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IDA VALLEY IRRIGATION SCHEME

SUPPLEMENTARY SUPPLY FROM HOPES CREEK

1. EXISTING IDA VALLEY SCHEME

1.1 Description of Established Scheme

The existing scheme, the second largest irrigated area in Central Otago, was built around an old mining system between 1912 and 1916, the first water being supplied in 1917. The scheme was designed to utilise the average runoff of the Manorburn watershed to irrigate 12,000 acres in the Ida Valley, the Upper Manorburn reservoir, completed 1914 to replace the old mining Greenland dam, providing equalisation of flow. From here water was to be carried to Hallidays Flat by the Upper Bonanza race, whence portion would be dropped down Moa Creek and portion would be carried on to Lows Saddle by the Lower Bonanza race.

Diversion weirs were built in Moa Creek and the Poolburn, these being linked by a new race, the former supplying Blacks No. 3 race along the western side of the valley and the latter the German Hills race on the eastern side. From Lows Saddle water is taken to the Syndicate race also along the western side of the Ida Valley and also down Dip Creek to the Galloway scheme.

In 1931 the Poolburn dam was completed providing employment through the depression years and additional storage for the scheme.

1.2 Water Requirements

At present the Manorburn-Poolburn reservoir and race system supplies a total of 12,357 acres in the Ida Valley with 18" water quota and 1515 acres in the Galloway scheme. This latter area has quotas varying from 20 to 30 inches, with a total annual requirement of 1515 cusec-days. The total annual requirement of the system, with 9270 cusec-days in the Ida Valley area, is 10,784 cusec-days, 3610 of which are to supply the 4817 acres allocated to the Poolburn source.

Losses in the race system average between 15% and 20% due to the rocky nature of the country and to the high velocities in some of the races. Taking a value of 17%, the water requirement at source of supply is about 13,000 cusec-days per season to give full quota to the scheme.

1.3 Manorburn and Poolburn Reservoirs

The Manorburn dam is a concrete arch structure 88 ft high and 387 feet long impounding a lake of 41,310 acre-feet and 1745 acres maximum area. A similar structure 83 ft high and 535 ft length provides 21,000 acre-ft of storage in the Poolburn over a maximum area of 1,120 acres. Between them the two reservoirs provide about 31,300 cusec-days in storage.

In the period to the end of 1945 the Manorburn catchment provided a net average yield of 10,015 cusec-days per season and the Poolburn 3045 cusec-days. This total of 13,060 cusec-days is sufficient to maintain full quota with 17% losses without considering additional gain from streams. At the beginning of October 1945 both dams were overflowing with 31,250 cusec-days in storage.

From October 1945 to September 1966, which includes the very wet 1957/58 period, a total of 160,600 cusec-days was drawn from the Manorburn reservoir and 53,200 from the Poolburn reservoir.

Also in this period the amount of water in storage between the Manorburn and Poolburn dams decreased by 6,000 and 6,800 cusec-days respectively. The net yields of the two catchments over the 21 year period are 166,600 and 60,000 cusec days respectively, or 7930 and 2860 cusec-days per year mean. This would provide an annual total of 10,790 cusec-days, 2,210 cusec-days less than requirement.

Full results of supply from Manorburn and Poolburn reservoirs, storage changes in the dams and net catchment yields are tabulated in Section 1.5.

1.4 Supply and Demand

Up until the 1945/46 season there had been sufficient water to satisfy all demands except in the 1929/30, 1930/31, and 1941/42 seasons when some rationing was necessary. Since then the catchment net yields have been considerably lower and despite two wet years 1957/58 the mean has been below requirements. Although both dams were full in 1945 and spilling between July and October the runoffs in the following years were very low resulting in severe rationing reaching peak in the 1950/51 season.

Matters improved somewhat following 1958, both dams filling to spill during the year, but the incentive to conserve water by a reduction in charges according to the amount saved has remained in force. Post 1958 figures where not all the water offered has been used, probably reflect this.

Full details of supply offered and percentage of quota used each season are tabulated in Section 1.5.

1.5 Tabulated Data

The following table shows the amount of water drawn from each reservoir over irrigation seasons 1945/46 to 1965/66 (21 years), the storage in the two dams on various dates and calculates the effective net catchment yields. All figures in cusec-days. The last 2 columns show the percentage of quota offered to each season and the percentage actually drawn.

	Manorburn Supply	Manorburn Storage	Net Yield	Poolburn Supply	Poolburn Storage	Net Yield	Offer	Drawn
1.10.45		20,850			10,400			
1945/46	9491			2657			-	-
1946/47	12307			4312			-	-
1947/48	10015			3537			85%	-
1948/49	5486	37,299		2054	12,560		46%	-
		16,449			2,160			
15.9.49		8,400	24,849		3,100	5,260		
			(6,200)			(1,320)		
1949/50	8909	8,909		2896	2,896		68%	-
		509			204			
8.9.50		1,870	2,379		480	276		
1950/51	2296			571			17%	-
1951/52	9968	12,264		2167	2,738		82%	-
		10,394			2,258			
30.9.52		6,114	16,508		3,267	6,525		
			(8,250)			(3,260)		
1952/53	7646	7,646		2652	2,652		67%	-
		1,532			615			
30.9.53		8,259	9,791		3,881	3,266		
1953/54	8779			3163			79%	-
1954/55	4909	13,688		1461	4,624		34%	-
		5,429			743			
30.4.55		430	5,859		225	968		
			(2,930)			(480)		
1955/56	7602			3127			75%	-
1956/57	3537			1107			40%	-
1957/58	4487			1000			100%	46%
1958/59	9490			3884			100%	93%
1959/60	8866			3836			100%	94%
1960/61	5662			2326			75%	58%
1961/62	8123			3383			100%	86%
1962/63	7871			3477			100%	88%
1963/64	7983	63,621		1896	24,036		75%	74%
		63,191			23,811			
8.9.64		9,766	72,957		2,089	25,900		
			(8,100)			(2,880)		
1964/65	6732	6,732		1317	1,317		75%	66%
		3,034			772			
3.9.65		15,204	12,170		4,034	3,262		
1965/66	8433	8,433		2348	2,348		100%	84%
		6,771			1,686			
1.9.66		14,662	7,891		3,743	2,057		
TOTALS:	160,592			53,171				

2. HOPES CREEK HYDROLOGY

2.1 Available Data

Basic data comes from the weir site in Hopes Creek some 30 chains downstream of the "Stone Hut". At this point a temporary weir was installed in February 1950, a permanent one a few months later and a recorder in January 1951. Results from these charts are fully tabulated in Alexandra file 15/11/5/1.

Readings commence with the recorder installation at the beginning of 1951, although occasional staff gauge readings were taken prior to this, and are available to May 1965. In all over this 168 month period, 4867 days of record are available, 9 months having no worthwhile record and 14 months with incomplete records. In analysis of readings daily level readings are converted to flows using an established rating curve, although it is not known what the basis was for the gauge height reading.

2.2 1955 Report

Previous analysis of readings from Hopes Ck was carried out by J.D. Watt for the above report, his period of record being from May 1950 to July 1955 (working in seasons May-April). This work is summarised in the following paragraphs so that comparisons may be made.

Over the above period the total yield from the Hopes Ck catchment was 56,980 acre-feet, compared with a net yield of 75,530 acre-ft in the Manorburn dam. The average percentage of Hopes Ck yield to Manorburn net yield is 75.4%, the figure of 75% being accepted and applied to Manorburn results over the 10 years to 30.4.55.

Other work in the report deals with particular proposals rather than general terms. It is noted however that comparative gaugings were made at the "Upper Tunnel" scheme (14.7 sq.miles) and at Stone Hut (23.7 sq. miles) between 24.3.50 and 11.6.51, flow at the former site being 74% of the latter. Also 85% is taken as ratio of flow to the proposed race intake (18.5 sq.miles). All three sites are related to Manorburn net yield by the percentages 57 at the Upper Tunnel site, 64 at the race intake and 75 at the Stone Hut.

2.3 Tabulation of Data

The available data from Hopes Creek is presented in tabulated form, first as a summary by years, and second as a summary by months. These tables show duration of flows in days, the peak flow (higher than 100 cusecs), the mean flow and the total runoff in cusec-days.

Year	Days of record	Flow Duration Days in which Flow Lay Within Range 0-5	5-10	≥10	≥25	≥100	Peak Flow	Mean Flow	Total Flow
1951	356	100	17	239	121	4	517	25.2	8714
1952	365	106	92	167	42	1	121	13.0	4727
1953	365	107	67	191	78	4	161	17.5	6384
1954	306	161	77	68	15			7.0	2138
1955	304	161	43	100	29			9.5	2898
1956	366	159	59	148	34			10.2	3745
1957	365	29	35	301	175	22	517	37.2	13557
1958	330	32	76	222	74	19	415	27.5	9098
1959	365	128	69	168	44	5	144	13.8	5023
1960	336	113	56	167	71	5	133	15.4	5183
1961	351	84	104	163	37	3	169	14.5	5066
1962	344	71	83	190	75	3	154	20.8	7162
1963	201	112	33	56	5			11.6	2334
1964	364	144	115	105	7			9.1	3313
1965	149	6	19	124	69	5	231	34.0	5062
TOTALS:	4867	1513	945	2409	876	71			84404

These figures give a mean flow of 17.4 cusecs over the period, equivalent to about 0.7 cusecs per sq. mile off 23.7 sq. miles, and an annual runoff over 365 days of 6300 cusec-days. The average duration shown by the flow is that it exceeds 5 cusecs 69% of the time, 10 cusecs 50%, 25 cusecs 18% and 100 cusecs 1.5% of the time.

The 695 day period 1957-1958 shows as being considerably wetter than the remaining years of record. Taking out this period, the remaining 4172 days of record gives a total runoff of 61749 cusec-days or a mean flow of 14.8 cusecs (about 0.6 cusecs per sq. mile). The duration is altered also to time exceeding 5 cusecs 65%, 10 cusecs 45%, 25 cusecs 16% and 100 cusecs 0.7%

Month	Days of Record	Flow Duration Days in which Flow Lay Within Range 0 - 5	5-10	≥10	≥25	≥100	Peak Flow	Mean Flow
Jan	456	297	81	78	21	3	205	9.4
Feb	421	322	54	45	15	1	242	7.9
Mar	465	265	65	135	40	5	231	11.2
Apr	450	205	87	158	43	10	415	13.4
May	453	83	81	289	115	16	517	25.1
Jun	361	0	87	274	116	16	415	29.7
Jly	304	0	48	256	114	4	169	24.4
Aug	368	9	8	351	161	7	161	29.1
Sep	371	0	19	352	114	2	133	24.0
Oct	403	23	186	194	60	2	121	15.4
Nov	383	122	126	135	38	3	161	12.3
Dec	432	187	103	142	39	2	205	12.6
TOTALS:	4867	1513	945	2409	876	71		

Looking at the October to March period, the 2506 days of record with a total runoff of about 29,180 cusec-days, give a mean flow of 11.4 cusecs. This spread of the 182 day 6 monthly period gives available water as 2080 cusec-days. Over this period the flow exceeded 5 cusecs 52.5% of the time, 10 cusecs for 28.5%, 25 cusecs for 8.5% and 100 cusecs for 0.6% of the time.

On the other hand the April to September period with 2307 days of record and a total flow of 55180 cusec-days, gives a mean flow of 24.0 cusecs or 4400 cusec-days over the 183 day period. The duration in this case gives 5 cusecs exceeded 87% of the time, 10 cusecs 73%, 25 cusecs 29% and 100 cusecs exceeded 2.5% of the time.

2.4 Summary of Results

These results above may be further summarised as in the table below, the catchment area being taken as 23.7 sq. miles at the Stone Hut, a standard year of 365 days being used, the irrigation season being considered as 200 days but using the figures for October to March inclusive.

	1951-1965	Irrigation Season	Off Season	1951-1965 minus 57.58
Mean Flow (cusecs)	17.3	11.4	24.0	14.8
Total Flow (cusec-days)	6300	2280	4960	5400
Time flow exceeded:				
5 cusecs	69%	52.5%	87%	65%
10 "	50%	28.5%	73%	45%
25 "	18%	8.5%	29%	16%
100 "	1.5%	0.6%	2.5%	0.7%
Runoff per sq.mile	0.73	0.48	1.01	0.62

3. DIVERSION OF HOPES CREEK

3.1 Basic Alternative Schemes

Means of diverting water from Hopes Creek into the Manorburn dam or the race system coming from it may be considered in the following alternatives:

(1) tunnel direct from Hopes Creek to Manorburn dam
(2) open race from Hopes Creek to Manorburn dam with or without major dam
(3) combination of race and tunnel feeding Manorburn dam
(4) race from Hopes Creek to the Upper Bonanza Race
(5) combination of race and tunnel to the Upper Bonanza Race

In the consideration of these various alternatives the amount of water available for diversion, determined by the intake level in Hopes Creek, and the use of Manorburn dam to store off season supplies, this determining the intake level in Hopes Creek, become the critical points. No worthwhile storage is available in Hopes Creek, meaning that, unless Manorburn dam is used, only summer flow is available for irrigation. In addition to this the higher intake level the less contributing catchment can be used.

All the above scheme alternatives may be used in conjunction with a dam for increasing head and hence capacity in the

case of the direct tunnel, or for lifting the level for the race intake. In both cases a certain amount of storage would be available.

In the 1955 report J.D. Watt reduces the above possibilities to three based on alternatives (1), (4) and (5), however, all will be looked briefly again. An earlier report in 1949 examined additional proposals including a new dam in the Manorburn downstream of the existing one.

3.2 Tunnel or Race

Although a considerably more expensive form of construction, tunnelling has certain advantages over open race in this country and as far as this scheme is concerned. With the high level of diversion works construction and maintenance of above ground structures would be difficult during the winter.

Construction of open race would involve relatively longer lengths of access roading, the race being cut into rock which would result in high losses probably. On the other hand tunnelling should be relatively straight forward in this type of country, although with the foliated nature of the rock a considerable amount of overbreak could occur. In certain areas schist breaks down completely on contact with air and allowance for concrete structural lining should be made over portion of the length of any tunnel.

Race by its nature is limited in its capacity thus causing the loss of the higher flows unless some storage is provided. A tunnel on the other hand will work under head and in conjunction with a comparatively small dam will pass quite high flows. Thus at any particular point the water diverted by tunnel will be greater than that by open race. Also open race is subject to both seepage and evaporation losses, amounting to about 0.5% per mile, although this could be made up by picking water up from streams crossed by the race.

Maintenance of a race diversion scheme would be expensive, requiring the employment of at least one extra raceman and from experience with the high level Mt Ida Race, would require almost continuous repair. In studies of possible schemes it is assumed that all water available would be diverted, but with an open race this is not possible due to the necessity to shut the system down for cleaning etc. This whole cost would be born by the scheme. On the other hand tunnelling would require a high capital cost, interest on this being charged against the scheme, but maintenance would be negligible and the diversion would largely be self-operating.

3.3 Upper Tunnel Scheme

This is the scheme detailed by J.D. Watt in the 1955 Report and involves a 37 ft high concrete arch dam (map reference S144:329258) and 16000 ft of tunnel to the reservoir (map reference S144:331258/386266). The dam would impound about 600 acre feet to a crest level of 2452 ft, or 4 ft above Manorburn crest level of 2448 ft. A tunnel of 1 in 1000 grade with invert level at intake of 2415 ft and cross-section 7'6" x 6', would carry 25 cusecs with both dams full, and 80 cusecs without heading up.

The catchment area at the dam site is 14.7 sq. miles at which point, reducing the flow of 17 cusecs mean at Stone Hut weir in proportion to the catchment area, a mean flow of 10.5 cusecs would be available. This gives a total annual of 3840 cusec-days of water available, say 3500 available for diversion.

At cost index 270 this scheme is estimated as follows:

Driving tunnel 7'6" x 6' section, 16000 ft at £22	352,000
Lining tunnel 3000 ft allowed at £30	90,000
Dam and intake excavation	1,300
Dam and intake concrete 500 cu.yd at £34	17,000
Access roading 7 miles at £1000	7,000
Culverts, etc.	1,000
Accommodation	8,000
Supervision and contingencies 10%	47,600
	£523,900

This gives a unit cost of £150 per cusec-day supply.

3.4 Lower Tunnel Scheme

This scheme is mentioned by J.D. Watt in the 1955 Report but rejected apparently on the basis of the magnitude of works above ground. The scheme is shown in detail on Alexandra drawings 930 (reservoir and dam sites) and 130 (tunnel line). Basically a dam of height 110 ft., storing 1000 acre-feet at a crest level of 2454 ft and an 11,200 ft tunnel are required. (Map ref. dam S144:337295 and tunnel S144:340290/378289). The tunnel would be similar to that above but would have an invert level at intake of 2390 ft, storage behind the dam being negligible below this level.

The catchment area contributing at this point would be slightly greater than that above, say 16 sq. miles, giving a mean flow of 11.5 cusecs and total annual of 4200 cusec-days. Say 4000 cusec-days available for diversion.

At cost index 270 this scheme is estimated as follows:

Driving tunnel 7'6" x 6', 11,200 ft at £22	246,400
Lining tunnel 2500 ft allowed at £30	75,000
Dam and intake excavation	7,000
Dam and intake concrete 4000 cu.yd at £34	136,000
Access roading 5 miles at £1000	5,000
Culverts etc.	700
Accommodation	10,000
Supervision and contingencies 10%	48,000
	£528,100

This gives a unit cost of £132 per cusec-day supply.

3.5 Race Supply Schemes

It is possible to bring water into Manorburn reservoir by race around the contour on the Manorburn-Hopes Ck ridge. Such a race however, would be about 35 miles long and, with the crest level of Manorburn dam at 2448 ft, would require an intake at about 2650 ft.

At this level an alternative scheme is possible, carrying water from Hopes Creek to a 2610 ft saddle (map ref. S144:367292) between the two catchments and allowing it to follow a natural watercourse to the Manorburn reservoir. In this case about 15 miles of race is required with an intake in Hopes Ck at slightly lower than 2700 ft.

The catchment area contributing at this level is only some 4 sq. miles, giving a mean flow on the same basis as before of 3 cusecs and total annual water of 1100 cusec-days. With a 15 cusec race almost the whole of this could be carried. In dry seasons there would be little or no water available for such a diversion.

Again on cost index 270, this proposal is estimated as follows:

Intake weir, piping up initial section etc.	5000
Race siding out of Hopes Ck 7 miles at £1500	10500
Race siding to saddle 10 miles at £850	8500
Stream crossings, major with intake 10 at £80	800
Stream crossings, minor 35 at £40	1400
Access bridges 5 at £800	4000
Spillways 4 at £120	480
Access roading 17 miles at £1000	17000
Accommodation	7000
Supervision and contingencies 10%	5470
	£60,150

This gives a unit cost for 900 cusec-days diverted of £67 per cusec-day.

3.6 Race and Tunnel Schemes

The possibility mentioned in the first paragraph above can be varied using a relatively short tunnel and cutting off considerable lengths of race. Thus a 2500 ft tunnel (map ref S144:357343/362350) would cut off about 7 miles of race, while a 4000 ft tunnel (map ref. S144:355331/370329) would cut off a total of 12 miles of race. Neither proposal would give a decrease in capital cost but maintenance cost and difficulty would be reduced, as would losses and access roading required.

A further possibility exists with a 5200 ft tunnel at 2500 ft level under the saddle previously mentioned (map ref. S144:356292/373288) and spilling into a natural watercourse feeding Manorburn reservoir. This is a somewhat longer tunnel again and only requires an additional 3 miles of race to reach the site of the 4000 ft tunnel.

These three proposals involve 29 miles of race and a 2500 ft tunnel to give an intake at about 2600 ft, 20 miles of race and a 4000 ft tunnel to give an intake at 2560 ft or 16 miles of race and a 5200 ft tunnel to give an intake at 2560 ft. At 2600 ft the catchment area contributing is about 6 sq. miles while at 2560 ft about 8 sq. miles, the mean flows at these points being 4.3 cusecs and 5.7 cusecs respectively. Thus about 1300 cusec-days and 1700 cusec-days would be available each year for diversion.

The longest tunnel scheme is estimated to cost as follows:

Intake weir, initial piping etc.		5,000
Race sidling out of Hopes Ck	13 miles at £1700	22,100
Race sidling to tunnel mouth	3 miles at £1100	3,300
Driving tunnel	5200 ft at £18	93,600
Lining tunnel	1000 ft at £25	25,000
Stream crossings	40 at £50	2, 000
Access bridges	6 at £800	4,800
Access roading	14 miles at £1,000	14,000
Accommodation		9,000
Supervision and contingencies 10%		17,900
		£196,700

This gives a unit cost of £115 per cusec-day diverted. This compares with a total cost of £185,800 and unit cost of £109 for the 4000 ft tunnel and costs of £148,700 and £104 for the 2500 ft tunnel.

3.7 Race to Bonanza Race

This proposal is fully discussed by J.D. Watt in the 1955 report and details given of the scheme. Briefly it involves an intake in Hopes Creek at about 2250 ft., 8 miles of race and a pipeline across the Manorburn to the Bonanza race.

Only flow during the irrigation season is available for this race, amounting to 2100 cusec-days over the period October to March (182 days) at Stone Hut weir, equivalent to a mean flow of 11.5 cusecs. At the race intake some 18.5 sq. miles are contributing giving mean available water of 1620 cusec days or say 1200 cusec days for diversion by 25 cusec race.

The estimate for this scheme is brought up to cost index 270 as follows:

Intake weir and gates		1,300
Pipe lines 30" dia	2450 ft at £8	19,600
Pipe lines 24" dia	450 ft at £7	3,150
Race 4 miles at £1700		6,800
Race 4 miles at £1100		4,400
Culverts under race	15 at £40	600
Race crossings	3 at £800	2,400
Accommodation		6,000
Access reading 4½ miles at £1000		4,500
Supervision and contingencies 10%		4,800
		£53,550

This scheme can be used in conjunction with a 43 ft dam at the site of the Upper Tunnel scheme dam, such a structure providing about 1200 acre-feet from storage. The estimate for this is also updated to cost index 270.

Arch dam concrete in place	500 cu.yd at £34	17,000
Excavation		3,000
Concrete core subsidiary dam	40 cu.yd at £34	1,360
Earth embankment	500 cu.yd at £1	500
Access road 2 miles at £1000		2,000
Supervision and contingencies		4,000
		£27,860

These two schemes, with or without the dam, give unit costs of £45 per cusec-day and £48 per cusec-day respectively.

3.8 Race and Tunnel to Bonanza Race

This proposal is also fully discussed by J.D. Watt with various alternatives, the adopted scheme involving a 100 ft high dam downstream of the Stone Hut weir, a tunnel to the Manorburn and pipe and race link to a relocated Bonanza race. With a crest level of 2018 ft and draw down level of 1985 ft the dam would provide 7000 acre-feet of usable storage.

A 8650 ft tunnel of 7'6" x 6' section and capacity 70 cusecs would lead directly to the Manorburn valley, whence a pipe and race connection would be made to the relocated Bonanza race. This last item is estimated to cost, on index 270, some £60,000.

The whole of the Stone Hut weir mean flow is available at this intake, amounting to some 6,300 cusec-days at 17.3 cusecs mean flow. However, as 4000 cusec-days mean occurs during the off season a lower figure of 4500 would seem a better estimate of divertable water.

The proposal is estimated as follows:

Excavation for dam foundations	7,500
Dam concrete 14,000 cu.yd. at £30	420,000
Driving tunnel 8,650 ft at £22	190,300
Lining tunnel 1,600 ft at £30	48,000
Race excavation 100 chns at £50	5,000
Manorburn siphon 36" dia 1800 ft at £9	16,200
Access roading 4 miles at £1000	4,000
Accommodation	8,000
Supervision and contingencies	70,000
	£769,000

This gives a unit cost for the scheme of £171 per cusec day, or, if the Bonanza race relocation is considered as well, £184 per cusec-day.

3.9 Comparison of Alternatives

A tabulated comparison of the various alternatives follow, the mean supply in cusec-days possible each year being shown in relation to the unit cost, (capital cost over supply) and total annual charge per cusec day to be borne by the scheme.

Description of Scheme

	Supply cusec-days	Capital Cost £	Interest £	Mainten. £	Renewal £	Cap.Cost/ Supply	Charge per C.D. £
1. Upper tunnel scheme - 16000 ft tunnel:	3500	523,900	6,550	nil	500	150	2.0
2. Lower tunnel scheme - 11200 ft tunnel:	4000	528,100	6,600	nil	500	132	1.8
3. Race supply over saddle:	900	60,150	750	2,500	750	67	3.8
4. Race and 5200 ft tunnel:	1700	196,700	2,500	2,000	1,300	115	2.8
5. Race and 4000 ft tunnel:	1700	185,800	2,300	3,000	1,250	109	3.5
6. Race and 2500 ft tunnel:	1300	148,700	1,900	3,000	1,250	104	3.9
7. Race to Bonanza Race without dam:	1200	53,550	670	2,500	1,300	45	2.8
8. Race to Bonanza Race with dam:	1800	81,410	1,000	2,500	1,300	48	2.1
9. Tunnel and Race to Bonanza Race	4500	769,000	9,600	2,000	1,500	171	2.7

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