


**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 35
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

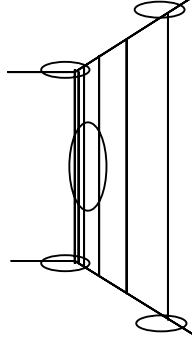
Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	C	C	
Corrosion	C	B	C	
Cracking	B	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	31.5	27.7	29.6	
Schmidt hammer	Ave. 29.63 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 36
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

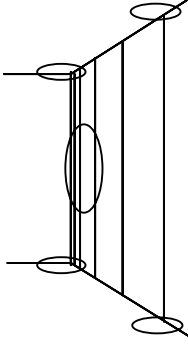
Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	C	C	
Corrosion	C	Flooring	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		5 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	30.9	29.0	27.1	
Schmidt hammer	Ave. 28.99 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 37
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

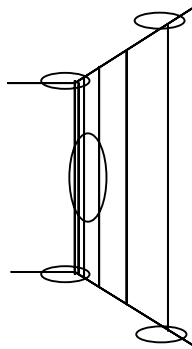
Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	C	C	
Corrosion	C	Flooring	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		10 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	27.1	30.3	27.7	
Schmidt hammer	Ave. 28.36 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 38
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	C	C	
Corrosion	C	B	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	28.4	33.4	32.8	
Schmidt hammer	Ave. 29.41 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

### BARRAGE LEDGER NOTE

DESIGN CONDITION	
Barrage Width	4,343 ft (1,324.66 m)
Gate Number	Nos. 65
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)
3 years Return period	13,000 m <sup>3</sup> /s
Longitudinal Profile	1/5,000
Crest Elevation (top)	RL 428 ft
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)
Crest Width	60 ft (18.29 m)
Crest Length	Upstream 28.0 m Down stream 40.0 m
Apron Length	Upstream 80.0 m Down stream 79.0 m
Cobble stone length	Down stream 80.6 m
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m

Gate No. 39



### CONCRETE DIAGNOSIS

Check Item	Concrete Diagnosis		Location
	Right Pier	Centre Crest	
(A) Deterioration			
Abrasion	B	A	B
Exfoliation	C	C	C
Corrosion	C	B	C
Cracking	C	C	C
(B) Displacement			
Cracking	C	C	C
Exfoliation	C	C	C
(C) Sedimentation	A	A	A
(D) Neutralization	7 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	27.7	29.6	30.9
Schmidt hammer	Ave. 29.41 N/mm <sup>2</sup>		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion
<u>Evaluation</u>	Partially Repair		
Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION	
Barrage Width	4,343 ft (1,324.66 m)
Gate Number	Nos. 65
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)
3 years Return period	13,000 m <sup>3</sup> /s
Longitudinal Profile	1/5,000
Crest Elevation (top)	RL 428 ft
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)
Crest Width	60 ft (18.29 m)
Crest Length	Upstream 28.0 m Down stream 40.0 m
Apron Length	Upstream 80.0 m Down stream 79.0 m
Cobble stone length	Down stream 80.6 m
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m

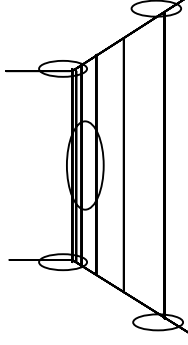
Gate No. 40



**CONCRETE DIAGNOSIS**

Check Item	CONCRETE DIAGNOSIS	
	Right Pier	Left Pier
(A) Deterioration		
Abrasion	B	B
Exfoliation	C	C
Corrosion	B	B
Cracking	C	C
(B) Displacement		
Cracking	C	C
Exfoliation	C	C
(C) Sedimentation	A	A
(D) Neutralization	7 mm	
(E) Concrete Strength (N/mm <sup>2</sup> )	32.2	33.4
Schmidt hammer	Ave. 31.95 N/mm <sup>2</sup>	
<u>Diagnosis</u>	Edge Corrosion	Edge Corrosion
<u>Evaluation</u>	Crest Abrasion	Partially Repair

Location




Comments

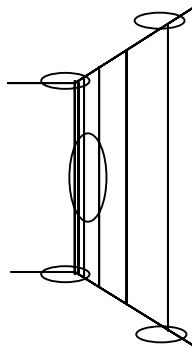
Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 41
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	


**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	B	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		5 mm		
(E) Concrete Strength (N/mm2)	32.8	32.2	32.2	
Schmidt hammer	Ave. 32.38 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

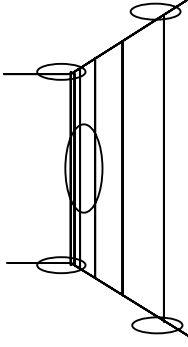
Category /A: need to repair /B: monitoring /C: not need to repair



**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No.42
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	B	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		6 mm		
(E) Concrete Strength (N/mm2)	27.1	29.0	29.0	
Schmidt hammer	Ave. 28.36 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair



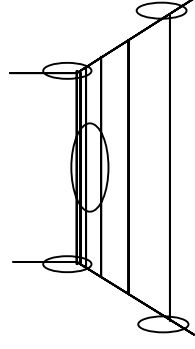
### BARRAGE LEDGER NOTE

DESIGN CONDITION	Gate No. 43
Barrage Width Gate Number Design Discharge 3 years Return period Longitudinal Profile Crest Elevation (top) Apron Elevation (down stream) Crest Width Crest Length Apron Length Cobble stone length Flood water level Flood water level	4,343 ft (1,324.66 m) Nos. 65 28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s) 13,000 m <sup>3</sup> /s 1/5,000 RL 428 ft RL 416 ft (h=12 ft / h=3.66 m) 60 ft (18.29 m) Upstream 28.0 m Down stream 40.0 m Upstream 80.0 m Down stream 79.0 m Down stream 80.6 m Upstream RL 447 ft (421 ft) h=7.63 m Down stream RL 440 ft (416 ft) h=7.32 m




### CONCRETE DIAGNOSIS

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	B	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation				
(D) Neutralization				
(E) Concrete Strength (N/mm <sup>2</sup> )	28.4	32.8	30.3	
Schmidt hammer	Ave. 30.47 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			



Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 44
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	A	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		5 mm		
(E) Concrete Strength (N/mm2)	30.3	27.7	30.9	
Schmidt hammer	Ave. 29.63 N/mm2			Partially exfoliation on the Crest
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Comments
<u>Evaluation</u>	Crest Repair			Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 45
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm2)	29.6	32.8	33.4	
Schmidt hammer	Ave. 31.95 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 46
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

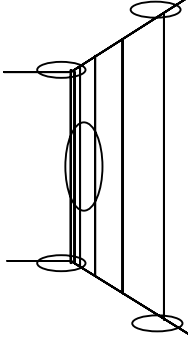
Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	A	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm2)	27.7	30.9	30.3	
Schmidt hammer	Ave. 29.63 N/mm2			Partially exfoliation on the Crest
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Comments
<u>Evaluation</u>	Crest Repair			Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 47
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	A	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm2)	33.4	31.5	32.2	
Schmidt hammer	Ave. 32.38 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION	
Barrage Width	4,343 ft (1,324.66 m)
Gate Number	Nos. 65
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)
3 years Return period	13,000 m <sup>3</sup> /s
Longitudinal Profile	1/5,000
Crest Elevation (top)	RL 428 ft
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)
Crest Width	60 ft (18.29 m)
Crest Length	Upstream 28.0 m Down stream 40.0 m
Apron Length	Upstream 80.0 m Down stream 79.0 m
Cobble stone length	Down stream 80.6 m
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m

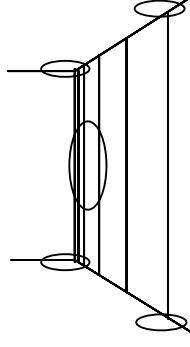
Gate No. 48



**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier
(A) Deterioration			
Abrasion	B	A	B
Exfoliation	C	B	C
Corrosion	C	A	C
Cracking	C	C	C
(B) Displacement			
Cracking	C	C	C
Exfoliation	C	C	C
(C) Sedimentation	A	A	A
(D) Neutralization		12 mm	
(E) Concrete Strength (N/mm <sup>2</sup> )	31.5	32.2	30.3
Schmidt hammer	Ave. 31.32 N/mm <sup>2</sup>		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion
<u>Evaluation</u>	Partially Repair		

Location




Comments

Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 49
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	


**CONCRETE DIAGNOSIS**

Check Item	CONCRETE DIAGNOSIS		Location
	Right Pier	Centre Creast	
(A) Deterioration			
Abrasion	B	A	B
Exfoliation	C	B	C
Corrosion	C	A	C
Cracking	C	C	C
(B) Displacement			
Cracking	C	C	C
Exfoliation	C	C	C
(C) Sedimentation	A	A	A
(D) Neutralization		8 mm	
(E) Concrete Strength (N/mm2)	26.5	29.6	27.1
Schmidt hammer	Ave 27.47 N/mm2		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion
<u>Evaluation</u>	Partially Repair		
Comments Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.			

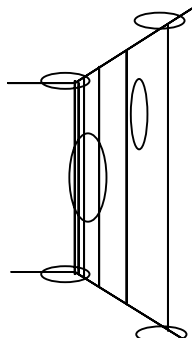
Category /A: need to repair /B: monitoring /C: not need to repair



**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 50
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

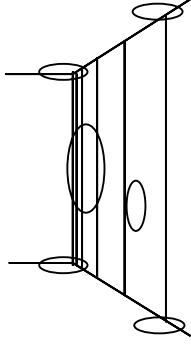
Check Item	Right Pier		Centre Crest	Left Pier		Location
	Edge Corrosion	Crest Abrasion	Edge Corrosion	Edge Corrosion	Crest Repair	
(A) Deterioration						
Abrasion	B	A	A	B		
Exfoliation	C	A	A	C		
Corrosion	C	A	A	C		
Cracking	C	C	C	C		
(B) Displacement						
Cracking	C	C	C	C		
Exfoliation	C	C	C	C		
(C) Sedimentation	A	A	A	A		
(D) Neutralization		13 mm				
(E) Concrete Strength (N/mm2)	31.5	33.4	32.8			
Schmidt hammer	Ave. 35.59 N/mm2					Partially exfoliation on the Crest
Diagnosis	Edge Corrosion	Crest Abrasion	Edge Corrosion	Edge Corrosion		Comments
Evaluation	Crest Repair					Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 51
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

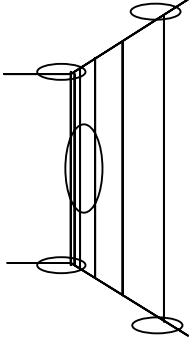
Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	A	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		5 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	29.0	29.6	31.5	
Schmidt hammer		Ave. 30.05 N/mm <sup>2</sup>		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Partially exfoliation on the Crest Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Crest Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 52
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

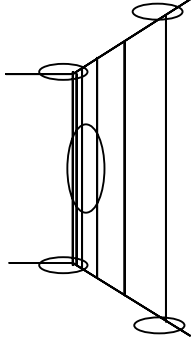
Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	B	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		11 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	30.9	30.3	27.7	
Schmidt hammer	Ave. 29.63 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 53
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	C	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm2)	32.2	27.7	29.6	
Schmidt hammer	Ave. 30.47 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

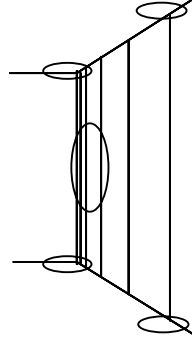
### BARRAGE LEDGER NOTE

DESIGN CONDITION	Gate No. 54
Barrage Width Gate Number Design Discharge 3 years Return period Longitudinal Profile Crest Elevation (top) Apron Elevation (down stream) Crest Width Crest Length Apron Length Cobble stone length Flood water level Flood water level	4,343 ft (1,324.66 m) Nos. 65 28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s) 13,000 m <sup>3</sup> /s 1/5,000 RL 428 ft RL 416 ft (h=12 ft / h=3.66 m) 60 ft (18.29 m) Upstream 28.0 m Down stream 40.0 m Upstream 80.0 m Down stream 79.0 m Down stream 80.6 m Upstream RL 447 ft (421 ft) h=7.63 m Down stream RL 440 ft (416 ft) h=7.32 m




### CONCRETE DIAGNOSIS

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	B	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		7 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	30.9	30.9	29.6	
Schmidt hammer	Ave. 30.47 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

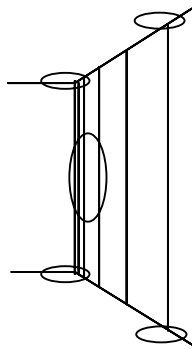


Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 55
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	B	C	
Corrosion	C	Flooring	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	29.6	29.0	30.3	
Schmidt hammer	Ave. 29.63 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 56
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	


**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	B	C	
Corrosion	A	A	A	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation				
(D) Neutralization				
(E) Concrete Strength (N/mm <sup>2</sup> )	33.4	8 mm	30.3	
Schmidt hammer	Ave. 32.17 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair



**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 57
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	C	A	C	
Cracking	C	B	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation				
(D) Neutralization				
(E) Concrete Strength (N/mm <sup>2</sup> )	29.0	8 mm	29.6	
Schmidt hammer		Ave. 29.84 N/mm <sup>2</sup>		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Comments
<u>Evaluation</u>	Partially Repair			Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

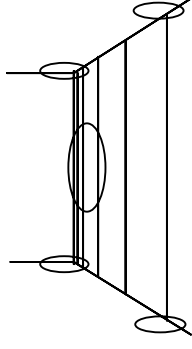
### BARRAGE LEDGER NOTE

DESIGN CONDITION	Gate No. 58
Barrage Width Gate Number Design Discharge 3 years Return period Longitudinal Profile Crest Elevation (top) Apron Elevation (down stream) Crest Width Crest Length Apron Length Cobble stone length Flood water level Flood water level	4,343 ft (1,324.66 m) Nos. 65 28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s) 13,000 m <sup>3</sup> /s 1/5,000 RL 428 ft RL 416 ft (h=12 ft / h=3.66 m) 60 ft (18.29 m) Upstream 28.0 m Down stream 40.0 m Upstream 80.0 m Down stream 79.0 m Down stream 80.6 m Upstream RL 447 ft (421 ft) h=7.63 m Down stream RL 440 ft (416 ft) h=7.32 m




### CONCRETE DIAGNOSIS

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	B	C	
Corrosion	B	Flooring	B	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation				
(D) Neutralization				
(E) Concrete Strength (N/mm <sup>2</sup> )	27.1	29.6	26.5	
Schmidt hammer	Ave. 27.72 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation at the gate edge on the both pier was repaired by concrete.
<u>Evaluation</u>	Partially Repair			

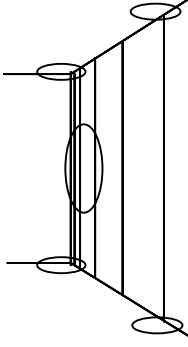


Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 59
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

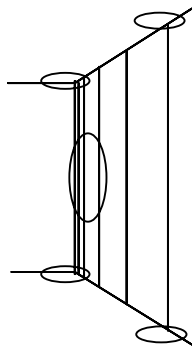
Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	C	Flooring	C	
Exfoliation	A	B	A	
Corrosion	B	Flooring	B	
Cracking	B	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm2)	29.0	27.7	30.3	
Schmidt hammer	Ave. 28.99 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation at the gate edge on the both pier was repaired by concrete.
<u>Evaluation</u>	Partially Repair			

Category /A: need to repair /B: monitoring /C: not need to repair


**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 60
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Creast	Left Pier	Location
(A) Deterioration				
Abrasion	C	Flooring	C	
Exfoliation	A	B	A	
Corrosion	B	Flooring	B	
Cracking	B	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		15 mm		
(E) Concrete Strength (N/mm2)	30.3	30.9	32.8	
Schmidt hammer	Ave. 31.32 N/mm2			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation at the gate edge on the both pier was repaired by concrete.
<u>Evaluation</u>	Partially Repair			Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 61
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	


**CONCRETE DIAGNOSIS**

Check Item	CONCRETE DIAGNOSIS		Location
	Right Pier	Centre Creast	
(A) Deterioration			
Abrasion	B	Flooring	B
Exfoliation	C	B	C
Corrosion	B	A	B
Cracking	C	C	C
(B) Displacement			
Cracking	C	C	C
Exfoliation	C	C	C
(C) Sedimentation	A	A	A
(D) Neutralization		8 mm	
(E) Concrete Strength (N/mm2)	32.8	30.3	33.4
Schmidt hammer	Ave. 32.17 N/mm2		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion
<u>Evaluation</u>	Partially Repair		

Comments  
Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation at the gate edge on the both pier was repaired by concrete.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**


DESIGN CONDITION		Gate No. 62
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m3/s (Max 21,530 m3/s)	
3 years Return period	13,000 m3/s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	A	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		5 mm		
(E) Concrete Strength (N/mm2)	31.5	30.3	30.9	
Schmidt hammer	Ave. 30.90 N/mm2			Partially exfoliation on the Crest
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Comments
<u>Evaluation</u>	Crest Repair			Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is at the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

**BARRAGE LEDGER NOTE**

DESIGN CONDITION		Gate No. 63
Barrage Width	4,343 ft (1,324.66 m)	
Gate Number	Nos. 65	
Design Discharge	28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s)	
3 years Return period	13,000 m <sup>3</sup> /s	
Longitudinal Profile	1/5,000	
Crest Elevation (top)	RL 428 ft	
Apron Elevation (down stream)	RL 416 ft (h=12 ft / h=3.66 m)	
Crest Width	60 ft (18.29 m)	
Crest Length	Upstream 28.0 m Down stream 40.0 m	
Apron Length	Upstream 80.0 m Down stream 79.0 m	
Cobble stone length	Down stream 80.6 m	
Flood water level	Upstream RL 447 ft (421 ft) h=7.63 m	
Flood water level	Down stream RL 440 ft (416 ft) h=7.32 m	

**CONCRETE DIAGNOSIS**

Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	A	B	
Exfoliation	C	A	C	
Corrosion	C	A	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		6 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	30.3	33.4	32.8	
Schmidt hammer	Ave. 32.17 N/mm <sup>2</sup>			Partially exfoliation on the Crest
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Comments
<u>Evaluation</u>	Crest Repair			Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is at the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair



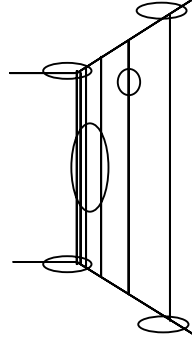
## BARRAGE LEDGER NOTE

DESIGN CONDITION	Gate No. 64
Barrage Width Gate Number Design Discharge 3 years Return period Longitudinal Profile Crest Elevation (top) Apron Elevation (down stream) Crest Width Crest Length Apron Length Cobble stone length Flood water level Flood water level	4,343 ft (1,324.66 m) Nos. 65 28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s) 13,000 m <sup>3</sup> /s 1/5,000 RL 428 ft RL 416 ft (h=12 ft / h=3.66 m) 60 ft (18.29 m) Upstream 28.0 m Down stream 40.0 m Upstream 80.0 m Down stream 79.0 m Down stream 80.6 m Upstream RL 447 ft (421 ft) h=7.63 m Down stream RL 440 ft (416 ft) h=7.32 m



## CONCRETE DIAGNOSIS

Check Item	Right Pier	Centre Crest	Left Pier	Location
(A) Deterioration				
Abrasion	B	Flooring	B	
Exfoliation	C	A	C	
Corrosion	C	Flooring	C	
Cracking	C	C	C	
(B) Displacement				
Cracking	C	C	C	
Exfoliation	C	C	C	
(C) Sedimentation	A	A	A	
(D) Neutralization		8 mm		
(E) Concrete Strength (N/mm <sup>2</sup> )	26.5	30.3	30.9	
Schmidt hammer	Ave. 29.20 N/mm <sup>2</sup>			
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion	Partially exfoliation on the Crest
<u>Evaluation</u>	Crest Repair			Comments
				Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is at the gate edge on the both pier.



Category /A: need to repair /B: monitoring /C: not need to repair

### BARRAGE LEDGER NOTE

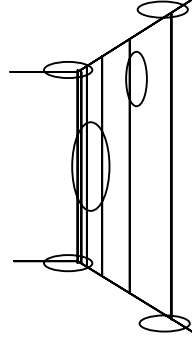
DESIGN CONDITION	
Barrage Width Gate Number Design Discharge 3 years Return period Longitudinal Profile Crest Elevation (top) Apron Elevation (down stream) Crest Width Crest Length Apron Length Cobble stone length Flood water level Flood water level	4,343 ft (1,324.66 m) Nos. 65 28,300 m <sup>3</sup> /s (Max 21,530 m <sup>3</sup> /s) 13,000 m <sup>3</sup> /s 1/5,000 RL 428 ft RL 416 ft (h=12 ft / h=3.66 m) 60 ft (18.29 m) Upstream 28.0 m Down stream 40.0 m Upstream 80.0 m Down stream 79.0 m Down stream 80.6 m Upstream RL 447 ft (421 ft) h=7.63 m Down stream RL 440 ft (416 ft) h=7.32 m

Gate No. 65



### CONCRETE DIAGNOSIS

Check Item	Concrete Diagnosis		Location
	Right Pier	Centre Crest	
(A) Deterioration			
Abrasion	B	Flooring	B
Exfoliation	C	A	C
Corrosion	C	A	C
Cracking	C	Flooring	C
(B) Displacement			
Cracking	C	C	C
Exfoliation	C	C	C
(C) Sedimentation	A	A	A
(D) Neutralization		10 mm	
(E) Concrete Strength (N/mm <sup>2</sup> )	31.5	30.9	33.4
Schmidt hammer	Ave. 31.95 N/mm <sup>2</sup>		
<u>Diagnosis</u>	Edge Corrosion	Crest Abrasion	Edge Corrosion
<u>Evaluation</u>	Crest Repair		



Partially exfoliation on the Crest  
Comments

Sedimentation before Gate is more than 2 m and Friction Block is silted. Exfoliation is at the gate edge on the both pier.

Category /A: need to repair /B: monitoring /C: not need to repair

添付 8

*Survey Report*

**JAPAN INTERNATIONAL COOPERATION AGENCY  
PAKISTAN OFFICE  
ISLAMABAD**

**TOPOGRAPHIC SURVEY FOR THE PREPARATORY  
STUDY ON THE PROJECT FOR  
REHABILITATION OF GATES OF TAUNSA BARRAGE**

**SURVEY REPORT**

**BY**

**NATIONAL DEVELOPMENT CONSULTANTS (Regd.)  
26-K-II, MODEL TOWN,  
LAHORE**

**Ph: 042-5867773, 5860870**

**Fax: 042-5869287**

**JANUARY, 2004**



1977-2002

## national development consultants

26-K-II, Model Town, Lahore-54700 (Pakistan)

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

No. NDC/ADMN/ 105  
Dated: January 31, 2004

Mr. Akihiro Matsuda  
JICA Study Team,  
for the Preparatory Study on the Project  
for Rehabilitation of Gates of Taunsa Barrage,  
3<sup>rd</sup> floor, COMSATS Building,  
Shahrah-e- Jamhuriat  
G-5/2, P.O Box 1772,  
Islamabad.

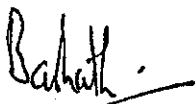
Subject:- TOPOGRAPHIC SURVEY OF TAUNSA BARRAGE

Dear Sir,

The Agreement for the subject-cited assignment was received by us vide JICA Pakistan Office letter No. JICA/01-16017/Admn/2003 dated Jan. 16, 2004. The survey work was started at site immediately thereafter and the field work was completed in the last week of January 2004. Survey Report along-with the relevant maps is submitted herewith for further necessary action by you.

With regards and assuring you of our best professional services at all times.

Very truly yours,  
For NATIONAL DEVELOPMENT CONSULTANTS (REGD.)

  
(Engr. Barkat Ali Luna)  
Chairman  
RA/MH

Encl:  
Survey Report  
as above (3 Sets)

C.W.C. to:-

1. Mr. Makoto Takahashi, Deputy Resident Representative JICA for information (without enclosures).



# TOPOGRAPHIC SURVEY FOR THE PREPARATORY STUDY ON THE PROJECT FOR REHABILITATION OF GATES OF TAUNSA BARRAGE

## Survey Report

### 1.0 Introduction

Taunsa Barrage is located on the Indus River. The major objectives of the Barrage were to provide irrigation facilities to areas in Muzaffar Garh & D.G. Khan Districts along with provision of assured irrigation supply to areas under inundation canal system in the Muzaffar Garh & D.G. Khan Districts. The Barrage commands a gross area of 2.354 million acres, out of which the culturable area is 2.225 million acres. The Barrage was originally designed for a discharge capacity of 1,000,000 Cs but due to retrogression the present discharge capacity has been limited at 750,000 Cs.

The Barrage provides water to river Chenab through Taunsa Punjnad Link for supplementing the supplies required at Punjnad Head works which feeds Punjnad & Abbasia canals of Rahimyar Khan and Bahawalpur Districts.

Taunsa Barrage has been facing several problems like heavy siltation in the right pocket resulting in excessive silt entry into D.G. Khan canal and reduced capacity, excessive retrogression on the downstream side of the Barrage uprooting of friction blocks/baffle blocks and reinforced concrete, seals, roller assembly, hoist mechanism, end girders of some gates, hydraulic structure and barrage foundations since its commissioning in 1958. These problems have been aggravated with the passage of time. The Barrage is more than 42 years old and in some components, aging effects have turned it to a critical condition. The significant problems at Taunsa barrage are identified through several piece-meal studies carried out by different experts and Consultants.

In order to find out damages to the u/s and d/s floors, glacis, stone aprons, it was proposed to carryout topographic survey of the barrage in a width of 1500 meters and length of 350 meters. The survey would yield to the preparation of topographic map, cross sectional and longitudinal profiles as well as a contour map to indicate the damages to the Barrage floor. The survey would help in appraisal of the Barrage condition showing the various damages that require rehabilitation.

## **2.0 Scope of Work**

The scope of work as outlined in the TOR consists of the following tasks.

- Preparation of topographic survey map of Taunsa Barrage which comprises an area of 1500 m across the barrage and approximately 350 m along the river, at a scale of 1: 2000 and on A1 size (84.1 cms x 59.4 cms) sheet with the contour interval of 1.0 meter.
- Surveying of 16 No. cross-sectional profiles, of which 06 No. on upstream and 10 No. on downstream of Taunsa Barrage and plotting it on A1 size (84.1cms x 59.4 cms) sheet at a scale of 1: 100 vertical and 1:2000 horizontal.
- Surveying of 06 No. of profiles at specified locations along the river through Taunsa Barrage and plotting it on A1 size (84.1 cms x 59.4 cms) sheet at a scale of 1: 100 vertical and 1: 500 horizontal.
- Report on damaged places of Taunsa Barrage (Damaged Condition Report)
- Survey Report.

## **3.0 Equipment Used**

The following equipment was used on this project.

- Total station Sokkia Set 2C, measuring accuracy  $\pm (3\text{mm}+2\text{ppm}\times\text{D})$  mm
- Topcon Automatic level
- Sokkisia Automatic level

## **4.0 Calibertion**

The total station was calibrated prior to sending it to site and was found in excellent state of adjustment.

The leveling instruments were tested for line of collimation error before the commencement of field work and were regularly checked at site during the field operations.

## **5.0 Reference Datum**

A project specified grid is the reference datum for horizontal controls  
For vertical controls, the benchmark established by the Executive Engineer Taunsa Barrage on the northern edge of gauge well structure situated at D/S, of left abutment of Taunsa Barrage is our vertical reference datum.

## **6.0 Survey Markers.**

A total of 09 No. of controls were established at the project area.  
A typical survey control point marker being a triangle painted red was fixed on various parts of Barrage structure. Detailed description sheets regarding each such control point are prepared on sample format provided with TOR and are included in appendix- A to this report.



## **7.0 Field Work Procedure**

### **7.1: Horizontal Controls**

Horizontal Control were established through horizontal traversing using total station and all observations were recorded in built-in devices.

The horizontal angle was observed on two zeros (Two pointing each way) and mean was used in computation provided the spread was within 20 seconds of arc. All traverse distances were measured in two directions (Forward and Back) and the mean distance was accepted for computation provided the two values agreed to within 1:1000. The traverse diagram is provided in appendix-B.

### **7.2: Vertical Controls**

Vertical Controls were established through leveling and check leveling process using Topcon and Sokkisia automatic leveling instruments and leveling staves of quality. Good leveling procedures applicable to this class of leveling were adopted and we aimed for and achieved leveling and check leveling accuracy of  $\pm 2 \text{ cm} \sqrt{K}$  where K is distance in Kilometers. Our start point was the benchmark established by the I&P Department on the northern edge of gauge well structure situated at D/S, left abutment of Taunsa Barrage, elevation 457.50 ft.

### **7.3: Topographic Survey**

Total station was used to carry out topographic survey of an area 1500 m across and 350 m along the river. All man made and physical features were surveyed. The control stations established earlier were used as reference stations occupied to carry out the topographic survey.

### **7.4: Cross Section and Cross Sectional Profile Survey**

The cross section and profiles locations were marked at site with the help of ranging rods and flags. Spot elevations were surveyed and recorded, on the specified marked locations specified, with the help of total station.

## **8.0 Survey Data Processing**

### **8.1: Horizontal Traverse Computation**

The field data was down loaded to computer where it was processed. The traverse computation is available in appendix-A of this report. The length of the traverse was 3000 m and linear mis-closure is 2.5 cm or

24

.025 m. This gives a relative accuracy of 1:143000. The closure was adjusted and adjusted Coordinates were obtained.

#### 8.2: Leveling Calculation

The leveling data was computed in computer using MS Excel Spread Sheet. The summary of the computation is provided in appendix-A to this report.

#### 8.3: Topographic Survey Data

This was acquired in digital format on magnetic media and directly down loaded to computer where it was processed for computer-aided mapping ( CAM). The CAM was carried out in Sokkia SDR map software and drawings suitable for computer-aided design were produced as per project consultants requirements.

#### 8.4: Cross Sectional Data

The Cross sectional data was computer processed and computer plotted.

### 9.0 Submissions.

With this Survey Report; the following data relating to Taunsa Barrage are being submitted:-

- |       |  |          |
|-------|--|----------|
| (i)   | Topographic Map for Taunsa Barrage Site                        | (3 sets) |
| (ii)  | Cross Sectional Profiles for Taunsa Barrage Site (16 profiles) | (3 sets) |
| (iii) | Longitudinal Profiles for Taunsa Barrage Site (5 profiles)     | (3 sets) |
| (iv)  | Location map of cross sectional and longitudinal profiles      | (3 sets) |
| (v)   | CD-ROM (including above data)                                  | (3 sets) |

**APPENDIX-A**

**DESCRIPTION OF SHEETS  
OF CONTROL POINTS**



**Benchmark established by the Executive Engineer  
Taunsa Barrage on the northern of gauge well structure  
Situated at D/S, of left abutment of Taunsa Barrage.**

DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

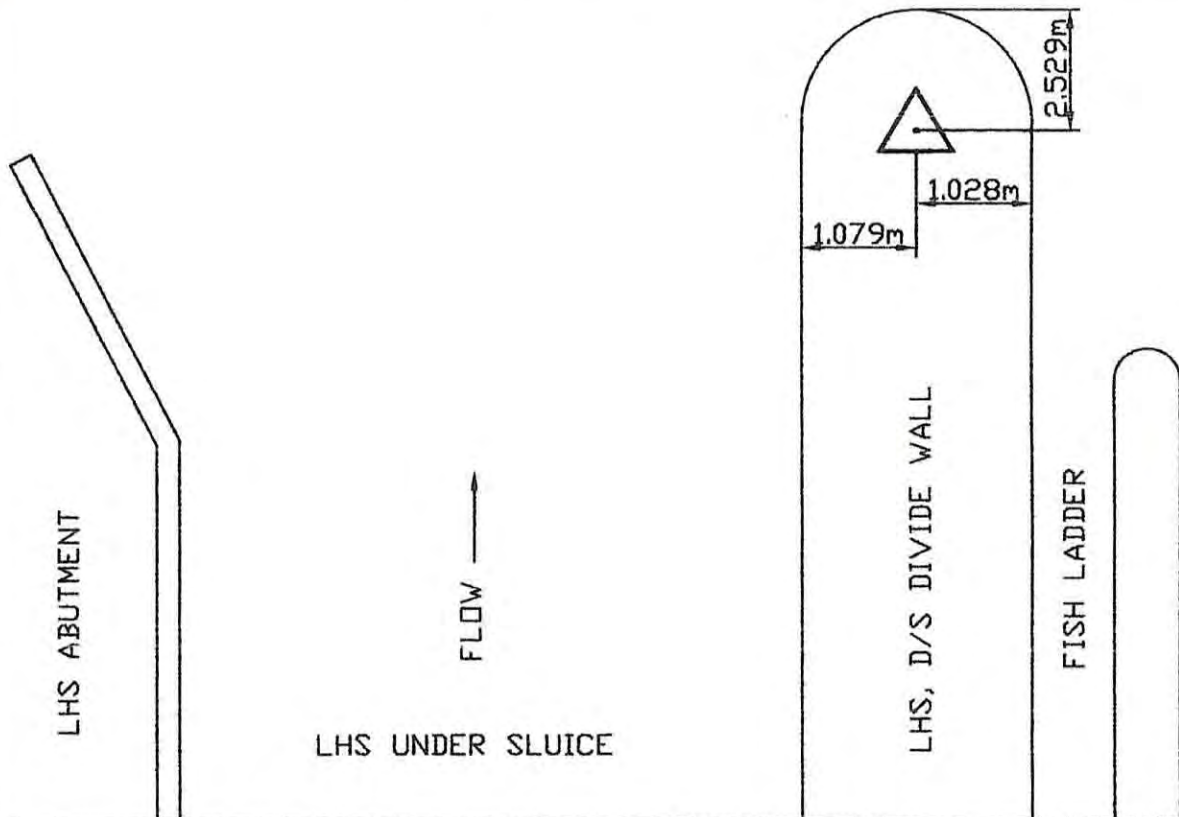
NAME OF CONTROL POINT:  
NDC.TBM-1

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
AT THE NOSE OF LHS, D/S  
DIVIDE WALL OF BARRAGE.  
E:30000.000  
N:10000.000  
EL:135.926



← TO KOT ADDU

TO TAUNSA →



DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

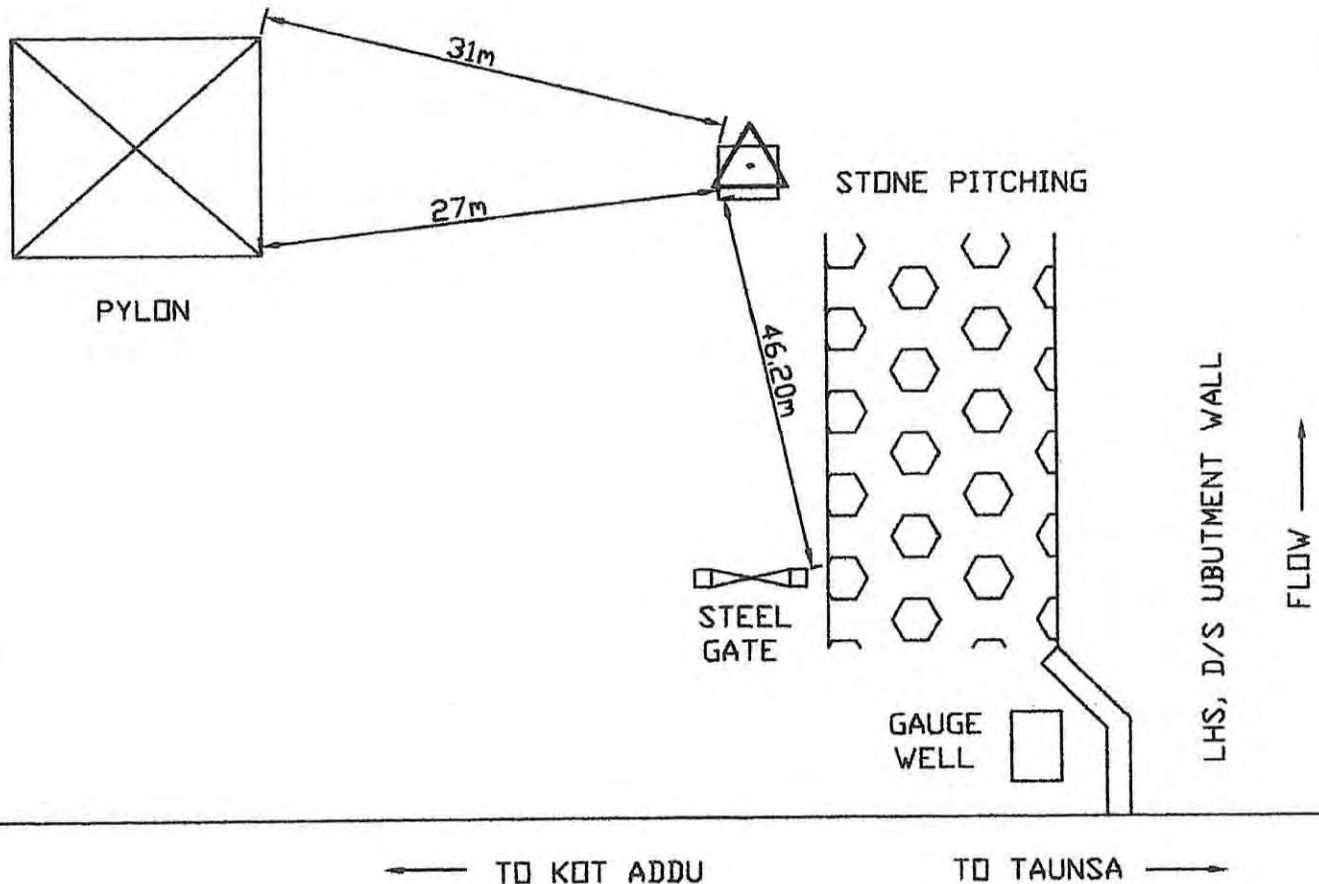
NAME OF CONTROL POINT:  
NDC.TBM-2

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
RED TRIANGLE MARK ON  
TOP OF CONCRETE MONUMENT  
FIXED ON LHS, D/S UBUTMENT  
E:30193.136  
N:9937.426  
EL:137.295



DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

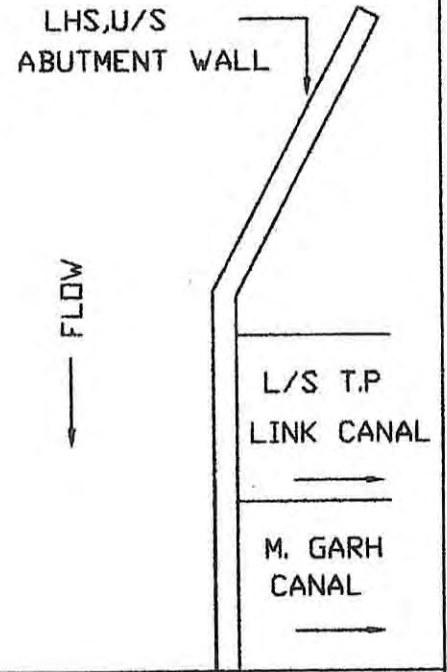
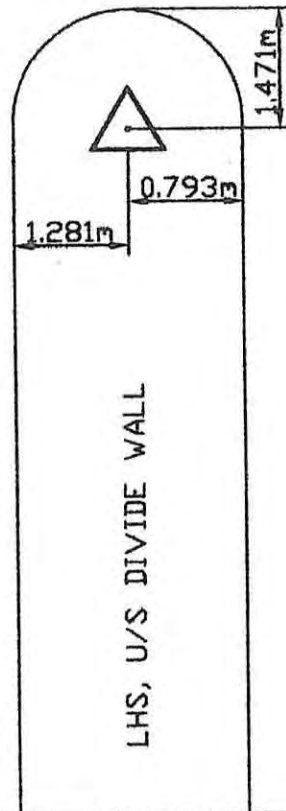
NAME OF CONTROL POINT:  
NDC-TP-3

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
AT THE NOSE OF LHS, U/S  
DIVIDE WALL OF BARRAGE.  
E: 30004.564  
N: 10232.796  
EL: 137.468



← TO KOT ADDU

TO TAUNSA →



DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

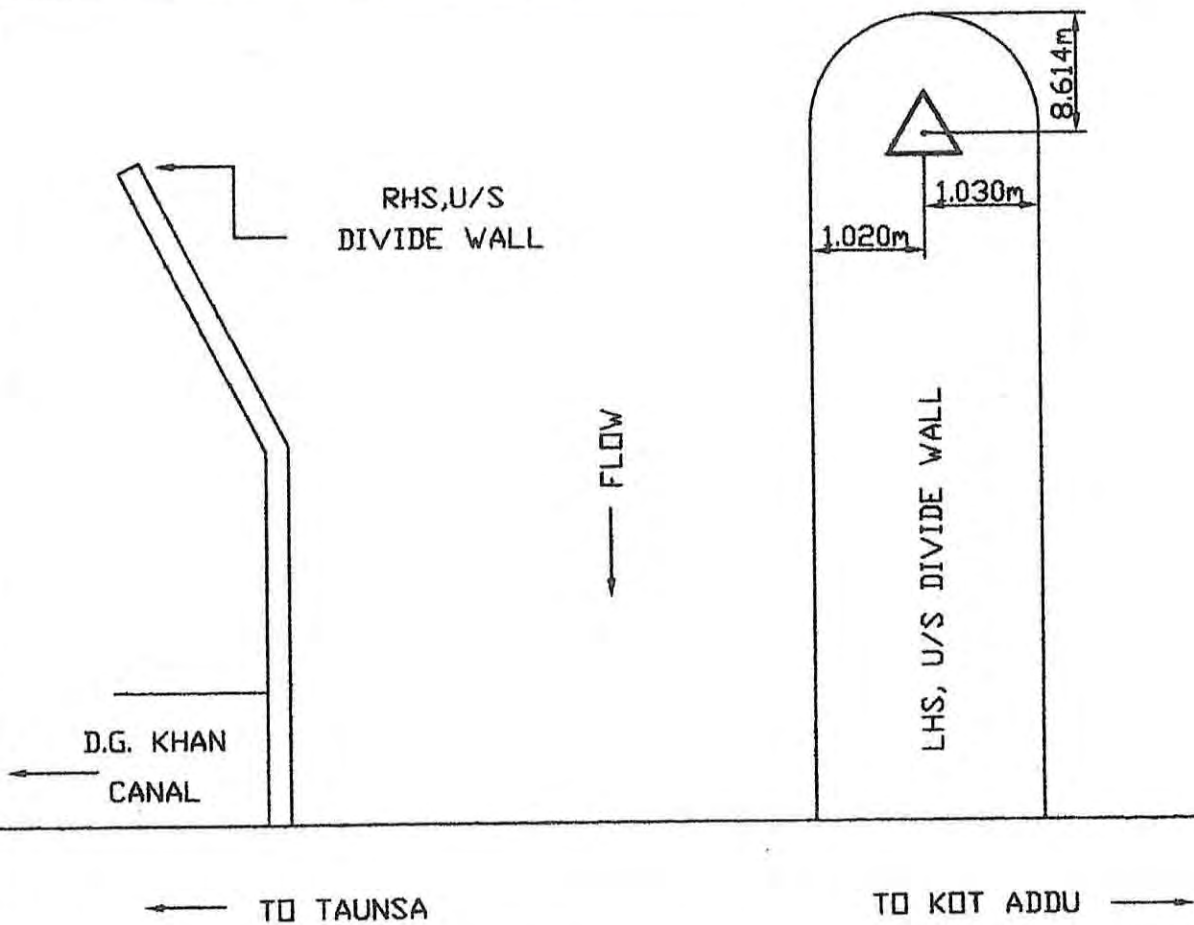
NAME OF CONTROL POINT:  
NDC.TBM-4

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
AT THE NOSE OF RHS, U/S  
DIVIDE WALL OF BARRAGE.  
E:28911.146  
N:10179.834  
EL:137.487





DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

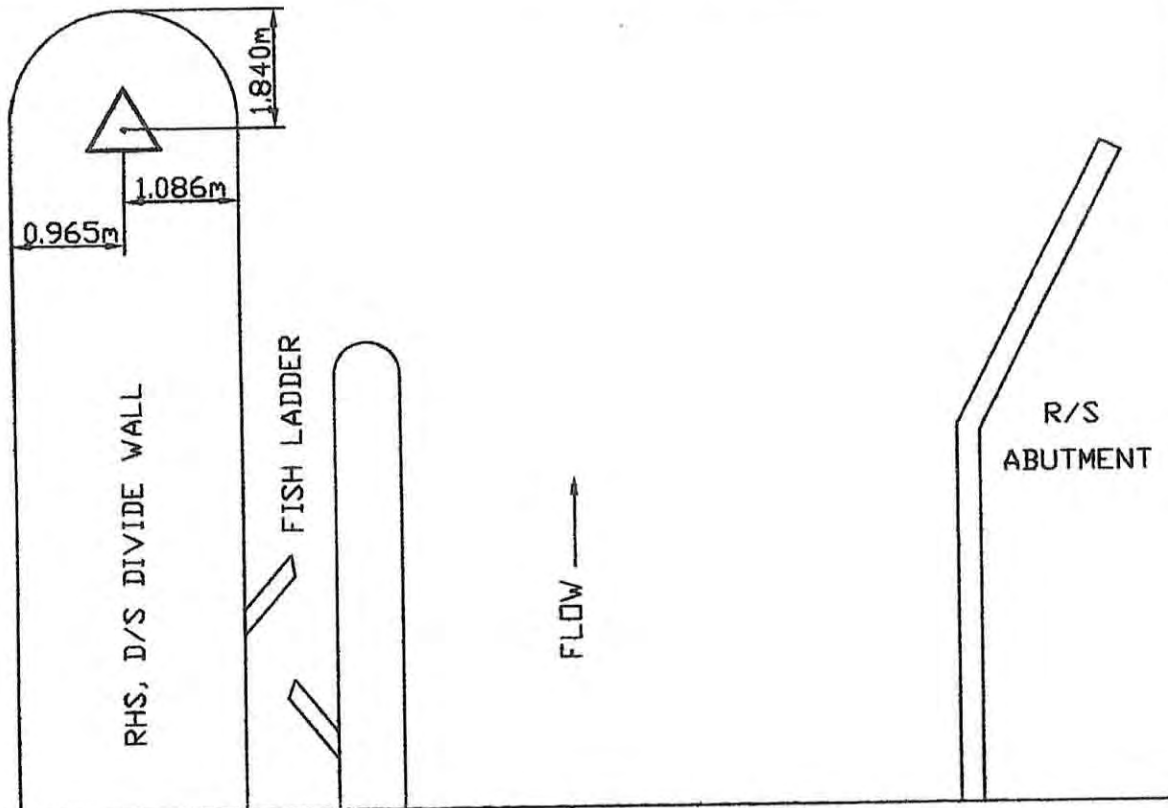
NAME OF CONTROL POINT:  
NDC.TBM-6

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
AT THE NOSE OF RHS, D/S  
DIVIDE WALL OF BARRAGE.  
E:28917.066  
N:9996.971  
EL:135.966



← TO KOT ADDU

TO TAUNSA →

DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

NAME OF CONTROL POINT:  
NDC.TBM-8

COORDINATE SYSTEM:  
PROJECT SPECIFIED

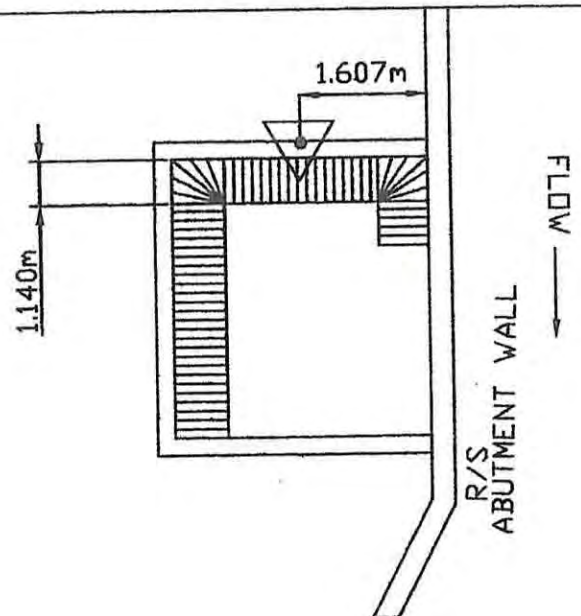
PHOTOGRAPH:



LOCATION:  
RED TRIANGLE MARK AT R/S  
D/S GAUGE WELL EDGE  
E:28828.731  
N:10083.884  
EL:139.446

← TO TAUNSA


TO KOT ADDU →






DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

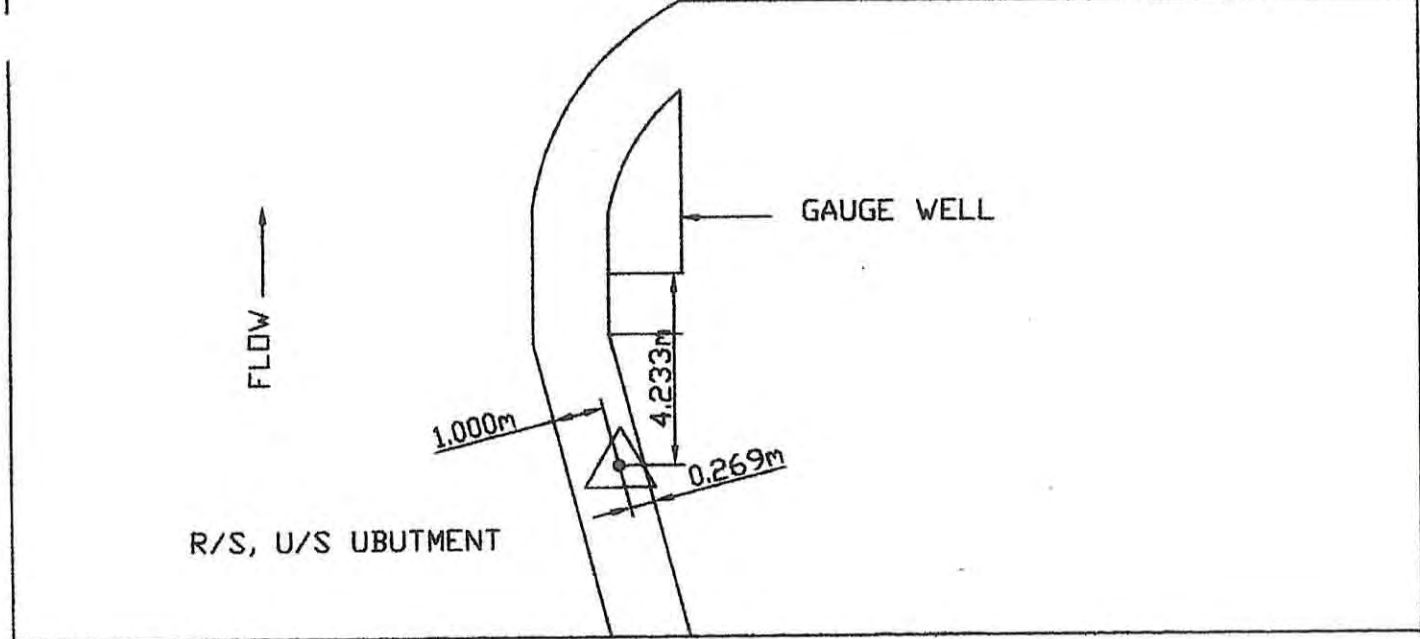
<p>NAME OF CONTROL POINT: NDC.TBM-9</p>	<p>COORDINATE SYSTEM: PROJECT SPECIFIED</p>
---	---

<p>PHOTOGRAPH:</p> 	<p>LOCATION: RED TRIANGLE MARK AT R/S U/S UBUTMENT WALL E:28828.368 N:10196.568 EL:139.468</p>
--	--

--

<p>← TO KOT ADDU</p>	<p>TO TOUNSA →</p>
----------------------	--------------------

	<p>D.G. KHAN CANAL →</p>
---	--------------------------



DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

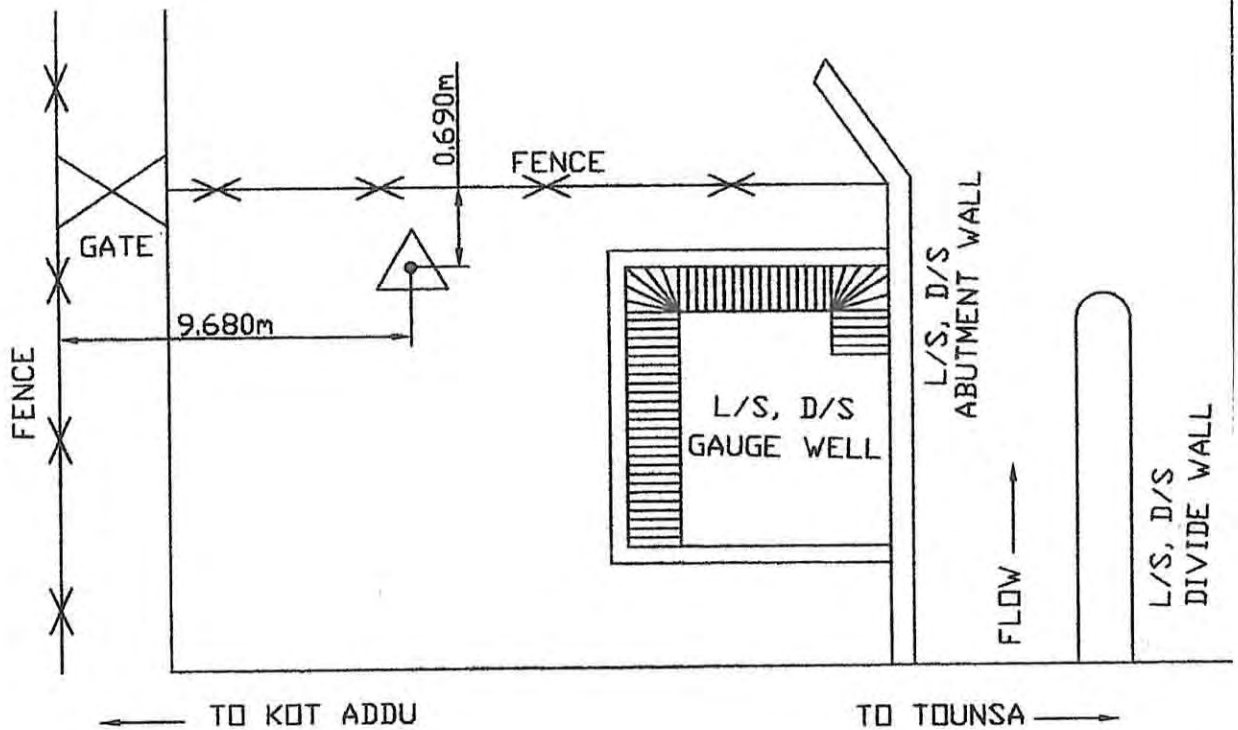
NAME OF CONTROL POINT:  
NDC.TBM-10

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
RED TRIANGLE MARK AT  
FLOOR OF LHS D/S  
CAR PARKING AREA  
E:30170.778  
N:10079.933  
EL:139.363





DESCRIPTION OF CONTROL POINT- TAUNSA BARRAGE

NAME OF CONTROL POINT:  
NDC.TBM-11

COORDINATE SYSTEM:  
PROJECT SPECIFIED

PHOTOGRAPH:



LOCATION:  
RED TRIANGLE MARK AT L/S  
U/S UBUTMENT WALL  
E:30164.778  
N:10261.861  
EL:139.498

← TO KOT ADDU

TO TOUNSA →

← MUZAFFAR GARH CANAL

← T.P. LINK CANAL

