

SAFETY OF SO-CALLED SMALL DAMS IN PAKISTAN

**BY
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Altaf-ur-Rehman¹

INTRODUCTION

Safety of so called Small Dams in Pakistan is not of concern and there has been recently several failures. The safety aspects are examined and measures suggested to improve the situation. The World Bank or any other financing agency requires certain procedures to be followed so as the design and construction are according to standard practice.

DEFINITION OF LARGE DAMS.

ICOLD defines a large dam which is 15 m high deepest foundation. Also dams between 10-15 m height if these have difficult foundation and Large capacity more than(1000 Aft) x-1.

Canada considers large dams as more than 2.5. m height Appendix – 2 whereas Finland considers height of 2.0 m to categorise the dam as large dam.

All the dams are cited in category of large dams and are actually listed in Register of Large Dams by ICOLD Appendix-3. These dams are therefore rightly the so called Small Dams.

The operational period is quite as important. It is thought that the dam is built and it will not require any future carrying. The concept of site staff is missing and if it is required for say operation of outlet, it is an illiterate beldar. No monitoring system exists at any dam and disasters could have been avoided. Dams are built in high hazard seismic zone and in case of major event, will cause additional misery. These aspects are elaborated

INCIDENTS AND FAILURES

There has been failures and incidents and these are detailed hereafter.

BOLAN DAM

Bolan Dam 135 feet high was an earth dam but in 1958. Failure in 1976 due to overtopping as spillway gates could not be operated. 24 lines were lost in addition damages to crops, animals and property. Failure has been investigated by NESPAK and also redesign. The d/s water rights by the farmers have held the reconstruction.

NAMAL DAM

The masonry dam concave upstream of 105 feet height built in 1913, did not fail but 12

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miles of Talagang Mianwali Road got flooded in 1976. The dam has silted up but still in operation.

WALI TANGI DAM

Wali Tangi earth rockfill dam of 79 feet height built in 1961 by Military Engineering Services. This has virtually no spillway capacity and has been overtopped several times in 1987 and 1994. The downstream shell gets washed off. The concrete core is cracked. The outlet is blocked since initial operation. There is enough seepage/leakage through left abutment which serves as its releases.

The hydrology and the spillway have not been studied even upto now. This is a potential failure embankment and will cause the downstream dam to be washed off.

DHOK TALIAN DAM

Dhoke Talian was a concrete gravity dam 72 feet high was built in 1971. This dam failed but fortunately no life was lost, only a few spans of a bridge stream was washed off and damages to animals and crops. It is being redesigned as on embankment dam.

KEWARI DAM

Reported failure in Daily Jang 14th July, 1999 by overtopping . 8 people lost life and damages to Towshik of Sanjlawi.

NIRALI DAM

Nirali Dam is 77 feet high built in 1970. Nirali dam spillway has been saved by timely action. The upper chute was laid on sand fill loosely compacted. Leakages at toe of stilling basin was known figure 1 but no action was taken to investigate the cause. Typical example of lack of review of design..

KHASALA DAM

This concrete gravity dam of 60 feet height built in 1985 was not overtopped and has on upstream concrete blanket. During 1992 floods, the dam was stressed and both left and right non overflow monoliths cracked through and through Figure 2.1. Another similar reservoir levels may cause complete failure,

WHAT IS LACKING

Several aspects are obvious about what happened to these dams.

REVIEW OF DESIGNS

The incidents with Wali Tangi Dam built by and designed by Brigadier Mushtaq, a non engineer and without studies of basic parameters i.e. hydrology to evaluate design flood,

yield and lack of inflow data and sediment delivery ratio to reservoir. In addition the seismic aspects have not been considered.

Dhok Talian and Nirali spillway would have been saved by Review of Design.

NO MONITORING SYSTEM

No monitoring system for such measurement as seepages, leakages, pore pressures, deformation, movement control, crackages exist on any dam.

SITE ORGANIZATION

The dams are operated and looked after by technical staff in town/cities. At the site is a beldar and may be couple of more on some dams.

During flood season, there is no addition at site. The flood hydrographs are not recorded even if these occur in day time.

The case of Wali Tangi failure is related to gates being not operated as there was no one to operate.

LACK OF HISTORY OF INCIDENTS

There is no data available of any incidents viz Khasala stilling basin was washed out in 1992 but there is no data on the same viz the flood size, depth of erosion and any revision to design.

DATA ON PERFORMANCE

The most important information is about seepage, quantity and quality. It is only the memory of visiting officials if the seepage has decreased or increased.

INSPECTION

There is not system of Annual inspections. Periodic inspections of Dams in Punjab have been undertaken by Dam Safety Organization (DSO), WAPDA. The team members should have an expert from outside DSO.

NEW CONCEPTS IN DAM SAFETY

Although these may come out of place for the small dams discussed but are produced to know where elsewhere safety requirements are practiced.

New ideas continue to pore in and the following references are for illustration of the same.

1. Oslo Norway meeting of ICOLD proposed that civil engineers are the best judge of how a dam project can be sabotaged and this be put in TOR for inspection.
2. Some thoughts on dam safety. International Water Power and Dam construction June 1998.
3. Gambling with public safety Water Power and Dam Construction November 1998.
4. Risk analysis – dam safety Water Power and Dam construction May 1997.
5. A new approach Dam Safety Water & Power March 1996.
6. The mathematics of Dam Safety Water and Power May 1997.
7. Monitoring or large dam inferring knowledge from previous events. Dam Engg. Volume VI issued.
8. Safety evaluation using reliability analysis Intt. Workshop on Dam Safety Evaluation 1993.
9. Long term performance and aging of old embankment dam ICOLD Q 651225.
10. Technical note – probability of failure Dam Engg. Vol. III issue.
11. Preventive maintenance March 1996 Water Power and Dam construction.

RECOMMENDATION – WHAT TO DO

It is required to cover what is lacking and has been said in previous paras. This is a summing up. World Bank operational Manuals clearly states the requirements.

Dams already constructed:

1. Carryout design review as part of periodic inspection with team having necessary expertise.
2. Setup monitoring system.
3. Frequent visit by engineering staff when reservoir is full.
4. Setup archives.

Dams to be constructed

1. Design to be reviewed by a panel of experts even if consultants have been engaged for design.
2. Monitoring system should be setup as part of the design by consultants.
3. Experienced geologists should cover the investigation, design and construction stages.

REFERENCES

1. World Bank Operational Manual Policies – Safety of Dam OP 4.37 September 1996.
2. Small Dam Organization – Government of the Punjab. Irrigation and Power Department Brochure.
3. ICOLD Register of Dam
4. USCOLD – Model Laws for Safety of Dam.

Appendix - 1

- a) It should apply to a dam, including appurtenant works, which does or will impound water and which has a height of 50 feet (15 meters) or more from the natural bed of stream measured at the downstream toe of the dam or from the lowest elevation of the outside limit of the dam, if it is not across the stream channel, to the maximum water storage elevation.
- b) It also includes impoundments including afterbays and forebays of a hydro-electric installation whether on main channel or off-channel and impoundments where full perimeter is an embankment, provided that the head cross is a minimum of 15 meters as defined in Para-2 (a).
- c) A dam between six and fifteen meters in height provided it satisfies one of the following conditions:
 - a) The length of the crest of the dam to be not less than 500 m (1640 feet).
 - b) The capacity of the reservoir formed by the dam to be not less than 1 million cubic meters (400 acre feet).
 - c) The maximum flood discharge dealt with by the dam to be not less than 2,000 cubic meters per second (700,000 cubic ft. per second).
 - d) The dam has especially difficult foundation problems.
 - e) The dam is of unusual design.
 - f) Hydro-electric scheme of 15 meters head.

DAM SAFETY GUIDELINES
Canadian Dam Safety Association

P.O. Box 4490, South Edmonton Postal Station, Edmonton, Alberta, Canada T6E 4X7

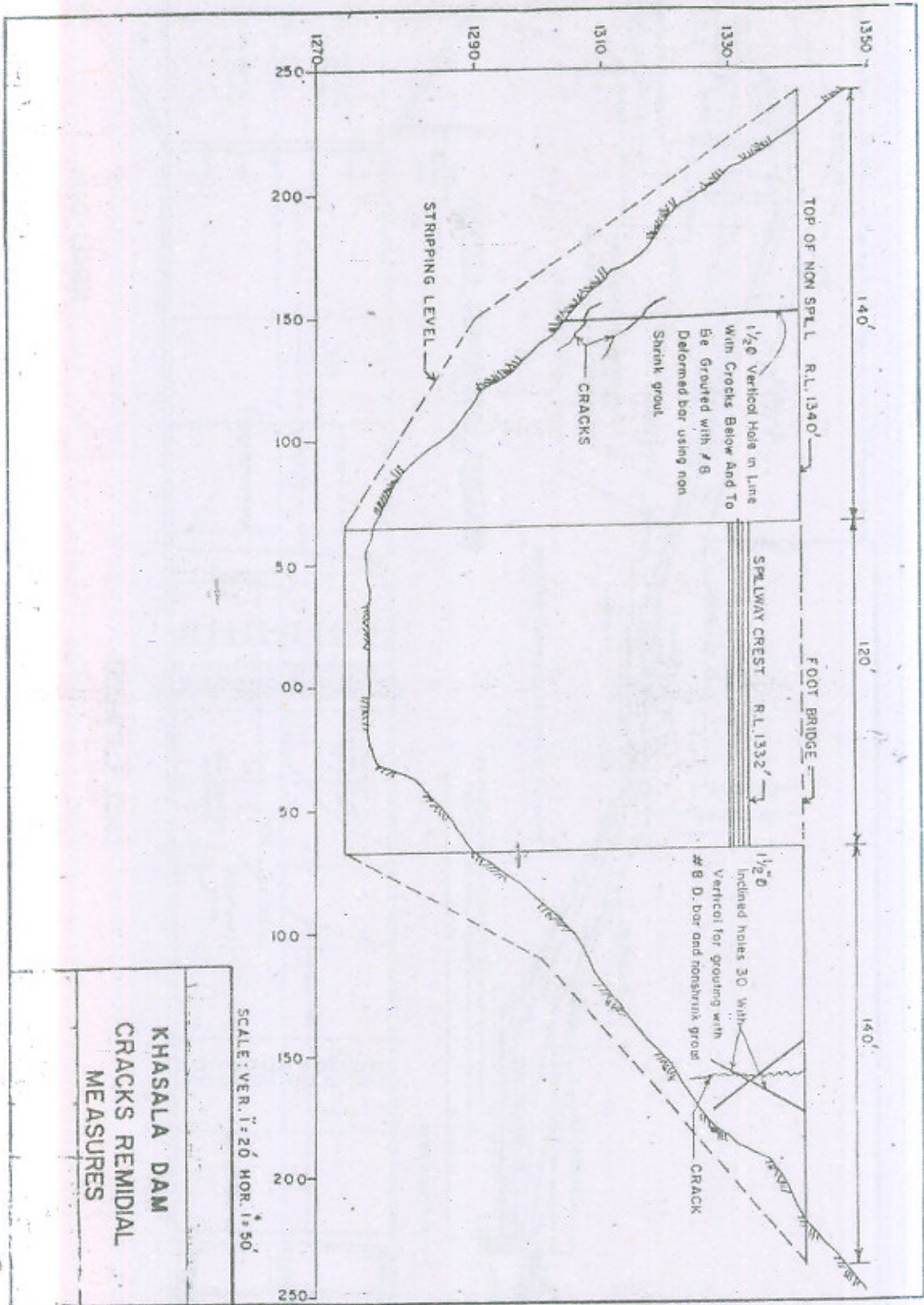
Dam: Barrier which is constructed for the purpose of enabling the storage or diversion of water, or water containing any other substance, that could impound 30,000 m³ or more and is 2.5 or more in height. The height is measured vertically to be top of the barrier, as follows:

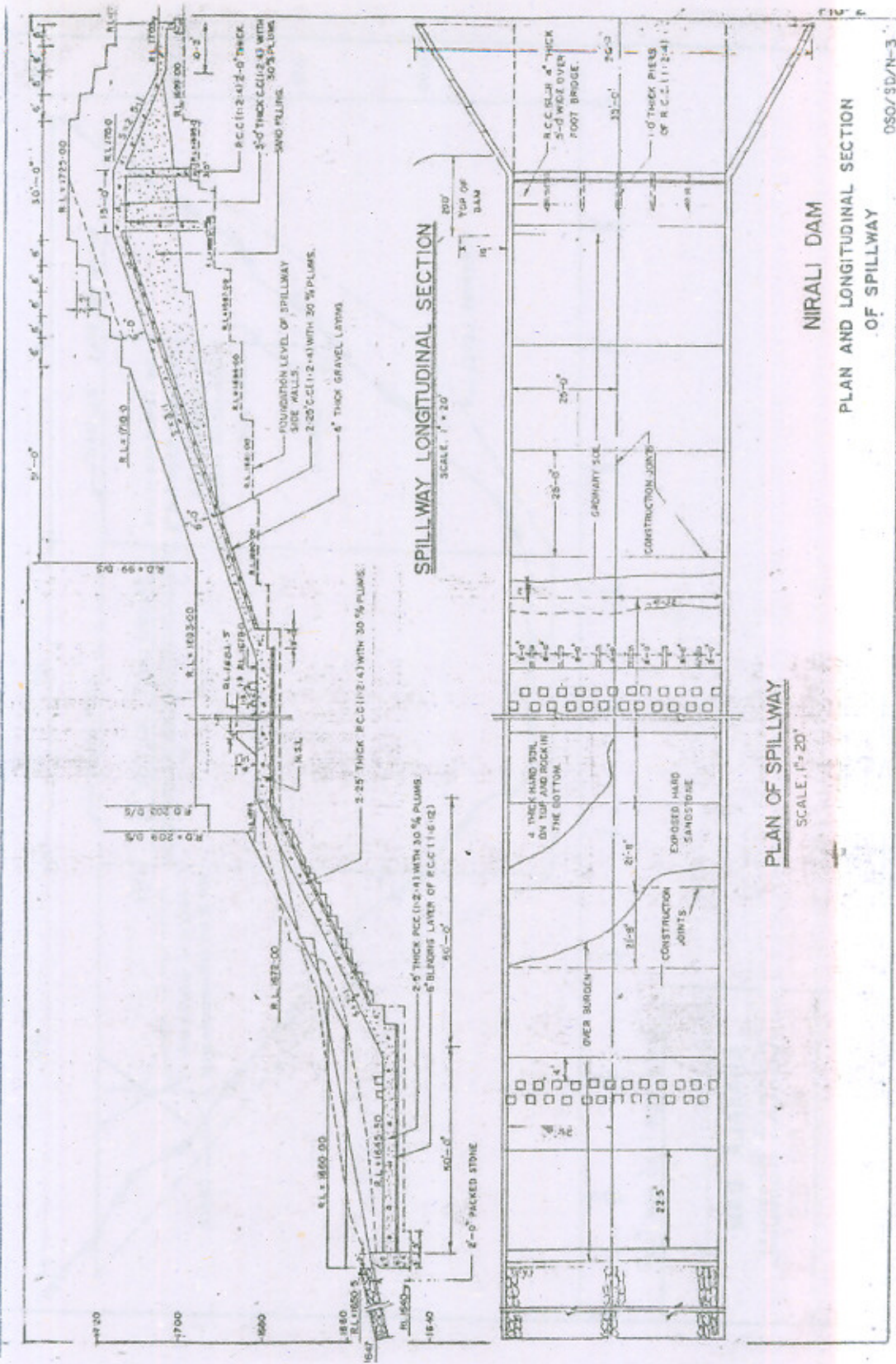
- i) From the natural bed of the stream or water course at the downstream toe of the barrier, in the case of a barrier across a stream or watercourse.
- ii) From the lowest elevation at the outside limit of the barrier, in the case of a barrier that is not across a stream or watercourse.

“Dam” is herein defined to include works (appurtenances) incidental to necessary for, or in connection with the barrier.

For purposes of these guidelines, this definition maybe expanded to include “dams” under 2.5m in height or which can impound less than 30,000 m³, if the consequences of failure would be unacceptable to the public, such as:

- Dams with erodible foundations where a breach could lower the reservoir more than 2.5m.
- Dams retaining toxic substances.





DSO/SD/N-3

NIRALI DAM
PLAN AND LONGITUDINAL SECTION
OF SPILLWAY

REGISTRE DES BARRAGES AU PAKISTAN
REGISTER OF DAMS IN PAKISTAN

FOIJD No. 1

No.	NOM DU BARRAGE NAME OF DAM	ANNEE D'ACHÈVEMENT YEAR OF COMPLETION	SITUATION - LOCATION			PROFONDEUR DE LA FOSSE DE LA FONDATION DEPTH OF FOUNDATION PIT	HAUTEUR DE LA BARRAGE HEIGHT OF DAM	LONGUEUR DE LA BARRAGE LENGTH OF DAM	VOLUME DE LA BARRAGE VOLUME OF DAM	CAPACITE TOTALE DU BARRAGE TOTAL DAM CAPACITY	CAPACITE DE LA BARRAGE DAM CAPACITY	TYPE DE BARRAGE DAM TYPE	AGENCE ENCHARGE RESPONSIBLE AGENCY	BUREAU DES ETUDES DESIGNING OFFICE	CONTRACTANT CONTRACTOR
			PROVINCE PROVINCE	DISTRICT DISTRICT	CITY CITY										
1	Barh Khwaja Dam	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
2	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
3	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
4	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
5	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
6	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
7	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
8	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
9	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
10	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
11	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
12	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
13	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
14	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
15	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
16	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
17	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
18	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
19	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
20	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
21	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
22	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
23	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
24	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
25	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
26	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
27	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
28	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
29	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	
30	Barh	1959	Punjab	Quetta	10.6	156.6	1.22	21,200	10	10	V	Government of Punjab	Engineering Department	Government of Punjab	

NOTE: The Dam has been reported & visited only during the period of 1970.