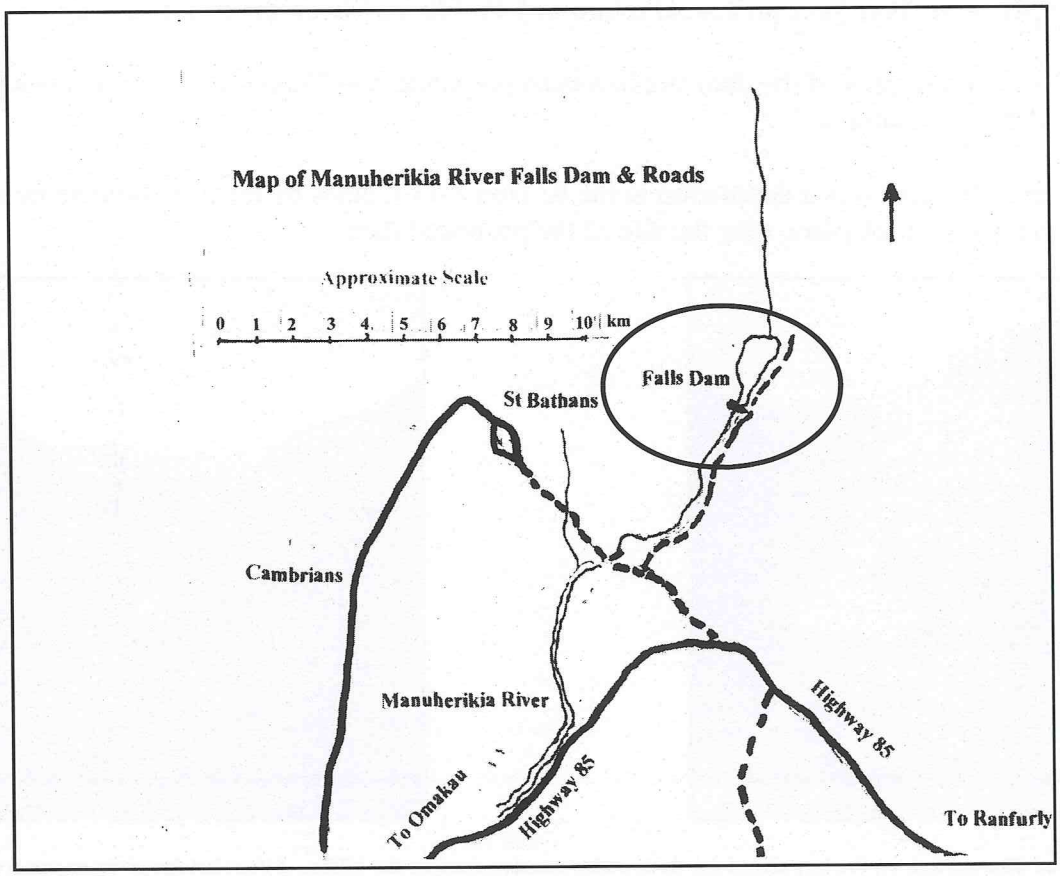
Falls Dam

Manuherikia River

Rock Fill Concrete faced dam	
Completed	1935
Height Above Stream bed	110ft
Length of Crest	510ft



Falls Dam

Upper Manuherikia River

This account is compiled from the Construction Report by J. T. Gilkison to the Society of Civil Engineers 1936-7, and the Public Works Department Files held by NZ Archives in Dunedin

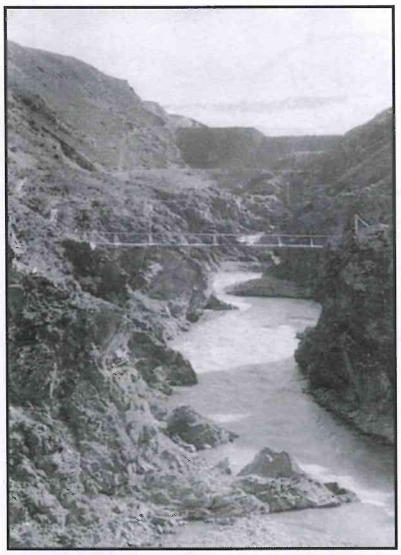
The original proposal

The Falls Dam was reported on in 1924 by J. R. Marks the Resident Engineer of the Public Works Department in Alexandra. He costed three dam proposals, £346,000 for a gravity dam, £261,000 for an arch dam, and £247,000 for a variable arch dam. These costs would refer to a high dam.

The total cost of the Manuherikia Irrigation Scheme was estimated to be £866,000 with revenue of 16 shillings an acre on 64,000 acres irrigated but offset by maintenance costs of 2 shillings and sixpence per acre. This gave an annual return of £43,000 or 5% on the capital outlay.

By 1925 a contour plan of the dam site had been prepared, and Head Office ordered test pits to be dug to test the foundations.

In March 1926 there was a deputation to the Rt Hon J. G. Coates by local runholders in support of the scheme, which took place near the site of the proposed dam.



The photograph on the left shows the dam under construction in the 1930s. A foot bridge gives access from the camp area to the right hand side of the dam. On the right, a similar view today with the rock dam and the Hawkdun Range behind.

Decision made to proceed

A decision was made to build a gravity dam in 1931, when there was a need to engage as many unemployed men as possible. It was estimated that a concrete dam would have had a 40% labour content compared to 60% for a rock fill. The other factor was the possible future raising of the dam to provide more storage. A rock fill dam could still be raised, if required, and it was the preferred option. The funding for the dam was to be spread over four years as this would allow a single shift over part of the construction period.

No economic analysis of the cost and return of the Upper Manuherikia Irrigation scheme was on the file nor any estimate of the cost of the dam. Also there were no letters setting out the terms of employment for the workers by the Unemployment Board.

Location of the dam

J. T. Gilkison in his Construction Report stated that the site for the dam was fairly definitely fixed. It would be positioned where the river, after flowing across some eight miles of gravel flat, cut through a gorge in the Home Hills before reaching the open Manuherikia Valley. The dam was built to a spillway level of 1840 feet with a storage capacity of 4200 day heads. The gorge marks the junction of the schist rock downstream and the greywacke upstream and the dam was located at the upstream end of the gorge. Here the rock is intermediate between a hard blue greywacke and the crushed and shattered rock in the vicinity of the junction with the schist.

The construction of the Falls Dam was started after the Poolburn and Idaburn Dams were completed. Access to the site was gained by constructing a road three miles long from the Oturehua to St Bathans Road. This road and the road to a sand pit, a heavy traffic bridge across the river, a 100 ft long suspension foot bridge and access tracks around the works, were built at a cost of £3,554. The rail head for supplies was Oturehua which is 100 miles from Dunedin. A contract for carting supplies the twelve miles to the dam was six shillings per ton.

Construction starts on the dam

In 1931 F. W. Lindup, the Public Works Department Resident Engineer at Alexandra, requisitioned drilling gear, compressors and railway track material to be sent to the dam site. The establishment of the camp and construction works would have been carried out during 1931.

In his Engineering Paper J. T. Gilkison referred to the transfer of the two 75KW diesel engine generators from the Poolburn Dam together with other plant, and it is presumed that the camp from the Poolburn Dam was shifted also. Work at Poolburn was completed in May 1931.

By November 1931 excavation work at the Falls Dam had established that there was 16ft of overburden at the upstream toe of the dam site.

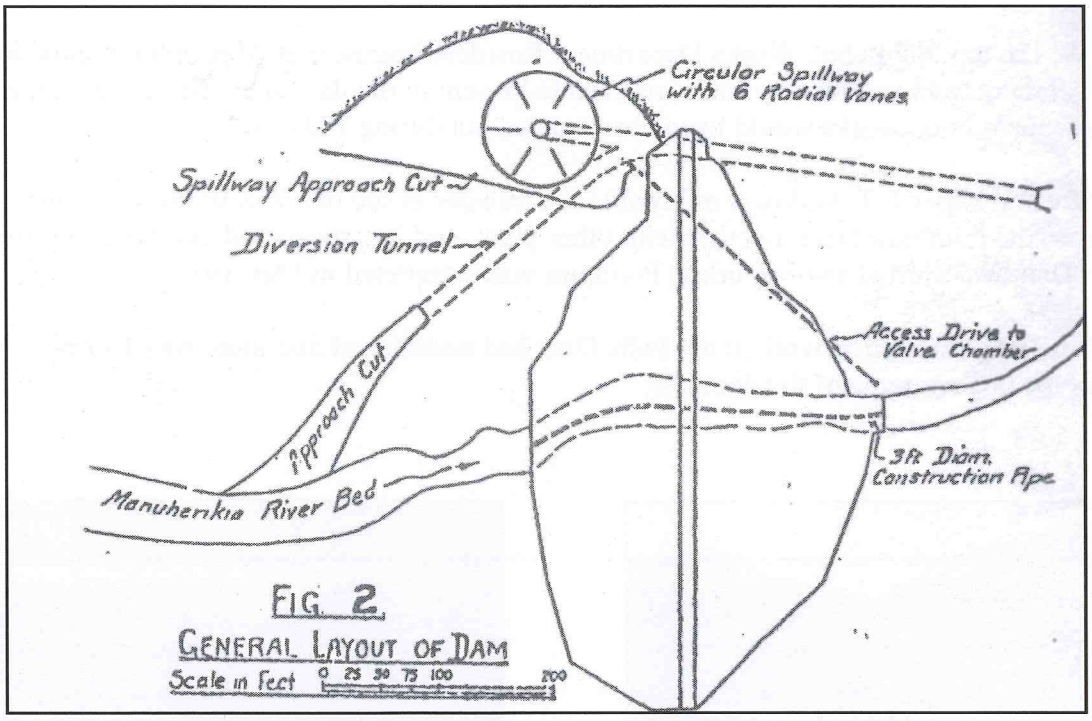
The camp and construction buildings in the 1930s. In the foreground is the diesel generator on the right, and cookhouse on the left. Behind these buildings are two houses and the workers tents are at the rear left.

The same flat area today. On the right of the road the rear willow trees are located around the foundations and chimneys of the two houses, which are the last remnants of the construction camp.

A letter from the District Engineer in Dunedin T. M. Ball to the Permanent Head Public Works Department Wellington in December 1931, stated that they had now placed 170 men at the Manuherikia Dam and this number was the limit that they could economically place. He requested permission to start the race work for the Omakau Irrigation Scheme and establish a depot and camp at Omakau. (It appeared that J. R. Marks had moved from the Dunedin District at this stage.)

Prior to this letter F. W. Furkert had been interviewed by W. Bodkin MP and asked if fifty of the most deserving married men on the local unemployment list could be placed on the scheme. Furkert told Bodkin that the men being placed had come from discontinued railway works. This would explain why the Government had given approval for the dam to proceed in 1931. J. T. Gilkison, who had been a site engineer at the Poolburn Dam in 1931, relocated to the Falls Dam in January 1932.

In February 1932 there is a letter from Wilson Hull to the Resident Engineer in Alexandra requesting permission to show pictures in the dining room at the camp. He would provide a projection room in the front of the building and pay any costs. The charge for admission would be one shilling and sixpence. The letter was referred to the District Office where reference was made to the tunnel excavation being in progress and the running of the diesel engines. With electricity operating, his cost per showing would have been two shillings and sixpence. His sole right for screening was approved.



This plan from the Engineering Paper presented by J. T. Gilkison shows the general layout in a simplified form. Early work was undertaken on the river bed and quarry on the left bank, but the diversion tunnel had to be completed before the dam could be formed across the river bed.

Early work on the dam as described by Gilkison

Excavation of the diversion tunnel was started in 1931, at the same time as the stripping of the dam area, the quarrying and placing of rock to the edge of the river was being carried out.

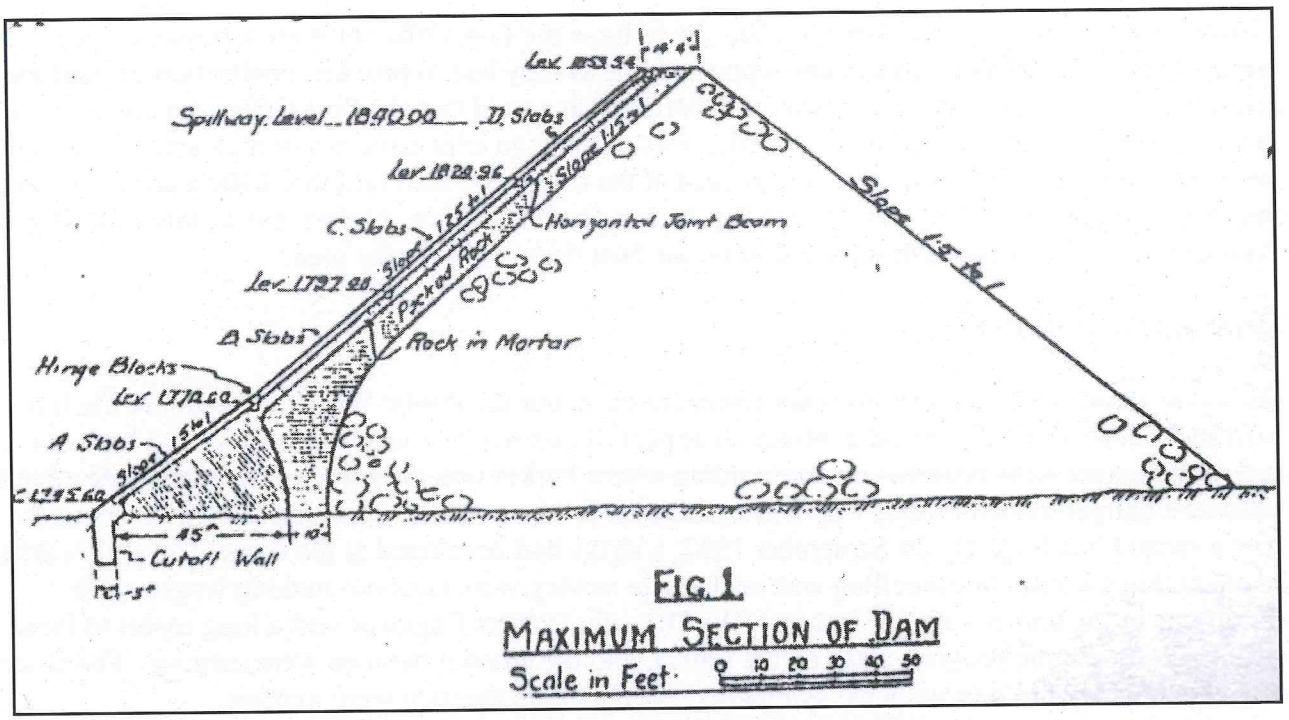
When the river had been diverted into the tunnel, a three foot diameter reinforced concrete pipe line was concreted into a trench excavated into the old river bed.

Work then proceeded on placing the rock in the dam, building a cut off wall, and installing the concrete face on the upstream wall. A quarry was established on the east side of the dam to provide rock for the bank, aggregate for the concrete and to clear a site for the spillway.

A circular concrete spillway was constructed and a vertical shaft provided to connect it with the diversion tunnel below. At a low flow period, the water was again diverted from the diversion tunnel to allow trash racks to be fitted, and a concrete plug and valves to be installed in the tunnel. The final operation consisted of sealing the upstream end of the three foot pipe under the dam.

A diagram showing the deflection of the upstream face shows filling of the dam took place in early November 1935. This is confirmed in a letter of protest in the Public Works Department file, by the Maniototo County Council claiming insufficient warning had been given before the diversion valve was closed on the 27 November 1935.

In the Public Works Department file there was a proposal by Head Office to install a 42 inch pipe below the tunnel floor to provide 120 cusecs for power generation purposes. At this stage the dam was planned to be much higher. The pipe size was later reduced to 36 inches and then deleted for the lower dam adopted in April 1932.



This diagram shows the components of the dam across the centre section. The upstream face has concrete slabs across it to form a water seal for the dam. This concrete was poured against stacked rock faced with a layer of rock in mortar.

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The accommodation for workers at Falls Dam. The standard of huts had improved from the Upper Manorburn days. Though still with canvas roofs and sides, the huts now have wooden floors. Huts are shown being assembled in the foreground. The camp had some married accommodation which joined two huts with a porch in the centre.

Postal services

There was a petition by the workers at the site to have the Post Office provide a postal service to the camp. The Public Works Department supported this as they had to provide a collection of mail and delivery to Oturehua. Lindup in a letter to District Office, said that the Post Office did not want to spend £75 for the service, but the Post Office was running an expensive motor mail service through the district for less population than was located at the camp. He also said that £400 a month in half pay money orders was being put through the Alexandra Post Office. Unfortunately this was all to no avail and the site management were left to do the best they could for the men.

Strike at the dam site

Gilkison's construction paper does not comment on it, but the Public Works Department file has correspondence about the tunnel contract. It appeared that workers had struck very hard broken rock and were making slow progress on one heading where Parker was in charge. Head Office decided to relocate a ganger named Butler, who was considered to be one of the best tunnellers in the country, to start a second heading. By 24 September 1932, a strike had developed at the tunnel site with workers adamant that the rate for tunnelling was inadequate as they were not even making wages, with conditions in the tunnel very unpleasant. The Dunedin District Engineer sent a long report to Head Office setting out the progress rates on the tunnel, and the amount the men were earning. The District Engineer appeared to be somewhat sympathetic to the claim the men were making.

A letter from the Engineer in Chief in Wellington, however, held that the original price of five pounds per foot had been set in comparison to other tunnel work and was considered ample. It had already been increased by twelve shillings per foot, which should have compensated for the hard rock encountered he said. He wanted to know if Butler, who was the ganger at the other end of the tunnel, had joined the men in the strike.

By this time the strike issue had reached the office of the Minister of Public Works. On 24 September 1932 F. W. Furkert , the Engineer in Chief, answered a telegram from W. Bodkin MP and a minute from the Minister on the strike issue. It appeared that men on the site were refusing to pay their storekeepers accounts. They were reportedly mainly tunnellers who were dissatisfied with their contract rate of pay and had decided to leave. There were 22 men involved. He advised that the Resident Engineer was withholding payment to the men until the storekeepers account was paid. The Engineer in Chief later told the Resident Engineer that this action was not legal, and the men would have to be paid the full amount of their earnings. It was proposed that men who left without settling their storekeepers account should be debarred from further employment by the Department. This was carried out and the men were reported to the Labour Bureau to ensure they were not offered future employment. In October 1932 there was a list of men who had left the site without paying storekeepers accounts. It totalled 66 workers of which only ten were tunnellers. The tunnellers had become the scapegoat, having taken strike action against their terms of employment.

A report to the Minister advised that the men concerned in the strike had been transferred from the South Island Main Trunk Railway when construction of that line was stopped. The report said trades people in Otago Central had always had trouble in collecting their accounts from a big percentage of the ex-railway construction employees.

Living conditions at the camp

In his report on the Falls Dam, J. T. Gilkison made the following comment on the conditions of employment. Except for some tunnellers, the majority of labour employed was unskilled and this led to a high accident rate and a high labour cost.

Pay to workmen per eight hour day

	Labourer	Skilled Labourer	Artisans
1932	12/6	13/6	16/10
1934	10/-	10/8	13/4
1935	12/-	12/8	16/-

Wherever possible, work was carried out by co-operative contract. This applied to all tunnelling, quarrying, a portion of stripping the dam, and hand packing of stone on the front face. The accommodation provided consisted of a 8ft by 10ft tent for two men, and a limited number of rent free married quarters consisting of two tents joined by a porch. A cookhouse was provided, but it was not well patronised and so eventually shut down. J. Craig operated the cookhouse in June 1933, and asked to be relieved of his contract. Craig had obtained the contract for the Poolburn Dam in 1930 so he had been providing for the workers at both projects. His problem was that the Department did not collect workers accounts for him, and that men left without paying. His contract was taken up by someone who had been catering at the Waitaki Dam.

In early 1934 the Workers Union requested that the Department consider the provision of baths for married families in camps. It appeared that they just had to make do in their tents. Lindup the Resident Engineer in Alexandra said that there were 31 married workers and families in works camps in Central Otago. Thus there would need to be ten bath tents provided with one for each four families. It would cost £25 per bath hut he said, and he did not recommend it. There was a policy for relief workers which did not include such luxuries!

While work was only made available for married men, other than skilled workers, the work camps only provided some accommodation for families. The men were paid monthly and expected to settle their storekeeper and cookhouse expenses monthly.

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Working in the diversion tunnel. Conditions were very difficult with hard and broken rock delaying progress. The rate of progress was so slow that the tunnellers went on strike. The dress was very casual in those days and drilling without ear protection must have been very harmful in the confined space.

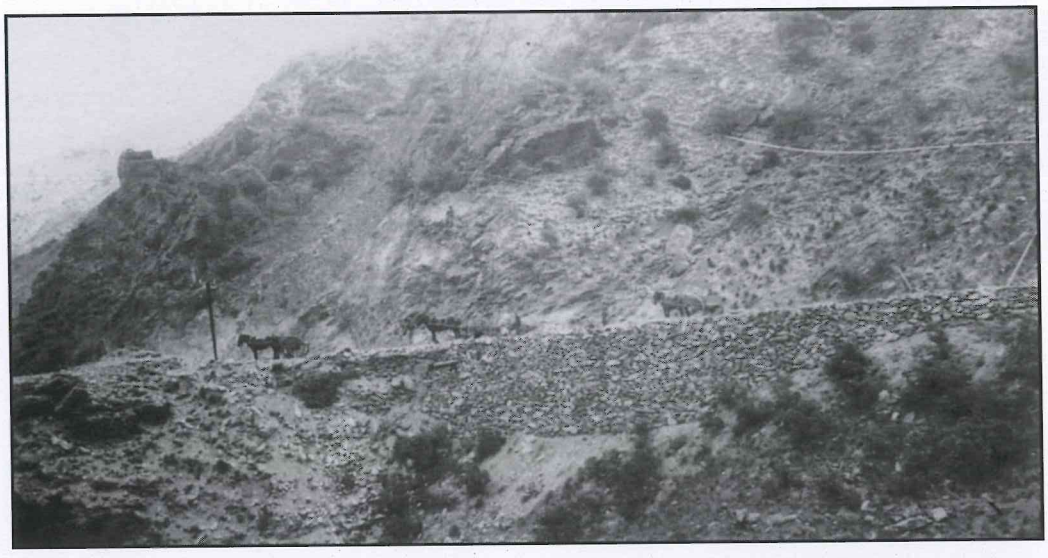
Progress on the tunnel

There is no progress report on the dam in the Engineering Report but it seems likely, with the delay in tunnelling, and the subsequent concrete lining and grouting, it would have taken until 1933 to complete the tunnel and divert the river. It is stated that the concreting of the tunnel closely followed the excavation due to the blocky and fractured nature of the hillside.

The tunnel excavation was timbered and the spoil was trucked out by horses in two cubic yard trucks on the downstream end and winched out up the 1 in 4 grade access ramp at the inlet end. The horseshoe section tunnel had a grade of 1 in 100 with an area of 227sq ft and a 16ft 6 inch diameter. This provided for a 5000 cusec flood flow during the construction period. To enable this flow to be handled with little heading up, the invert of the inlet portal was set about 4 ft below the river bed which required a 35ft cut and a 1 in 4 slope to the river bed. The outlet was set 13ft above water level and as the hillside was dangerously overhanging, a concrete portal was required before tunnelling commenced.

Quarrying of rock and placing the fill rock

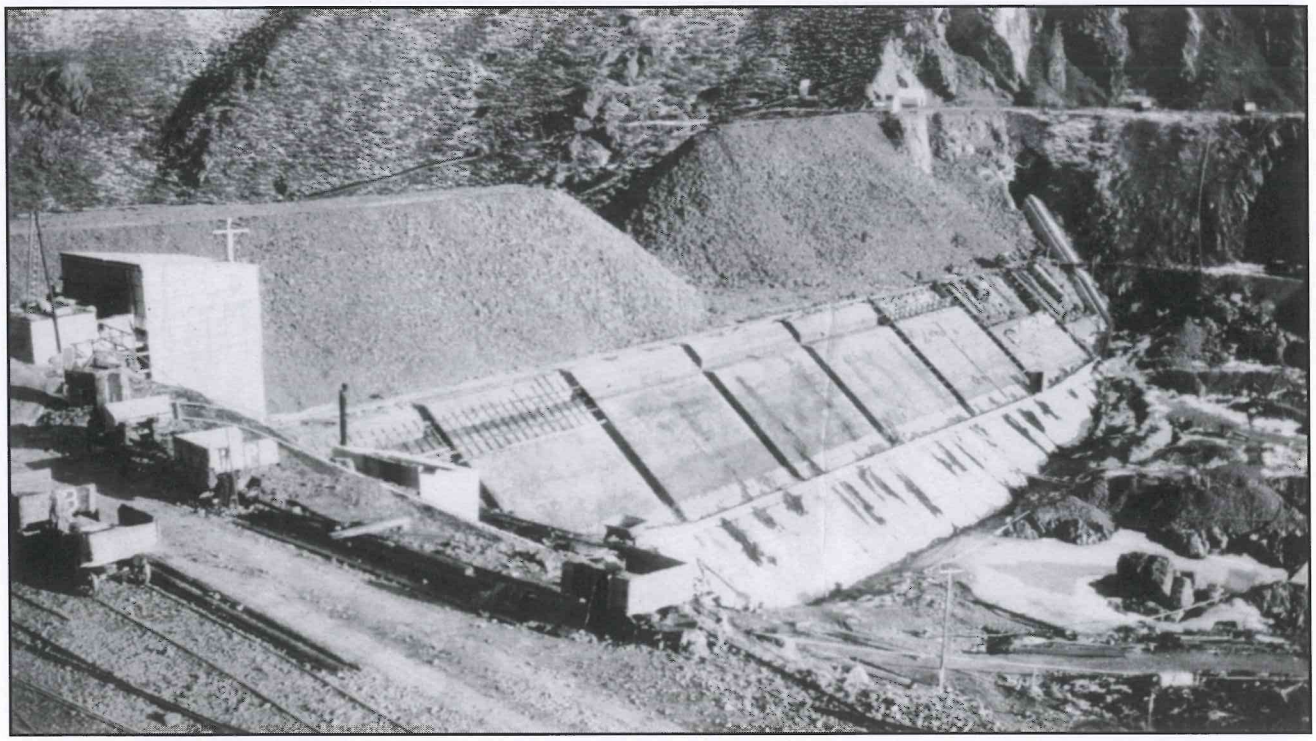
J. T. Gilkison reported that the rock for the dam was mainly obtained from the east and west quarries located upstream of the dam. The east quarry was finished at the level which allowed the spillway to be constructed. The west quarry was taken down to the crest level of the dam. These quarries are shown on the construction photographs. The drilling of rock in all the quarries was difficult because of the fissured nature of the rock. Drill holes for blasting were limited to 12ft deep, and no mechanical aids were used to load the stone onto the trucks. Very little popping was needed to reduce it to a size for hand loading.



Horse and carts transporting rock from the right abutment quarry to the dam. A roadway has been made with rock quarried from the hillside.

View of quarry on the right hand abutment. Horse drawn trucks are shown transporting rock onto the dam. There was road access on the left side of the dam with foot tracks on the right.

Horses hauled the 2 cubic yard trucks carrying rock to be tipped on the dam, and any material under 2½ inch was rejected. Selected stone from the tunnel and the river channel was used for the lowest section of the dam. At no time were two tips allowed to run more closely together than 20ft. This distance was maintained by hand-packing the stones in level courses between the tips and thus preventing any arching in between with consequent loss of density and stability. This must have been a very labour intensive process.



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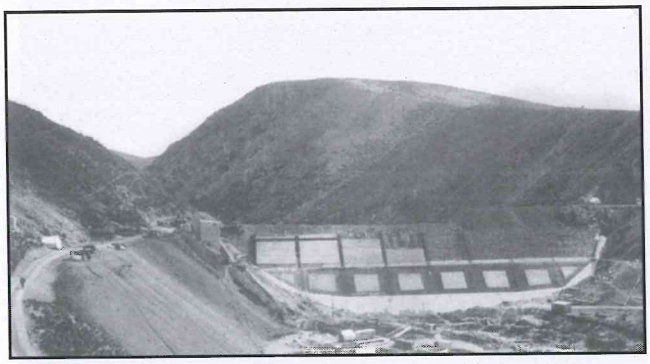
This photograph provides an interesting view of the dam during construction. The base of the dam was laid and this allowed the cut off wall and lower sections of the concrete face to proceed. On the left is the concrete batching plant. The rock from the left abutment quarry was placed first and there is a gap in the middle of the dam. Material is shown being carted from the right hand abutment quarry to finish the dam.

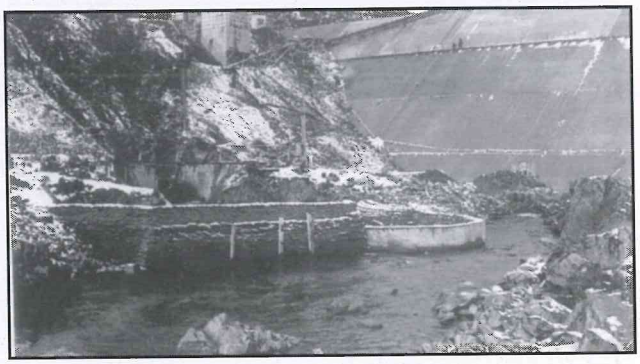
The dam contains 168,000 cu yds of rock and the measured loose volume of rock placed was 175,000 cu yds. The difference is the compaction in the bank. (Using 2 cubic yard trucks would have required 87,500 trips, which over a two and a half year construction period requires 17 loads per hour.)

Upstream face of the dam

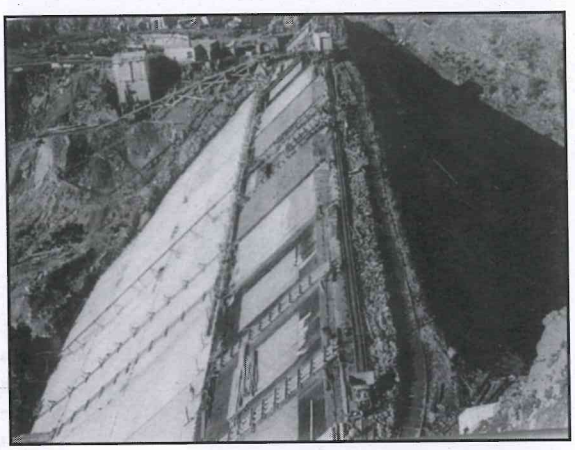
To seal the dam, a concrete cut-off wall was constructed at the upstream toe. This also served as a footing for the concrete slabs laid above. The nominal width at the top was 5ft, but where it was needed to excavate down 20ft to solid rock, the width was greater. The excavation was done with paving breakers which made it very laborious work. Spoil was loaded in tubs and removed by light moveable jib cranes. The concreted sections, 15 to 24ft long, were made watertight with copper strips and shear blocks.



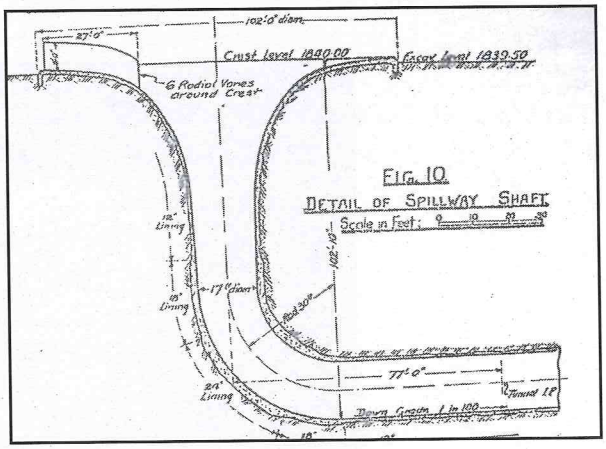
View of the upstream face of the dam with the base completed and concrete slabs being poured above. Access to upstream work is from the left abutment quarry.



The upstream cut off wall is further advanced. A cofferdam is in place at the tunnel entry and water is passing through the pipe under the dam wall.



The concrete slabs are almost at the crest of the dam. Concrete is mixed in the batching plant at the left and transported along the light rail. A second rail allows rock to be dumped across the dam from the right



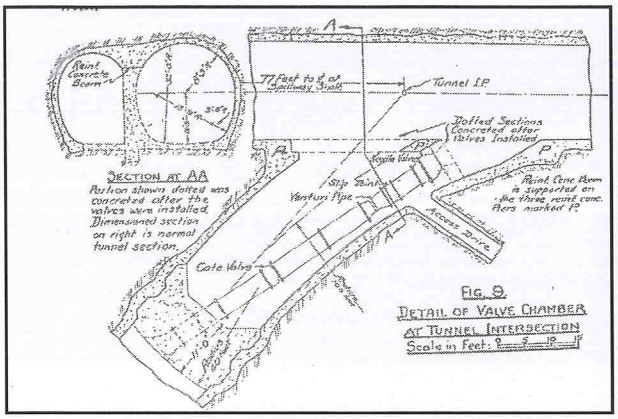
Design of the spillway and discharge tunnel

Grouting of the cut off wall

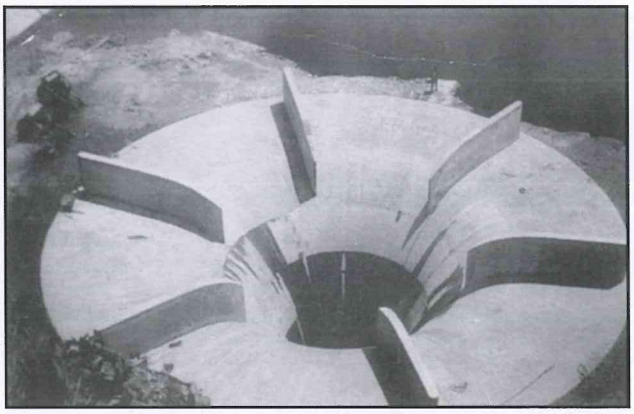
Before concreting, 10ft holes were drilled in the bottom of the trench, at 2ft centres up to within 85ft of the level of the crest and thereafter at 4ft centres. One inch pipes were sealed in place before the concrete wall was poured and left protruding from the top of the wall. Three inch cored holes were provided every 4ft across the cut off wall so that 40ft holes could be drilled down into the rock. These were then grouted to provide an upstream seal across the base of the dam.

Watertight concrete face of the dam

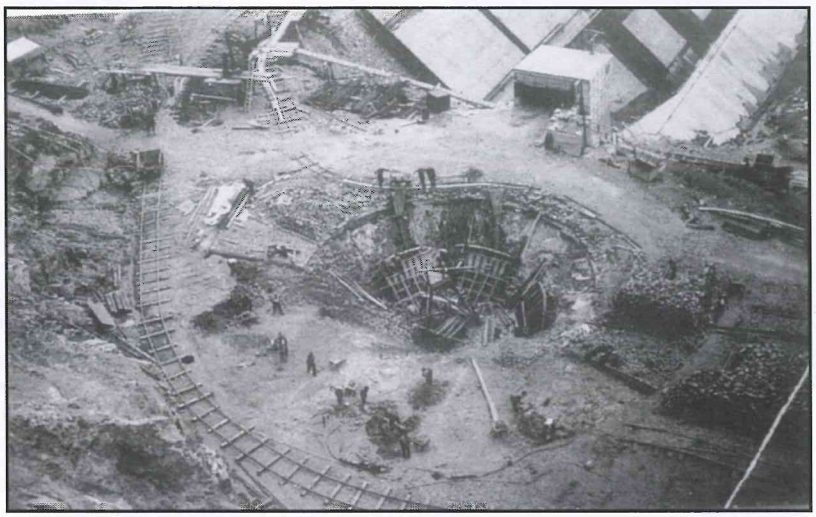
To provide a water seal for the upstream face of the dam, concrete slabs were laid with a semi rigid bearing, being a layer of packed stone built against the embankment, with a further layer of rock in mortar against this packed stone.



Arrangement of discharge pipe and tunnel entry



The completed 'Morning Glory' spillway shown as the dam was being filled.



The vertical shaft for the spillway under construction. At the rear is the concrete batching plant for the dam and behind, the concrete slabs for the upstream sealing of the dam.

Concrete batching plant

The plant consisted of a half cu yd Anderson mixer driven by a 10HP motor. In a floor immediately above were placed the batching boxes. Above this floor and feeding into the boxes were the aggregate bins with 24yds of greywacke aggregate and 15 cu yds of sand. The aggregate was quarried at the east quarry and sand brought in half a mile to the site.

The mixer was set up about mid level of the dam. Concrete was distributed by chute lines where possible and elevated by air winches up ramps where necessary. Steam was used during the cold weather to raise the water temperature and also to keep the sand bin from freezing. The batching plant is shown in the photographs of the dam construction.

Cost of the dam

The construction report gives the following breakdown of expenditure on the dam.

Dam	67,980	58%
Diversion Tunnel	20,098	17%
Spillway	11,126	9%
Overheads	18,522	16%
TOTAL	**£117,726**	

Subsequent events

In 2003 Pioneer Generation completed the installation of a small hydro electric station at the dam. The generator utilises the water which is surplus to irrigation and also the discharge from the dam for irrigation schemes on the Manuherikia River.

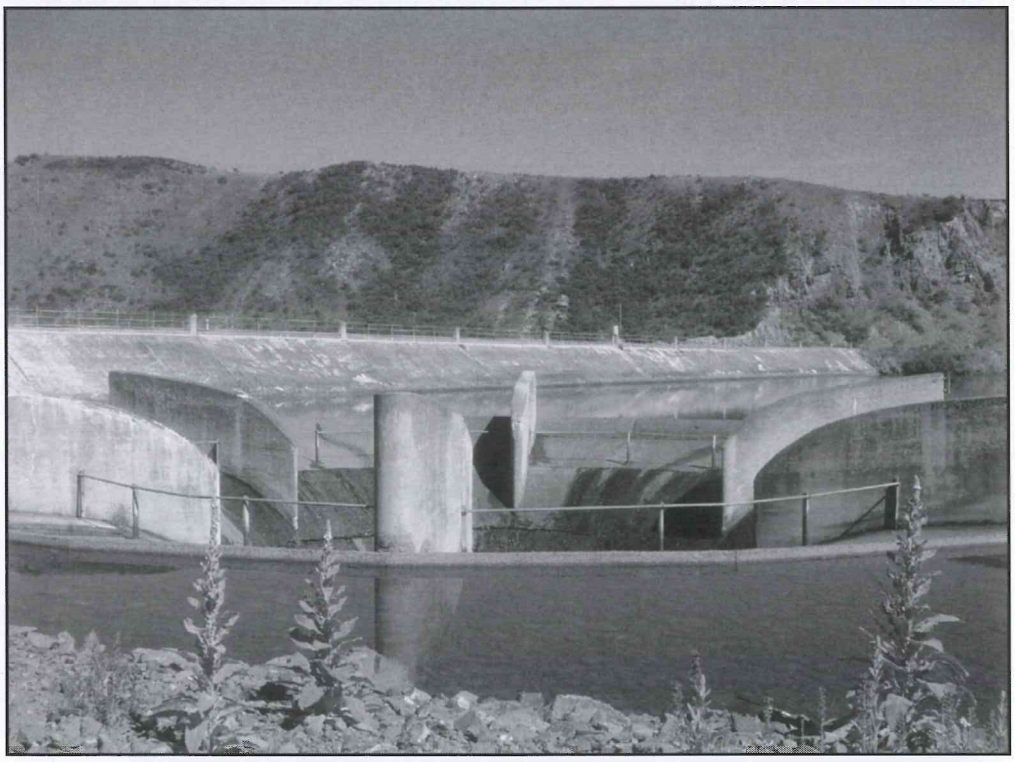
The Kaplan water turbine operates at a nominal head of 105ft or 32 metres, and water is obtained through a 1200mm siphon and a 900mm pipe connection to the lower discharge pipe. These combine to feed a 1400mm penstock to the turbine.

The station discharges water adjacent to the diversion tunnel outlet. The peak output of the machine is 1320 KVA, producing 9 million kWhr per annum.

Thus Furkert's original idea of the Public Works Department generating power at the dam has come to fruition.

The new power house under construction in 2003.

A recent view of the downstream face of the dam with the old quarry along the right abutment. Beyond the lake, at the rear, is the Hawkdun Range.



A recent view looking across the 'Morning Glory' spillway to the concrete upstream face of the dam. The lake level is just below the spillway crest.