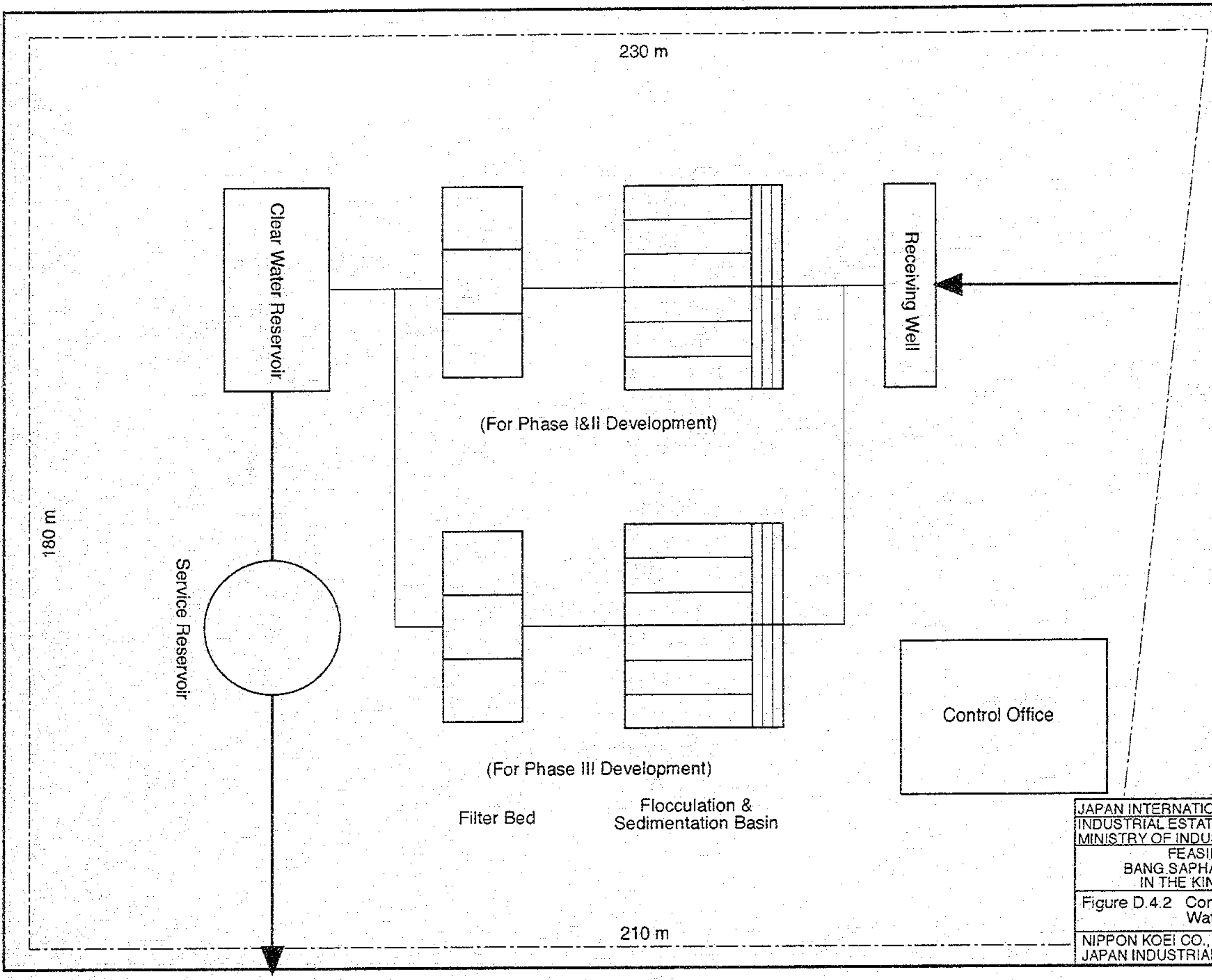

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Figure D.4.2 Conceptual Layout of Water Filtration Plant

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Pipe No.	Length (m)	Diameter (mm)
A-B	1,240	300
C-B	250	300
B-D	440	300
D-E	450	600
E-F	280	600
F-G	100	800
H-D	360	300
O-J	1,900	300
P-J	1,650	300
J-D	1,260	600
O-N	1,200	300
N-F	1,680	500
I-E	630	300
L-N	350	300
M-K	300	300

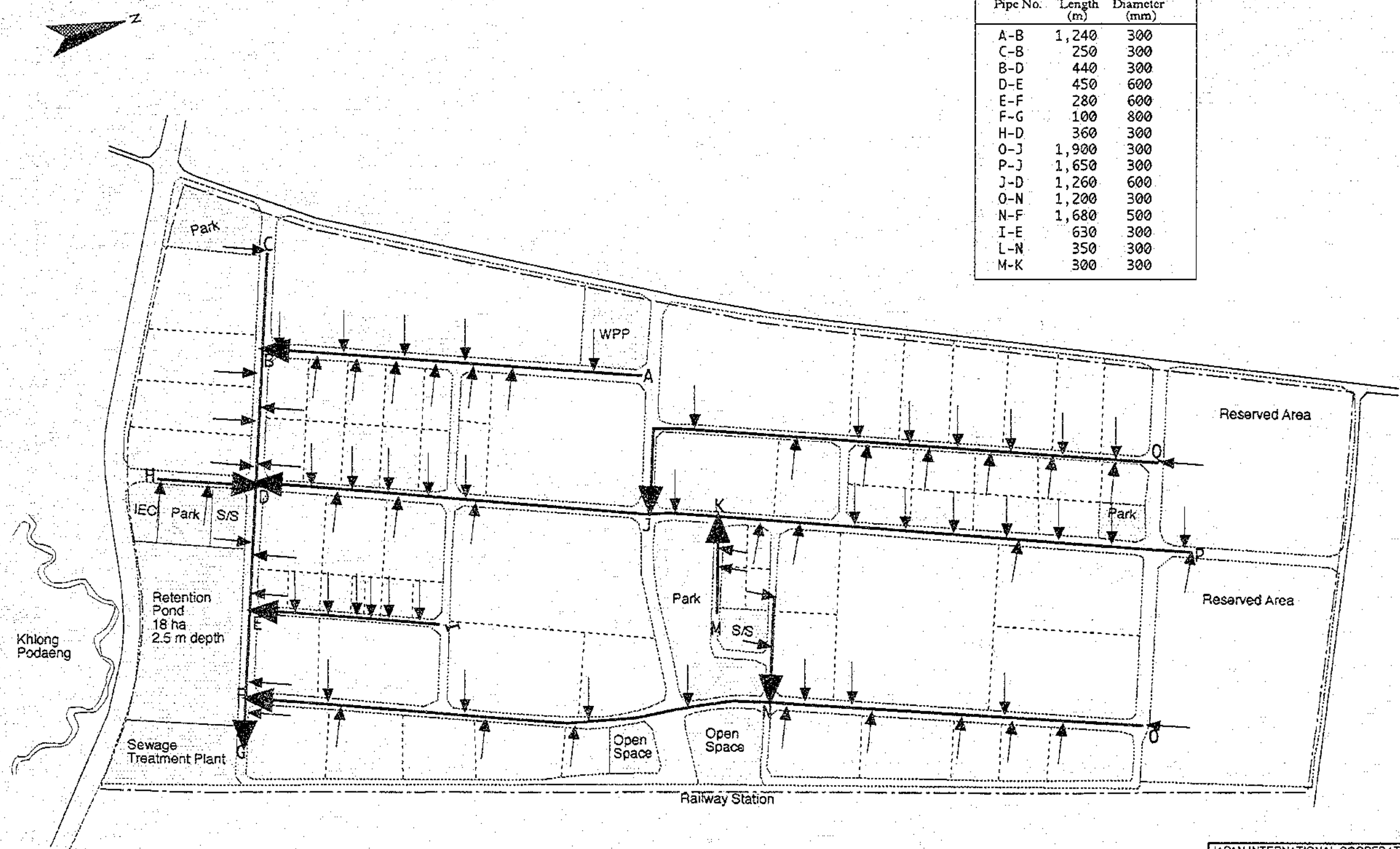

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Figure D.5.1 Sewer Collection System Plan

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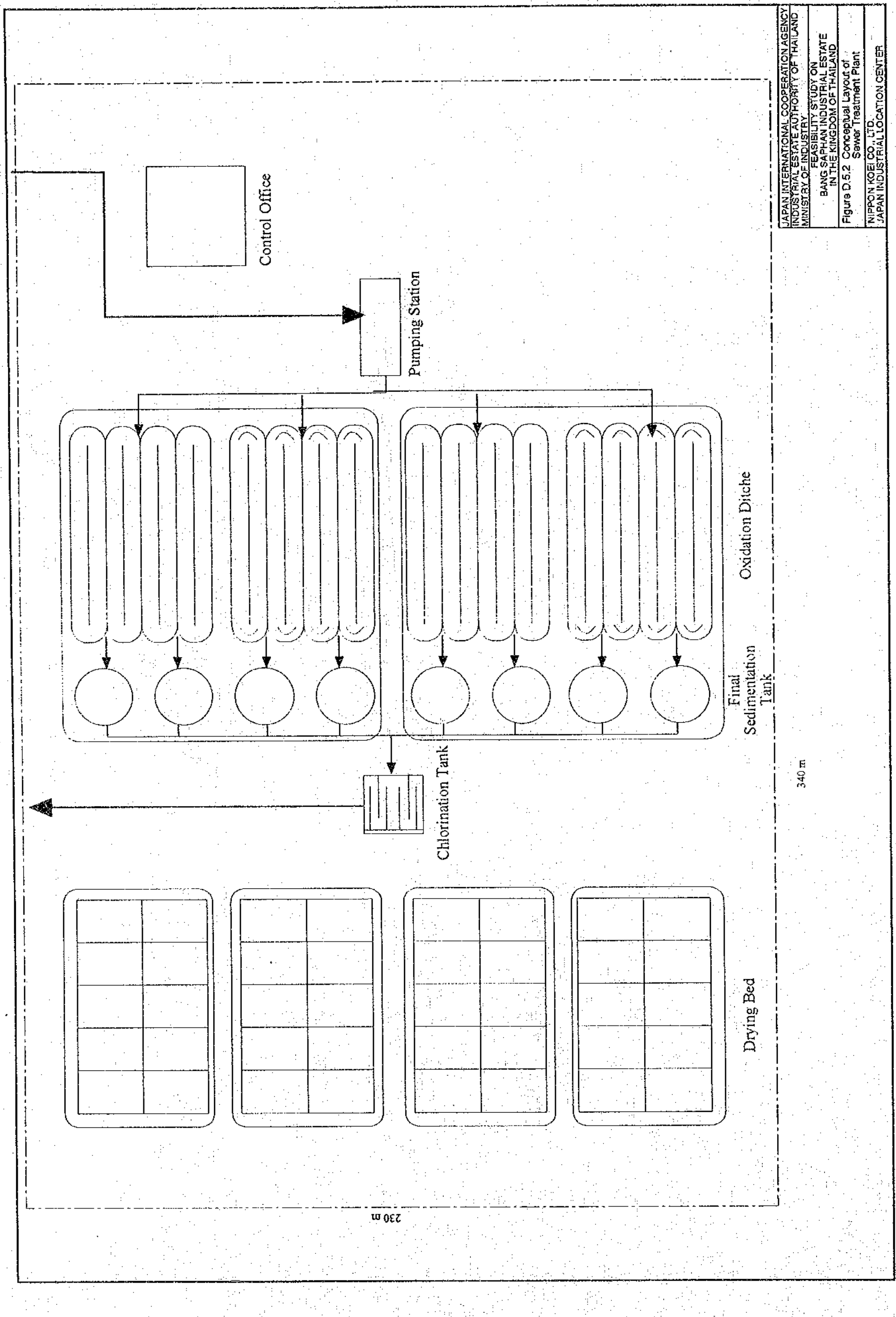
Control Office
Pumping Station
Oxidation Ditche
Final Sedimentation Tank
Chlorination Tank
Drying Bed
340 m
230 m
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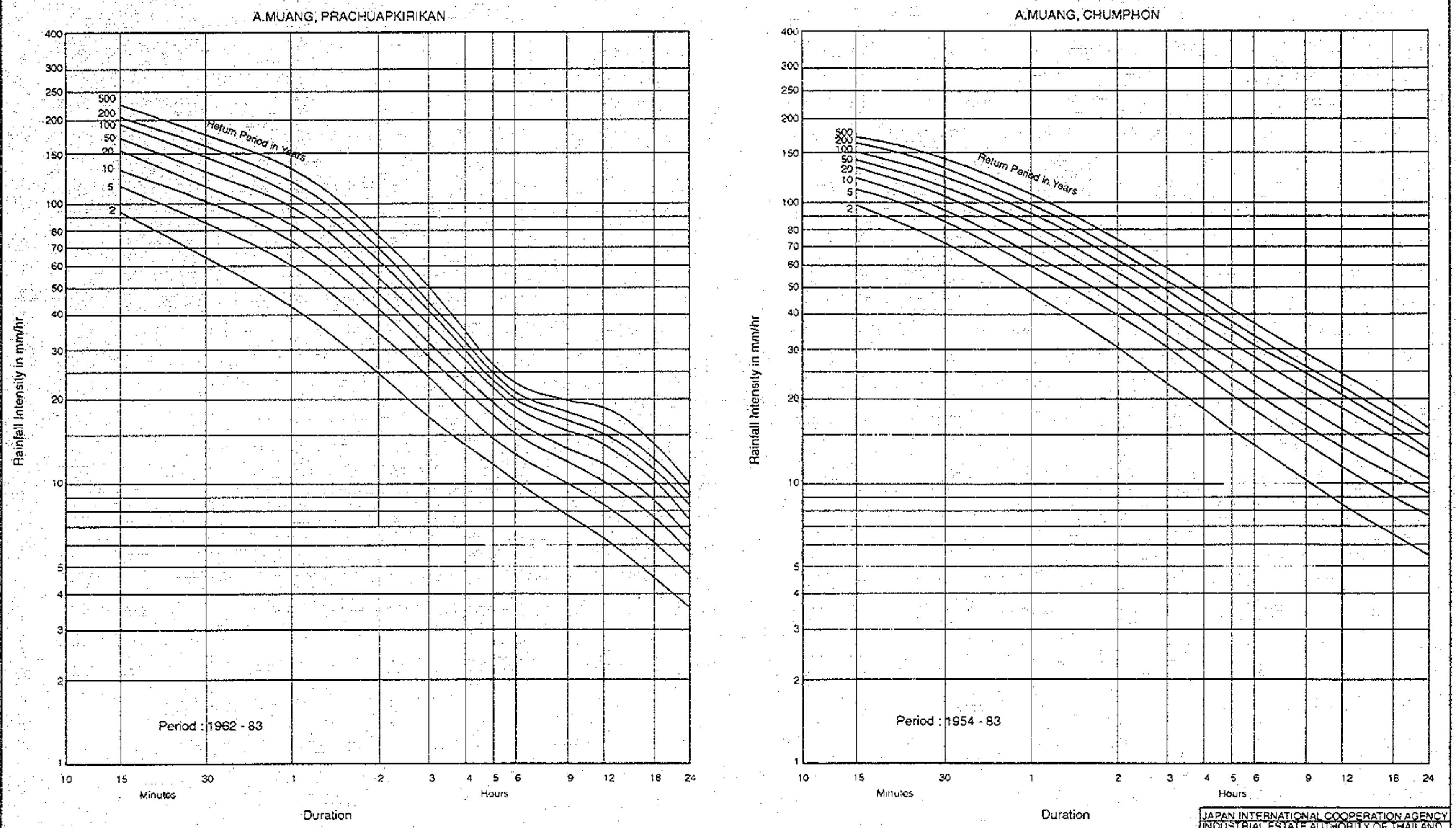
IN THE KINGDOM OF THAILAND
Figure D.5.2 Conceptual Layout of Sewer Treatment Plant
NIPPON KOEI CO., LTD.
JAPAN INDUSTRIAL LOCATION CENTER



Source : EGAT

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Figure-D.6.1 Rainfall Intensity - Duration - Frequancy Curve

NIPPON KOEI CO., LTD.
JAPAN INDUSTRIAL LOCATION CENTER

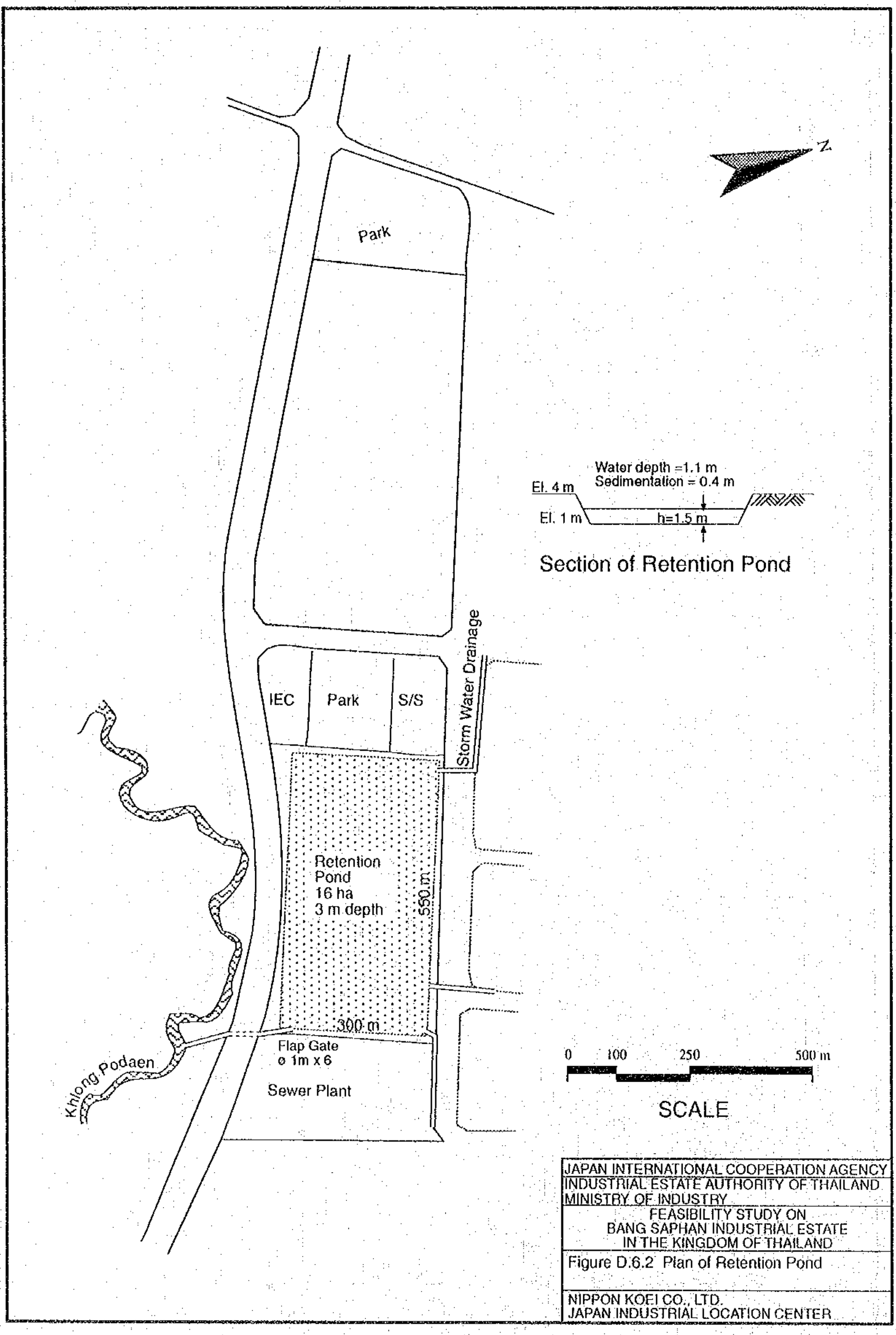
Park
Water depth =1.1 m
Sedimentation = 0.4 m
El. 4 m
El. 1 m
h=1.5 m
Section of Retention Pond
Storm Water Drainage
IEC
Park
S/S
Retention
Pond
16 ha
3 m depth
550 m
300 m
Flap Gate
ø 1m x 6
Sewer Plant
Khlong Podaen
0
100
250
500 m
SCALE
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Figure D.6.2 Plan of Retention Pond
NIPPON KOEI CO., LTD.
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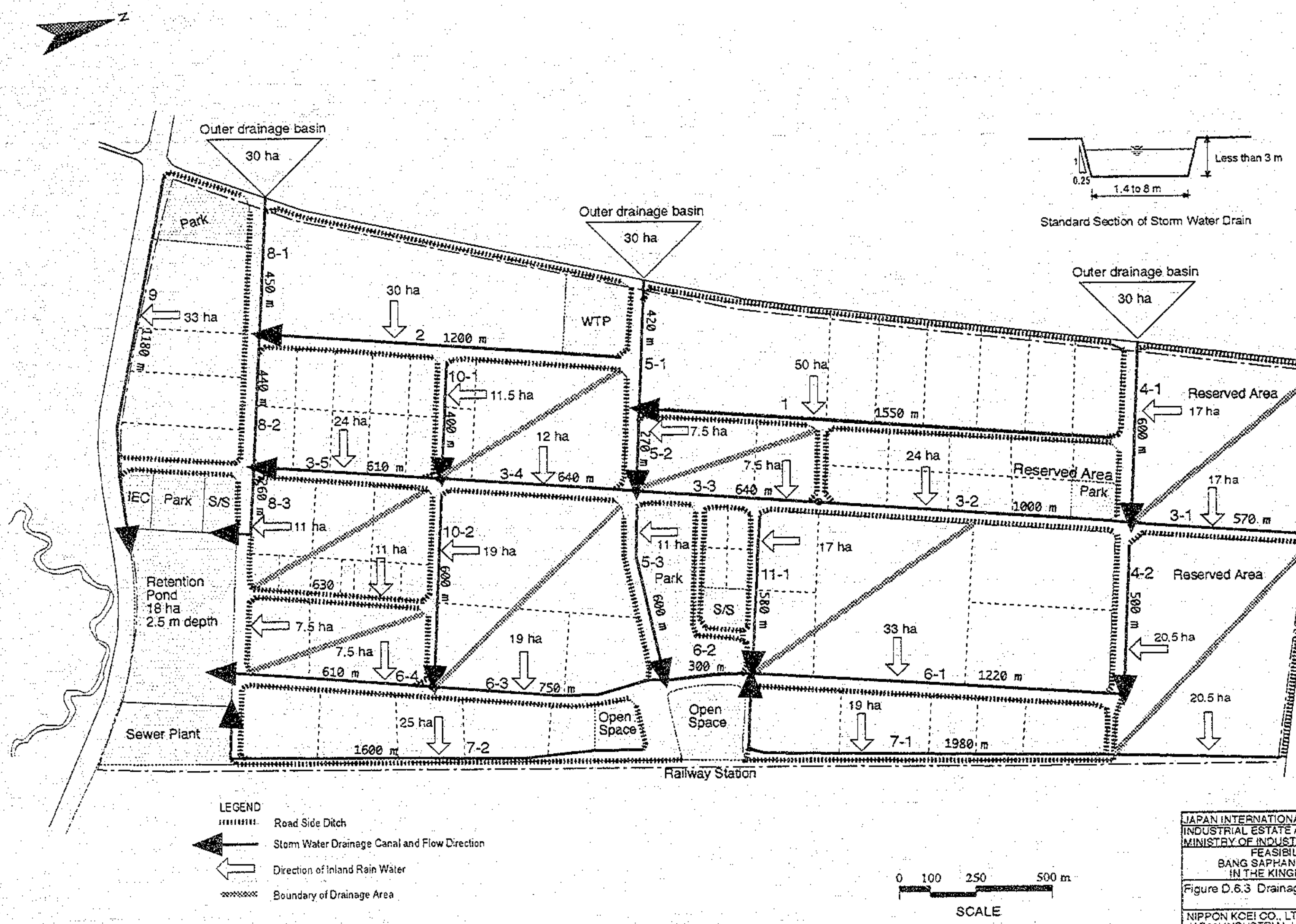

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Figure D.6.3 Drainage System Plan

NIPPON KOEI CO., LTD.
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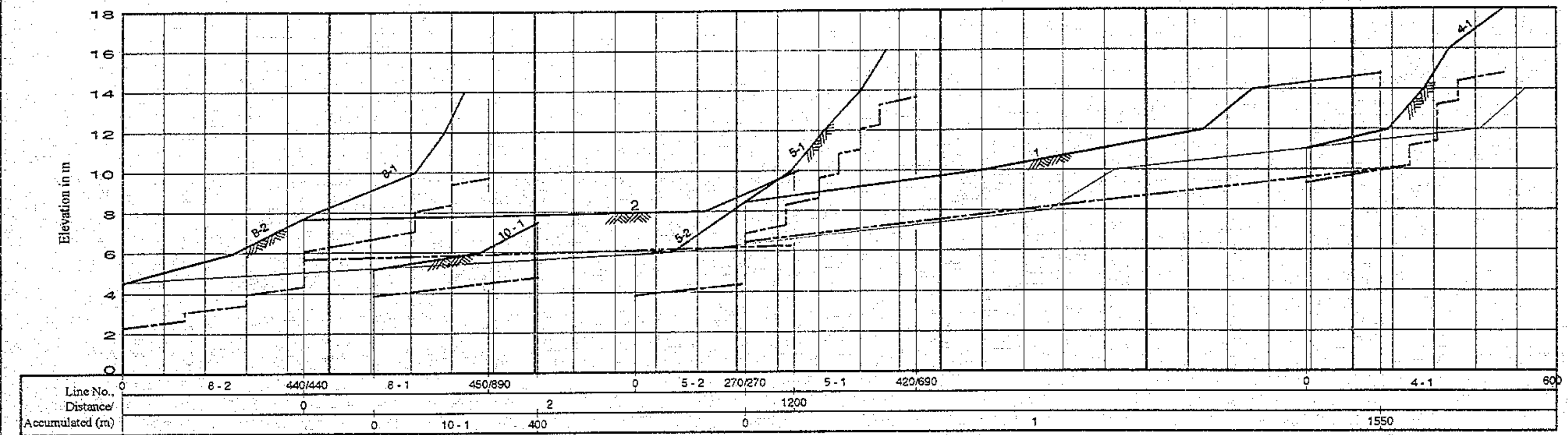
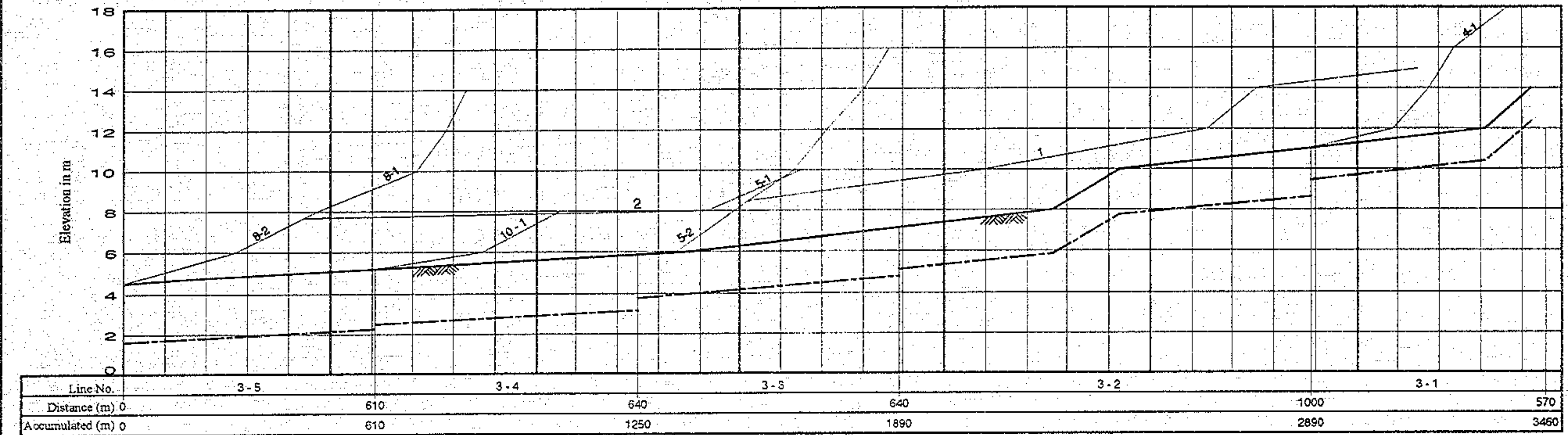


Longitudinal Profile of Branch Storm Water Drainage



Longitudinal Profile of Storm Water Drainage Line 3

LEGEND

Road Profile

Invert Level of Storm Water Drainage

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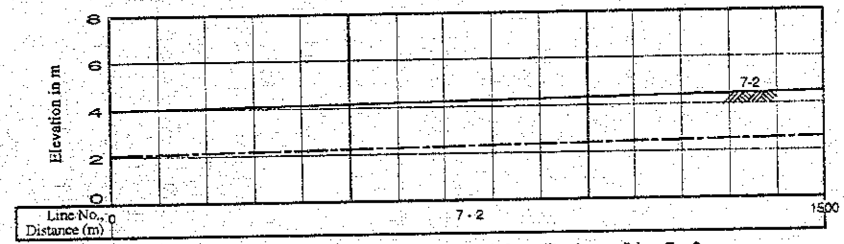
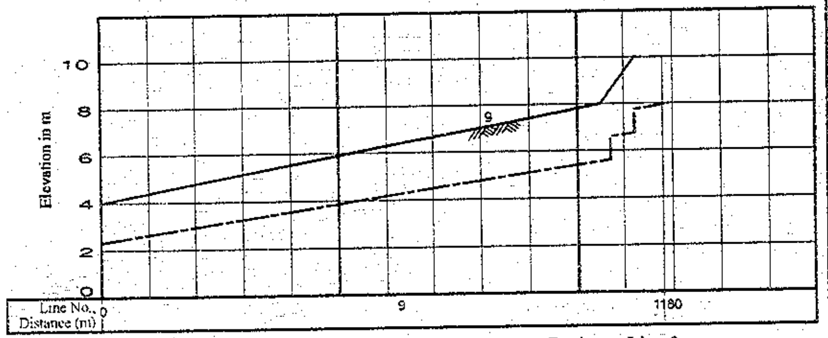
Figure D.6.4 Longitudinal Profile of Storm Water Drainage (1/2)

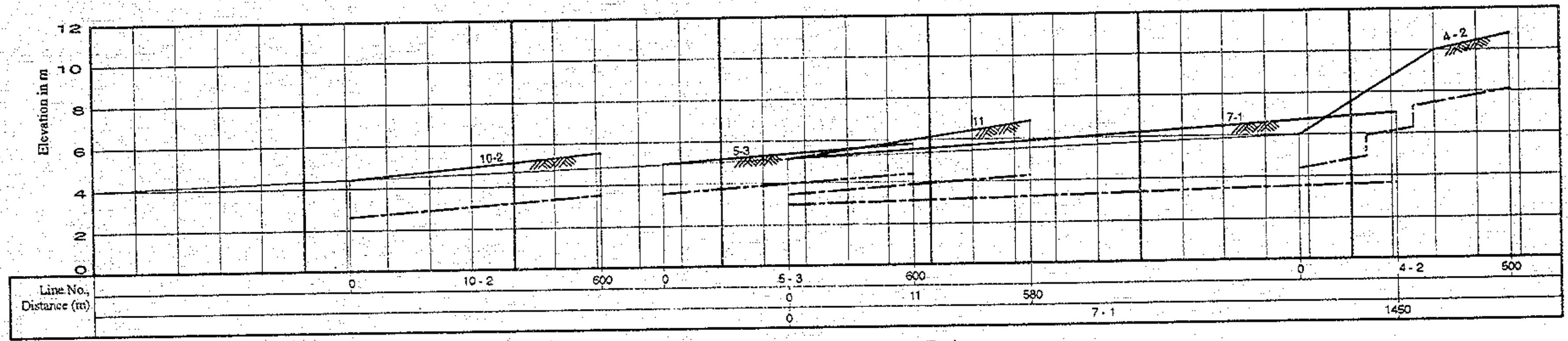
NIPPON KOEI CO., LTD.
JAPAN INDUSTRIAL LOCATION CENTER



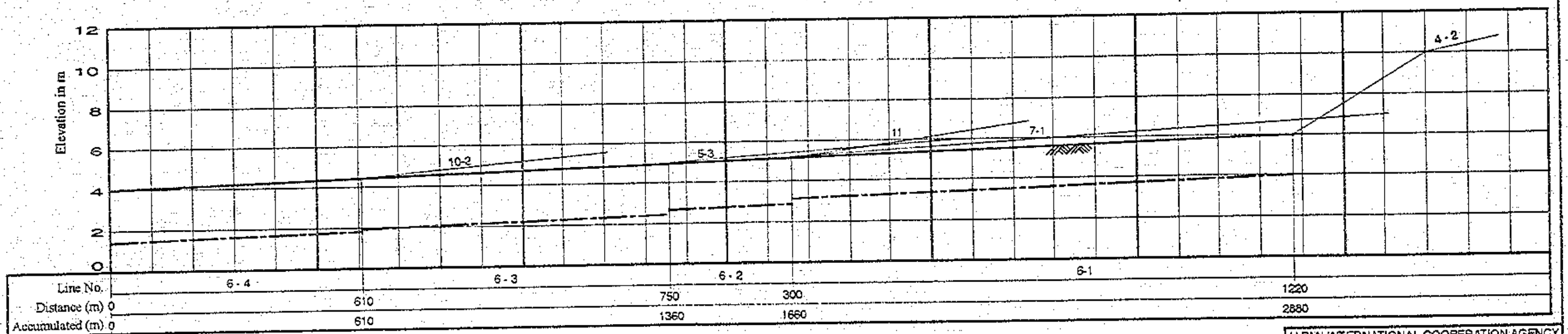
Longitudinal Profile of Storm Water Drainage Line 7 - 2



Longitudinal Profile of Storm Water Drainage Line 9



Longitudinal Profile of Branch Storm Water Drainage



Longitudinal Profile of Storm Water Drainage Line 6

LEGEND

Road Profile

Invert Level of Storm Water Drainage

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Figure D.6.5 Longitudinal Profile of Storm Water Drainage (2/2)

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JAPAN INDUSTRIAL LOCATION CENTER

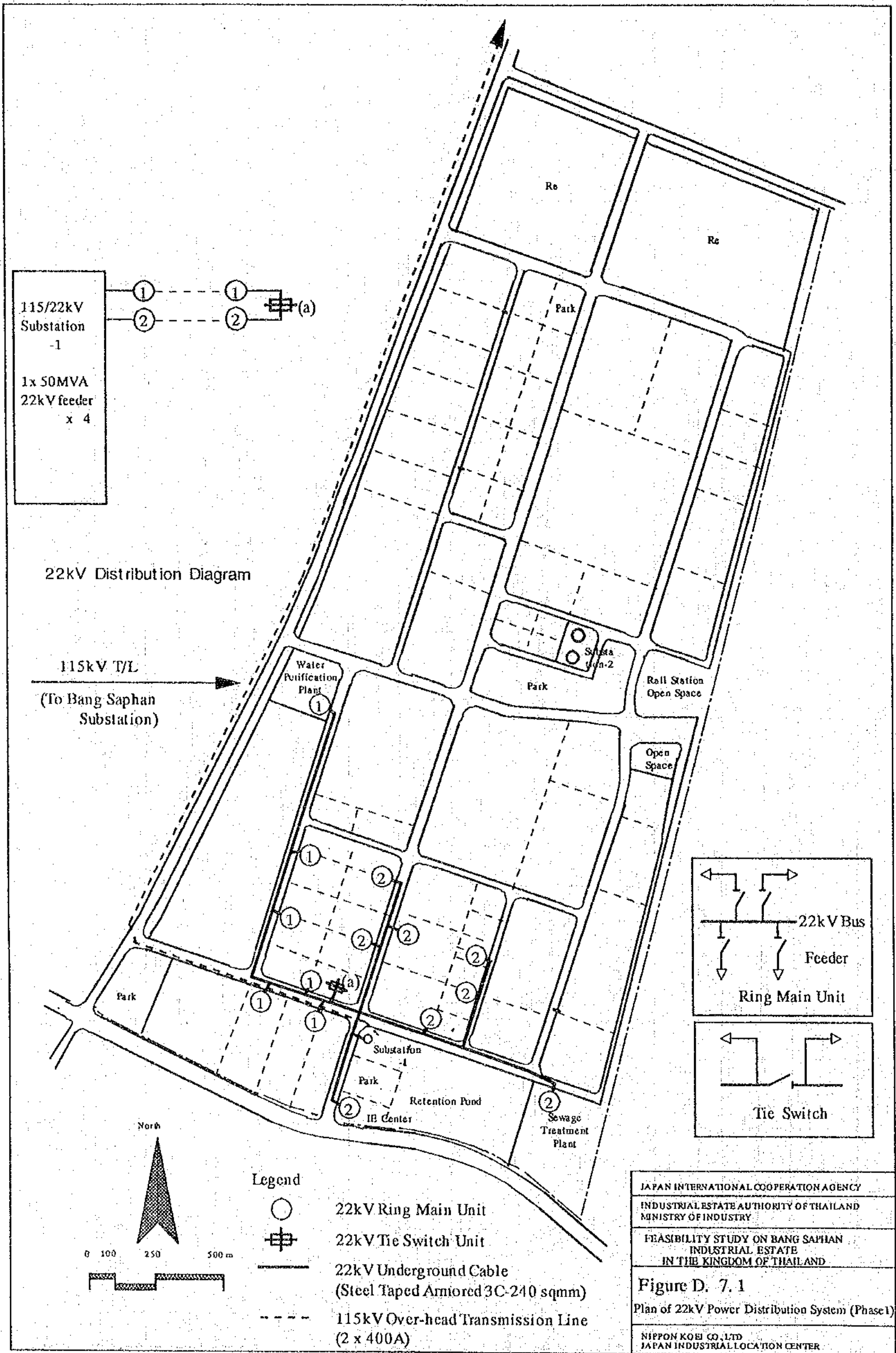

Figure D. 7. 1
Plan of 22kV Power Distribution System (Phase1)

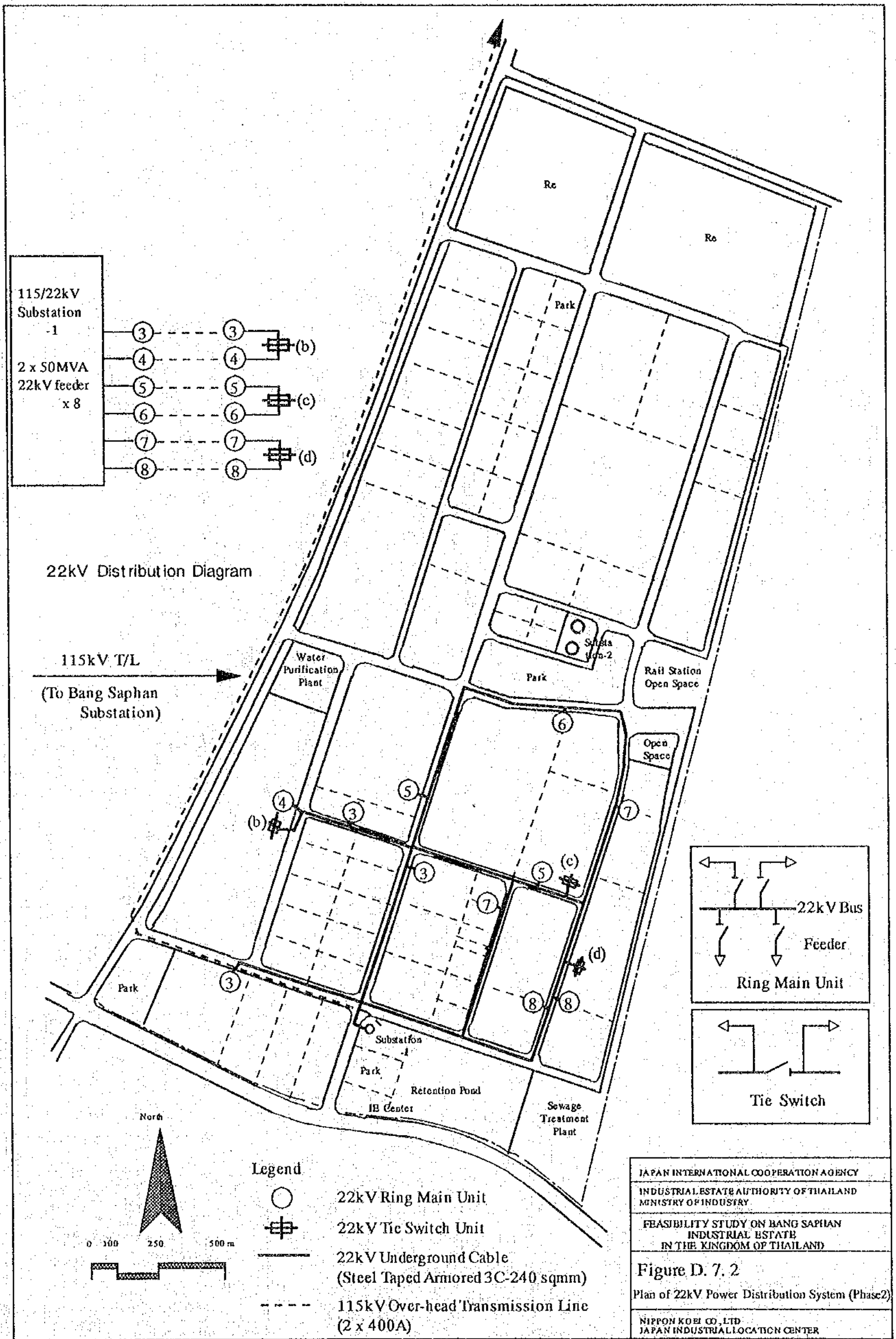

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Figure D. 7. 2

Plan of 22kV Power Distribution System (Phase2)

NIPPON KOEI CO., LTD
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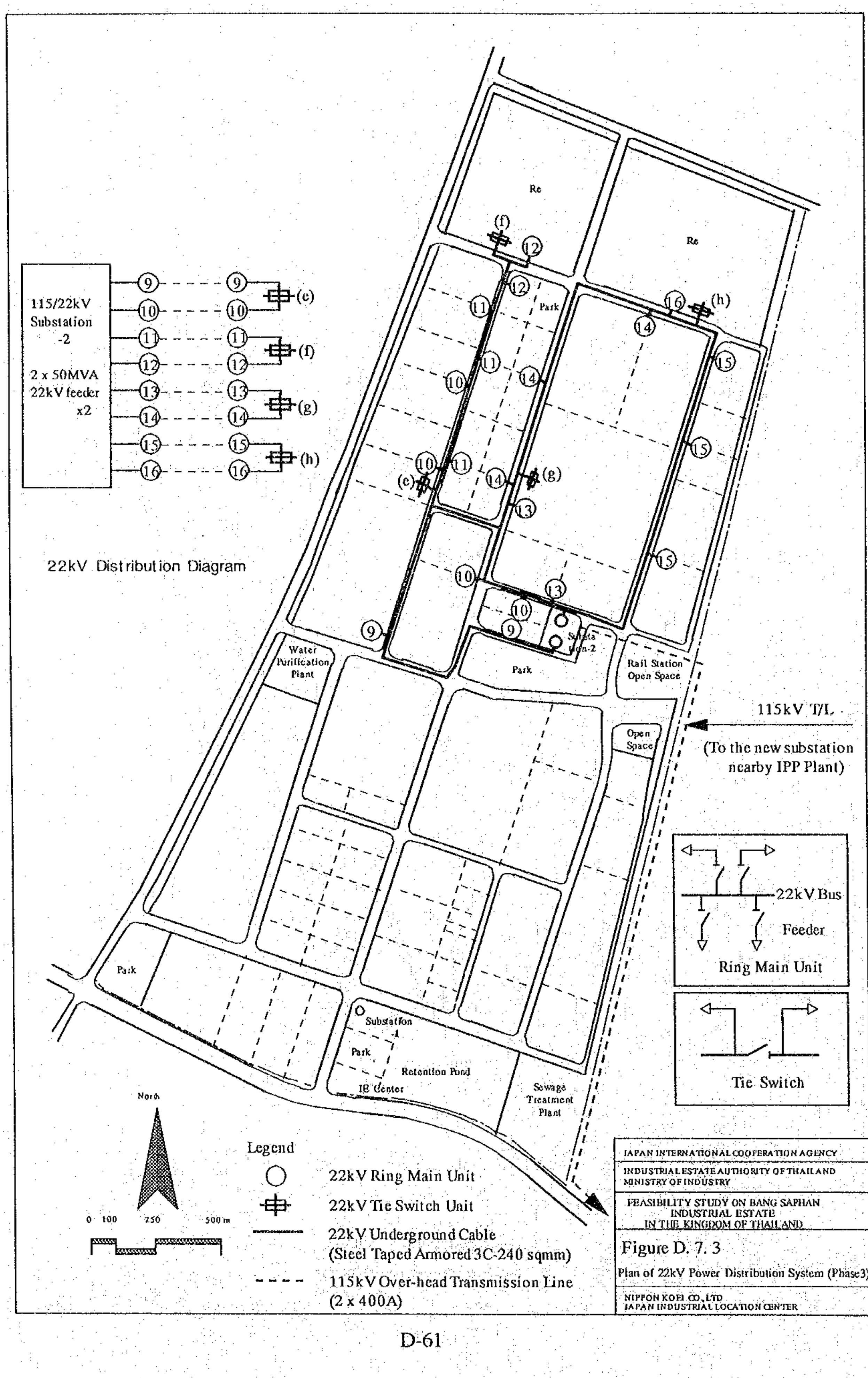

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Figure D. 7. 3

Plan of 22kV Power Distribution System (Phase3)

NIPPON KOEI CO., LTD
JAPAN INDUSTRIAL LOCATION CENTER

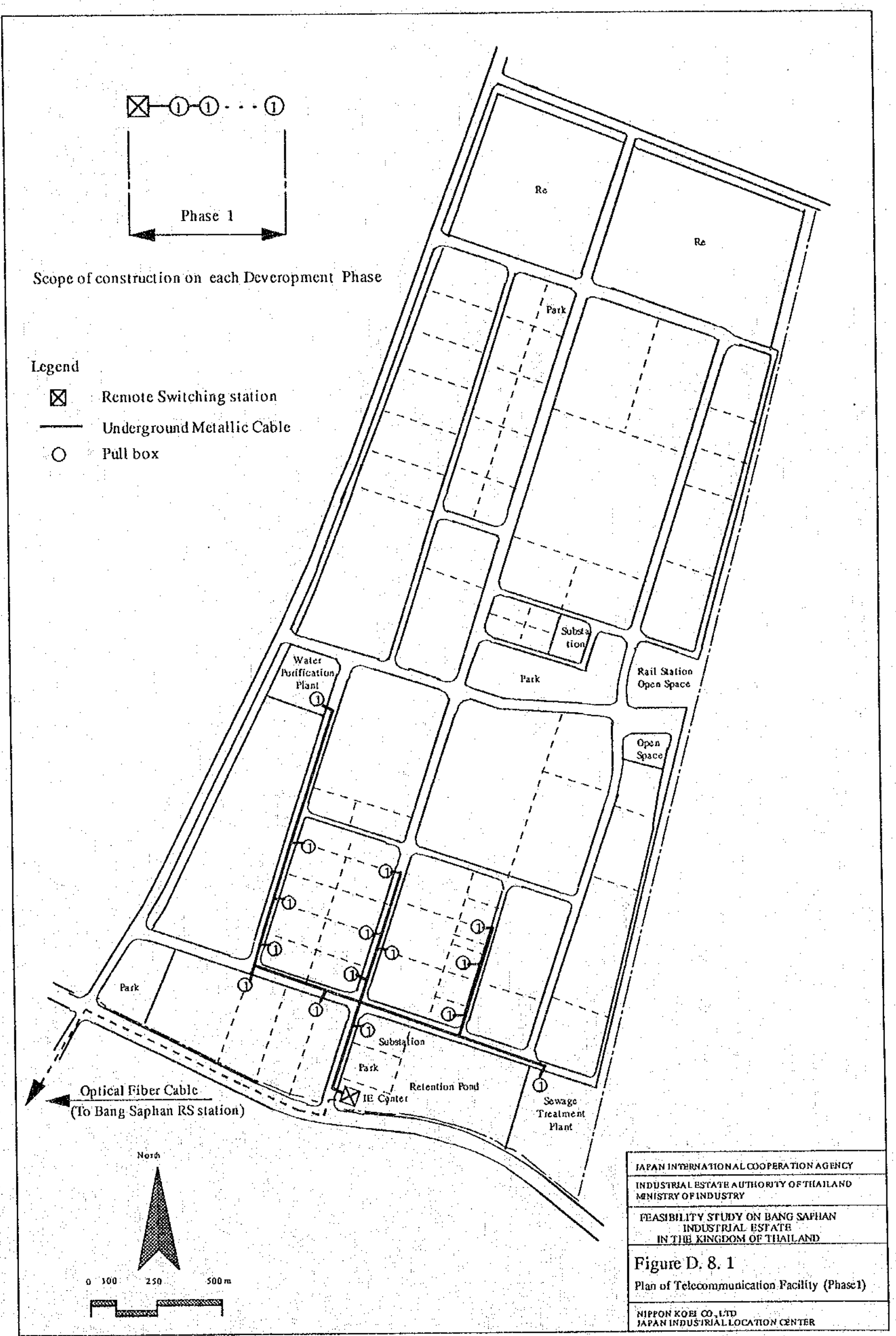

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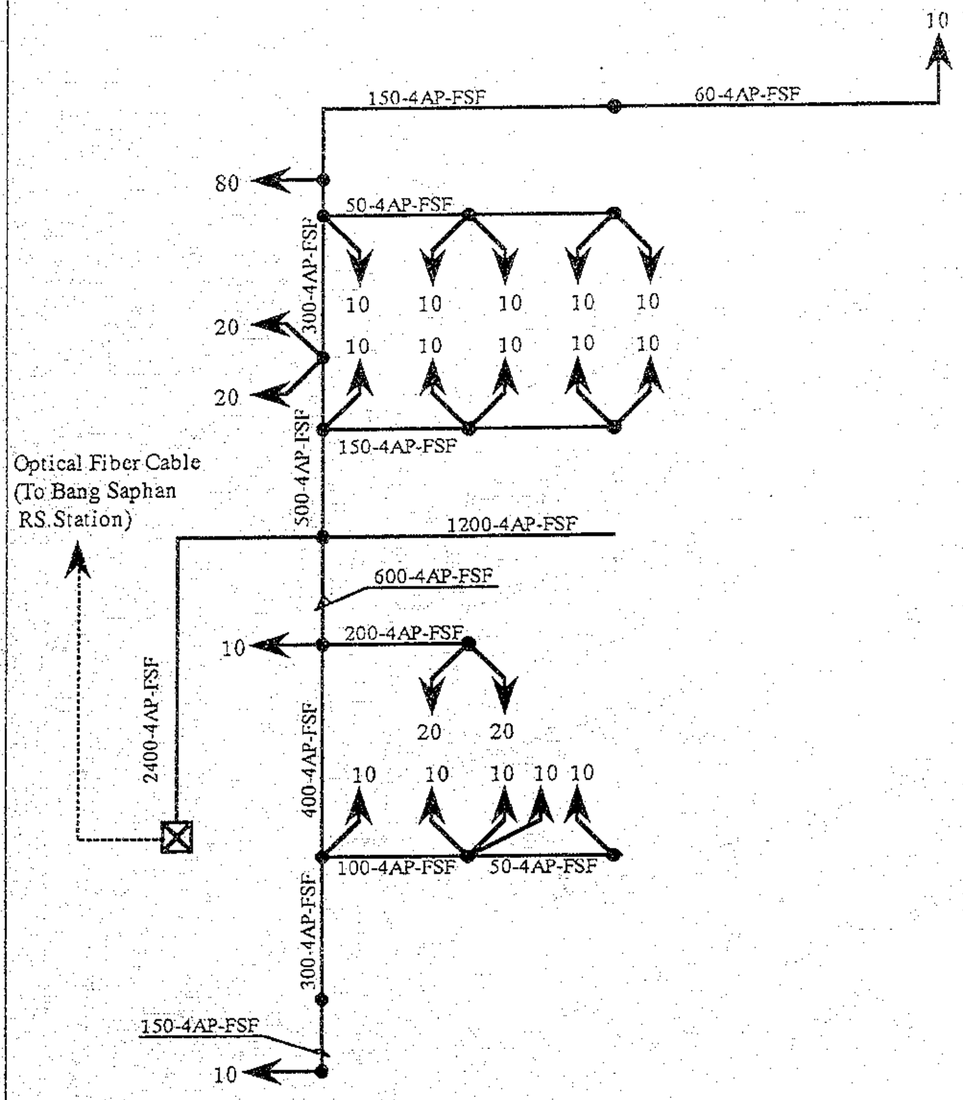
Figure D. 8. 1

Plan of Telecommunication Facility (Phase1)

NIPPON KOEI CO., LTD
JAPAN INDUSTRIAL LOCATION CENTER



Legend

- Trunk line to be constructed in Phase 1 development
- Pull box
- Remote switching station

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Figure D. 8. 2
Wiring Plan of Telephone Cable (Phase1)

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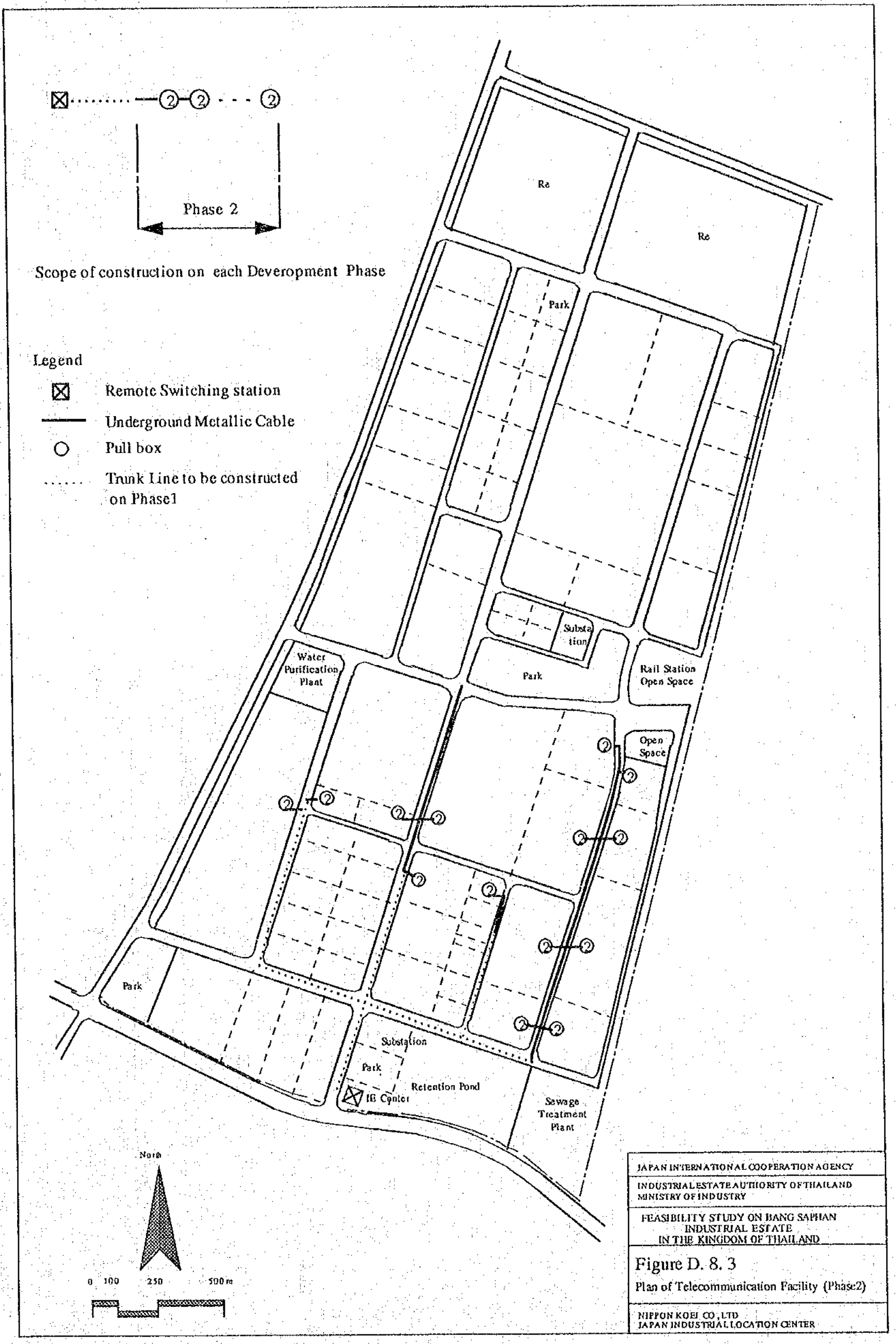

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Figure D. 8. 3
Plan of Telecommunication Facility (Phase2)

NIPPON KOEI CO., LTD
JAPAN INDUSTRIAL LOCATION CENTER

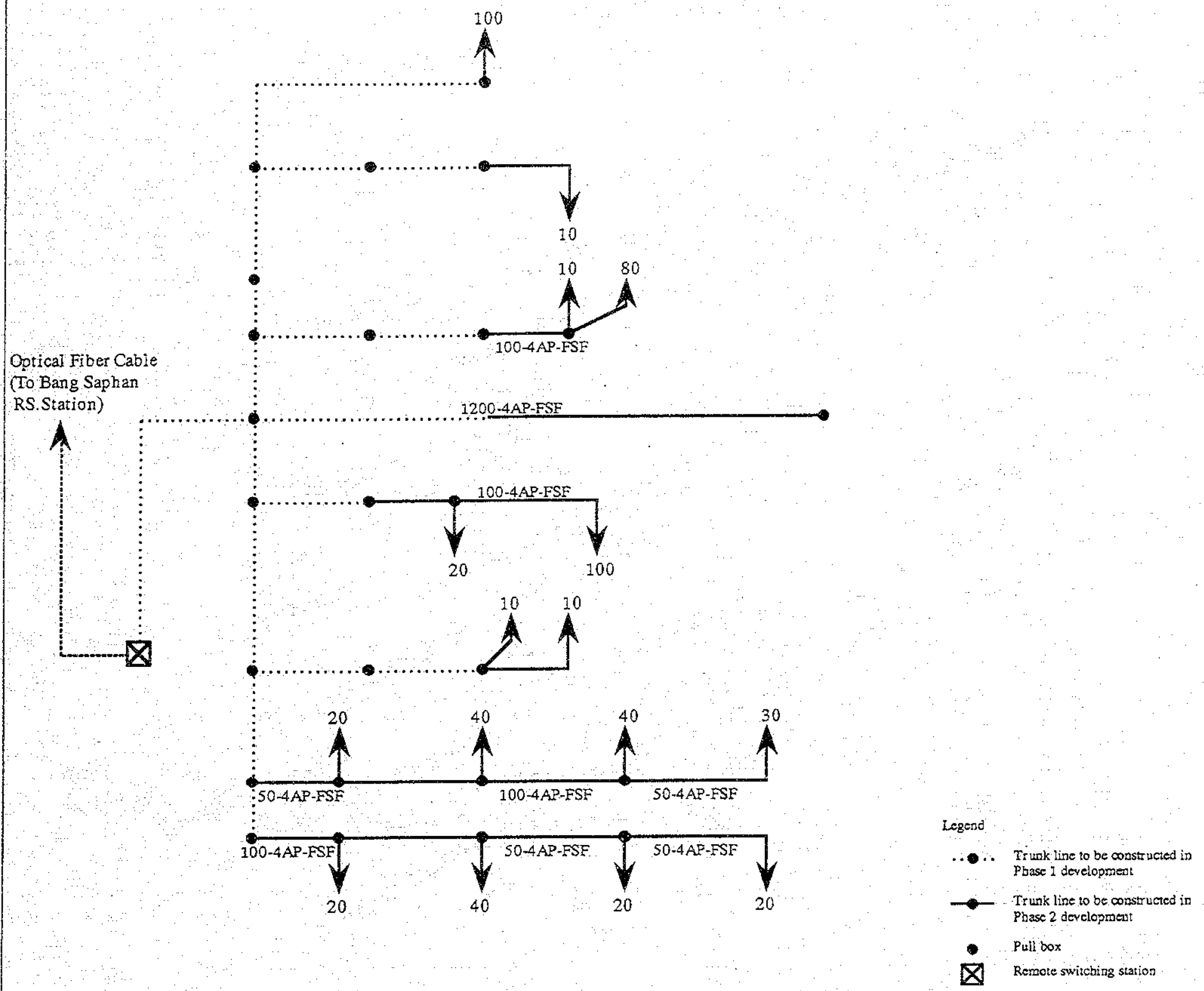

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Figure D. 8. 4

Wiring Plan of Telephone Cable (Phase2)

NIPPON KOEI CO., LTD
JAPAN INDUSTRIAL LOCATION CENTER

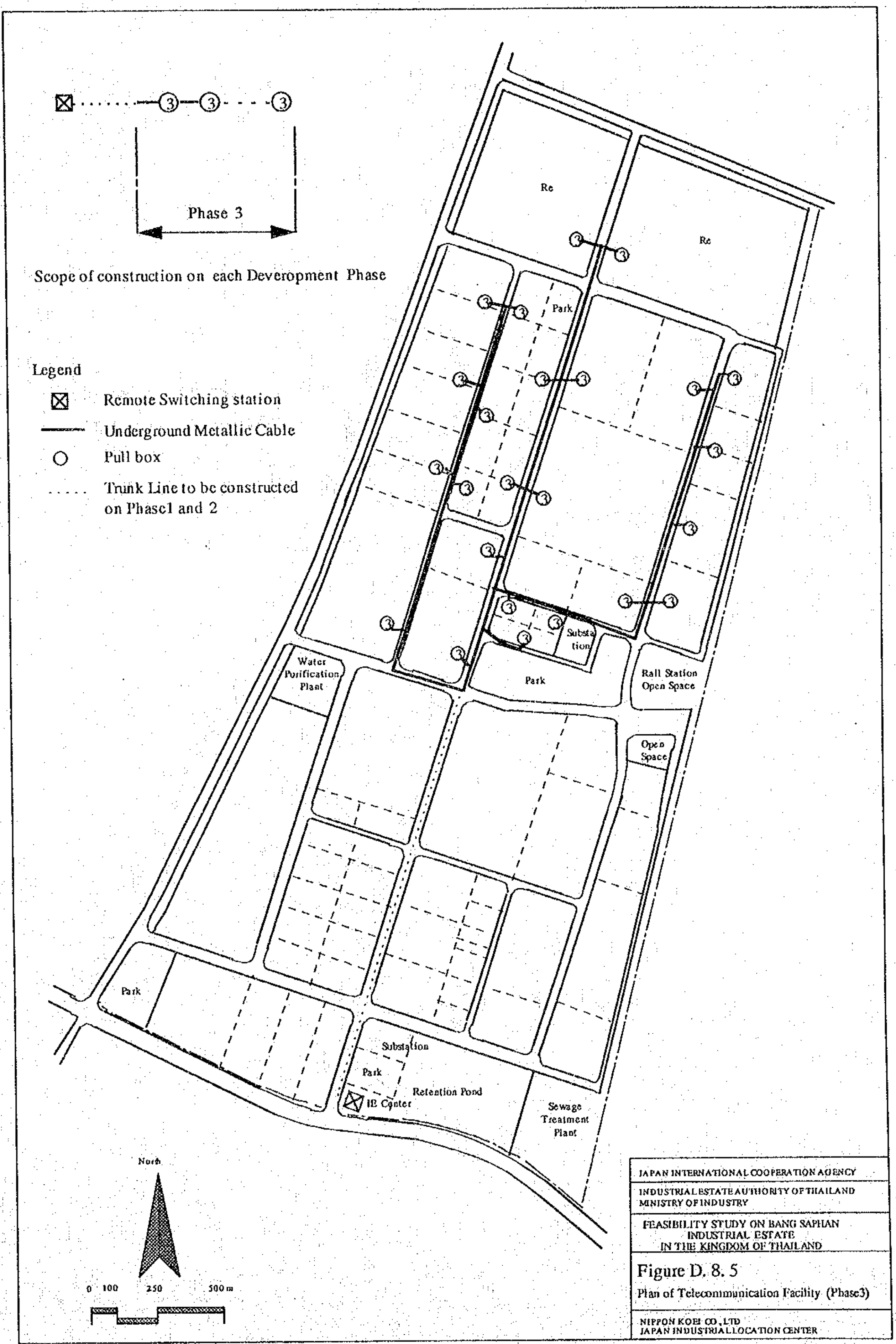
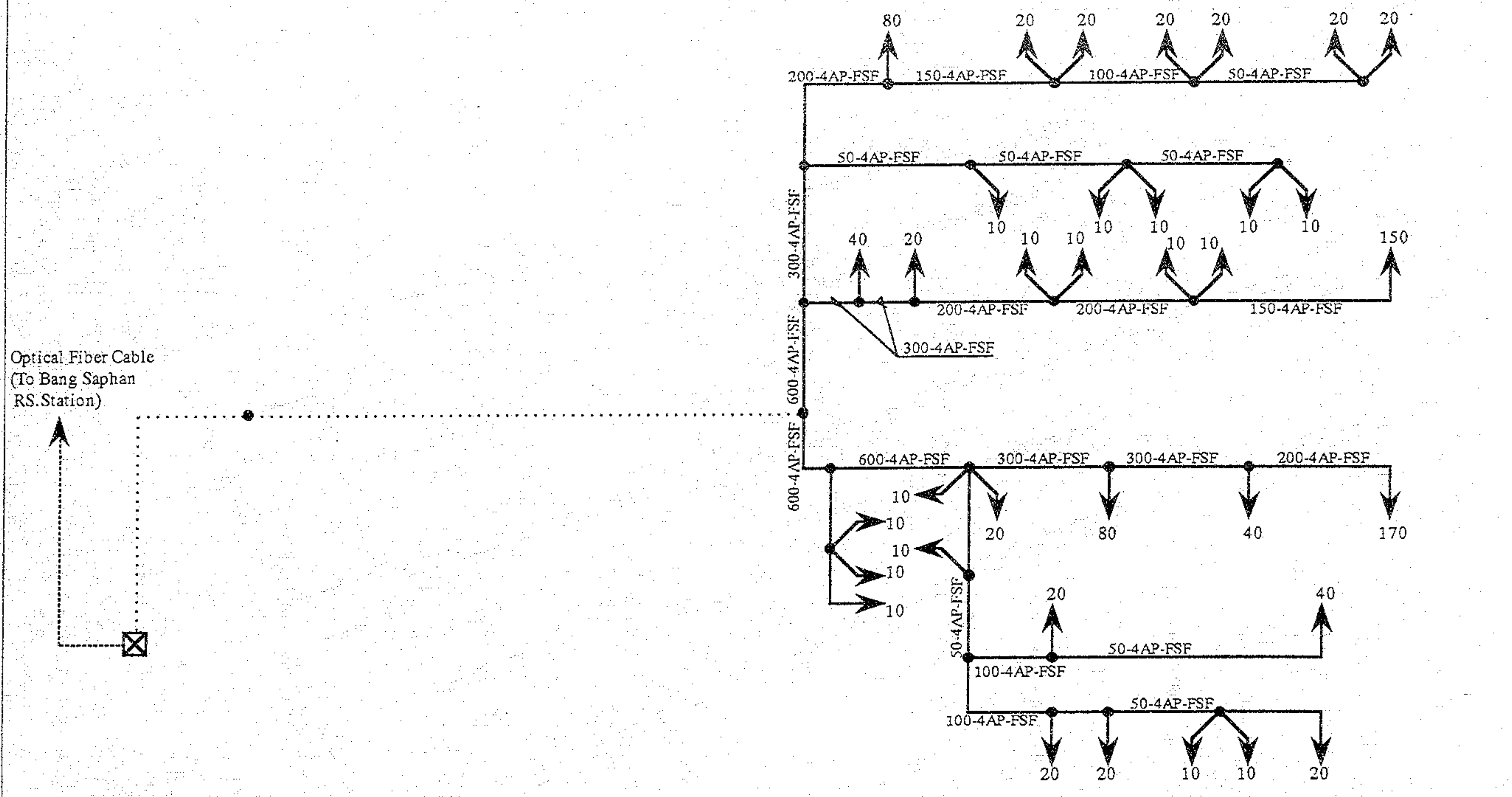


Figure D. 8. 5
Plan of Telecommunication Facility (Phase3)



Legend

- Trunk line to be constructed in Phase 1 and 2 development
- Trunk line to be constructed in Phase 3 development
- Pull box
- Remote switching station

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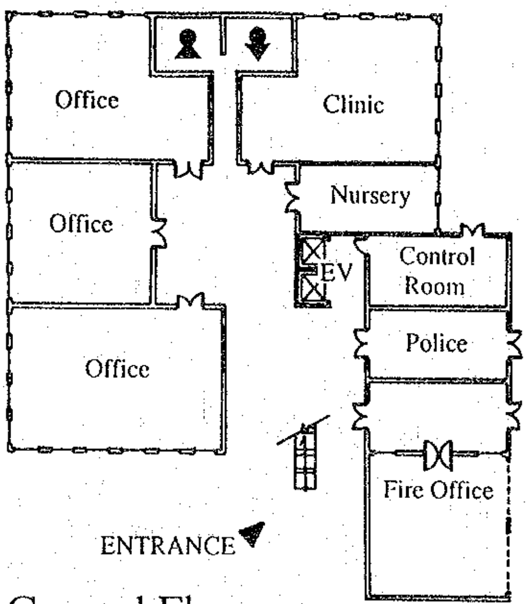
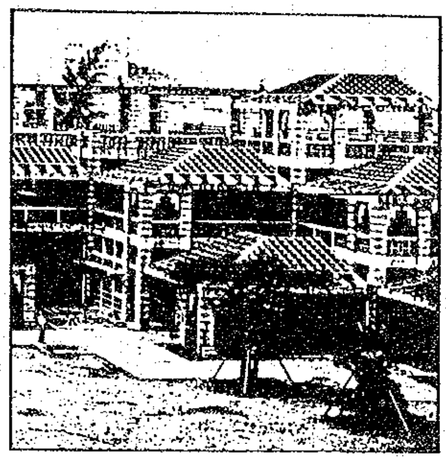
Figure D. 8. 6
Wiring Plan of Telephone Cable (Phase3)

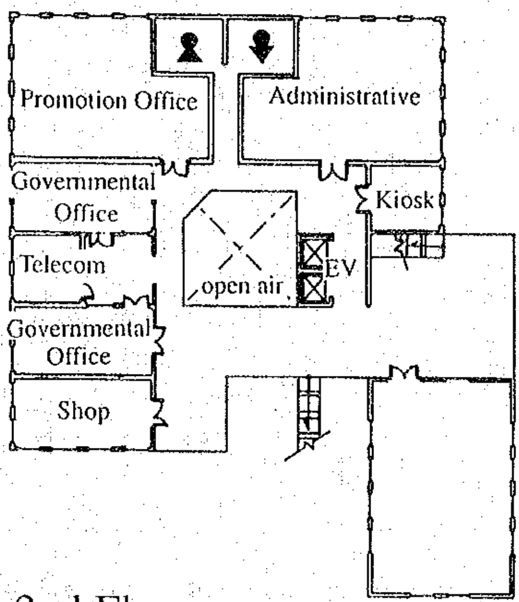
NIPPON KOEI CO., LTD
JAPAN INDUSTRIAL LOCATION CENTER



Ground Floor

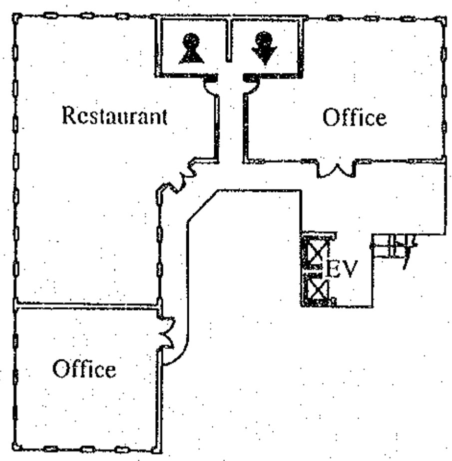
image picture





Office

2nd Floor



3rd Floor

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Figure D.9.1 Plan of Industrial Estate Center

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JAPAN INDUSTRIAL LOCATION CENTER

APPENDIX E DEVELOPMENT PLAN OF EXTERNAL INFRASTRUCTURE

CONTENTS

Tables

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APPENDIX E DEVELOPMENT PLAN OF EXTERNAL INFRASTRUCTURE

The development plan of the external infrastructure related to the Bang Saphan industrial estate is studied in this sector. The development scenarios of the Bang Saphan industrial estate by development scale discussed in Chapter 5 of the Main Text were fully considered in the study on water supply facilities to examine and evaluate the development potential of the Bang Saphan area.

E.1 Water Supply

E.1.1 Present Situation of Bang Saphan Area

Water supply for domestic use in the Prachuap Khiri Khan Province is undertaken by the Municipal Water Works Authority and the Provincial Waterworks Authority. Main water sources of domestic water are shallow and deep wells. There are 985 shallow wells and 601 deep wells which were developed by DMR, PWD and ARD. DMR has a plan to develop 15 more deep wells for domestic use with a budget of 7.5 million Baht.

There are some public water supply systems in 3 sanitary districts of the Bang Saphan District. Present production capacity is 11,520 m^3. 10,320 m^3 of clean water were produced and distributed to 1,186 customers in the Bang Saphan sanitary districts in 1994. However the majority of households are served by their own well or by water venders.

Steel manufacturing industries are being developed by the Sahaviriya groups in the Bang Saphan District. Industrial water is taken from the Bang Saphan Yai river at a rate of 0.5 m^3/s in the rainy season and water in the dry season is supplied from the on-site reservoir. In general, industrial water for the industrial estate is developed by each estate. Each estate provides a reservoir and filtration plant for investors/tenants. Water sources are wells and surface water. Water supply capacity is designed to be in the range between 7 and 20 $m^3/d/rai$ (40 and 125 $m^3/d/ha$).

E.1.2 Water Demand

(1) Domestic Water Demand

There are 3 sanitary districts, Kamnert Noppakhun, Ban Krut, and Ron Thong in the Bang Saphan District. The characteristics of these sanitary districts are summarized below:

Characteristics of Sanitary Districts in 1995

	Kamnert Noppakhun	Ban Krut	Ron Thong	Sanitary District Total	Bang Saphan District Total
Population	3,097	6,573	9,070	18,740	65,503
	(4.7%)	(10.1%)	(13.9%)	(28.6%)	
Household	721	1,332	1,864	3,917	13,460
	(5.4%)	(9.9%)	(13.8%)	(29.1%)	
Household Size	4.3	4.9	4.9	4.8	4.9
Land Area (km^2)	2.8 (0.3%)	10.5 (1.2%)	39.5 (4.5%)	52.8 (6.0%)	880
Density (people/km^2)	1,106	626	230	355	74

The population of the sanitary districts is projected to increase at a growth rate of 0.69%. In addition, the population increase due to industrial development is also estimated below.

Population Projection

	1995	2001	2006	2011
Sanitary Districts	18,740	19,396	19,936	20,776
Population Increase by Industrial Development				
Scenario 1	-	9,000	24,100	55,000
Scenario 2	-	9,000	30,500	87,900

Per capita water consumption is estimated at 90 liter per capita per day (lcd) in view of the fact that the Kamnert Noppakhun Sanitation Water Works produced 300 m^3/d of clean water and distributed to 700 households in 1994. Future per capita consumption of domestic water is estimated at 100 lcd which is a 10% increase from the present demand. The service ratio is assumed at 100% for the sanitary districts and total domestic water demand is estimated as follows:

Domestic Water Demand Projection in MCM/year

	1995	2001	2006	2011
Sanitary Districts	0.62	0.71	0.73	0.76
Demand by Population Increase				
Scenario 1	-	0.33	0.88	2.01
Scenario 2	-	0.33	1.11	3,21
Total				
Scenario 1	0.62	1.04	1.61	2.77
Scenario 2	0.62	1.04	1.84	3.97

(2) Industrial Water Demand

Industrial water demand is estimated on the basis of unit consumption of the prospective industries as summarized below. Detailed demand by industrial category is presented in Appendix A.

Industrial Water Demand Projection in MCM/year

	1995	2001	2006	2011
Scenario 1	1.96	12.86	45.52	59.16
Iron/Steel Group	1.83	11.68	36.03	36.03
General Industry	0	1.00	8.65	22.29
Power Plant	0	0	0.66	0.66
Port	0.13	0.18	0.18	0.18
Scenario 2	1.96	12.86	52.60	72.22
Iron/Steel Group	1.83	11.68	36.03	36.03
General Industry	0	1.00	15.73	35.35
Power Plant	0	0	0.66	0.66
Port	0.13	0.18	0.18	0.18

(3) Irrigation Water Demand

Irrigation water demand in the Bang Saphan area is estimated as shown below.

Irrigation Water Demand Projection in MCM/year

Crop	Area(rai)	Apr.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Local Rice	3,700	0	0	0	2.74	0.883	0.946	0.468	0.568	0.164	0	0	0	5.77
HYV Rice (dry)	1,850	1.165	0.864	0	0	0	0	0	0	0	0	1.557	0.96	4.55
Pineapple	580	0.118	0.06	0.049	0.043	0.039	0.033	0	0.008	0.089	0.138	0.075	0.118	0.77
Para Rubber	840	0.186	0.099	0.081	0.073	0.068	0.059	0	0.021	0.141	0.215	0.119	0.185	1.25
Coconut	1,840	0.406	0.218	0.178	0.159	0.148	0.128	0	0.046	0.309	0.471	0.261	0.406	2.73
Mango	240	0.052	0.026	0.021	0.018	0.017	0.014	0	0.003	0.039	0.061	0.033	0.052	0.34
Total	7,200	1.927	1.267	0.329	3.033	1.155	1.18	0.468	0.646	0.742	0.885	2.045	1.721	15.4

Source: Pre-F/S Report on Water Source for Sahaviriya Steel Plant Phase II by Panya Consultants Co., Ltd.

Total water demand of the Bang Saphan area would be 79 ~ 93 million m^3 per annum in 2011 as shown below.

Water Demand Projection in MCM/year

	1995	2001	2006	2011
Scenario 1	17.98	29.30	62.53	77.33
Domestic Water	0.62	1.04	1.61	2.77
Industrial Water	1.96	12.86	45.52	59.16
Iron/steel industry	1.83	11.68	36.03	36.03
General Industry	0	1.00	8.65	22.29
Others	0.13	0.18	0.84	0.84
Irrigation Water	15.40	15.40	15.40	15.40
Scenario 2	17.98	29.30	69.84	91.59
Domestic Water	0.62	1.04	1.84	3.97
Industrial Water	1.96	12.86	52.60	72.22
Iron/steel industry	1.83	11.68	36.03	36.03
General Industry	0	1.00	15.73	35.35
Others	0.13	0.18	0.84	0.84
Irrigation Water	15.40	15.40	15.40	15.40

E.1.3 Development Concept of Water Supply System

(1) Water Resources

Present Condition

It is assumed that the existing water supply is fully utilized to meet the present demand. Therefore, it is necessary to develop new water resources to cope with the future water demand increase.

Studies of water resources have already been made by NESDB, RID and the Sahaviriya Group. RID proposed the development of the Tha Sae dam project, which will supply industrial water at a capacity of 30 million m^3 per annum to the Bang Saphan Industrial Estate, and is waiting for the approval of the Cabinet through the approval of the Environmental Department. If the Tha Sae dam project is approved in 1997 or 1998, the project will be commenced immediately and completed around the year 2003 or 2004.

The Bang Saphan river, from which the Sahaviriya iron and steel factories are exploiting water through a weir and pumping station with a capacity of 0.4 m^3/sec, should be the main water resource because of its proximity to the Bang Saphan industrial city. The minimum and average annual runoffs during 1980 ~ 1989 as recorded by RID near the weir were 59.5 million m^3 (MCM) (1.88 m^3/sec as the average flow) in 1980 (see Table E.1.1) and 147 MCM per year (4.68 m^3/sec), respectively. Most droughty runoff during the 50-year period from of 1939 to 1989 was estimated by Sahaviriya Group at 43.2 MCM per year (1.37 m^3/sec).

Note : Runoff in 1980 is estimated as the sixth droughty year among the reconstituted runoff of 50 years.

Water Resource Potential

Assuming that 85 % of the runoff of the Bang Saphan river can be practically exploited, the balance between demand and water resources mentioned above can be calculated as shown in the table below.

(unit: MCM)

	1995	2001	2006 Scenario 1	2006 Scenario 2	2011 Scenario 1	2011 Scenario 2
I Resources						
1 Bang Saphan River						
1) average (1980-1989)	125.0 /1	125.0	125.0	125.0	125.0	125.0
2) drought in 1980 (actual data recorded by RID)/2	50.4 /1	50.4	50.4	50.4	50.4	50.4
3) most droughty during 50 years (estimation)	36.7 /1	36.7	36.7	36.7	36.7	36.7
2 Tha Sae River	0.0	0.0	30.0	30.0	30.0	30.0
3 Total						
1) average (1980-1989)	125.0	125.0	155.0	155.0	155.0	155.0
2) drought in 1980 (actual data recorded by RID)/2	50.4	50.4	80.4	80.4	80.4	80.4
3) most droughty during 50 years (estimation)	36.7	36.7	66.7	66.7	66.7	66.7
II Demand (Domestic, Industry and Irrigation use)	18.0	29.3	62.5	69.8	77.3	91.6
III Balance						
1) average (1980-1989)	107.0	95.7	92.5	85.2	77.7	63.4
2) drought in 1980 (actual data recorded by RID)/2	32.4	21.1	17.9	10.6	3.1	-11.2
3) most droughty during 50 years (estimation)	18.7	7.4	4.2	-3.1	-10.6	-24.9

Note: /1 Exploitable volume: 85 % of runoff
/2 The minimum flow during 10 years of 1980-1989 recorded by RID
/3 Most droughty year during 50 years of 1939 - 1988 (estimated by Sahaviriya group)

As shown in the table above, water shortages will happen by in the industrial development scenario 1 and 2 in 2011 and scenario 2 in 2006 in the case of runoff of the most droughty year (1947). Further, in the drought year of 1980, average drought year, a shortage of 11 MCM is expected in 2011 for scenario 2.

In other words, if the water resources in the Bang Saphan river basin are adequately developed and the water conveyance pipeline from the Tha Sae dam is constructed, the water resources are sufficient for the development of the Bang Saphan industrial city in the average drought year as recorded in 1980 except for demand of scenario 2 in 2011. To cover the deficit, another water resource in another river basin should be exploited in addition to the Bang Saphan river and Tha Sae river.

If the Tha Sae dam project is not completed, a water shortage in the order of 15 ~ 20 MCM and 30 ~ 40 MCM is anticipated to occur in 2006 and 2011, respectively.

(2) Development Plan of Water Supply System

Strategy of Water Resource Development

A water supply system development strategy for the Bang Saphan industrial city is preliminarily proposed as follows, for the purpose of securing sufficient water for the average drought year in consideration of the implementation schedule of the Tha Sae dam and development possibility of new reservoirs in the Bang Saphan river basin.

Step - (1) Upgrade and expand the existing water intake system located in the Bang Saphan river to meet the water demand in 2001

Step - (2) Develop the Tha Sae dam and conveyance pipeline

Step - (3) Study the possibilities of developing other reservoirs in the Bang Saphan river basin and develop economically viable reservoirs

In 2001, expansion of the existing pumping system in the Bang Saphan river with a capacity of 18 MCM per year will be necessary because the Tha Sae dam has not yet been implemented. For scenario 1 in 2006, a pipeline from the Tha Sae dam with a capacity of 30 MCM will be sufficient to meet the demand of 47 MCM.

For scenario 1 in 2011 and scenario 2 in 2006, in addition to the expansion of the pumping system in the Bang Saphan river with a capacity of 18 MCM and the Tha Sae dam's 30 MCM, construction of new reservoirs in the upper stream of the Bang Saphan river will be necessary.

For scenario 2 in 2011, development of additional water resources in other river basins outside the Bang Saphan river will be necessary.

In case the strategy mentioned above is taken, water supply will be balanced with the demand as summarized in the table below. An integrated water supply system to meet the water demand of scenario 1 for the Bang Saphan industrial city is illustrated in Figure E.1.3.

Water Supply System for the Bang Saphan Industrial City in Drought Year

(unit: MCM)

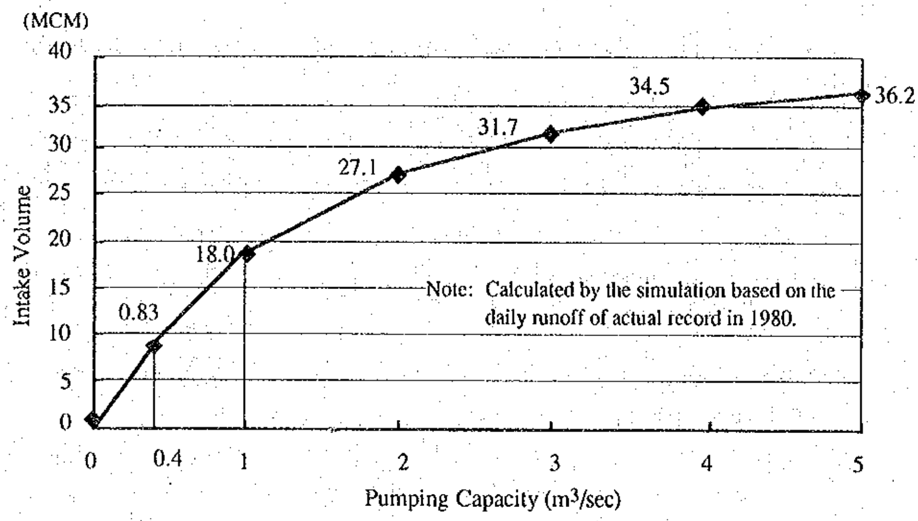
	1995	2001	2006 Scenario 1	2006 Scenario 2	2011 Scenario 1	2011 Scenario 2
I Resources						
1 Bang Saphan River						
1) Pumping at the weir /1	8.3 /2	18.0 /3	18.0	18.0	18.0 /5	18.0
2) Reservoir	0.0	0.0	0.0	8.0	17.0 /5	17.0
Subtotal	8.3	18.0	18.0	26.0	35.0	35.0
2 Tha Sae Dam	0.0	0.0	30.0 /4	30.0	30.0	30.0
3 Other river basin	-	-	-	-	-	15.0 /6
4 Total	8.3	18.0	48.0	56.0	65.0	80.0
II Demand (Domestic, Industrial use) /5	2.6	13.9	47.1	54.4	61.9	76.1
III Balance	5.7	4.1	0.9	1.6	3.1	3.9

Note: /1 Calculated based on the runoff record in 1980.
/2 0.5 m3/sec
/3 1.0 m3/sec
/4 Conveyance pipeline is necessary from Tha Sae dam to BSIE.
/5 50 MCM (18+17+15(irrigation use)) meets 50 MCM as potential development volume of Bang Saphan river.
/6 Development of other river basin will be necessary for scenario 2

Intake by Pump at the Bang Saphan River Weir

Sahaviriya Group has installed the pumping system at the weir on the Bang Saphan river, which has a capacity of 0.4 m^3/sec taking approximately 8.3 MCM. Approximately 18 MCM can be extracted after the intake of an irrigation water volume of 15.4 MCM and a river maintenance flow of 2.4 MCM (0.1 m^3/sec), if the pump is expanded up to a capacity of 1 m^3/sec as shown in the figure below. A detailed calculation of the possible intake volume is shown in Tables E.1.2 - E.1.5.

Note: Additional pipelines and site reservoirs are necessary for water conveyance and storage. Considering the high cost of site reservoir, triple higher than river reservoir (dam), development of reservoirs in the upper stream of the Bang Saphan river is preferable. However, difficulties of the river reservoir development cannot allow the on-time service of the reservoir, so expansion of the existing pumping facility is a practical way.



Possible Intake at the Bang Saphan River Weir in the Drought Year
(after intake of irrigation water volume of 15.4 MCM and river maintenance flow of 2.4 MCM)

Water Conveyance from Tha Sae Dam

According to RID plans, the Tha Sae dam will supply 30 MCM of industrial water to the Bang Saphan industrial city. The conveyance pipeline from the Tha Sae dam to Bang Saphan over a distance of 72 km is necessary to convey 30 MCM of water per year (1.0 m^3 /sec). Two pipelines have been preliminarily designed to be constructed in consideration of the convenience of maintenance work and the unexpected destruction of pipeline. Two sets of 750 mm diameter steel pipe, which will be buried underground in the right of way of Route 4 and pump station, are designed. Figures E.1.1 and E.1.2 present an alignment plan and a vertical section plan of the pipeline. Development cost of the pipeline is estimated as tabulated in Appendix H.

Development of Reservoirs in Bang Saphan River Basin

Development of new reservoirs in the Bang Saphan river basin will be necessary by 2011. Some ideas concerning new reservoirs were already proposed by the RID as shown below.

Potential Water Resources in Bang Saphan River

Name of Dam	Storage Capacity (MCM)	Original Purpose
Bang Sai Tong	7.8	Irrigation 4,000 rai
Khlong Loi	6.3	Irrigation 7,000 rai
Khlong Tong	9.2	Irrigation 5,000 rai

These small dams will be the prospective alternatives for water resource development in the Bang Saphan river and it is recommended that detailed study be conducted in consideration of environmental matters and water demand for other uses.

E.2 Port

E.2.1 Existing Prachuap Port

Prachuap Port is located in the cove of Laem Mae Ramphung. The water depth in the cove is rather deep. A seabed contour of -15 m below Mean Sea Level (MSL) lies as close as 900 m off the coastline. This natural water depth has a good potential for developing a deep seaport.

The port site of Prachuap faces the open sea "Gulf of Thailand" to the east, so that offshore waves directly come into the cove that stretches between two small points (headlands). The shoreline where Prachuap Port exists was a rocky beach, covered with cobble stones, large and small. The narrow strip of rocky beach was skirted by a rural road that runs to the town area of Bang Saphan. The cobble stone-covered shoreline was occasionally washed by seasonal high waves and the trees standing near the road partly fell down. The natural site condition necessitates the construction of a breakwater to protect the port basin against severe monsoon waves.

To run the steel factory operation of Sahaviriya, Prachuap port plays an essential role in shipping in and out steel cargoes. Steel materials (steel slabs) are imported mostly from Japan and steel products are shipped out from the port. The port consists of two berths, namely a main berth and a secondary berth. The main berth has a total quay length of 450 m and secondary berth 245 m. The water depth along the quayside is 15.0 m below MSL in the main berth and 10.0 m below MSL in the secondary berth. As MSL is 1.7 m above the chart datum, the water depth at the quayside is equal to -13.3 m below the Chart Datum (CD) and -8.3 m below CD respectively, which means that the maximum berthing capacity would be equivalent to 45,000 DWT and 7,000 DWT respectively in full loaded condition.

The port basin is protected by a rock-mound breakwater that is armoured by precast concrete blocks named "Accropode". In spite of its high cost, Accropode were used, because large-size armour rocks could not be obtained within an economical reach of the port site and construction time was so limited that speedy construction by use of concrete blocks instead of natural rocks was required.

Cargo handling along the quayside is performed chiefly by ships' derrick cranes and supplemented by onshore mobile cranes. Imported heavy steel slabs are directly unloaded onto the trailer trucks parking in the quay and trucked away from the quayside to the factory site inshore.

According to the latest port statistics, the cargo shipment and vessel calls are summarized below, where the figures of the upper side show the throughputs of cargo and those of the lower side indicate the number of ship calls.

Cargo Shipment and Ship Calls in Prachuap Port

(Ton / No.)

	1994	1995	1995/1994
Import	550,101	1,606,126	292%
	48	134	279%
Export	425,278	819,630	193%
	55	232	422%
Total	975,379	2,427,756	249%
	103	366	355%

As shown above, Prachuap Port has, since its inauguration in 1994, been experiencing a very high growth of cargo throughputs. The annual growth rate recorded between 1994 and 1995 was 249% in terms of cargo traffic and 355% in terms of ship calls. According to the Prachuap Port authority, the cargoes other than those for Sahaviriya steel factory also seem to be rather high in volume. Affected by the booming construction works such as buildings and roads/bridges in the region, various construction materials like cement and steel have been unloaded through Prachuap Port. It is expected that this tendency of cargo shipment growth will continue in the future.

The Ministry of Transport of Thailand envisages developing a national seaborne traffic network of Ro/Ro ferry service in the Gulf of Thailand, linked to the existing major ports like Bangkok Port and Laem Chabang Port. In this program, the domestic feeder service of container cargo crossing the Gulf of Thailand from the above mother ports to local ports is one of the major shipping targets. Prachuap Port, situated in the strategic location along the coast of the Gulf of Thailand, will have a good potential of being integrated into this Ro/Ro cargo distribution network. This shipping potential should be positively taken into account in the development of Prachuap Port.

E.2.2 Cargo Traffic Demand in Future

On the basis of the cargo demand forecast related to Bang Saphan industrial development, the seaborne cargoes in Prachuap Port excluding bulky mineral ores are projected in Table E.2.1 ~ E.2.3 and summarized below.

Bangsaphan Industrial Estate -based Cargo Demand in Prachuap Port

(Unit: 1,000 tons)

	1995	2001	2006	2011
Iron/Steel Group	1,800	4,980	3,150	4,080
General Industry	–	470	1,020	2,640
Total	1,800	5,450	4,170	6,720

In addition to ongoing steel industry, iron-making, power plant and bulk-cargo-based heavy industries are expected to start operation in the year 2006. In this connection, the import of bulk cargo is projected to be in the order of 7.5 ~ 8.58 million tons in 2006 and 14.78 million tons in 2011.

The cargo demand related to the regional development in Prachuap Khiri Khan should not be overlooked. Even in the initial development stage of Prachuap Port, as much as 500,000 tons of break-bulk cargo were reportedly unloaded at the Port. Without the port development in Prachuap, this kind of break-bulk cargo must have been either trucked a long way from Bangkok or shipped in from the adjacent ports, most likely at Chumporn Port and trucked to Bang Saphan. As Prachuap Port is still young in history, the traffic growth trend of cargo shipment cannot be easily forecast.

As such, the following assumption has been made to project the future traffic of locally based general cargo demand.

(a) Local cargo will expand 10% annually up to the year 2001.

(b) After the year 2001, local cargo will expand 5% annually.

On the basis of the above assumption, the locally based general cargo demand can be projected as follows:

Locally Based General Cargo

(Unit: 1,000 tons)

	1995	2001	2006	2011
General/Break-Bulk Cargo	500	805	1,030	1,310

Adding up the shipment of mineral bulk cargo such as iron ore and coal, the total cargo demand of Prachuap Port has been projected as shown below.

Prachuap Port - Cargo Demand

(Unit: 1,000 tons)

	1995	2001	2006	2011
Steel Related General Cargo	1,800	4,980	3,150	4,080
Industrial Estate General Cargo	–	470	1,020	2,640
Locally Based General Cargo	500	805	1,030	1,310
General Cargo Total	2,300	6,255	5,200	8,030
Bulk Cargo Total	–	–	7,500	14,780
Grand Total	2,300	6,255	12,700	22,810

Note: Refer toTable D.3.1 for details.

E.2.3 Berth Demand in Future

In 1995, 2.3 million tons of cargoes were handled at Prachuap Port, while the berth length available totaled 695 m, which means that the berth productivity is 3,300 tons/m/year. Simply applying the current berth productivity to future cargo demand, the berth length requirement for the shipment of general cargoes in the years 2001, 2006 and 2011 could be estimated as follows:

Berth Requirement for General Cargo Shipment

		2001	2006	2011
(1)	Steel Cargo and General Cargo (1,000 tons)	6,255	5,200	8,030
(2)	Required Berth Length (m)	1,895	1,940	2,430
(3)	Required Berth Expansion** (m)	1,200	1,245	1,735

** (3) = (2) - 695 m

As calculated above, in the year 2011, the berth length requirement would be 2,430 m, which means that an additional 1,735 m berth should be newly developed.

E.2.4 Port Expansion Plan

(1) General Cargo Berth Zone

Alternative Plan A

To meet the above berth demands, several port development plans have been worked out. A possible port expansion Plan A has been prepared as shown in Figure E.2.1, where the offshore berth will be expanded by 210 m immediately south of the existing main berth, and the existing shoreline inside the port will be reclaimed, providing a port area with a marginal wharf in front, about 1,000 m long x 200 m wide. To the south of this marginal wharf, small-size cargo berths will also be constructed.

To protect the expanded port basin, the existing breakwater will be further projected southward, and an additional eastern breakwater will be constructed to the south of the small-size cargo berths.

The total berth length would be 2,265 m which is not long enough to meet the berth demand up to 2011, when a total berth length of 2,430 m approximately would be required.

Alternative plan B

If Prachuap Port singlely keeps on playing as a major port in the Western Seaboard zone, and its port demand expands steadily as projected, the proposed Plan A could not be accepted. As such, other port expansion plans could be proposed, namely Plan B and Plan C. In Alternative Plan B, the existing main breakwater will project southeastward, instead of southward and the nearshore land reclamation will be expanded southward around the small point. To protect the turning basin for the southward expansion zone, a detached breakwater will be provided about 350 m - 400 m off the berth line. This port configuration will easily allow continuous southward expansion in future (see Figure E.2.2).

In addition to conventional cargo handling, there will be a high possibility of receiving Ro/Ro vessels in Prachuap Port, most of them linked to Laem Chabang Port, where Ro/Ro ferry terminals are being blueprinted. To meet this demand, the Ro/Ro berths in Prachuap Port would be located in the southern end of the newly built marginal wharf, so as not to block the traffic in the main cargo handling zone. Moreover, it is said that there is some possibility of developing a commercial dock capable of building and fixing 10,000 DWT class vessels within the Prachuap Port Complex. To cope with this likely port demand, one dock facility zone is also included in the port expansion area.

Alternative Plan B, though having a wide flexibility in port expansion to the south in future, will require the construction of a new breakwater, separately from the expansion of the existing breakwater. The predominant wave direction in the port area is from NE, followed by E to S, so that the effect of the sub-breakwater could not be so large as the main breakwater's. To evaluate the effect of this secondary breakwater, more detailed wave analysis will be necessary. In this sense, one more alternative port development plan has been proposed.

Alternative Plan C

This lastly recommended port Plan C will have the following port configuration (see Figure E.2.3).

* The existing breakwater will be expanded southward with a slight skew to the sea side.

* Along the existing N-S shoreline, about 200 m wide land reclamation will be executed and its southern water front will serve as a general cargo berth zone.

* The land reclamation around the point will project out to the sea in the direction of ESE.

* Along the northern water front of the ESE reclamation, general cargo berths will be developed.

* In the south of the ESE reclamation, a commercial dock could be developed.

* Ro/Ro ferry terminals, which do not require deep berth depth, could be provided along the northern part of N-S reclamation (the rocky seabed appears in a rather shallow elevation).

Optimum Plan

As discussed above, three alternative plans of the future port expansion have been prepared. Each alternative plan has merits and demerits in terms of port planning.

Alternative Plan A is the most compact and economical port development, possibly implemented within the existing port boundary, but imposing some physical constraint on the latitude of future port expansion to the south. The growth of cargo demand for Prachuap Port, though projected in the preceding section, still remains uncertain, particularly for the seaborne cargo for non-steel industry. As such, it is recommended to start with the N-E shoreside reclamation and wait for the actual growth of future cargo demand for a while.

In case the port demand for Ro/Ro ferry terminal has been surely confirmed, Ro/Ro berth facilities could be accommodated within the N-E reclamation zone. There is a possibility of constructing a dock yard to the north of the small point. If so implemented, the possible development zone for berth expansion would be considerably limited. As such, total port economy including these special port facilities should be carefully studied in due course.

Alternative Plan B, on the other hand, will have a wide latitude of future port expansion to the south. The port expansion beyond the point, however, will require some clearance of the port boundary, and careful consideration over the environmental impact in the newly developed area.

If the magnitude of port demand in future has been surely confirmed, the proposed southward expansion could be well justified. In any event, the fast track of port development in Alternative Plan B would start from the shoreside reclamation within the coverage of the existing breakwater. This approach is the same as proposed in Alternative Plan A.

Alternative Plan C would be a modification to Alternative Plan A. The expansion of the existing main breakwater will be projected further southward than in Alternative Plan A, and the berth zone near the point will be more enlarged by reclaiming offshore. A commercial dock yard will be developed in the leeside of this reclamation.

If the berth demand of Ro/Ro ferry is imminent, Ro/Ro berths could be developed in the northern half of the N-S reclamation zone. If not, the N-S reclamation could be fronted with a marginal wharf.

In conclusion, the port demand in Prachuap should be timely clarified, particularly with regard to the needs of Ro/Ro berths and shipbuilding yard. On that basis, "most economical", "less physically constraint in future expansion" and "easy to get quick returns in capital investment" should be implemented. Though all the above questionable points still remain unsettled, our study proposes that Alternative Plan C would be the most realistic solution, and further implementation study has been made on the basis of Alternative Plan C.

(2) Mineral Bulk Berth Zone

In addition to the general cargo berth, bulk berths should also be developed to unload bulk cargo of 8,580,000 tons in 2006 and 14,780,000 tons in 2011. Unlike general cargoes, mineral bulk will be transported by large bulk carriers, most likely in the size of 60,000 - 140,000 DWT. The former one is called "Panamax-Size" and the latter "Cape-Size". In case that Cape-Size bulk carriers (140,000 DWT) call in Prachuap