Ministry of Infrastructure
Mongolia

BASIC DESIGN ON THE PROJECT FOR REHABILITATION OF RAILWAY FACILITIES

BASIC DESIGN REPORT

OCTOBER 2000

JAPAN INTERNATIONAL COOPERATION AGENCY
PACIFIC CONSULTANTS INTERNATIONAL (PCI)
TONICHI ENGINEERING CONSULTANTS,INC.

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a basic design study on the Project for the Rehabilitation of Railway Facilities and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Mongolia a study team from April 3 to May 17, 2000.

The team held discussions which the officials concerned of the Government of Mongolia, and conducted a filed study at the study area. After the team returned to Japan, further studies were made, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the teams.

October, 2000

Kunihiro Saito
President
Japan International Cooperation Agency

October, 2000

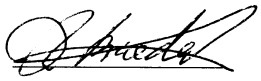
Letter of Transmittal

We are pleasure to submit to you the basic design report on the Project for Rehabilitation of Railway Facilities in Mongolia.

The study was conducted by PACIFIC CONSULTANTS INERNATIONAL and TONICHI ENGINEERING CONSULTANTS, INC. under a contract to JICA, during the period from March 17, 2000 to October 16, 2000. In conducting the study, we have examined the feasibility and rational of the project with due consideration to the present situation of Mongolia and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,



Kenji Maeda

Project Manager

Basic design study team on the
Project for the Rehabilitation of
Railway Facilities in Mongolia

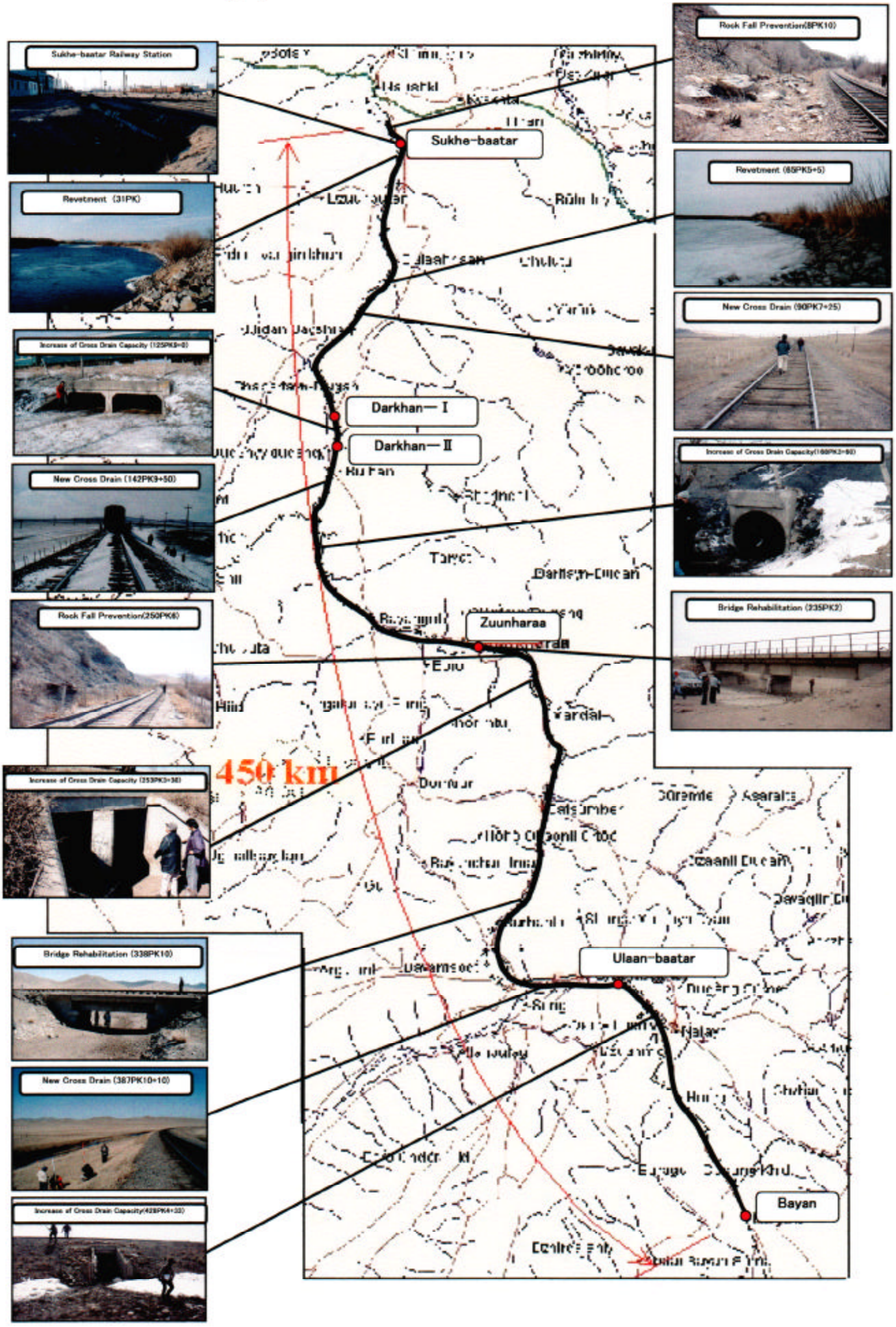
Pacific Consultants International
in association with
Tonichi Engineering Consultants, INC.

Location of the Project

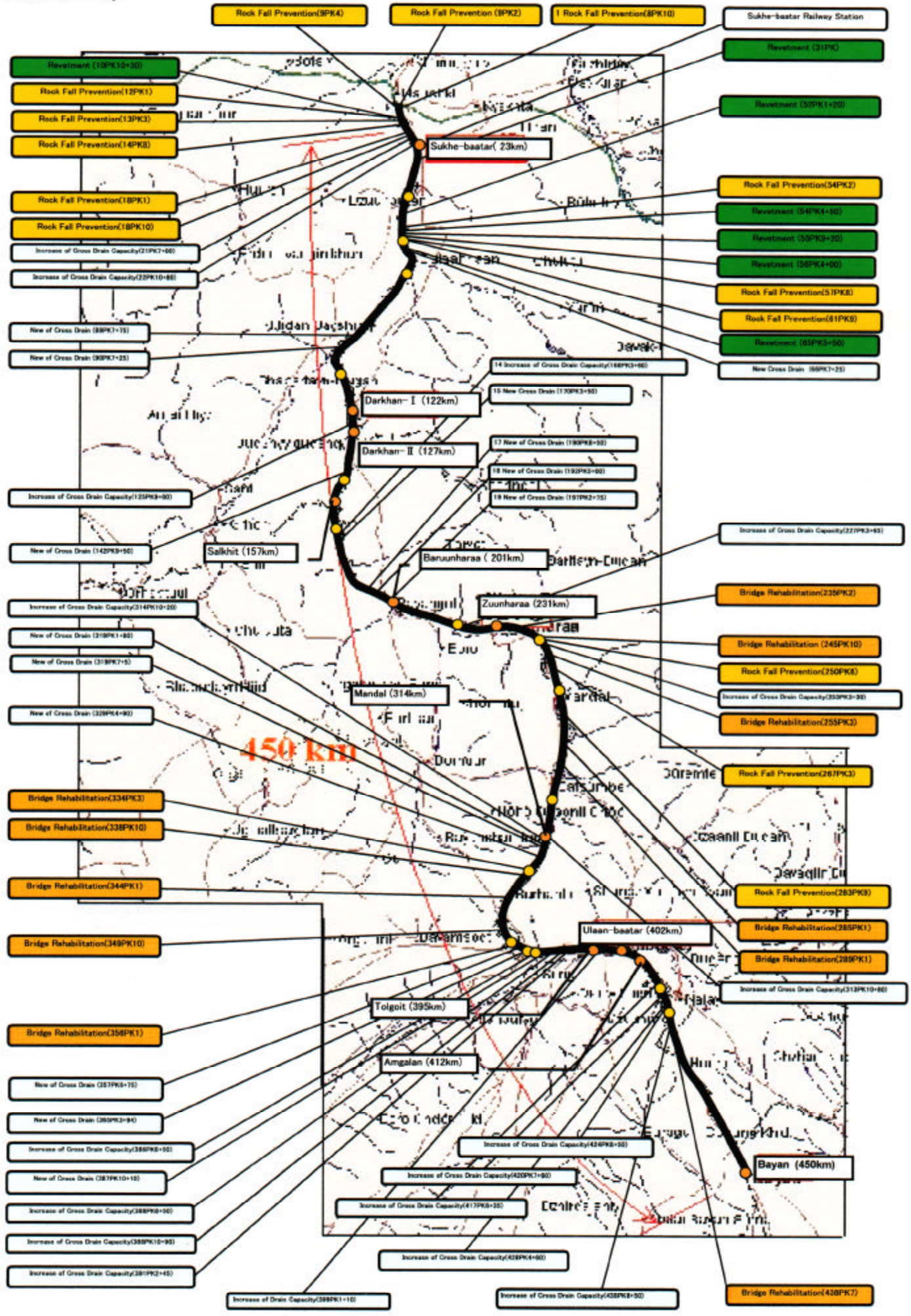
1） Location of the Mongolia

2） Mongolian Railway Map

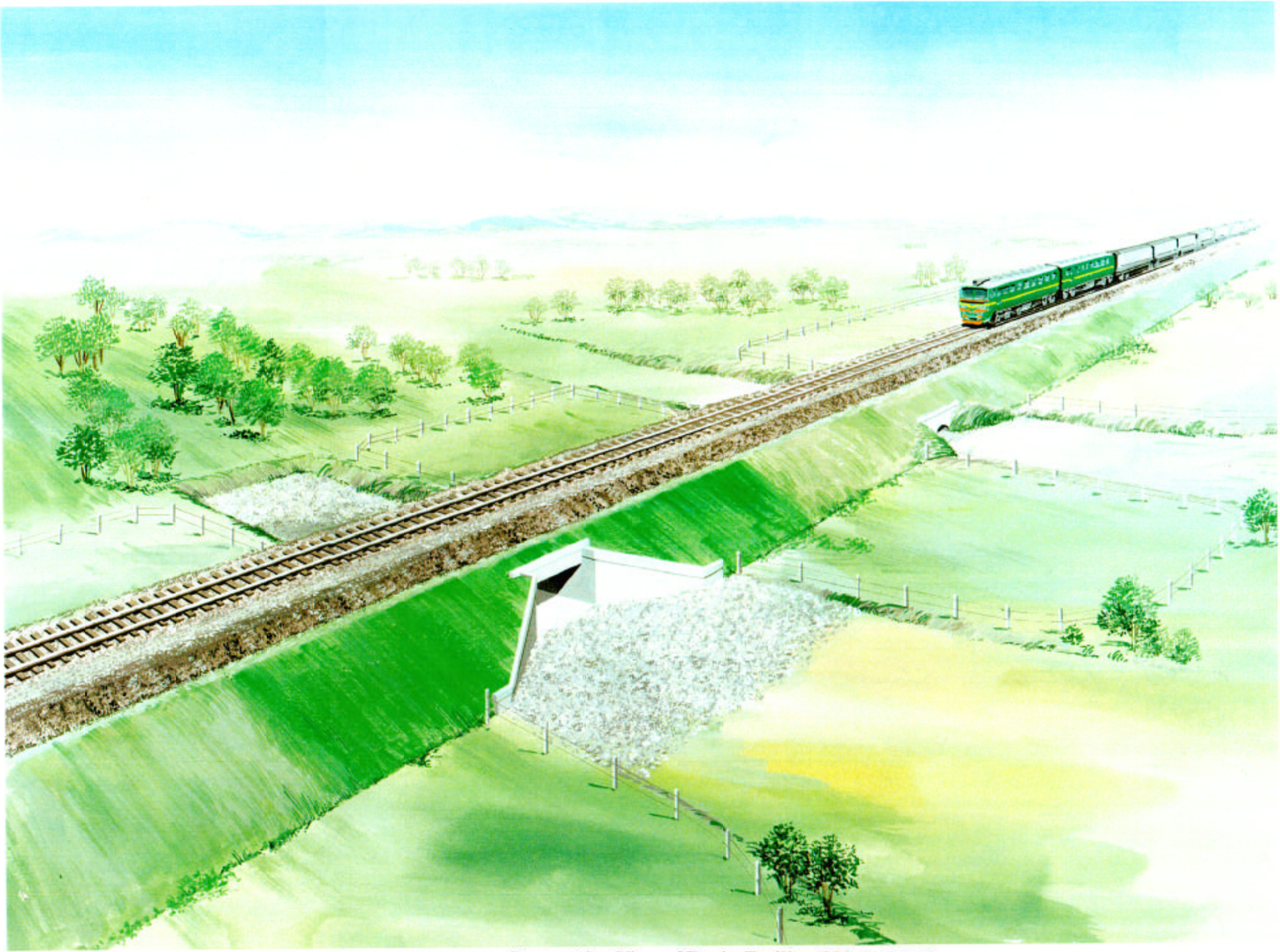
Location Photograph



Location Map



Perspective View of Drain Facility (23pk1)



Perspective View of Drain Facility (280pk10+35)

Abbreviations

MOER	:	Ministry of External Relation
MOF	:	Ministry of Finance
MOID	:	Ministry of Infrastructure and Development
MONE	:	Ministry of Nature and Environment
MR	:	Mongolian Railway
JICA	:	Japan International Cooperation Agency

A	:	Area
B	:	Breadth
BC	:	Beginning of Curve
BM	:	Bench Mark
C	:	Clay
c t c	:	Center to Center
CL	:	Curve Length
D	:	Depth
Dwg	:	Drawing
E	:	Elastic Modulus
EC	:	End of Curve
GH	:	Ground Height
GWL	:	Ground Water Level
H	:	Height
HWL	:	High Water Level
I	:	Moment of Inertia of Area
i	:	inclination
K	:	K Value
L	:	Length
R	:	Radius
M	:	Moment
m	:	Meter
mm	:	Millimeter
N	:	N Value
RC	:	Reinforce Concrete
RH	:	Rail Height
S	:	Shear
S	:	Second
SM	:	Sand-Mo
t	:	Ton
Tug	:	Mongolian Tugrik
US$	:	United States Dollar
V	:	Volume
W	:	Weight
Z	:	Modulus of Section
ϕ	:	Angle of Internal Friction
%	:	Percent
σ CK	:	Concrete Design Stress

TABLE OF CONTENTS

CHAPTER 1

BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Background of the Project

As Mongolia is an inland country, the Mongolian Railway is playing a key role providing domestic and international transportation services. Particularly, the Mongolian Railway trunk line running across the country from north to south and connecting Russia and China at the border stations of Sukhbaatar and Zamynuud, in consideration of rudimentary developed road infrastructure, plays an important role as a vital transportation artery.

According to the data for 1998 on the traffic volumes transported by railways, the transported cargo and passenger volumes were 2,815 million ton-km (or 96 % of total transport modes) and 981 million pass-km (or 55 % of total) respectively that demonstrates a great effect of this basic railway transport mode on the life of Mongolian people.

This railway line was introduced based on Russian Railway standard of 4th category of classification, which could not satisfactorily be equipped because of financial reduced for construction. After operation of 50 years, the engineering facilities are largely damaged and the deterioration is progressing heavily because the railway facilities have not been properly maintained since commencement of the transportation activities under severe winter climatic conditions. Moreover, during the spring freshet season between March and April and the rainy season between June and August, the railway sub-structure such as the bridges, earth structures etc. are severely suffered by the floods, wash-outs of rail-track and submergence of track (due to insufficiency of drain capacities), and rock slides etc. These disasters cause frequent suspension of the train operation, complicating all serious impacts on the national economy.

Particularly, such damages are heavy in the 450 km long railway section from Sukhbaatar to Bayan running through the valleys and hills. Considering the seriousness of the present situation, the Government of Mongolia requested the Government of Japan to prepare the rehabilitation plan for the existing railway structures in this section.

Upon receipt of this request, Government of Japan dispatched the Study Team from July 1996 to November 1997 to compose a master plan for the rehabilitation of

specific railway structures, and selected 184 objective spots for short-term urgent projects. Further the Feasibility Study was conducted and the feasibility of the rehabilitation plans were duly confirmed. Basing on the results of this study and taking into consideration the difficult financial situation being faced by the Mongolian Railway as well as technically complicated execution of the construction works, in May 1999 the Mongolian Government requested the Government of Japan to provide a grant for rehabilitation of 101 locations through Stage 1 and Stage 2 extracted from the Master Plan.

CHAPTER 2

CONTENTS OF THE PROJECT

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2.1 Objective of the Project

As Mongolia is surrounded by the land, railway line plays an important role as the nation's life line by providing transportation service as trunk route which is connecting border countries of Russia and China, and to support national economic activities as life line.

The project area is stretched from Russian border to Bayan station, 40 km southward of the Ulaanbaatar capital city, with a total length of 450 km. In this section, suspension of the train operation is frequent, caused by natural disasters such as scouring of the river banks, rock falls from weathered slope near the border, loosen soil flow into Sukhebaatar station, heavily weathered concrete in bridge structure, flood water flows across the track structure.

Upon receipt of this request, the JICA study was conducted from 1996 to 1997 and Master Plan on the Rehabilitation Project of the Mongolian Railway was made up. Following this study result, this project was authorized by Mongolian cabinet meeting as the reinforcement of disaster prevention of railway facilities, and requested to make up the rehabilitation for the existing railway facilities.

This project aims of securing safe and reliable train operation. For achieving the project objectives, implementation plan for 65 locations as river bank protection, slop stability, flood protection measure, bridge rehabilitation and drainage facilities.

2.2 Basic Concept of the Project

2.2.1 Comprehensive Approach

With the knowledge of above, in response to the request by the Government of Mongolia, "The Feasibility Study on the Rehabilitation Project of the Mongolian Railway " has been executed by JICA, which proposed 184 locations in need of rehabilitation. Based on the result of the study, in consideration of the financial condition of the Mongolian Railway and expected technical difficulties of the rehabilitation, the Government of Mongolia requested the Government of Japan to provide the grant aid. Among all, Government of Mongolia requested 101 prioritized locations to be rehabilitated in two stages, Stage One (1999-2004) and Stage Two (2006-2009), based on the recommendation by the aforementioned study.

Particularly, in line with the request of securing reliable and safe train operation, such as for river bank protections, slop stability, bridge rehabilitation and drainage facilities, the Study Team have conducted site investigations in order to clarify the magnitude of damages of the sites for urgent rehabilitation. Result of site investigation and assessment of necessity is summarized as follows:

a. Urban Facilities (to be rehabilitated by the Urban Authority)

This project is supposed to rehabilitate "railway" facilities. However, water pipelines inside 394 pk box culverts installed at the project site have been installed as "urban" facilities after construction of railway facilities. Because of this, due to reduced capacity of water discharge, track is flooded during the rainy season and track structures are damaged by scouring of railway embankment. The urban authority, the urban authority expressed an opinion that construction of planned extension of conduit bank located in north of the project site will enable the existing facility to deal with the expected water flow after the completion of the conduit bank.

b. Track Shifting

Mongolian side proposed to introduce track shifting from existing line at 31 pk for dissolving river bank erosion to railway line. However we made a decision when river bank work is implemented it is possible to

Protect for this erosion. This proposal is change to river bank protection work, accordingly.

c. Summary of the Result of the Site Investigation

Based on the site investigation, necessity assessment of the necessity regarding the remaining 100 sites excluding 394 pk are conducted comprehensively from the viewpoint of the construction capability of the Mongolian Railway, condition of each facility, actual obedience to the control of train operation, suffer record from natural disaster and social impact which incurring by suspension of train operation, according by 65 locations was selected for urgent improvement project. The basic policy of the necessity assessment is summarized in Table 2.2.1.

Table 2.2.1 Subject and Contents of the Necessity Assessment

Subject	Contents
1. Construction Experience	If previous rehabilitation by Mongolian Railway have fine results, such technical field should not be included in the project. Nonetheless, if it is deemed urgent, those shall be included concerning the financial capability of the Mongolian Railway.
2. Soundness Diagnosis of Structure	Level of soundness was examined and deformation of the facilities are evaluated for the bank protection, rock falling protection and bridges. However, the surrounding conditions have not taken into account regarding the track crossing drainage.
3. Natural Disaster Record / Speed Resurrection	Following shall be included in the project: - Where past damages are reported (track crossing drainage); - Where speed restriction are required (Bridges).
4. Impact to Social Consequence	It is difficult to predict bridge accident. Moreover, most of this accidents will entails the casualties under train operation. On other hand, fabrication of bridge girders will take 2 months because there is no fabrication experience in Mongolia. As a consequence, a long period suspension of the train operation could cause the social problem by interruption of supply of major good flow by the railway.

The evaluation procedure for each locations and selected spots are shown in Table 2.2.2. The results of selection of the objective locations in consideration of original proposal and urgency of rehabilitation is shown in Table 2.2.3.

Table 2.2.3 Subject and Contents of the Assessment

Subject	Number of Requested Locations	Result
1. River Bank Protection	8	7
2. Slope Stability	20	13
3. Track Shifting	1	Change to River Bank Protection
4. Flood Protection Measure	1	1
5. Bridge Rehabilitation	11	11
6. Drainage Facilities	60	33
Total	101	65

As a result, 65 locations were selected for urgent rehabilitation from requested 101 locations, based on their assessed conditions and safety demand. By conducting these rehabilitation, this project aims at ensuring stable train operation which is inevitable for the economic activities in Mongolia, as well as secure basis of the people's life of the whole nation.

Table 2.2.2 Selection of Urgent Improvement Project

Work Item and Location	Implementation Plan	Selection Criterion for Project Component				Selection of Project Component	Note Applicable Criterion
		1. Construction Experience	2. Soundness Diagnosis of Structure	3. Record of Past Damage and Speed Restriction	4. Social Impact		
1. River Bank Protection							
1 10Pk10+30	Revetment and Groyne (L=200m)		7.5			●	Criterion - 2
2 31pk	Revetment and Groyne (L=450m)		9			●	Criterion - 2
3 52pk1+20	Revetment and Groyne (L=200m)		6.13			●	Criterion - 2
4 54pk4+50	Revetment (L=200m)		8.5			●	Criterion - 2
5 55pk9+20	Revetment and Groyne (L=200m)		9.57			●	Criterion - 2
6 56pk4	Revetment and Groyne (L=300M)		10			●	Criterion - 2
7 65pk5+5	Revetment and Groyne (L=200m)		9.26			●	Criterion - 2
8 89pk1	Revetment (L=260m)	v	6.09 v				
9 208pk1	Revetment (L=170m)	v	7.39 v				
Sub Total						(7)	
2. Slop Stability							
1 8pk10	Removal of overhang and weathering (L=95m)		7.83			●	Criterion - 2
2 9pk2	Removal of weathering rock (L=125m)	v	3.04 v				
3 9pk4	Removal of overhang and weathering (L=95m)		8.08			●	Criterion - 2
4 10pk7	Removal of weathering rock (L=175m)	v	3.04 v				
5 10pk9	Removal of weathering rock (L=110m)	v	3.04 v				
6 12pk1	Removal of overhang and weathering (L=95m)		8.83			●	Criterion - 2
7 13pk3	Removal of overhang and loose rock (L=175m)		10			●	Criterion - 2
8 14pk8	Removal of overhang and loose rock (L=110m)		8.09			●	Criterion - 2
9 17pk5	Removal of weathering rock (L=90m)	v	2.61 v				
10 18pk1	Stability/removal of boulder and weathering (L=89m)		8.22			●	Criterion - 2
11 18pk10	Removal of overhang rock (L=115m)		8.96			●	Criterion - 2
12 51pk8	Removal of weathering rock (L=65m)	v	3.04 v				
13 52pk3	Removal/stability of boulders rock (L=120m)		3.04 v				
14 52pk10	Removal/stability of boulders rock (L=35m)		1.3 v				
15 54pk2	Stability/removal of boulder and weathering (L=140m)		8.83			●	Criterion - 2
16 57pk8	Stability/removal of boulder and weathering (L=145m)		8.83			●	Criterion - 2
17 61pk9	Stability/removal of boulder and weathering (L=180m)		8.83			●	Criterion - 2
18 250pk6	Removal of overhang and weathering (L=170m)		8.24			●	Criterion - 2
19 267pk3	Removal of overhang and weathering (L=160m)		8.24			●	Criterion - 2
20 283pk9	Removal of overhang and loose rock (L=380m)		8.29			●	Criterion - 2
Sub Total						(13)	
3. Flood Measure							
1 23pk	Flood measure of Sukhbaatar station (L=1100m)			v		●	Criterion - 3
						(1)	
4. Bridge Rehabilitation							
1 235pk3	Repair of main girder and overhang slab		8.06	v	v	●	Criterion - 2
2 245pk10	Repair of overhanging slab		3.91 v		v	●	Criterion - 4
3 255pk2	Repairmen of main girder and overhang slab		7.39	v	v	●	Criterion - 2
4 285pk1	Repairmen of main girder and overhang slab		5.65 v		v	●	Criterion - 4
5 289pk1	New beam installation		10		v	●	Criterion - 2
6 334pk3	Repairmen of main girder and overhang slab		7.84	v	v	●	Criterion - 2
7 338pk10	New beam installation		8.7		v	●	Criterion - 2
8 344pk1	New beam installation		9.26		v	●	Criterion - 2
9 349pk1	Repairmen of slab		4.78 v		v	●	Criterion - 4
10 356pk1	Repairmen of main girder		5.22 v		v	●	Criterion - 4
11 438pk7	Repairmen of Abutment with strot		4.35 v		v	●	Criterion - 4
Sub total						(11)	
5. Drainage Facility							
1 21pk7	Augment drain capacity (New design)			v		●	Criterion - 3
2 22pk10+80	Augment drain capacity (New design)			v		●	Criterion - 3
3 66pk7	New construction (New design)			v		●	Criterion - 3
4 89pk7+75	New construction (New design)			v		●	Criterion - 3
5 90pk7+25	New construction (New design)			v		●	Criterion - 3
6 93pk8	New construction (New design)						
7 97pk5+45	Augment drain capacity (MR standard)	v					
8 100pk7+30	Augment drain capacity (New design)						
9 116pk2+55	Augment drain capacity (New design)						
10 125pk9	Augment drain capacity (New design)			v		●	Criterion - 3
11 138pk5+81	Augment drain capacity (New design)						
12 142pk9+50	New construction (MR standard)			v		●	Criterion - 3
13 145pk1+30	Augment drain capacity (New design)						
14 168pk3+60	Augment drain capacity (MR standard)	v		v		●	Criterion - 3
15 170pk3+50	New construction (New design)			v		●	Criterion - 3
16 173pk1+50	Augment drain capacity (New design)	v					
17 190pk850	New construction (New design)			v		●	Criterion - 3
18 192pk5	New construction (New design)			v		●	Criterion - 3
19 197pk2+75	New construction (MR standard)			v		●	Criterion - 3
20 205pk8+10	Augment drain capacity (New design)			v		●	Criterion - 3
21 210pk6+5	New construction (New design)						
22 216pk6	Augment drain capacity (New design)						
23 217pk9+90	New construction (New design)						
24 227pk3+65	New construction (New design)			v		●	Criterion - 3
25 237pk4+35	New construction (New design)						
26 242pk9+90	Augment drain capacity (MR standard)	v					
27 253pk3+30	Augment drain capacity (New design)			v		●	Criterion - 3
28 258pk6+60	Augment drain capacity (New design)						
29 268pk7+95	Augment drain capacity (New design)						
30 280pk10+35	Augment drain capacity (New design)						
31 282pk10+90	Augment drain capacity (New design)						
32 294pk455	New construction (New design)						
33 313pk10+80	Augment drain capacity (New design)			v		●	Criterion - 3
34 314pk10+20	Augment drain capacity (New design)			v		●	Criterion - 3
35 319pk1+80	New construction (New design)			v		●	Criterion - 3
36 319pk7+5	Augment drain capacity (New design)			v		●	Criterion - 3
37 324pk5_+55	Augment drain capacity (New design)						
38 329pk4+55	New construction (New design)			v		●	Criterion - 3
39 331pk9+90	Augment drain capacity (New design)						
40 334pk4	Augment drain capacity (MR standard)	v					
41 341pk1+80	Augment drain capacity (New design)						
42 348pk10+10	New construction (New design)						
43 350pk1+25	Augment drain capacity (MR standard)	v					
44 352pk8+20	Augment drain capacity (MR standard)	v					
45 356pk1+50	Augment drain capacity (MR standard)	v					
46 357pk6+75	New construction (New design)			v		●	Criterion - 3
47 365pk3+94	New construction (New design)			v		●	Criterion - 3
48 386pk6+50	Augment drain capacity (New design)			v		●	Criterion - 3
49 387pk10+10	New construction (New design)			v		●	Criterion - 3
50 388pk8+50	Augment drain capacity (New design)			v		●	Criterion - 3
51 388pk10+90	Augment drain capacity (MR standard)	v		v		●	Criterion - 3
52 391pk2+45	Augment drain capacity (New design)			v		●	Criterion - 3
53 399pk	Demolition of Abutment			v		●	Criterion - 3
54 416pk4+75	New construction (New design)						
55 417pk6+35	Augment drain capacity (New design)			v		●	Criterion - 3
56 420pk7+60	Augment drain capacity (New design)			v		●	Criterion - 3
57 424pk8+50	Augment drain capacity (New design)			v		●	Criterion - 3
58 428pk4+60	Augment drain capacity (New design)			v		●	Criterion - 3
59 438pk8+50	Augment drain capacity (MR standard)	v		v		●	Criterion - 3
Sub total						(33)	
Total						(65)	

2.2.2 Facility Planning

(1) River Bank Protection

1) Proposed location

The proposed location was 9 locations as indicated in Fig. 2.2.1. This location is also included 31pk as river bank protection work instead of the proposed track shifting as the result of technical consideration.

2) Selection of Objective Location

The necessity and appropriateness for proposed location for implementation were evaluated from the structure soundness analysis and the inference condition to railway line as outer element. 7 objective locations were selected to give priority from result of analysis and the required urgent countermeasure. Table 2.2.4 is shown the analysis result and selected objective locations.

Table 2.2.4 Result of Analysis Evaluation

No.	Location and Length		Stage in F/S (The Bank Protection Works)	Stage in F/S (River Management Works)	Basic Design Study														
					Unsoundness								External factors			Evaluation			
	Location	Length (m)			Present Condition of Bank Protection	Slide of the Bank by Scouring	Magnitude of River Bending	Flood River Discharge	Flood River Current Velocity	River Bed Material	Damage by Ice flow	Unsoundness	Difference between Flood Level and RL	Distance Between the Railway and the River Bank	Existing road between river and railway	Comment	Priority	Result
1	10pk 10+95 ~ 11pk 2+95	200	I	II		△	○	◎	◎	○	○	II	◎	◎	○	The river bank is partly approaching.	M	Adopt
2	31pk2+25 ~ 31pk6+75	450	I	-		△	◎	◎	◎	○	○	I	◎	○	○	The river bank is partly approaching fast in recent year.	H	Adpot
3	52pk 1+25 ~ 52pk 3+25	200	I	II		△	○	◎	○	○	○	II	◎	○	○		M	Adopt
4	54pk 4+25 ~ 54pk 6+25	200	I	II			◎	◎	○	○	○	I	○	◎	○	The river bank is approached to 10m.	H	Adpot
5	55pk 8+80 ~ 55pk 10+30	150	III	III		◎	○	◎	○	○	○	I	○	○	○	Land slide damage by scouring is	H	Adopt
6	56pk 3+75 ~ 56pk 6+75	300	I	-	△		◎	◎	○	○	○	I	○	◎	○	Scouring is expanding. Conducting additional stone placing partly.	H	Adopt
7	65pk 6+85 ~ 65pk 9+35	250	II	III		◎	◎	○	○	○	△	I	◎	△	○	Land slide damage by scouring is expanding.	H	Adopt
8	88pk 1+10 ~ 88pk 3+60	250	III	-		△	○	○	△	○	△	III	△	△	△		L	No
9	208pk 1+00 ~ 208pk 2+70	170	I	II		△	◎	△	◎	○	△	III	○	△	△		L	No

Unsoundness : large ◎
: middle ○
: small △

Note : In scoring, land slide damage is counted double of other criteria, concerning its actual consequences.

Unsoundness : Evaluation of river revetment in current condition.
I An urgent countermeasures are inevitable due to river bank erosion, river meandering, washed away of rubble of revetment
II An urgent countermeasures are inevitable partly due to river bank erosion, river meandering, washed away of rubble of revetment
III An urgent countermeasures are needed due to river bank erosion, river meandering, washed away of rubble of revetment

Priority : H, M, L of priority are evaluated by the urgency in the unsoundness and external factors.

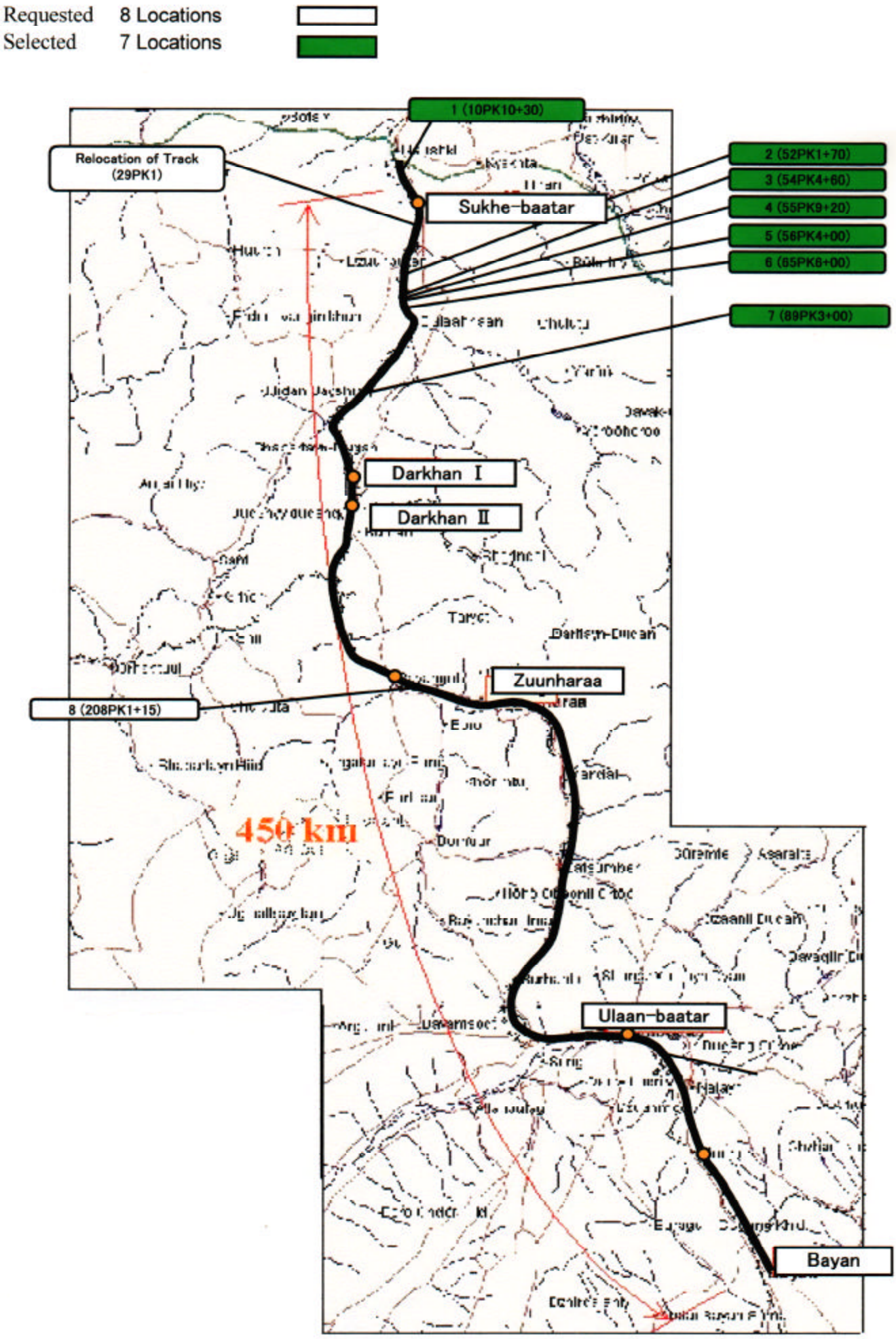


Fig. 2.2.1 River Bank Protection

(2) Slope Stability

1) Proposed Location

The proposed location were 20 locations as indicated in Fig. 2.2.2.

2) Selection of Objective Locations

The necessity and appropriateness for proposed location were evaluated from structure soundness analysis for slop condition of crack/joint, overhang, weathering, loose boulders and talus (scree), and the priority was decided through a comprehensive evaluation in consideration of driver's visibility of rock fall accident as well. 13 locations were selected from the study result of priority and urgency of counter measure for this slop stability. Table 2.2.5 is indicated the analysis result and selected locations.

Table 2.2.5 Evaluation of Soundness and Priority for Measures against Rock Fall

No	Location/Extension of Places subject to Rock Fall Measures			F/S	Basic Design Investigation									
					Item of Soundness Evaluation							Priority Evaluation		
	Location	Section subject to Measures	Extension (m)	Stage	Crack/Joint	Overhang	Weath-ering	Loose Boulders	Talus (Scree)	Soundness	Visibility for Driver	Comments	Priority	Ranking for Reference
1	8pk10	8pk10+00m～8pk10+95m	95	I	▲	◎*		△	◎	I		Dangerous due to overhanging massive rocks	H	4
2	9pk2	9pk1+85m～9pk2+50m	65	*1	▲		◎			III		Downward joints	L	14
3	9pk4	9pk4+00m～9pk5+25m	125	II	▲	○	○		○	II		A totally large scale	M	11
4	10pk7	10pk7+00m～10pk8+00m	100	II			○			III	△	Poor visibility	L	16
5	10pk9	10pk8+75m～10pk9+50m	75	II			○			III	△	Ditto	L	17
6	12pk1	11pk10+60m～12pk1+55m	95	II	▲	◎*		△	○	I		Dangerous due to overhanging massive rocks	H	5
7	13pk3	13pk2+75m～13pk4+50m	175	I	▲	◎*	○	△	◎	I	△	Ditto	H	1
8	14pk8	14pk7+85m～14pk8+95m	110	II	▲、—▲	○		◎	△	II		A totally large scale	M	12
9	17pk5	17pk5+50m～17pk6+40m	90	I	—▲		◎			III		Upward joints	L	19
10	18pk1	17pk10+95m～18pk1+75m	80	I、II	▲		◎	○		II		A totally large scale, Downward joints	M	13
11	18pk10	18pk9+75m～18pk10+90m	115	I *2		◎	◎		△	I	△	Overhang/weathered massive rocks	H	6
12	51pk8	51pk8+35m～51pk9+00m	65	III			△		△	III	△	Poor visibility	L	18
13	52pk3	52pk3+30m～52pk4+50m	120	II			△	○	△	III		Comparative large scale in Soundness III	L	15
14	52pk10	52pk9+90m～52pk10+25m	35	II				△		III		A small scale	L	20
15	54pk2	54pk2+75m～54pk4+15m	140	I			◎	◎	○	II	△	A totally large scale	M	8
16	57pk8	57pk8+25m～57pk9+70m	145	I	▲	△	◎	○	△	II	△	Ditto	M	9
17	61pk9	61pk9+10m～61pk10+90m	180	I		△	◎	○	○	II		Ditto	M	10
18	250pk7	250pk6+40m～250pk8+10m	170	I	▲、—▲	◎	○		○	I		Overhanging massive rock/weathered rock, sedimentary rock	H	7
19	267pk3	267pk2+50m～267pk4+10m	160	I		◎*	◎		○	I		Dangerous due to overhanging massive rocks	H	3
20	283pk9	283pk8+00m～284pk1+80m	380	I		◎*	○	○	◎	I		Ditto	H	2

▲ Dangerous rock wall with downward joints toward track
—▲ Less dangerous rock wall with upward joints toward track

◎* Dangerous due to massive rocks subject to the measures
◎ A large quantity of rocks subject to the measures
○ A medium quantity of rocks subject to the measures
△ A small quantity of rocks subject to the measures

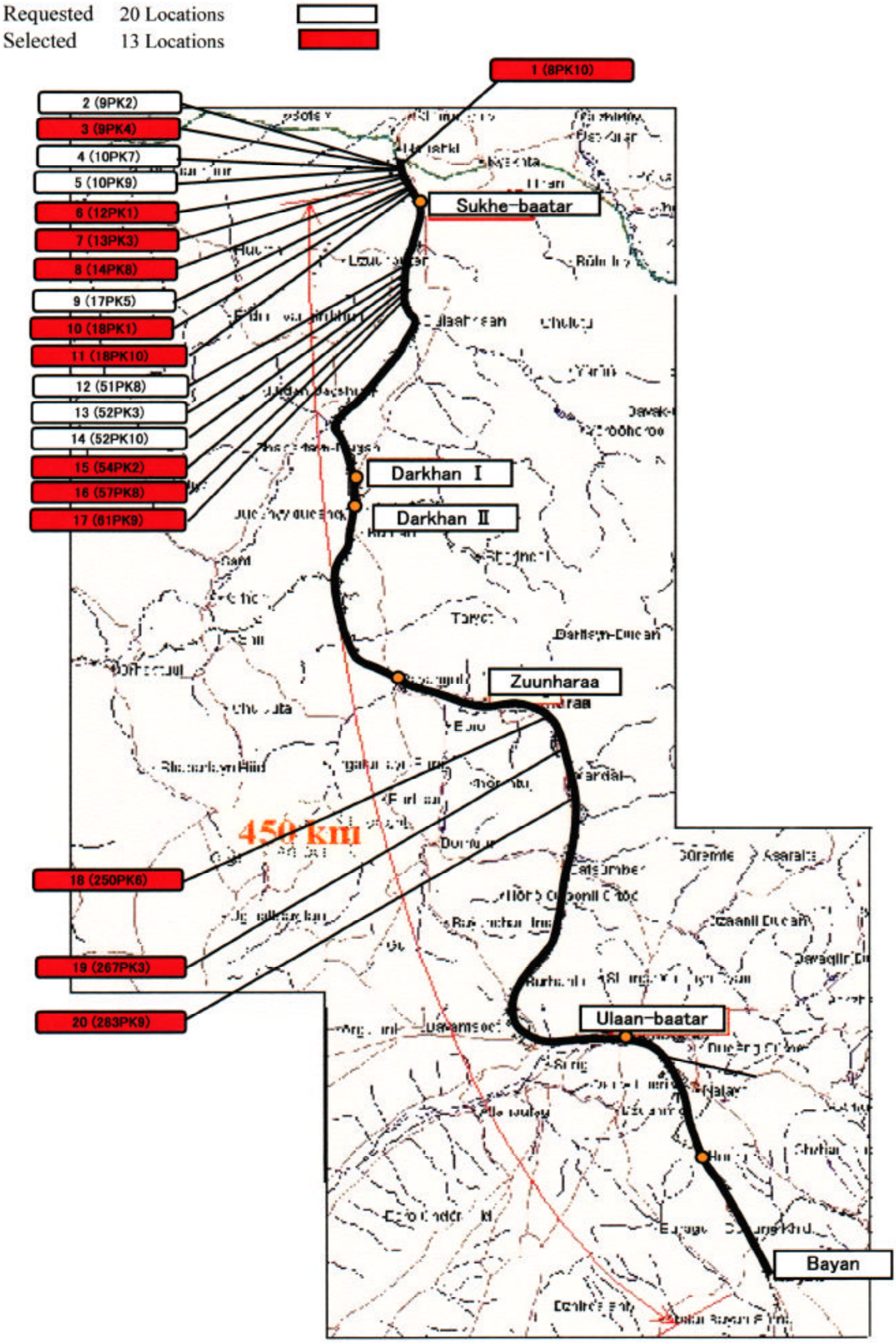


Fig. 2.2.2 Slope Stability

(3) Flood Protection Measure Works

1) Proposed Location

Sukhebaatar Station use to be covered by flooded water from the mountainside and loosen soil into the station yard and silted soil. These damaged railway facilities such as points, and suspend the train operation of international train towards Russian and coal transport freight wagon during rainy season. This location is judged to require urgent countermeasure.

(4) Bridge Rehabilitation

1) Proposed Location

Proposed locations were 11 locations as indicated in Fig. 2.2.3.

2) Selection of Objective Location

The necessity and appropriateness for proposed location were evaluated from the priority of project, in consideration of structure soundness analysis and conditions to speed restriction of train operation as outer element. The result of structure soundness analysis is shown in Table 2.2.6 and result of evaluation is indicated in Table 2.2.7.

Table 2.2.6 Result of evaluation

No	Location	Stage of F/S	Basic Design Study																
			Evaluation Item of Healthy Investigation															External Condition	
			Main Girder					Overhanging Slab					Abutment and Pier					Evaluation	Slowly Drive Section
			Reinforced Concrete Exposure	Leakage of water	Isolation Omission Dropping Fixsitu	Crack	Check Hammer	Reinforced Concrete Exposure	Leakage of water	Isolation Omission Dropping Fixsitu	Crack	Check Hammer	Reinforced Concrete Exposure	Isolation Omission Dropping Fixsitu	Crack	Frost Heave Scour	Check Hammer		
①	235PK3+5	I	○	△	△	△	△	○	△	○	△	△			△			Ⅱ	○
②	245PK10	I		△		△		△	○	△	△	△			△			Ⅲ	
③	255PK3	I	△	△	△	△	△	○	○	○	△	△			△	△		Ⅱ	○
④	285PK1	I	△	△	△	△	△	△	○	△	△	△			△	△		Ⅲ	
⑤	289PK1	I	◎	△	◎	○	◎	○	○	○	○	○			△			I	
⑥	334PK3	I	△	△	○	△	△	○	○	○	△	△			△	△		Ⅱ	○
⑦	338PK10	I	◎	△	◎	○	◎	○	△	△	○	△			△			I	
⑧	344PK1	I	◎	△	◎	○	◎	○	△	△	△	△			△			I	
⑨	349PK10	*	○	△	△	△	△		△	△	△	△			△			Ⅲ	
⑩	356PK1	I	○	△	△	△	△	△	△	△	△	△			△			Ⅲ	
⑪	438PK7	*		△	△	△	△		△	△	△				△	○		Ⅲ	

* Because the site is investigated, and damage is small, the sign changes from 362PK9,342PK2 of the F/S stage to

◎ Large Damage
○ Middle Damage
△ Small Damage

Evaluation of Healthg Investgation

Ⅰ : Do the state of the transformation or it is defective in Main-structure and Sub-structure.It is necessary to Bridge beam replacement.

Ⅱ : Do the state of the transformation or it is defective in Main-structure and Sub-structure.It is necessary to Large-scaie repair.

Ⅲ : Do the state of the transformation or it is defective in Main-structure and Sub-structure.It is necessary to Middle-scaie repair or Small scaie repair.

Table 2.2.7 Priority of Project and Selected Result

Location		Integrated evaluation	Priority	Result
1	235PK3+5	It is necessary to repair Main girder and Overhanging Slab.The damage of Overhanging does the going slowly drive because the fall of the ballast is greatly worried.	M	Repair of beam
2	245PK10	It is necessary repair Overhanging Beam.Main girder is considered good by Healthy Investigation	L	Repair of beam
3	255PK3	It is necessary to repair to Main girder and Overhanging Slab.The damage of Overhanging does the going slowly drive because the fall of the ballast is greatly worried.	M	Repair of beam
4	285PK1	It is necessary to repair to Main girder and Overhanging Slab.	L	Repair of beam
5	289PK1	It is necessary to replace Bridge Beam. L=11.5m	H	Replacemnt of Beam
6	334PK3	It is necessary to repair to Main girder and Overhanging Slab.The damage of Overhanging does the going slowly drive because the fall of the ballast is greatly worried.	M	Repair of beam
7	338PK10	It is necessary to replace Bridge Beam. L=7.3m	H	Replacemnt of Beam
8	344PK1	It is necessary to replace Bridge Beam. L=7.3m	H	Replacemnt of Beam
9	349PK10	It is necessary to repair to Slab.	L	Repair of beam
10	356PK1	It is necessary to repair Main girder.	L	Repair of beam
11	438PK7	It is necessary to repair Abutment with strot	L	Pepair of Abatment

H : Urgent treatment is necessary.
M : Immediate treatment is necessary.
L : It is necessary to process when it is necessary.

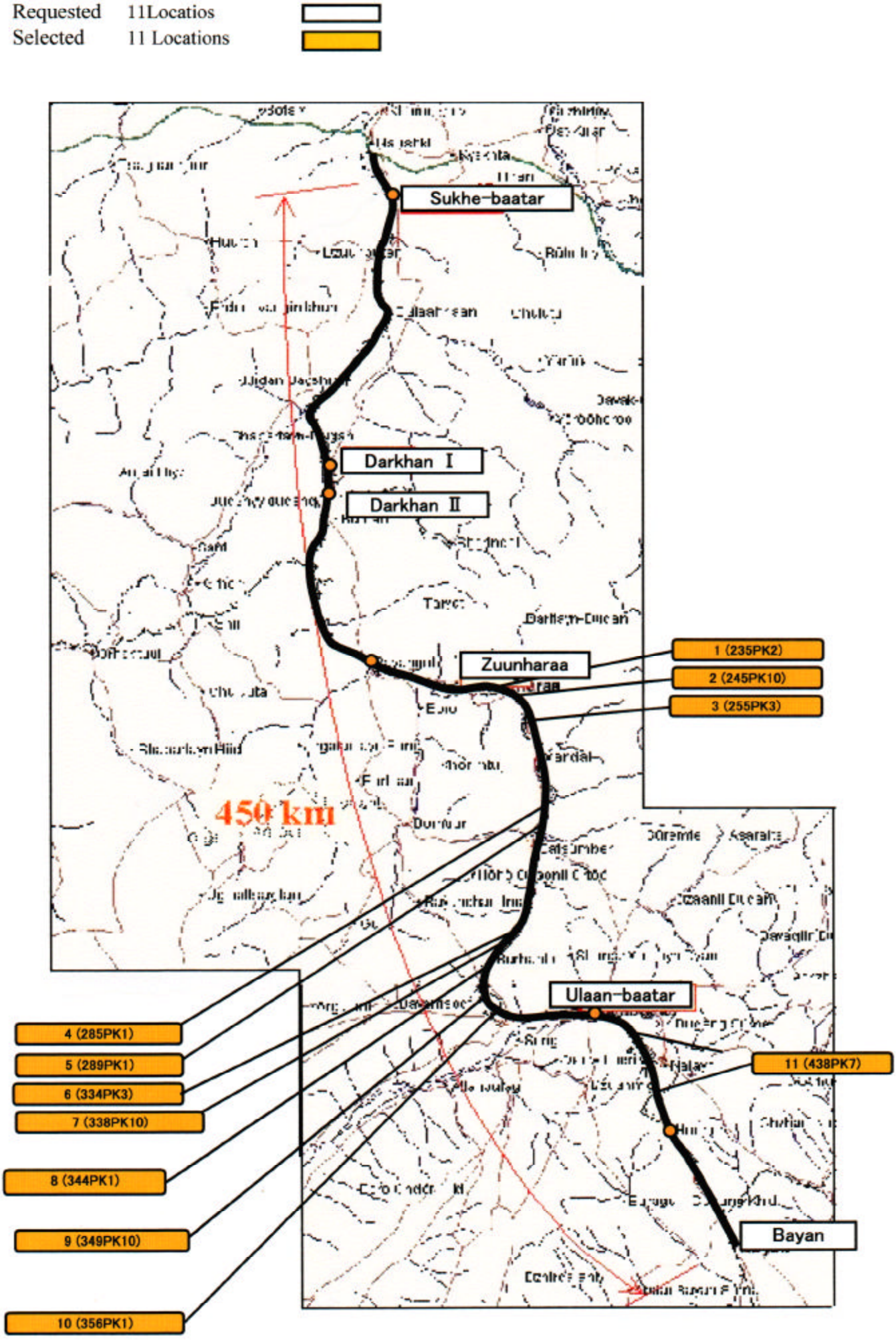


Fig. 2.2.3 Bridge Rehabilitation

(5) Drainage Facilities

1) Proposed Location

The proposed location were 60 locations as indicated in Fig. 2.2.4.

2) Selection of Objective Location

The necessity and appropriateness for proposed location were evaluated based on site survey and material of and hydrological data and analyzed discharge capacity at track crossing drainage, lack of water flow capacity, disaster record. Location of 22 pk is one of Skhebaatar food protection measure. The result of selection of Objective location is shown in Table 2.2.8.

(6) River Width Improvement Work (399pk 1)

1) Urgency of Countermeasure

Recently, river width improvement works have been executed by Ulannbaatar city, and simultaneously, a new railway bridge has also been constructed by the Mongolian Railway. However, as a consequence, the old bridge girder and abutment made by concrete and the old river bank protection were left untouched along the river side.

These left facilities cause to decrease the water discharge capacity and thus to increase the possibility of flood, which damages the railway facilities and the suburban citizen.

This project is judged necessity and appropriate for implementation.

Table 2.2.8 Results of Evaluation and Selected Locations

No	Measure	Location Pk m			Stage (F/S)	Analysis of Present Condition				Evaluation	
						Urgency (F/S)	Catch Area Distribution (>33.3%)	Shortage of Drain Capacity(>5m3/s)	Disaster Record	Priority	Result
1	Capacity I	21	7	0	2		△	△	◎	L	Adopt
2	Capacity I	22	10	80	1	○	○	○	◎	H	Adopt
3	New	66	7	25	1	○	○	△	◎	M	Adopt
4	Capacity I	89	7	75	1	○	△	△	◎	M	Adopt
5	New	90	7	25	3		△	△	◎	L	Adopt
6	New	93	8	30	1	○	○	○		M	No
7	Capacity I	97	5	45	1	○	○	◎		M	No
8	Capacity I	100	7	30	1	○	○	○		L	No
9	Capacity I	116	2	55	2		○	○		L	No
10	Capacity I	125	9	0	1	○	○	○	◎	H	Adopt
11	Capacity I	138	5	81	2		○	○		L	No
12	New	142	9	50	1	○	○	○	◎	H	Adopt
13	Capacity I	145	1	30	1	○	○	○		L	No
14	Capacity I	168	3	60	1	○	○	○	◎	H	Adopt
15	New	170	3	50	1	○	○	△	◎	M	Adopt
16	Capacity I	173	1	50	2		○	○		L	No
17	New	190	8	50	1	○	△	○	◎	M	Adopt
18	New	192	5	0	3		△	○	◎	L	Adopt
19	New	197	2	75	1	○	○	○	◎	H	Adopt
20	Capacity I	205	8	10	3		○	△	◎	L	Adopt
21	New	210	6	5	1	○	△	△		L	No
22	Capacity I	216	6		2		△	△		L	No
23	New	217	9	75	1	○	○	○		L	No
24	New	227	3	65	3		△	△	◎	L	Adopt
25	New	237	4	35	3		△	△		L	No
26	Capacity I	242	9	90	1	○	○	◎		M	No
27	Capacity I	253	3	30	1	○	○	○	◎	H	Adopt
28	Capacity I	258	6	60	3		○	○		L	No
29	Capacity I	268	7	95	2		○	○		L	No
30	Capacity I	280	10	35	3		○	○		L	No
31	Capacity I	282	10	90	2		○	△		L	No
32	New	294	4	55	3		○	△		L	No
33	Capacity I	313	10	80	1	○	△	△	◎	M	Adopt
34	Capacity I	314	10	20	1	○	○	◎	◎	H	Adopt
35	New	319	1	80	3		○	△	◎	L	Adopt
36	Capacity I	319	7	5	2		○	△	◎	L	Adopt
37	Capacity I	324	5	55	2		○	△		L	No
38	New	329	4	90	1	○	○	△	◎	M	Adopt
39	Capacity I	331	9	90	3		△	△		L	No
40	Capacity I	334	4		1	○	△	◎		L	No
41	Capacity I	341	1	5	1	○	△	△		L	No
42	New	348	10	10	2		○	○		L	No
43	Capacity I	350	1	25	2		△	○		L	No
44	Capacity I	352	8	20	1	○	○	◎		M	No
45	Capacity I	356	1	50	1	○	△	○		L	No
46	New	357	6	75	2		○	△	◎	L	Adopt
47	New	365	3	94	2		△	○	◎	L	Adopt
48	Capacity I	386	6	50	3		△	△	◎	L	Adopt
49	New	387	10	10	3		○	△	◎	L	Adopt
50	Capacity I	388	8	50	1	○	△	△	◎	M	Adopt
51	Capacity I	388	10	90	1	○	△	○	◎	M	Adopt
52	Capacity I	391	2	45	1	○	△	△	◎	L	Adopt
53	Capacity I	394	4		1	Replacement of Heating Pipe					No
54	Capacity I	399	1		1	Removal of bridge abutment and beam					Adopt
55	New	416	4	75	1	○	○	△		M	No
56	Capacity I	417	6	35	1	○	○	△	◎	M	Adopt
57	Capacity I	420	7	60	1	○	△	△	◎	L	Adopt
58	Capacity I	424	8	50	1	○	○	△	◎	M	Adopt
59	Capacity I	428	4	60	1	○	○	○	◎	H	Adopt
60	Capacity I	438	8	50	1	○	△	○	◎	M	Adopt

Large ◎ Suffer, Drain Capacity (More than 15m3/s)

Middle ○ Drain capacity (more than 5m3/s, Distribution ofcChatchment area (more than 33.3%), Stage 1 ii

Small △ Drain capacitu (less than 5m3/s), Distribution of chatchment area (less than 33.4%)

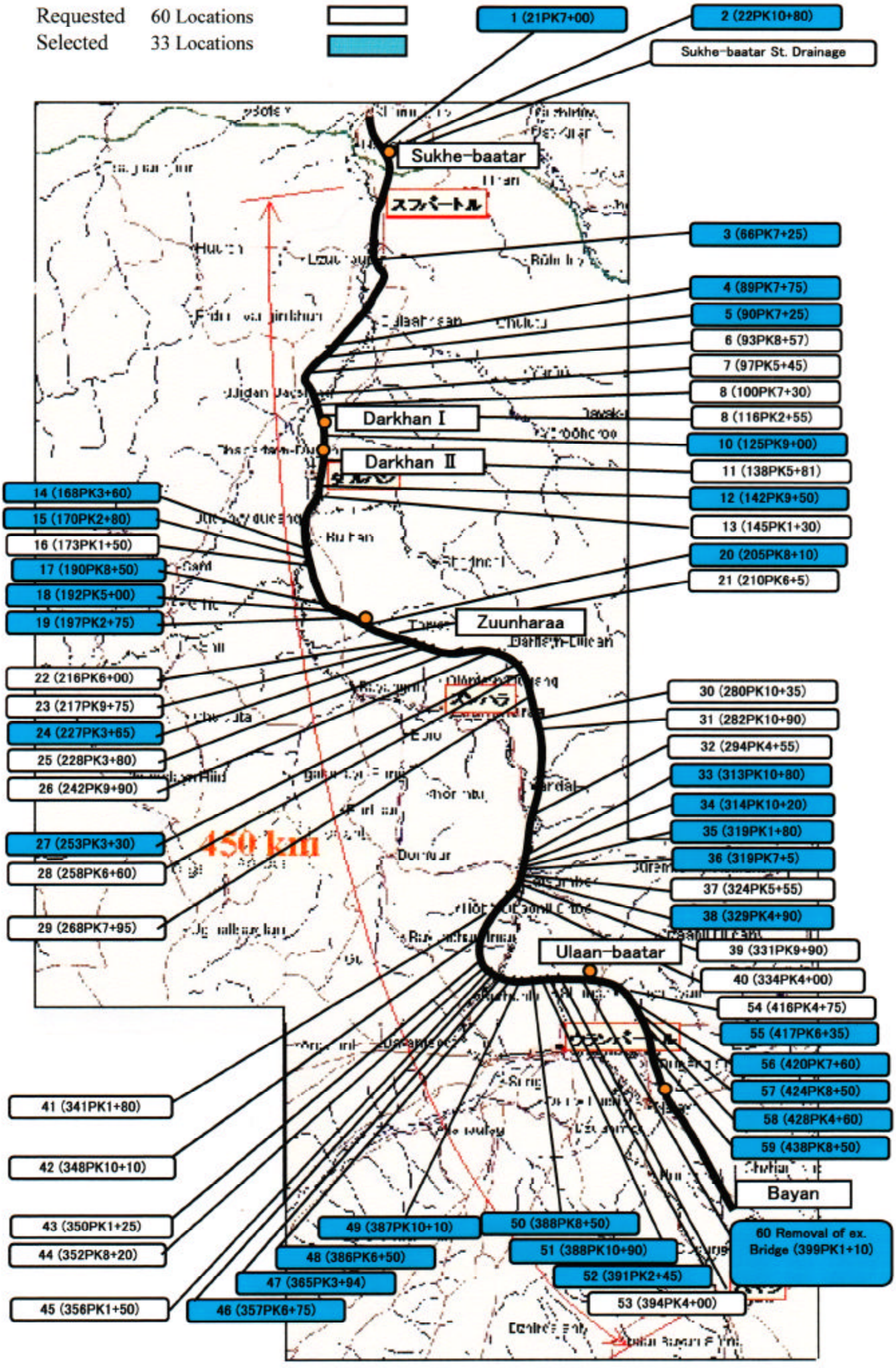


Fig. 2.2.4 Drainage Facilities

2.3 Basic Design

2.3.1 Concept

In consideration of the natural conditions of Mongolia, the maturity of construction situation in Mongolia, the availability of construction of machinery and material in Mongolia and the capability of Mongolian Railway to operate and maintain its railway facilities, the following shall be the basic principles for design;

① The construction work at the spot in the coldest area during the coldest season of the year, when a concrete pouring work is extremely difficult, shall be limited as much as possible.
② It shall be basically considered to adopt the construction method with security and simplicity.
③ Accordingly, the pre-cast concrete materials manufactured in plant shall be utilized as much as possible.
④ Since most of construction works are performed at places nearby/at the railway facilities under operation, all possible measures shall be taken to secure the safety during construction.
⑤ The type of railway facilities shall be chosen in view of their easy maintenance, and the design shall be made on the basis of the reduction of maintenance cost.
⑥ As to the construction term, it shall be basically incorporated in the schedule of design and execution to complete the construction within shortest term as possible, taking into consideration the financial aspect.

2.3.2 Basic Design

(1) River Bank

The design of river bank works is carried out based on River, Erosion and Sediment Control Manual published by the Ministry of Construction of Japan.

1) Area of rubble mound revetment

It is purposed to protect the railway against meandering of river. The length of river bank is planned to start from meandering point of river or area of water crashing river bank and 1.5 ~ 2.0 times of river width in downstream and some allowance in upstream, and also includes the area for river to fix direction of flow.

In case of two continuous meandering points of river, revetment is planned to be continuous between two meandering points.

2) Rubble mound revetment

a) Average size of rubble stone

At each location, the rubble stone size required is calculated as a weak joint model based on dragging power of river by the above design standard manual. Table 2.3.1 is shown rubble stone size.

Table 2.3.1 Rubble Stone Size

Location	Velocity of Water flow (m/s)	Size of Rubble stone as a weak joint each others (m)	Gradient of Slope
10pk	3.5 - 3.6	0.38	1:2
31pk	2.89 - 3.09	0.25	1:2
52pk - 65pk	2.66 - 2.72	0.22	1:2
88pk	2.35	0.17	1:2
205pk	3.3 - 3.36	0.33	1:2

Since there is no suitable material for the bag of foot protection in Mongol, rubble mound revetment and rubble mound foot protection have been adopted.

b) Slope of river bank

The slope of river bank has been decided as 1:2 in accordance with the natural slope of the surrounding river wall which is stable at site. This enabled to avoid cutting the natural slope and existing trees in major parts.

c) Existing flora at site

Existing trees and plant shall be remained as much as possible, since it is possible to expect the considerable protection of river bank because of the covering with trees and plant and direct protection of surface of river bank by root of trees.

d) Thickness of rubble mound revetment

The thickness of rubble mound revetment use three time of the ruble size in compliance with the manual of River and Erosion and Sediment Control Manual.

Mainly rubble mound revetment is used for sand river bed, it is required two primary functions namely, separation and filtration. In this project, although it is policy to use the local materials as much as possible for the maintenance later, since soil condition of all locations is almost same as a silty sand river bed, geotextile revetment filters for river bank is used.

Rubble mound revetment is put on about 15 cm thickness of the protective gravel or crashed stone covering geotextile revetment filter. Filling and stuffing into gap of revetment shall be carried out as much as possible. Thickness of rubble mound revetment is as follows at each locations.

10pk	1,250 mm
31pk	1,000 mm
52pk-65pk	800 mm

3) Foot protection works

It is difficult to find the material for foot protection works other than rubble stone.

Foot protection also use rubble mound foot protection which has been constructed by Mongolian railway in recent year and is favorable for environment of river side.

Thickness for rubble mound foot protection is same to revetment.

4) Scouring at the crown of revetment

Flat protection of the top of revetment should be protected with 2 meters and end side should be protected by cut off wall, etc.

5) Groyne

In this project, the impermeable and overflow groyne type is used aiming to reduce the velocity of water flow, and to prevent the erosion of river bank together with rubble mound revetment. The shape and pitch of groyne are as follows.

Shape of groyne

Height	0.5 ~ 1.0 m above the Mean Water Level at its connection with bank.
Slope of top	10 % down slope from its connection with bank.
Width of top	2.5 m
Gradient of slope	1:1.2

Pitch of groyne

as a supplementary of rubble mound revetment, 3 ~ 4 times of the length of groyne.

6) Basic Design conditions

a. Condition of River

- Rail level and Flood Water level at each site.

No.	Location	Coefficient of roughness (main stream)		River bed slope	Velocity of flow (m/s)		Discharge ($m^{3/}$ s)	Max. depth of flow (m)	
		Uniform flow	Non-uniform flow		Uniform flow	Non-uniform flow		Uniform flow	Non-uniform flow
1	10pk 10+95~ 11pk 2+95	0.025	0.028	1/1600	3.52	3.59	3600	8.4	8.21
2	31pk1 ~ 31pk6	0.025	-	1/1400 - 1/1600	2.89 - 3.09	-	1600	6	-
3	52pk 1+25 ~ 52pk 3+25	0.025	0.028	1/1800	2.72	2.66	1600	6	5.73
4	54pk 4+25 ~ 54pk 6+25	0.025	0.028	1/1800	2.72	2.66	1600	6	5.73
5	55pk 8+80 ~ 55pk 10+30	0.025	0.028	1/1800	2.72	2.66	1600	6	5.73
6	56pk 3+75 ~ 56pk 6+75	0.025	0.028	1/1800	2.72	2.66	1600	6	5.73
7	65pk 6+85 ~ 65pk 9+35	0.025	0.028	1/1800	2.72	2.66	1600	6	5.73
8	89pk 1+10 ~ 89pk 3+60	0.025	-	1/1400	2.35	-	600	4.5	-
9	208pk 1+00 ~ 208pk 2+70	0.025	0.03	1/800	3.36	3.3	730	5.5	4.81

- Condition of calculation for rubble mound revetment

No.	location of river revetment	location		Rail level	Flood water level	Water level during investigation	River bed slope
		km	pk	(m)	(m)	(m)	
1	10pk 10+95~ 11pk 2+95	11	1	600.03	598.8	594.4	1/1600-1/2000
2	31pk1 ~ 31pk6	31	4	610.40	607.5	606.0	1/1400-1/2000
3	52pk 1+25 ~ 52pk 3+25	52	2	623.51	622.1	619.1	1/1600-1/2000
4	54pk 4+25 ~ 54pk 6+25	54	5	625.40	623.2	621.7	1/1600-1/2000
5	55pk 8+80 ~ 55pk 10+30	55	10	625.63	623.3	621.5	1/1600-1/2000
6	56pk 3+75 ~ 56pk 6+75	56	4	626.90	624.4	623.2	1/1600-1/2000
7	65pk 6+85 ~ 65pk 9+35	65	6	631.00	629.5	625.9	1/1600-1/2000
8	89pk 1+10 ~ 89pk 3+60	89	2	651.14	644.4	640.8	1/1400-1/1600
9	208pk 1+00 ~ 208pk 2+70	208	1	815.45	813.6	809.8	1/700-1/800

b. Condition of Structure

The structure shall be selected from Mongolian products as much as possible in order to facilitate maintenance and management after completion. River bank protection is adopted by combination of the rubble mound revetment, foot protection and groyne because Mongolian Railway is already familiar with these works using the local material. Therefore, it will be possible for Mongolian Railway to maintain and manage the works basing on its vast past experience, and also the materials are favorable for environment of river side.

The depth of river, frieezing of river in winter, rise of the river with melted snow, and flood in rainy season were taken into account for the structure of revetment.

7) Construction Method

According to the present site and hydrographic investigations, the combination of the rubble mound revetment, foot protection and groyne is adopted for the following two locations. One is 10 pk which is having a big rate of flow, high velocity of flow and effective groynes at site, and another one is 31 pk which was constructed one groyne for test of the effectiveness. Two location of 52 pk and 65 pk are adopted with a combination of the rubble mound revetment, foot protection and partial groynes. For the other 3 locations, only the rubble mound revetment/foot protection is adopted. The construction method is shown in Table 2.3.2

Table 2.3.2 Countermeasure works for river bank protection

No.	Location and Length		Name of River	Countermeasure
	Location	Length (m)		
1	10pk 10+95~ 11pk 2+95	200	Serenge	Rubble-mound revetment / foot protection, addition of groyne
2	31pk2+25 ~ 31pk6+25	450	Orhon	Rubble-mound revetment / foot protection, addition of groyne
3	52pk 1+25 ~ 52pk 3+25	200	Orhon	Rubble-mound revetment / foot protection, partly groyne
4	54pk 4+25 ~ 54pk 6+25	200	Orhon	Rubble-mound revetment / foot protection
5	55pk 8+80 ~ 55pk 10+30	150	Orhon	Rubble-mound revetment / foot protection
6	56pk 3+75 ~ 56pk 6+75	300	Orhon	Rubble-mound revetment / foot protection
7	65pk 6+85 ~ 65pk 9+35	250	Orhon	Rubble-mound revetment / foot protection, partly groyne
8	89pk 1+10 ~ 89pk 3+60	250	Hara	Excluding from this project
9	208pk 1+00 ~208pk 2+70	170	Hara	Excluding from this project

(2) Slope Stability

In basic design, the slopes in the section subject to the measures against rock fall were classified in accordance with the slope classification shown in the Technical Manual on Rock Fall issued on March 1999 by Japan Railway Technical Research and Institute.

1) Basic Consideration for Construction Work

① The above rock bed excavation shall be aimed principally at the minimum removal of overhang, weathered rocks, loose boulders and talus (scree), which cause rock fall, including a reinforcement of rock foot and an installation of rock pool.

The following measures shall not be adopted as a rule because of a need of concrete pouring on the spot, a difficulty of its execution in limited space, impossibility of its work in winter and a large amount of construction cost.

② As a result of site survey, the natural grade (angle of repose) of talus(scree) is of about 30 to 35 degrees, and the one of stable slope above overhang is about less than 35 degrees.

Accordingly, the cutting grade with 35 or less degrees is ideal for the removal of overhang. However, in case of the slope grade with 30 to 35 degrees above overhang, the cutting grade shall be of 40 degrees in order to prevent the cutting volume from being massive.

③ In consideration of the reduction of construction cost, the scale of construction shall be limited to the minimum so as to maintain a stability of slope.

④ As a result, the disposal amount of rock waste is expected to be the minimum, and the environmental impact can be limited to the minimum.

⑤ It shall be planned not to dump the rock wastes in rivers so as to avoid the river contamination.

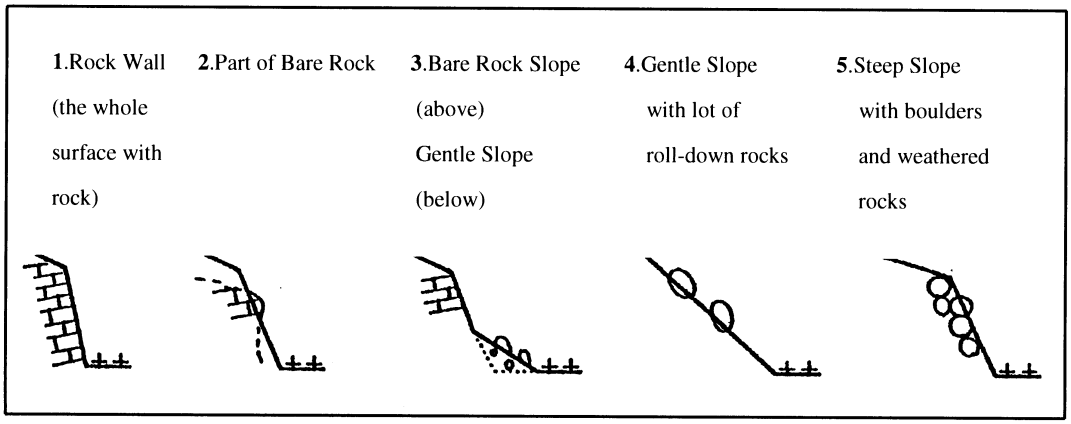
2) Classification of Slope

The type of slope for the objective location is indicated in Table 2.3.3.

Table 2.3.3 Classification of Slope

No.	Location/Extension needing Rock Fall Measures			Slope Classification				
	Location	Section subject to measures	Extension (m)	1	2	3	4	5
1	8pk10	8pk10+00m – 8pk10+95m	95			○		
2	9pk2	9pk1+85m – 9pk2+50m	65	○				
3	9pk4	9pk4+00m – 9pk5+25m	125	○		○		
4	10pk7	10pk7+00m – 10pk8+00m	100	○				
5	10pk9	10pk8+75m – 10pk9+50m	75	○				
6	12pk1	11pk10+60m – 12pk1+55m	95			○		
7	13pk3	13pk2+75m – 134pk4+50m	175			○		
8	14pk8	14pk7+85m – 14pk8+95m	110			○	○	
9	17pk5	17pk5+50m – 17pk6+40m	90	○				
10	18pk1	17pk10+95m – 18pk1+75m	80	○				
11	18pk10	18pk9+75m – 18pk10+90m	115	○				
12	51pk8	51pk8+35m – 51pk9+00m	65			○		
13	52pk3	52pk3+30m – 52pk4+50m	120	○				
14	52pk10	52pk9+90m – 52pk10+25m	35	○				
15	54pk2	54pk2+75m – 52pk10+25m	140				○	
16	57pk8	57pk8+25m – 57pk9+70m	145	○		○		
17	61pk9	61pk9+10m – 61pk10+90m	180			○	○	
18	250pk7	250pk6+40m – 250pk8+10m	170	○		○		
19	267pk3	267pk2+50m – 267pk4+10m	160			○		
20	283pk9	283pk8+00m – 284pk1+80m	380			○	○	

Reference: Slope Classification in the Technical Manual on Rock Fall Measures (issued on March 1999 by Japan Railway Technical Research and Institute)



3) Implementation Method of Slope Stability

With the Grant Aid scheme, measures against rock fall will be implemented in 13 locatios shown in Table 2.3.4.

Table 2.3.4 Implementation Method against Rock Fall

No	Location/Extension of Places subject to Rock Fall Measures			Item of Measures against Rock Fall				
	Location	Section subject to Measures	Extension (m)	Overhang	Weath-ering	Loose Boulders	Talus (Scree)	Rock Pool
1	8pk10	8pk10+00m~8pk10+95m	95	O		O	O	O
2	9pk4	9pk4+00m~9pk5+25m	125	O	O		O	O
3	12pk1	11pk10+60m~12pk1+55m	95	O		O	O	O
4	13pk3	13pk2+75m~13pk4+50m	175	O	O	O	O	O
5	14pk8	14pk7+85m~14pk8+95m	110	O		O	O	O
6	18pk1	17pk10+95m~18pk1+75m	80		O	O		O
7	18pk10	18pk9+75m~18pk10+90m	115	O	O		O	O
8	54pk2	54pk2+75m~54pk4+15m	140		O	O	O	O
9	57pk8	57pk8+25m~57pk9+70m	145	O	O	O	O	O
10	61pk9	61pk9+10m~61pk10+90m	180	O	O	O	O	O
11	250pk7	250pk6+40m~250pk8+10m	170	O	O		O	
12	267pk3	267pk2+50m~267pk4+10m	160	O	O		O	O
13	283pk9	283pk8+00m~284pk1+80m	380	O	O	O	O	O

12pk1, 13pk3, 267pk3 and 283pk9 will required replacement of telecommunication cable.

(3) Sukhebaatar Station Drainage Works

1) Area of Rehabilitation

The rehabilitation will be done for a section where flooded water runs through between two locations. One is a track crossing drainage located at 1,100 m north from the station building (at 20 pk 10) and another one is a location where drainage separates the railway track passing through another track crossing drainage for siding track located at 700 m south and one more track crossing drainage for shunting track for coal transportation at 860 m south from the station building. Length of south side drainage is ca. 1 km. Total length of the improved drainage is ca. 2.1 km.

The water flow into the track at north side occurs due to the incomplete drainage running along railway track and at south side occurs due to loss water head of crossing drainage under siding track and shunting track, gentle gradient and shallow channel.

2) Condition of Design

a) Catchment Area

Under investigation of site map that 2/3 of the rainfall from whole catchment area will flow into this section, the drainage facilities parallel to the track alignment should have the capacity of 18 m^3/s at northern side and 11 m^3/s at southern end of the rehabilitation site.

b) Design conditions

Concrete U shape channel		
Coefficient of roughness	0.015	
Whole discharge	29 m^3/s	
Discharge in north channel	18 m^3/s	length 1.1 km
Discharge in south channel	11 m^3/s	length 1.0 km

c) Structure design

Coefficient of earth pressure at rest	0.5
Unit weight of earth	1.9 tf/m^3
Unit weight of water	1.0 $^{th}/m^3$
Surcharge load	1.0 tf/m^2
Unit weight of concrete	2.5 tf/m^3
Strength of Concrete	240 kg/m^2
Grade of steel bar	SD345

5) Countermeasure Works

a) Track Crossing Drainage Facilities

While number of track at the station yard is 12 ~ 16, it is easy to install easily track crossing drainage facilities at the both ends. The crossing drainage at north end of yard has 3 tracks and two locations at south end of yard have 1 track. The track crossing facilities is installed at the north end of the station yard and at south end with pre-cast box culvert. Water flow divide into the newly constructed box culvert and the existing pipe culvert.

b) Paralleled Drainage Facilities to the Track Alignment

Calculation for discharge of U ditch was carried out by uniform flow and non uniform flow.

U type drainage structure of cast in place concrete will be used for drainage facilities paralleled to the track alignment because of necessity of bottom concrete slab of ditch against the scouring. Use of cast in place concrete drainage will result in cheap construction expenses.

At north side, cast in place concrete box culvert (1.5 x 1.5, L = 6 m) is used under road entrance and concrete slabs (1.5 m width) are used for passenger foot path at two locations of north side of station yard.

(4) Bridge Rehabilitation

1) Design Concept

a. Replacement of bridge beam

- Design of bridge bean will introduce Mongolian standard.
- Construction will be done by precast products for following reason.

	Precast product	Cast-in-place Chino product
Feature	・Carrying the material is easy. ・Bridge beam can be carried by the railway. ・Concrete form can be used combinedly. ・The manufacture preparation can be done in the winter. ・The construction period in the site is short. ・The quality control is good.	・Road for carrying the materials to the construction site is necessary. ・Concederable time is required for the transportation of the material by the railway for unloading the material piling up.The train operation will be suspended. ・Form cannot be used combinedly. ・The construction period is long. Anti flood Measures of the flood are necessary. (According to the site information, the water level by 1m-1.5m thaw water or usual rain collects in the vicinity of the railway.) ・The quality control is inferior. ・The traffic of the domestic animal is hindered.
Recommendation	○	

b. Repair of main girder and overhanging beam.

- When damage is evaluated by to be healthy investigation, middle or small, it is assumed to be repaired.

- The place of exfoliation and falls out of concrete slab will replace the resin mortal.
- The place of over aged concrete at the overhang slab will replace will replace the new concrete.
- Exfoliation and falls out of concrete and water proof between beams replace the new concrete.
- Expansion joint at overhang slab will replace the new water proof material.

(3) Design Conditions

a. Design Load

Live load (Equivalent uniform load)

Span	K=1				K=14			
λ	Starting Point α=0		Span Center α=0.5		Starting Point α=0		Span Center α=0.5	
	KN/m	tf/m	KN/m	tf/m	KN/m	tf/m	KN/m	tf/m
1.0	49.03	5.000	49.03	5.000	686.5	70.00	686.5	70.00
1.5	39.15	3.992	34.25	3.493	548.1	55.89	479.5	48.90
2.0	30.55	3.115	26.73	2.726	427.7	43.61	374.2	38.16
3.0	24.16	2.464	21.14	2.156	338.3	34.50	296.0	30.18
4.0	21.69	2.212	18.99	1.936	303.7	30.97	265.8	27.10
5.0	20.37	2.077	17.82	1.817	285.2	29.08	249.5	25.44
6.0	19.50	1.988	17.06	1.740	272.9	27.83	238.8	24.35
7.0	18.84	1.921	16.48	1.681	263.7	26.89	230.7	23.53
8.0	18.32	1.868	16.02	1.634	256.4	26.15	224.4	22.88
9.0	17.87	1.822	15.63	1.594	250.2	25.51	218.9	22.32
10.0	17.47	1.781	15.28	1.558	244.5	24.93	214.0	21.82

(1984 Mongolian Standard Change load)

Dead load

Ferroconcrete	D1 = 2.5 tf/m^3
Inclination concrete	D2 = 2.35 tf/m^3 (In case of one : 2.5 tf/m^3)
Orbit load	D3 = 6.825 tf/m
Ballast	D4 = 1.9 tf/m^3

b. Impact

$1 + \mu = 1 + 10 / (20 + \lambda)$ (Mongolian Standard)

c. Material

Superstructure concrete	σ ck = 400 kgf/cm^2 (Mongolian Standard test)
Substructure concrete	σ ck = 300 kgf/cm^2 (Mongolian Standard test)
Plain concrete	σ ck = 200 kgf/cm^2 (Mongolian Standard test)
Reinforcing bar	SD295 or SD345

d. Replacement Superstructure is Mongolian standard design recapitulative.

(4) General Drawing

Major repair items are indicated in Table 2.3.5.

Table 2.3.5 Major Repair Work

Location		
1	235pk3+5	Repair for main girder and overhang beam
2	245pk10	Repair for overhang beam
3	255pk3	Repair for main girder and overhang beam
4	285pk2	Replacement of One span girder and repair for main girder and overhang beam for other girder
5	334pk3	Repair for main girder and overhang beam
6	338pk10	Replacement of beam (L=7.3m)
7	344pk1	Replacement of beam (L=7.3m)
9	349pk10	Repair for deck girder
10	356pk1	Repair for main girder and overhang beam
11	438pk7	Installation of sturt for deform of abutment

(5) Drainage works

1) Condition of Structure

There are several possible solutions such as new bridge and new box culvert construction. Up to present, the Mongolian Railway used to adopt the solution with box culvert construction method. With this method, pre-cast fabricated box culverts are installed after swift removal of the embankment within 10 hours' interval of train operation. Provided that interval of train operation is secured, this method is most economical, time efficient and safe. In addition, by fabricating pre-cast concrete product in winter season, production efficiency can be increased with this method.

On the contrary, the construction works under train operation is not recommendable even if the train operation should be maintained, as it requires far more cost and time for construction of temporary abutments and erection of temporary bridge girder. In order to maintain desirable quality, it is not recommended to mix concrete at the construction site. This project is introduced precast box-culvert type.

According to the site information, we found that the flow of water into railway track occurs due to insufficient of capacity of existing drainage even as the river along railway is flood. Therefore cross sectional area of box culvert is estimated to flow the required water volume in the condition of 0.4m of different water level between left and right sides of railway embankment.

This estimate method was found in a study report of Mongolian consultant entrusted to conduct hydrological study by Mongolian railway.

2) Design Condition

a. Box culvert sizes

The following sizes of box culvert were adopted as the standard. Standard design of Mongolian was adopted for Type D and E of the bigger size of box culvert. Other size have been designed in this project.

Type		Clearance		Thickness			Hunch
	BxH	Height	Width	Upper slab	Lower slab	Side wall	Width & Height
A	1.5x1.5	1.5	1.5	0.15	0.15	0.13	0.20
B	2.0x1.0	2.0	1.0	0.20	0.20	0.14	0.20
C	2.5x1.5	2.5	1.5	0.26	0.26	0.18	0.20
D	2.5x2.0	2.5	2.0	0.20	0.20	0.13	0.20
E	3.0x2.5	3.0	2.5	0.29	0.29	0.20	0.25

b. Connecting steel bar

As described in construction method, pre-cast concrete blocks with 1 m ~ 2 m unit of length are placed under the track. Mongolian standard design has no material connecting concrete blocks each other which is 1 meter length. In order to prevent the gap of blocks by vibration under train operation, steel bars are installed in the hole made at four corners of

concrete block and bolted at both end. Size of steel bar is ϕ 22mm of SD 345 equivalent or more.

c. Design standard

Box culvert design of Mongolian standard is follows Russian standard design. New design has been applied the Japan design standard using Mongolian live and impact loads design.

d. Design conditions

① Design load

i) Live Load

Live load refer to the Mongolian standard live load issued in 1984.

ii) Dead load

Reinforced concrete	2.5 tf/m^3
Track material	6.825 tf/m
Ballast	1.9 tf/m^3
Earth	1.8 tf/m^3

iii) Impact load

Impact coefficient = $10/(20+\lambda)$

iv) Coefficient of earth pressure

K= 0.5 (Sandy soil, earth pressure at rest)

v) Earthquake

Earthquake is not considered because of no effect on structural design.

② Material and material standard

Air entraining agent shall be used

Concrete (Pre-cast concrete)	σ ck = 400 kg/m^2
Concrete (Foundation block)	σ ck = 200 kg/m^2
Concrete (Non-reinforced)	σ ck = 150 kg/m^2
Reinforce bar	SD 345 or equivalent

3) Installation Work

a. Type of Box Culvert

The type of box-culvert for 33 location (including in river winding) is shown in Table 2.3.6.

Table 2.3.6 Box Culvert Sizes at each Locations

No.	Counter-measure	Chainage PK	Chainage m	Direction of Flow	Catchment area	Required Additional Capacity	Size of Box Culvert	Additional capacity	Remarks
1	Increse of Capacity	21	0	L-R	17.3	4.00	Box-New 1.5x1.5	5.61	
2	Increse of Capacity	22	80	L-R	29.2	10.96	Water Head 2.0m Box-New 1.5x1.5	12.54	3 trasks in Sukhebaatar St. Existing 2m Dia
3	Constructio n	66	25	L-R	11.6	4.35	Box-New 1.5x1.5	4.98	
4	Increse of Capacity	89	75	L-R	18.7	3.50	Box-New 1.5x1.5	5.61	
5	Constructio n	90	25	L-R	18.7	3.50	Box-New 1.5x1.5	5.61	
6	Increse of Capacity	125	0	L-R	37.4	14.30	Box-New 2-2.5x1.5	14.57	Double tracks between Dulhan 1and Dulhan 2
7	Constructio n	142	50	L-R	29.7	10.45	Box-MR 2.5x2.0	12.46	
8	Increse of Capacity	168	60	L-R	15.4	11.44	Box-MR 2.5x2.0	12.46	5 tracks (Ehrnet St. yard)
9	Constructio n	170	50	L-R	8.5	3.86	Box-New 1.5x1.5	5.61	
10	Constructio n	190	50	L-R	22.7	6.80	Box-New 2-2.0x1.0	9.97	
11	Constructio n	192	0	L-R	46.0	13.30	Box-New 2-2.5x1.5	13.33	
12	Constructio n	197	75	L-R	18.0	14.25	Box-MR 3.0x2.5	17.57	
13	Increse of Capacity	205	10	L-R	3.6	1.72	Box-New 1.5x1.5	5.61	
14	Constructio n	227	65	L-R	8.7	0.90	Box-New 2.0x1.0	4.98	
15	Increse of Capacity	253	30	L-R	24.5	12.80	Box-New 2-2.5x1.5	17.19	Double traks Uhnet St.
16	Increse of Capacity	313	80	R-L	9.3	2.36	Box-New 1.5x1.5	5.61	
17	Increse of Capacity	314	20	R-L	19.1	16.49	Box-New 2-2.5x1.5	18.69	5 tracks(Mandar St. yard)
18	Constructio n	319	80	R-L	5.6	3.18	Box-New 1.5x1.5	5.61	
19	Increse of Capacity	319	5	R-L	5.2	3.20	Box-New 1.5x1.5	5.61	
20	Constructio n	329	90	R-L	3.0	1.74	Box-New 2.0x1.0	3.34	
21	Constructio n	357	75	L-R	7.9	3.06	Box-New 1.5x1.5	5.61	
22	Constructio n	365	94	L-R	21.6	5.30	Box-New 1.5x1.5	5.61	
23	Increse of Capacity	386	50	L-R	38.6	1.55	Box-New 2.0x1.0	4.29	
24	Constructio n	387	10	L-R	0.8	0.77	Box-New 2.0x1.0	2.54	No earth cover
25	Increse of Capacity	388	50	L-R	43.2	4.76	Box-New 1.5x1.5	5.61	
26	Increse of Capacity	388	90	L-R	43.2	14.27	Box-MR 3.0x2.5	18.69	
27	Increse of Capacity	391	45	L-R	6.6	1.49	Box-New 1.5x1.5	5.61	
28	Increse of Capacity	417	35	R-L	6.7	3.69	Box-New 1.5x1.5	5.61	
29	Increse of Capacity	420	60	R-L	56.5	0.44	Box-New 1.5x1.5	5.61	
30	Increse of Capacity	424	50	L-R	11.4	4.10	Box-New 1.5x1.5	5.61	
31	Increse of Capacity	428	60	L-R	16.8	9.35	Box-New 2.5x1.5	9.35	
32	Increse of Capacity	438	50	R-L	60.5	11.2	Box-MR 2.5x2.0	12.46	

Note:Box-New means new design, Box-MR is applied Mongolian raiway standard desig

Improvement relating to ross drainage facilities

1	Increase of Capacity	399	1	L-R	River Expansion (Demolish of old concrete abutments and girder)		Ulanbaatar city

b. Frost Heave Protection

Frost heave takes place where soil composes of clay or silt. In order to secure stable train operation and track structure by preventing frost heave, such soils shall be replaced with suitable material. The locations for such replacement are determined according to the data from Mongolian Railway as follows.

No.	Locations pk			Frost heave (mm)	Remarks
1	242	9	90	35	Hrost heave occurred in the original ground
2	253	3	30	45	ditto
3	268	7	95	15	ditto
4	280	10	35	15	ditto
5	313	10		20	ditto
6	314	10		20	ditto
7	349	10		20	ditto
8	352	10		20	ditto
9	420	7		20	ditto

(6) River Width Improvement Work (399 pk 1)

The countermeasure should be carried out by the municipal government of Ulaan-bartar.

Among the required tasks, this project will deal with removal of the two bridge abutment and concrete girders. Demolition of the old bank protection, construction of new bank protection and dredging should be done by Mongolian side.

2.4 Soft - component

2.4.1 Background

Various facilities have not completely been maintained nor controlled in Mongolian Railway, and the restoration works are being done every time not for the maintenance of the existing old facilities but for the damaged parts. Accordingly, management of maintenance and control for the facilities has been getting harder because of the limited financial resources.

It is desired that management of the maintenance and control for the various facilities should be run with the preventive maintenance to keep the amount of natural disaster to the minimum, to control the repair cost per damaged part, and to ensure safety and accurate train services simultaneously.

2.4.2 Necessity of introduction for Soft - component and the Effect

Soundness analysis for the structure of the facilities has been periodically carried out to maintain the facilities as the precautionary measures in Japan. It presents to prevent the occurrence of an accident due to the disaster previously, to manage the train services to the minimum interference.

According to the Mongolian Railway Foundation Improvement Plan, 65 places of the facilities including River Bank Protection Works, Slope Stability Works, Bridge Rehabilitation Works, Drainage Facilities Works etc will be scheduled to improve under the Japan Grant Aid Plan. It is indispensable to maintain the these new facilities for the preventive maintenance.

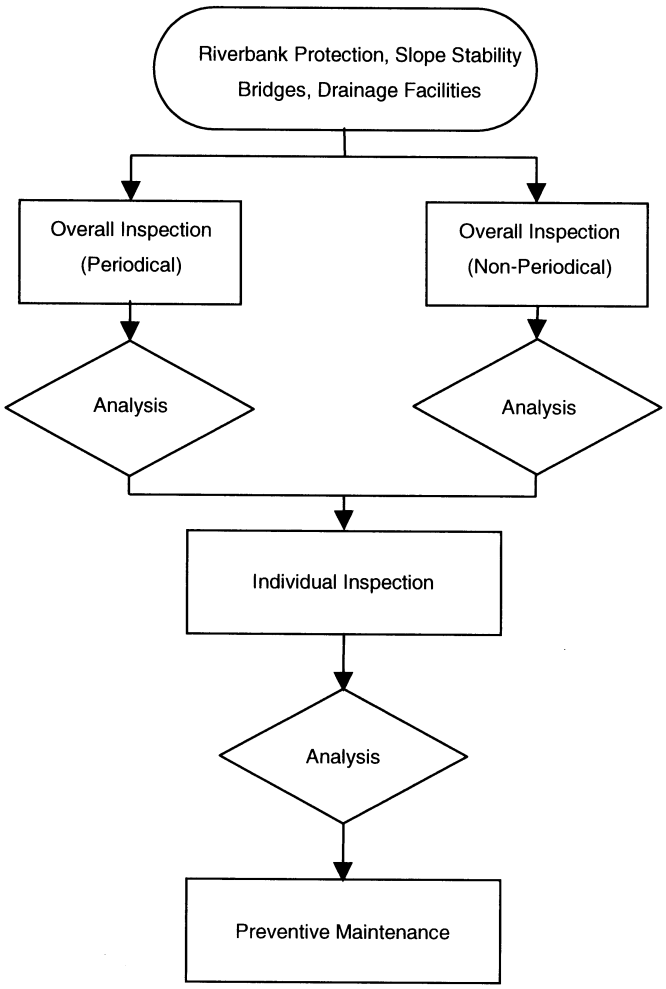
Therefore, the introduction of soft component for [the establishment of a system for management to control the new facilities effectively] should be advanced, and it will be effective to keep the facilities in good working order by teaching the know - how to the client under the Japan Grant Aid Plan, and the execution of new manual for investigation and maintenance for the Mongolian Railway which will be prepared in accordance with the actual condition in Mongolia, based on regular manual for investigation and maintenance used in Japan.

(1) Objective

It is aimed to thoroughly familialize the preventive maintenance concept in Mongolia, regarding the management of maintenance and control of the facilities under the particular condition of the Mongolian Railway. At the sametime, it is required to put into practice a new manual for investigation and maintenance (Manual) which describes the working plan, the valuation method and the classification for the soundness

analysis for the structure of the facilities. Following is the flow chart which is common in Japan for the inspection of civil structure.

Main contents of Manual are as follows:



1) the overall inspection (periodical/non-periodical):
   Inspection and Valuation for Railway Structure
   Inspection and Valuation after heavy rain / heavy snow

2) the individual inspection (whenever necessary):
   follow-up survey for the facilities checked by the overall inspection

Based on the manual which are prepared in accordance with the Mongolian custom, the staff of Mongolian Railway Institution are requested to be educated the method of investigation for the structure of the facilities and the management of maintenance for the facilities for the purpose of the preventive maintenance.

(2) Result

On the condition that the aforementioned objective has been achieved successfully, the results in compliance with the implementation of this soft - component will be as follows.

1) By the new Manual in which The working plan , the valuation method and the classification of the sound investigation for the facilities are described, conditions of the existing facilities which are scattered about the railway and the malfunction can be evaluated on the same level.
2) The result of evaluation can be useful to manage the maintenance and control of the facilities for the purpose of the preventive maintenance.
3) 65 places of the facilities can fulfill their functions for a long period of time by the thorough management for the maintenance and control of the facilities.
4) Stable train services can be ensured to keep the bad influence to a minimum for train services.

(3) Activity

Business contents of the maintenance and control for the facilities in accordance with the soft-component are mainly as follows:

a. Completely grasp the actual situation and an abstraction of the point for the present Mongolian Railway Institution Management Method on the maintenance and control for the facilities can be carried out and its Manual can be developed.

b. Inspection method based on the Manual should be well trained at site.

1) Business contents / result for each project

a. Project 1: Inspection manual should be developed after completely taking the actual situation and an abstraction of the point for the present Mongolian Railway Disaster Measures.

b. Project 2: Direction should be done at site in accordance with the Manual.

2) Details of actual working plan

Aforementioned working plans are as follows:

- 2 Japanese Specialist shall be dispatched twice to the Mongol.
- At first, 2 Japanese Specialist 2 should grasp the actual situation of management of the Mongolian Railway Institution and should prepare the inspection manual, and finally, should explain how to put into practice to the participant at workshop.
- Secondly, 2 Japanese Specialist should teach and exercise the inspection method in accordance with the Manual.

The Mongolian Railway bear the cost for following items.

- The Mongolian Railway should appoint the full time counter part.
- The Mongolian Railway should nominate the person engaged in the site training from each division of track maintenance section.
- The Mongolian Railway should bear the expenses for the site investigation.
- (provision of inspection train, expense for site survey)

CHAPTER 3

IMPLEMENTATION PLAN

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

The construction section for this project is 450 km long stretching from Bayan (50 km south from Ulaanbaatar) to Sukhbaatar (Russian border). This section connects 3 large urban centers including Ulaanbaatar and is an important means of communication with Russia and China. The construction works in this section should be implemented considering seriousness of the impacts such as suspension of railway transportation and ensuring the safety of the train operation.

The climatic surroundings in this area in winter season is severe, particularly, from November to March the air temperature decreases to 20°C below zero when execution of the concreting and ballast tamping works is impossible.

Accordingly, due to the actual construction period which is shorter than under normal conditions, the period from commencement to completion of construction works has been extended. Therefore, the whole construction period is divided into two stages. The priority of construction work items is determined considering such factors as the required construction time for each location, avoidance of dispersion of construction sites as well as volume of construction works.

For the construction works, as far as possible, the Mongolian labor will be employed and, simultaneously with large engagement of Mongolian employees, the construction related technology transfer will be conducted. Regarding the construction management, as for MR's engineers, the mastering by the MR, the technical knowledge and know-how including construction management to enable MR to maintain the constructed facilities by themselves will be encouraged in every possible way.

In order to reduce as far as possible the construction period, heavy construction machines will be used. Due to the large-scale construction works and lack of appropriate experience of MR, Japanese technical specialists and experts in the fields of civil engineering and track engineering will be dispatched on the short-term basis and the technical transfer relating to the heavy machines' operation, construction methods, quality control, construction supervision etc. will be provided for local engineers and technicians.

The Mongolian Railway which is an organization responsible for implementation from the Mongolian side, as an agency that will implement the project, has started the selection of the project staff and, basically, the chief persons of the project are nominated basing on the established organizational structure. At present, the chief persons were selected from the facilities (for construction engineering and supervision) and traffic control (for control on the train operation control and material transportation) divisions and relevant organizational structure is established.

3.1.2 Implementation Condition

- For the shortening of the construction period and the quality control of the concrete, the precast concrete with high quality shall be adopted for the construction of drain facilities and bridge rehabilitation. Special attention shall be paid for concrete curing because of the low air temperature.

- Management of the work schedule, quality of materials & equipment, and labor control are very important for the construction of drain facilities and bridge rehabilitation, because these works shall be carried out within a window time period.

- There are leasing companies of Heavy Equipment in Ulaanbaatar, their Heavy Equipment are mostly from Russia and quality is not sufficient. These might be old and deteriorated. Additionally, it is difficult to get the spare parts.

  As this project lays importance on the construction period, it is undesirable to procure the equipment from these lease companies.

- The most of required materials for this project are not difficult to be procured. The cement can be procured at Ulaanbaatar, the reinforcement bar can be procured at Darkhan, and the rubble stone for River Bank Protection will be procured from MR`s quarry located 320 km south from Ulaanbaatar. The special tools and materials, generator and heating apparatus are expected to be procured from Japan and third countries.

- There is no working safety regulations as in Japan, the safety education and safety measures generally practiced in Japan would be performed to the workers for preventing accidents during work. The safety measures against general traffic vehicles and regional people should also be taken.

3.1.3 Scope of Works

The implementation of the project under the grant aid of the Japanese government will require the share of the works between the Japanese and Mongolia government as described hereafter.

(1) The Share to be borne by the Japanese Government

- Construction of river bank protection, slope stability, bridge rehabilitation, and drain facilities.
- Construction of approach road.
- Installation and removal of camp yard and construction yard.
- Procurement of the materials, equipment and labor.

(2) Items to be Born by Mongolian Side

- Revision and adjustment of train operation diagram during construction period.
- Dispatch of MR supervisors during construction period.
- Supply control/management for Boulder.
- Replacement of optical fiber cable

3.1.4 Consultants Supeervison

(1) Basic Policy

The basic policy of the construction supervision will be as follows:

- The construction supervision engineers will endeavor to perform the construction supervision operations as smoothly as possible. Furthermore, it is necessary to adopt a backup system for this project in Japan.

- The bridge beam for rehabilitation and abutment is assumed to be not so familiar to the Mongolian engineers. Therefore, the Japanese supervisors will carry out technical transfer related to the bridge works to the Mongolian engineers in cooperation with the contractor.

(2) Consultant Supervision

A supervisor will be required to perform the following construction supervision works.

- Approval of the Construction Schedule and Construction Drawings:

  Supervisors inspect and approve the construction schedule and shop drawing submitted by the contractor, as according to the contract document, contract drawings, specification and others.

- Schedule Control:

  Supervisors gives adequate and essential instructions required for the completion of the project, receiving progress reports from the contractor.

- Quality Control:

  Supervisors examine and approve the quality of construction materials and construction methods according to the contract drawings and specifications.

- Inspection of Completed Construction Works:

  Through the inspection of the final sections, plane figures, and others, supervisors check the completed construction works according to the criteria and also certifies the quantity.

- Issuing of Certification Requested by the Contractor:

  Supervisors issue the necessary certificates for payment of contractor, the completion of construction and the expiration of warranty term.

- Submittal of Reports:

  Supervisors inspect the monthly report, final drawings and final pictures prepared by the contractor and submit them to the Mongolian authorities, JICA and others. Furthermore, the supervisors prepare the final report after the completion of the construction.

(3) Consultant Supervision System

Considering the construction contents and time schedule, the number and the term of Japanese engineers to be engaged to the construction supervision services will be as follows :

Project Manager, 1 Person:

The Project Manager will make spot checks at times of starting, progress and completion of each fiscal year work.

Sloop Protection Engineer, 1 Person

The Sloop Protection engineer will be assigned periodically for the duration of construction period.

Bridge and Drainage Engineer, 1 Person

The Bridge and Drainage engineer will be assigned periodically for the duration of construction period.

Resident Engineer, 1 Person

The resident engineer will be assigned permanently for the duration of construction period.

Additionally, some of the local civil engineers, who will be engaged in technical transfer from the resident engineer, will assist the resident engineer in his supervision.

3.1.5 Procurement Plan

(1) Procurement Sources of Materials

As a general rule, materials for the construction will firstly be procured from local sources as much as possible. Imported materials that can be procured easily in Mongolia will be considered as local materials.

However, imported materials when the quality of the material is uncertain, or the volume in circulation will not permit the procurement in sufficient time, then the material will be obtained from Japan or third country.

(2) Major procurement condition

The present procurement conditions of the major construction materials required for this project are shown as below:

1) Debris

Construction material for river revetment works will supply from MR's quarry site.

2) Cement

In Mongolia, cement is produced at private plants so call Type A (ordinary portland cement) generally use for construction materials. Consequently there will be no serious problems for quality of cement.

3) Reinforcing Bar

Reinforcement or deformed bar is produced in Mongolia, manufacturing standard is in conformity to JIS.

Table 3.1.1 Type of Reinforcing Bar

Local Production	
Deformed Bar (SD295/SD345/SD390)	10mm~32mm
Plain Bar	12mm~22mm

4) Asphalt Concrete

Asphalt materials which import from Russia, it is advisable to procure asphalt concrete from plants in major cities.

5) Materials for Concrete Forms

Metal concrete forms are applied for box-culvert and concrete panel of antifreeze process are difficult to procure from domestic market are supplied from overseas. The material of forms will be imported form Japan in consideration of procurement period and quality of forms.

6) Concrete Plant

The information for ready mixed concrete are obtain from concrete plants in and near Ulaanbaatar City. One of concrete plant was established in 1996, maximum production capacity is 15,000 m^3 per year, and average production volume per year is 10,500 m^3 (900 m^3 monthly).This project will be consumed approximately 4,000 m^3 for construction period of 10 months, 400 m^3 per month are practicable to make an order to this concrete plant.

7) Others

Resin mortar used for bridge is not procured from domestic market and procured from Japan, because reliance of this quality is not certain.

(2) Construction Equipment

1) Basic Policy

The procurement policy for construction equipment is similar to the construction materials. Considering the present conditions mentioned below, The construction equipment for common use will be procured locally. On the other hand basically, large-scaled or special equipment will be imported from Japan in order to avoid breakdowns or malfunctions that may affect greatly to the schedule and progress of the work.

2) Present Procurement Conditions of Construction Equipment

a. General Conditions of Construction Equipment

As both the official and the private firms have the construction equipment to some extent, leasing is available, if the leasing charge and using time of equipment are mutually agreed between the owner and the user. Equipment for bridge work however are limited in kinds and numbers. Small-sized equipment such as water pump is available in local markets and can be easily procured.

b. Construction Equipment of Heavy Equipment

There are leasing companies of Heavy Equipment in Ulaanbaatar, however, such Heavy Equipments are mostly from Russia and quality is not sufficient. However, as most of these equipment were procured from USSR, these might be old and deteriorated. Additionally, it is difficult to maintain these equipment for financial reasons. As this project lays importance on the construction period, it is undesirable to procure the equipment from this lease companies because of the above conditions.

3) Procurement Plan of Construction Equipment

The procurement plan of major construction equipment is shown in Table 3.1.2.The plan is based on the present procurement conditions mentioned at the above.

Table 3.1.2 Procurement Plan for Major Construction Equipment

Material and Equipment	Supply Source		
	Local	Japan	Third Counties
[Material]			
Rail Protection Board (t=22mm)		○	
Water Proof Asphalt		○	
Resin Mortar		○	
Form Plywood		○	
Box-culvert Form		○	
Metal Form		○	
Geotex Tile (t=3mm)		○	
Rubble stone (more than 40cm)	○		
Concrete Anchor Bolt (12mm)		○	
Rail R65	○		
Wood Sleeper	○		
Silicon Waterproof Material		○	
Dynamite (Kiri No.3)	○		
Crushed Stone (more than 40mm)	○		
Reinforcing Bar	○		
Ballast	○		
Cement	○		
Coarse Aggregate	○		
Sand	○		
Chemical Admixture	○		
Gasoline		○	
Light Oil	○		
	○		
Composition (%)	80	20	
[Machine]			
Rough-terrain Crane (45t 1set)		○	
Rough-terrain Crane (25t 1set)		○	
Backhoe ($1.0m^2$ 2sets)	○		
Backhoe ($0.6m^3$ 5sets)	○		
Compressor (35ps 4sets)		○	
Track-crane (20t 5sets)	○		
Railway Track-crane (125t 1set)	○		
Railway Track-crane (25t 2sets)	○		
Backhoe ($1.0m^3$ 2 sets)		○	
Bulldozer (21t 2sets)	○		
Bulldozer (15t 1set)	○		
Generator (35KVA 8sets)		○	
Hand breaker (30kg 8sets)		○	
Pick hammer (8sets)		○	
Bucket for boulder ($2m^2$ 2sets)		○	
Vibratory roller (2sets)		○	
Leg hammer (5sets)	○		
	○		
Composition (%)	65	35	

(3) Transport Plan of Materials and Construction Equipment

1) Transport Routes

Most of the construction materials and equipment will be carried in or out from Ulaanbaatar to the site. In general, the materials and construction equipment procured from overseas are transported to site through Zamynuud by way of China will be adopted.

2) Transportation Period for Materials and Equipment to be procured from Japan

The materials and equipment from Japan will be transported using the following route and time.

	Transport Route	Time (month)
Delivery, Ship Loading.	Factory→Port in Japan	0.25
Ocean transport.	Japan→Tenpin Port (China)	0.50
Unloading, Custom Clearance.	Tenjin Port Zamyunuud	0.25
Inland transport.	Zamyunuud→Ulaanbaatar→Site	0.20

Total delivery time: 1.20 months

3.1.6 Implementation Schedule

This project of concrete placing works and earth works will be carried out in April through October, domestic construction work is standstill during November to March because atmospheric temperature reach to minus 20 degrees C., and surface soil became frozen. Temperature data obtained from meteorological observatory information 1970~2000. The construction works against rainfall is not required because the amount rain fall is 200mm to 300mm in a year.

The start of construction works will be March 2001. It will be implemented in accordance with the detailed design, tendering, and construction/construction supervision schedule. Table 3.1.3 is shown the Project Implementation Schedule.

(1) Detailed Design

The detailed design for each phase will be performed as followings by the consultant who has entered into the design contract with the Mongolian government.

Detailed design includes bill of quantities for river bank protection works, slope stability works, flood protection measure works, bridge rehabilitation works and drainage facilities works.

Construction cost estimate, preparation of tender documents including technical specification.

(2) Tendering

The tendering for the project will be performed by the consultant for the Mongolian government in Japan in accordance with the phases, and will consist of the following:

Receipt of the contractors requesting pre-qualification
Evaluation of the contractor and preparation of Short List of Tenderers
Holding of meeting with Tenders for Question/Answer Session
Receipt, opening of tenders, and evaluation of tenderers
Evaluation meeting , and award of contract, and notifying the successful tenderer

(3) Construction/Consultant Supervision

After signing the contract, the approval of the Japanese government will be obtained, and the works will be commenced. The construction operations will consist of; preparation of the construction site, temporary work, river bank protection works, slope stability works, flood protection measure works, bridge rehabilitation works, drainage facilities works and removal works. The construction at first phase will start 2001 after the Exchange of Note. Each phase will require 8 months and 13 months respectively.

The above construction operation will require the construction supervision works to be performed by the consultant.

3.1.7 Items to be Born by Mongolian Side

The land acquisition and tax exemption are to be born by Mongolian side.

The procedures of land acquisition and tax exemption in Mongolia are as follows:

Procedure for Land Acquisition

a. Ministry of Infrastructure (MOI) and Mongolian Railways (MR) will confirm land and houses by the drawings and land ledgers.

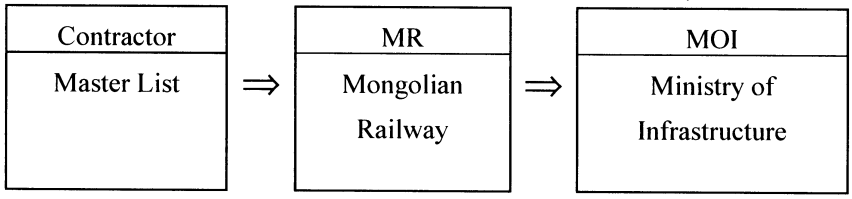
b. Compensation cost will be estimated by MOI and MR, and public officers in the project area.

c. Negotiation with landholders and house owners will be conducted and the results will be reported to the Ministry of Economic and Finance(MOEF).

d. After the investigation and approval by the MOEF, the bilateral agreement will be made.

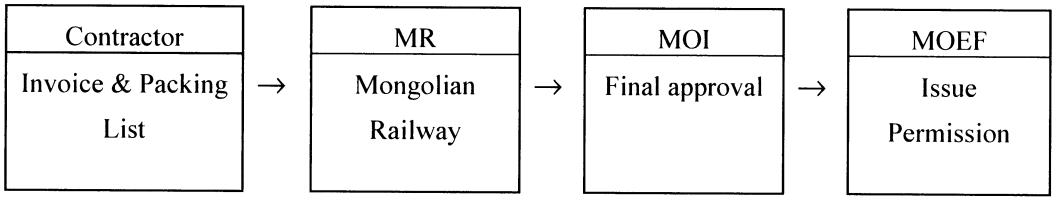
Procedure for Tax Exemption

First Step (Prior Preparation)



a. The contractor makes master list and submits it to the agent.
b. The MR submits the approval sheet to MOI.
c. MOI issues the approval sheet after the approval by the MOEF.

Second Step (in case of Import)



a. The contractor submits the invoice and packing list to the MR.
b. The MR submits them to MOI.
c. MOI issues the approval sheet after the approval by the MOEF.

d. After the approval of MOI, the contractor submits the approval certification to MOEF to conduct custom clearance. After the approval of MOEF, the contractor makes all the procedures.

3.2 Project Cost Estimation

The expenditure items to be born by Mongolian side and expected during the project implementation are presented in Table 3.1.3.

Table 3.1.3 Expenditure Items to be Born by Mongolian Side

Expenditure Items	Amount (in '000 Tug)
1. Revision and adjustment of train operation diagram during construction period	1,594
2. Travelling allowances for MR supervisors during construction period	3,188
3. Supply control/management of Boulder	2,125
4. Optical fiber cable removal and re-installation cost	11,690
Total 1	18,597

3.3 Operation and Maintenance Plan

3.3.1 Operation and Maintenance System

Present days, operation and maintenance of railway facilities are conducted by Mongolian Railways. Although large-scale repair works will not be necessary until before 10 to 30 years after the completion of this project, following periodical inspection are required for preserve against the natural disaster. Therefore, the operation and maintenance after the completion of this project will be carried out by the present system.

3.3.2 Operation and Maintenance Method

Though the main objective of this project is the protection of natural disaster, river bank protection, slope stability, drain facilities and bridge required the maintenance. That doing after the completion of the facilities must be performed in line with Table 3.1.4.

This project section are managed under the track maintenance depot 1 and 2. And maintenance personnel works 607 person (No.1) and 800 person (No.2), the maintenance of facilities by this project are fully take care of present personnel.

It is important to keep records of the results of periodical checking on the condition of damage in order to establish the repair schedule and its scale. Therefore, the periodical checking system must be established at the early hands.

Table 3.1.4 Maintenance and Operation Schedule

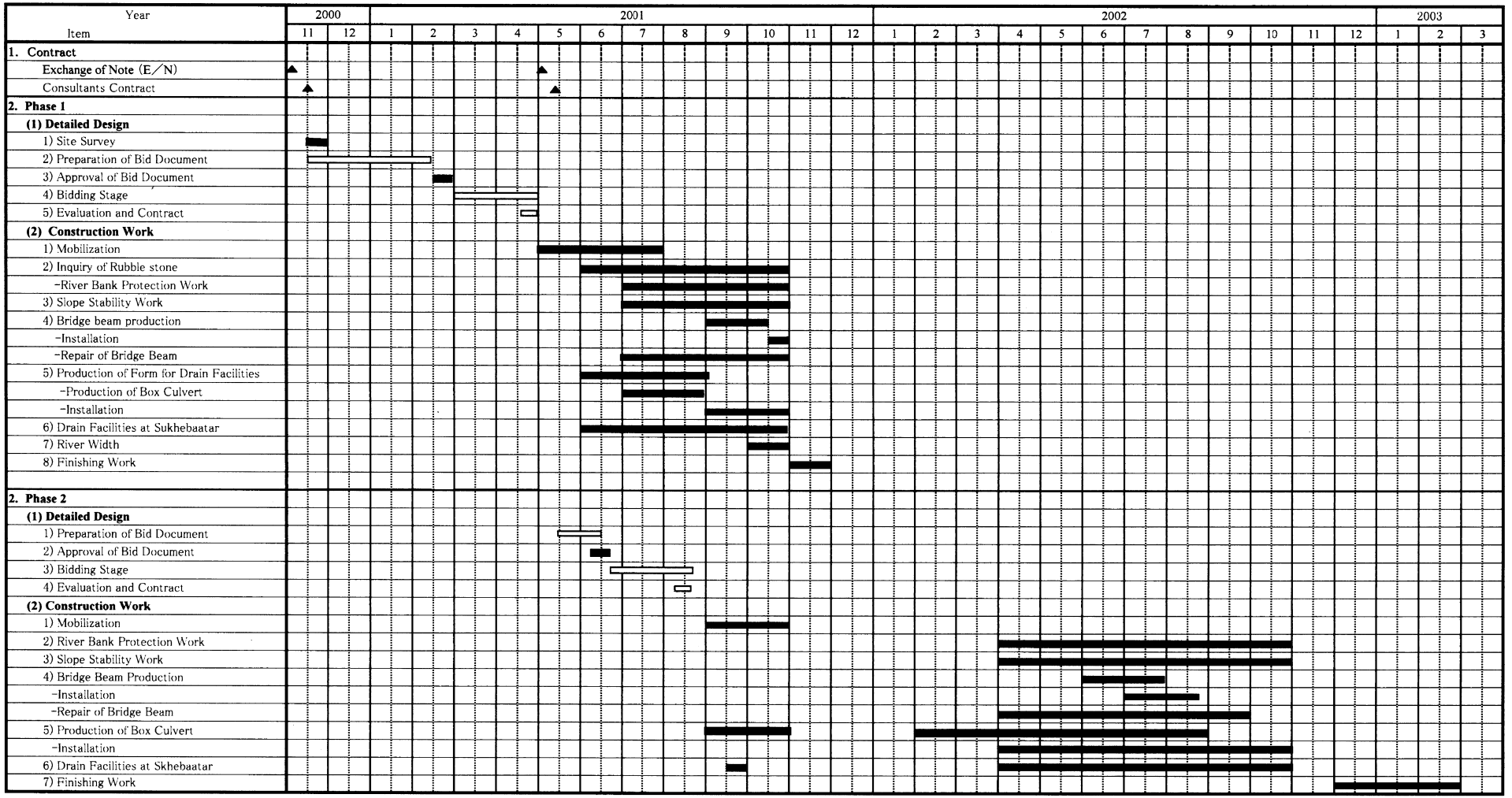
Item	Maintenance and Repairing Works	Period
① River Bank Protection	Maintenance of shape	6 months
② Slop Stability	Removal of weathered rock	6 months
③ Drain Facilities	Removal of earth deposits	12 months
④ Bridge	Repairing of cracks	12 months

3.3.3 Operation and Maintenance Cost

By the implementation of this project which is aimed at the rehabilitation of superannuated railway sub-structures, the new maintenance cost is anticipated to be considerably lower than the present restoration cost of the railway facilities damaged by natural disasters.

The operation and maintenance cost per year is estimated to cover present operation and maintenance system by Mongolian Railways not required more additional cost for this project. There should be no problems both in terms of the budgets and manpower concerning with the operation and maintenance.

Table 3.1.1 Project Implementation Schedule



CHAPTER 4

PROJECT EVALUATION AND RECOMMENDATION

CHAPTER 4 PROJECT EVALUATION AND RECOMMENDATION

4.1 Project Effect

Following present conditions should be considered to as the basic assumption to evaluate the effect of the project:

As the roads are poorly developed, in 1998, the cargo traffic volume was 2,815 million ton-km, making 96 % of total transported cargo, and carried passengers was 981 million pass-km or 54 % of the total. These figures demonstrate the significance of "life-line" having an utmost influence on the general quality of life of Mongolian people.

The study area is located in the valley and hill area, stretched for 450 km from Sukhbaatar to Bayan, from central part to northern boundary of Mongolian country. With having Haraa, Selenge and Orkhon rivers along side, the section is extremely vulnerable by natural disasters. This causes tremendous difficulties to maintain the safety and regularity of train operation.

In general, in nation wide, electricity is generated by thermal power plant using the coal transported by railway. Other major cities use diesel power plant, also dependent upon coal. The power plant is important as people are dependent upon electricity for their heat (there is no natural gas supply), and side effect heat generated by the thermal power plant used for the regional hot water heating.

Suspension of the train operation largely affects the life of the people nation wide, as the source of energy for living and industry is coal in large part, which is transported by the railway.

This project, in order to ensure the safe freight and passenger transportation, is aimed at execution of the construction works for rehabilitation and improvement of railway sub-structures, and the benefits expected for normal railway operation could be summarized as follows.

(1) Direct Benefits

i) Secure the safe and regular operation

Because of the geographical location and keen continental climatic conditions of Mongolia, the vehicle operation in winter season is difficult. 45 % of Mongolian population is habitat along the railway line, and are depend on the railway transport. By this project, stabilization of human movements and procurement of vital goods for living will bring about direct beneficial effects to almost half of Mongolian people.

ii) Stable procurement of energy

The electricity supply of the main cities in Mongolia depends on the coal power generators which consumes domestic raw materials, while the petroleum products are imported by railway transport. The continuous procurement of the above energy resources by stable train operation will be ensured by the implementation of this project.

iii) Stable transportation of goods

Mongolia exports the mineral resources and imports the industrial goods. Therefore the more stable train operation by the implementation of this project will lead the stable condition for the economy of Mongolia.

iv) Reduction of maintenance cost

In consideration of the financial difficulties faced by the Mongolian Railway, the considerable expenses are spent for restoration of the railway sub-structures damaged by the natural disasters. The implementation of the project will allow the maintenance expenses to be reduced notably.

(2) Indirect Benefit

i) Confidence on domestic transportation

Due to underdeveloped road infrastructure and constant threat of shortage of petroleum products in Mongolia, although the people's dependence on railway transportation is high, by the implementation of the project the confidence on domestic transportation will be strengthened.

ii) Confidence on international transportation

The Mongolian Railway is an important segment of international transportation route connecting China and Russia. By ensuring the safe train operation in Mongolia's railway, the confidence of both countries will be established and transit cargo traffic is expected to increase.

4.2 Recommendation

In order to keep the safety and stability of railway transportation, it is unavoidable to maintain the facilities. The railway is the most important mode of transportation in Mongolia. Therefore, considering the expected high social and economic benefits to the people in nation wide by the implementation of this project, it shall be concluded that it is reasonable to adopt a grant aid.

It should be fully aware of utmost importance of maintenance of the facilities. It is recommendable to create maintenance system which will enable Mongolian Railway to independently manage and maintain the constructed facilities, basing on the system to be established during the project implementation period.

On the other hand, in order to reduce cost for repair and maintenance of the facilities, softcomponent concept, which is oriented for the hazard prevention, should be adopted and utilized.