［Appendices］

Appendix 1 Member List of the Study Team

1-1 Site Study in Palau (from January 18, 2006 to February 16, 2006)

No.	Name	Assignment	Organization
1	Mr. NOTSU Yoshio	Leader	JICA Palau Office
2	Mr. SAKABE Hidetaka	Project Coordinator	Grant Aid Management Department, JICA
3	Mr. MARUOKA Kenji	Chief Consultant / Road Transportation Planning	CTI
4	Mr. TSUCHIHASHI Masahisa	Road Design	CTI
5	Mr. SHOJI Takao	Natural Condition Survey/ Environmental and Social Consideration	CTI (JOC)
6	Mr. TAKEUCHI Tomoaki	Procurement and Construction Planning / Cost Estimate	CTI (JOC)
7	Mr. TAKATA Satoshi	Consultant Coordinator /Assistant to Cost Estimate	CTI

1-2 Discussion on Draft Report in Palau (from May 28, 2006 to June 3, 2006)

No.	Name	Assignment	Organization
1	Mr. NOTSU Yoshio	Leader	JICA Palau Office
2	Mr. MARUOKA Kenji	Chief Consultant / Road Transportation Planning	CTI
3	Mr. TSUCHIHASHI Masahisa	Road Design	CTI

1-3 Discussion on Draft Report in Palau (from August 29, 2006 to September 2, 2006)

No.	Name	Assignment	Organization
1	Mr. NOTSU Yoshio	Leader	JICA Palau Office
2	Mr. SAKABE Hidetaka	Project Coordinator	Grant Aid Management Department, JICA
3	Mr. MARUOKA Kenji	Chief Consultant / Road Transportation Planning	CTI
4	Mr. TSUCHIHASHI Masahisa	Road Design	CTI

Appendix 2 Study Schedule

2-1 Site Study in Palau (from January 18, 2006 to February 16, 2006)

Itinerary				Team Leader		Chief Consultant / Road Transportation Planning	Road Design	Consultant Coordinator /Assistant to Cost Estimate	Natural Condition Survey/ Environmental and Social Consideration	Procurement and Construction Planning / Cost Estimate
No.	Date		Day	NOTSU Yoshio	SAKABE Hidetaka	MARUOKA Kenji	SUTIHASI Masahis	TAKATA Satoshi	SHOJI Takao	TAKEUCHI Tomoaki
1	Jan.	18	Wed	Japan → Palau						
2		19	Thr	Holiday (Field Reconnaissance)						
3		20	Fri	Explanation and Discussion on IC/R			Field Survey	Field Survey		
4		21	Sat						Japan → Palau	
5		22	Sun						Field Survey	
6		23	Mon							
7		24	Tue	Signing of M/D						
8		25	Wed	Palau → Japan		Field Survey				
9		26	Thr			Holiday				
10		27	Fri			Field Survey	Field Survey	Field Survey	Field Survey	
11		28	Sat							
12		29	Sun							
13		30	Mon							
14		31	Tue							
15	Feb.	1	Wed							
16		2	Thr			Holiday				Japan → Palau
17		3	Fri			Field Survey	Field Survey	Field Survey	Field Survey	Field Survey
18		4	Sat							
19		5	Sun							
20		6	Mon							
21		7	Tue							
22		8	Wed							
23		9	Thr			Holiday				
24		10	Fri			Field Survey	Field Survey	Field Survey	Field Survey	Field Survey
25		11	Sat							
26		12	Sun							
27		13	Mon							
28		14	Tue			Discussion on Major Findings				
29		15	Wed			Data Compiling and Analysis				
30		16	Thr			Palau → Japan				

2-2 Discussion on Draft Report in Palau (from May 28, 2006 to June 3, 2006)

Itinerary				Team Leader		Chief Consultant / Road Transportation	Road Design
No.	Date		Day	NOTSU Yoshio		MARUOKA Kenji	TSUTIHASI Masahisa
1	May	28	Sun		Japan → Palau		
2		29	Mon	Explanation and Discussion on DBD			
3		30	Tue				
4		31	Wed	Signing of M/D (Failed)			
5	Jun.	1	Thr		Joint survey and confirmation on affected properties		
6		2	Fri				
7		3	Sat		Palau → Japan		

2-3 Discussion on Draft Report in Palau (from August 29, 2006 to September 2, 2006)

Itinerary				Team Leader		Chief Consultant / Road Transportation	Road Design
No.	Date		Day	NOTSU Yoshio	SAKABE Hidetaka	MARUOKA Kenji	TSUTIHASI Masahisa
1	Aug.	29	Mon		Japan → Palau		
2		30	Tue	Explanation and Discussion on DBD			
3		31	Wed				
4	Sep.	1	Thr	Signing of M/D			
5		2	Fri		Palau → Japan		

Appendix 3 List of Parties Concerned in Palau

3-1 Site Study in Palau (from January 18, 2006 to February 16, 2006)

Embassy of Japan in Palau	Mr. Naotake Yamashita, Charge d' Affaires ad interim
Palau Office, Japan International Cooperation Agency (JICA)	Mr. Yoshio Notsu, Resident Representative
	Mr. Kenji Aizono, Project Formulation Advisor
Office of the President	Mr. Tommy Remengesau Jr, President
	Mr. Kione J. Isechal, Engineering Adviser on Infrastructure Matter
	Mr. Jeff R. Ngirarsaol, Grant Coodinater
	Mr. Donald Haruo, President Special Economic Adviser & Japan
Ministry of Resources and Development	Mr. Fritz Koshiba, Minister
Bureau of Land & Survey, Ministry of Resources and Development	Mr. Gilbert Dernei, Director
Bureau of Public Works, Ministry of Resources and Development	Mr. Masasinge Arurang, Director
Palau Automated Land And Resource Information System	Ms. Balkuu Kumangai, Program Manager
	Mr. Alejandro Caraig, Surveyor
Palau Automated Land and Resource Information System (PALARIS)	Ms. Kelly L. Raleigh, Program Manager
	Ms. Nobuko Murai, GIS Analyst (JOCV)
Secretary of MRD Minister	Ms. Della Mobel, Secretary
Capital Improvement Program (CIP)	Mr. Richard Mangham, Manager
	Mr. Gail Manalastas, Project Manager
Bureau of Public Safety	Mr. Hazime Telei, Director
	Mr. Norvert H. Yano, Deputy Director
Environmental Quality Protection Board	Ms. Portia K. Franz, Executive Officer
	Mr. Donald Dengokl, Assistant Executive Officer
	Mr. Alex A. Apostol, Environmental Engineer
National Weather Service	Ms. Maria Ngemaes, Meteorologist
National Oceanic & Atomospheric Administration	Mr. Theo Isamu, Officer

State of Koror	Mr. John C. Gibbons, Governor
Koror State Public Land Authority	Mr. Daijiro Nakamura, Director
	Ms. Viviana Ucherbela, Director
	Ms. Vera Kanai
	Ms. Pasquana Blesam
	Mr. Auyero Udui
State of Airai	Mr. Tmewang Rengulbai, Governor
Nippon Koei Co., Ltd.	Mr. Fumihiko Shishido, Resident Engineer

3-2 Discussion on Draft Report in Palau (from May 28, 2006 to June 3, 2006)

Embassy of Japan in Palau	Mr. Naotake Yamashita, Charge d' Affaires ad interim
Palau Office, Japan International Cooperation Agency (JICA)	Mr. Yoshio Notsu, Resident Representative
	Mr. Kenji Aizono, Project Formulation Advisor
Office of the President	Mr. Tommy Remengesau Jr, President
	Mr. Kione J. Isechal, Engineering Adviser on Infrastructure Matter
	Mr. Donald Haruo, President Special Economic Adviser & Japan
Ministry of Resources and Development	Mr. Fritz Koshiba, Minister
Bureau of Public Works, Ministry of Resources and Development	Mr. Masasinge Arurang, Director
State of Koror	Mr. Yoshitaka Adachi, Governor
State of Airai	Ms. Vicky N. Kanai, Governor
	Mr. Flavin Uno, Officer

3-3 Discussion on Draft Report in Palau (from August 29, 2006 to September 2, 2006)

Embassy of Japan in Palau	Mr. Naotake Yamashita, Charge d' Affaires ad interim
Palau Office, Japan International Cooperation Agency (JICA)	Mr. Yoshio Notsu, Resident Representative
	Mr. Kenji Aizono, Project Formulation Advisor
Office of the President	Mr. Tommy Remengesau Jr, President
	Mr. Kione J. Isechal, Engineering Adviser on Infrastructure Matter
	Mr. Billy G. Kuartes, Chief of Staff to the President
Ministry of Resources and Development	Mr. Fritz Koshiba, Minister
State of Koror	Mr. Yoshitaka Adachi, Governor
State of Airai	Ms. Vicky N. Kanai, Governor
Palau Public Utilities Corporation (PPUC)	Mr. James Mengeolt, Power Distribution Manager
	Mr. Nilo L. Andres, P.E.E Manager of System Control Division

Appendix 4 Minutes of Discussions

4-1 Minutes of Discussion (January 24, 2006)

Minutes of Discussions
on Basic Design Study
on the Project for the Improvement
of Urban and Rural Roads in Koror and Airai
in the Republic of Palau

Referring to the results of Preliminary Study conducted in August 2005, the Government of Japan decided to conduct a Basic Design Study on the Project for the Improvement of Urban and Rural Roads in Koror and Airai (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to Palau the Basic Design Study Team (hereinafter referred to as "the Team"), headed by Mr. Yoshio Notsu, Resident Representative of JICA Palau Office, and is scheduled to stay in the country from January 18 to February 16, 2006.

The Team held discussions with the concerned officials of the Government of Palau. In the course of the discussions, both sides have confirmed the main items of described in the attached sheets. The Team will proceed to further works and prepare the Basic Design Study Report.

Koror, January 24, 2006

Yoshio Notsu
Leader
Basic Design Study Team
Japan International Cooperation Agency
Japan

Fritz Koshiba
Minister
Ministry of Resources and Development
Republic of Palau

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the Urban and Rural Roads in Koror and Airai States.

2. Project Site

The site of the Project is shown in Annex-1.

Each section of the road is defined as shown in the table below.

Section		Length(m)
Section A	PVA Intersection ~ Mobile Top-side Intersection	2,580
Section B	Minato Bridge ~ PVA Intersection	600
Section C	Mobile Top-side Intersection ~ Airai Causeway	2,554
Section D	PVA Intersection ~ Meyungs Causeway	360
Section E	Meyungs Causeway~ PPR	2,930
Section F	KB Bridge ~ Airport Intersection	3,213
Total Length (m)		12,237

3. Responsible and Implementing Organizations

The responsible and implementing Ministry is the Ministry of Resources and Development (hereinafter referred to as "MoRD").

The organization chart of MoRD is shown in Annex-2.

4. Items Requested by the Government of Palau

The following items were requested by the Palauan side.

(1) To improve the existing roads composing of following items at necessary sections;
- To replace of the base course,
- To overlay the pavement,
- To improve the intersections and road way capacity,
- To construct the sidewalk with lighting,
- Lane marking, and etc.

(2) To improve the drainage system at necessary sections.

(3) To repair the land slide at necessary sections.

(4) To install and/or repair the Guard Rail (Concrete Barrier) at necessary sections.

JICA will assess the appropriateness of the request and will recommend to the Government of Japan.

5. Japan's Grant Aid Scheme

The Palauan side understood the Japan's Grant Aid scheme and the necessary measures to be taken by the Palauan side as explained by the Preliminary Study Team and described in the Annex-4 and 5 of the Minutes of Discussions signed by both sides on August 19, 2005.

6. Schedule of the study

6-1. The consultants will proceed to further study in Palau until February 16, 2006.

6-2. JICA will prepare the draft report in English and dispatch a mission to Palau in order to explain its contents around the end of May 2006.

6-3. In case that the contents of the report are accepted in principle by the Government of Palau, JICA will complete the final report in English and send it to the Government of Palau by August, 2006.

7. Other Relevant Issues

7-1. The Palauan side explained that the draft report of the Environment Assessment had submitted to Environmental Quality Protection Board (EQPB), and procedure for the approval was on progress. Both sides confirmed that the Palauan side should obtain the approval by the end of January, 2006.

7-2. The Palauan side confirmed that the following undertakings should be taken by the Palauan side at the Palauan expenses.

(1) Relocation, improvement and/or repair of existing utilities (power lines, telecommunication lines, water lines, etc.), if necessary.

(2) Necessary arrangement for vehicles to make detour or set up a diversion at necessary sections.

(3) Necessary arrangement for the tax exemption of import materials.

(4) Securing and clearance of the temporary yard.

(5) Securing of site for disposal of waste.

(6) Maintaining the security at the sites and yards for the Project.

7-3. The Palauan side shall secure enough budget and personnel necessary for the operation and maintenance of the facilities improved by the Project, including the periodical maintenance work after the completion of the Project.

7-4. Both sides confirmed that the Palauan side should establish suitable measures for traffic safety enlightenment to control the traffic violators, especially fault loading, which are essential for appropriate operation and maintenance of the roads improved by the Project.

7-5. The Palauan side requested the Team to conduct the in-depth study on the following points:

(1) Flood prone area in Section B, Section E and Section F

(2) Traffic safety measures for sharp S-curve sections in Section C and Section F

(3) Necessity of concrete barrier and sidewalk along the approach road to Minato Bridge in Section B

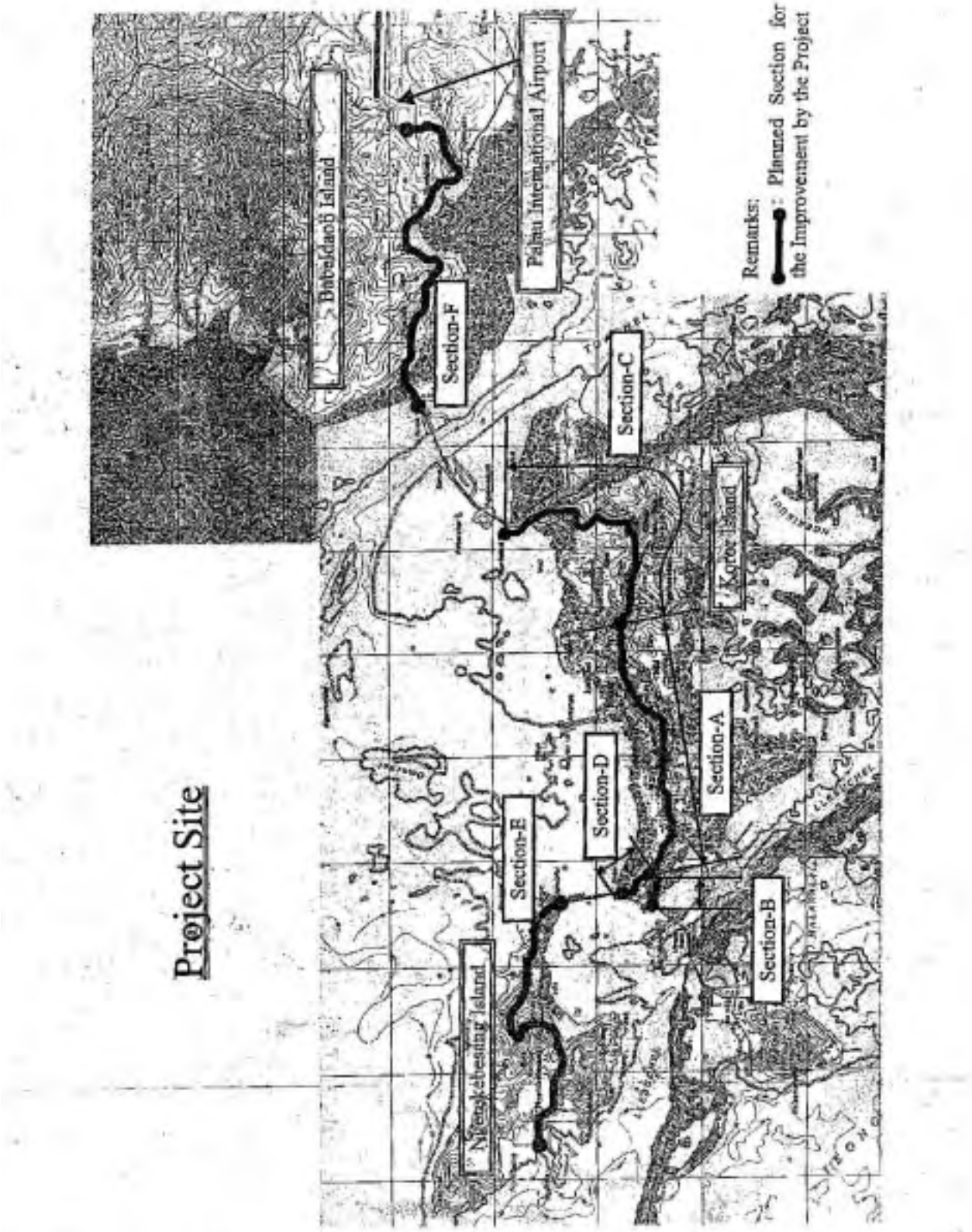
7-6. Both sides confirmed the necessity to make the following items clear during the field survey.

(1) Utilization of existing facilities such as drainage, sidewalk, street lighting and so forth.

(2) Amount of space required for drainage and sidewalk in Section A.

(3) Location of potential properties and facilities to be affected by the Project.

(Annex-1)


Project Site
Babeldaob Island
Section-F
Palau International Airport
Section-C
Koror Island
Section-A
Section-D
Section-E
Section-B
Ngemelis Island
Remarks:
: Planned Section for the Improvement by the Project

(Annex-2)

Organization Char of the Ministry of Recourses and Development

4-2 Minutes of Discussion (September 1, 2006)

Minutes of Discussions
on Basic Design Study
on the Project for the Improvement of Urban and Rural Roads
in Koror and Airai States
in the Republic of Palau
(Explanation of Draft Report)

In January 2006, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on the Project for the Improvement of Urban and Rural Roads in Koror and Airai States (hereinafter referred to as "the Project") to the Republic of Palau (hereinafter referred to as "Palau"), and through discussions, field survey and technical examination of the results in Japan, JICA prepared a draft report of the study.

In order to explain and to consult with the concerned officials of the Government of Palau on the contents of the draft report, JICA sent to Palau the Basic Design Explanation Team (hereinafter referred to as "the Team"), which is headed by Mr. Yoshio NOTSU, Resident Representative, JICA Palau Office, from August 29 to September 2, 2006.

As a result of discussions, both sides confirmed the main items described in the attached sheets.

Koror, September 1, 2006

Yoshio NOTSU
Leader
Basic Design Explanation Team
Japan International Cooperation Agency

Fritz KOSHIBA
Minister
Ministry of Resources and Development
Republic of Palau

Witness:

Yoshitaka ADACHI
Governor of Koror State
Republic of Palau

Witness:

Vicky KANAI
Governor of Airai State
Republic of Palau

ATTACHMENT

1. Components of the Draft Report

The Palauan side agreed and accepted in principle the contents of the draft report of Basic Design Study by the Team.

2. Japan's Grant Aid Scheme

The Palauan side reconfirmed the Japan's Grant Aid scheme and the necessary measures to be taken by the Palauan side as explained by the Preliminary Study Team and described in the Annex-4 and 5 of the Minutes of Discussions signed by both sides on August 19, 2005.

3. Schedule of the Study

JICA will complete the Final Report in accordance with the confirmed items and send it to the Palauan side by the end of October 2006.

4. Other Relevant Issues

4-1. Both sides confirmed that the Palauan side shall conduct the undertakings by the time limit as shown in Annex-1. The Palauan side shall have a meeting with related organizations and/or agencies to confirm the procedures and make an implementation plan of each undertaking, and submit the plan, which is made as a check list on the basis of Annex-2, to JICA Palau Office by the end of September, 2006. The Palauan side will conduct each undertaking based on the plan, and report its progress to JICA Palau Office with the check list every two month until the completion of all of the undertakings.

4-2. Palauan side shall conduct following items as needed for smooth implementation of construction works on the Project.

(1) Necessary arrangement for vehicles to make detour or set up a diversion at necessary sections.
(2) Maintaining the security at the sites and yards for the Project.
(3) Public relations and dealing with any complaints raised by affected persons.
(4) Coordination to relevant agencies regarding traffic control during construction.

4-3. The Palauan side shall secure enough budget and personnel necessary for the operation and maintenance of the facilities improved by the Project, including the periodical maintenance work after the completion of the Project.

4-4. Both sides confirmed that it was necessary to control over-loaded vehicles in order to make road maintenance rational, and accordingly both sides reconfirmed that the Palauan side should establish suitable measures for traffic safety and control especially over loading traffic, which are essential for appropriate operation and maintenance of the roads improved by the Project.

The Palauan side requested that the concept of rules and regulation regarding the control of over-loaded vehicles enforced in Japan should be introduced because no practical measures are taken due to lack of institute and experience although heavy vehicles are increasing in Koror and Airai States.

4-5. Traffic Safety Measure at Airport Access Intersection

The Palauan side pointed out that some traffic safety measure is required at Airport Access Intersection that is located on the road access to the international airport in Airai State, Babeldaob Island. Both sides confirmed that traffic safety measure such as traffic sign and road marking would be taken in line with the improvement of Section F1.

4-6. Progressive Erosion in Section C

The Japanese side pointed out that it is necessary to take practical measures against progressive erosion in Section C by storm water immediately, otherwise the main road between Koror Island and Babeldaob Island would be affected seriously. The Palauan side takes note of it.

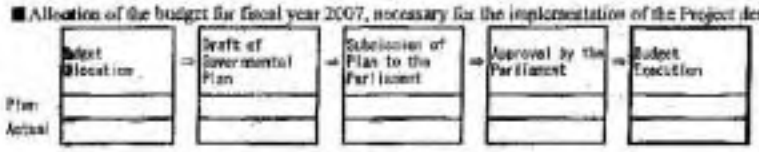
The Major Undertakings to be taken by the Palauan side
for the Project of the Improvement of Urban and Rural Roads in Koror and Airai State

No.	Items to be taken by the Palauan side	Time limit
1	Allocation of the budget for fiscal year 2006/2007, necessary for the implementation of the Project described as follows	October, 2006
	Commission for Banking Arrangement, issuing the Authorization to Pay, payment to Consultant and Contractor	
	Tax exemption and customs clearance of the imported products for the Project at the port of disembarkation	
	Conduction of the other undertakings to be taken by the Palauan side	
2	Obtainment of the approval from EQPB for the Project, including amendment of Environmental Assessment approved on February 14, 2006 (especially for Historical Clearance)	August, 2007
3	Obtainment of the permission for remove and/or relocation of trees, structural object, and any other objects to be affected by the implementation of the Project.	
4	Securing the land necessary for the Project (including the land for temporary yards and parking, detour during the construction etc.) based on the contents of Draft Report and/or Final Report of the Project, especially for following areas.	
	Necessary land for PVA intersection Improvement	
	Necessary land for widening of road at Section A	
5	Relocation, improvement and/or repair of existing utilities (power lines, telecommunication lines, water lines, etc.)	September, 2007
6	Removal and/or relocation of trees, structural object, and any other objects to be affected by the implementation of the Project.	
7	Securing of site for disposal of waste	
8	Identification of underground utilities located within the site	
9	Necessary due procedures for Contractor to be exempted from responsibilities when unidentified utilities are damaged by the Contractor's work.	June, 2007

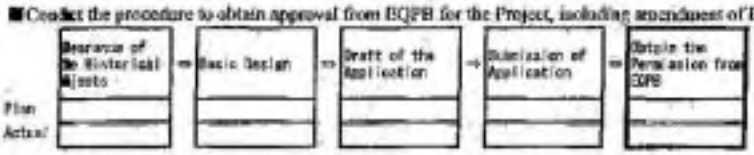
*Important Notice: Any Calendar year and month expressed in the plan are only tentative, and they don't represent the official policies, opinions or statement of JICA.

Check List of the Progress of Each Undertakings to be taken by the Palauan side for the Project
for the Project for the Improvement of Urban and Rural Roads in Koror and Airai States

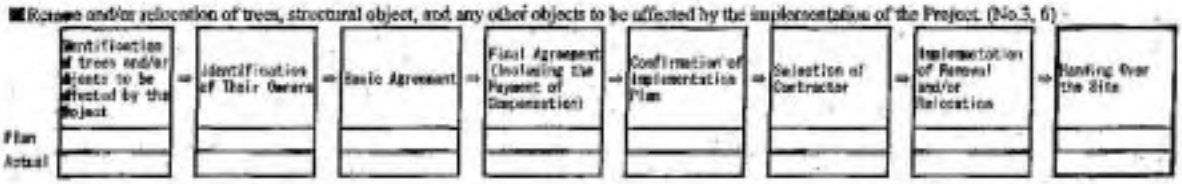
■Allocation of the budget for fiscal year 2007, necessary for the implementation of the Project described as follows (No.1)



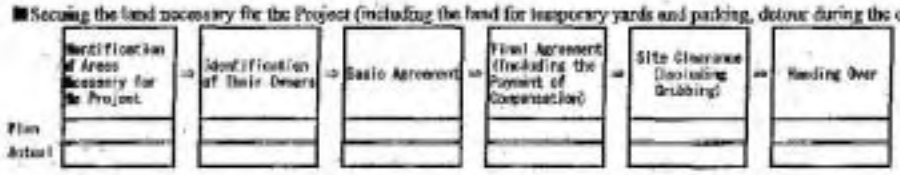
■Conduct the procedure to obtain approval from EQPB for the Project, including amendment of Environmental Assessment (No.2)



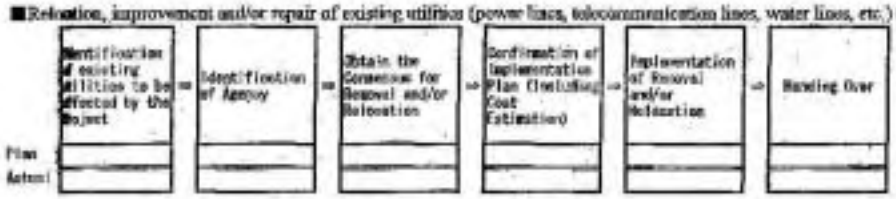
■Remove and/or relocation of trees, structural object, and any other objects to be affected by the implementation of the Project. (No.3, 6)



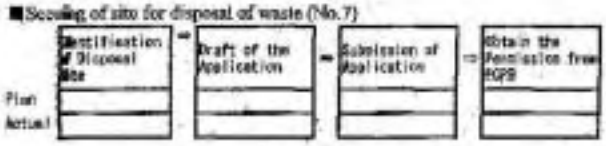
■Securing the land necessary for the Project (including the land for temporary yards and parking, detour during the construction etc.) (No.4)



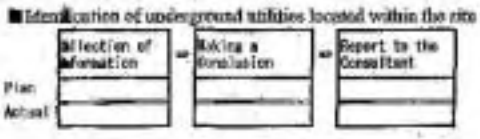
■Relocation, improvement and/or repair of existing utilities (power lines, telecommunication lines, water lines, etc.) (No.5)



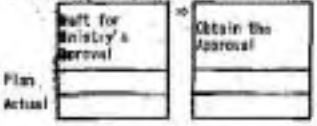
■Securing of site for disposal of waste (No.7)



■Identification of underground utilities located within the site (No.8)



■Necessary due procedures for Contractor to be exempted from responsibilities when unidentified utilities are damaged by the Contractor's work. (No.9)



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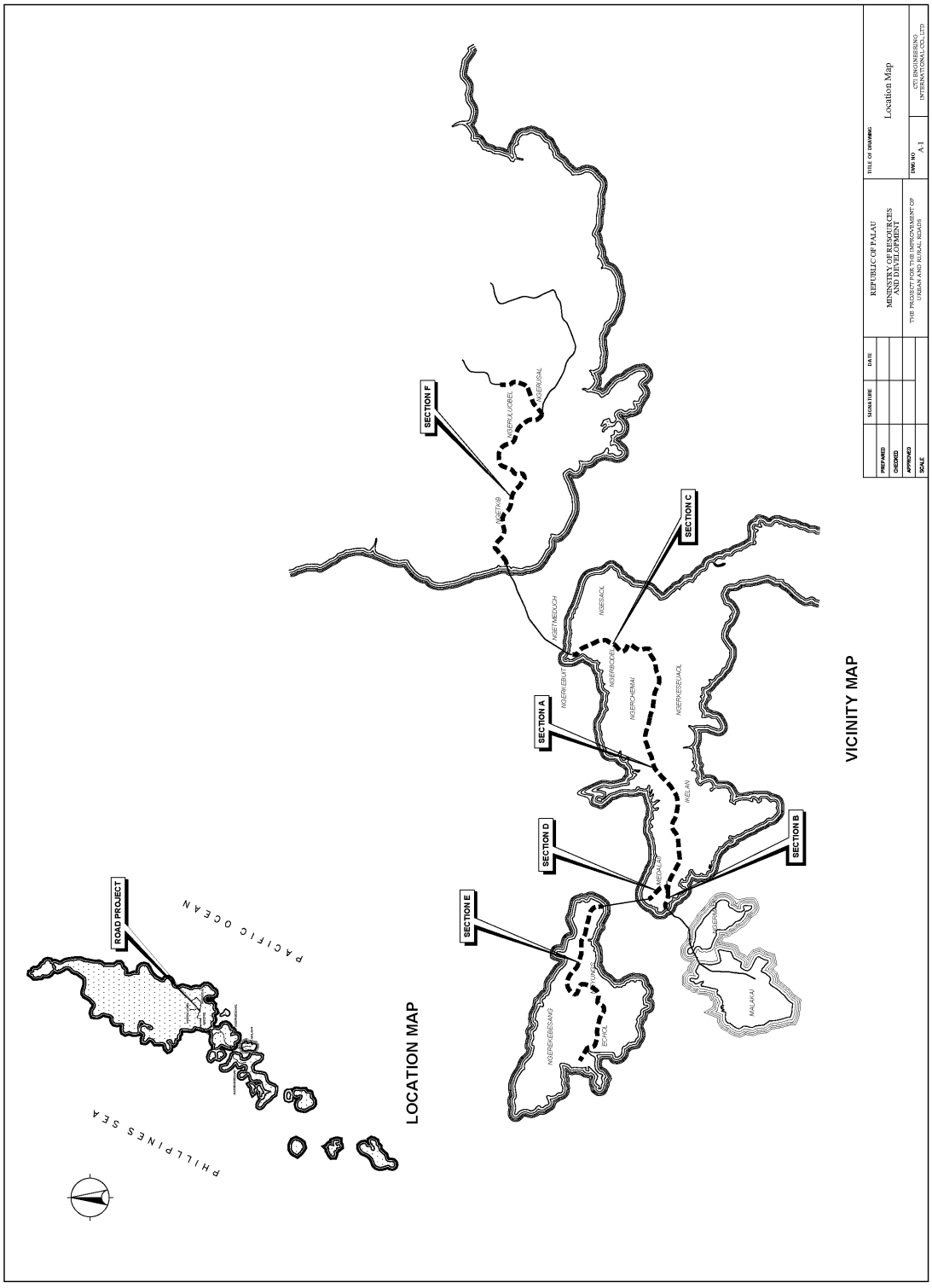
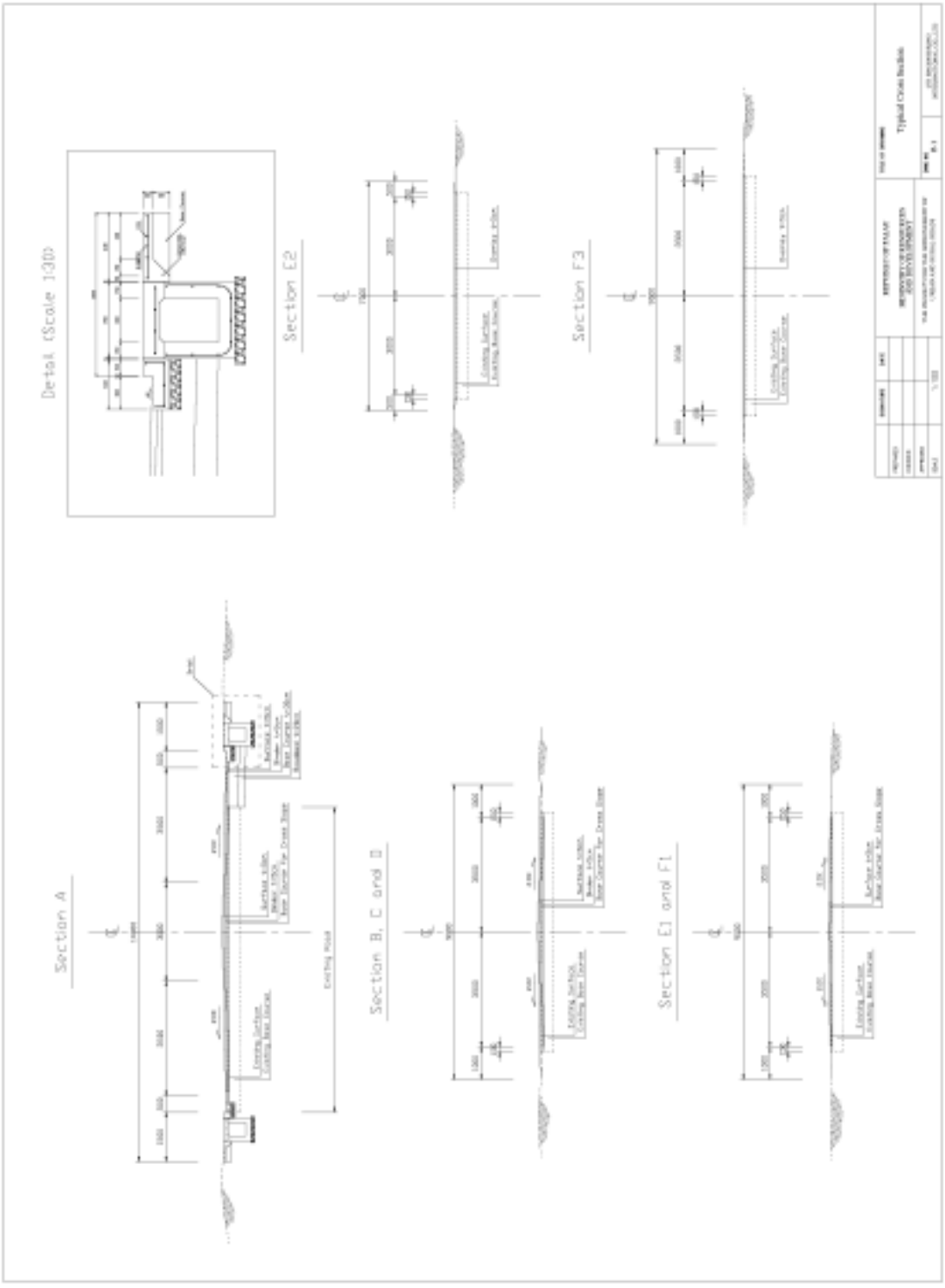
Appendix 5 Drawings

Drawing Schedule

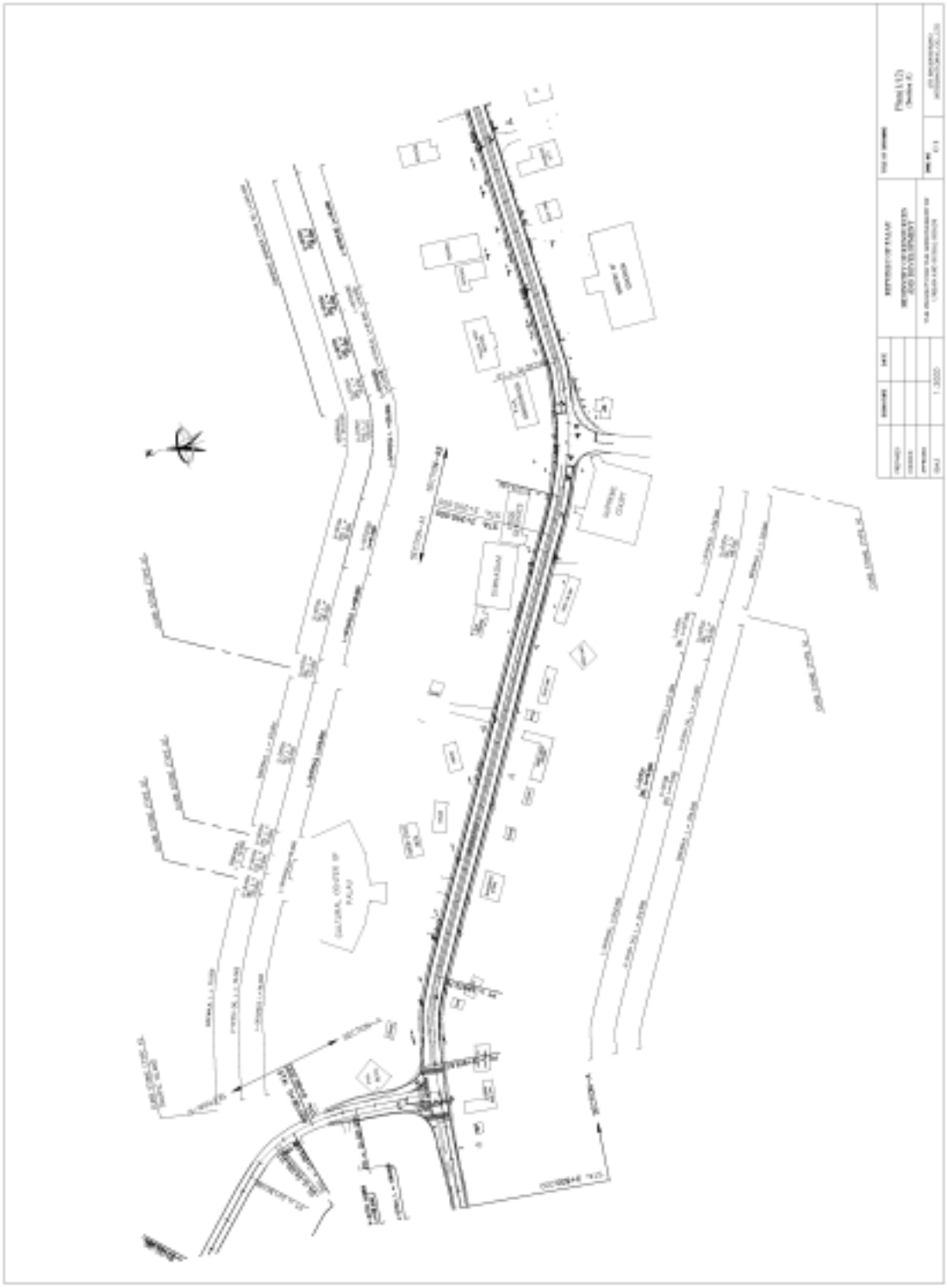
A-1 Location Map



B-1 Typical Cross Section

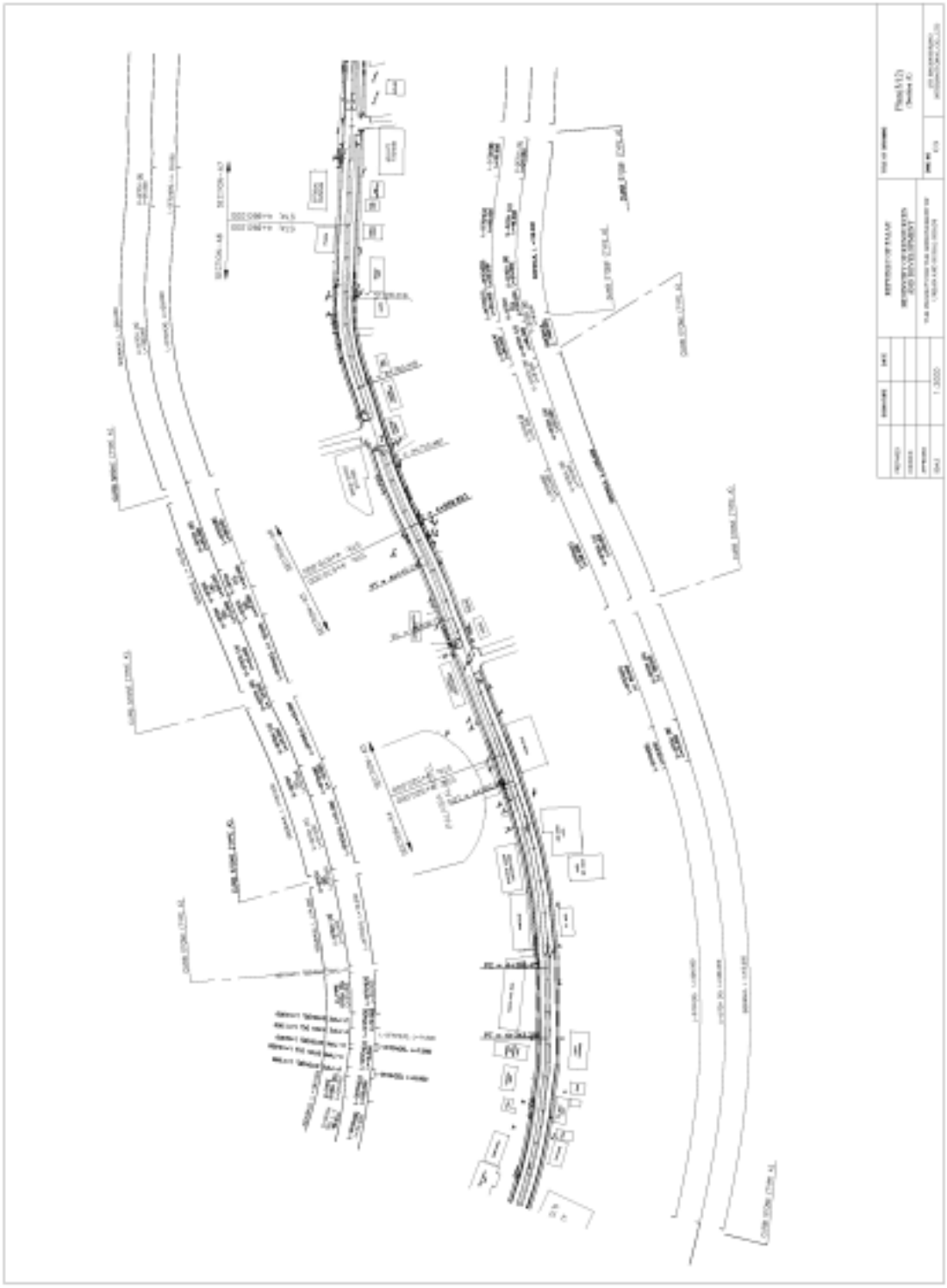


C-1 Plan(1/12) Section A



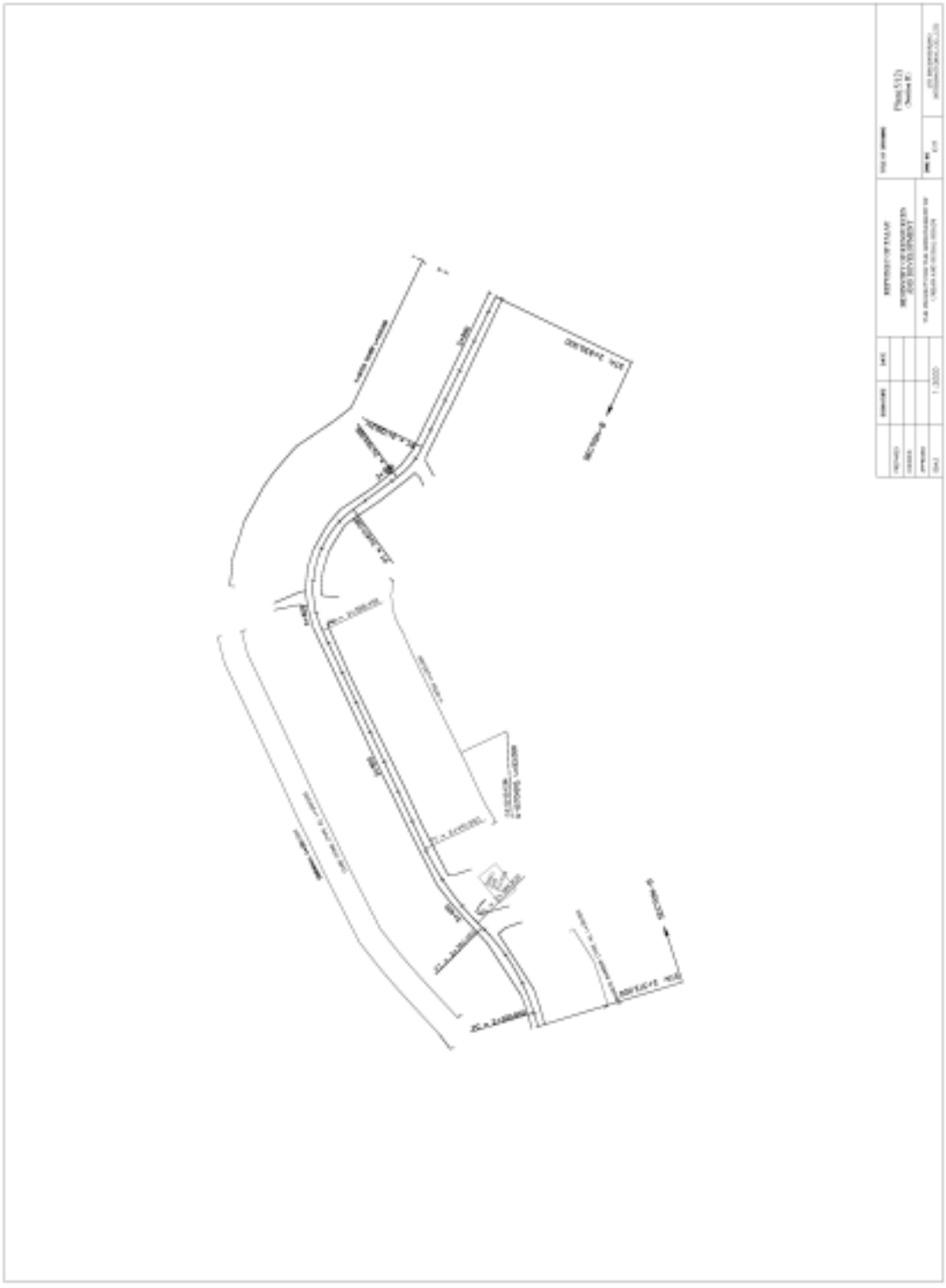
C-2 Plan(2/12) Section A

C-3 Plan(3/12) Section A

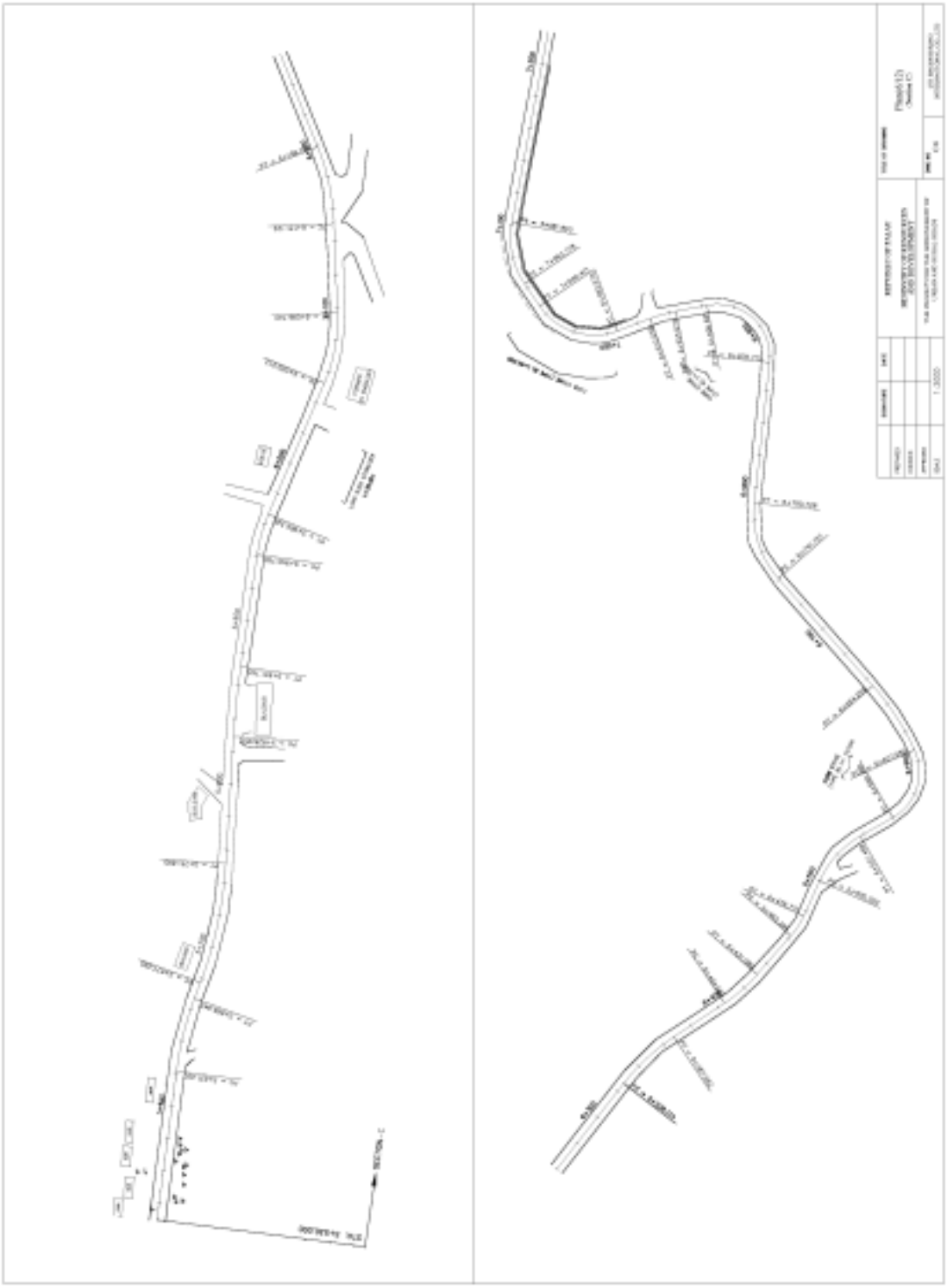


C-4 Plan(4/12) Section A

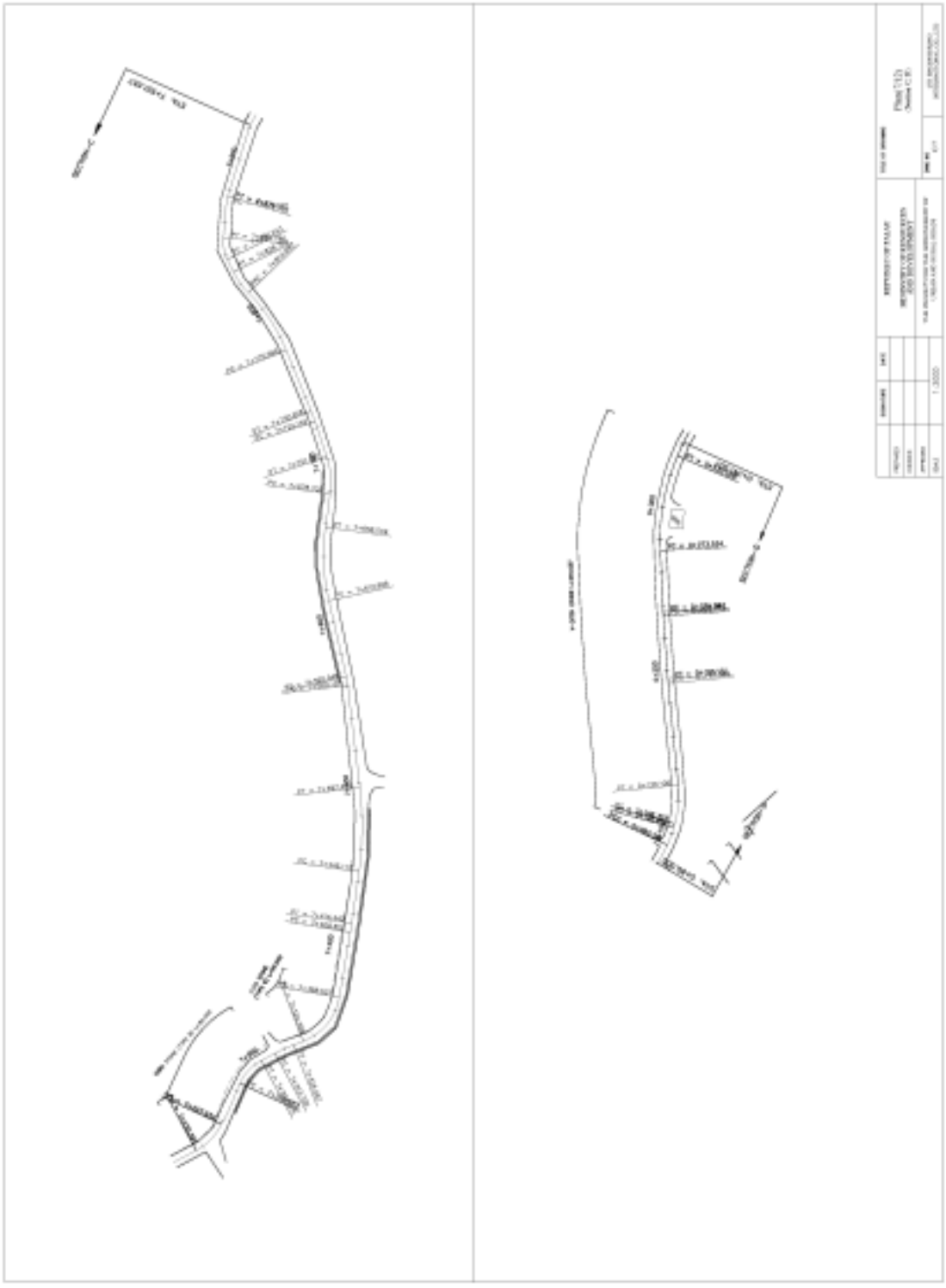
C-5 Plan(5/12) Section B



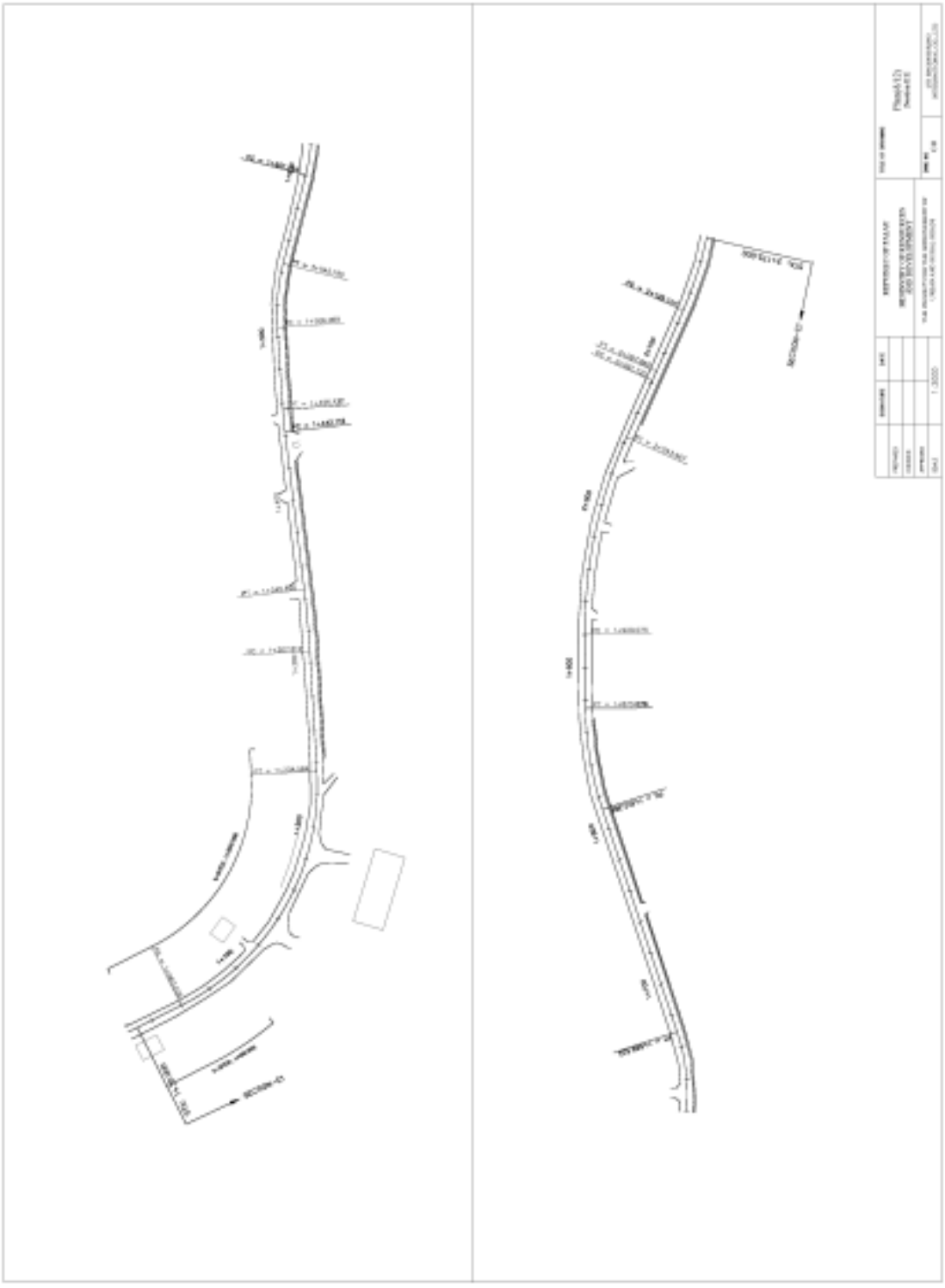
C-6 Plan(6/12) Section C



C-7 Plan(7/12) Section C.D



C-8 Plan(8/12) Section E_1



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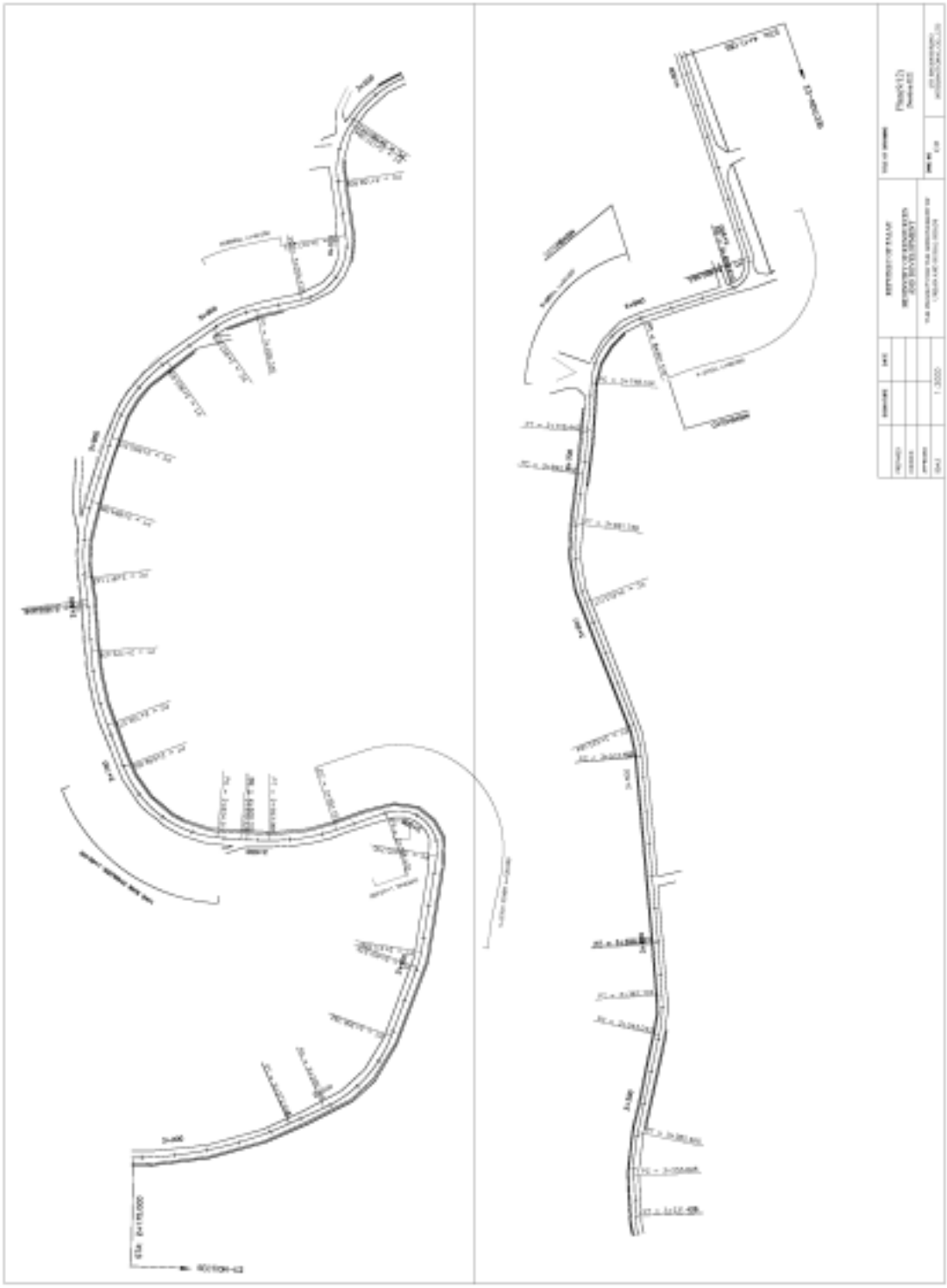
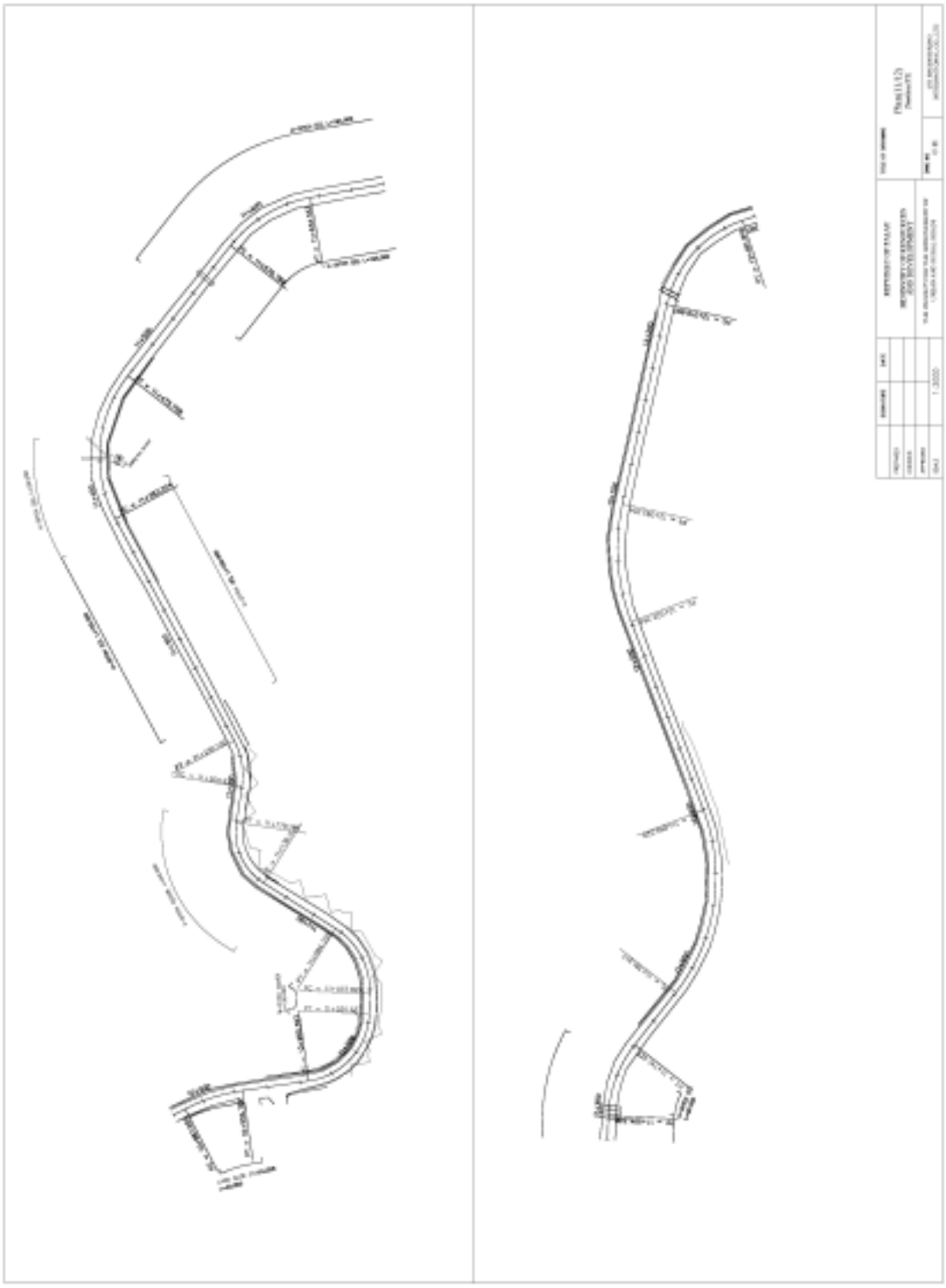
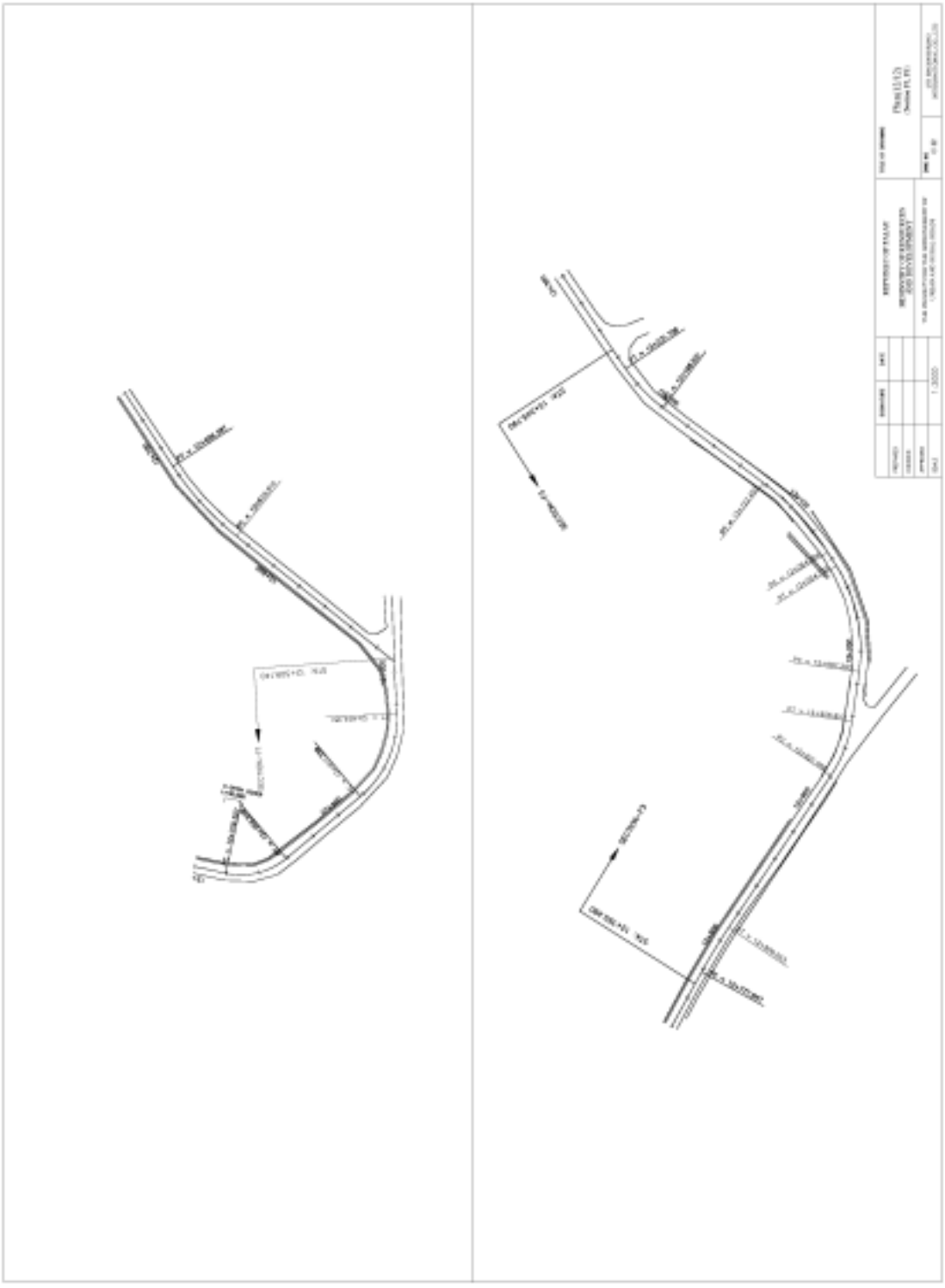


C-10 Plan(10/12) Section F_1

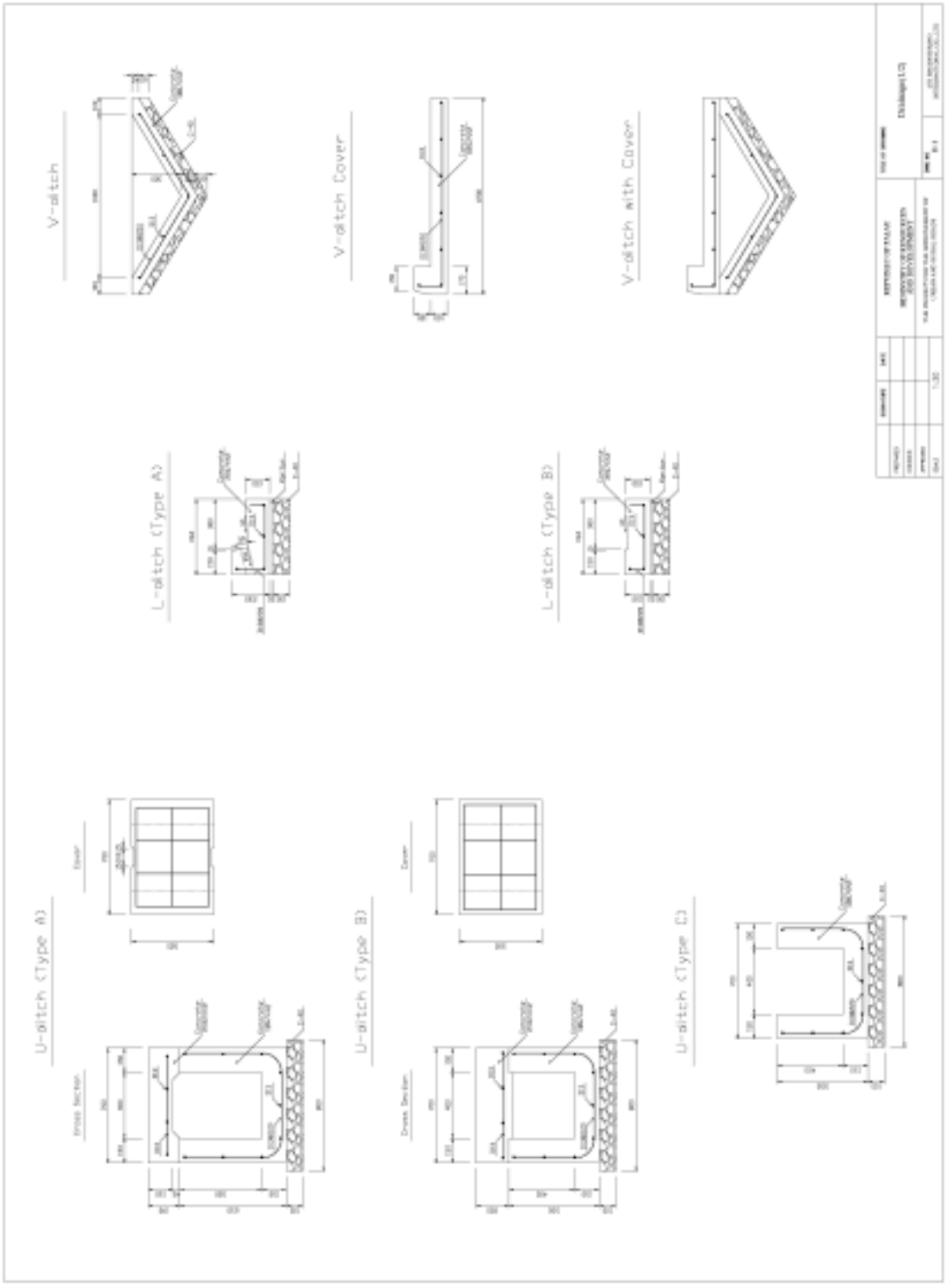
C-11 Plan(11/12) Section F_1



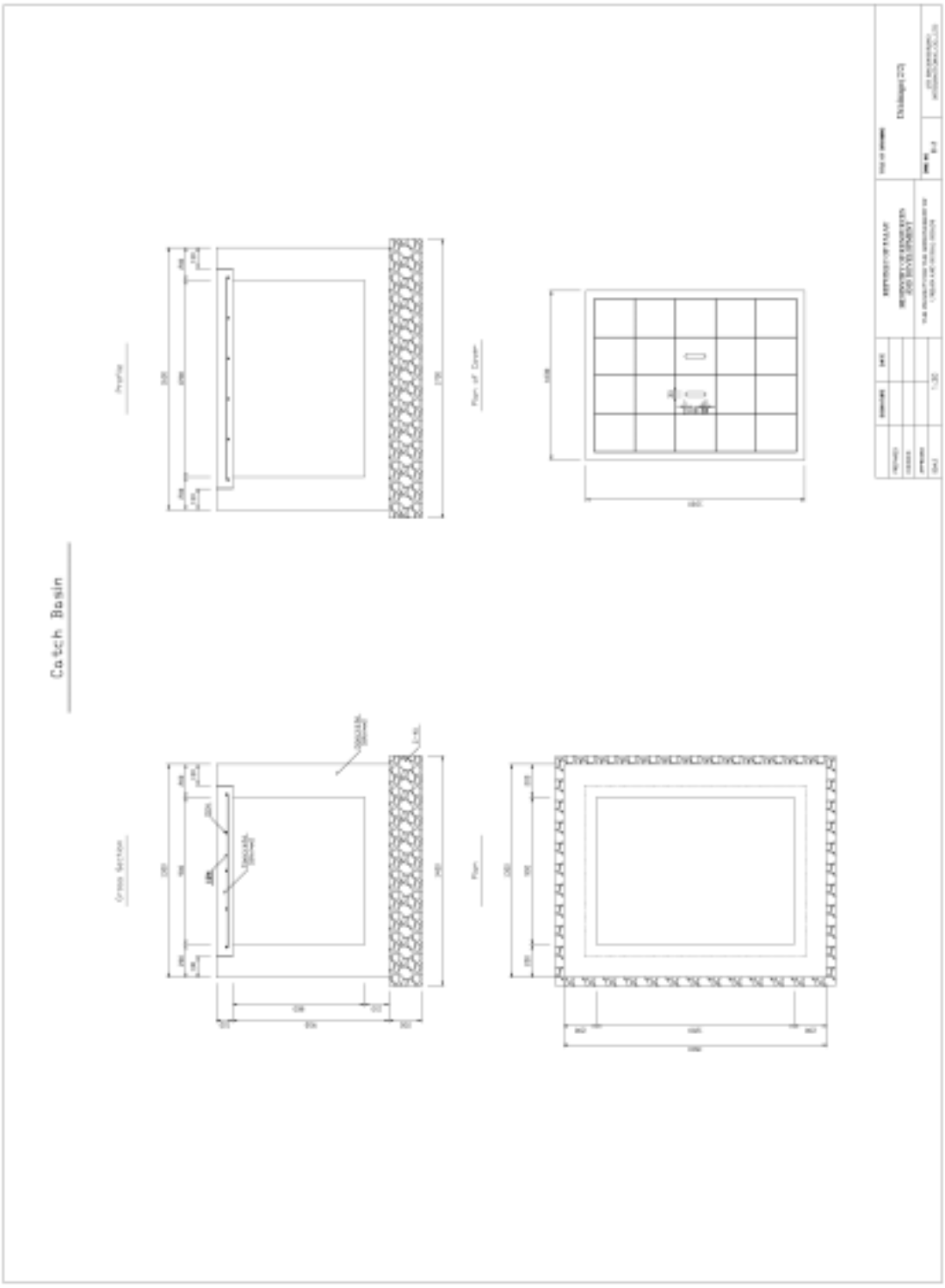
C-12 Plan(12/12) Section F_1, F_3



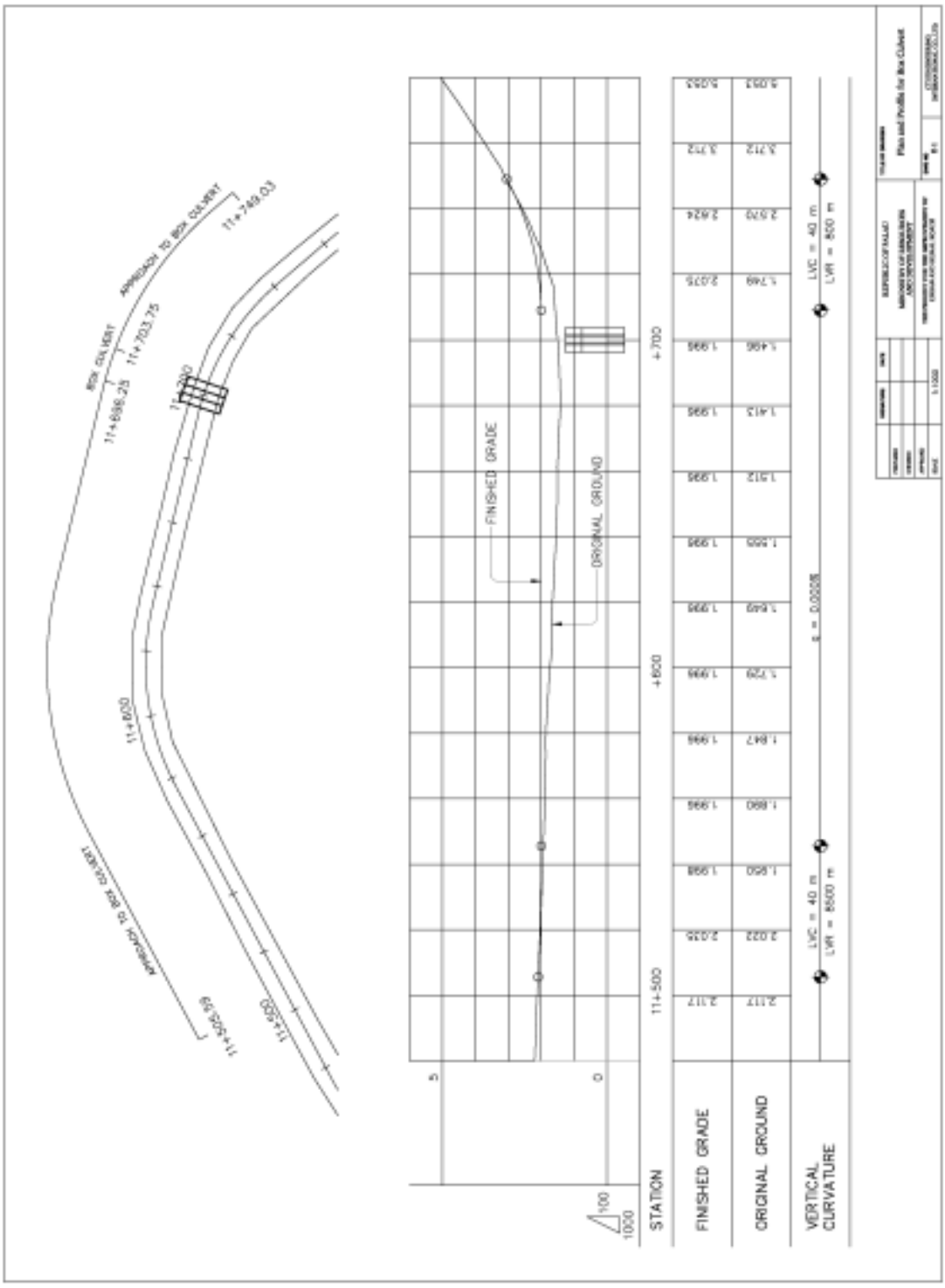
D-1 Drainage (1/2)



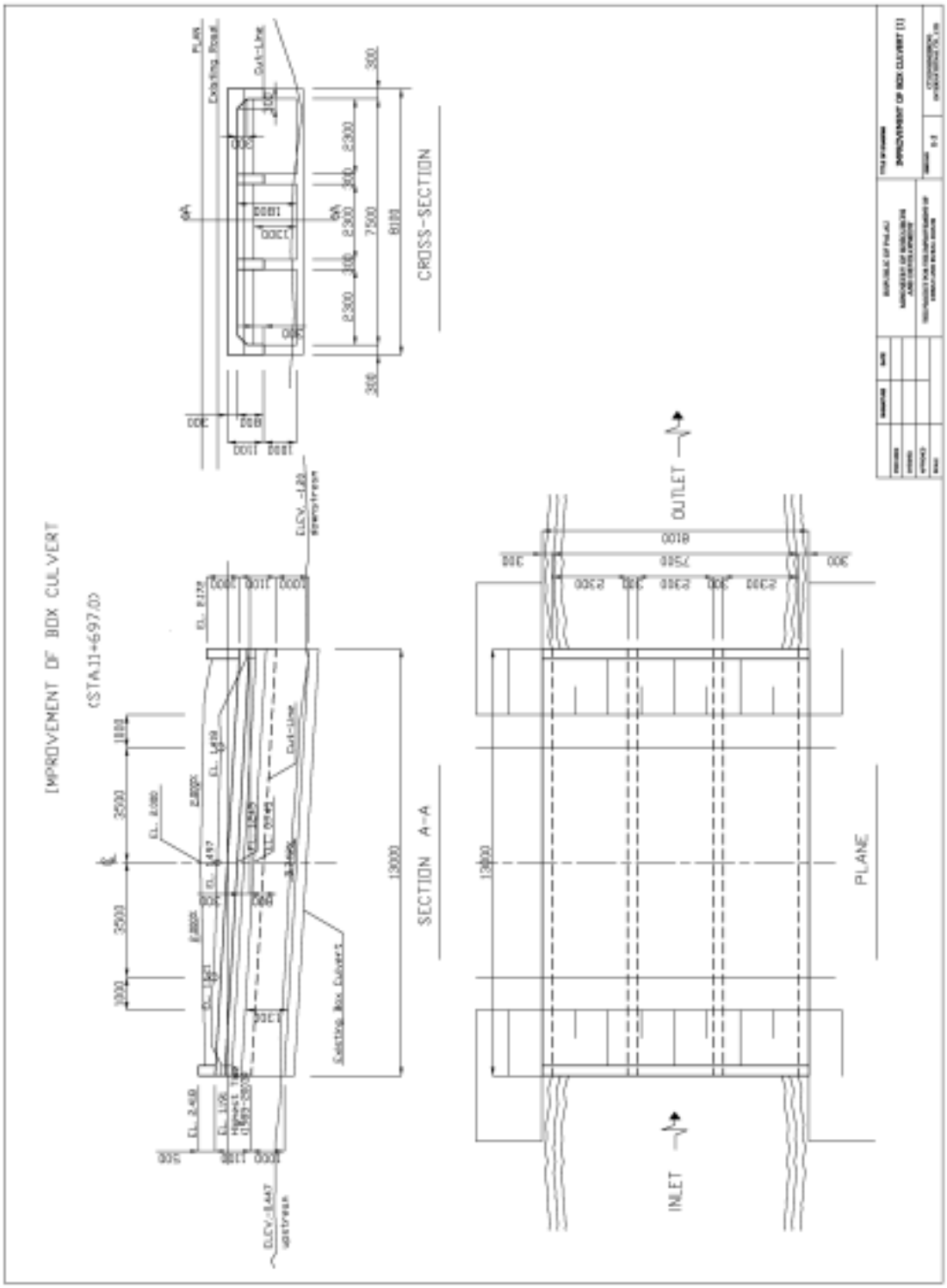
D-2 Drainage (2/2)



E-1 Plan and Profile for Box Culvert



E-2 Improvement of Box Culvert (1)



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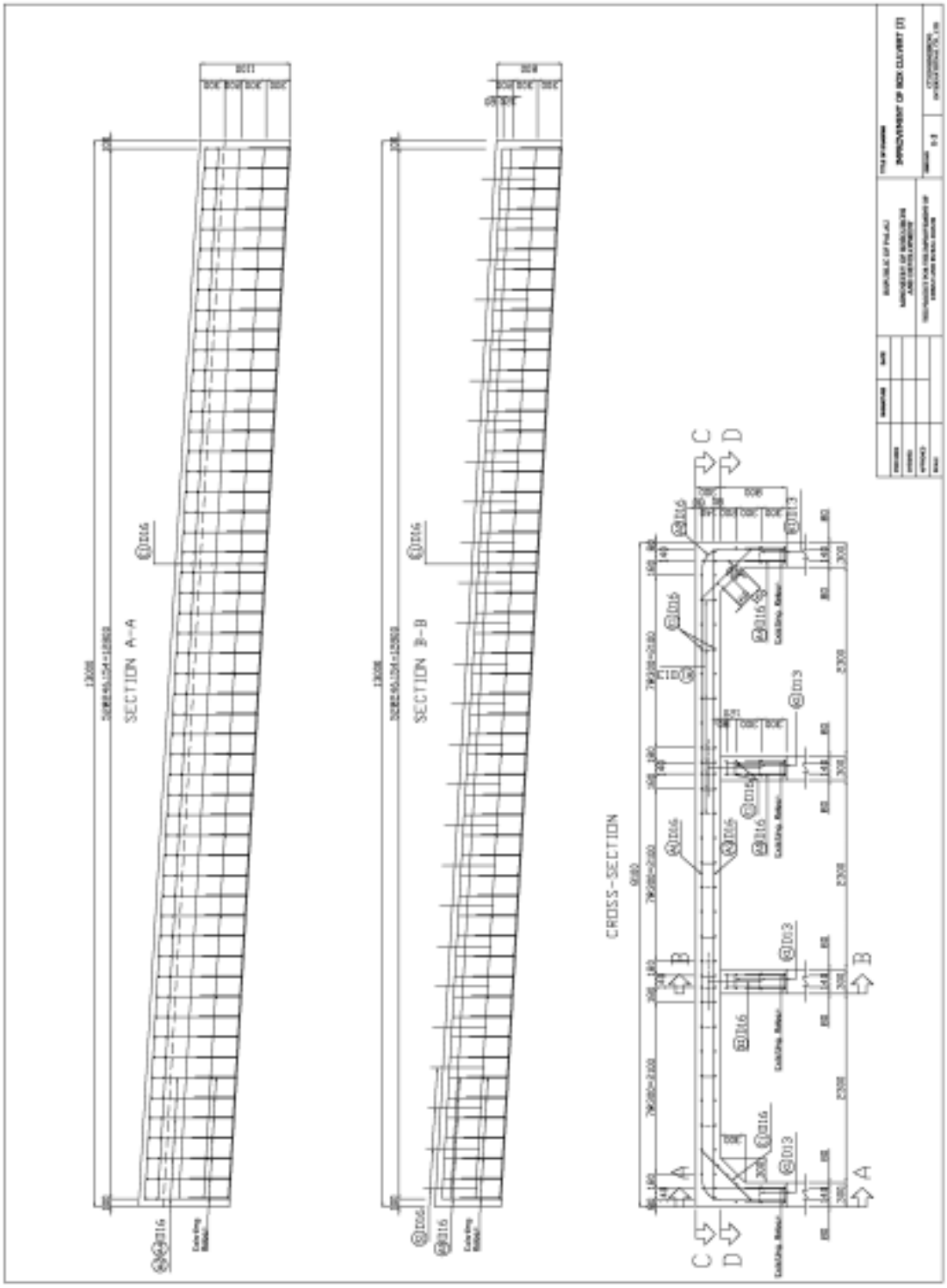
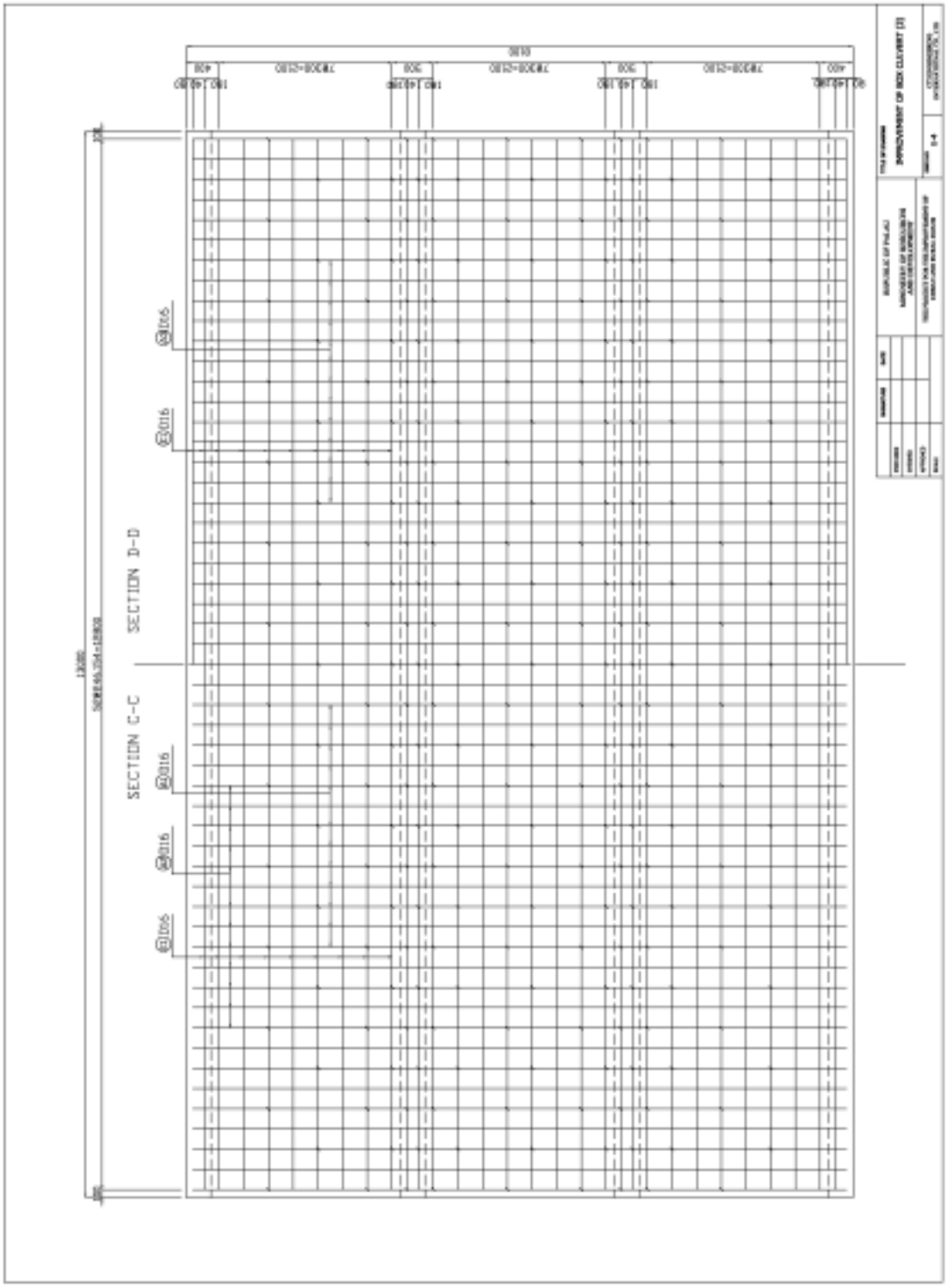


E-4 Improvement of Box Culvert (3)



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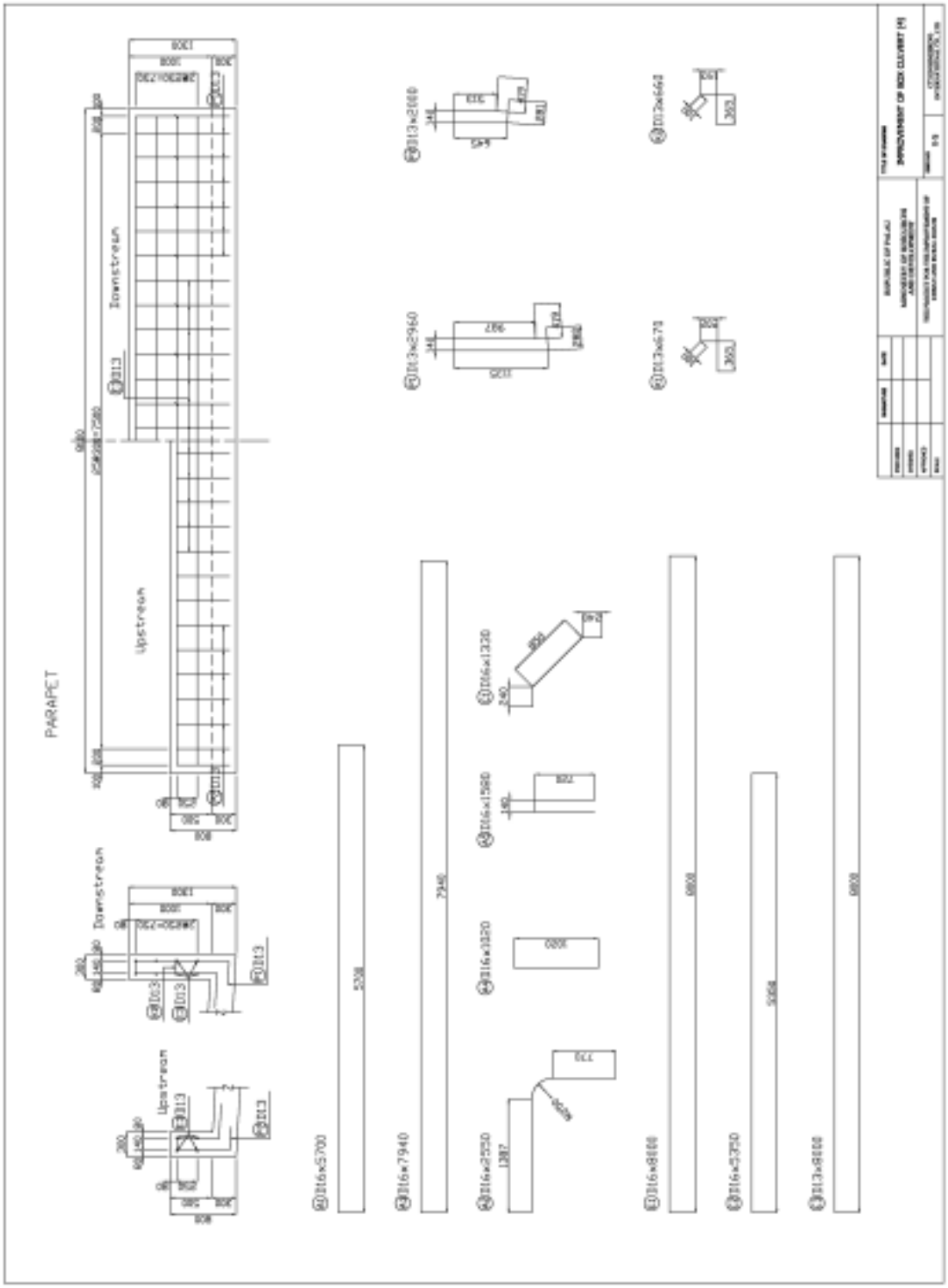
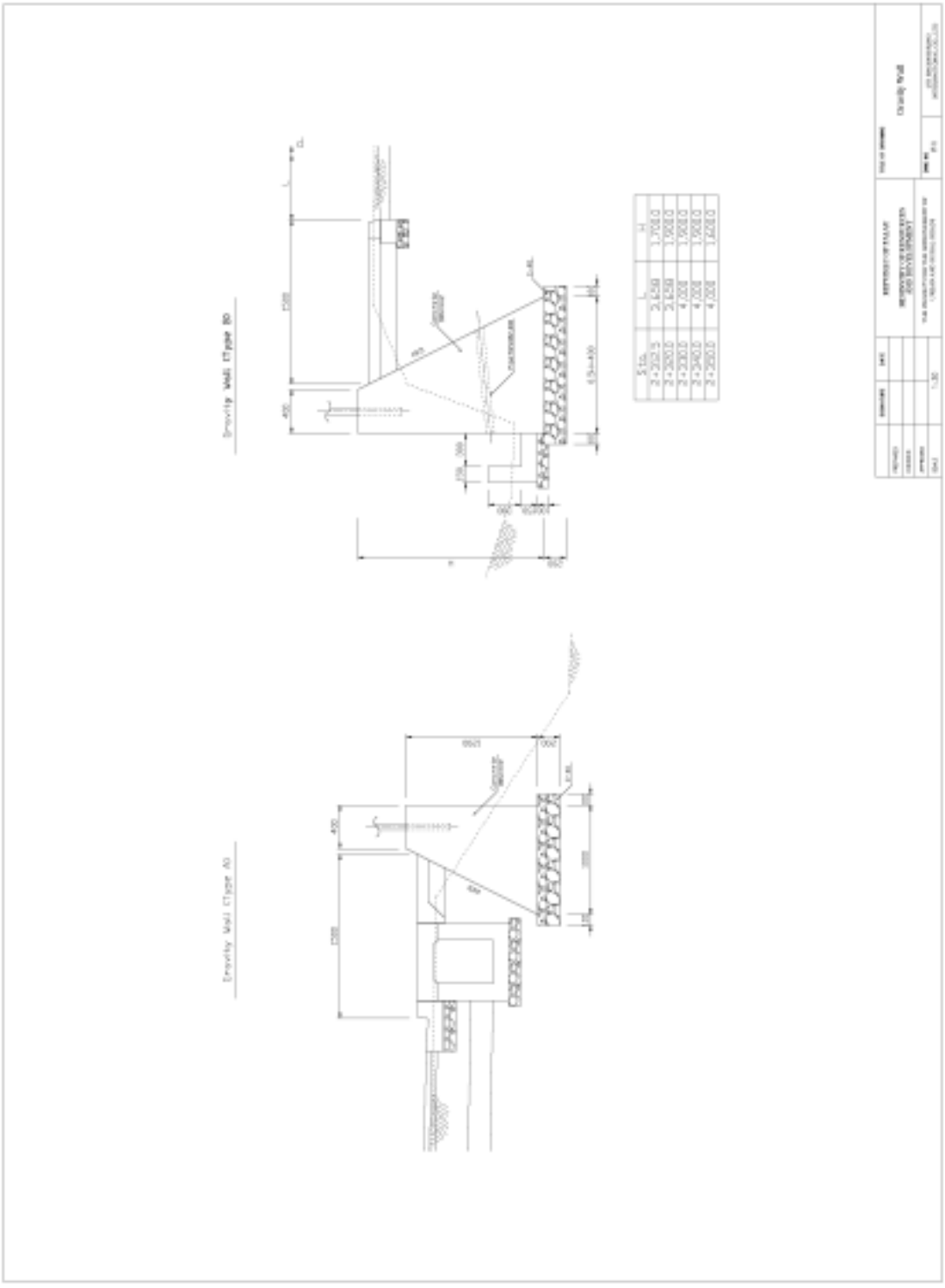
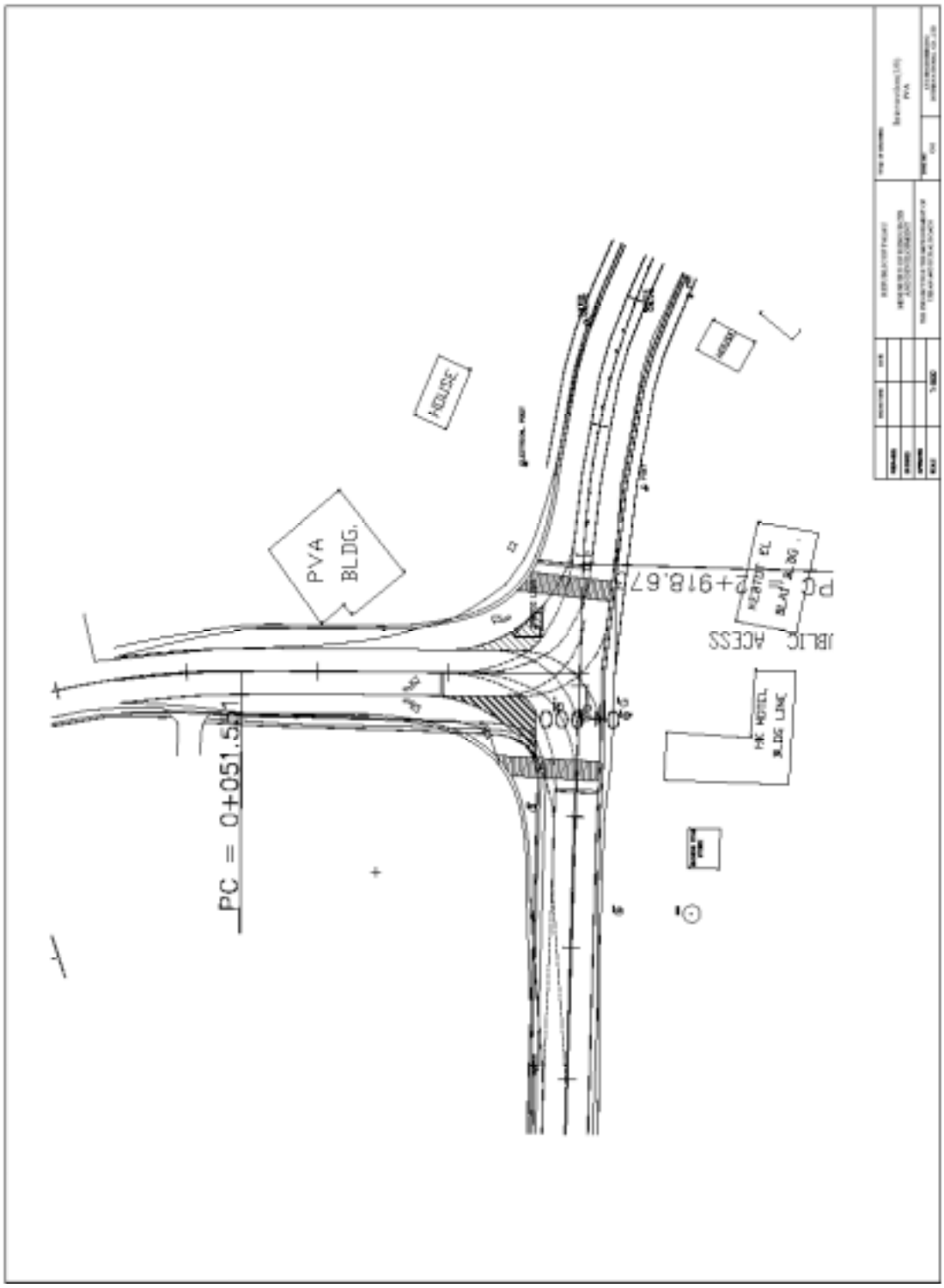


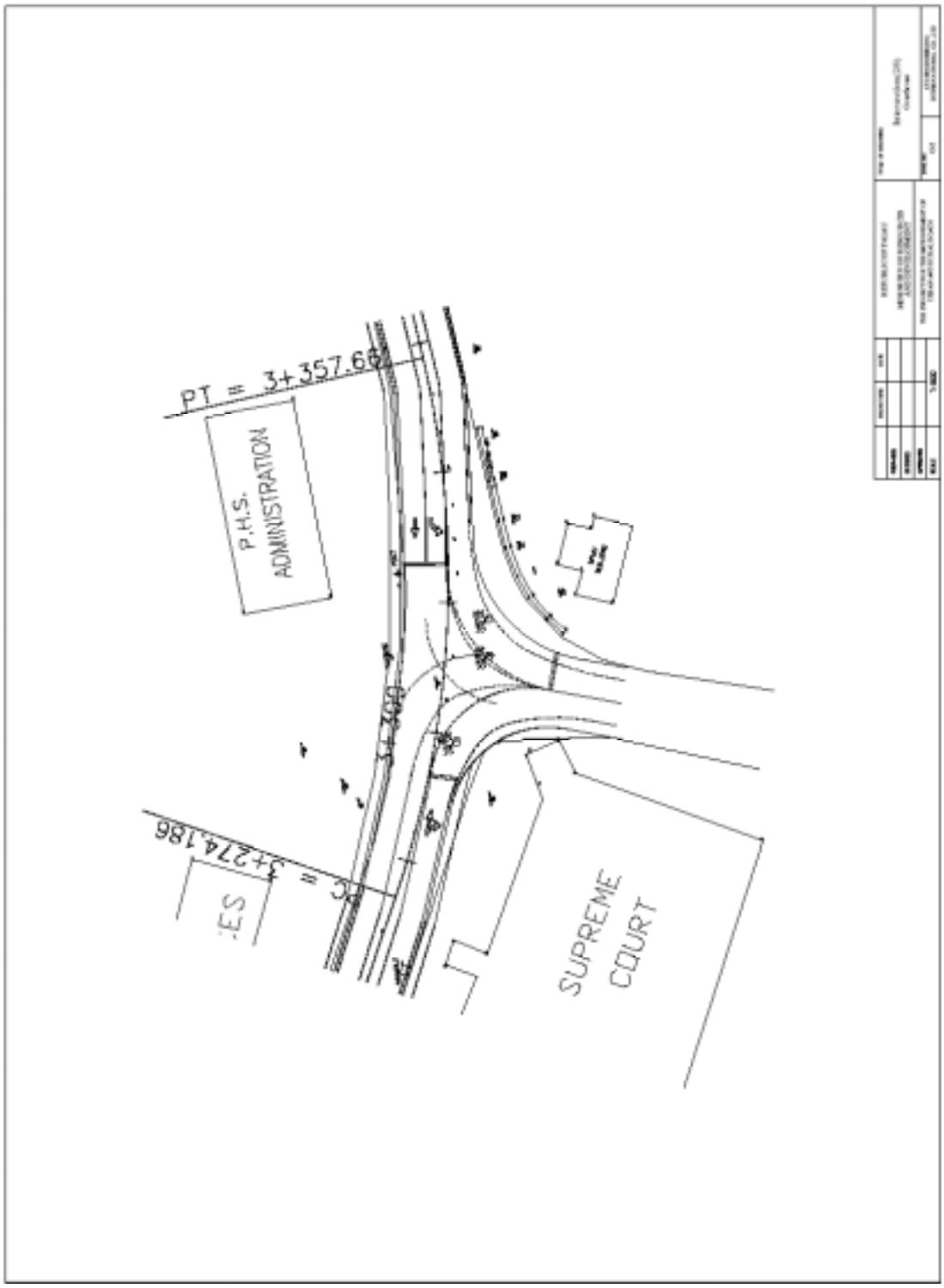
F-1 Gravity Wall



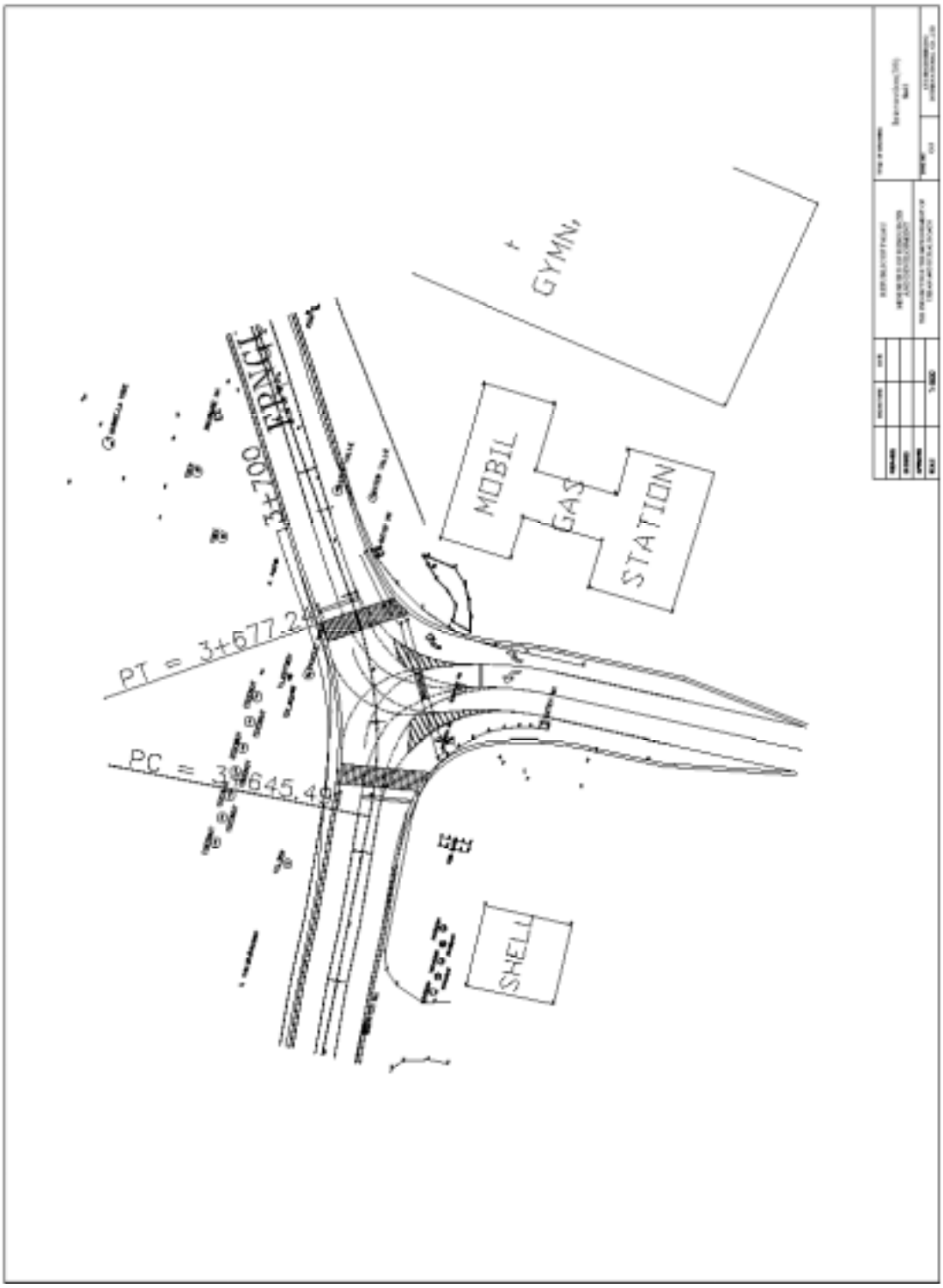
G-1 Intersection (1/6), PVA



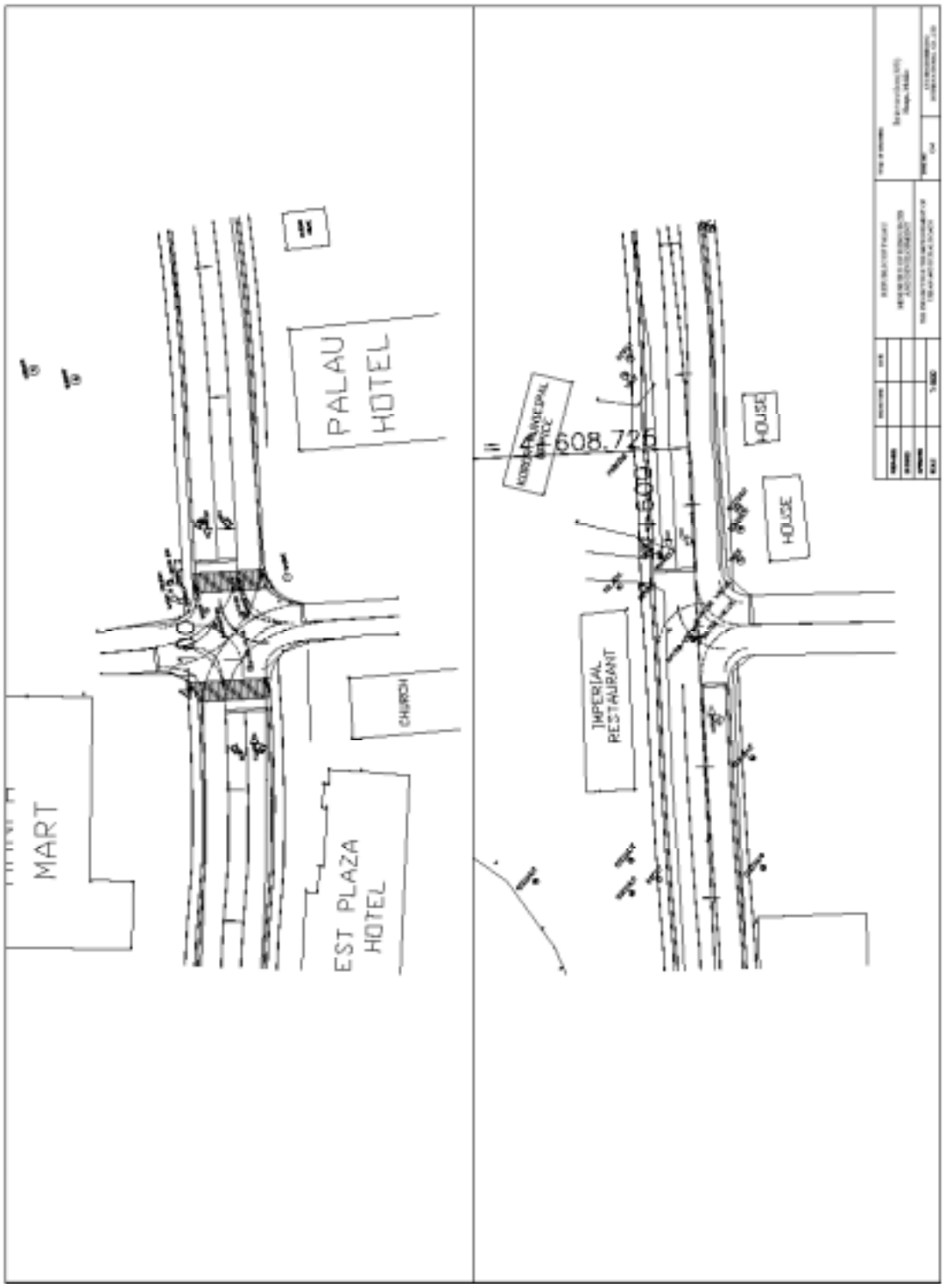
G-2 Intersection (2/6), Courthouse



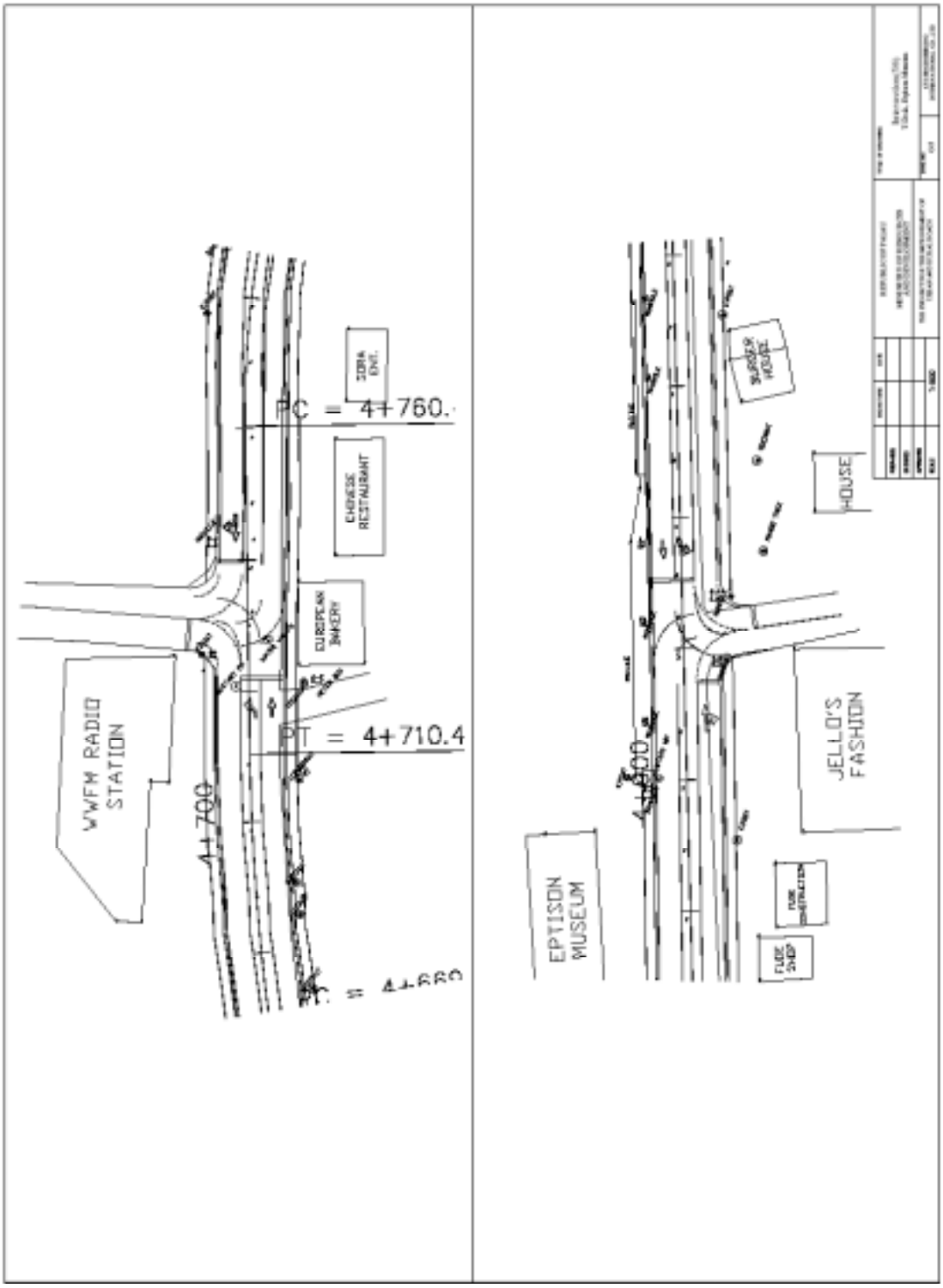
G-3 Intersection (3/6), Shell



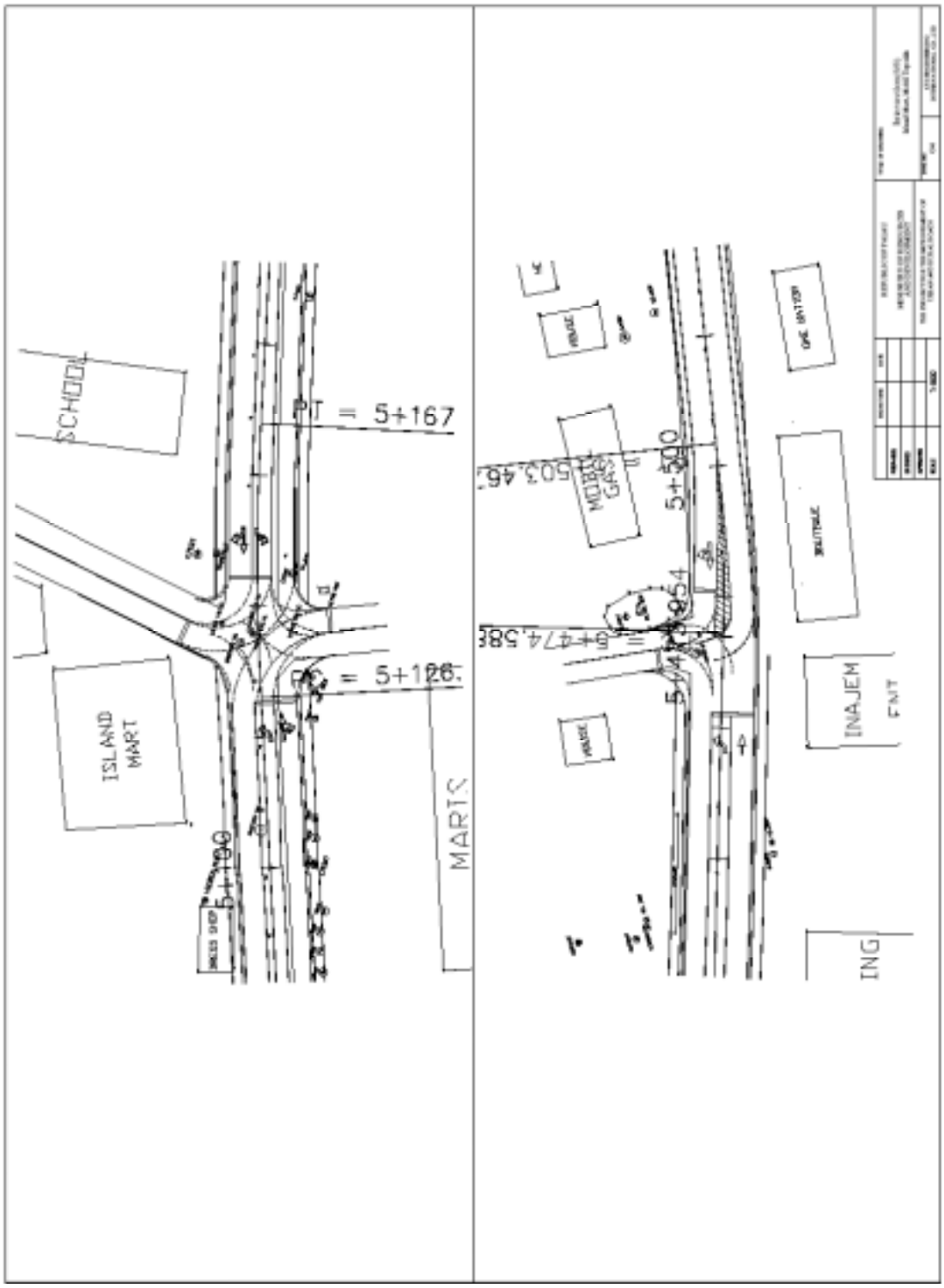
G-4 Intersection (4/6), Hanpa, Mokko



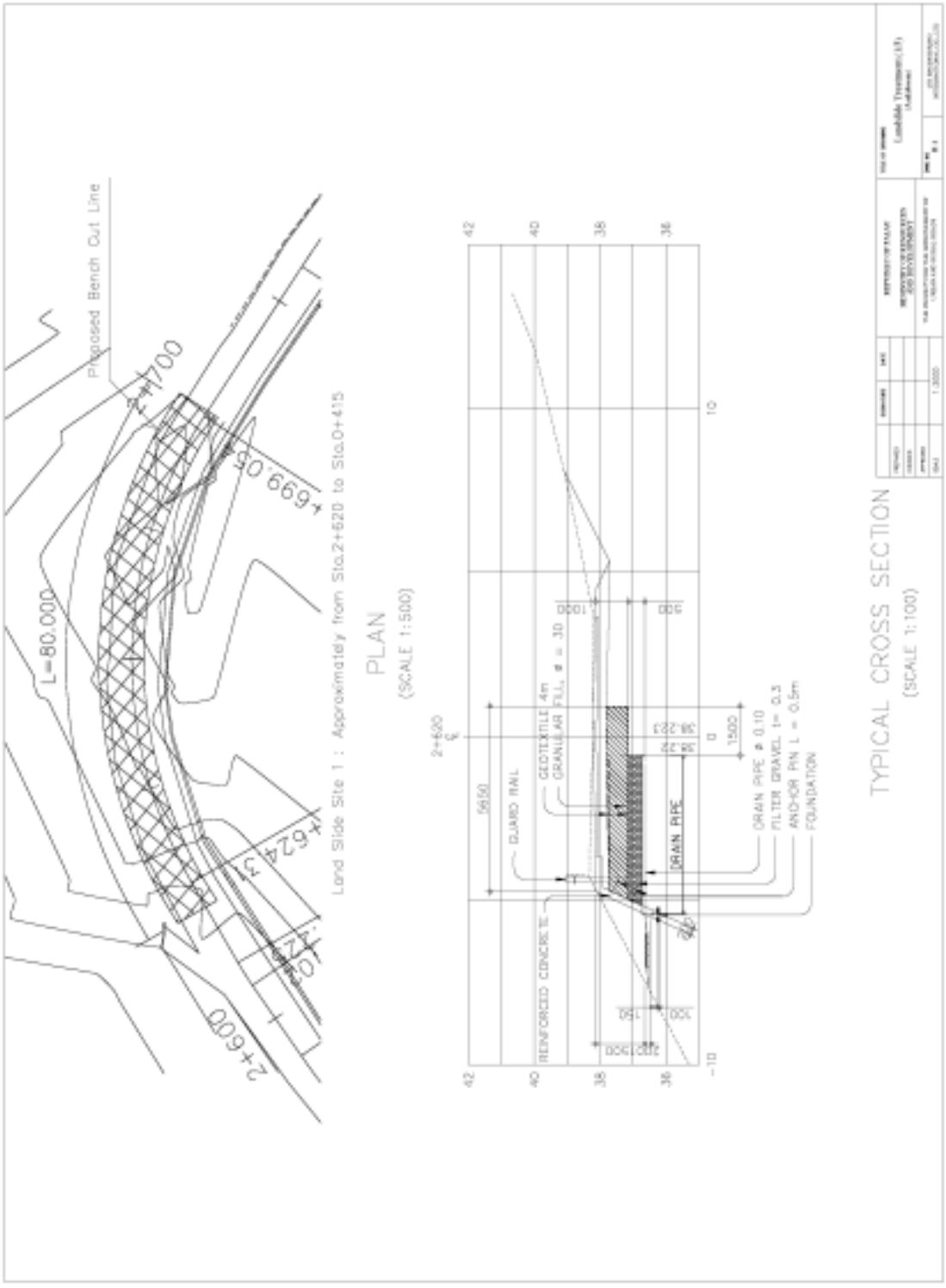
G-5 Intersection (5/6), T-Dock, Etpison Museum



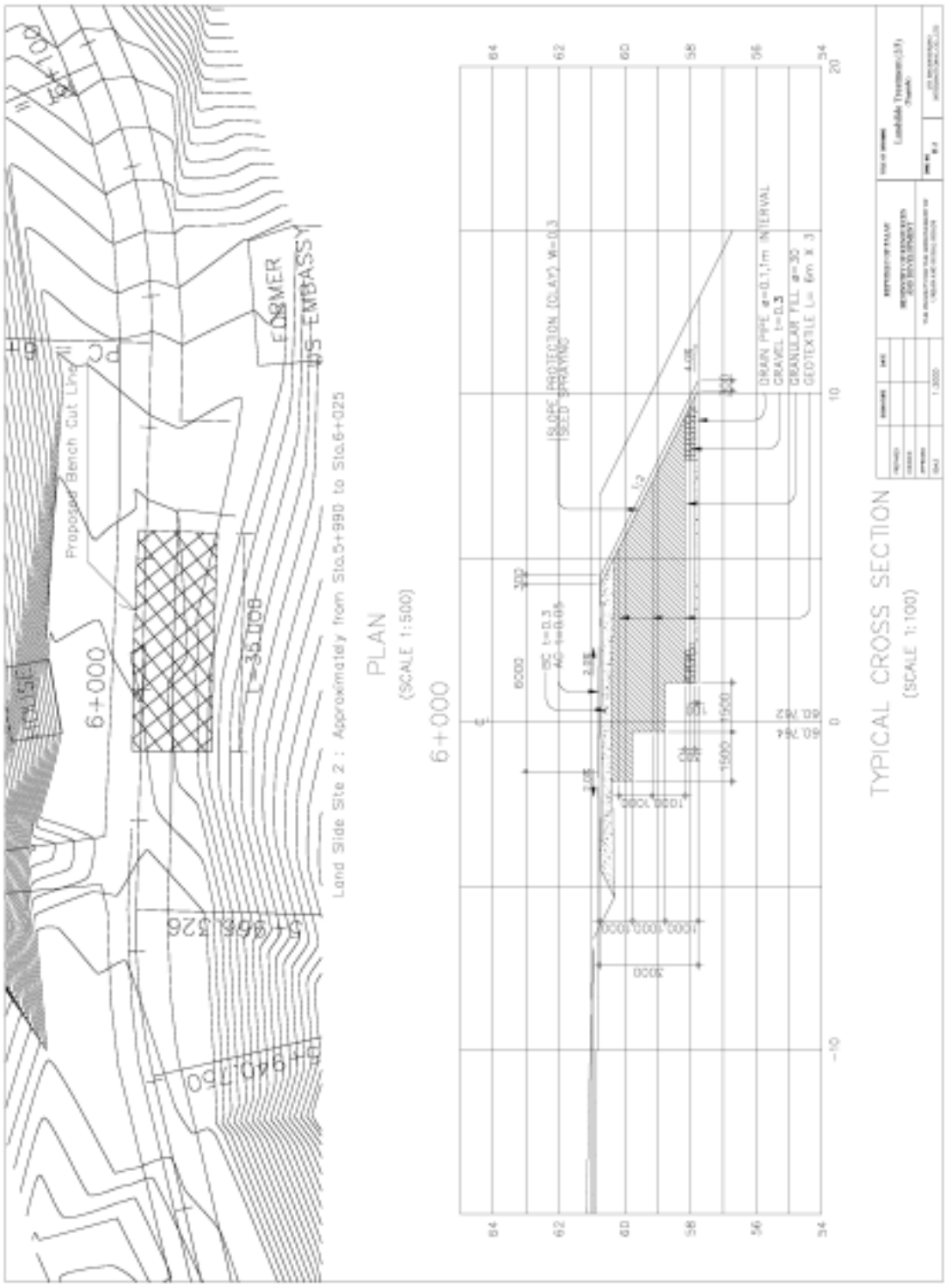
G-6 Intersection (6/6), Island Mart, Mobil Top-side



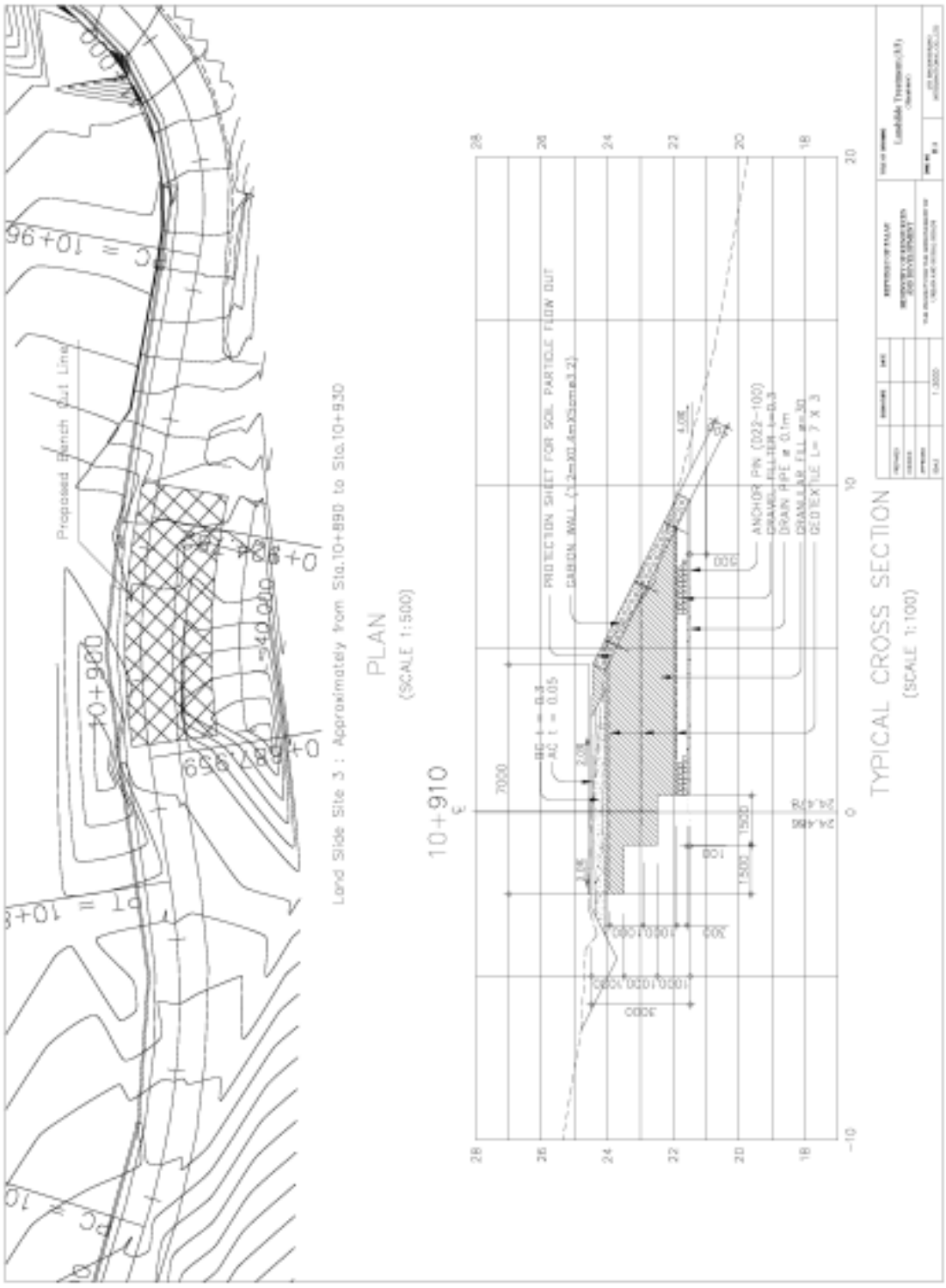
H-1 Landslide Treatment (1/3), Arakabesan



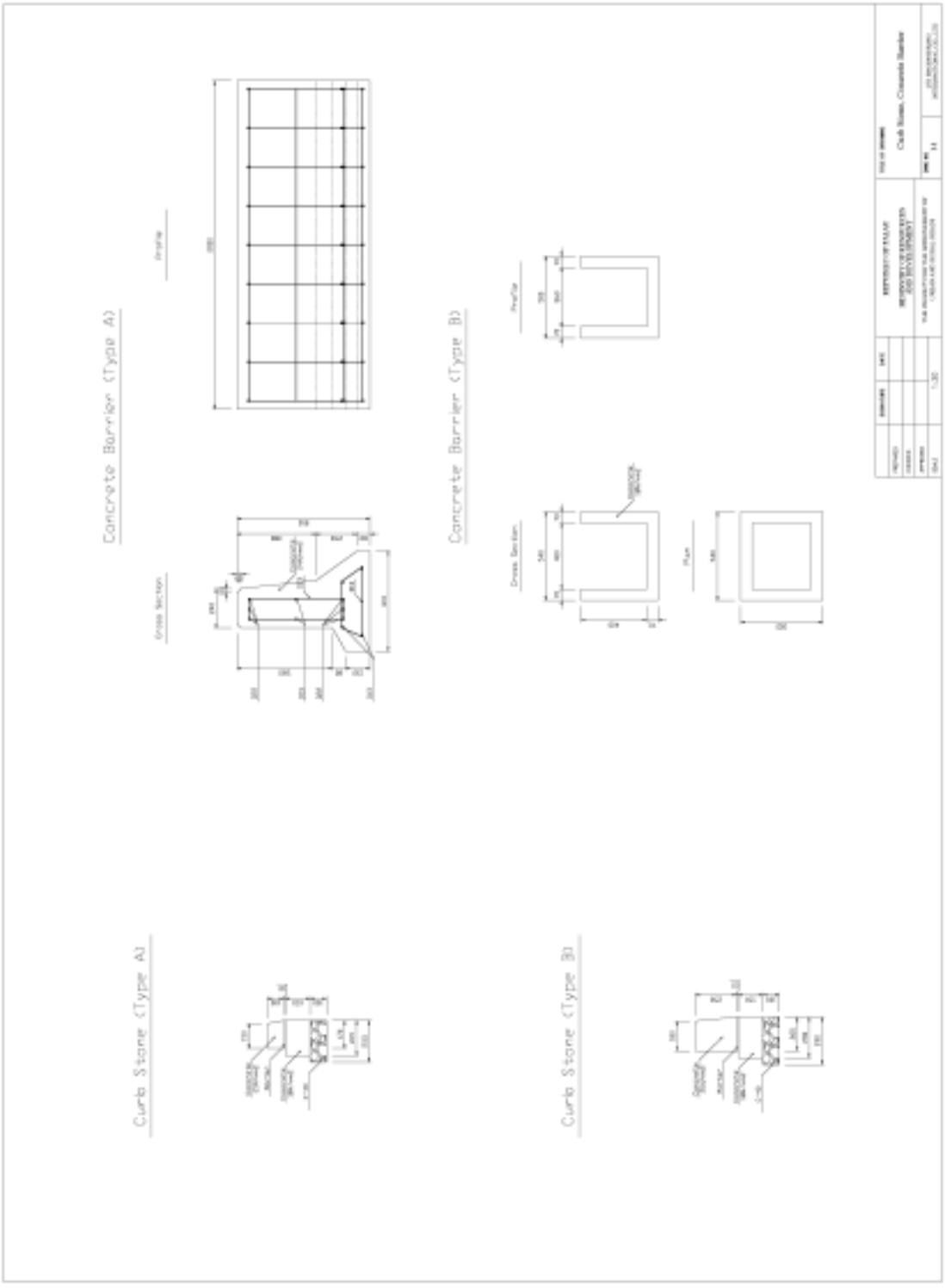
H-2 Landslide Treatment (2/3), Topside



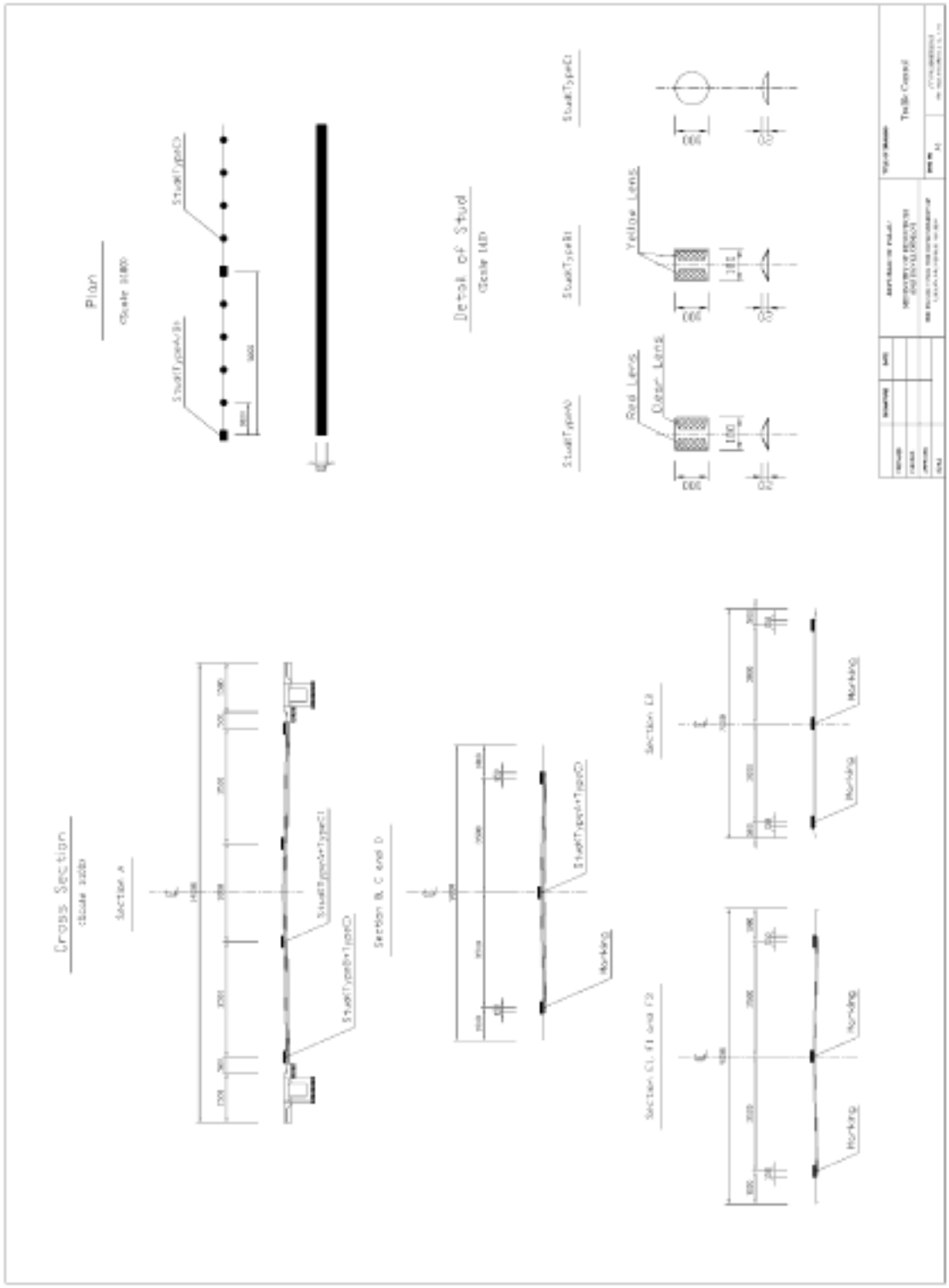
H-3 Landslide Treatment (3/3), Airaiview



I-1 Curb Stone, Concrete Barrier

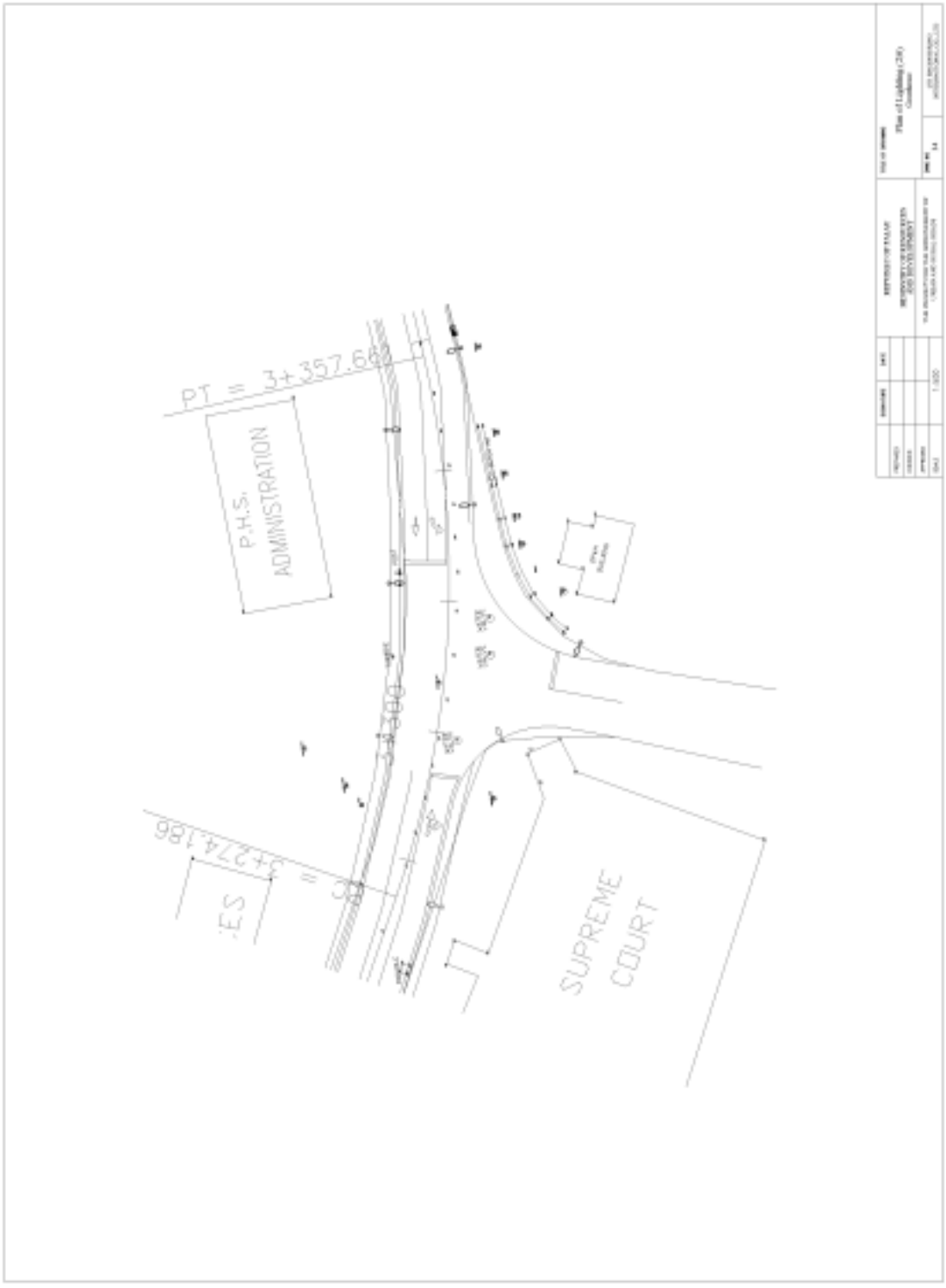


I-2 Traffic Control



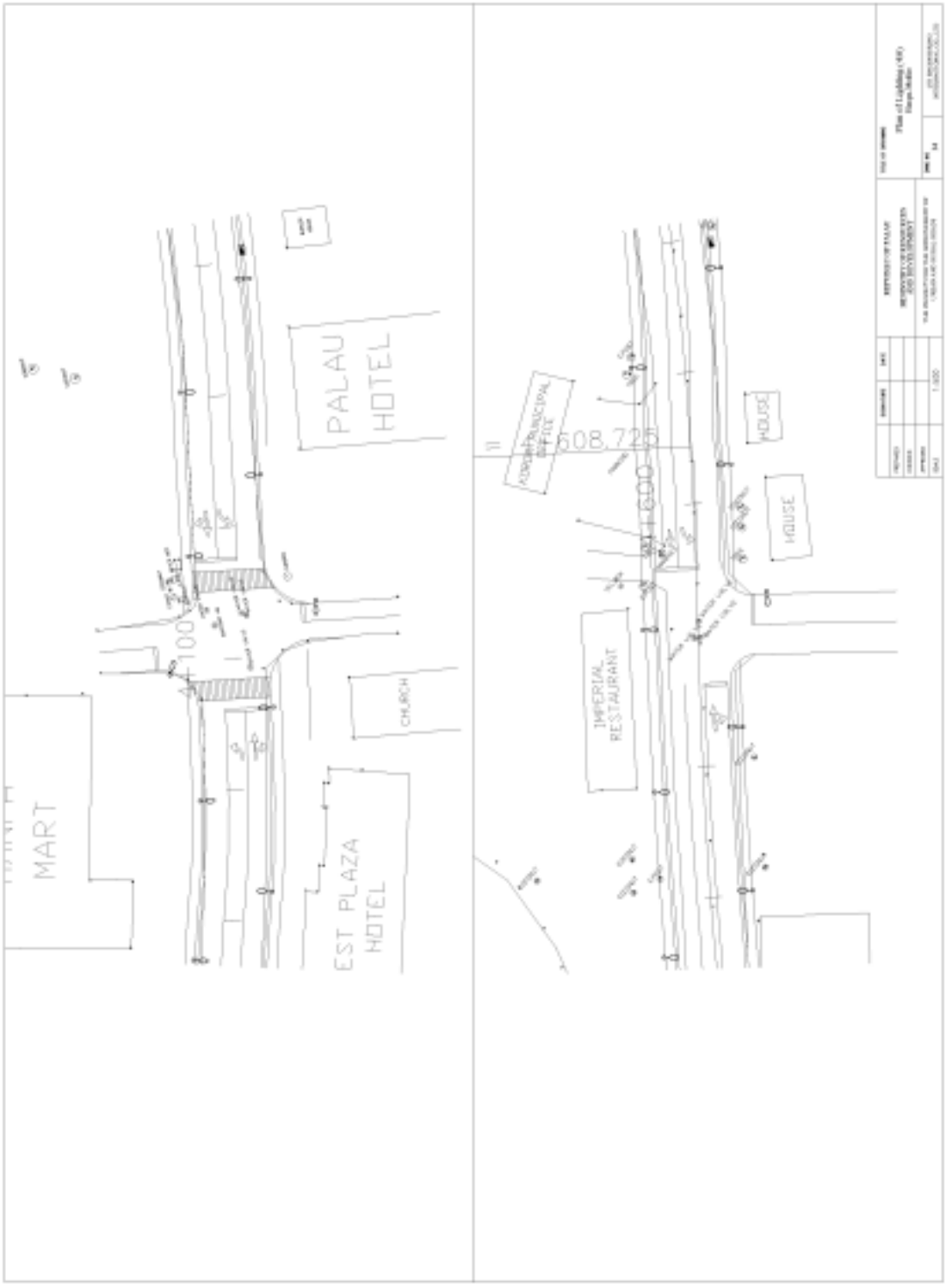
I-3 Plan of Lighting, (1/6) PVA

I-4 Plan of Lighting, (2/6) Courthouse

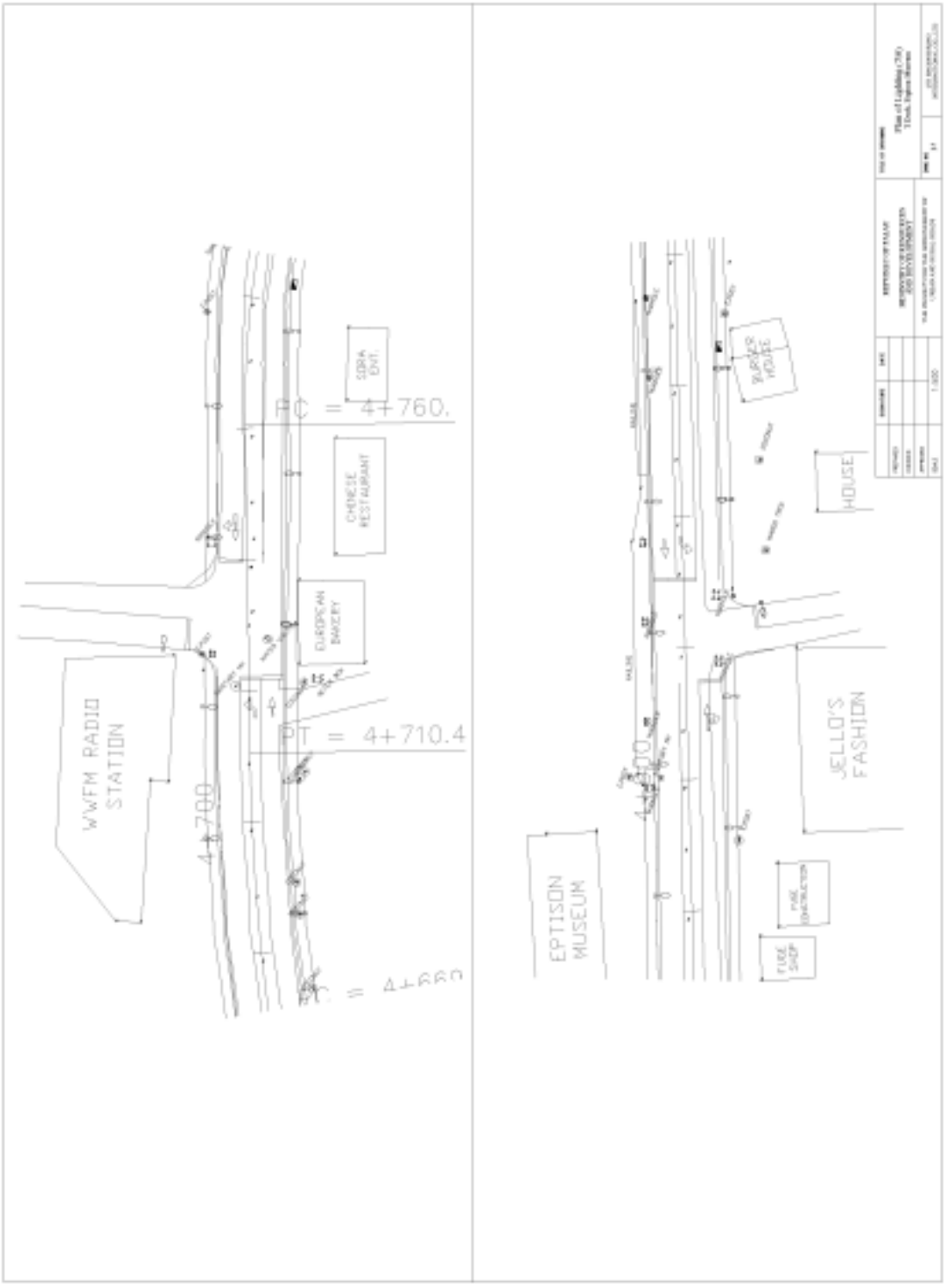


I-5 Plan of Lighting, (3/6) Shell

I-6 Plan of Lighting, (4/6) Hanpa, Mokko

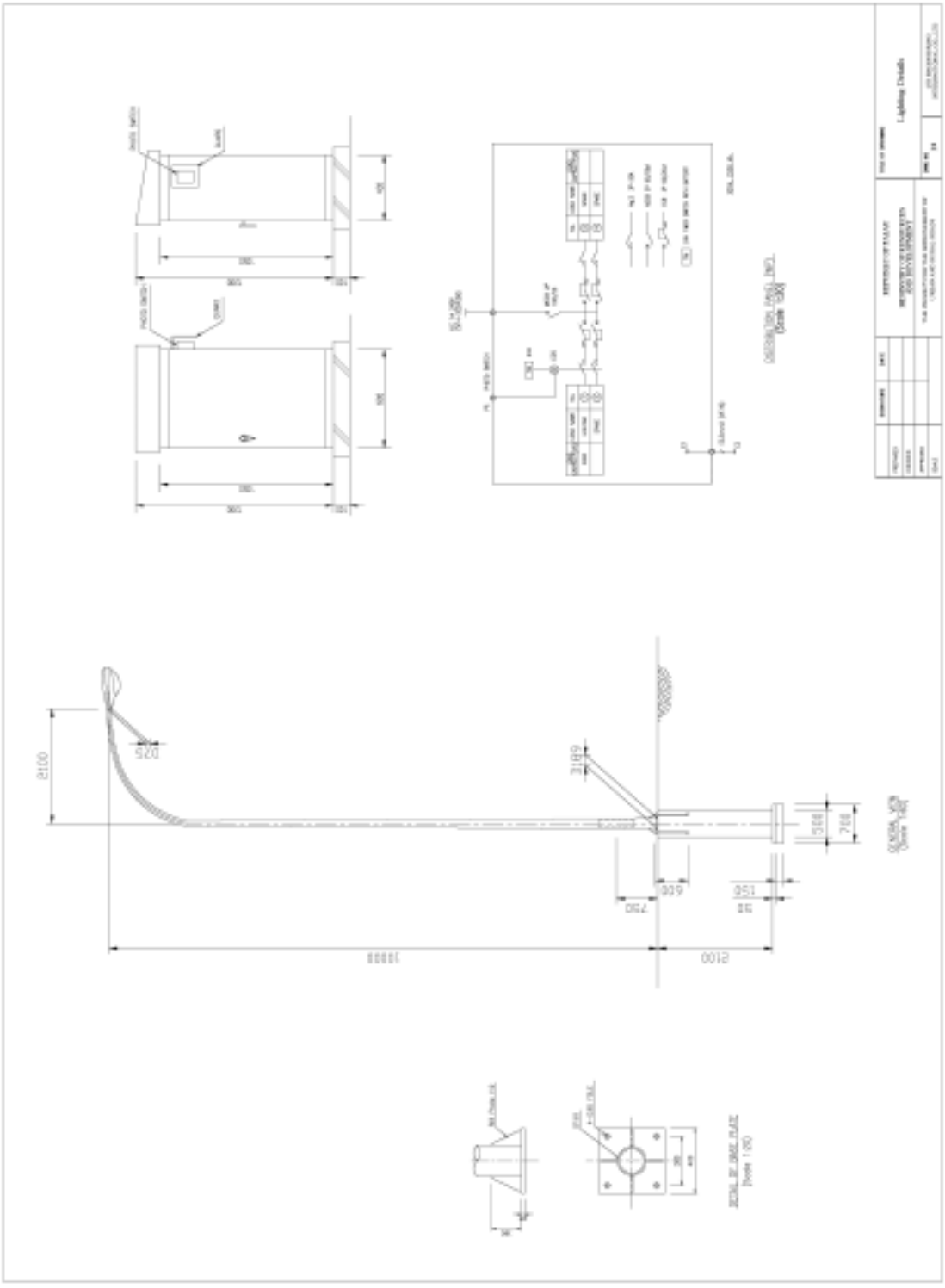


I-7 Plan of Lighting, (5/6) T-Dock, Etpison Museum

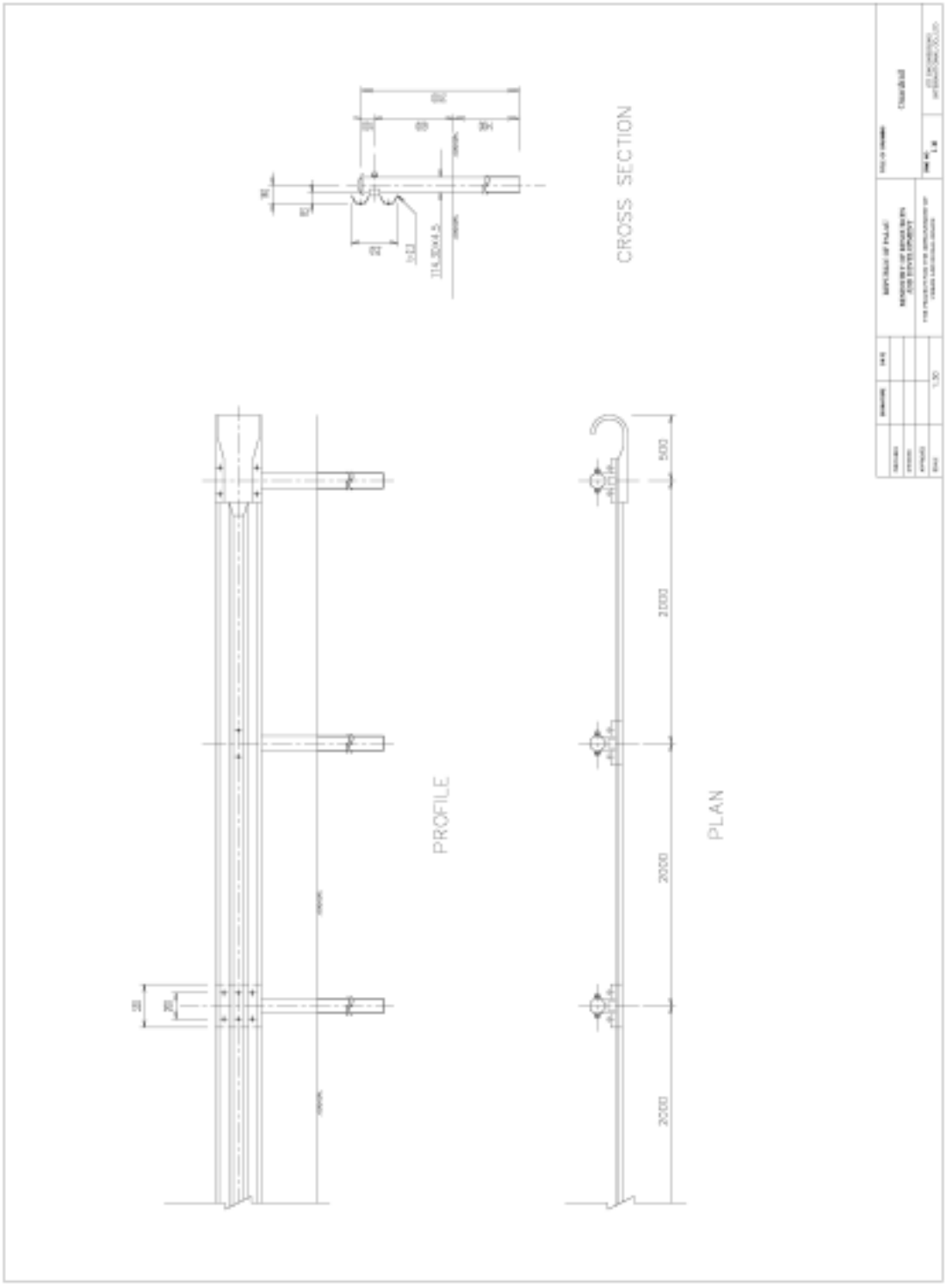


I-8 Plan of Lighting, (6/6) Island Mart, Mobil Top-side

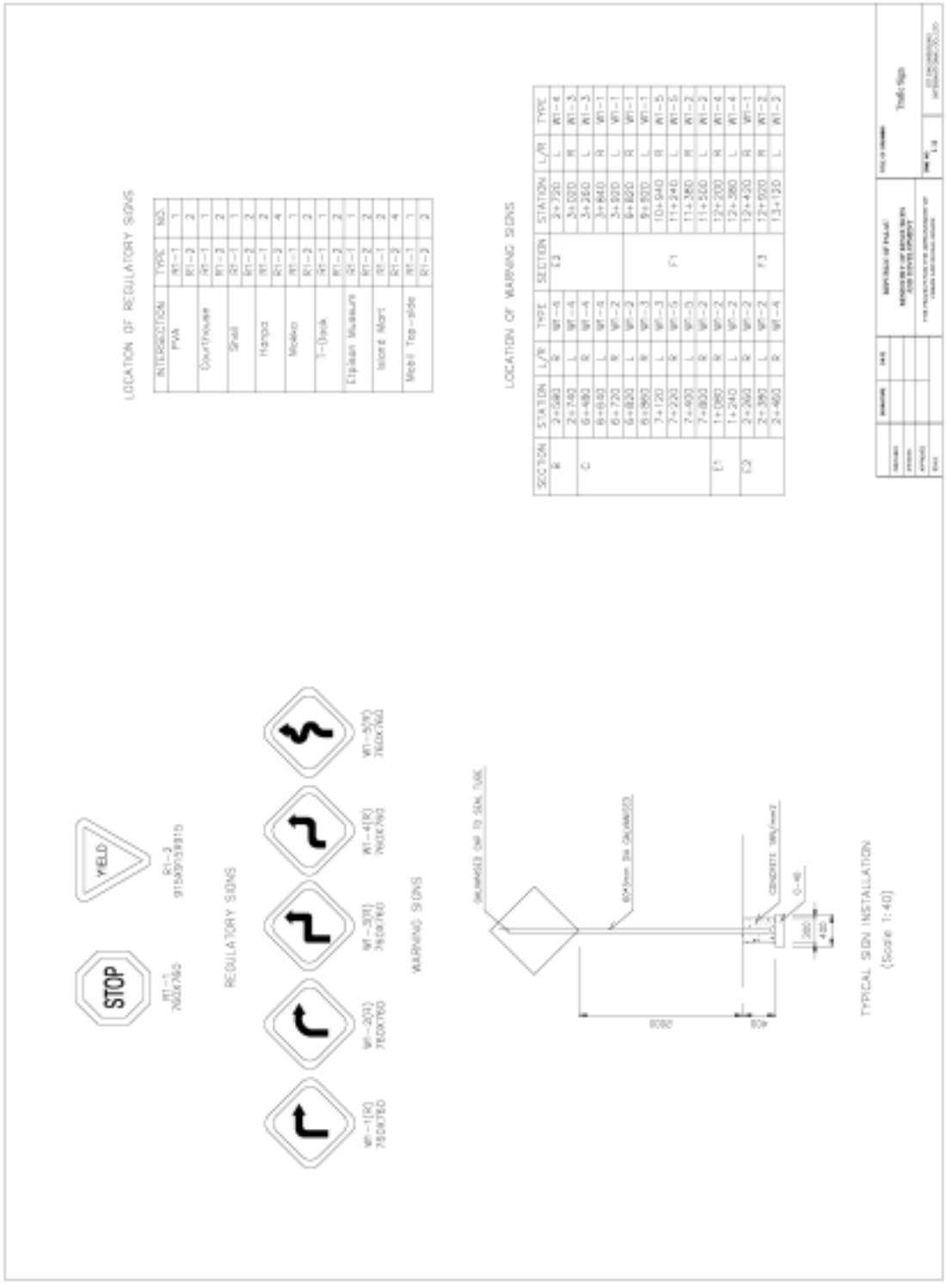
I-9 Lighting Details



I-10 Guardrail



I-11 Traffic Sign



Appendix 6 Design Data

6-1 Explanatory Note on Concrete Pavement Damage on Airport Access Road

May 29, 2006

Important Notes:

The opinions expressed in this note are solely those of the author and do not represent the official policies, opinions, or statements of JICA.

1. Introduction

The Government of Palau requested to the Government of Japan to implement the improvement of urban and rural roads in Koror and Airai States in August 2004. The request consists of the rehabilitation and improvement of metropolitan trunk roads, including pavement damages at four locations where a land slide took place in the past. In response to the request for Japan's Grant Aid Scheme, the Japan International Cooperation Agency (JICA) dispatched the study team to conduct site investigation and survey. The study team worked in Palau from 18 January 2006 to 16 February 2006 to collect information and data as well as to conduct site survey regarding pavement damages at four locations. These information and data were analyzed in Japan and the basic design was made to propose practical measures how to rehabilitate the function of the project roads. However, the damaged concrete pavement of Airport Access Road in which the concrete pavement (L=314 m) was constructed in 1997 in financial assistance by the Government of the Republic of China (Taiwan) seems to be due to shortfall of bearing capacity because the concrete parapet along the pavement is kept as it was and no phenomenon of land slide is observed in the slope and its surroundings.

The objective of this note is to summarize the results of survey and analysis and to reveal the cause of damages in the concrete pavement for the selection of optimum repair work.

2. Historical Background and Present Condition

The Airport Access Road was constructed on the lean ridge of f heavily weathered rocks, such as tuff and tuffaceous sandstone where there were landslides occurred a few times in the past.

Optical fiber cable was buried along the shoulder of the access in 1997, at which time trench was dug up to 1m deep from ground surface and kept open for 3 months. All runoff water flown into the open trench and softened the ground. In addition to this, the backfill of the trench was never properly compacted. Subsurface drain system was also not accomplished.

The 2001 landslide was caused directly due to a heavy rain (about 180mm per day) in July and indirectly due to the characteristics of the landslide-prone geology and improper underground utility

installation work. Under these conditions, using Taiwanese fund, exploratory boring and laboratory soil tests were carried out, retaining wall was constructed and concrete pavement was done. However in 2002, the concrete pavement suffered cracks along the same portion, probable due to poor compaction of road embankment, triggered by the heavy rain again.

The summary of historical background is presented in Appendix-1.

3. Cause of Pavement Damage

It is reported that the embankment (roadbed) was dug in order to bury the optical fiber cable. The dug portion had been left for a few months in order to bury the cable and it had let plenty of storm water penetrate into the embankment. It may weaken base course and roadbed unless any countermeasure might be taken before being covered by the concrete pavement. According to the observation of recent damage of concrete pavement happened in 2002, it can point out "depressions" due to shortfall of bearing capacity because the concrete parapet along the pavement is kept as it was and no phenomenon of land slide is observed in the slope and its surroundings.

Since blocking with a barricade presently does not result in traffic bottleneck because of 9.2 m wide carriageway and limited traffic volume, it envisages the necessity of further damage prevention in spite of a slim chance of justifying urgent repair.

4. Proposed Measures

The damaged concrete pavement caused by settlement is 35m long, and the cause of settlement is "depressions" due to shortfall of bearing capacity because the concrete parapet along the pavement is kept as it was, and no phenomenon of land slide is observed in the slope and its surroundings.

The design concept for depression repair is the practical measures that comprise demolition of damaged concrete pavement, excavation of base course and sub-grade 1.5 m deep, refill by selected material, compaction and construction of concrete pavement as shown in Appendix-2.

5. Conclusions and Recommendation

It is of opinion that the contractor should be responsible for the repair on condition that the loose base course and roadbed cause the defect of pavement. I could not get rid of my skepticism of poor construction method on this matter.

Accordingly, it is recommended coping with this matter that it shall be implemented by the Palauan side as the study team proposes the practical countermeasure. It also has advantage of making it clear the demarcation of responsibility between the Palauan side and the Japanese side against further damage on concrete pavement.

Table 1　Repair Work for Concrete Pavement Damage on Airport Access Road

Work Item		Quantity	Remarks
Slope Protection			
	Sodding	87.5 ㎡	
	Blanket Soil	13.125 m3	
Roadbed			
	Excavation	383.6875 m3	
	Fill		
	Waste	383.6875 m3	
	Imported Material（ϕ=30）	294.805 m3	
	Roadbed Soil	156 m3	
	Geotextile	735 ㎡	
	Geotextile Placing	490 ㎡	100cm、2 layers
Drainage			
	Filter	102.9 m3	
	PVC Pipe	280 m	
Pavement			
	Asphalt Concrete Surface	204.75 ㎡	Thickness t=10cm
	Base Course	66.675 m3	

6-2 Explanatory Note on Control of Overloaded Vehicles

August 27, 2006

Important Notes:

The opinions expressed in this note are solely those of the author and do not represent the official policies, opinions, or statements of JICA.

1. Introduction

In the course of discussions with the first Basic Design Explanation Team from May 28 to June 2, 2006, the Government of Palau and the Japanese side confirmed that it is necessary to control over-loaded vehicles in order to make road maintenance rational, and accordingly both sides reconfirmed that the Palauan side should establish suitable measures for traffic safety and control especially over loading traffic, which are essential for appropriate operation and maintenance of the roads improved by the Project. In this context, The Government of Palau requested to the study team to introduce rules and regulation of the control of over-loaded vehicles enforced in Japan.

The objective of this note is to introduce the institutions and actual practices in Japan.

2. Institutions and Actual Practices in Japan

As for control of overloaded vehicles, three major laws are involved, namely the Road Transport Vehicles Law, the Road Law and the Road Traffic Law.

The Road Transport Vehicles Law established in 1951 stipulates the registration of car ownership, safety measures of vehicles, conservation of environment and securing of vehicular soundness regarding automobiles, motorcycles and non-auto vehicles. The Safety Standard of Road Transport Vehicles is the provisions of the Road Transport Vehicles Law to stipulate the regulations regarding technical requirements of vehicles such as structures, devices, capacity of passengers and maximum weight limits.

The Road Law established in 1952 stipulates that the road network and its classification are prescribed to determine the beginning and ending of each route, its maintenance and operation, the sources of fund. The Vehicle Restriction Ordinance is the provisions of the Road Law to stipulate the maximum values of width, weight, height, length and minimum curvature.

The Road Traffic Law established in 1960 stipulates that the rules and regulations of road traffic including penal regulations are prescribed to prevent traffic accidents and enhance traffic safety.

As for control of overloaded vehicles, the following limitations are imposed:

	Max. Weight (ton)	Remarks
Total Weight	20	For ordinary cars
	24 (max. axle interval of 8m to 9m)	For trailer trucks
	25.5 (max. axle interval of 9m to 10m)	
	27 (max. axle interval more than 10m)	
Single Axle	10	
Wheel	5	

The following penal regulations are enforced:

Violations	Penalty
Ordinary Loading Limitations	Less than ¥300,000
Bridge Loading Limitations	Less than 6-month servitude or Less than ¥100,000

The following measures are taken:

Step	Violator	Controller	Legal Organization (LO)
1	Move to weighbridge		
2		Announce LO to start the enforcement	
3			Accept the process
4		Identify the vehicle and driver	
5		Measure the weight by the devices	
6		Examine the certificate of automobile inspection	
7		Notice the content of penalty	
8		Confirm LO to issue the order	
9			Issue No. of the order
10		Prepare a traffic ticket	
11		Hand a traffic ticket to the violator	
12	Accept a traffic ticket		
13		Announce LO to end the enforcement	

Note: The actual practice is carried out that the excess portion may be unloaded and transferred to other vehicles to enable to continue travel after the issuance of traffic ticket.

6-3 Explanatory Note on Cause of Defects on Asphalt Pavement in Palau

August 27, 2006

Important Notes:

The opinions expressed in this note are solely those of the author and do not represent the official policies, opinions, or statements of JICA.

1. Present Conditions

Almost all kinds of defects are found in the project roads. Over two decades have passed since the project roads of Section A, B and C have been constructed, and some rehabilitation works overlaid by a slurry seal were carried out in some sections (Section A and a part of Section E) several years ago. Site photos regarding defects are presented in the Annex.

Pavement defects are classified as follows:

- Form of Alligator Cracks in a part of Section E
- Forms of Alligator Cracks, Grooving/Rutting and Raveling in Section A and a part of Sections B, C, D and F
- Forms of Alligator Cracks and Raveling in a part of Section E
- Form of Raveling in a part of Sections C, E and F
- Classification of Cracks and Form of Raveling in a part of Section E

No heavy industry exists in Palau and accordingly heavy vehicles are limited to be construction equipment such as trailer, concrete mixing truck and tank lorry, sand and aggregate hauling vehicles and commercial trucks and buses.

Average annual rainfall rises up to 4,000 mm and rainfall intensity is so high that the deterioration of pavement is in progress. For example, the deterioration of pavement at International Airport demonstrates its level of intensity because the level of deterioration is obviously distinguished at the area with roof from without roof. The deterioration caused by traffic is also found on apron at International Airport compared with its parking lots.

Site investigations were carried out at the asphalt pavement (Year 2001 construction) at Top-side in Section C nearby Ex-US Embassy, at the asphalt pavement (Year 2002 construction) done by Taiwan in front of Etpison Museum, at the asphalt pavement (Year 2003 construction) done by Japan at International Airport and at the asphalt pavement (Year 2005 construction) done by Japan at Airai Causeway. As the result of site investigation, Progressive Raveling exists at Top-side. Minor loss of cover aggregate is found in front of Etpison Museum, while progressive Raveling is found partially at International Airport. It is pointed out the facts at Airai Causeway that minor loss of cover aggregate is found on

carriageway due to asphalt abrasion while loose aggregates from aggregate hauling vehicles may cause small holes found in shoulder. Similar phenomenon seems to happen on Meyungs Causeway in addition to local rutting and scratching surface by sudden wheel traction.

2 Causes of Pavement Defects

Table 1 summarizes the classification of defects, its cause and method of repair.

Table 1 Damage Classification, Main Cause and Repair Methods of Pavement

Damage Classification			Main Cause	Repair Method
Damage concerning road properties chiefly	Partial Crack	Hair-crack	Defective quality of mixture、Crack because of unsuitable of compaction temperature	Seal of crack, fog seal, and seal coat. After V is cut, a wide crack is filled with the asphalt mortar. (Construction joint, etc.) For the crack of the base-course etc. (Reflection crack) apply cutting-reconstruction (local) or in-place surface recycling method
		Line-crack	Defective construction、Deferential settlement of boundary between embankment and cut, Crack of base course and binder course	
		Longitudinal		
		Transverse	Non uniformity of bearing capacity of subgrade and base course	
		Construction joint Crack	Defective of spreading and compaction	
	Difference	Ruggedness in the vicinity of structure	Shortage of compacrion to subgrade, base course and mixture、Unevenness by differential settlement	Patting、Local reconstruction
	Transformation	Rutting	Excessive large-sized car traffic, Defective quality of mixture	Cutting of raised portion、and carpet coat , overlay or local reconstruction, wholly reconstruction, In-place surface recycling method
		Ruggedness of longitudinal direction, corrugation, hollow	Defective quality of mixture、Non uniformity of bearing capacity of subgrade and base course、Construction defective of prime and	Armor coat, Carpet coat, Patting, Local reconstruction, Cutting of raised portion
		Flush	Construction defective of prime and tack coat, Defective quality of mixture（Especially, defective quality of asphalt）	Spray of crashed stone or rough sand
	Wear-out	Raveling	Use of tire chain and spiked tire after snow is cleared (cold district)、Defective quality of mixture	Armor court, Carpet court, Patting, Overlay, In-place surface recycling method
		Polishing	Problem of aggregate quality、Defective of mixture quality	Seal coat, Armor coat, Carpet coat
		Peeling	Defective quality of mixture、Lack of compaction	Patting, Local reconstruction
	Collapse	Pot-hole	Defective quality of mixture、Lack of compaction	Patting, Local reconstruction
		Stripping、Senility	Appetence shortage of aggregate and asphalt、Moisture that infiltrates mixture, Deterioration in bitumen material of mixture	Seal coat, armor coat, fog coat, carpet coat, slurry seal, and overlay
	Others	Imprint of a tire, scar	Abnormal temperature、Defective quality of mixture	
		Swelling of surface	Defective quality of mixture、Air expansion of surface layer	
Damage concerning structure chiefly	Crack of whole area	Alligator crack	Defective of pavement thickness、Unsuitable of mixture, base and subgrade、Traffic volume more than plan、Grand water	Armor coat、Carpet coat、Overlay、Cutting & reconstruction, Local reconstruction, wholly reconstruction
	Others	Boiling	Defective of pavement thickness、Grand water	wholly reconstruction

The causes of crack may enumerate in general as follows;

- Insufficient bearing capacity of subgrade
- Inappropriate pavement structure thickness
- Improper asphalt pavement mixtures or inferior aggregates
- Poor pavement design or expiration of design life
- Poor surface and/or underground drainage

Since Alligator Cracks and Raveling are found commonly in the project roads, the cause of these two defects is investigated first.

It is pointed out that the deterioration brought by expiration of design life is the primary cause of defect, although physical tests such as asphalt content, grade, penetration index and so forth are not revealed.

Poor pavement design and/or poor construction methods are usually found to cause pavement defects in case that some defects happen within the design life. Heavy traffic beyond demand forecast may incur shortfall of pavement thickness and it falls under the category “poor pavement design”. Overloaded vehicles may bring about this kind of defect.

The category “poor construction methods” comprises adoption of inferior aggregates, improper mix design and insufficient compaction due to low temperature of asphalt mixtures.

Since the pavement design is made generally considering 10-year cumulative axle load applications, overlay by a slurry seal was deemed suitable when rehabilitated several years ago. However, major construction works such as International Airport, KB Bridge and Compact Road forced to increase the number of heavy vehicles and accordingly the project roads are suffered damages and it causes finally the deterioration of pavement such as cracks, rutting and raveling. It can be seen from the fact that many cracks exist in the section overlaid by a slurry seal and raveling is found in the section other than overlaid.

The cause of rutting in Section A is not insufficient bearing capacity of subgrade/inappropriate pavement structure thickness but deterioration by storm-water penetration through cracks and/or overloaded vehicles. Sections with widespread cracks on the pavement seem to have the cause “expiration of design life”.

Existing pavement layer thickness was surveyed at three test pits, and the results of survey are shown in Site Photograph No.7. 5 cm thick surface course, 15cm – 30 cm base course (CBR: 100), 25cm – 30cm subbase course (CBR: over 20) were surveyed. CBR of subgrade was measured approximately 8 because of granular sand and gravel. Under such conditions, existing pavement structure seems to have enough strength as expressed by

Ta=15.3 – 20.5. It is insufficient against Class B Traffic specified by Manual for Asphalt Pavement (Japan Road Association), while it is sufficient against Class A Traffic when the road was overlaid by a slurry seal several years ago.

According to traffic survey conducted in January 2006, daily heavy vehicles in a range of 620 – 670 observed at Shell Intersection, while 360 vehicles at Mobil top-side Intersection. These traffic falls under Class B Traffic and accordingly progressive cracks are found due to shortfall of pavement structure strength.

Coarse aggregates are apt to be exposed on pavement surface regardless of traffic volume where more than 10 years elapsed after construction even in Japan. However, no phenomenon happens in Japan because rehabilitation works are done in several years interval. New pavement method shown in Site Photograph No.8 is different concept of pavement, namely “storm-water penetration pavement”.

The cause of raveling in Palau seems to be inferior aggregates, improper asphalt pavement mixtures and poor construction methods.

Aggregates of which quarry is on a basis of Basalt contain mica and it may be troublesome for making aggregates dry or getting rid of water. Remaining water causes asphalt abrasion. It is reported in Japan that such mica-rich aggregate requires two-time heating before mixing.

Site Photograph No.3 shows such raveling phenomenon that loss of surface material is in progress due to by abrasion.

Raveling takes place in Palau where more than 5 years elapsed after construction. It is pointed out the facts that top-size of aggregates that exceeds 25 mm have gone and fine aggregate in top-2.5 mm thick is lost in surface course. It is necessary to reduce top-size of coarse aggregate in case of 50 mm surface thickness (it should be less than 13 mm in case of 50 mm thick.) and to wash fine aggregates by fresh water in case of using coral sand.

Physical properties of coarse aggregate are summarized in Table 2. Basalt-base aggregate can meet technical specification for surface course. However, it should be evaluated whether these aggregates have enough quality or not, making full use of the results of asphalt abrasion test and soaked Marshall test.

Table 2 Outline of Comparison of Major Properties for Coarse Aggregate

Quarry Site	Polycarp	Ngaremlengui	PTC	HBR	Japanese Standard (Surface and binder layer)
Location	Ngechesar (Babeldaob)	Ngaremlengui (Babeldaob)	Malakal	Koror	
Rock Type	Basalt	Basalt	Basalt	Limestone	
Bulk specific gravity, Dry	2.45～2.73	2.31～2.48	2.56～2.61	2.42	
Absorption (%)	1.6～4.8	3.1～6.4	2.2～2.3	2.8	
Abrasion (%)	11～30	20～28	23～31	35	<30
Soundness by sodium sulfate method (%)	10～27	47*	0.3～9.8	1.2	<12

* Magnesium sulfate method, which obtains higher results compared to sodium sulfate method (ASTM c-88).

Source: quarry companies or owner

3. Practical Measures

Local material should be given priority for road construction because it should be maintained continuously after opening. In this aspect, material tests and quality control during construction is crucial for utilization of local materials in Palau. It will work to keep quality by rejection whenever poor quality aggregates are found or likely mixed.

It is recommended that the following practical measures are taken as the comprehensive action in order to prevent asphalt pavement from earlier deterioration:

1) The control against overloaded vehicles is also important to maintain durability of pavement even though 10 cm thick overlay on the existing pavement has enough strong for 10 years.
2) Since available local aggregates are Basalt-base that contains mica, it is recommended that two-time heating before mixing and utilization of resin-mixed asphalt are used.
3) Top-size of coarse aggregate for surface should reduce up to one third of surface thickness and coral sand should be washed by fresh water to prevent pavement from raveling.