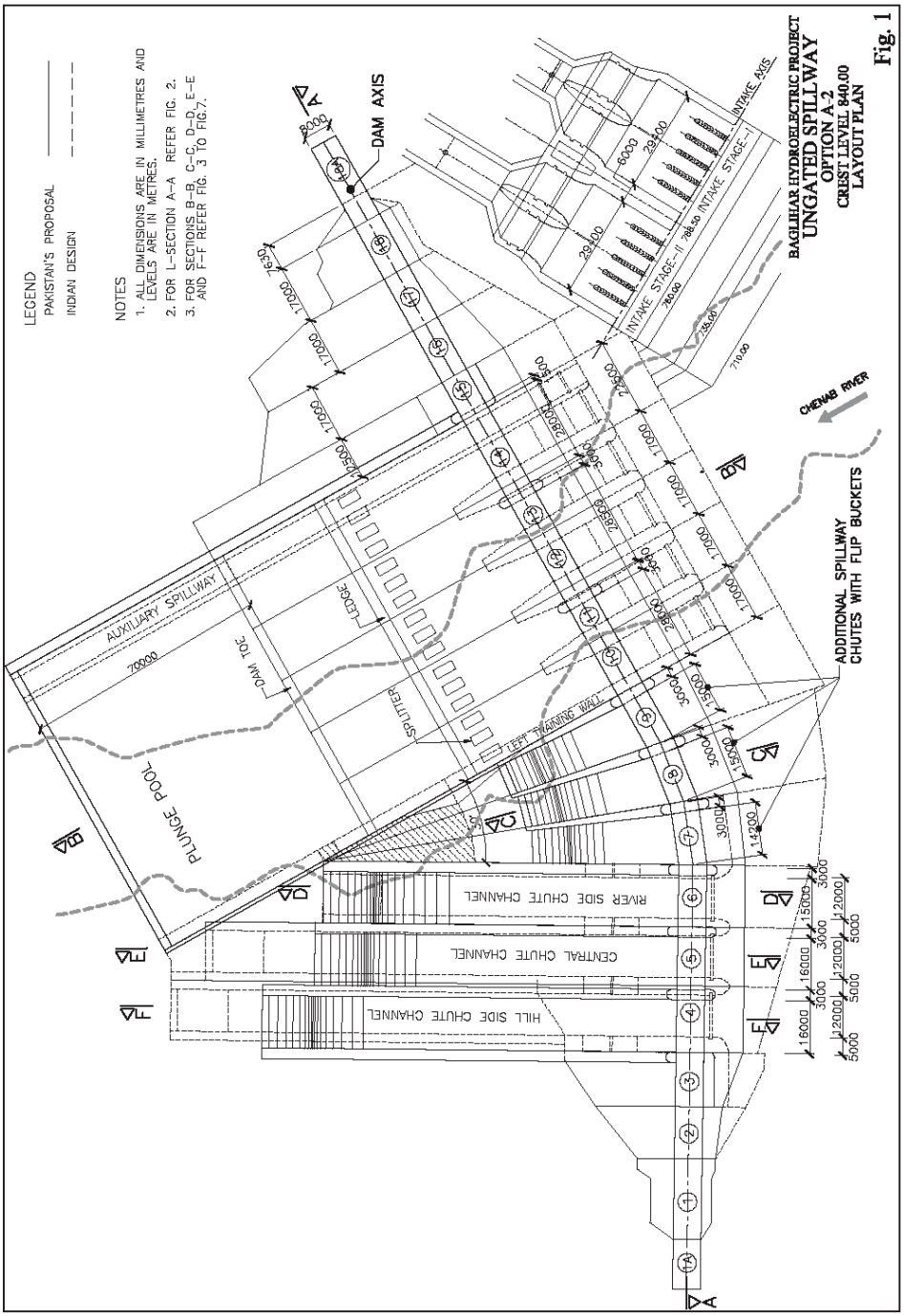
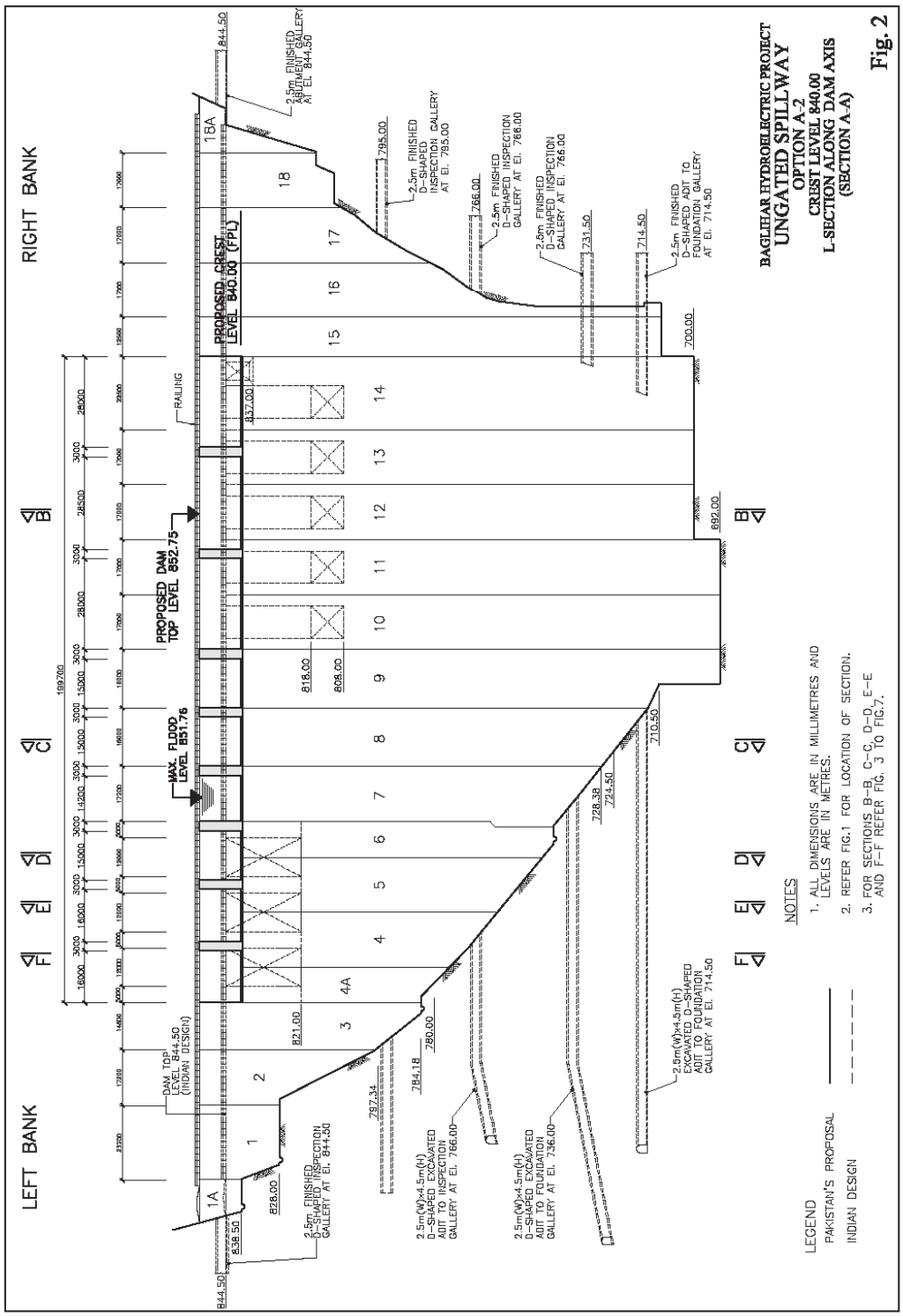
ANNEX 5

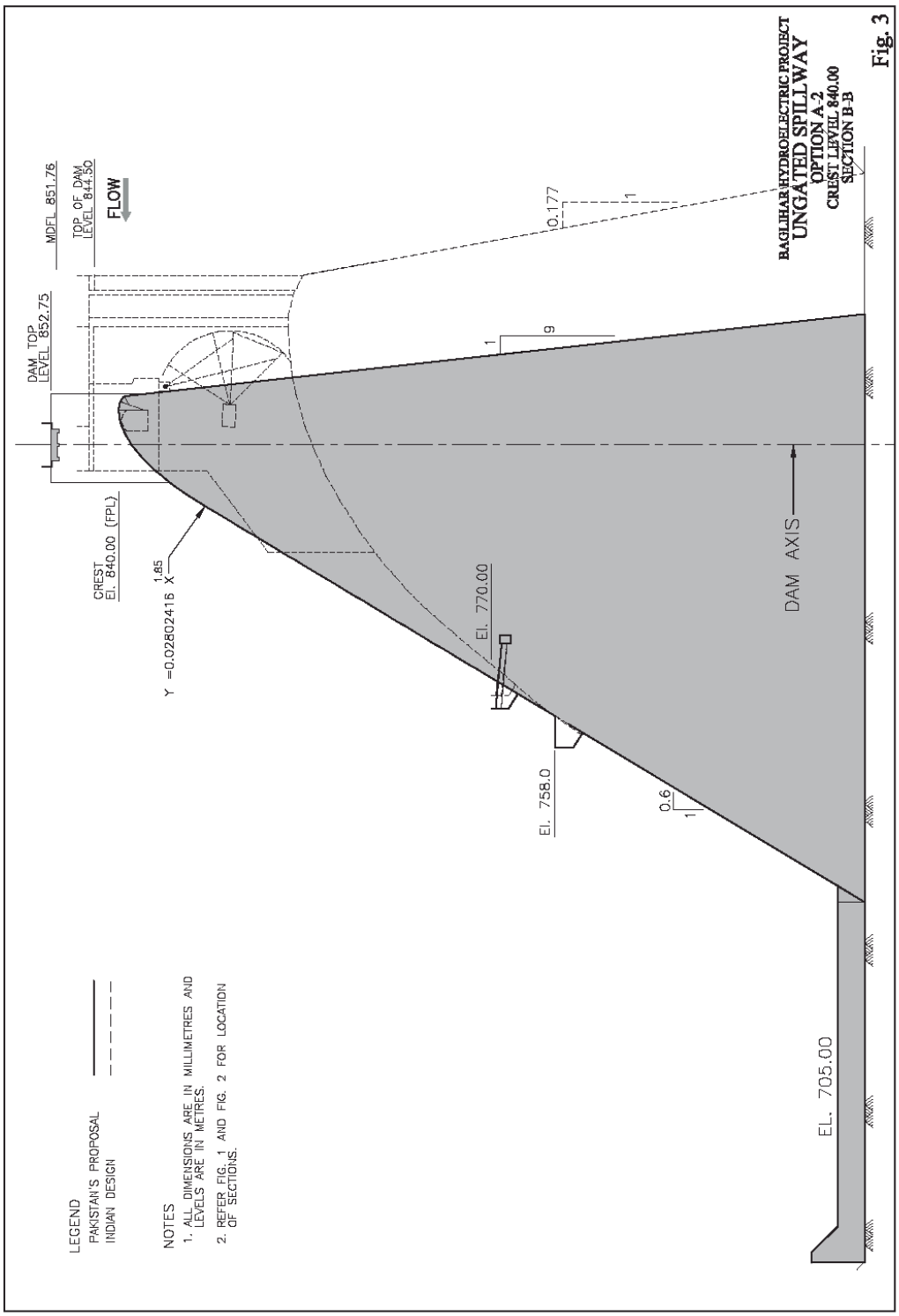
Design proposed by Pakistan for the spillway
Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



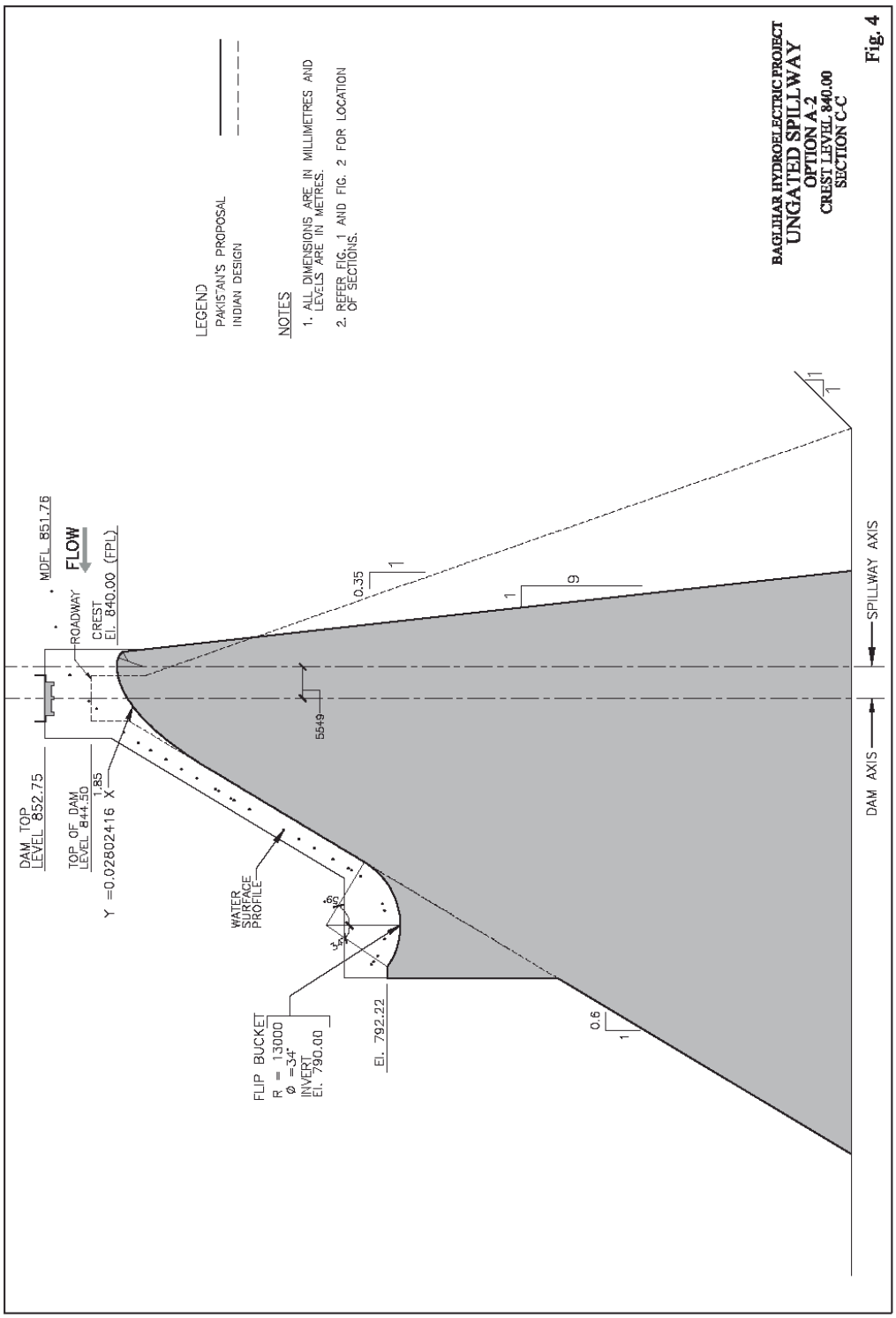
Design proposed by Pakistan for the spillway
Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



Design proposed by Pakistan for the spillway
Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2

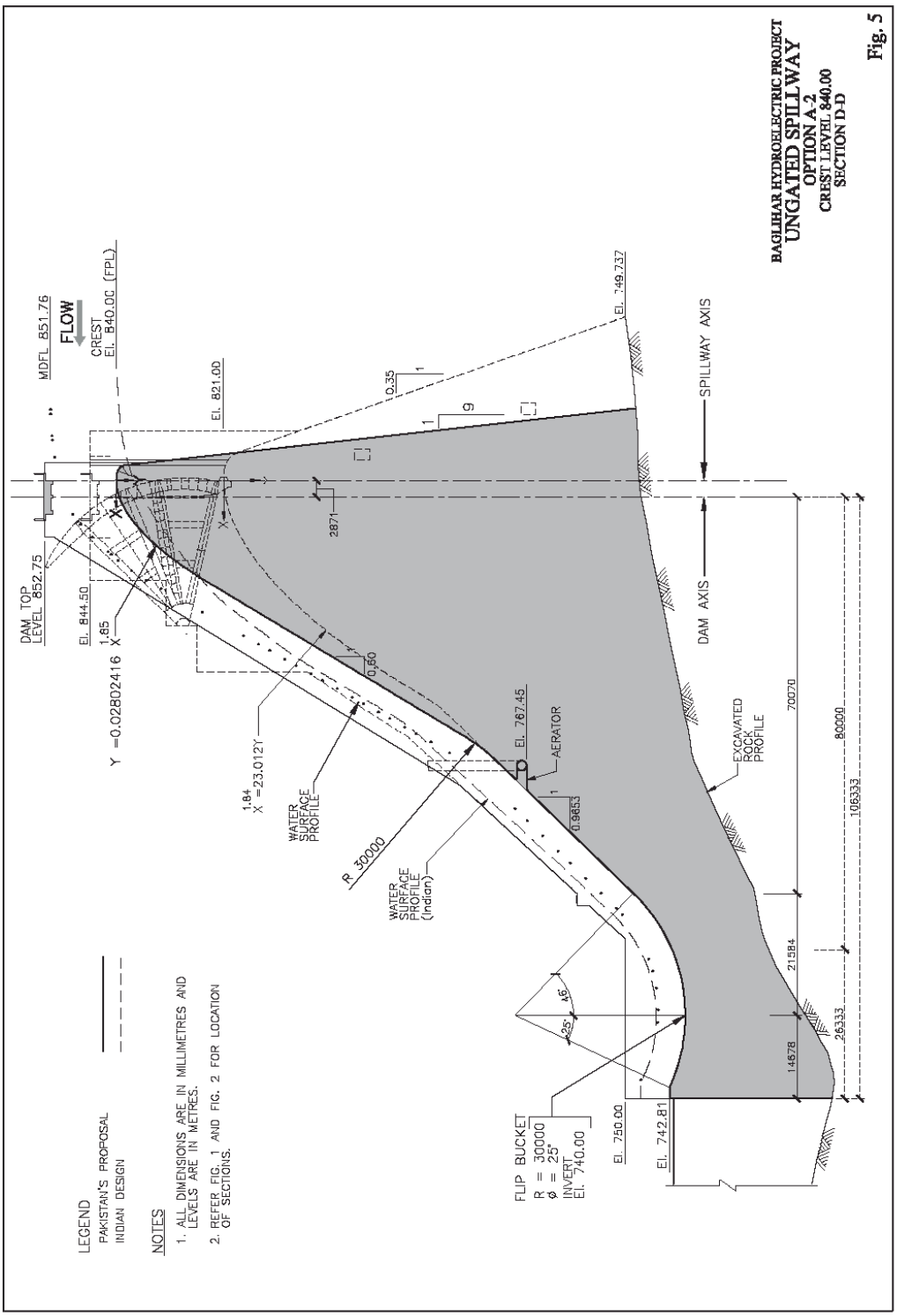


Design proposed by Pakistan for the spillway
Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



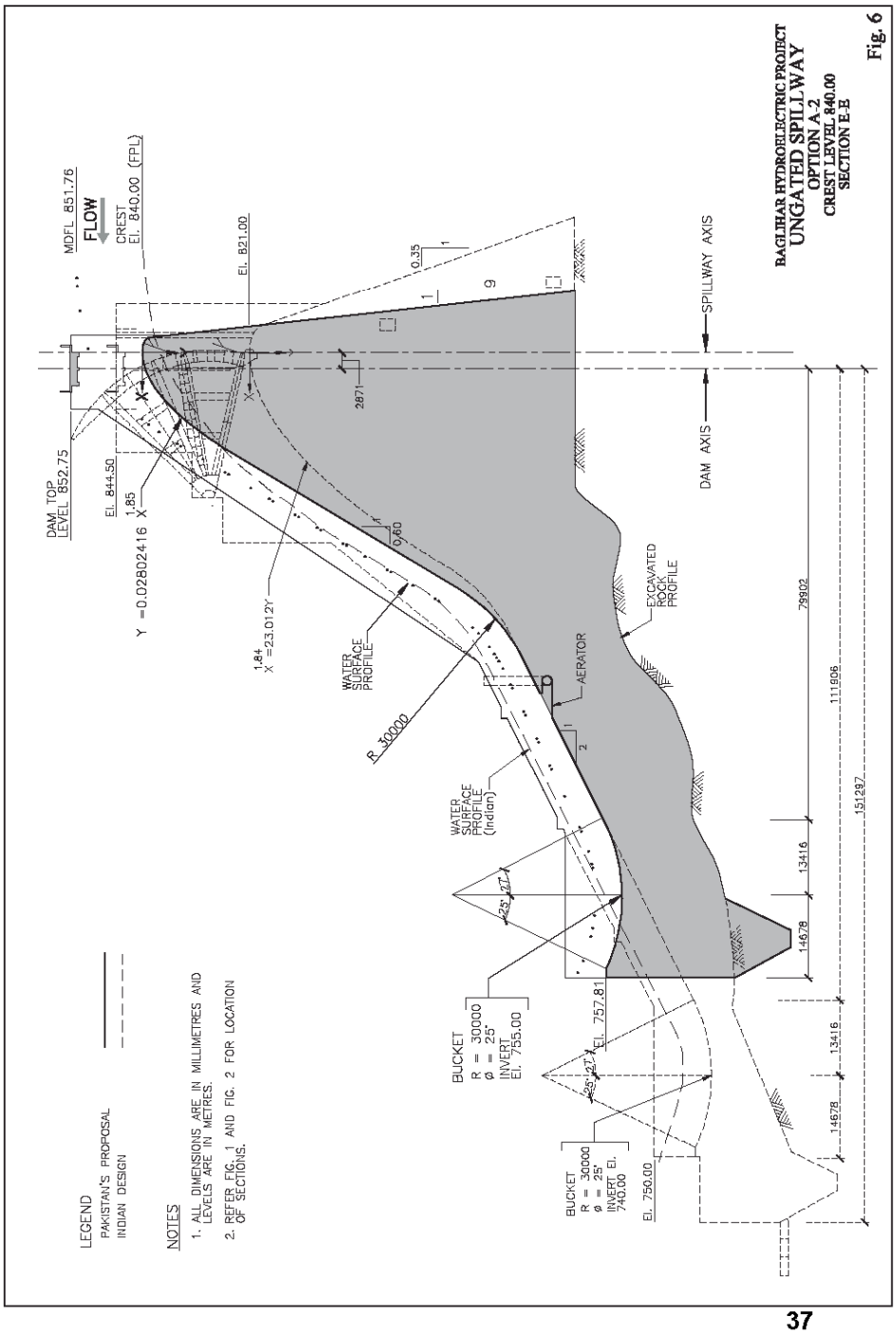
Design proposed by Pakistan for the spillway

Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



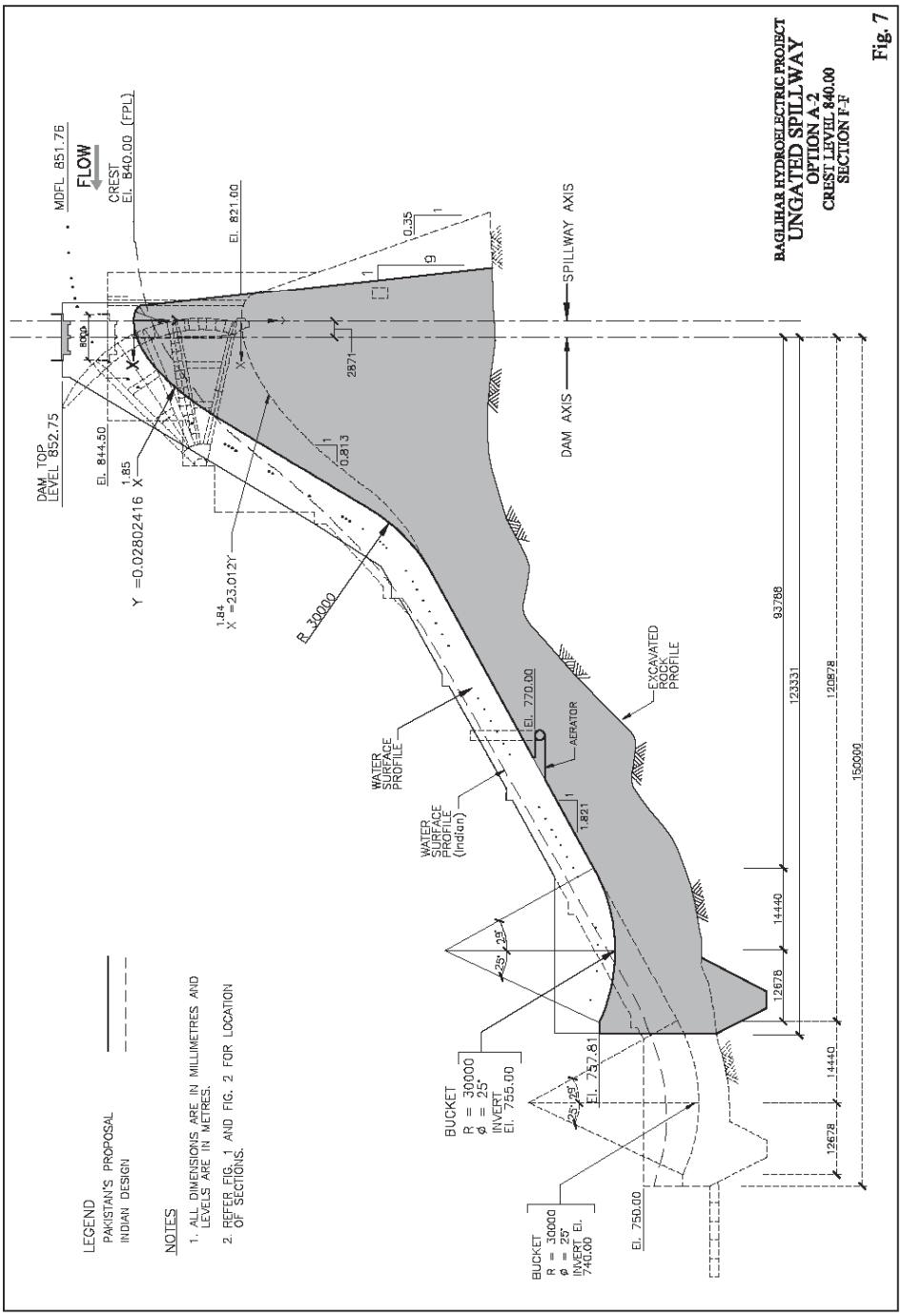
Design proposed by Pakistan for the spillway

Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



Design proposed by Pakistan for the spillway

Ungated Spillway Option A-2, extract from Memorial of Pakistan, Exhibit 2



Economic comparison between gated and ungated overflow chute spillway alternatives

The purpose of this note is to compare the economical conditions for decision making between a gated surface spillway alternative and an ungated free overflow spillway alternative, considering the shape of the valley and the flood discharge.

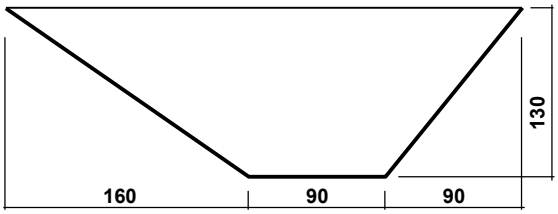
Following parameters are taken into consideration:

Dam body geometry

Type of dam: gravity

Dam height for NWL: 130 m (including freeboard)

Valley profile:



Dam face batter: downstream: 1:0.85, upstream: 1:0.10

Crest length available for overflow spillway: ca 180 m

Crest length available for gated spillway: ca 120 m

Design discharge Q = 16,000 m^3/s

Prices

For gates: A unit price of USD 15,000 per ton has been considered. It includes furniture, manufacturing and montage. Hoisting system and maintenance costs during 30 years life duration are also considered.

For dam concrete: A unit price of USD 130.00 per m^3 has been considered. This price is to be applied on the difference of concrete volume between two alternatives.

All other contingencies, such as energy dissipation arrangement, crest bridges, costs related to flood protection of reservoir shores, are not taken into consideration in this demonstration.

The volume of concrete can be estimated using the following formula:

$$V = \tfrac{1}{2}\left(m_{US} + m_{DS}\right) H^2 \left[b + \tfrac{1}{3}\left(\frac{1}{S_L} + \frac{1}{S_R} \right) \cdot H \right]$$

where V Volume of concrete

H Height of dam

m_{US} Dam upstream face batter

m_{DS} Dam downstream face batter

b Width of riverbed – horizontal section of the dam in transversal section

S_L and S_R: left and right slope of foundation

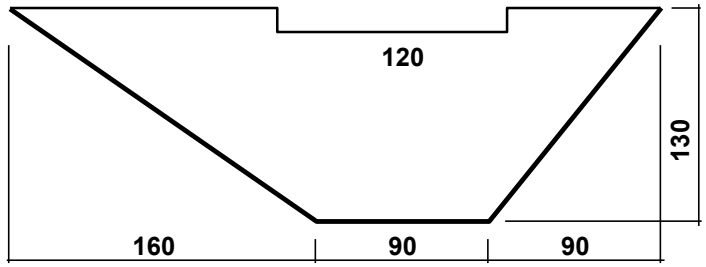
The weight of a surface radial gate can be estimated using the following formula[1]:

$G = 0.64 \cdot (B^2\, h\, H)^{0.682}$

where G Weight of gate, in [kN]
B span of gate, in [m]
h height of gate, in [m]
H head on the sill, in [m]

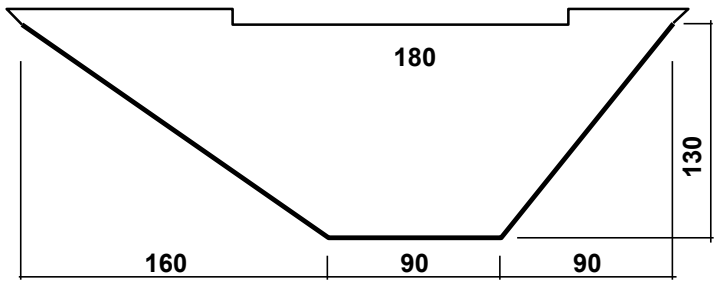
This formulation is based on a statistical analysis of dozens of radial gates, built since 1960, with height from 6.0 to 22.3 m.

Alternative I – gated spillway:



Gates	8 radial gates W= 12 m, H= 18.7 m		
Piers	7 piers, W = 3.5 m, K_p=0.01, K_a=0.08		
Volume of concrete :	1,390,000 m^3 (estimate)		
Cost of concrete		Mio. USD	181.0
Weight of gates	8 x 111 tons = 888 tons		
Cost of gates		Mio. USD	13.5
		Sum Mio. USD	194.5

Alternative II – free overflow spillway:



Bays	8 bays W = 20 m	
Piers	7 piers, W = 3.0 m, K_p=0.01, K_a=0.08	
Head above weir	13 0 m	
Dam height	143 m	
Volume of concrete :	1,760,000 m^3 (estimate)	
Cost of concrete		Mio. USD 229.0

[1] Erbisti, Paulo C.F., Design of Hydraulic Gates, Balkema Publishers, 2004, page 184

This simplified and approximate calculation shows that ungated spillway alternative leads to higher costs than the correspondent gated spillways alternative.

Taking into account the simplifications made, the difference is Mio. USD 34.5, corresponding to an increase of the costs by 17.7 % for the dam body.

This numerical result is evidently also tributary of the unit prices used for the calculation, but for a gravity type dam in a narrow valley, the cost comparison is always in favour of gated spillway alternative.

* * * * *

Spillways of Dams commissioned since 1940

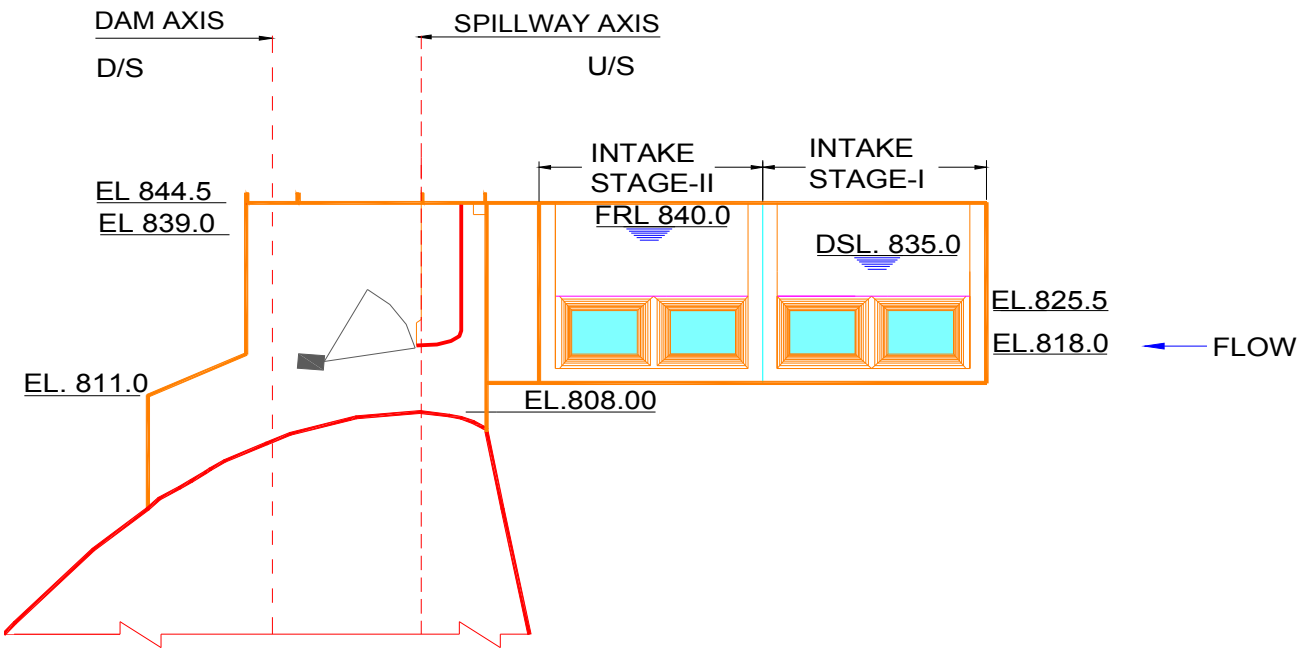
ungated: only equipped with ungated overflow spillways
gated: only equipped with gated spillways (surface or orifice)
mixed: equipped with both type of spillways

	TOTAL			1940-1944			1945-1949			1950-1954			1955-1959			1960-1964			1965-1969		
	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed
>40'000	1	32	-	-	1	-	-	-	-	-	1	-	-	3	-	-	-	-	-	3	-
27'000-39'999	1	28	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	3	-
22'000-26'999	3	26	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	4	-
20'000-21'999	6	20	3	-	1	-	-	-	-	-	-	-	-	-	-	1	4	1	1	-	-
18'000-19'999	-	26	-	-	-	-	-	-	-	-	2	-	-	1	-	-	1	-	-	3	-
sum > 18'000	***11***	***132***	***3***	***-***	***2***	***-***	***-***	***-***	***-***	***-***	***3***	***-***	***-***	***6***	***-***	***1***	***8***	***1***	***1***	***13***	***-***
16'000-17'999	2	23	3	-	-	-	-	-	-	-	1	-	-	-	1	1	1	2	-	1	-
14'000-15'999	3	27	1	-	-	-	-	-	-	-	-	-	-	2	-	-	5	-	1	3	1
sum 14'000-17'999	***5***	***50***	***4***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***1***	***-***	***-***	***2***	***1***	***1***	***6***	***2***	***1***	***4***	***1***
13'000-13'999	5	25	-	-	-	-	1	-	-	-	1	-	-	1	-	-	4	-	-	4	-
12'000-12'999	2	32	1	-	-	-	-	1	-	-	1	-	-	1	-	-	6	-	-	4	-
11'000-11'999	7	32	3	-	1	-	-	1	-	1	2	-	1	6	-	1	4	-	-	2	1
sum 11'000-13'999	***14***	***89***	***4***	***-***	***1***	***-***	***1***	***2***	***-***	***1***	***4***	***-***	***1***	***8***	***-***	***1***	***14***	***-***	***-***	***10***	***1***
10'000-10'999	6	45	4	-	2	-	-	-	-	-	3	2	-	3	-	-	6	-	-	6	-
9'000-9'999	7	30	1	-	-	-	-	1	-	1	1	-	1	4	-	1	4	-	-	2	-
8'000-8'999	8	43	2	-	1	-	-	-	-	-	2	-	3	3	-	1	6	-	1	4	-
7'000-7'999	15	50	3	-	1	-	-	-	-	-	3	1	1	4	-	3	4	-	2	8	-
sum 7'000-10'999	***36***	***168***	***10***	***-***	***4***	***-***	***-***	***1***	***-***	***1***	***9***	***3***	***5***	***14***	***-***	***5***	***20***	***-***	***3***	***20***	***-***
6'000-6'999	25	93	3	1	2	-	3	1	-	-	7	-	-	7	1	2	11	-	1	11	-
5'000-5'999	34	124	7	-	4	-	-	2	-	2	10	-	1	10	-	6	12	1	4	14	-
4'000-4'999	42	135	11	-	2	-	-	4	-	-	6	1	-	25	2	3	20	2	4	13	-
3'000-3'999	78	220	11	-	6	-	2	5	2	3	15	1	7	20	1	6	26	2	11	30	1
2'000-2'999	177	374	25	2	11	1	3	9	-	8	19	2	7	37	3	16	53	3	15	39	3
sum 2'000-6'999	***356***	***946***	***57***	***3***	***25***	***1***	***8***	***21***	***2***	***13***	***57***	***4***	***15***	***99***	***7***	***33***	***122***	***8***	***35***	***107***	***4***
1'000-1'999	490	697	91	10	17	3	6	26	6	23	36	5	36	83	9	37	105	8	49	94	5
500-999	779	695	123	7	8	3	10	23	8	24	38	13	52	84	12	65	80	12	87	76	14
sum 500-1'999	***1'269***	***1'392***	***214***	***17***	***25***	***6***	***16***	***49***	***14***	***47***	***74***	***18***	***88***	***167***	***21***	***102***	***185***	***20***	***136***	***170***	***19***
0-499	6'343	1'499	467	62	30	19	84	34	21	141	60	44	378	142	63	536	142	67	630	153	42
Total	**8'034**	**4'276**	**759**	**82**	**87**	**26**	**109**	**107**	**37**	**203**	**208**	**69**	**487**	**438**	**92**	**679**	**497**	**98**	**806**	**477**	**67**
Grand total			**13'069**			**195**			**253**			**480**			**1'017**			**1'274**			**1'350**

	1970-1974			1975-1979			1980-1984			1985-1989			1990-1994			1995-1999			2000-2001		
	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed	ungated	gated	mixed
>40'000	-	4	-	-	2	-	-	4	-	1	5	-	-	2	-	-	4	-	-	3	-
27'000-39'999	-	1	-	-	2	-	-	3	-	-	3	-	-	3	-	-	8	-	1	2	-
22'000-26'999	1	7	-	2	5	-	-	1	-	-	3	-	-	-	-	-	2	-	-	2	-
20'000-21'999	-	4	1	3	3	-	-	2	-	1	1	1	-	-	-	-	-	-	-	5	-
18'000-19'999	-	-	-	-	3	-	-	4	-	-	2	-	-	3	-	-	4	-	-	3	-
sum > 18'000	***1***	***16***	***1***	***5***	***15***	***-***	***-***	***14***	***-***	***2***	***14***	***1***	***-***	***8***	***-***	***-***	***18***	***-***	***1***	***15***	***-***
16'000-17'999	-	3	-	-	8	-	1	1	-	-	2	-	-	2	-	-	-	-	-	4	-
14'000-15'999	1	4	-	1	3	-	-	3	-	-	1	-	-	2	-	-	4	-	-	-	-
sum 14'000-17'999	***1***	***7***	***-***	***1***	***11***	***-***	***1***	***4***	***-***	***-***	***3***	***-***	***-***	***4***	***-***	***-***	***4***	***-***	***-***	***4***	***-***
13'000-13'999	-	2	-	-	3	-	3	2	-	-	1	-	-	3	-	-	3	-	1	1	-
12'000-12'999	-	3	-	1	6	-	-	1	-	-	5	-	-	1	-	1	3	1	-	-	-
11'000-11'999	-	2	-	1	1	1	1	6	1	-	1	-	1	3	-	-	2	-	1	1	-
sum 11'000-13'999	***-***	***7***	***-***	***2***	***10***	***1***	***4***	***9***	***1***	***-***	***7***	***-***	***1***	***7***	***-***	***1***	***8***	***1***	***2***	***2***	***-***
10'000-10'999	-	3	-	2	8	-	1	3	1	1	3	-	1	3	-	-	4	1	1	1	-
9'000-9'999	1	2	-	-	2	1	-	3	-	-	2	-	-	1	-	1	5	-	2	3	-
8'000-8'999	-	9	1	-	4	-	3	3	1	-	3	-	-	-	-	-	7	-	-	1	-
7'000-7'999	1	5	1	-	4	-	5	8	-	1	3	-	-	4	-	1	2	-	1	4	1
sum 7'000-10'999	***2***	***19***	***2***	***2***	***18***	***1***	***9***	***17***	***2***	***2***	***11***	***-***	***1***	***8***	***-***	***2***	***18***	***1***	***4***	***9***	***1***
6'000-6'999	-	12	-	2	10	-	6	6	-	2	16	1	5	4	-	2	4	1	1	2	-
5'000-5'999	4	10	1	2	11	1	3	16	1	5	11	1	1	5	-	5	13	1	1	6	1
4'000-4'999	9	10	2	7	12	1	5	13	1	5	14	-	1	6	-	5	4	1	3	6	1
3'000-3'999	11	18	1	8	22	-	5	23	-	7	20	1	5	9	1	6	21	1	7	5	-
2'000-2'999	28	45	2	21	34	1	21	32	4	17	28	1	11	33	2	10	27	3	18	7	-
sum 2'000-6'999	***52***	***95***	***6***	***40***	***89***	***3***	***40***	***90***	***6***	***36***	***89***	***4***	***23***	***57***	***3***	***28***	***69***	***7***	***30***	***26***	***2***
1'000-1'999	68	73	9	46	59	2	60	50	14	36	58	4	46	37	14	51	47	12	22	12	-
500-999	116	105	9	100	89	12	79	71	12	72	45	12	63	25	5	80	38	10	24	13	1
sum 500-1'999	***184***	***178***	***18***	***146***	***148***	***14***	***139***	***121***	***26***	***108***	***103***	***16***	***109***	***62***	***19***	***131***	***85***	***22***	***46***	***25***	***1***
0-499	927	210	55	1'174	271	54	738	153	36	534	104	28	528	89	22	518	93	14	93	18	2
Total	**1'167**	**532**	**82**	**1'370**	**562**	**73**	**931**	**408**	**71**	**682**	**331**	**49**	**662**	**235**	**44**	**680**	**295**	**45**	**176**	**99**	**6**
Grand total			**1'781**			**2'005**			**1'410**			**1'062**			**941**			**1'020**			**281**

Reference: ICOLD World Register of Dams, 2003

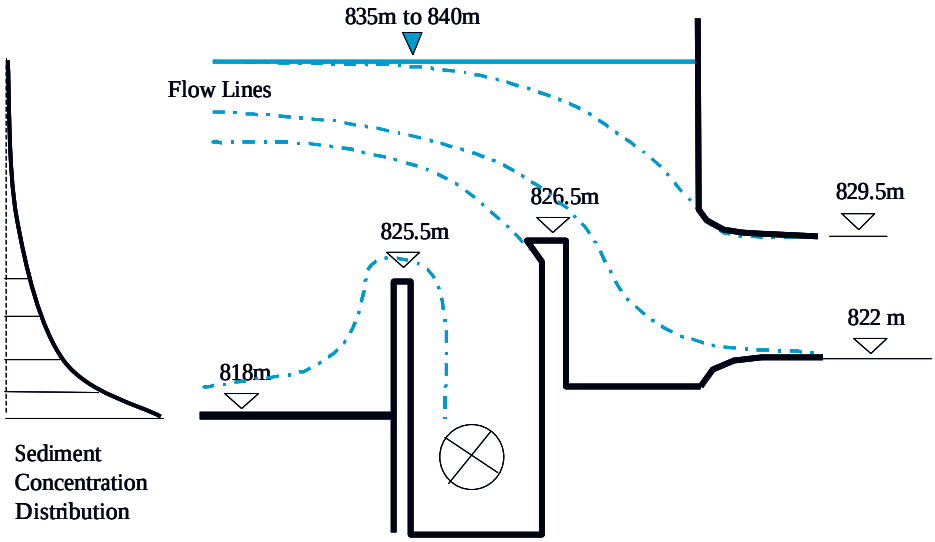
Section across sluice spillway right bay and elevation of power intake
Design submitted by India



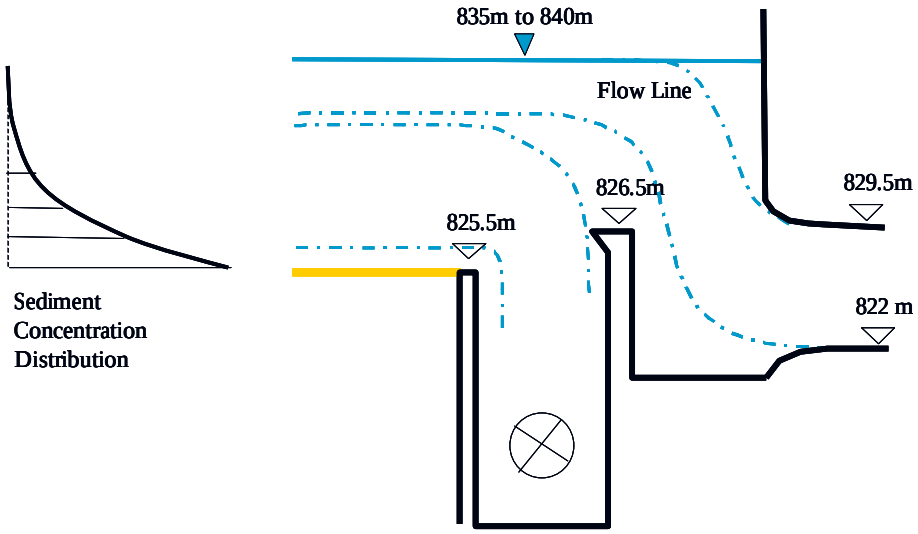
Source: India's Presentation on Intakes, London, 27th May, 2006 (powerpoint file)

Design of Intakes – Pakistan design with SET

Scenario 1 – Sediment level at elevation 818 m asl

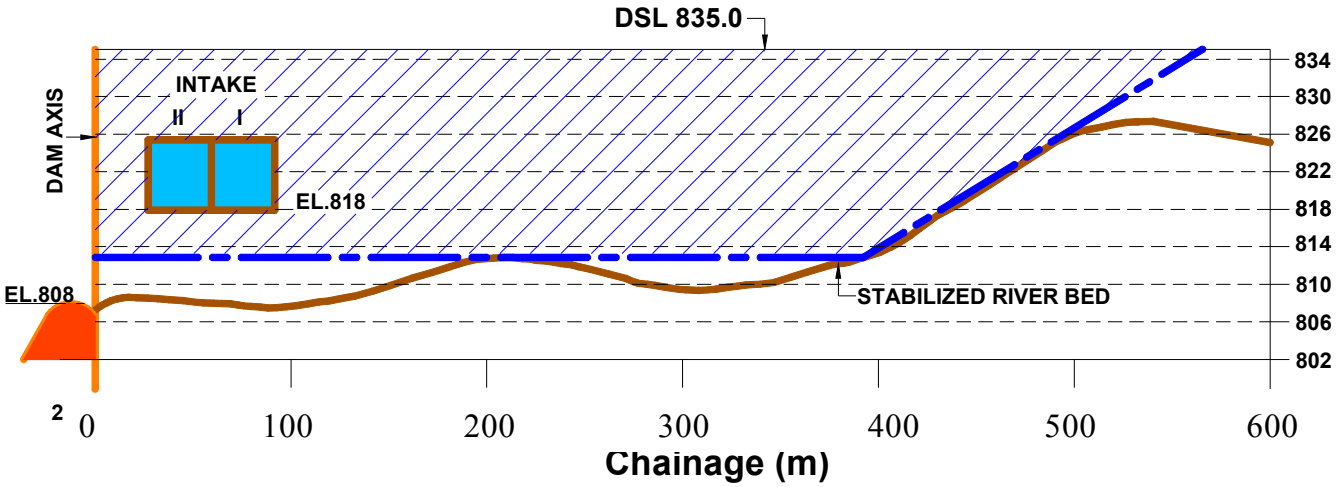


Scenario 2 – Sediment level at elevation 825.5 m asl



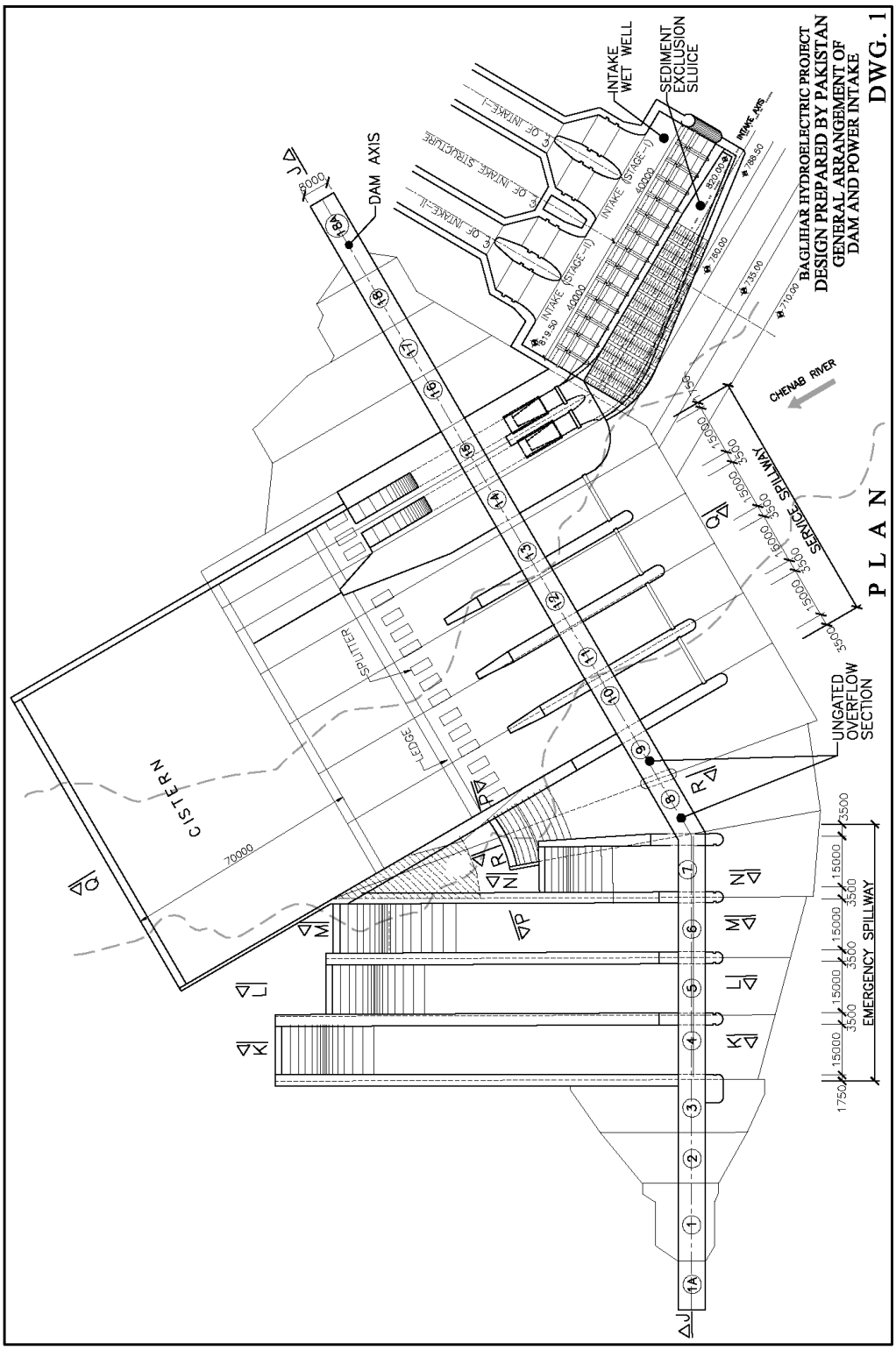
Source: Pakistan's Presentation on suspended sediments, Q_{ssm} 1 to 4, London, 25th May, 2006 (powerpoint file)

Stabilized bed profile in the near field, according to India

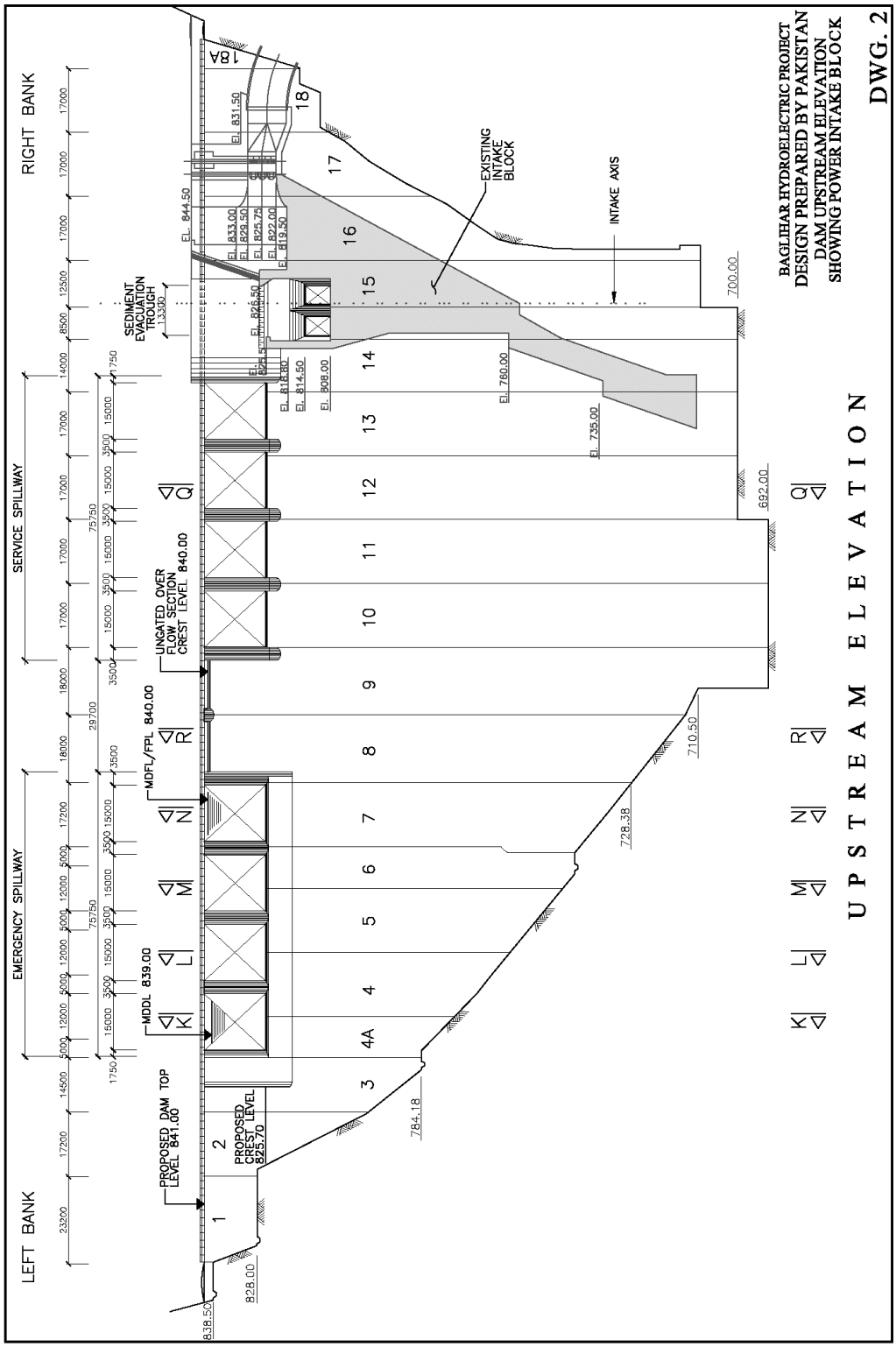


Source: India's presentation on suspended sediments, Q_{ssm} 1, London, 25th May, 2006 (powerpoint file)

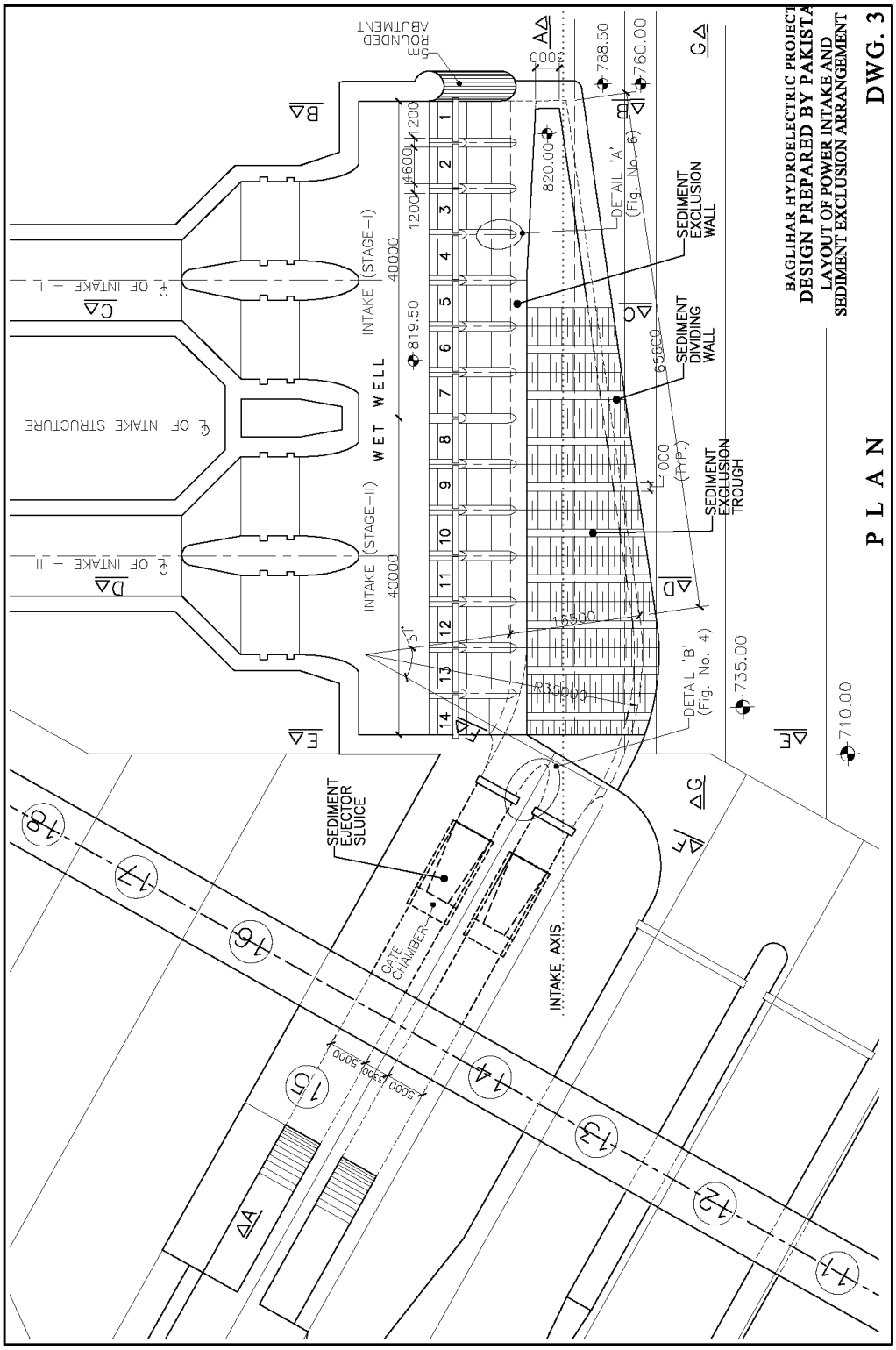
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



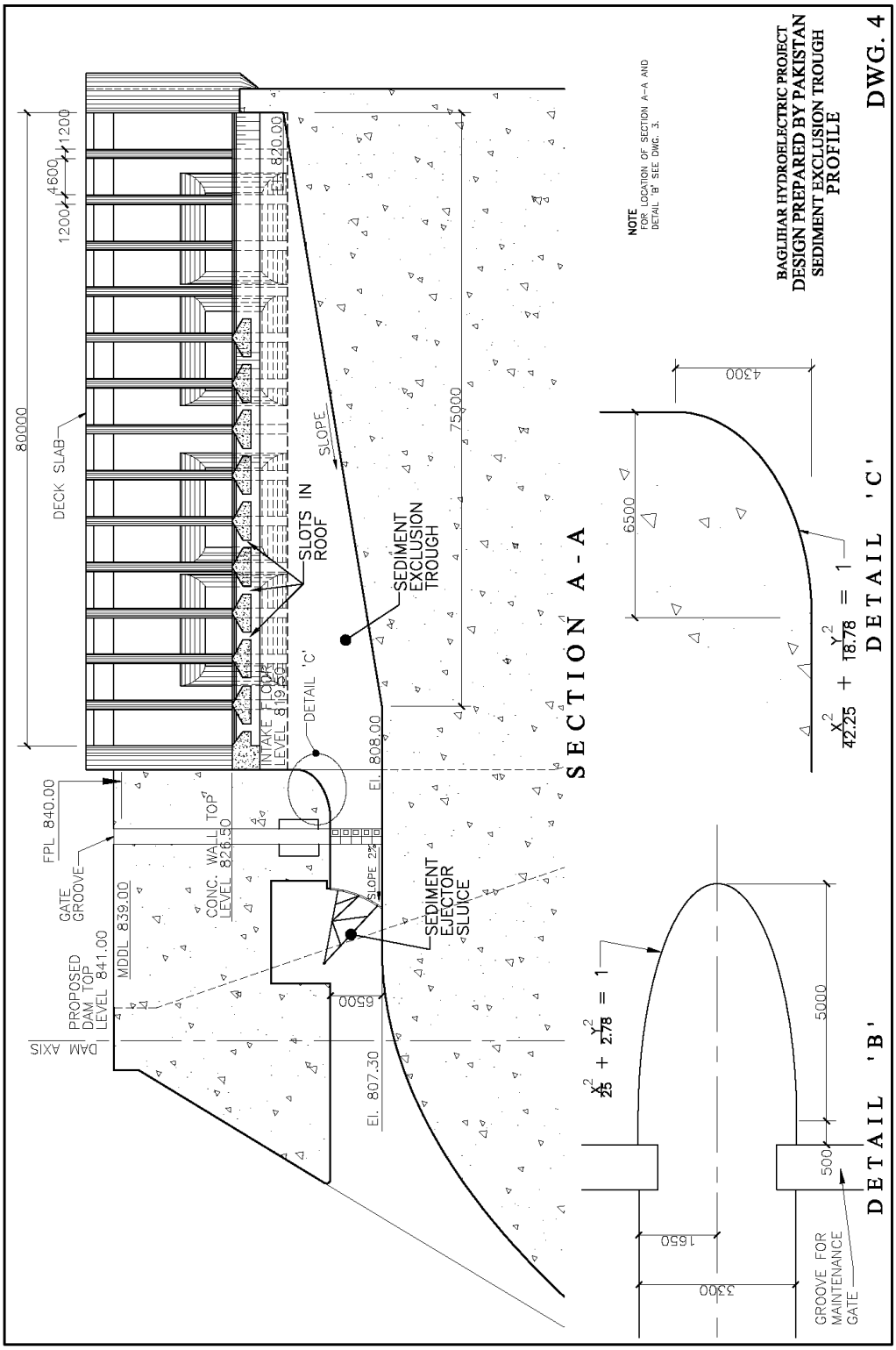
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



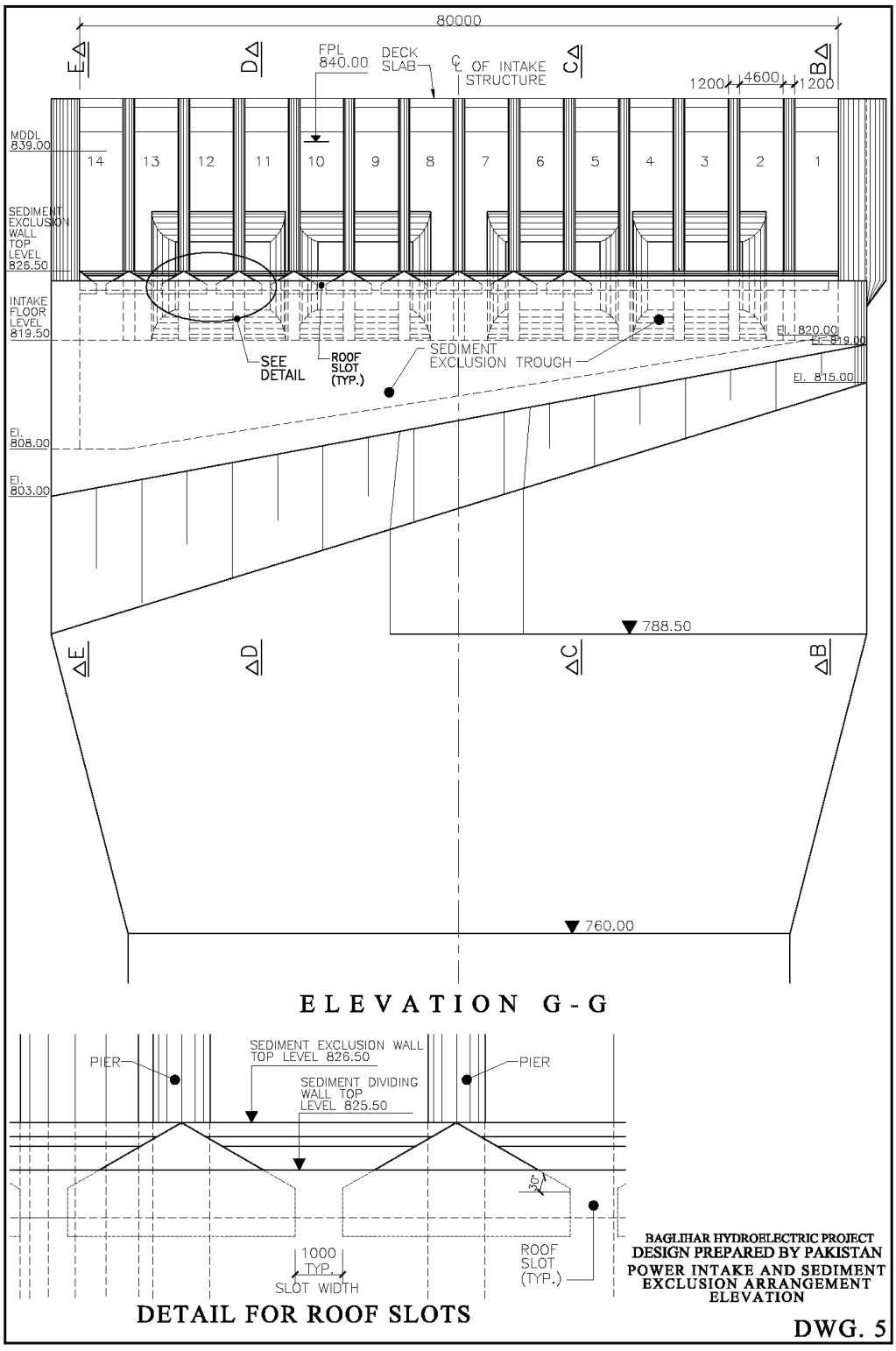
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



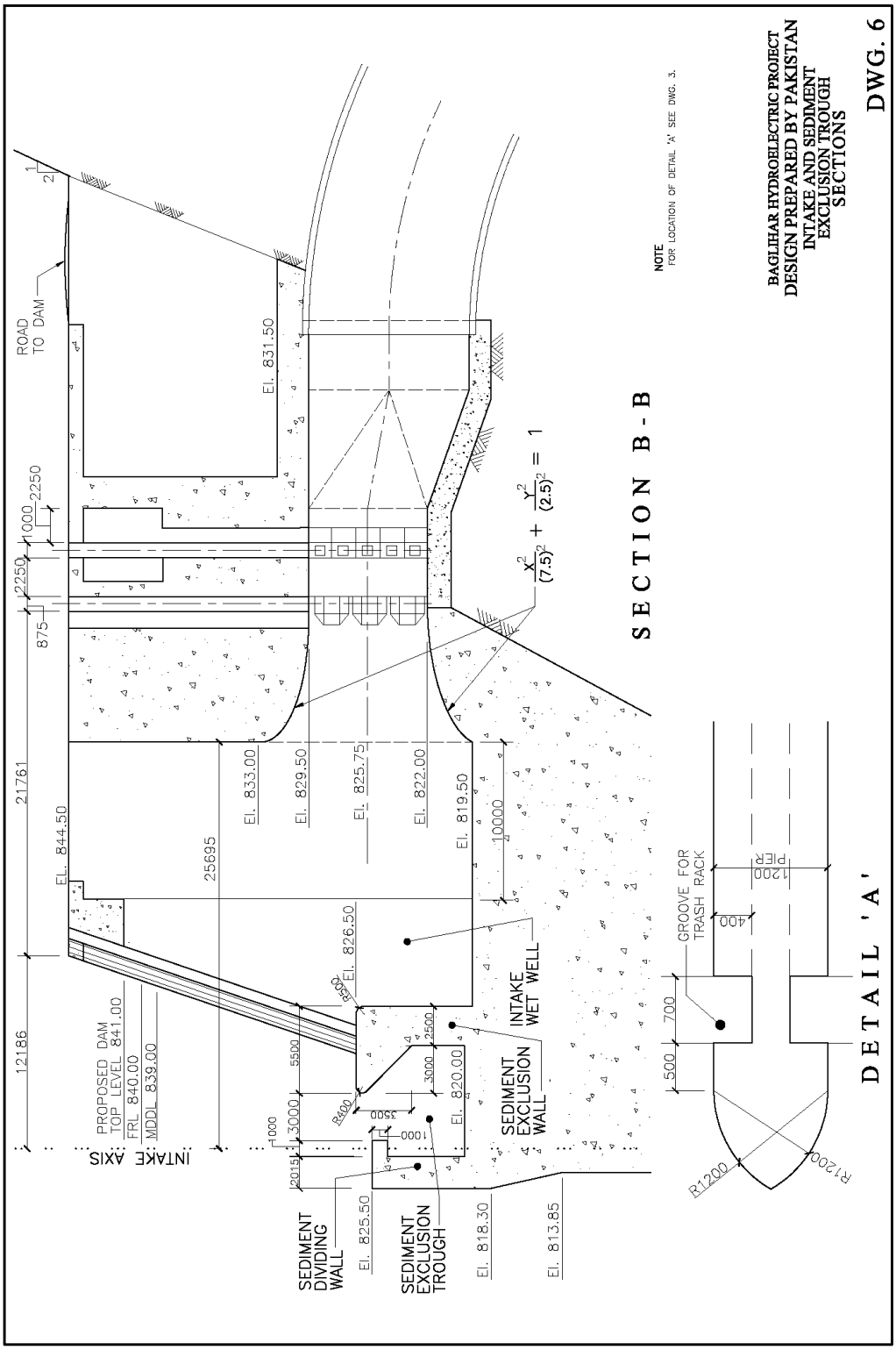
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



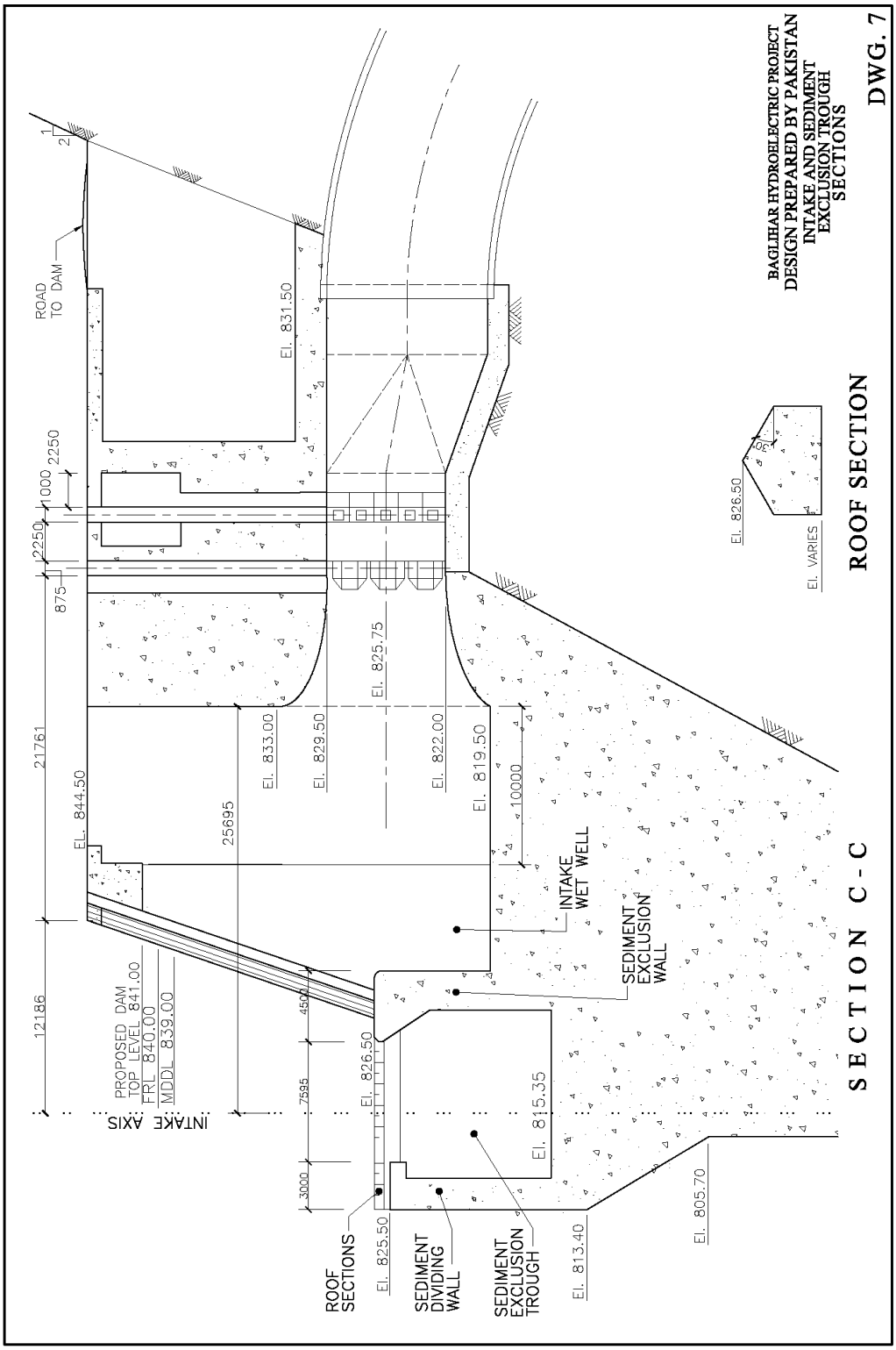
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



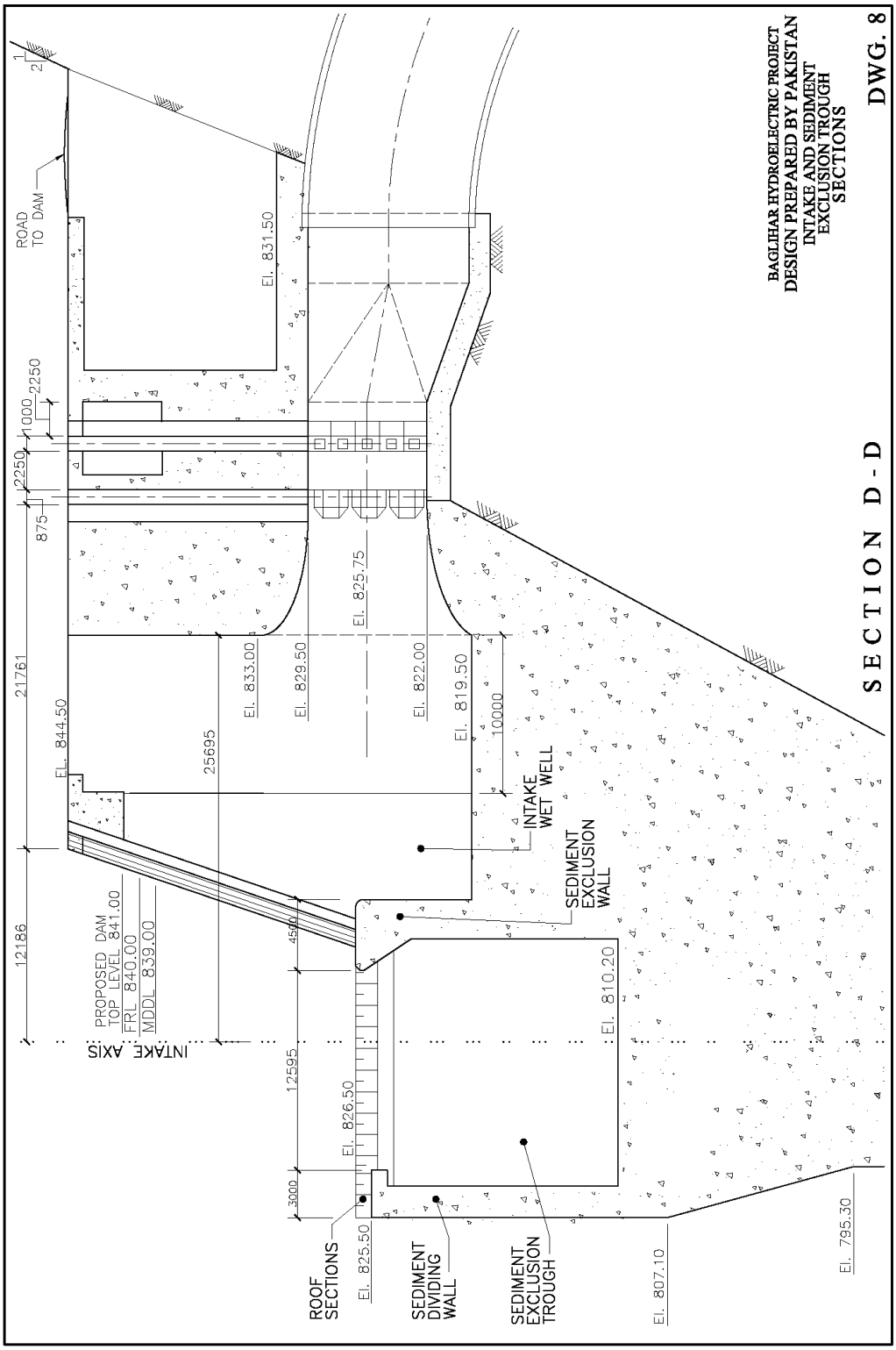
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



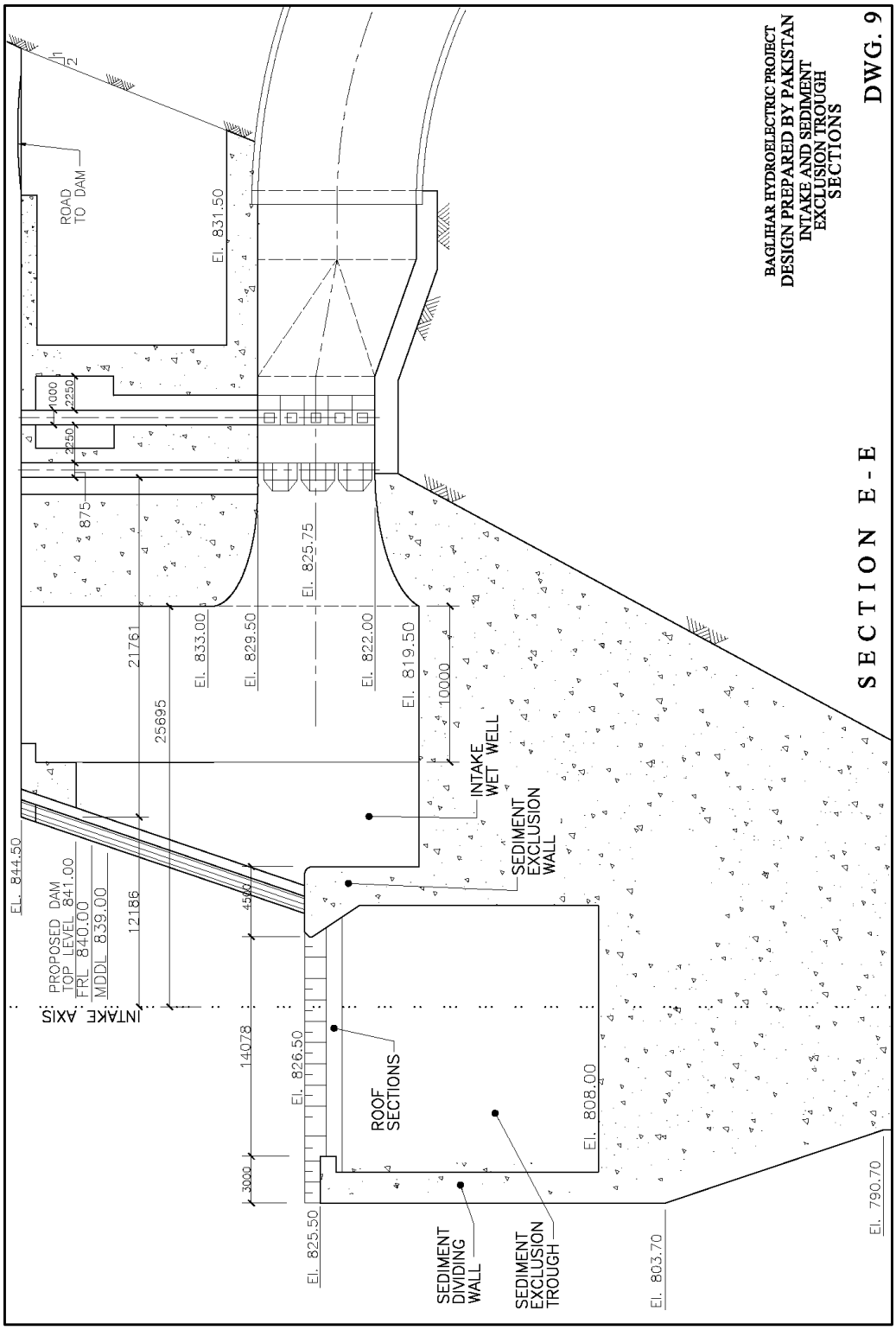
Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



Design proposed by Pakistan for the power intake
From Pakistan' reply, Part II, Annex II-D



Extract from *Les Pierres Sauvages*

Fernand POUILLON
Editions du Seuil, Paris, pages 109-111

Translated from the French text by Alison Bartle

This passage relates to a Master Builder giving instruction to his pupil Bernard, during the design of a Cistercian abbey in the 12th century.

"How can those masters of the profession know in advance that a building designed in this way will not collapse?", he asked me.

That is how we established unity in the design of schemes; the cornerstone of our art. Already, in the previous observation of Bernard, I had observed that technical issues seemed to be set apart in his mind from the design of shapes.

Since when have we separated, even just in the mind, modelling from technique, or structural shapes from construction materials? Architect and project manager are not simply titles, they are clearly defined and absolute functions. Shapes, volumes, weights, strengths, pressures, deformations, equilibrium, movement, outlines, loads and overloads, humidity, dryness, warmth and cold, sound, light, shade and half-light, perceptions, earth, water and air: each one of these is contained in the sovereign set of functions, in the unique brain, of an ordinary human builder.

This man, the builder, is all: clay and sand, stone and wood, iron and bronze. He becomes as one with his construction materials, and assumes their identity; all the elements, and all the tangible and spiritual forces. He will carry them within him, evaluate them, measure them, view them through his soul, as if he were holding them in his hands. I don't intend these to be poetic images: they are material facts, which for me are unquestionable, and I even regard them as quite prosaic.

If I were a wooden beam resting between two supports twenty feet apart, I would estimate the strength of the fibres of my back, and broaden myself sufficiently to allow my body to resist the bending caused by my own weight, and by the forces I should have to withstand. Simultaneously, I would consider my external appearance: the effect of my trajectory and my colour; thus I would determine my material composition, considering whether I should be made of oak or pine. These considerations are sparked off during the early stage of a study, with unconditional simultaneity.

This simple example, which I have just described, can be carried through to all other aspects of the work: the beam can represent a simplified image of a flying buttress and its aerial structure; a solid buttress; an arch. I can, and I must, be capable of breaking myself down

into the individual stones of the arch; feel myself to be the keystone of the arch, the cross beam or the voussoir. I must recognize the stone in my flesh, regard it as my own skin, make it follow a chosen profile, and fit in with the resulting volume. The ultimate shape will be defined by this choice. Structure is all; shape is all; matter is all.

How can one explain this mystery, without recognizing that man contains all of this within himself? Why speak of calculations, which are nothing, which create nothing, when technical problems are contained in the final shape? Why is it necessary to check volumes when they have been determined? No doubt it is for the satisfaction, for the pleasure, of answering 'yes' to oneself. But if the answer is 'no', what then? Is it necessary to start all over again, returning to the initial study?

Calculations are the proof, but they will never be a means in themselves. Did the very first builder know how to count? Certainly he did not. But he did have a clear objective: to create shelter. This basic necessity assumed a certain beauty, because this man saw before him nature, the sky, light and colour, mountains with their particular profile, stones and the material of which they were made.

The first collapse of a building represented the first failure, and probably the first anxiety, the first calculation. To sanctify calculations would amount to recognizing failure as an original work of art. Should we allow that? Any theory can be defended, but I leave it to men of the faith to reply to this question.

In conclusion, I think that duality, plurality in the design of a work of art is worse than a weakness; it is a vice. Beauty cannot exist without equilibrium, nor technique without material, equilibrium without beauty.

Flood routing using India's rating curves

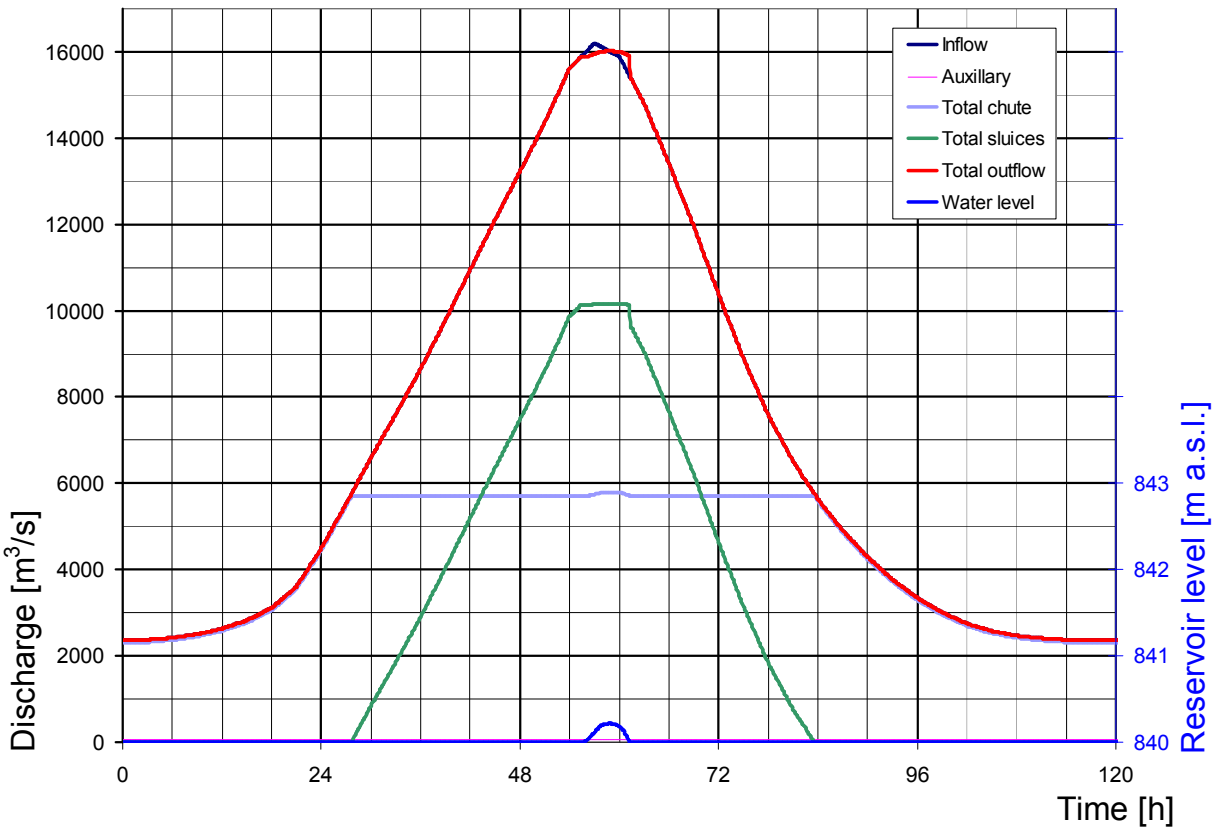
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
3 chute spillways
1 auxiliary spillway

Max WL	840.22	masl
Max auxillary	57	m3/s
Max chute spillways	5'793	m3/s
Spec. Discharge	*161*	m2/s
Max sluice spillways	10'166	m3/s
Max outflow	16'017	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835		3'607	9'130
836		4'003	9'338
837		4'412	9'541
838	11	4'831	9'739
839	29	5'260	9'934
840	52	5'698	10'125
841	77	6'144	10'313
842	104	6'598	10'497
843	131	7'059	10'678

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.10	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	19	m
Cd	0.494	
Ka	0.1	
Kp	0.01	
Sluice spillway		
Number Outlets	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.411	
Orifice operation level	840.05	
Delta orifice opening	0	



Flood routing using India's rating curves

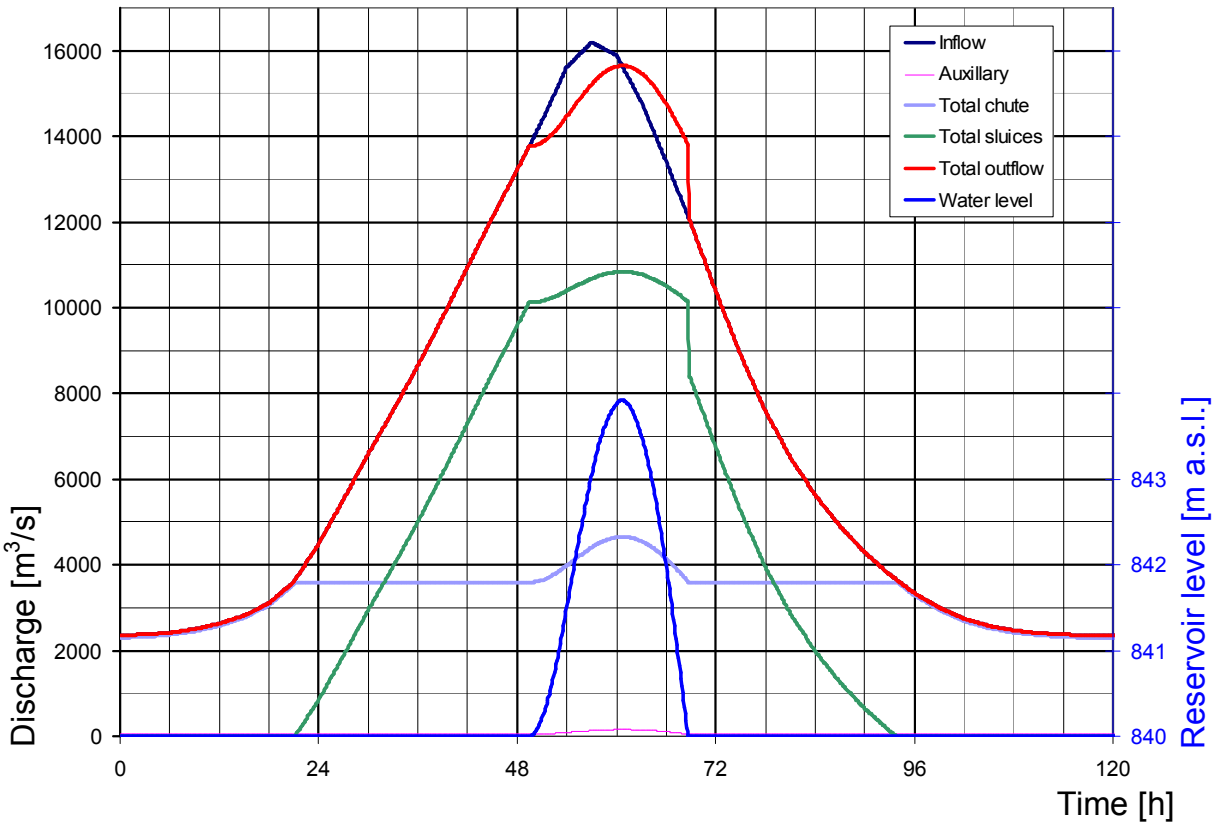
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
2 chute spillways
1 auxiliary spillway

Max WL	843.92	masl
Max auxillary	156	m3/s
Max chute spillways	4'655	m3/s
Spec. Discharge	*194*	m2/s
Max sluice spillways	10'842	m3/s
Max outflow	15'653	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835		2'312	9'130
836		2'558	9'338
837		2'810	9'541
838	11	3'066	9'739
839	29	3'327	9'934
840	52	3'592	10'125
841	77	3'860	10'313
842	104	4'130	10'497
843	131	4'403	10'678

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.10	
Gate opening level	840	masl
Chute spillway		
Number bays	2	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	19	m
Cd	0.494	
Ka	0.1	
Kp	0.01	
Sluice spillway		
Number Outlets	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.411	
Orifice operation level	840.05	
Delta orifice opening	0	



Flood routing using India's rating curves

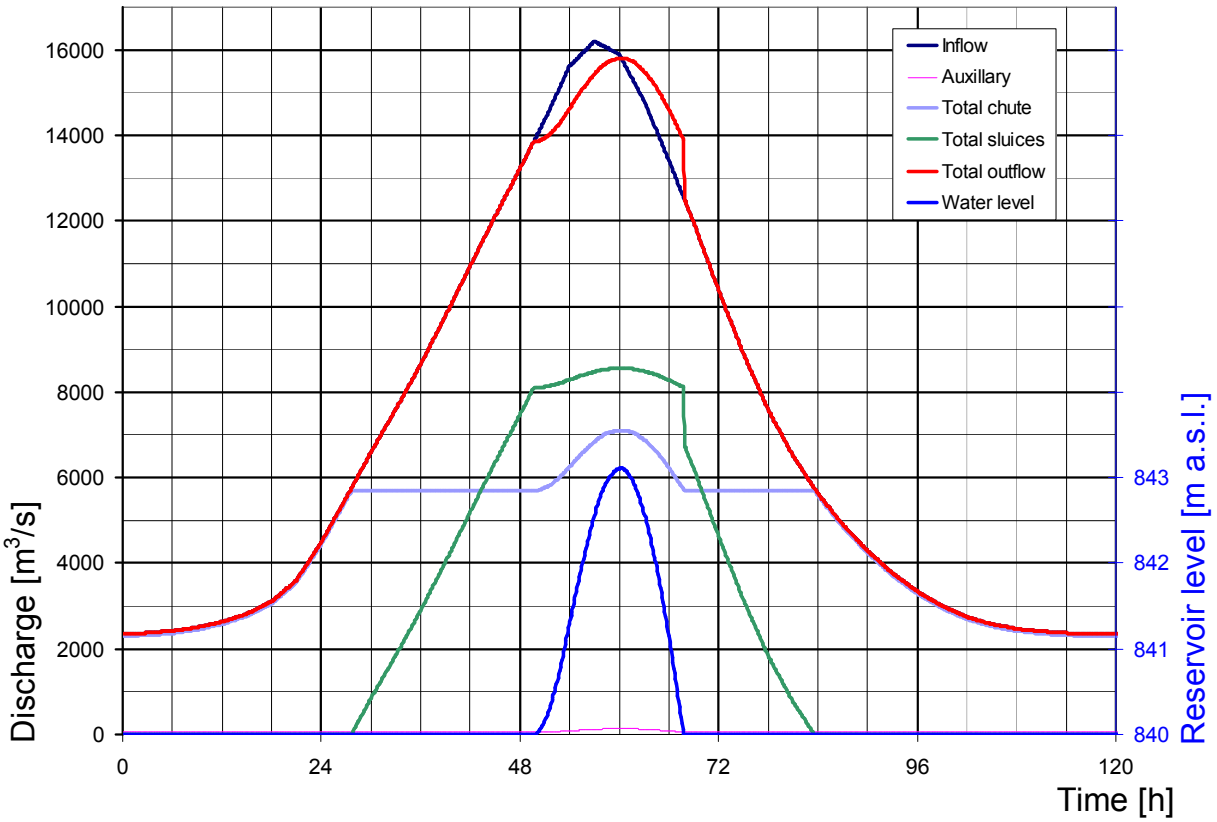
Inflow : PMF (or 10'000-years flood)

Outlets : **4 sluice spillways**
3 chute spillways
1 auxiliary spillway

Max WL	843.11	masl
Max auxillary	134	m3/s
Max chute spillways	7'111	m3/s
Spec. Discharge	*198*	m2/s
Max sluice spillways	8'558	m3/s
Max outflow	15'803	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835		3'607	7'304
836		4'003	7'470
837		4'412	7'633
838	11	4'831	7'792
839	29	5'260	7'947
840	52	5'698	8'100
841	77	6'144	8'250
842	104	6'598	8'398
843	131	7'059	8'542

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.10	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	19	m
Cd	0.494	
Ka	0.1	
Kp	0.01	
Sluice spillway		
Number Outlets	4	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.411	
Orifice operation level	840.05	
Delta orifice opening	0	



Flood routing using Pakistan's rating curves

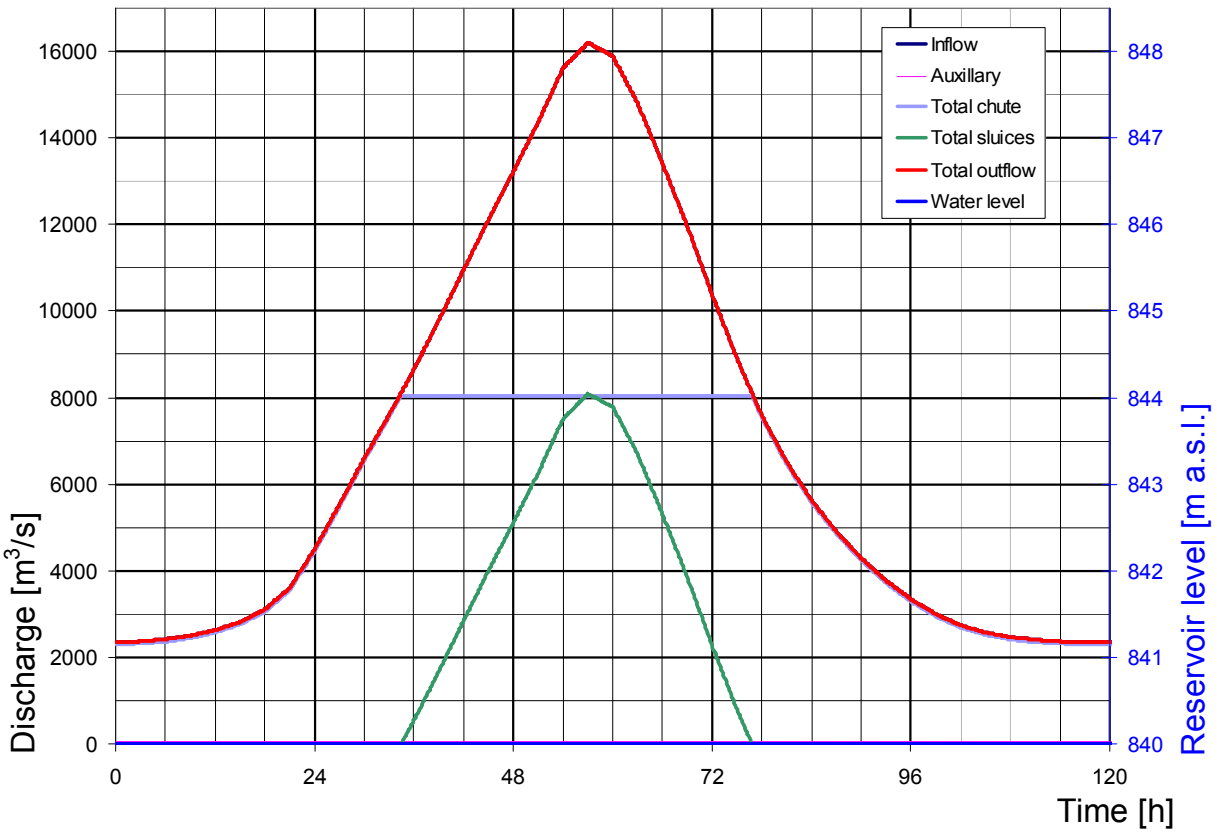
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
3 chute spillways
1 auxiliary spillway

Max WL	840.00	masl
Max auxillary	52	m3/s
Max chute spillways	8'054	m3/s
Spec. Discharge	*224*	m2/s
Max sluices spillways	8'088	m3/s
Max outflow	16'195	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835			
836			
837			
838			
839		4'565	8'915
840		5'168	9'088
841		5'836	9'257
842		6'575	9'423
843		7'391	9'587

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.05	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd		m
Cd		
Ka		
Kp		
Sluice spillway		
Number Orifices	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
xi		
Orifice operation level	840.005	masl
Delta orifice opening	0.001	m



Flood routing using Pakistan's rating curves

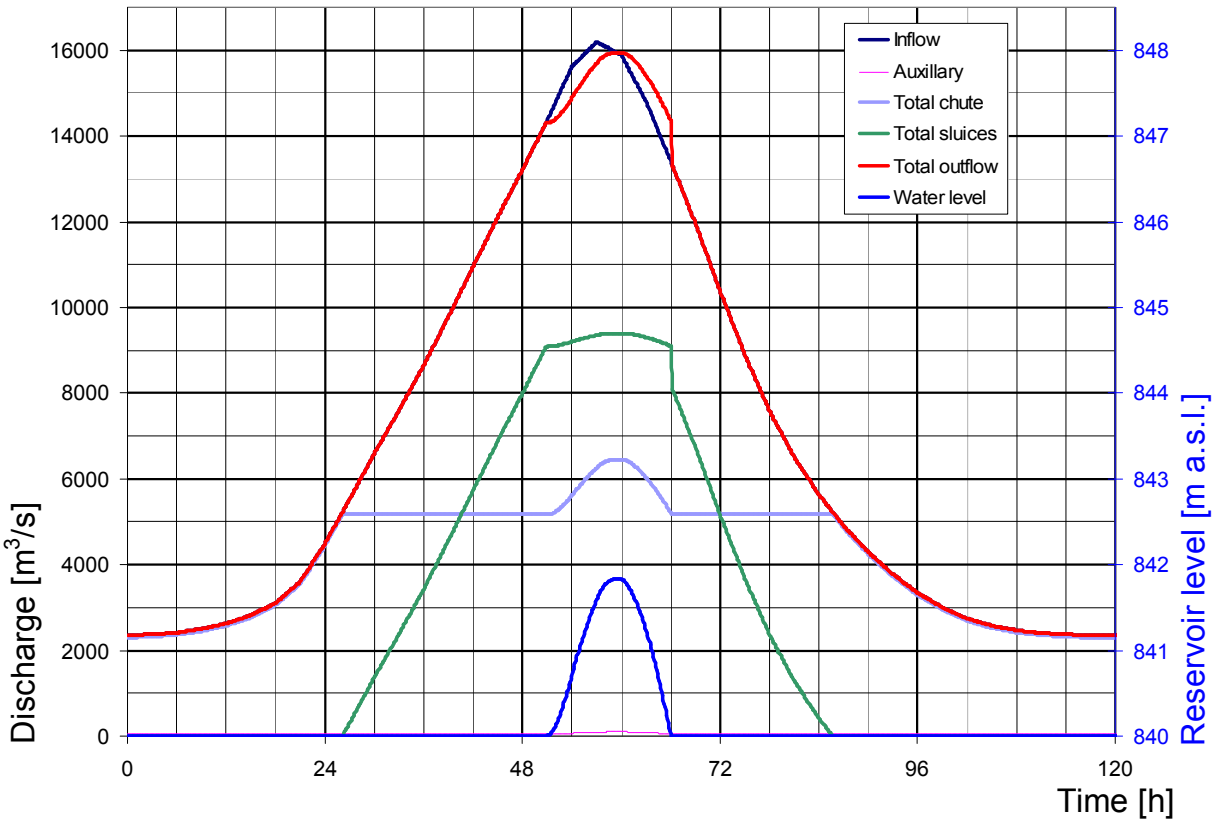
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
2 chute spillways
1 auxiliary spillway

Max WL	841.83	masl
Max auxillary	100	m3/s
Max chute spillways	6'452	m3/s
Spec. Discharge	*269*	m2/s
Max sluices spillways	9'396	m3/s
Max outflow	15'947	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835			
836			
837			
838			
839		4'565	8'915
840		5'168	9'088
841		5'836	9'257
842		6'575	9'423
843		7'391	9'587

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.05	
Gate opening level	840	masl
Chute spillway		
Number bays	2	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd		m
Cd		
Ka		
Kp		
Sluice spillway		
Number Orifices	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
xi		
Orifice operation level	840.005	masl
Delta orifice opening	0.001	m



Flood routing using Pakistan's rating curves

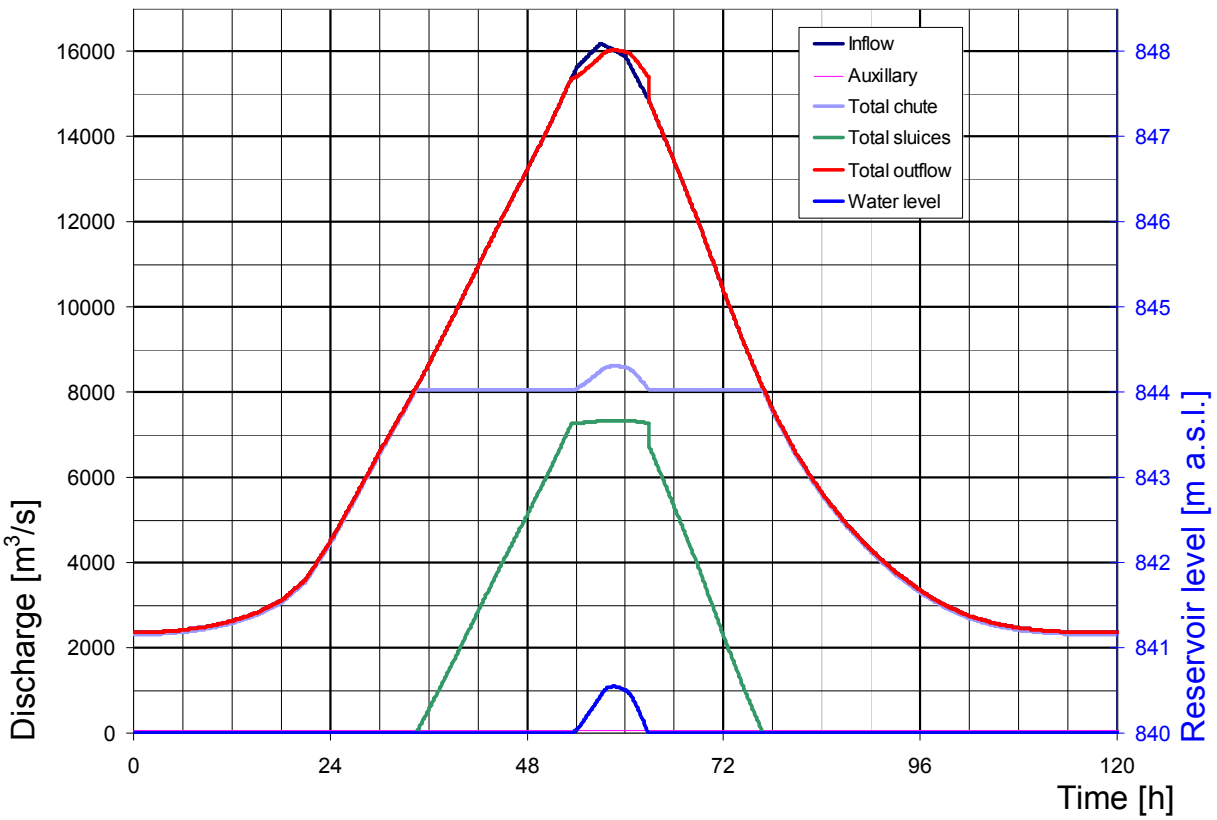
Inflow : PMF (or 10'000-years flood)

Outlets : **4 sluice spillways**
3 chute spillways
1 auxiliary spillway

Max WL	840.54	masl
Max auxillary	66	m3/s
Max chute spillways	8'624	m3/s
Spec. Discharge	*240*	m2/s
Max sluices spillways	7'344	m3/s
Max outflow	16'034	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835			
836			
837			
838			
839		4'565	8'915
840		5'168	9'088
841		5'836	9'257
842		6'575	9'423
843		7'391	9'587

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.05	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd		m
Cd		
Ka		
Kp		
Sluice spillway		
Number Orifices	4	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
xi		
Orifice operation level	840.005	masl
Delta orifice opening	0.001	m



Flood routing using the rating curves defined by the NE

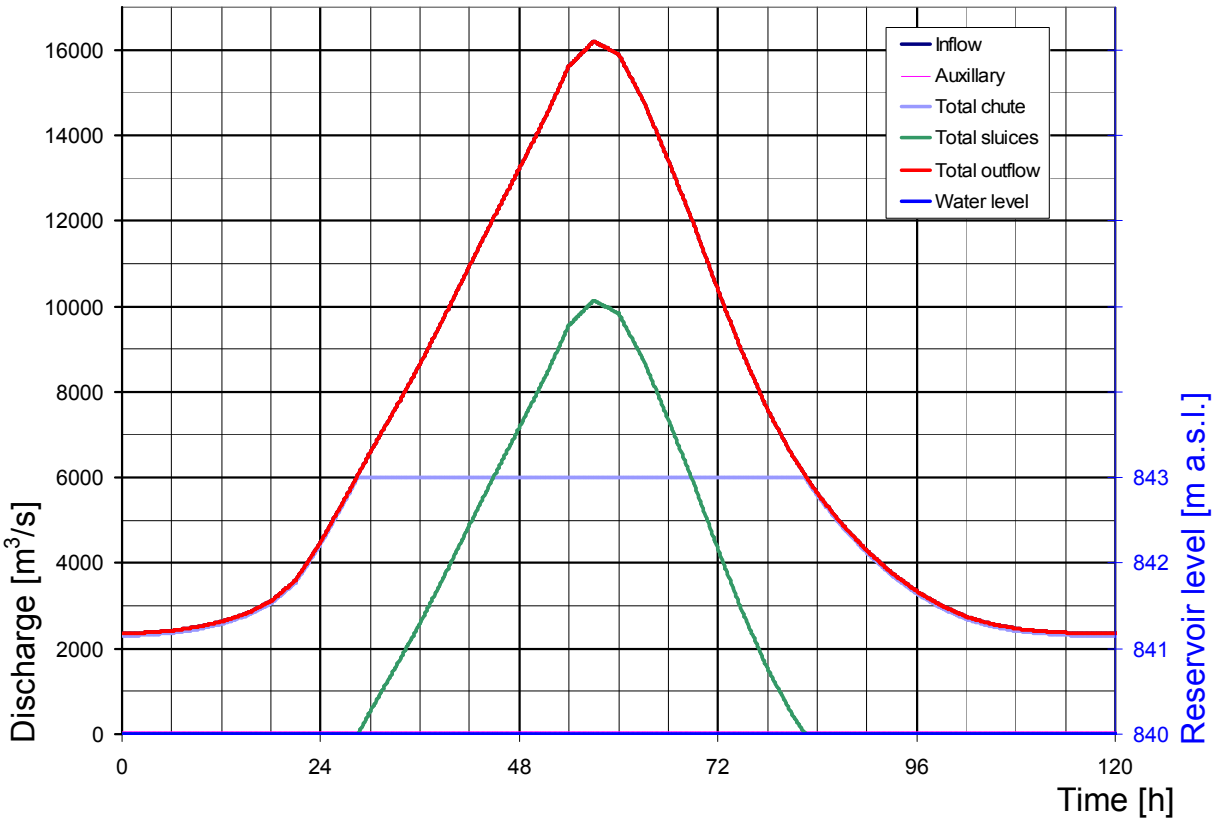
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
3 chute spillways
1 auxiliary spillway

Max WL	840.00	masl
Max auxillary	53	m3/s
Max chute spillways	6'003	m3/s
Spec. Discharge	*167*	m2/s
Max sluice spillways	10'138	m3/s
Max outflow	16'195	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835		3'774	9'512
836		4'195	9'728
837		4'629	9'940
838	11	5'076	10'147
839	30	5'534	10'350
840	53	6'003	10'549
841	80	6'483	10'744
842	108	6'972	10'936
843	138	7'471	11'125

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.08	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	15	m
Cd	0.494	
Ka	0.08	
Kp	0.01	
Sluice spillway		
Number Outlets	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.3	
Orifice operation level	840.05	
Delta orifice opening	0	



Flood routing using the rating curves defined by the NE

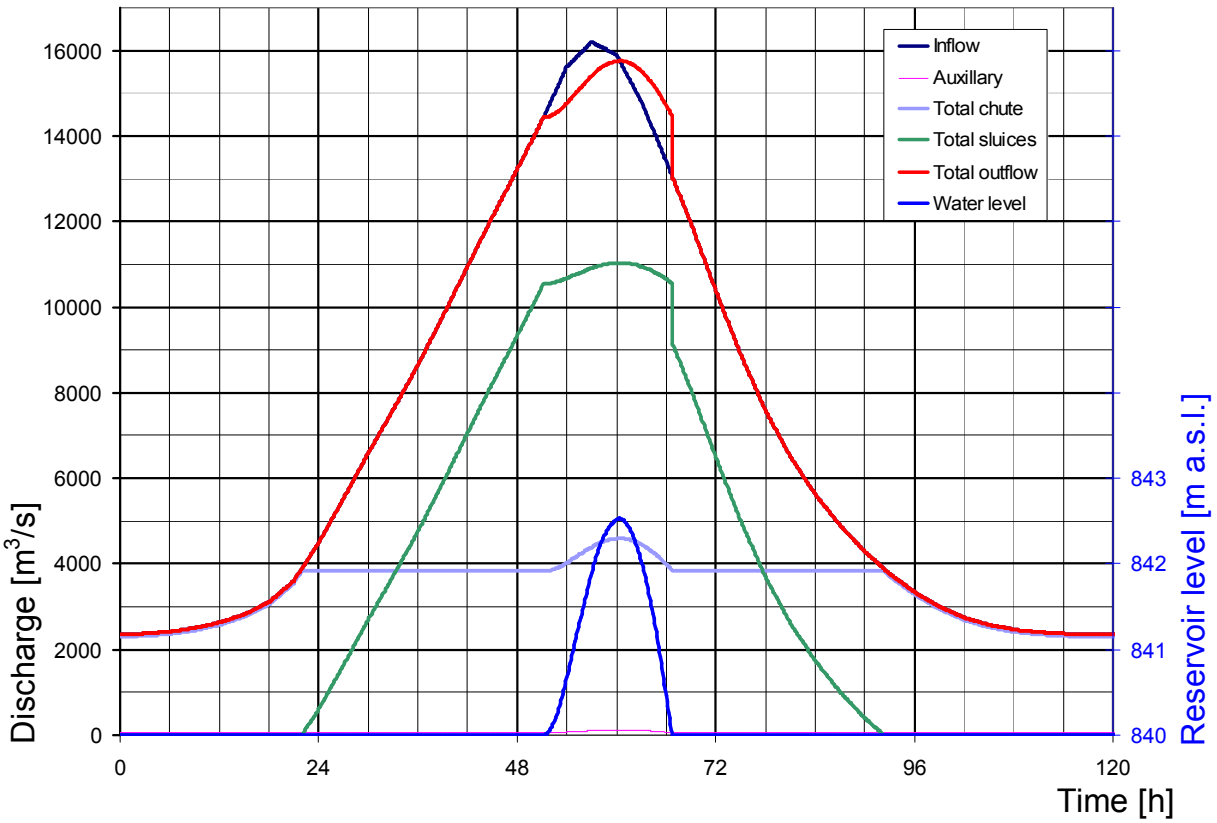
Inflow : PMF (or 10'000-years flood)

Outlets : 5 sluice spillways
2 chute spillways
1 auxiliary spillway

Max WL	842.53	masl
Max auxillary	124	m3/s
Max chute spillways	4'595	m3/s
Spec. Discharge	*191*	m2/s
Max sluice spillways	11'037	m3/s
Max outflow	15'755	m3/s
Max inflow	16'195	m3/s

Elevation	Auxillary	Chute	Sluice
835		2'442	9'512
836		2'708	9'728
837		2'981	9'940
838	11	3'260	10'147
839	30	3'546	10'350
840	53	3'837	10'549
841	80	4'133	10'744
842	108	4'433	10'936
843	138	4'738	11'125

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.08	
Gate opening level	840	masl
Chute spillway		
Number bays	2	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	15	m
Cd	0.494	
Ka	0.08	
Kp	0.01	
Sluice spillway		
Number Outlets	5	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.3	
Orifice operation level	840.05	
Delta orifice opening	0	



Flood routing using the rating curves defined by the NE

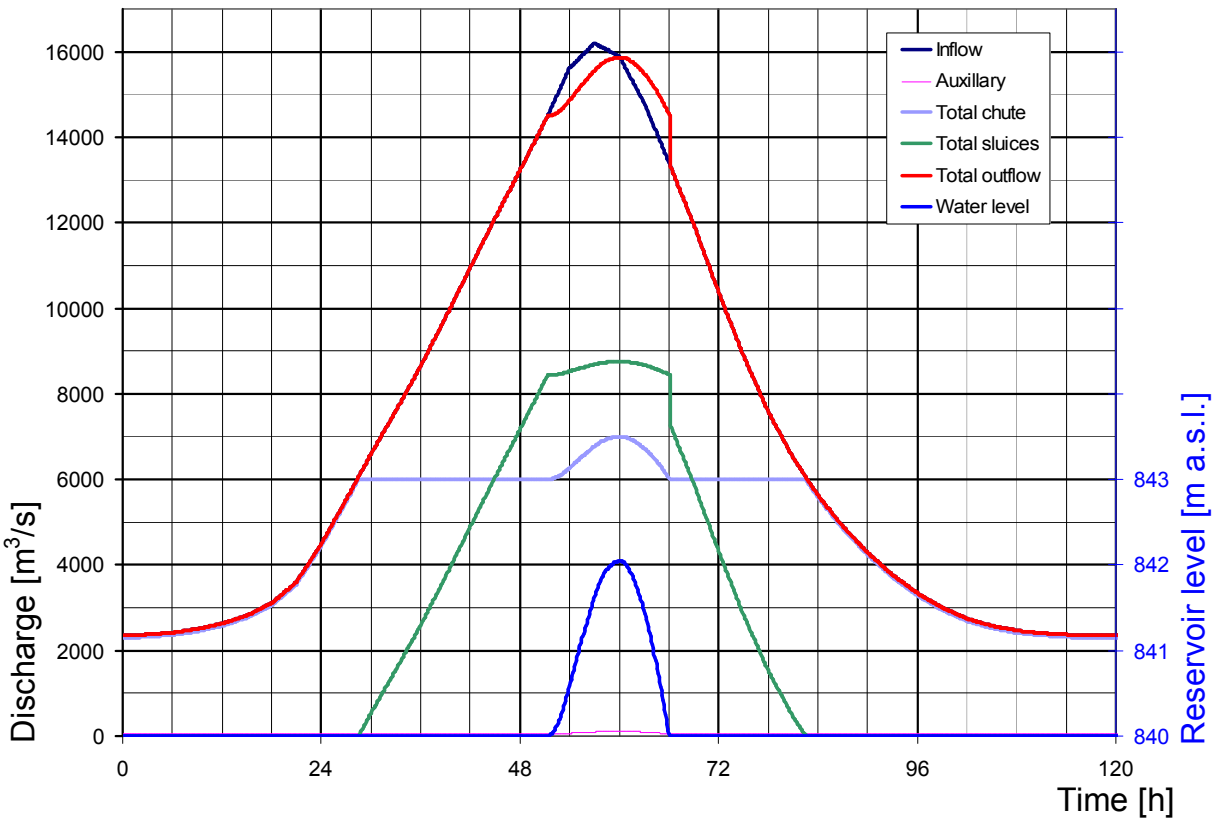
Inflow : PMF (or 10'000-years flood)

Outlets : **4 sluice spillways**
3 chute spillways
1 auxiliary spillway

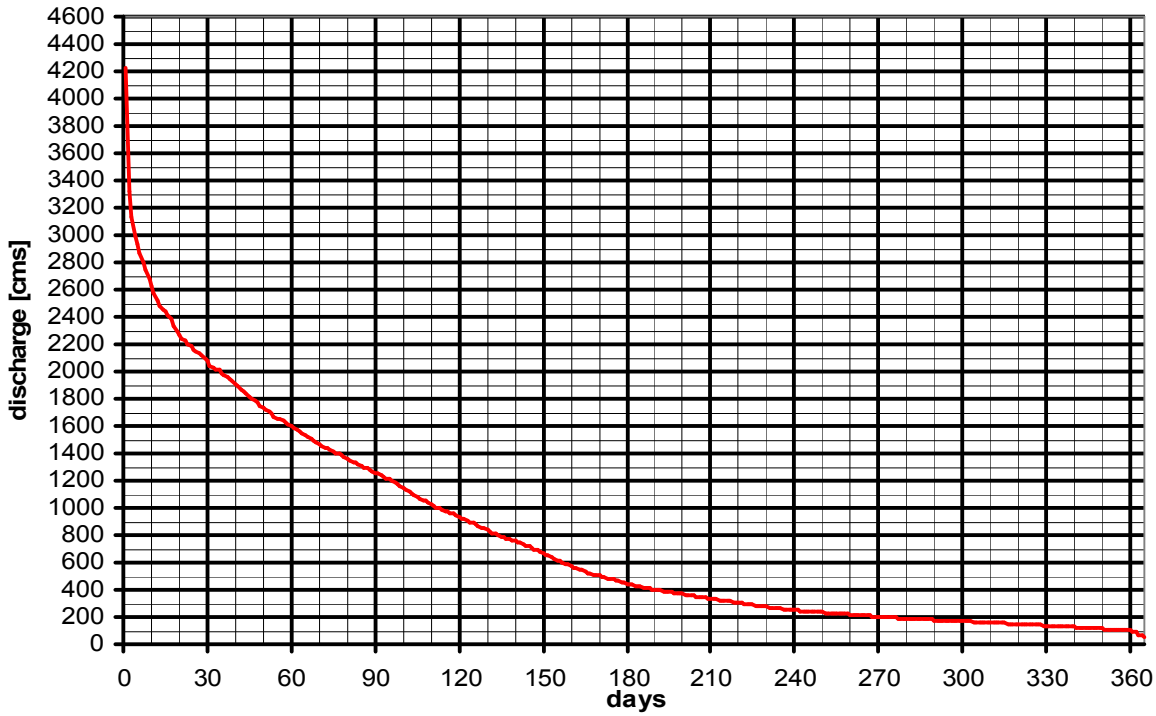
Max WL	842.04	masl
Max auxillary	109	m3/s
Max chute spillways	6'994	m3/s
Spec. Discharge	*194*	m2/s
Max sluice spillways	8'756	m3/s
Max outflow	15'859	m3/s
Max inflow	16'195	m3/s

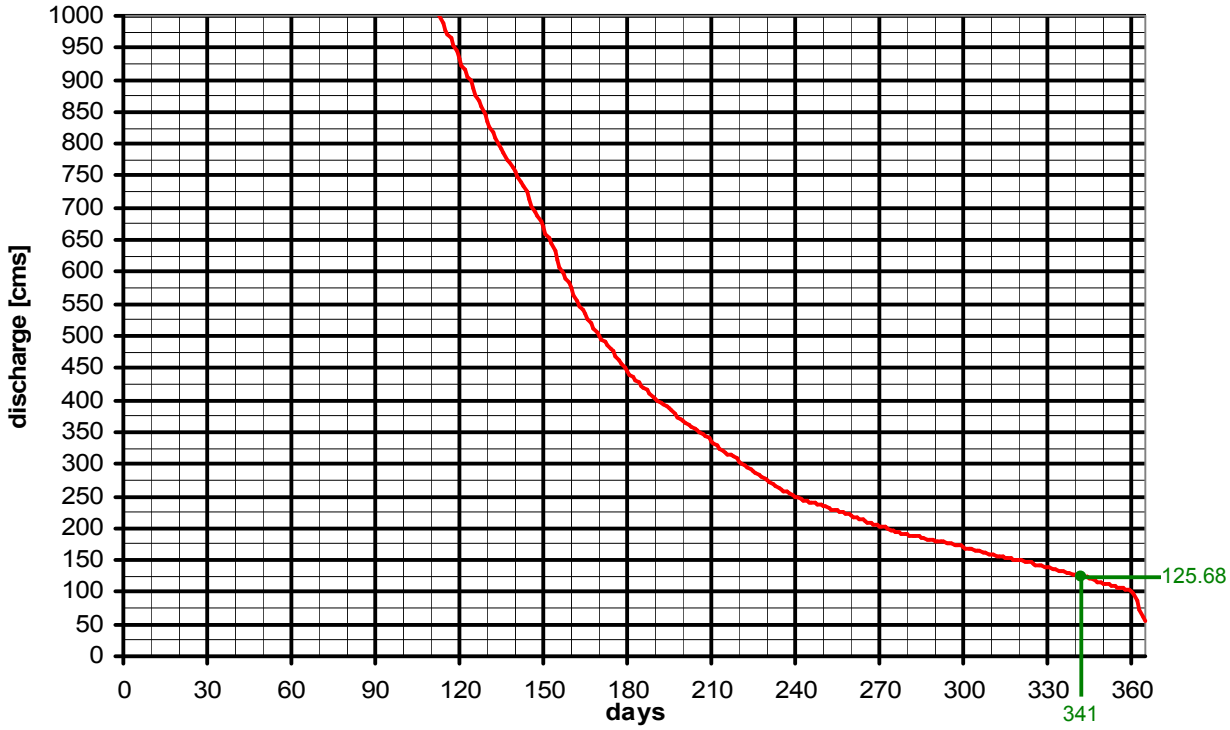
Elevation	Auxillary	Chute	Sluice
835		3'774	7'610
836		4'195	7'782
837		4'629	7'952
838	11	5'076	8'117
839	30	5'534	8'280
840	53	6'003	8'439
841	80	6'483	8'595
842	108	6'972	8'749
843	138	7'471	8'900

Hydrograph Nr.	1	
Inflow Hydrograph	PMF*	
Peak discharge	*16200*	
Initial water level	840	masl
Auxillary spillway		
Number bays	1	
Bay width	6	m
Seal level	837	masl
Hd	3	m
Cd	0.42	
Ka	0.08	
Gate opening level	840	masl
Chute spillway		
Number bays	3	
Bay width	12	m
Seal level	821	masl
Gate opening level	840	masl
Delta gate opening	0.002	m
Hd	15	m
Cd	0.494	
Ka	0.08	
Kp	0.01	
Sluice spillway		
Number Outlets	4	
Height	10.5	m
Width	10	m
Elevation	813.25	masl
Ki	1.3	
Orifice operation level	840.05	
Delta orifice opening	0	



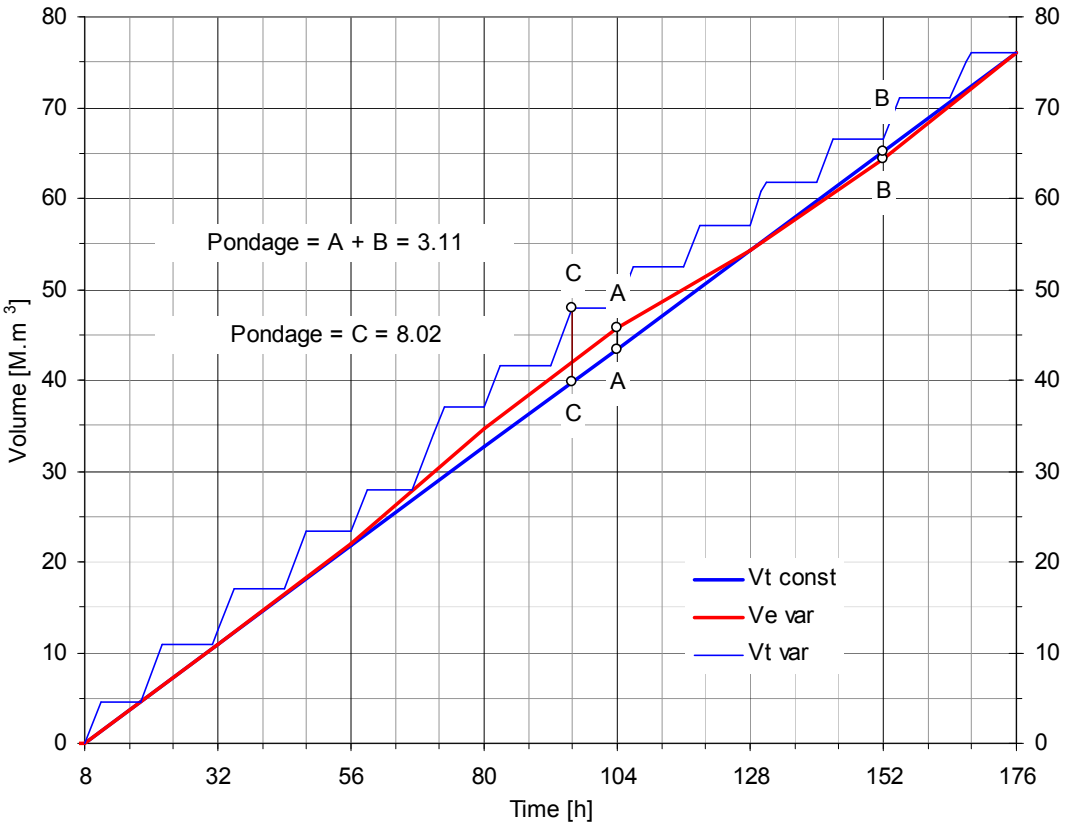
Flow duration curve
of Chenab river at Baglihar





Complete years : 1977, 1981 to 1983, 1988, 1990 to 2004 :	20 years
Completed years : 1976, 1978, 1980, 1989	
(completed with months from 1979 and 1987, which are incomplete years) :	4 years
1st semester 2005 and 2nd semester 1987 :	1 year
Total	**25 years**

Pondage calculation done by Pakistan



Pondage calculation done by India