural survey of farms on the Ida Valley Scheme - excluding those in the Crawford Hills - Galloway area supplied from the Upper Manorburn - had been completed by 1976. A full summary of the data collected is given in the Appendix.

Recent on-farm development on some properties is not accounted for in this report, but this would not be too significant in relation to the whole scheme area. Neither stocking rates nor land use policies are considered to have changed to any marked degree since the farm surveys were undertaken.

5.2 Irrigable Area

Ida Valley irrigators farm a total area of 51 712 ha, of which 10 135 ha are commanded by the gravity race network. The total agreed irrigable area of 5016 ha represents nearly 50% of this commanded area.

A summary of present and possible irrigable areas is as follows:

Method	Present Irrigation		Possible Irrigation	
	ha	%	ha	%
Border dyke	236	4.1	5 283	66.9
Efficient contour	4 744	82.7	2 376	30.1
Partial irrigation	759	13.2	241	3.0
TOTAL	5 739		7 900	

TABLE 4

NOTE: Efficient contour - water reasonably well utilised, ie, excess picked up and re-used.

Partial irrigation - inefficient water use, but usually only involves one or two waterings per season.

While almost 50% of the area below the races is covered by agreement, the actual area irrigated is about 57% of the commanded area or 14% (723 ha) greater than the agreed area. It is noted that this "extra" irrigated area is virtually the same as that shown as being only partially irrigated.

Although the survey indicates 78% of the area below the races could possibly be irrigated if a greater water supply was available, many farmers stated that they would be quite satisfied with their present agreed areas provided their full quotas could be supplied each season. As mentioned elsewhere in this report, however, this is a rare occurrence, and the need to fully supply the existing agreed areas each season should take priority over any increase in irrigated land.

It is significant that only 4% of the irrigated area on a scheme that has now been operating for 60 years has been border-dyked, and this lack of development is very likely one of the results of the uncertainty involved with the high possibility of farmers not receiving full quotas each season.

5.3 Land Utilisation

For the areas both above and below the races, land use is classified in terms of lucerne, grass, crop (mainly winter feed crops), and native (under-developed).

See next page for table.

	Area below Races		Area above Races	
	ha	%	ha	%
Lucerne	1 044	10.3	707	1.7
Grass	8 349	82.4	5 272	12.7
Crop	373	3.7	151	0.4
Native	369	3.6	35 446	85.2
TOTAL	10 135		41 576	

TABLE 5

From the above, and also from Table 6 that follows, Ida Valley farming is essentially based around sheep grazing. However, some flexibility in stocking systems is used to cope with the ever-present uncertainty of whether or not water quotas will be met in full. This is done either by cattle policies that allow farmers to sell when water quotas are running out, or by cash cropping of lucerne; when quotas are low in any year, this lucerne is grazed and therefore less hay is sold.

5.4 Stocking Rates

Stock numbers wintered on each property have been converted to stock units (su) as in the Appendix and are summarised below:

	Stock Numbers	%
Sheep	107 950	85.4
Cattle	18 480	14.6
TOTAL	126 430	

TABLE 6

The farmer with average ability would be stocking his irrigated pasture at about 15 su/ha, while the top farmers assess their carrying capacity at 20 su/ha. These rates are about 10 su/ha above dryland potential for the Ida Valley.

6 WATER RESOURCE ASSESSMENT

6.1 Previous Analysis

The 1955 report by J D Watt (4), using Hopes Creek records from May 1950 to July 1955, gave the total yield of 56 980 acre-ft (70 200 Ml) as being 75.4% that of the net yield of 75 530 acre-ft (93 100 Ml) of the Manorburn Reservoir over the same period.

Watt adopted the figure of 75% of Manorburn net yield as being the Hopes Creek yield and applied this to Manorburn results for the ten years prior to April 1955 to derive an average yield of 11 800 Ml for Hopes Creek. His report then covered in detail diversion proposals from three sites on Hopes Creek, viz Stone Hut Flat (Site D), the proposed race intake at Site C, and the upper tunnel intake Site A. Catchment areas given were 61.4, 47.9 and 38.1 km^2 respectively (refer to map 3).

Another possible diversion site known as the lower tunnel intake (Site B), with a catchment area of 41.4 km^2, was referred to, but rejected on the basis of the considerably greater work above ground, in relation to the other sites, that would be required. All, however, are looked at again.

Reference was also made to comparative gaugings that were carried out between March 1950 and June 1951 at these sites, with results as follows:

Flows at Site A were 74% of those at Site D.
Flows at Site C were 85% of those at Site D.

This enabled all three sites to be related to Manorburn yields by the following percentages:

Hopes Creek at Site A : 57%, ie, 9 000 Ml/yr
Hopes Creek at Site C : 64%, ie, 10 100 Ml/yr
Hopes Creek at Site D : 75%, ie, 11 800 Ml/yr.

Using Hopes Creek recorded data up to May 1965, reports were compiled by M R Bolt (5) in August 1965 and C J Reid (6) in November 1966, both giving average annual yields of 15 500 Ml at the Stone Hut weir. The latter also contained a comprehensive analysis of the water resource of Hopes Creek and applied this to the various diversion proposals.

It should be noted here that the catchment areas for Hopes Creek listed above were derived originally by J D Watt from cadastral maps only, and were subsequently used in both succeeding reports. These values have been checked from 1:63360 topographical maps that are now available, and this has revealed that differences in catchment areas exist, especially so at the Stone Hut weir site (see Table 7).

The effect of the large discrepancy between areas at the Stone Hut is that the specific discharge of the Hopes Creek catchment is, on the average, only 78% of what it was previously considered to be, with the result that the annual and seasonal yields calculated for the possible diversion sites have been over-estimated.

For comparison, catchment areas, mean annual yields and specific discharges as given in the 1966 report and the present values (from Section 6.2) during the period 1951-65 are as follows:

	Watt 1955			Bolt/Reid		
	Catchment Area (km^2)	Annual Yield (Ml)	Specific Discharge $l\ s^{-1}$ km^{-2}	Catchment Area (km^2)	Annual Yield (Ml)	Specific Discharge $l\ s^{-1}$ km^{-2}
Site A	38.1	9 600	8.0	41.4	8 200	6.3
Site B	41.4	10 500	8.0	50.1	9 900	6.3
Site C	47.9	12 100	8.0	54.1	10 700	6.3
Site D	61.4	15 500	8.0	78.5	15 500	6.3

TABLE 7

The specific discharge of 6.3 $l\ s^{-1}\ km^{-2}$ shows much closer agreement to the 6.6 $l\ s^{-1}\ km^{-2}$ for the Manorburn catchment during the same period, and the quantities of water available for diversion are calculated on the basis of the specific discharge at the Stone Hut weir being applied to the re-defined catchment areas of the possible diversion sites.

6.2 Hopes Creek Hydrology

6.2.1 Available Data

A temporary weir governing a catchment area of 78.5 km^2 was installed on Hopes Creek at the Stone Hut Flat in February 1950, followed by a permanent one a few months later. Occasional water levels were taken until January 1951 by which time a recorder was installed and operating. Daily water level readings obtained from the charts were converted to daily mean flows with results up to May 1965 summarised below.

(It will be noticed that there are periods with incomplete records, but 4868 days of record are available out of the total 5265 day period).

6.2.2 Run-off

Analysis of Hopes Creek flow data was carried out on a yearly and seasonal basis with results shown in Table 8.

For Table 8 see next page

Yearly Summary					
Year	Days of Record	Mean Flow (m^3/s)	heads	Total Flow (cumec-days)	Run-off (Ml)
1951	356	0.69	25	246.7	21 200
1952	366	0.37	13	134.1	11 700
1953	365	0.50	18	180.9	15 800
1954	306	0.20	7	60.5	5 300
1955	304	0.28	10	84.9	7 400
1956	366	0.29	10	106.4	9 200
1957	365	1.04	37	380.3	32 800
1958	330	0.77	28	253.1	22 000
1959	365	0.39	14	141.4	12 300
1960	336	0.44	16	147.4	12 800
1961	351	0.37	13	130.6	11 200
1962	344	0.51	18	175.3	15 100
1963	201	0.21	7	41.7	3 600
1964	364	0.23	8	83.3	7 200
1965	149	0.96	60	143.4	12 400
TOTAL	4 868			2 310.0	200 000

TABLE 8

The mean flow over this 15 year period is therefore 0.48 m^3/s, ie, an average annual yield of 15 500 Ml.

Monthly Summary					
Month	Days of Record	Mean Flow (m^3/s)	heads	Total Flow (cumec-days)	Mean Monthly Run-off (Ml)
Jan	456	0.20	7	91.2	500
Feb	422	0.15	5	65.3	400
Mar	465	0.31	11	142.6	800
Apr	450	0.40	14	181.2	1 000
May	453	0.71	26	321.5	1 900
Jun	361	0.84	30	303.0	2 200
Jul	304	0.70	25	213.7	1 900
Aug	368	0.82	30	302.4	2 200
Sep	371	0.68	24	252.9	1 700
Oct	403	0.44	16	176.6	1 200
Nov	383	0.35	13	132.6	900
Dec	432	0.29	10	127.0	800
TOTAL	4 868			2 310.0	15 5000

TABLE 9

From the above, the mean yield during the November - April period is given as 4400 Ml at a mean flow of 0.28 m^3/s, and the May - October period yields 11 100 Ml at a mean flow of 0.70 m^3/s.

10 heads

25 heads

Flow duration curves on a seasonal and an annual basis are shown in the Appendix. While the mean flow for each period is equalled or exceeded only about 30% of the time, this would be insignificant provided diversion involved storage capable of fully controlling flood flows. However, if diversion was to be only on a "run-of-the-river" basis during the irrigation season, yields would be markedly lower than mean flow conditions indicate.

6.3 Summary

During the period for which recorded data are available for Hopes Creek at the Stone Hut weir, Manorburn run-off totalled 286 500 Ml over 5178 days, giving a mean annual yield of 20 200 Ml. This shows that the Hopes Creek catchment yield was 76.5% of the Manorburn Dam net yield; note that this closely agrees with the 75.4% derived by Watt from five years of record (see Section 6.1) and his figure of 75% is also adopted for this report.

As mentioned in Section 4.5, long term averages, or indeed 1951-65 data alone, are considered to be too optimistic for this area, with the result that the 1945-77 period is selected as the basis on which to derive average yields of the Manorburn, Poolburn and Hopes Creek catchments.

Between 1945 and 1977, 75% of the annual net yield of 19 400 Ml from the Manorburn gives a value of 14 500 Ml to be expected from Hopes Creek at the Stone Hut weir. This design period Hopes Creek yield of 14 500 Ml is 93% of the mean annual yield of 15 500 Ml as recorded between 1951 and 1965, and the mean seasonal yields at each possible diversion site during this period are adjusted accordingly in Table 10 below.

Adopting a season of 220 days, Hopes Creek mean flows for the November - April period are used to obtain the total yields for the irrigation season of mid-September to the end of April.

Hopes Creek Diversion Site Yields			
Period of Record 1951-65		Mean Flow (m^3/s)	Yield (Ml)
Stone Hut weir	Annual	0.48	15 500
	Irr season	0.28	5 300
Design period 1945-77 (93% of 1951-65 recorded data)			
Stone Hut weir (Site D)	Annual	0.45	14 400
	Irr season	0.26	4 900
Race intake (Site C)	Annual	0.31	9 900
	Irr season	0.18	3 400
Lower tunnel (Site B)	Annual	0.29	9 200
	Irr season	0.16	3 100
Upper tunnel (Site A)	Annual	0.24	7 600
	Irr season	0.14	2 600

TABLE 10

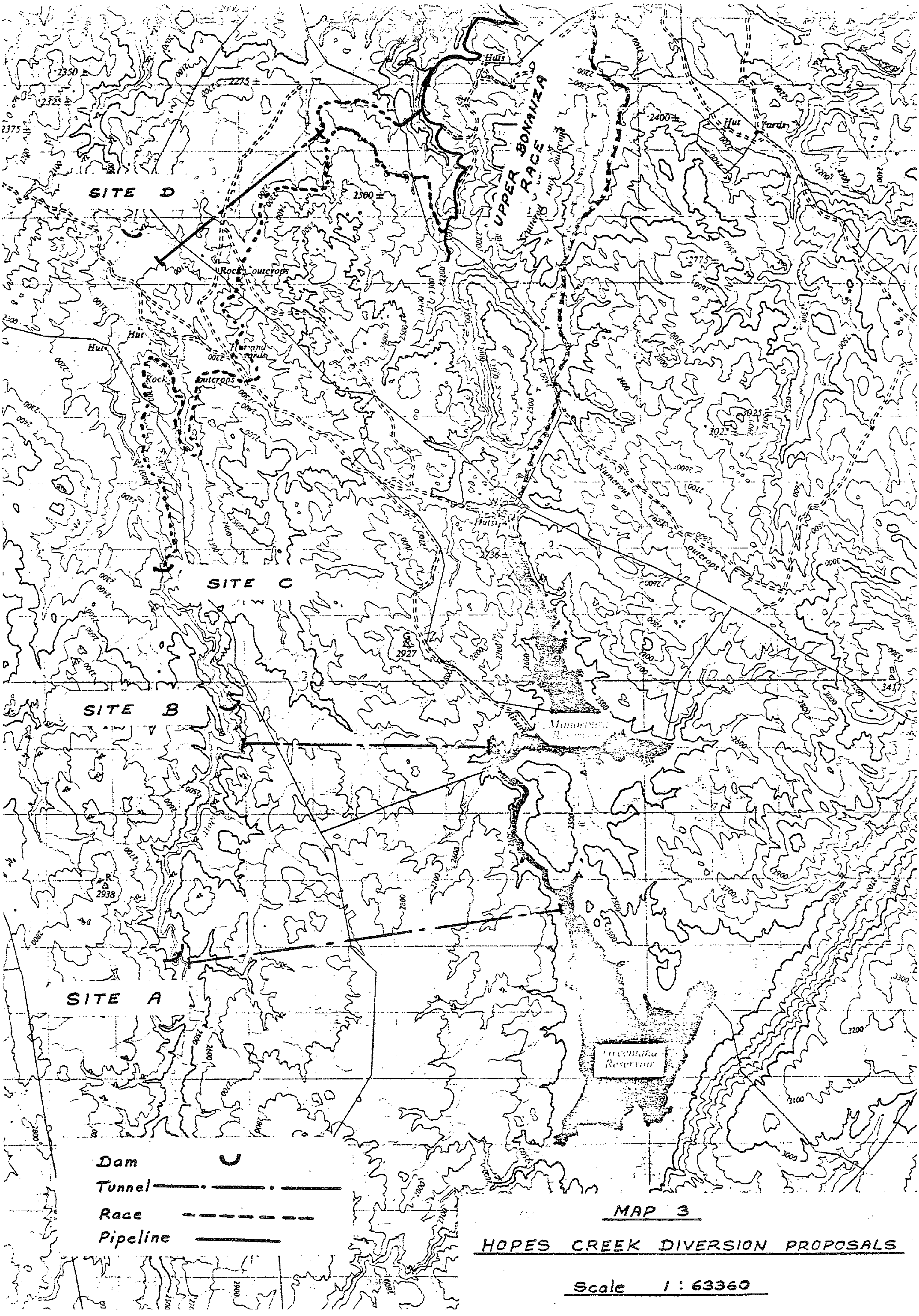
7 HOPES CREEK DIVERSION PROPOSALS

7.1 Alternative Schemes

These proposals are indicated on map 3, and as with the findings of previous investigations already referred to, they are really the only possible alternatives with regard to such factors as dam-site suitability, the contributing catchment hence run-off, and the ease of connection to the Manorburn supply system.

Basically the diversion proposals involve either a direct tunnel link between Hopes Creek and the Manorburn Reservoir using Sites A or B, or a Hopes Creek - Upper Bonanza Race connection which could be effected by an open race from Site C or a combination of tunnel and race from Site D.

Including distribution losses, the average deficiency per season is given as 6700 Ml and only diversion proposals capable of supplying at least approximately this amount are considered in this report. With reference to Table 10 it can be seen that storage



MAP 3

HOPES CREEK DIVERSION PROPOSALS

Scale 1 : 63360

would be necessary if the full quota is to be supplied to the present area under agreement. That is, even assuming that all run-off during the irrigation season could be diverted from a race intake at Site C to the Upper Bonanza Race, only about half the water required could be supplied. This proposal alone would therefore make no major contribution to the present deficient water supply, but it is looked at in conjunction with storage at Site B.

From the earlier reports, Sites A, B and D have been credited with having storage capacities of 800 Ml, 1200 Ml and 8600 Ml respectively and none of these could be considered as being capable of giving full regulation of run-off. For this to be achieved, the Manorburn Reservoir would have to be used, but as Hopes Creek is at a lower level than the Manorburn throughout its length, a connection by means of a tunnel located high enough in Hopes Creek, ie, from Sites A or B, is the only viable method.

Because of the relatively high cost of tunnelling, a number of possibilities of bringing water into the Manorburn Reservoir by open race, with or without tunnels to significantly reduce race lengths, have been fully examined in the 1966 Report. None of these race supply systems are attractive propositions for the following reasons:

(a) Snow and freezing conditions above 760 m (2500 ft) in this region would seriously affect the capacity of an open race during the winter and spring periods when most run-off occurs. At that altitude, a race could not be depended on to carry water throughout the year as snow drifts may cause blockages until late in the spring. Also, races are naturally limited in their capacity and loss of the higher flows would result if storage is not provided or if the storage that is available is at a maximum when high flows occur. With a tunnel, which can pass high flows under head, it is estimated that virtually all run-off at Sites A or B could be diverted into the Manorburn Reservoir.

(b) Races would have to be cut in rock in many places where side slopes are quite steep and this would probably result in high seepage losses such as have occurred in the similar type of country that the Upper Bonanza Race traverses. Maintenance would be expensive and probably not possible for prolonged periods when weather conditions would make access very difficult and working conditions very harsh. In comparison, a tunnel would require negligible maintenance and the diversion system would largely be self-operating.

In the past, where dams on Hopes Creek have been involved with the various diversion proposals, it is noted that virtually no consideration has been given to the possibility of building earth dams, concrete structures being costed in all scheme estimate. This was very likely due to labour intensive concrete dams being a cheaper proposition at a time (up to the mid-1950's) when machinery for a major earthwork project was not readily available. Modern construction plant means this drawback does not now apply, and it is proposed in this report that an earthfill dam would be more appropriate than a concrete structure.

As well as the cost factor, other advantages are that:

(a) Schemes involving diversion from Sites A or B have previously been considered unfavourable mainly because of the large amount of above-ground concrete works at such a high altitude resulting in a relatively short construction season. A more or less total earthmoving operation would not be affected by climatic conditions to quite the same extent as a concrete dam, hence the construction season each year should be longer.

(b) Spillways would not be required at either of the upper sites as all Hopes Creek run-off could be controlled by the Manorburn Dam. There is therefore no real reason why a completely earthfill dam would not be suitable at Sites A or B.

A description of each diversion proposal follows and includes an up-dating of cost estimates as well as a re-appraisal of the various features covered in (4) and (6).

(For ease of reference to the available topographical maps with MSL datum, levels are given in feet where appropriate; otherwise, metric units are used).

7.1.1 <u>Upper Tunnel Scheme : Site A</u>

An earthfill dam (map reference S144:329258) about 12 m high and estimated dam volume of 14 000 m^3 would form a reservoir of about 800 Ml at a maximum level of 2452 ft, ie, 4 ft (1.2 m) above the Manorburn Dam crest level. If the height of a dam at this site was to be increased much above this level, a subsidiary dam on a nearby low saddle would be necessary.

A 4800 m long tunnel (map reference S144:331258/386266) to the Manorburn Reservoir with a 2.3 m x 1.8 m cross-section and a 1:1000 grade would have an invert level of 2415 ft. It could maintain an 0.7 m^3/s minimum flow with both dams full, and 2.3 m^3/s without heading up at either the inlet or outlet.

The dam and tunnel should be capable of regulating all the Hopes Creek annual run-off of 7600 Ml from the 41.4 km^2 catchment that it controls. However, with storage capacity of only 800 Ml behind the dam, the adjoining low saddle could be used as an emergency spillway if necessary.

As indicated in the Appendix, the total estimated cost is $5 710 000, the tunnel alone accounting for about $4 300 000.

The unit cost can therefore be given as $751 per Ml diverted.

7.1.2 Lower Tunnel Scheme : Site B

The shortest possible direct link between Hopes Creek and the Manorburn Reservoir would be provided by a 3400 m long tunnel from this site. This connection has been looked at frequently in the past but rejected mainly on the basis of the concrete works that would be required, and also insufficient storage capacity.

A 35 m high dam (map reference S144:337295) would give a crest level of 2455 ft and, according to previous reports, form a reservoir of about 1200 Ml.

However, on checking this storage capacity by using the topographical map now available, it was found that a dam having a crest level of 2390 ft would give about 1200 Ml of storage, while the desired crest level of 2455 ft would provide 12 000 Ml. This is very significant in view of the fact that storage here has not previously been considered worthwhile, the dam only being of value for short-term run-off regulation and as a means of diversion via the connecting tunnel.

It is apparent when comparing levels of the topographical map of the area and Alexandra Drawing No. 930, from which the 1200 Ml was derived, that this major difference in storage volume is a result of the datum of the latter being about 65-70 feet too high. Consequently, the proposed reservoir capacity has been greatly under-estimated in all previous investigations.

A dam at Site B, with an on-grade tunnel of similar dimensions to that for the Upper Tunnel Scheme, having an invert level of 2390 ft, would provide effective storage of approximately 11 000 Ml. Together with the 51 000 Ml capacity of the Manorburn Reservoir the total storage capacity becomes 62 000 Ml from a combined Hopes Creek - Manorburn catchment having an average annual yield of 28 000 Ml. It is anticipated that such storage capacity in relation to run-off would provide complete flow regulation of both catchments with all control provided by the Manorburn Dam.

Tunnelling costs of $3 060 000 again form the major portion of an overall cost estimated to be $6 160 000, ie, a unit cost of $670 per Ml diverted.

7.1.3 Race to Upper Bonanza Race : Site C

This would be the cheapest and easiest method of supplying water to the Ida Valley race system, but without any storage upstream of the race intake, only spring and summer flows could be diverted. Also, with a limitation on the capacity of an open race, it is unlikely that more than about 3 000 Ml could be supplied each season, and for this reason a race by itself cannot be seriously considered.

The supply situation could be improved somewhat if this race was to be used in conjunction with a reservoir at Site B (Site A has insufficient storage) but the disadvantages of open races mentioned in Section 7.1 would still apply. However, if further investigations indicate these problems would not be too severe, the estimated capital cost is $4 500 000 for a dam on Hopes Creek and a 14 km long race connection to the Upper Bonanza Race to provide an additional 7000 Ml per season, the unit cost being $643 per Ml.

7.1.4 Stone Hut Flat Dam : Site D

This is another of the schemes discussed in the 1955 and 1966 Reports and involves a 30 m high dam at the downstream end of Stone Hut Flat (map reference S144:324368), a tunnel (map reference S144:327365/350384) to the Manorburn catchment and a pipe and race connection to the relocated Upper Bonanza Race. This last item is necessary because the Hopes Creek race level would be about 10 m lower than the Upper Bonanza Race, and reconstruction of the latter is estimated to cost about $300 000.

At a maximum possible crest level of 2018 ft the dam would provide about 8600 Ml of storage and the invert level of the 2500 m long tunnel would be 1985 ft. Similar to the others, the capacity of this tunnel would be about 2.3 m^3/s.

The estimated cost of the dam, tunnel plus race and pipe connection and relocated Bonanza Race is $6 260 000.

The average annual yield at the Stone Hut weir is given as 14 400 Ml, but with about

10 000 Ml of this occurring during the winter months, it is considered that the reservoir capacity would be insufficient to prevent some loss of water during periods of high flow and an annual average of 10 000 Ml seems a more realistic estimate of the amount of water available for diversion to Ida Valley.

The unit cost of water diverted is $626/Ml.

7.2 Summary

Table 11 below summarises the main features of the four diversion possibilities, with the unit costs also showing the capital cost per hectare on the basis of a 460 mm depth application per season on any "extra" area to be irrigated after the full quota on the present agreed area has been met.

Scheme	Supply (Ml)	Capital Cost ($)	Unit Cost ($/Ml)	"Extra Area" (ha)	"Extra Area" Headworks Cost ($/ha)
Upper Tunnel	7 600	5 710 000	751	-	-
Lower Tunnel	9 200	6 160 000	670	420	3 050
Race to Upper Bonanza Race with dam at Site B	7 000	4 500 000	643	-	-
Stone Hut Flat	10 000	6 260 000	626	550	2 850

TABLE 11 SCHEME SUMMARY

Even with distribution losses reduced to an acceptable level of 20%, expenditure of the order listed above would only serve to ensure that the full quota for the area under agreement could be supplied each year, with perhaps some surplus for extending the present scheme area.

This virtually means that a capital cost of about $1100/ha, excluding any on-farm works, is required to merely raise the existing average quota of about 360 mm to 460 mm and this would be quite uneconomic. Generally speaking, this has been the finding of all previous reports dealing with Hopes Creek diversion.

Another course of action is open, however, and that is to write-off the capital value of all assets of the present scheme as it now exists, and look at alternative proposals for what in effect would be a "new" Ida Valley Scheme.

8 NEW IDA VALLEY SCHEME

8.1 General

For an area that has been served with irrigation for 60 years, reversion to dryland farming cannot be considered under any circumstances because of the drastic social and economic effects such a decision would have on Ida Valley residents. However, the stage has now been reached where solutions to water supply problems and escalating running costs of the scheme will have to be found.

Reference has been made earlier in this report to the major problem of there being insufficient water available for the whole area under agreement to be supplied with the full quota each season. This is due mainly to an over-committal of the water resource that has really only become obvious over the latter half of the scheme's existence. During the last 30 irrigation seasons, the full quota has been offered to the farmers on only nine occasions with rebates given on the amount of water each saved. It is most likely that if farmers had used their quotas each season that 100% was offered, then rationing during the dry seasons that have frequently occurred would have been even more severe than it has been.

This uncertainty about water availability from one season to the next is the main cause of the farmers having little confidence in the ability of the present scheme to ensure irrigation farming in Ida Valley realises its full potential. The solution lies in either augmenting the water resource from Hopes Creek or decreasing the irrigable area under agreement so that full quotas can be supplied each season.

Methods of distributing water would also have to be further upgraded to reduce racemen's duties hence operating costs.

One given some consideration was the installation of a telemeter control system for the outlet valve on the Manorburn Dam. Such an arrangement would have dispensed with the need to have a raceman permanently stationed at the dam throughout the irrigation season, his present duties there being to manually adjust the valve to meet variations in water demand, and also to regularly patrol the Upper Bonanza Race.

It is the latter of these that is the most important. If a major failure occurred on this section of race during the irrigation season, almost the entire scheme area would be without water until repairs had been effected. Possible washouts or other causes of failure can only be foreseen by the human eye, and as "prevention is better than cure", these regular patrols will have to be continued. This being the case, alterations to the outlet valve could be carried out by a raceman who is either retained at the dam, or, with a reduced workload resulting from an upgrading of the distribution system, one from Ida Valley who could visit the dam (when necessary) as part of normal race patrols.

The most significant reduction in the labour content required to run the scheme could be achieved by the replacement of measuring boxes with Neyrpic-type turnouts for head-races on each property. There are about 260 of these boxes in the main races alone, serving 50 properties in the valley and a great deal of the racemen's time is spent on adjusting and checking them to suit the farmers' requirements.

The installation of Neyrpic gates, probably one or two being sufficient for each property, would quite substantially relieve racemen of turnout duties especially if the farmers' interest and involvement in their own scheme could then be fostered to such an extent as to include operating these turnouts.

Rosters should also be introduced for the scheme particularly during mid-season when peak demand conditions arise. However, water quotas would have to be assured each season for rosters to operate effectively, so without addition to the present water resource there would have to be a re-assessment of water allocations over the whole scheme. This could possibly be achieved by a reduction in areas that, although they are covered by irrigation agreements, are not yet developed.

Rosters could be worked out within existing race capacities to deliver flow units in multiples of 200 m^3/h up to say 800 m^3/h, these probably being adequate to suit most irrigators on the scheme. Where applicable, eg, on border-dyked paddocks, the use of higher flows over short durations would considerably reduce the labour input that is necessary when irrigating from contour ditches with flows of 100-200 m^3/h commonly used at present. While the irrigators on each of the main races would have to agree on how the rosters would operate, day to day running would be under the racemen's control.

8.2 <u>Water Availability and Irrigable Area</u>

Allowing for 20% distribution losses, the total water requirement of 32 000 Ml for the existing scheme consists of 4500 Ml for the Crawford Hills - Galloway area and 27 500 Ml within Ida Valley itself. However, the Manorburn and Poolburn reservoirs combined are capable of supplying only about 26 000 Ml during an average season.

Because of this shortfall, consideration has been given to discontinuing water supplies to the Crawford Hills - Galloway area of 600 ha now irrigated quite effectively using contour ditches, and thereby keep all Manorburn water within Ida Valley. While this would make a significant contribution to conserving supplies for the drier years, the Crawford Hills area in particular has no other reliable source of water during the summer months and the loss of water here would be a severe blow to the farmers concerned.

Termination of supply to the Syndicate Race has also been considered in conjunction with the above as this would mean the Lower Bonanza Race could be dispensed with altogether. Again however, about 500 ha lying above and extending further north of the Blacks No. 3 Race would be affected, and this includes some of the most suitable irrigable land in the valley.

On the basis that partial irrigation (80% of requirement) on 1100 ha would have to be sacrificed to enable the full 460 mm quota to be applied on 4500 ha, there seems little justification for closing down the Lower Bonanza, Crawford Hills and Syndicate Races. Certainly the farmers who would then have little or no irrigated land would not find such a proposal at all acceptable, and it is unlikely sufficient support for an upgraded scheme could be generated if these races were to be shutdown.

There is scope however to reduce the requirement for the Crawford Hills - Galloway area by dispensing with the quotas that now vary between 500 mm and 760 mm. It is not known why these higher quotas were set for the area, but it seems appropriate to adopt the same quota here that applies to the remainder of the scheme, ie, 460 mm; the water requirement would therefore decrease from 4500 Ml to 3300 Ml.

The areas that could be irrigated using the present water resource, with or without one of the Hopes Creek proposals listed in Table 11 are summarised in Table 12:

Manorburn + Poolburn resources	Water Resource (Ml)		Irrigable Area (ha)	
	Gross	Net	Ida Valley	Total
with Upper Tunnel Scheme	33 500	26 800	5250	5850
with Lower Tunnel Scheme	35 200	28 200	5550	6150
with race from Site B dam	33 000	26 400	5150	5750
with Stone Hut Flat dam	37 000	29 600	5850	6450
as at present	26 000	20 800	4000	4500

TABLE 12

(It will be noted that each proposal incorporating Hopes Creek run-off allows for the present agreed area of 600 ha in the Crawford Hills - Galloway region to be retained. However, with a reduction in water allocations being required, as in the last case above, then this area has been reduced accordingly to 500 ha).

Solely in terms of additional water, the Stone Hut Flat dam would be the best diversion proposals, but even this in combination with the present water resource would be sufficient for only 58% of the total area commanded by races of the existing scheme. Since the land already commanded should be developed as fully as is possible before any race extensions are considered, it is assumed that any water diverted from Hopes Creek would be fully committed to irrigation within the confines of the existing race system.

8.3 Scheme Costs

Although each proposal is costed as fully as is possible in the absence of detailed survey data, the estimated costs given in Table 13 should be regarded more for comparative purposes than for absolute accuracy. The following points should also be noted:

(a) The capital costs given for headworks consist of those costs for each Hopes Creek diversion proposal plus a further $100 000 for continued improvements on the Bonanza Races and possibly for telemeter control of the outlet valve on the Manorburn Dam.

(b) The engineering assessment (see Appendix) completed in October 1971 involved a walkover survey of the entire distribution system. The report that followed consisted of an inventory of all race controls and structures, and the condition of these as well as comments on the races themselves were also noted. A renewal programme for the following 40 years was also compiled and has been the basis for an upgrading programme that has progressively improved the race network to what is now regarded as being in good overall condition for the type of scheme it serves.

The major expenditure for scheme works would be for:

(i) Re-shaping parts of some races that are excessively wide thereby reducing seepage and evaporation losses.

(ii) Installation of Neyrpic turnouts and water level check structures to replace the measuring boxes and sub-standard checks throughout the system.

(iii) Farm and road access crossings to be improved by replacing unreinforced concrete and old steel pipes with adequately covered reinforced concrete pipes between well constructed headwalls.

(iv) All the main races to be brought up to such a standard that they can be machine-cleaned, and ready access throughout is possible at least by motor-cycle.

(v) Concrete drops and/or short pipelines on the steeper distributaries to prevent scouring.

(vi) Fencing off sections of race where appropriate to prevent stock damage.

(vii) Repairs to the Totara Creek Race and diversion weir which, although lying above the winter snowline and hence being difficult and expensive to maintain, supplies a significant proportion (15-20%) of the mean annual yield of the Poolburn Reservoir.

An overall cost of $600 000 is estimated for upgrading the distribution system to a level where operation and maintenance costs are minimised, and this cost would be independent of the area under each proposal as the present commanded area could fully utilise any additional water supplies.

(c) Because of topographical limitations and water availability, it is suggested that the irrigation methods likely to be adopted would consist of 20% contour ditch, 50% border-dyke, and 30% spray. Including headraces, structures, land development, drainage, etc, estimated costs are based on:

Contour ditch	$80/ha
Border-dyke	$350/ha
Spray (permanent works only)	$300/ha.

Adding 15% for supervision and contingencies, the average on-farm development cost is therefore given as $320 per ha. While this may seem low (compare current Maniototo border-dyke development costs are $400-440/ha) it allows for on-farm development that has already been carried out.

	Scheme				
	Manorburn and Poolburn Resources:				
	with Hopes Creek diversion by:				with present scheme upgraded
	Upper Tunnel, Site A	Lower Tunnel, Site B	Race with Dam at Site B	Stone Hut Flat Dam, Site D	
Total irrigable area (ha)	5 850	6 150	5 750	6 450	4 500
Net water resource (Ml)	26 800	28 200	26 400	29 600	20 800
CAPITAL COSTS					
Headworks	$5 810 000	$6 260 000	$4 600 000	$6 360 000	$100 000
Schemeworks	600 000	600 000	600 000	600 000	600 000
On-farm	1 870 000	1 970 000	1 840 000	2 070 000	1 440 000
TOTAL	$8 280 000	$8 830 000	$7 040 000	$9 030 000	$2 140 000
Cost/ha	$1415	$1435	$1225	$1440	$475
Headworks cost/Ml	$217	$222	$174	$215	$5

TABLE 13

8.4 Annual Charges

Under the Public Works Amendment Act 1975, these are required to meet the full cost of operating and maintaining the scheme, provide a fund for planned renewals of off-farm supply works and repay half the cost of schemeworks, ie, those distribution works within the irrigation district. Ruling rates of interest apply and scheme accounts are required to balance by the fortieth year.

As referred to earlier in this report, the major cost of Ida Valley irrigation has in the past been for operation and maintenance (currently about $65 000 per year). Capital expenditure on schemeworks should significantly reduce the present high labour content required to operate the scheme, the cost of which is likely to rise even more steeply in the future if nothing is done.

Maintenance involves repairs to various structures and controls such as turnouts, weirs, culverts and crossings, but more significantly the attention that has to be given to the races themselves. This essentially consists of general repairs during the off-season, the latter - until recently - being largely a labour intensive operation. However, much of the cleaning can now be done by machine and with further access improvements, this method would be suitable for all the main races. Grader trimming of the race banks would also be appropriate on most of the distributaries to restore the now rectangular sections to more easily maintained and less troublesome triangular shaped races. An annual sum of $8000 is accepted for maintenance.

These overall improvements should at least mean that the present need for one raceman per 750 ha could be reduced to say, one per 1100-1200 ha. At an annual cost of $10 000 per raceman, including vehicle running, the saving in running costs each year would be substantial if scheme operation can be handled by fewer racemen using farmer assistance in water distribution.

Annual renewal (sinking) fund payments for items such as pipework and various control structures are difficult to evaluate at this stage, but in view of the engineering assessment completed some years ago about $25 000/year would be required.

Charges for each of the alternatives are derived from the following expressions:

$$\text{Basic charge} = \frac{\$600\ 000 \times 0.5 \times 0.12352}{\text{irrigable area (ha)}}$$

$$\text{Availability charge} = \frac{0.12352 \left\{(600\ 000 \times 0.5) + (3.219 \times O\ \&\ M)\right\} + O\ \&\ M + 25\ 000}{\text{supply unit } (Ml = 1000\ m^3)}$$

and are summarised as follows:

	Scheme: Manorburn and Poolburn Resources: with Hopes Creek diversion by: Upper Tunnel, Site A	Lower Tunnel, Site B	Race with Dam at Site B	Stone Hut Flat Dam, Site D	with present scheme upgraded
Total irrigable area (ha)	5 850	6 150	5 750	6 450	4 500
Net water resource (Ml)	26 800	28 200	26 400	29 600	20 800
No. racemen required	5	5	5	6	4
Operation & Maintenance	$58 000	$58 000	$58 000	$68 000	$48 000
Basic Charge per ha	$6.30	$6.00	$6.40	$5.80	$8.20
Availability charge per ha	$24.50	$23.30	$24.90	$24.40	$28.70
Availability charge per Ml (based on 460 mm average usage)	$5.30	$5.10	$5.40	$5.30	$6.20

TABLE 14

9 CONCLUSIONS

Because of the severe socio-economic effects that would result with closure of the scheme, irrigation within Ida Valley will have to be continued. However, the existing scheme is in need of an upgrading programme to overcome the present main problems of an over-committed water resource and excessive running costs.

Raising the Manorburn Dam crest level by one to two m could increase the present storage capacity by 7000-16 000 Ml, but as there have been only two occasions (the winter months of 1945 and 1958) when water has been spilled from the reservoir since the dam was constructed in 1914, the use of such a facility for storing this "surplus" run-off would be negligible. There is also the strong possibility that the structural condition of the dam may in itself be enough to prevent any serious thoughts of increasing its height.

While Hopes Creek is the only potential source of extra water, it is apparent that its use would be more for augmenting supplies on the present agreed area rather than for area extensions such as those along the German Hills side of the valley that have been suggested in the past.

At an estimated capital cost of between $4.6 M and $6.4 M a Hopes Creek - Ida Valley connection would ensure full seasonal quotas could be supplied to the present area covered by agreement, and any water surplus to this requirement could be used within the area already commanded by the existing race system.

More efficient on-farm use of the water that is available seems the only practical alternative to Hopes Creek diversion proposals. This could best be achieved by works (refer to Section 8.3) estimated at $600 000 to upgrade the distribution system, and also further on-farm development costing about $1 M that would have to be an integral part of such an upgrading programme.

Improvements to the race system and operating procedures would be required if running costs of the scheme are to be minimised, ie, the scheme would have to be brought up to a standard where fewer than seven full-time racemen are needed to operate it. In the short-term, expenditure of $180 000 would ensure that those structures in the poorest condition could be replaced, but a renewals programme for the scheme of $25 000/year, whether this or the major upgrading option is carried out, should also be instituted.

Farmer assitance with water distribution would play an important part in reducing operating costs, as any savings that are made would be reflected in the water charges. For instance, the water charge reduction on this scheme due to just one man's duties being handled by the irrigators themselves would be equivalent to about $2.50/ha per year.

If Hopes Creek diversion is not to be proceeded with, part of the upgrading of the present scheme would have to include a re-assessment of land classed as irrigable on each property thus ensuring that water quotas could be supplied each season. While this would result in an average reduction of 20% in terms of assessed irrigable areas, the amount of water available to each irrigator would not differ markedly from what he now receives. Rebates for portions of quotas not drawn in any season could be dispensed with and irrigators would be able to farm according to assured seasonal water quotas.

Any reconstruction works would have to be carried out in such a way that normal water supplies could be delivered each season. Agricultural restraints associated with on-farm development would also play an important part in the timing of the upgrading programme which, because of these two main factors, could take up to 10 years.

Unless Hopes Creek diversion is to be regarded as headworks for what in effect would be a new scheme within the boundaries of the existing races, there seems little justification for expenditure of about $1100/ha - excluding on-farm works - merely to raise seasonal quotas from 360 mm to 460 mm.

Major improvements to the existing scheme would mean that prevailing annual water charges averaging $8/ha would rise to $25-30/ha. Continuation of the scheme as at present would require annual charges of about $20/ha if they are to be commensurate with current operating costs - annual adjustments to cope with escalating running costs would also be necessary while the scheme's high labour content remains.

Regular patrols of the Upper Bonanza Race are necessary to ensure the risk of failure is minimised, and if this can best be achieved by having a raceman retained at the Manorburn Dam, then there would be no need to install a remote-control system to operate the dam's outlet valves. However, savings of $8000 - $10 000/year could be made if this part of the scheme was to be looked after by a raceman from Ida Valley and if a telemeter link with the dam was available.

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DJC

andholder	Total Area (ha)	Area Below (ha)	Agreed Irrig. Area (ha)	Water Quota (Ml)	Govt. Scheme Present Irrigation * B/D			Possible Irrigation B/D			Private Irrigation B/D			Land Utilisation below races L					Land Utilisation above races L					Stock in S.U. Sheep				Water Quota (mm)
					B/D	Eff. Cont.	Part.	B/D	Eff. Cont.	Part.	B/D	Eff. Cont.	Part.	L	G	C	N	O	L	G	C	N	O	Sheep	Cattle	Other	Total	
RSON N.	277	277	73	936	—	49 (4)	Spray 20 (2)	208	—	—	—	—	—	97	150	—	30	—	—	—	—	—	—	1840	60	—	1900	460
RSCN J.M.	1124	95	73	336	—	81	—	81	—	—	—	—	—	—	87	8	—	—	40	324	—	665	—	2320	650	—	2970	"
RSON P.J.	152	152	72	331	5 (4)	67 (4)	—	111	41	—	—	—	—	10	121	18	3	—	—	—	—	—	—	1320	60	—	1380	"
TRONG A.R.& Son	1516	162	109	501	—	142 (4)	spray 20	142	—	20	—	—	—	—	118	24	20	—	20	—	40	1294	—	3270	230	—	3500	"
UR I.W.A.	299	251	71	327	—	182 (2)	—	162	89	—	—	—	—	16	204	29	2	—	—	—	—	48	—	2080	210	—	2290	"
EY I.R.A.& J.W.W.	1283	12	8	37	—	—	spray 8	8	—	—	—	—	—	12	—	—	—	—	61	81	36	1093	—	2630	150	—	2780	"
CH PARTNERSHIP (G. NEVILL)	468	468	224	1030	16 (3)	208	—	259	121	—	—	—	—	79	244	64	81	—	—	—	—	—	—	2800	750	—	3550	"
AS G.A.	202	202	28	129	—	40 (4)	—	162	—	—	—	—	—	20	178	—	4	—	—	—	—	—	—	1600	240	—	1840	"
AS W.J. (Estate)	517	193	30	138	—	40 (3)	80	40	80	—	—	—	—	18	175	—	—	—	74	—	—	250	—	2210	70	—	2280	"
DALE TRUST (C.F.R. HARREX)	2630	202	81	373	49	62	spray 10	142	60	—	—	—	—	35	140	7	20	—	24	—	—	2404	—	4770	730	—	5500	"
EX C.F.R.	2630	162	67	308	—	121	—	121	10	—	—	—	—	8	123	11	20	—	—	202	—	2266	—	In conj. with Dovedale Trust				"
WER K.A (& Trust)	4350	100	75	345	—	81 (4)	—	81	12	—	—	—	—	12	85	—	3	—	81	3643	—	526	—	4040	740	—	4780	"
NERY T.	259	259	142	653	54 (4)	109 (4)	—	202	—	spray 45	—	—	—	45	182	32	—	—	—	—	—	—	—	2600	500	—	3100	"
NERY M.J.& Son	234	234	85	391	—	85	—	85	—	—	—	—	—	24	210	—	—	—	—	—	—	—	—	1700	320	—	2020	"
NERY P.J.& J.G.	1659	324	312	1350	—	243 (4)	—	243	—	—	—	—	—	12	312	—	—	—	81	—	—	1254	—	6820	1240	—	8060	"
ES Chas.	159	150	132	607	—	109 (4)	spray 5	34	80	—	—	—	—	20	126	2	2	—	—	—	—	9	—	1260	130	—	1390	"
SON B.M.	795	36	17	78	6	—	12	11	—	7	—	36	—	17	19	—	—	—	57	702	—	—	—	2000	230	—	2230	"
S C.M.	79	79	20	92	—	10	12 (1)	16	—	—	—	—	—	24	45	—	10	—	—	—	—	—	—	270	240	—	510	"
H BROS.	701	121	106	488	—	105 (3)	—	—	121	—	—	—	—	3	118	—	—	—	—	—	—	580	—	1190	—	—	1190	"
ESON D.R (& Trust)	220	219	166	764	—	166 (4)	—	—	166	—	—	—	—	26	193	—	—	—	—	—	—	—	—	2120	400	—	2520	"
EEN W.	355	355	142	653	—	162 (4)	20	101	243	—	Private right 1 cfs			45	302	8	—	—	—	—	—	—	—	1920	470	—	2330	"
TOSH G.	890	324	202	929	—	182 (3)	—	243	81	—	—	—	—	12	304	8	—	—	—	—	—	566	—	1440	630	—	2070	"
TOSH J.K.	814	219	219	1007	16	162 (3)	—	162	—	—	—	—	—	16	193	10	—	—	—	—	—	595	—	2080	200	—	2280	"
TOSH Keith	312	310	182	837	—	121 (3)	—	81	182	—	—	—	—	40	258	12	—	—	—	—	—	2	—	1230	1220	—	2450	"
TOSH N.T.	121	121	16	74	—	16 (5)	spray 16	16	16	spray 61	spray 20 (4)	16 (4)	—	12	63	6	40	—	—	—	—	—	—	1160	160	—	1320	"
NO RIDGE LTD. (J. PATERSON)	1416	2	2	9	"Non-irrigation" farm. Property not visited.										2							1414		In conj. with Omakau property				
LLY H.L.	1902	81	45	207	—	28 (3)	—	61	12	—	—	—	—	7	28	—	46	—	15	—	—	1806	—	3370	250	—	3620	"
ENA J.G.	2009	44	28	129	—	44 (3)	—	44	—	—	—	—	—	—	44	—	—	—	49	—	—	1916	—	2520	—	—	2520	"
LL G.	1578	364	299	1375	—	202 (3)	—	182	101	—	—	—	—	8	295	—	61	—	—	—	—	1214	—	3220	500	—	3720	"
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—	[illegible]	40	—	—	—	—	—	108	—	—	—	77	176	—	—	—	2320	—	—	2320	"

Landholder	Total Area (ha)	Area Below (ha)	Agreed Irrig. Area (ha)	Water Quota (Ml)	Govt. Scheme Present Irrigation* B/D	Eff. Cont.	Part.	Possible Irrigation B/D	Eff. Cont.	Part.	Private Irrigation B/D	Eff. Cont.	Part.	Land Utilisation below races L	G	C	N	O	Land Utilisation above races L	G	C	N	O	Stock in S.U. Sheep	Cattle	Other	Total	Water Quota (mm)
OLSON A.W.	261	221	123	566	–	121 (4)	–	40	162	–	–	–	–	47	174	–	–	–	3	–	20	17	–	1940	430	–	2370	460
OLSON I.S.	376	376	162	745	32 (6)	98 (5)	32 (2)	304	–	–	–	–	–	73	285	18	–	–	–	–	–	–	–	2510	500	–	3010	"
D I.H.	514	486	166	764	–	243 (3)	spray 24 (3)	324	162	–	–	–	–	24	450	12	–	–	16	–	12	–	–	2980	490	–	3470	"
IE J.T. & R.H.	1133	405	61	281	5	16 (4)	380 (1)	20	25	–	–	20	–	40	365	–	–	–	–	–	–	728	–	2850	910	–	3760	"
RSON LTD J.R.	7140	502	55	253	32 (4)	7 (3)	–	81	–	–	–	–	–	40	462	–	–	–	–	–	–	6638	–	6060	3020	–	9080	"
ERFORD J.H.	243	243	24	110	–	24 (3)	–	101	–	–	–	–	–	8	225	10	–	–	–	–	–	–	–	1330	110	–	1440	"
ERFORD H.	121	121	55	253	–	81	–	101	20	–	–	–	–	–	121	–	–	–	–	–	–	–	–	650	50	–	700	"
T A.D.	274	170	57	262	14	81 (3)	–	111	–	40	–	–	–	30	117	23	–	–	24	49	31	–	–	3750	520	–	4270	"
T L.C.	258	254	154	708	–	162 (3)	–	182	61	–	–	–	–	32	202	20	–	–	–	4	–	–	–	In conj. with A.D. Scott				
AMON J.T.	277	277	79	363	–	83 (3)	–	–	144	–	–	–	–	33	244	–	–	–	–	–	–	–	–	1960	180	–	2140	"
AMON L.V.	128	128	121	557	–	128 (4)	–	97	–	–	–	–	–	3	119	6	–	–	–	–	–	–	–	1240	–	–	1240	"
AMON W.L.	504	100	61	281	–	61 (3)	–	19	81	–	–	–	–	4	96	–	–	–	–	44	–	360	–	1000	–	–	1000	"
L D.G.	8255	71	51	235	–	30 (4)	spray 20	30	20	–	–	–	–	18	32	–	21	–	8	–	–	8176	–	5660	480	–	6140	"
L D.H.	618	101	95	437	–	95 (4)	–	81	–	14	–	–	–	4	91	–	6	–	–	–	–	517	–	In conj. with D.G. Small				
L P.J.	1396	251	227	1044	7	208 (3)	–	190	61	–	–	–	–	6	233	12	–	–	24	16	–	1105	–	3180	610	–	3790	"
RT J.	216	216	117	538	–	97	spray 24 (2)	81	81	54	–	–	–	12	197	7	–	–	–	–	–	–	–	1500	30	–	1530	"
ER R.H.	255	162	51	235	–	61 (3)	–	81	81	–	–	–	–	12	138	12	–	–	53	28	12	–	–	1660	160	–	1820	"
AMSON D. (Trust)	121	115	81	373	–	81 (3)	34	97	16	–	–	–	–	13	102	–	–	–	–	3	–	3	–	1150	210	–	1360	"
AMSON D.	121	121	81	373	–	81	20	121	–	–	–	–	–	12	103	6	–	–	–	–	–	–	–	1000	–	–	1000	"
AMSON D.C.	189	189	108	497	–	108 (3)	22	162	–	–	–	–	–	15	166	8	–	–	–	–	–	–	–	1430	400	–	1830	"
							spray 147 other 612			spray 106 other 135	spray 20																	
TOTAL	51712	10135	5016	23000	236	4744	759	5282	2376	241	20	72	–	1044	8349	373	369	–	707	5272	151	35446	–	107950	18480	–	126430	

* Nos. in brackets indicates irrigations per season.

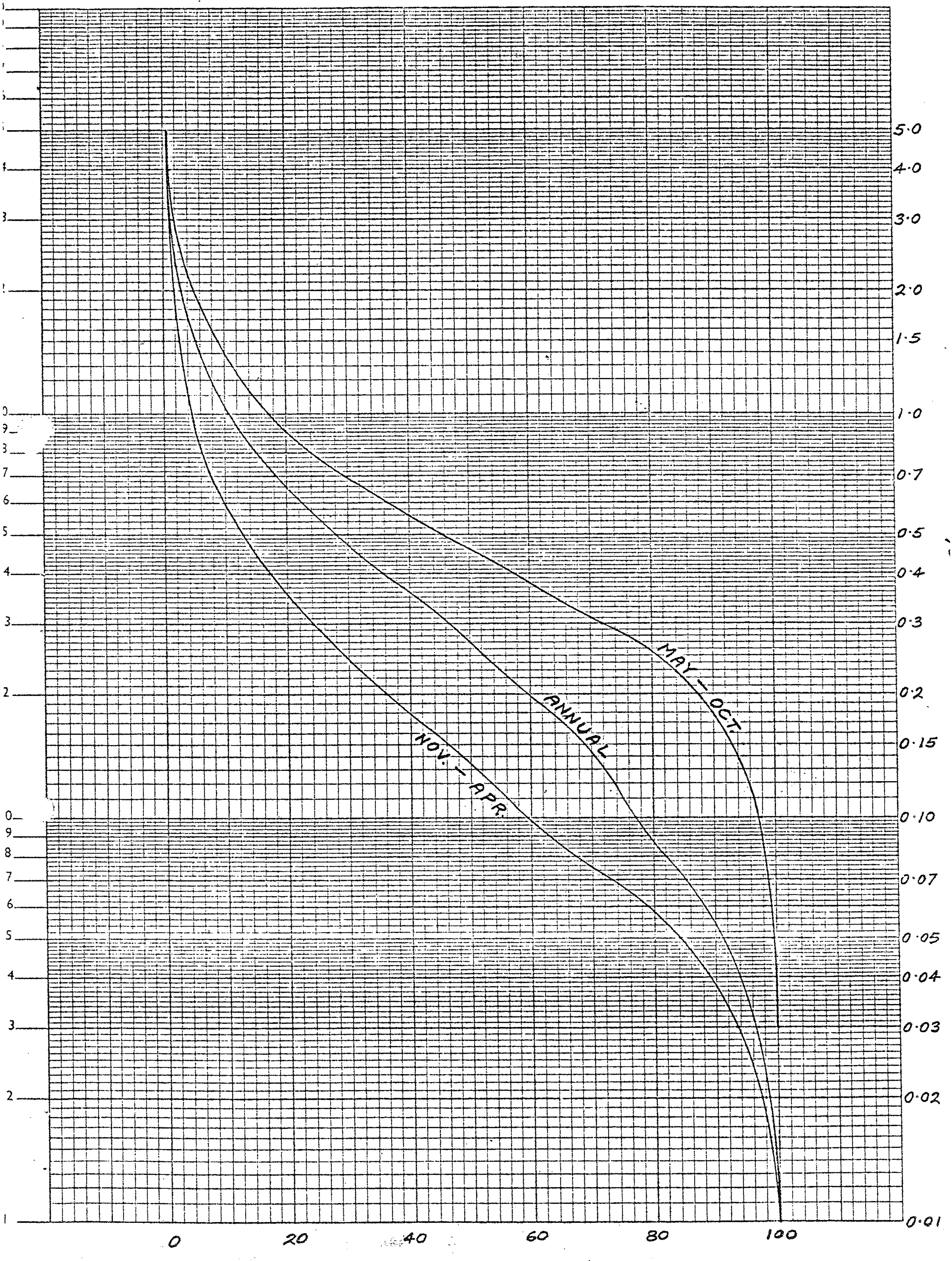
HOPES CREEK at STONE HUT FLAT

R = Runoff (cumec.-days) D = No. of days M = Mean flow (m³/s)

YEAR		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANN.
	R	1.99	1.81	1.57	14.53	29.17	28.16	30.00	19.54	48.85	33.05	16.91	21.04	246.62
'51	D	22	28	31	30	31	30	31	31	30	31	30	31	356
	M	0.09	0.06	0.05	0.48	0.94	0.94	0.97	0.63	1.63	1.07	0.56	0.68	
	R	8.15	2.57	2.76	2.62	6.98	8.54	16.15	23.85	14.94	20.83	21.20	5.45	134.04
'52	D	31	29	31	30	31	30	31	31	30	31	30	31	366
	M	0.26	0.09	0.09	0.09	0.22	0.28	0.52	0.77	0.50	0.67	0.71	0.18	
	R	3.82	1.91	6.41	23.48	18.49	8.67	12.93	49.31	28.26	20.51	4.76	2.21	180.78
'53	D	31	28	31	30	31	30	31	31	30	31	30	31	365
	M	0.12	0.07	0.21	0.78	0.60	0.29	0.49	1.59	0.94	0.66	0.16	0.07	
	R	2.05	1.11	1.37	5.53	5.32	9.35	3.30		18.27	6.90	3.23	4.08	60.51
'54	D	31	28	31	30	31	30	8		25	31	30	31	306
	M	0.07	0.04	0.04	0.18	0.17	0.31	0.41		0.73	0.22	0.11	0.13	
	R	2.66	2.53	2.67	2.28	20.65			19.08	22.03	6.69	4.96	1.38	84.9
'55	D	31	28	31	30	31			31	30	31	30	31	304
	M	0.09	0.09	0.09	0.08	0.67			0.62	0.73	0.22	0.16	0.04	
	R	0.69	0.35	0.45	1.30	6.46	17.01	25.29	12.96	14.92	12.98	4.50	9.45	106.3
'56	D	31	29	31	30	31	30	31	31	30	31	30	31	366
	M	0.02	0.01	0.01	0.04	0.21	0.57	0.82	0.42	0.50	0.42	0.15	0.30	
	R	17.17	2.95	15.85	10.18	51.84	101.93	29.94	42.65	17.20	28.26	33.85	28.35	380.1
'57	D	31	28	31	30	31	30	31	31	30	31	30	31	365
	M	0.55	0.11	0.51	0.34	1.67	3.40	0.97	1.38	0.57	0.91	1.13	0.91	
	R	19.35	18.59	11.39	63.21	73.27	27.93		11.50	9.91	6.68	3.83	7.34	253.
'58	D	31	28	31	30	31	30	—	27	30	31	30	31	330
	M	0.62	0.66	0.37	2.11	2.36	0.93		0.43	0.33	0.22	0.13	0.24	
	R	7.41	2.83	2.36	5.51	27.39	34.97	12.00	11.93	11.71	5.23	4.78	15.17	141.
'59	D	31	28	31	30	31	30	31	31	30	31	30	31	365
	M	0.24	0.10	0.08	0.18	0.88	1.17	0.39	0.38	0.39	0.17	0.16	0.49	
	R	2.61	1.91	7.70	5.13	1.84	11.22	24.31	36.83	23.79	9.59	15.16	7.24	147.
'60	D	31	29	31	30	19	12	31	31	30	31	30	31	33

YEAR		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANN
	R	2·67	2·93	14·33	8·94	8·41	8·69	21·00	25·26	18·20	11·38	3·98	4·69	130·4
'61	D	31	28	31	30	31	30	24	31	30	31	23	31	351
	M	0·09	0·10	0·46	0·30	0·27	0·29	0·68	0·81	0·61	0·37	0·17	0·15	
	R	6·14	6·52	10·74	9·92	16·66	29·85	27·74	36·27	9·97	8·22	8·73	4·49	175·2
'62	D	31	28	31	30	31	30	24	31	16	31	30	31	344
	M	0·20	0·23	0·35	0·33	0·54	1·00	1·16	1·17	0·62	0·26	0·29	0·14	
	R	3·00	3·31	4·76	4·72	10·99	9·74						5·22	41·7
'63	D	31	28	31	30	31	19						31	201
	M	0·10	0·12	0·15	0·16	0·35	0·51						0·17	
	R	2·85	0·60	3·20	2·78	4·42	6·85	10·97	13·14	14·79	6·17	6·65	10·90	83·5
'64	D	31	29	31	30	31	30	31	31	30	31	30	29	364
	M	0·09	0·02	0·10	0·09	0·14	0·23	0·35	0·42	0·49	0·20	0·22	0·38	
	R	10·61	15·40	56·9[illegible]	20·93	38·47								143·
'65	D	31	26	31	30	31								149
	M	0·34	0·59	1·84	0·70	1·27								
MEAN FLOW		0·20	0·15	0·31	0·40	0·71	0·84	0·70	0·82	0·68	0·44	0·35	0·29	0·4
(Ml)		500	300	800	1000	1900	2200	1900	2200	1800	1200	900	800	155

HOPES CREEK FLOW DURATION 1951 – 65



APPENDIX D

HOPES CREEK PROPOSALS COST ESTIMATES

UPPER TUNNEL SCHEME : SITE A

	$
Establishment and site preparation	300 000
Driving tunnel (2.3 x 1.8 m x/s) 4800 m @ $900/m	4 320 000
Lining tunnel, say 1000 m @ $200/m	200 000
Earthen dam 14 000 m^3 @ $6.50/$m^3$	91 000
Access roading, 12 km @ $4000/km	48 000
Culverts, etc	7 000
Supervision and contingencies 15%	745 000
	5 710 000

LOWER TUNNEL SCHEME : SITE B

	$
Establishment and site preparation	300 000
Tunnel, 3400 m @ $900/m	3 060 000
Lining tunnel, say 700 m @ $200/m	140 000
Earthen dam 280 000 m^3 @ $6.50/$m^3$	1 820 000
Access roading, 8 km @ $4000/km	32 000
Culverts, etc	4 000
Supervision and contingencies 15%	804 000
	6 160 000

RACE TO UPPER BONANZA RACE : SITE C

	$
Site establishment	100 000
Intake weir and gates	10 000
Pipeline, 600 mm dia, 900 m @ $80/m	72 000
Race, 13 000 m @ $10/m	130 000
Under-race culverts, 15 @ $300	5 000
Race crossings, 3 @ $5000	15 000
Access roading, 7 km @ $4000/km	28 000
Supervision and contingencies 15%	50 000
	410 000
Plus dam at Site B	4 190 000
	4 600 000

STONE HUT DAM : SITE D

	$
Establishment and site preparation	300 000
Dam excavation	50 000
Dam concrete 11 000 m^3 @ $200/$m^3$	2 200 000
Driving tunnel, 2700 m @ $900/m	2 430 000
Lining tunnel, say 500 m @ $200/m	100 000
Race 2000 m @ $10/m	20 000
Manorburn syphon, 750 mm dia, 600 m @ $90/m	54 000
Access roading 6.5 km @ $4000/km	26 000
Supervision and contingencies 15%	780 000
	5 960 000
Relocated Bonanza Race	300 000
	6 260 000

ENGINEERING ASSESSMENT

The general race descriptions that follow and that are still largely applicable, excluding the Upper Bonanza Race on which extensive works have been carried out during the past five to six years, are taken directly from the engineering report produced by J W K Symons and B L Washington in 1971. The location of each structure was defined in terms of distance measured in feet from the beginning of each race and shown on 1:15840 (20 ch/1 in) topographical maps, and its condition was classified according to one of the following:

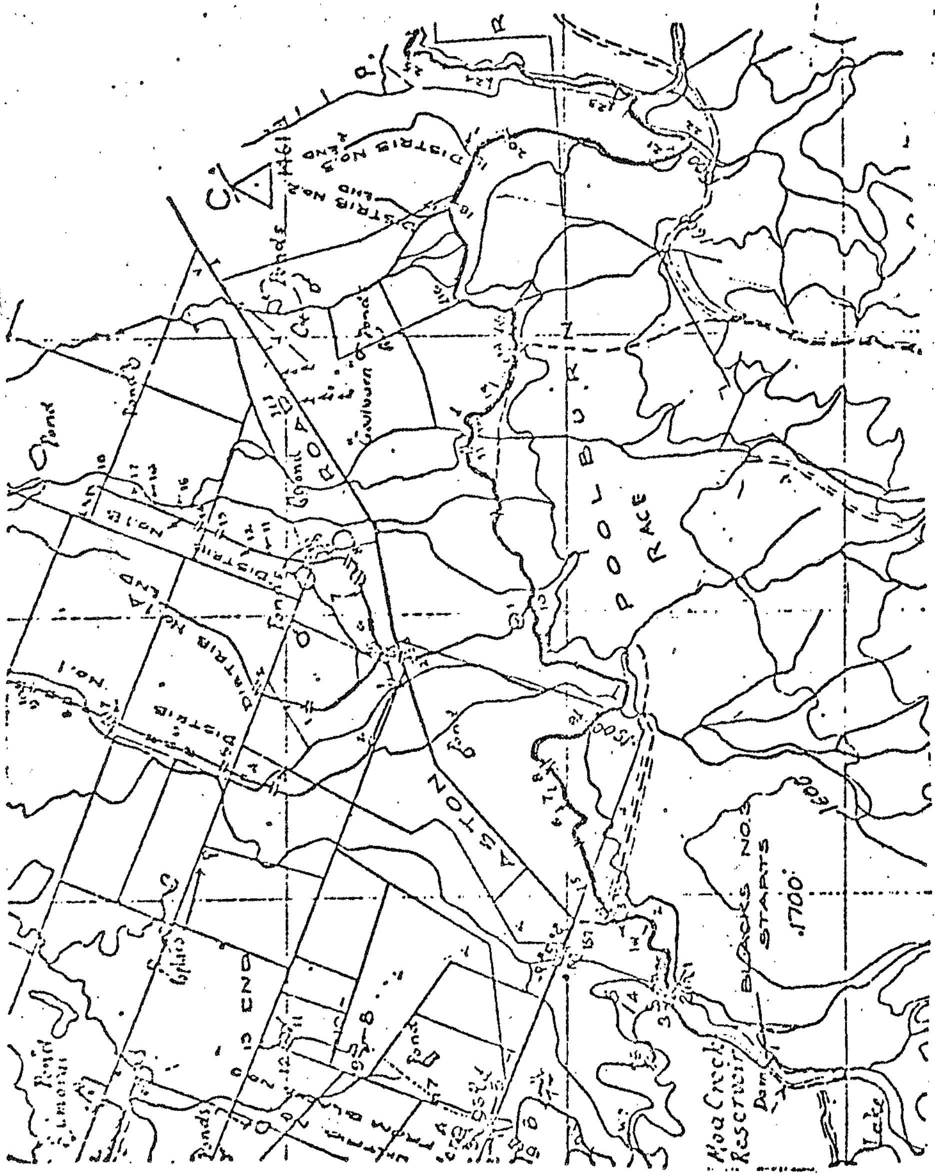
New	Installed within the previous two to three years
Good	Estimated lives of 20+ years for steelwork and timber, and 40+ years for concrete
OK	Structures satisfactory with estimated life exceeding 10 years, but possibility of lasting 20 years
Fair	Structures satisfactory, some patching necessary, but should last about 10 years
Poor	Structures old and needing major attention or replacements in the next few years
Bad	Needs major attention.

(An example of how the information was compiled is shown for part of the Poolburn Race only, as the complete report is too extensive to be included here).

A renewal programme for the 40 years from 1971 was compiled from the report and while some major renewals and repairs have been carried out during the last few years, the scheme layout is basically unchanged.

With this in mind, the engineering assessment and renewal programme have been used to estimate the present day cost of bringing the distribution system up to the "OK" standard (at least); the replacement of the "fair" to "bad" structures on each of the main races and their distributaries is estimated as follows:

	$
Upper Bonanza Race	8 000
Totara Creek Race	27 500
Crawford Hills Race	7 900
Lower Bonanza Race	5 400
Poolburn Race	5 600
Poolburn Distributaries	17 700
German Hills Race	12 000
German Hills Distributaries	31 000
Syndicate Race	10 600
Syndicate Distributaries	6 900
Blacks No. 3 Race	26 000
Blacks No. 3 Distributaries	19 400
TOTAL	178 000
SAY	180 000



IDA VALLEY SCHEME

POOLBURN RACE

Map Ref. S 144/2

Length 25,815'. Starts at No.2 structure on Blacks No. 3 at Waterway 12' wide x 2' deep.

No.	Structure	Condition	Remarks
1	Siphon over Moa Creek Steel pipes 85' x 30" Concrete pipes 125' x 30"	New	
2	Wood outlet 10' x 20" x 10" L.H.	Bad	
3	Stone and concrete Bywash 6' wide x 1'6" deep L.H. Prefab. concrete stop. 5' wide, 2' high.	Poor O.K.	
4	Bridge wood 12' x 10'6" Concrete abutts.	Good	
5	Concrete M.B. 20" L.H.	O.K.	No race stop. H.R.
6	Concrete M.B. 20" L.H.	O.K.	
7	Concrete M.B. 20" L.H.	O.K.	
8	Bridge wood on steel rails Concrete sills 15' x 10'	Good	
9	Concrete M.B. 20" L.H. Concrete stop 4'6" wide 18" deep.	O.K. Poor	
10	Concrete pipe and head-frame outlet. 6' x 18" L.H.	Good	
11	Bridge wood 12' x 3'	O.K.	
12	Concrete M.B. 20" L.H. Prefab. concrete stop 5' wide, 16" high.	O.K. O.K.	
13	Wood M.B. 10" L.H. Concrete stop Prefab. 5' wide x 12" deep	Poor O.K.	
14	Bridge wood 13' x 12'	Poor	
15	Concrete M.B. 20" L.H. Concrete stop.	Fair Bad	Needs repairs to headframe. H.R.
16	Concrete M.B. 20" L.H.	O.K.	No stop. H.R.
17	Concrete M.B. 20" L.H.	O.K.	No stop. H.R.
18	Concrete Box Culvert 20' x 6'. Waterway 5' wide x 4' deep. Inlet and outlet wingwalls	Good Good	 Some old cracking, but solid.
19	Concrete M.B. 20" L.H. Concrete stop	O.K. Bad	

((Example of Race Inventory))

IDA VALLEY 40 YEAR RENEWAL PROGRAMME (FROM 1971)

	Dams	Div dams & weirs	Syphons	Pipe-lines	Pipe Xings	Road Xings	Farm Access	Race Controls	Turn-outs	Drop Structures	Race Sealing	Total ($)
Manorburn Poolburn	200 000											200 000
Upper Bonanza		31 800	10 000				3 200	1 000			80 000	126 000
Crawford Hills		5 000	16 200	1 100			1 600		11 200	11 200		46 300
Lower Bonanza						500	3 200		3 200			6 900
Poolburn			2 700			3 200	2 000		8 000			15 900
Poolburn Distribs						5 000	5 400		9 000	19 500		38 900
German Hills		35 000			7 200	12 800	20 000		36 000			111 000
German Hills Distribs					2 800	32 800	15 200		44 400	26 000		121 200
Syndicate			4 500		400	5 200	8 800		36 000	2 000		56 900
Syndicate Distribs				6 000		500	800		400	4 000		11 700
Blacks No. 3		50 000	800	12 500	4 000	8 800	15 200	1 000	42 400			134 700
Blacks No. 3 Distribs			12 000		3 200	18 000	12 000		21 600	9 600		76 400
TOTAL ($)	200 000	121 800	46 200	19 600	17 600	86 800	87 400	2 000	212 200	72 300	80 000	946 000

LOWER BONANZA RACE

This race starts from the Upper Bonanza Race at 34 395 feet, flows down a moderately steep grade in a channel cut mostly through broken schist rock and then down a natural gully until it enters the race proper at 10 500 feet.

It is cut in the main through schist rock in varying stages of decomposition which carried an overlay of soil which varies from a scanty covering on the sunny faces to an appreciable amount in gullies and on the dark faces.

Generally the waterway is in good condition but due to the porosity of the shattered rock of which the banks are composed it is subject in parts to excessive loss unless given constant attention.

The worst section is between 30 000 and 32 000 ft where parts of the bank need reconstructing.

The maximum economic capacity of the race is 0.7 m^3/s. Any water entered in excess of this amount results in the loss of up to half of the extra water entered.

Some of the water lost from the race is regained in the Blacks No. 3 race as the natural outflow of all water from the area through which the Lower Bonanza passes is crossed by Blacks No. 3 at 17 100 feet.

Any enlarging of the Lower Bonanza Race would be straightforward because of the few structures involved but would necessitate the use of explosives as all cutting would have to be done on the inside bank and through rock.

CRAWFORD HILLS AREA

Water supplied from the Upper Manorburn Dam is released from the Lower Bonanza Race at structure No. 23 at Lows Saddle and from this point flows down a dry gully.

At a point 1700 feet down this gully water is entered into the Crawford Hills Race and any water supplied to irrigators lower down continues on down the gully until it enters Dip Creek at 2700 feet and continues on down this creek for 19 500 feet to Tohills Intake Race from which three irrigators on the Galloway Scheme are supplied. No water from the Upper Manorburn Dam is supplied from Dip Creek below this point.

Between the point of entry of water to Dip Creek and Tohills Intake Race, two irrigators draw supplies.

1. At 7900 feet water is supplied through a hole into a break tank from which it is pumped.

2. At 9900 feet water is supplied from an open earth intake into a farm race.

Very little expense is incurred in maintaining the waterway in Dip Creek.

POOLBURN RACE

This race takes Upper Manorburn Dam water from the Blacks No. 3 race to the Poolburn Weir. It is used to irrigate land below it and supply water to the German Hills race. This helps to conserve storage in the Poolburn Dam.

The race 7870 m long and has a capacity of 0.7 m^3/s at its beginning, gradually reducing to 0.35 m^3/s when it enters the Poolburn Weir. The race proper starts at the outlet of the new syphon across Moa Creek and is cut mainly through fairly hard schist rock. The general condition of the waterway is very good and its banks are ample. One had feature of this race is the race stops at turnout boxes. Some of the turnouts have concrete stops and others have no stop. The condition of the existing stops is poor and therefore practically all turnouts are complemented by a heap of rocks in the race. These are functional but cause scouring of the race and should be replaced by larger concrete stops. The waterway through these stops should be the width of the race and the concrete floor of the stop should extend, say 2 m down the race.

GERMAN HILL RACE

GENERAL

The race starts at the outfall of the measuring weir at the Poolburn Diversion Weir.

The cutting is through schist rock until it reaches structure 24 where the country softens. From this point until its end, the cutting is mainly through soil, clay and soft sandy country with some short sections of light gravel fans.

Some sections show a lot of bank erosion and crumbling. The worst of these is between structure 36 and structure 45 where a lot of filling of the outside bank is necessary.

The ground here is very soft and it would be advisable to use a certain amount of gravel in the soil available on the site so as to establish a beaching effect and minimise the possibility of further undermining of the bank.

Gravel for this section and for any other isolated short sections would have to be carted from the nearest county pits in the area.

The general condition of the waterway is reasonably good considering that the normal seasonal cleaning out and tidying up has not yet been carried out.

STRUCTURES

Concrete Box Culvert Crossings

On this race there are 21 of these structures and their condition has been noted on the Walk-over report.

Their one significant weakness is in the inlet and outlet wingwalls which have broken away from the structure at, or near, their junction with the culvert proper. These walls are partly vertical and partly splayed.

No construction joints are evident and it appears that the entire structures have been made in one continuous pour and that no reinforcing has been used.

The floors of the structures are only about 75 mm thick and although there is a lot of old cracking evident in some cases no movement or scouring has occurred.

We recommend that when the damaged wingwalls are replaced they are well based and vertical but angled from the width of the culvert waterway to the full race-bottom width and solid floors are incorporated in their construction; also that "cut-off" walls are used at both inlets and outlets.

The present "safe" maximum flows sent through these races have been arrived at from experience gained over many years of operation.

This includes tributaries from Dovedale and Maori Creeks.

BLACKS NO. 3 RACE

Capacity to 1320 feet at outlet to Poolburn Race - 1.4 m^3/s. Capacity from measuring weir at 1455 feet is 1 m^3/s reducing gradually to 0.1 m^3/s at its termination where it enters a farmer's race at 82 040 feet.

From its beginning at 70 feet, the outfall of the Moa Creek measuring weir, the race is cut mainly through schist-rock which varies in nature from hard to entirely decomposed and soft, until it reaches the Crawford Hills Road at 18 820 feet.

From this point to its end the cutting is through soft country comprising sections of heavy and light gravel fans to soft clays and soil.

The width of the race is rather indeterminate except in the harder rock sections but it is evident that over the years it has become excessively wide in some sections.

It is very probable that losses through evaporation and seepage could be reduced if these sections were narrowed down to their original width.

These sections are between structure No. 28 and structure No. 45. From this point to its end, the race is in good condition except for short sections which have not yet had their normal seasonal cleaning.

The race banks, as apart from the waterway, are, in several places, lower than could be desired and gravel fill is to be carted in for their building up when access track conditions are suitable. It is also intended to cart fill for cover over pipe crossings at the same time.

STRUCTURES

Measuring boxes are mainly OK except for some wooden boxes which will all be replaced with concrete ones within the next two years.

Most of the crossings are of unreinforced concrete pipes with dry stone or stone and mortar head walls. The wingwalls and floors at the outlet end of the crossings appear to have been added after heavy scouring had occurred early in the race history. These are of dry stone and require yearly attention to keep them reasonably operational.

Here again we have a repetition of the conditions applying to the Syndicate Race, ie, the siting of crossing pipes on the race bottom, instead of half of their diameter below it, and creating a problem of scouring which could be avoided.

There is a further hazard with multiple pipe crossings (triple and double in this race, and double in the Syndicate Race) and this is their tendency to collect wind-blown debris, and I would recommend that their replacement should be made with concrete box culverts or concrete bridges which too will cause no restriction and added water-flow velocity with its resultant scouring at outlets.

There are no race stops in this race between point No. 14 and point No. 70 and rocks are used to raise the water to outlet level at the measuring boxes. However, a start has already been made on installing concrete stops in other races on the scheme and a full complement of these structures will eventuate as time and labour allows.

BLACKS NO. 3 RACE DISTRIBS

General

There are nine distributary races from the Blacks No. 3 Race and the general condition of their waterways is good and the banks are ample except in odd places where cattle-tramping has occurred.

This is a perennial problem and repairs are made during the normal off-season cleaning.

With the increase of cattle numbers on farms in this area, so the keeping of the smaller races in a reasonably operational condition must also increase, even up to the point of some form of protection becoming necessary.

As well as damage to race banks, measuring boxes are being broken through cattle ambling on and horning at the headframes. Damage from this has been minimised on some of the boxes on these distribs by using the lowest possible headframes.

Race Drops

Most of these distribs run more or less at right-angles to the main race and the excess fall on them has been controlled by installing stone pitching. Over the years of usage these have, in the main, been successful and with some yearly repairs have remained operational though by today's standards would be considered unsightly and outmoded.

We have not recommended their replacement with concrete steps as we consider that, due to the small amounts of water in the races, they present no serious or immediate hazard.

SYNDICATE RACE

Capacity 0.37 m^3/s reducing gradually to 0.04 m^3/s at its entry to a farm race at 87 760 feet. Waterway about 2 m wide and 0.4 m deep reducing to 1 m wide 0.3 m deep.

The race leaves the Lower Bonanza Race at 40 920 feet, flows down a scoured channel over a schist rock outcrop into a natural gully and enters the race proper at 4250 feet. It then flows along the foot of the Raggedy Range on the left hand side of the Ida Valley Irrigation Scheme until its termination at 87 760 feet.

The general condition of the race is good and the banks are ample.

STRUCTURES

With the exception of some wooden boxes which are under replacement with concrete ones, the measuring boxes are OK.

Crossings are mainly of unreinforced concrete pipes with drystone or stone and mortar headwalls. One bad factor in the placing of the crossings is that the pipes are sited on the race bottom and not the accepted one half of their diameter below it and the resultant increase in water velocity has caused scouring at the outlets.

Although this race is well over 50 years old no concrete stops have been installed in the upper end of this race and heaps of rock have been used in their stead. This lack of stops could be due to an expectation that the race would be running to capacity at all times, or to a failure to make provision for a probability. It is intended that stops will be put in the race as time and labour permit.

SYNDICATE DISTRIBS

GENERAL CONDITION

No. 1 Distrib

The waterway is reasonably good and the banks are ample.

The only problem in this race is the stone-pitched drops. We recommend that eventually these should be replaced in concrete from the start of the race to Noone Road and that from this point they should be replaced with a concrete pipeline down Noone Road to the point where the race turns right and enters a farm paddock.

There would have to be two breaks in the line to allow for the installation of "turnouts" and the total length of the line would be 500 m (1600 ft).

No. 2 Distrib

The water is carried wholly in a concrete pipeline from the turnout in the Syndicate race to its entry into a farm race on the right hand side of the Poolburn-Auripo Road.