F.3 Formulation of Irrigation Developmet Master Plan

F.3.1 Irrigation Development Potential

(1) Irrigation Development Potential Area

Based on the morpho-pedological justification, the following areas have been selected as having irrigation development potential;

Area	Estimated Acreage (gross)	Estimated Net Irrigable Area
Fahé, San-Pédro Dam Downstream	430 ha	300 ha
Cpt. Colonel	130 ha	90 ha
San-Pédro Paddy Project Area	766 ha(extension)	575 ha
Total	1,326 ha	965 ha

Note: As far as the Right Bank irrigation areas, both of them have not enough catchment area, therefore only the pumping irrigation is possible. Considering the scale of the irrigable area, these areas shall be developed by private farmers then they are excluded potential area in this study.

(2) Water Resources Potential

The future demand in the year of 2015 has been estimated to confirm the water balance in the San-Pédro river basin. The proposed demand of each sector is worked out as described below:

1) Irrigation
The diversion water requirement for the whole proposed irrigation areas (total 965 ha) is calculated as tabulated below:

(Unit: MCM)

Irrigation Area	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Upstream Area (965 ha)	3.3	0.0	2.2	3.8	2.1	1.7	1.6	0.3	3.2	3.5	4.2	3	28.7

The irrigation water for all the proposed area is to be taken from the San-Pédro dam in 2015.

2) Municipal Water Supply
The future demand of municipal water supply for the San-Pédro city is estimated considering the population increase, the extension of service area and the increase of consumption per capita. As a result, it is found that the production and distribution capacity of the water supply system has to be increased to 30,000 m^3/day in 2015. Thus, the monthly diversion volume for municipal water is calculated as tabulated below:

(Unit: MCM)

Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec	Jan	Feb	Mar	Total
Municipal Water Supply Demand	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	11.0

It is proposed that, in the future also, the raw water for the municipal water supply will be taken from the same location as the present SODECI pump station.

3) Industrial Water
Since no realistic industrial development plan exists, the water allocation for the industrial sector is not considered.

4) Water Balance and Allocation
Considering the above water demands, the water balance of the San-Pédro river basin has been examined. The monthly run-off volume calculated for the drought rainfall of 5-year return period is applied for the balance calculation. The water balance for the hydrological year from April and to March is presented in Fig. 4.2.1 and its annual balance is summarized below:

- Total run-off volume:	527.2 MCM	(100.0%)
- Evaporation from the San-Pédro dam:	4.5 MCM	(0.9%)
- Irrigation water demand:	28.7 MCM	(5.4%)
- Municipal water supply demand:	11.0 MCM	(2.1%)
- Annual balance:	483.0 MCM	(91.6%)

The annual run-off in the San-Pédro river basin is estimated at 527.2 MCM for the drought year of 5-year return period, and the balance after deducting the various consumption is as large as 483.0 MCM, equivalent to 91.6% of the total run-off.

The monthly variation of the run-off volume at the tail of dam is also calculated. As a result, it is found that the hydropower generation is possible throughout a year even in the drought years, and the possible hour of operation becomes over 2,900 hr. in a condition that about 70% of the run-off at the tail of dam are used for hydropower generation. This value is considered to be almost same as the total operation hour of the record for 1990.

Although the balance of run-off volume is confirmed on the monthly basis, extremely low discharge may occur in the daily variation. It is, therefore, important to prepare proper rules of water allocation among the water users in order to provide for such urgent cases.

F.3.2 Proposed Irrigation Projects

(1) Re-functioning of San-Pédro Paddy Project

Cultivation of rice under the pump irrigation was stopped because of the shortage of fund for purchasing fuel for the pump operation and other reasons. Among the irrigation development potential areas in the Study Area, only this area has irrigation infrastructures such as irrigation canal and properly land-leveled fields, even though they are not sufficient as discussed in section 3.7. Considering its location and scale, the rehabilitation of this area is considered as the most important and practicable irrigation development project area in the Study Area.

Considering the failed pump irrigation system being one of most important factors of the failure of the project, several alternative water sources were studied in detail. The most favorable irrigation system is gravity irrigation from the economic and managerial points of view. The smallest investment cost on the rehabilitation of this project area may be realized by repairing pump facilities without adverse environmental effects. However, it will require the high cost and high technique for proper maintenance of pump equipment by the farmers themselves. Careful comparison study in consideration of the sustainable operation of the facilities was made.

1) Basic Conditions

- Highest ground elevation in the Project Area :	7.2m
- Highest water level of the Canal A	7.5m
- Head race canal hydraulic gradient	1/5,000
- Present flow capacity of the San-Pédro river	150 to 200m^3/s
- Upsurge caused by weir installation during flood	not allowed
- Developed net irrigable area	330 ha
- Expandable net irrigable area	210 ha

2) Alternatives of Water Intake

Considering the above basic conditions and the survey results of San-Pédro river, the following alternatives are considered for the San-Pédro Paddy Development Area rehabilitation.

	Alternatives	Canal Length	Intake Level Required	Protection of Right Bank	O&M
Gravity Irrigation	Weir at Section 26 (at the confluence with the Kre river)	3.0km	EL.8.1m	Protection on the right bank required	- Occasional movable weir operation to reduce upsurge
	Weir at Section 33 (1.5km south of Cpt. Colonel)	8.1km	EL.9.2m	Less upsurge during normal water stage and less influence	- High rise of weir (H=5m) - Movable weir - Many drainage crossing conduits required - Long canal
	San-Pédro Grand Canal From Former Industrial Water Intake in the Dam	18.2km	EL.11.3m (EL.17.5m)	No influence	- Long canal with 3 irrigation areas. - Close coordination with CIE
Pump Irrigation	Repair of existing pumps operated by diesel generators			No influence	- Same condition of previous failure
	Repair of Existing Pumps operated by Electricity			No influence	- High electricity tariff

Considering the influence of the up surge of headworks to the right bank classified forest area and previous failure of the irrigation system, it is possible to say that there are three (3) alternative intake plans to be considered; Alternative 1: Weir intake at south of Cpt. Colonel, Alternative 2: Grand Canal from the San-Pédro dam and Alternative 3: Pump rehabilitation and operated by electricity. The values of EIRR from corresponding alternatives are as follows:

Item	1. Pump Rehabilitation	2. Installation of Water Intake	3. Grand Canal
EIRR	18.1 %	10.1 %	11.3 %
Project Cost	F.CFA 3,529 mil.	F.CFA 6,704 mil.	F.CFA 6,358 mil

From the above, as the project cost of Alternative 1 with F.CFA 3,529 mil. (where the rehabilitation cost for the pump: F.CFA 140 mil.) is the lowest, its EIRR of 18.1 % is the highest among the three (3) alternatives. For the Alternative 2, as its project cost of F.CFA 6,704 mil. is the highest, its EIRR of 10.1 % is found to be low. For the Alternative 3, despite its long distance for water conveyance, the installation is not so complexed, resulting in a rather low construction cost of F.CFA 6,358 mil. and an EIRR of 11.3 %. From the national economic viewpoint for project implementation, the Alternative 1 (pump irrigation) is the best opportunity for investment.

After the completion of the project facilities, for the realization of facility management by farmers themselves, the low charge on operation and maintenance costs by farmers will be the most important issue for a sustainable project management. The operation and maintenance costs per ha including replacement cost for each alternative is shown as follows:

Items	1. Pump Rehabilitation	2. Installation of Water Intake	3. Grand Canal
Operation Cost and Replacement Cost	F.CFA 169,000	F.CFA 107,000	F.CFA 98,000

From the above table, with the Alternative 1 (pump irrigation), operation and maintenance costs will be F.CFA 169,000, or about 1.7 times those of Alternative 3 (Grand Canal) as F.CFA 98,000. For making no pressure on farmers' living conditions as well as for improving their living standards, the Alternative 3 is considered as the best one.

It is impossible to realize a sustainable development and to contribute to the improvement of the farmers' living standards, if its farming plan is considered vulnerable to the change of external conditions even though the project shows a good economic return from the national economic viewpoint. The heavy burden of operation and maintenance costs is considered as one of the reasons why the San-Pédro Paddy Irrigation Project was failed although the pumping units were replaced by the external assistance. It is necessary to mitigate such burden of the farmers as much as possible in order to make the project bearable to the changes of external conditions such as fluctuation of rice price due to the change of future economic situations toward sustainable development project.

Considering the above contexts, the San-Pédro Paddy Development Project area has been selected as the priority area for the further feasibility study, and the irrigation water for the area will be taken at the existing intake on the San-Pédro dam providing a new conveyance canal (Grand Canal) of 18.2 km for conveying the irrigation water (Alternative 3).

3) Other rehabilitation works

In addition to the intakes, the following rehabilitation works will be included in the project:

Item	Rehabilitation Works
Rehabilitation of irrigation facilities	- Irrigation canal lining- decrease water losses and head losses - Reconstruction of irrigation facilities including gates and checks - Improvement of O&M and inspection roads (rural roads) - Tertiary irrigation canal (by farmers)
Land leveling	- Securing of proper water ponding in each plot - Confirmation of equalized water distribution - Down sizing of plots by bunds and land consolidation or redistribution
Drainage improvement	- Maximization of cultivable land - Rearrangement of drainage system - Proper drainage management - Installation of retarding basin - Increasing road crossing culvert

4) Work Items and volume

Description		Work Volume			Remarks
		Alternative 1	Alternative 2	Alternative 3	
Water Intake Facility	Headworks installation	1 unit		-	
	Intakes in San-Pédro dam	-	1 unit	-	
	Rehabilitation of Existing pumps	-	-	1 unit	
Head Race		8.1 km	18.2 km	-	concrete lining
Irrigation Facilities	Primary Canal	5.7 km			concrete lining
	Secondary Canal	7.5 km			concrete lining
	Tertiary Canal	20.1 km			
Farmland Re-Leveling		575 ha			
Drainage Facilities	Primary Drainage Canal	3.4 km			
	Secondary Drainage Canal	10.3 km			
Road Works	Primary Road	5.1 km			grading
	Secondary Road	19.6 km			grading
	Inspection Road	11.7	21.3 km	- km	

(2) Fahé Area Irrigation Development

Fahé irrigation project area is located just downstream of San-Pédro dam on the left bank with potential gross area of 430 ha (or 300 ha in net). The area spreads with 0.2 % slope southwards. And the southern boundary faces the casual flooding area caused by the flooding of the San-Pédro and Niré rivers. Presently, tree crops are planted on the elevated area and maize and paddy are cultivated in bas-ponds. Rubber tree plantation has started to extend from northern part of the area recently. There is no irrigation system in the area. Un-paved roads penetrate the area from the San-Pédro dam on the western border and at the center of the area. Upstream portion of the San-Pédro Grand Canal (at 4.3 km) is used as the head race canal of the Fahé irrigation project. And other major works of the irrigation and drainage facilities are summarized as follows:

Work Item		Work Volume	Remarks
Irrigation Facilities	Primary Canal	6.0 km	concrete lining
	Secondary Canal	6.0 km	
	Tertiary Canal	18.0 km	
Farmland Leveling		300 ha	reclamation
Drainage Facilities	Primary Drainage Canal	7.5 km	
	Secondary Drainage Canal	12.0 km	
Road Works	Primary Road	15.0 km	grading
	Secondary Road	6.0 km	grading

(3) Cpt. Colonel Area Irrigation Development

Cpt. Colonel irrigation area is located about 1.5 km south from Cpt. Colonel village. This area is spreading on the almost flat alluvial plain with 130 ha in gross (or 90 ha in net). Presently, this area is covered with forest and maize and upland paddy cultivation, and is inundated by the flood water from the San-Pédro river and its tributary coming from IDEFOR area. The area can be irrigated by pumped water from the San-Pédro river or the San-Pédro Grand Canal (at 10.1 km). Topographic condition of upstream restricts the small dam construction for the irrigation of this area. The major works for the paddy irrigation development in this area are estimated as follows:

Work Item		Work Volume	Remarks
Irrigation Facilities	Primary Canal	1.8 km	concrete lining
	Secondary Canal	1.8 km	
	Tertiary Canal	5.4 km	
Farmland Leveling		90 ha	reclamation
Drainage Facilities	Primary Drainage Canal	2.3 km	
	Secondary Drainage Canal	3.6 km	
Road Works	Primary Road	4.5 km	grading
	Secondary Road	1.8 km	grading

(4) Water Balance on Actual River Flow

To confirm the allocation of surface water resources, the water balance is examined on daily basis. The daily mean discharges observed in the Fahé gauging station from April 1, 1992 to March 31, 1996 is applied for the simulation. The annual summary of the calculation is tabulated below.

Hydrological Year	Flow-in Dis. (m^3/s)	Flow-in Vol. (MCM)	Irri. Vol. (MCM)	Hydro-Power (MCM)	Operation Hours	Run-off Vol. From Spillway (MCM)	Min. Dis. At Tail of Dam (m^3/s)
1991 – 1992	24.05	764.70	28.72	468.72	5,208	267.23	1.98
1992 – 1993	14.74	465.20	28.72	312.21	3,469	138.60	0.84
1993 – 1994	15.21	481.60	28.72	341.55	3,795	111.33	2.22
1994 – 1995	29.03	917.18	28.72	536.40	5,960	347.93	1.79
1995 – 1996	21.25	670.10	28.72	482.85	5,365	162.82	5.14

As shown in the table, the inflow volume to reservoir varies from 465 MCM to 917 MCM, and the surface water resource is generally considered enough to provide irrigation water to the proposed command areas, and about 3,469 hours of hydropower generation is considered possible. The minimum discharge at the tail of dam reaches to a minimum of 0.84 m^3/s. This discharge is considered enough to fulfill the municipal water supply demand which is estimated at about 350 lit./s for 2015.

F.3.3 Prioritization of Projects

From the evaluation of the priority projects, the lowland paddy development program is selected as the most effective and urgently required to implement. Then herein, the priority project areas of the paddy development for the feasibility study in the Study are considered among the following areas:

1) San-Pédro Paddy Project Area
2) Cpt. Colonel Area
3) Fahé Area

Through the comparison of these three (3) areas based on the socio-economic circumstances, etc. for project implementation, the highest priority project site for the feasibility study has been selected accordingly. The social and economic features of each aforementioned area are shown in Table F.3.1.

The San-Pédro Paddy Development Area in the downstream has a high IRR of 22.4 % and a highest beneficiary population of 383 families. As this area has been equipped with irrigation facilities, the rehabilitation of these facilities will offer high impacts to the project. Besides, as the farmers presently living in this area have experiences on paddy cultivation, the effectiveness from extension of farming techniques, therefore, can be expected. From these viewpoints and based on socio-economic conditions, the area of San-Pédro Paddy Development Project is evaluated as the most suitable site for priority project.

Considering the above contexts, the San-Pédro Paddy Development Project area has been selected as the priority area for the further feasibility study, and the irrigation water for the area will be taken at the existing intake on the San-Pédro dam providing a new conveyance canal (Grand Canal) of 18.2 km for conveying the irrigation water (Alternative 3). It is necessary to study on the possibility to include other programs proposed as the components of the master plan as well as the elements for the necessary irrigation facilities, reinforcement of farmers' organization and possibility of step-wise implementation of the project. Especially, it is necessary to propose the measures required for farmers' organization and agricultural extension to be considered in such step-wise implementation.

F.3.4 Proposed Implementation of Irrigation Development Master Plan

Based on the prioritization components of integrated rural development, projects/programs shall be implemented. During the medium term period high priority project/program, the rehabilitation of San Pedro Paddy Development Project Area, shall be implemented based on the availability of the finance and other sector development programs. Based on the evaluation of medium term activity results, the next project and program such as Fahé and Cpt. Colonel irrigation development will be implemented up to the long term target year of 2015.

F.3.5 O&M Plan for Irrigation Development Master Plan

Basically, all project/program shall be operated and maintained by the farmers' or villagers organization and farmers' participation. Appropriate advice and guidance shall be given them by ANADER and MINAGRA

O&M works for irrigation system is consist of 1) water management, 2) facility maintenance and

3) administration as shown in F.4.7.

All farmers' organizations (OPAs) in the irrigation command area shall be established a water users' organization for the O&M of irrigation and drainage supervised by ANADER. Some part of water management and facility maintenance is carried by private institutions on contract bases.

F.4 Feasibility Study of Priority Projects

F.4.1 Irrigation Planning

(1) Climate Conditions

Mean monthly climatic data at San-Pédro Airport between 1984 and 1997 and IDEFOR San-Pédro Station between 1975 and 1998 are available. The San-Pédro Airport locates south of the Study Area and has daily records full element of meteorology. But available record of the IDEFOR-San-Pédro Station locates at the middle of Study Area is limited on temperature and rainfall by decade.

(2) Irrigable Area

Basically the irrigable area of the Project is the same as the previous ARSO/SODERIZ developed area covering about 600 ha. The following modification of the area is made on the irrigable area:

a) Involve the northern extension area that is presently irrigated by another pump separately.
b) Omit the southernmost area which is irrigated by separate pump but is included in the San-Pédro Port Extension Area.

Total gross irrigable area excluding the hilly area spreading in the Project Area is estimated at 766 ha. Net irrigable area is estimated to be 75 % of gross area, 575 ha, after considering the area to be occupied by irrigation and drainage facilities (Fig. F.4.1).

(3) Irrigation Method and Cultivation Block

1) Irrigation method

As is practiced for paddy cultivation, the proposed irrigation method is the flooding one bounded by the field levee. As the irrigation water is conveyed through 18.2 km long Grand Canal from San-Pédro Dam, the irrigation water supply is made for 24 hour a day continuously when it is required. No farm pond is considered. Irrigation area is divided into three rotation blocks based on the canal alignment. The irrigation water distribution is to be rotated block by block and each rotation be made within 10 days.

2) Arrangement of farmland block (Fig. F.4.2)

Field Lot

- Considering the mechanized cultivation, the size of field lot is 20 to 30 m x 100 m (0.2 to 0.3 ha)
- A field lot is the minimum area of land leveling and crop diversification.
- A field lot shall be surrounded by the fixed earth levee with 30 cm crest wide and maximum 30 cm high tripod.
- A field lot can be divided into several lots by providing temporary levee.
- A field lot is the unit of irrigation to be made a day.

Field Block

- Individual farmers are provided with 1.5ha field.
- Basically, one field block is divided into 20 field lots.
- A field block is irrigated within 5 days.

Irrigation Block

- The irrigable area in the Project Area is divided into 4 irrigation block based on the irrigation canal command area
- An irrigation block is irrigated within 10 days

F.4.2 Irrigation Water Requirement

(1) Estimation of irrigation water requirements

Irrigation water requirements are composed of crop water consumption, puddling water for land preparation, ponding water for field management and irrigation losses based on the cropping calendar. The paddy is mainly cultivated in the Project Area and tomato or other vegetables are planned to cultivate in small area in the dry season. Since the water consumption of paddy is larger than that of tomato, then the irrigation water requirements are estimated based on the paddy cultivation. The estimation has made been using the following procedure on the 10-days basis.

(2) Reference evapotranspiration(ETo)

Crop water requirement is estimated based on the revised FAO method, Penman-Monteith method described in FAO Irrigation and Drainage Paper No.49. Using the climatic data shown above, the reference evapotranspiration(ETo) is calculated by the CROPWAT for windows developed by FAO and IIDS. The calculation results are shown as follows:

San-Pédro AP	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ETo (mm/day)	3.8	4.1	4.4	4.3	3.9	3.9	3.4	3.2	3.4	3.9	3.8	3.5

(3) Crop coefficients (Kc)

Referring to the crop coefficient shown in FAO Irrigation and Drainage Paper No.24 and coefficients applied for similar projects, crop coefficient (Kc) at each paddy growing stage is decided.

(4) Percolation losses

Pounded water in the paddy field percolates to the underground. Percolation loss is estimated at 5 mm/day considering the soil types and topographic conditions of the Project Area.

(5) Puddling water requirement

Considering the soil water holding characteristics and root depth of paddy, the puddling water requirement needed before sowing paddy is set at 150mm. The puddling period in each tertiary block is planned to be within 10 days.

(6) Effective rainfall (ER)

i) Drought rainfall

Crop-water-needs can be fully or partly met by rainfall. The dependable level of rainfall is set as selected 4 years out of 5 years. This means that the irrigation plan is made based on the drought probability being 20 % (1/5 year). It is favorable to use rainfall data of longer period in order to obtain the better results, then the drought monthly rainfall data at IDFFOR are analyzed and drought rainfall is estimated as shown below:

ii) Effective rainfall

Effective monthly rainfall is estimated based on the USA Soil Conservation method using the drought rainfall of 20 % probability at IDDEFOR-San-Pédro station between 1972 and 1998.

(unit mm/month)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly mean rainfall	17.5	48.3	82.9	108.0	239.7	366.0	91.4	66.5	76.2	128.4	90.3	38.8
Probable monthly rainfall	14.9	41.0	70.4	91.7	203.6	310.9	77.7	56.5	64.7	109.0	76.7	33.0
Effective monthly rainfall	14.5	38.3	62.5	78.2	137.3	156.1	68.0	51.4	58.0	90.0	67.3	31.3

(7) Nursery bed requirement (NW)

Proposed farming plan of the paddy cultivation is prepared on condition that the direct sowing is applied for 50 % of the field and transplanting for the remaining. In the case of direct sowing, paddy field shall be of no ponding condition after puddling is completed. For transplanting, the nursery bed is required at 5 % of total paddy field. In the plan, 50 % of normal Kc is applied for the field of direct sowing for 20 day period immediately after sowing.

(8) Field ponding water depth (PM)

Water ponding of 75 mm during paddy growing period is considered up to 20 days before harvesting.

(9) Irrigation efficiency(Ei)

Considering the efficiency of the operation and maintenance of the canal, the main irrigation canal is planned to be of concrete-lined one up to the secondary canals. Referring to standards and previous experiences, the irrigation efficiency of the Project is set at 65% as shown below:

Efficiencies	Condition	Efficiency
Conveyance Efficiency(Ec)	Continuous supply with no substantial change flow*	90 %**
Field Canal Efficiency (Eb)	Block larger than 20 ha, lined*	90 %
Field Application Efficiency (Ea)	Surface irrigation, basin and level border	80 %
Irrigation Efficiency (=Ec*Eb*Ea)		65 %

Notes: * ICID/ILRI, FAO Irrigation and Drainage Paper 24,

** Moritz formula for canal seepage losses :

$S = 0.0619 * C * \sqrt{} Q / V$ where S = Seepage losses(m^3/sec/km), Q = Discharge (m^3/sec), V = velocity (m/sec), C = coefficient (minimum for sandy loam cemented with gravel and soil pan at 0.06). Then Q=1.2(m^3/sec) and V=0.8(m/sec), S=0.0045(m^3/sec/km). Increase of canal length 18 km, S=0.082(m^3/sec). It is equivalent to 6.8% of canal discharge.

(10) Unit Irrigation water requirement

As the results of the above items and cropping calendar, the unit irrigation water requirement is set at 1.62 lit/sec/ha (Table F.4.1).

F.4.3 Irrigation Facilities

(1) Intake

1) Present Conditions

The original plan of industrial development for the San-Pédro Dam was cancelled after installation of water intake on the San-Pédro Dam in 1970s. The existing industrial water intake is planned to be utilized as the intake of irrigation for the Project. Its structural details are obtained by the contractor of the Dam. Intake tower and its gates were confirmed by the Study Team in January 1999, but the conduits under the Dam embankment could not be confirmed.

According to the workers who were the labour of intake structure in Fahé, the construction of the conduit was stopped in the Dam embankment.

Main structure of the intake facility of bank cross conduit was set on the original land under the dam bank. The bottom elevation of conduit is EL=13.95 m above the sea level. Compared to the water level of San-Pedro Dam high water level (H.W.L.) of EL=23.10 m and bottom elevation of the conduit, the intake structure is strained by the high inner water pressure. In addition, the transition water level for the Grand Canal of EL=18.30 m will be 5.0 m low from the H.W.L. of the dam. The intake facility should endure seepage from the dam.

2) Design of Intakes

According to careful field observation and detailed inspection of as built drawings, the following viewpoints are made. These conditions were discussed before starting the design of project facilities.

(a) L.W.L (Low water level) of San Pedro Dam is higher than intake water level. Stable temporary work in the dam for dry work is necessary.
(b) The conduit under the dam bank is strained under high water pressure. Watertight structure for bank crossing should be constructed.
(c) Water seepage from the structure will become a serious cause for a flood disaster.

The intake facilities were designed as follows (Fig. F.4.3):

(a)	Intake Gate	Two manual operation intake gates in the Dam with a dimension of 1.6 x 1.3 m should be replaced. Temporary cofferdam or stop log strengthening works should be necessary for gates replacing under drying work.
(b)	Conduit	The conduits should be extended from the end of existing conduit. The extension conduits were structured by 1.5 x 2.5 m concrete box culverts. And the joint between proposed and existing structure should be covered by reinforced concrete collar for the protection from the inner water pressure seepage. Long distance concrete box culvert is suitable for protection from water seepage outside of the structure.
(c)	Connection Pipe	The intake facility needs watertight structure and stable protection work from inner water pressure. Steel pipe structure is suitable for conduit extension to the ground level. After crossing existing road, a butterfly valve with box shall be installed to control intake water discharge.
(d)	Measurement Structure	The triangular notch weir should be installed at the starting point of the Grand Canal for the discharge measurement.

(2) The Grand Canal

The Grand Canal of 18.2 km is the conveyance canal conveying the irrigation water from San-Pédro Dam to the Project Area through the future irrigation areas of Fahé and Cpt. Colonel (Fig.F.4.4). Considering the operation and maintenance, the Grand Canal shall be of concrete lining with 10 cm thick. Inspection road for the operation and maintenance of irrigation canal shall be provided along the Canal. The road is also considered as the main rural road of the Study Area transporting the agricultural products along the Grand Canal.

1) Design Discharge

The calculated canal capacity is 0.93 m³/sec for irrigating 575 ha of the Project Area. Due to the consideration of the further extension of the irrigation area at the upper reaches, the cross section of the Canal has been determined. According to the longitudinal survey results, ground slope and required canal capacity of its each section are shown as follows:

Section No.	Section	Command Area (ha)*	Required Canal Capacity (m³/sec)	Slope
1	Intake up to main diversion for Fahé Area	965	1.56	1/800
2	Fahé main diversion to Cpt. Colonel	665	1.08	1/1,000 1/4,000
3	Cpt. Colonel to Main canal of San-Pédro Paddy Irrigation development	575	0.93	1/4,000

Note : * including future extension.

2) Longitudinal and Cross Sectional Design

The Grand Canal route was selected following the existing village road. And the route can be divided into two categories such as hillside route and swamp route. Considering the earthwork costs of excavation and banking, the longitudinal section of the canal was followed to the existing ground slope. The concrete lining canal was planned for the smooth water transportation and maintenance work.

The swamp area route needs the following considerations:

1) Soft soil foundation and consolidation settlement for banking
2) Uplifting force for canal lining by ground surface water
3) Inundation water from the San Pedro river

The design of Grand Canal swamp areas was made by selecting the high banking method. This counter measurement can solve the above three consideration items. The following table shows the basic information and dimension of the canal.

Section No.	Section	Required Canal Capacity (m³/sec)	Longitudin al Slope (1m/length)	Canal bed width (m)	Depth (m)	Velocity (m/s)
1	Intake up to main diversion for Fahé Area	1.56	1/800	1.0	0.710	1.287
2	Fahé main diversion to Cpt. Colonel	1.08	1/1.000 1/4,000	1.0 1.0	0.619 0.887	1.075 0.644
3	Cpt. Colonel to Main canal of San-Pédro Paddy Irrigation development	0.93	1/4,000	1.0	0.824	0.620

The plan and profile of the Grand Canal is shown in Fig. F.4.5, and the standard cross section is shown in Fig. F.4.6.

3) Related Structures

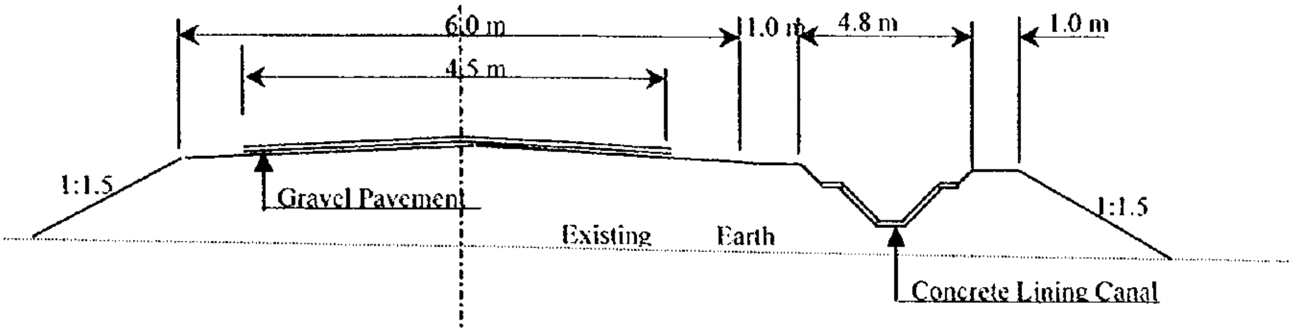
The Grand Canal passes through many swamps and tributaries and also crosses the rural roads, resulting eight siphons, seven box culverts and fourteen drainpipes to be installed. Following structures were planed on the Grand Canal and irrigation canals.

a. Diversion Diversions should be set on the intake of distribution canals or

		outlets. This structure consists of diversion box, sluice gates, box culvert bridge and water measurement structure.
b.	Spillway	After the diversion works were set, spillway should be constructed on the bank. This structure functions for canal bank protection from the over flowing irrigation water discharge. This structure consists of 10 m flood way on the canal bank that is protected by 15 cm thickness reinforced concrete.
c.	Box Culvert Bridge	The canal alignment crosses some village roads and the box culvert structure should be planed at these road crossings. This structure is set along the canal with the same sectional discharge area (Fig.F.4.7 and 4.8).
d.	Cross Drain (pipe culvert)	Across the Grand Canal route, there are some existing streams and canals. For the construction of the canal and road body banking work, these canals should be connected to the existing canal lines. The Pipe Culvert cross drains are adopted.
e.	Siphon	Some swamp areas are located in the Grand Canal route. Geological survey showed the deep and soft soil layers under the areas. Siphon is the effective way to cross the swamp areas. The siphon is planned reinforced concrete box culvert. (Fig. F.4.9)

4) Inspection road and related structures

The inspection road is constructed along the Grand Canal. The inspection road also functions as the main rural road for the villagers along the Canal. The width of the road is 6 m and the gravel pavement is constructed at 4.5 m width for allowing the passage of two pick-up tracks. Its total length is almost the same as that of the Grand Canal.



Typical Cross Section for the Grand Canal and its Inspection Road

(3) Irrigation Canal

1) Category of irrigation canal

Irrigation canals were divided into the following four categories:

(a)	Primary Canals	These canals are the trunk line of the irrigation system in the priority area. The canals send water directly to the intakes of secondary canals. The discharge of the canals range from 0.93 m^3/s to 0.24 m^3/s.
(b)	Secondary Canals	Secondary canals receive irrigation water from primary canals and convey them to turnout of tertiary canals. The discharge of these canals range from 0.18 m3/s to 0.06 m^3/s.
(c)	Tertiary Canal	Tertiary canals transport irrigation water to field blocks.
(d)	Farm Ditch	Farm ditches supply irrigation water to each field lot.

2) Arrangement of irrigation canals

Net irrigation area is 575 ha. It is divided into four irrigation blocks. A-block is located in the western part covering 64 ha. B-Block is located in the central part covering 194 ha. C-Block is located in the eastern part covering 227 ha. D-Block is located in the northern part covering 89 ha. The water measurement devices such as the Parshall flume are installed at the first diversion structure of each block. Irrigation schematic diagram is shown in Fig. F.4.10.

Almost all the primary and secondary canals are aligned as same as the existing canal route (Fig. F.4.1). Total lengths of the canals are 5.7 km of the primary canal, and 7.5 km of the secondary canals, and 20.1 km of the tertiary canals. Plan and profile of the proposed irrigation canals are shown in Fig.4.11.

3) Primary canal

The Primary Canals covers 575 ha of net irrigation area. It is divided into two primary canal lines after sending water to 47 ha of irrigation area by north secondary canal. An area of 43ha is irrigated directly by the primary canal. The West Primary Canal irrigates 258 ha connecting west and central secondary canals. The East Primary Canal supplies irrigation water to 227 ha through east and south secondary canals. The water measurement devices of the Parshall flume are installed at the first diversion structure of secondary canals.

Total canal length of the Primary canals was 5.7 km. The canals were planned on the ridge of the priority project area. The purpose of the canals is to support the existing canal network that were constructed for pump irrigation system. The longitudinal design is made based on the transit water head of the secondary canal diversions. The canals were categorized by discharge capacity. Canals with a discharge capacity of above 0.20 m^3/s are defined as Primary Canals.

i) Canal Section

Most portion of canals should be constructed on the high mount of earth bank. Concrete lining canal is adopted for less water leakage, bank stability and to reduce O&M cost of irrigation canal as shown in Fig.F.4.12.

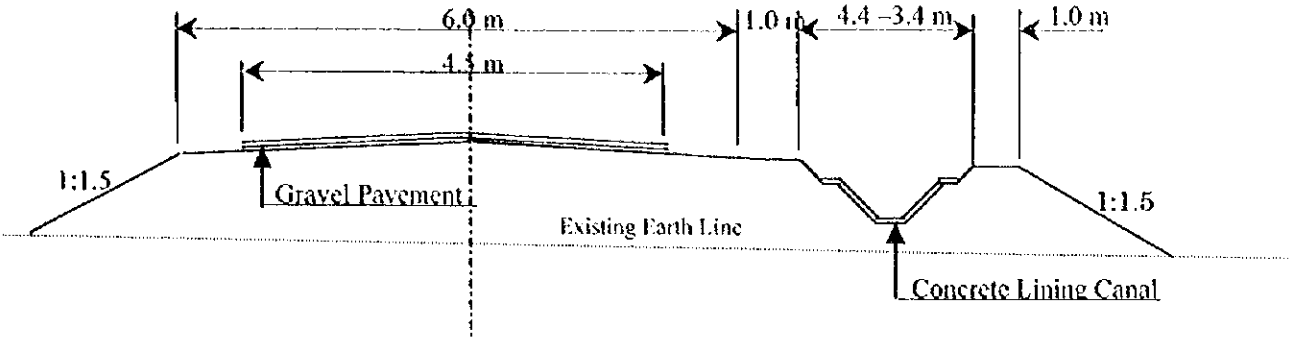
ii) Related Structures

Most of the existing structures need repair/re-insulation because of deterioration and change of canal structure from earth lining to concrete lining is also required. The following structures should be constructed on the Primary Canals.

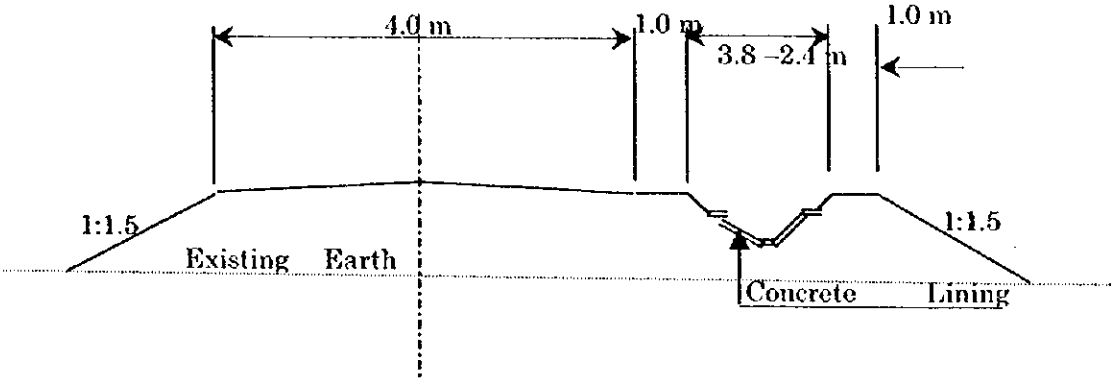
a)	Diversion	Diversions should be set on the intake of secondary canals. This structure consists of diversion box, sluice gates and box culvert bridge for operation. (Fig. F.4.13)
b)	Spillway	After the diversion works were set, spillway is necessary for canal bank protection. This structure consists of 10 m flood way on the canal bank that is protected by 15 cm thickness reinforced concrete.
c)	Cross Drain	According to the canal network setting, existing drainage streams cross under the Primary Canal route. Cross drain structure should be planned for the stream crossing. These structures were made of reinforced concrete box culvert.

iii) Inspection Road

Inspection roads of primary canals are considered as the main farm roads except for the West primary Canal. They are planned to be of 4.5 m width of gravel surface with an effective width of 6.0 m. Inspection road of the West Primary Canal was planned as 4.0 m effective width as standard inspection road section.



Typical Cross Section for the Primary Canal and East Primary Canal



Typical Cross Section for the West Primary Canal and Secondary Canals

3) Secondary Canals

Secondary canals are laid on the existing water distribution canal network to keep the existing farmer's water management system. Total lengths of the proposed canals are 7.5 km.

i) Canal section

These canals should be constructed on the high mount earth bank. Concrete lining canal is adopted for less water leakage, strengthening of bank stability and reducing O&M cost of the canals.

ii) Related Structures

The following structures are planned on the Secondary Canals.

1)	Diversion	Diversions should be set on the intake of tertiary canals. This structure consists of diversion box, sluice gates, box culvert bridge and water measurement structure.
2)	Spillway	At the rear side of the diversion works, spillway is necessary for canal bank protection. This structure consists of 10 m flood way on the canal bank that is protected by 15 cm thickness reinforced concrete.
3)	Cross Drain	According to the canal network setting, existing drainage streams cross under the irrigation canal route. Cross drains were set under the banking body to keep smooth drainage condition of the target area. The structures consist of concrete box culvert or pipe culvert.

(6) Operation and Maintenance (O&M) Road

O&M roads of primary and secondary canals are considered as the main farm roads. They are planned to be of gravel surfacing with effective width of 6.0 m for the primary road along the primary canal, and to be of earth surfacing with effective width of 4.0 m for the secondary roads along primary, secondary and tertiary canals. Existing O&M roads are under rather better condition and to be improved under the Project.

F.4.4 Drainage Conditions

(1) Present Drainage System and Constraints

The drainage condition of the Project Area is generally characterized by the flood prone nature and poor drainage capacity due to low elevation of the area as shown in Fig. F.4.14. The floodwater of the San-Pédro river reaches sometimes the low lying areas around Grand Gabo, and flows into the Gonou river and the small channels in the paddy areas together with the run-off of the Gonou river itself.

The drainage water consisting a part of flood in the upper Gonou and the San-Pédro is at present removed by gravity through the drainage channels in the area. When the previous paddy irrigation project was implemented, these drainage channels were constructed by merely improving the existing natural streams resulting complicated drain networks.

There are three (3) drainage channels flowing directly into the San-Pédro river, but they do not function as expected because of the inundation along the San-Pédro river during the flood. In the eastern side of the area, there exist two (2) streams flowing into the Geranova river. This area is also suffered from poor drainage capacity because of water stagnation occurred near the conjunction with the San-Pédro river. Some flood protection dikes are constructed along the San-Pédro and the Gonou rivers to mitigate the intrusion of such flood and run-off from the outside of the paddy areas, but they are found to be insufficient.

Considering the above situation, the drainage system is proposed as follows:

- Flood protection dikes shall be provided along the northern side of the Project Area to prevent the intrusion of the floodwater from the San-Pédro river and the run-off from the Gonou river.
- In order to facilitate the drainage effects by gravity in normal time and to prevent the intrusion of stagnated water from the San-Pédro river during the flood, drainage sluices shall be provided at the drainage outlets.
- The existing drainage canals shall be improved by dredging in order to facilitate smooth flow of drainage water as well as to reduce the waste land for development.
- To reduce the drainage load in downstream of the drainage system especially in the southern part of the area, the drainage water of the northern extension area (D-Block) shall be planned to be removed separately to the San-Pédro river.

(2) Drainage Requirement

Taking into account the importance of the system and the growing of paddy, the sum of continuous three (3) days rainfall of 10-year return period is employed for determining the drainage requirement in the Project Area. The unit drainage requirements for the paddy fields and the other areas are proposed to be 7.75 lit./sec/ha and 33.53 lit./sec/ha, respectively.

1) Paddy Area

The targeted drainage system aims to drain the probable three days rainfall in the project area smoothly within three days by the proposed drainage facilities. The calculation method for drainage discharge estimation is a kind of rational formula analysis. The rainfall in the area should be drained after temporary storage for a period in the fields, although total draining time should not exceed three days. This method is applied to the terminal lots for the paddy monoculture and can allow inundation to a certain extent.

Estimated unit drainage discharge for three days is calculated by average rainfall intensity which is the equivalent depth of average rainfall intensity from the ten years return period three days rainfall, runoff coefficient and unit area. The calculation formulae are as follows.

Average rainfall intensity (r) is calculated by the following formula

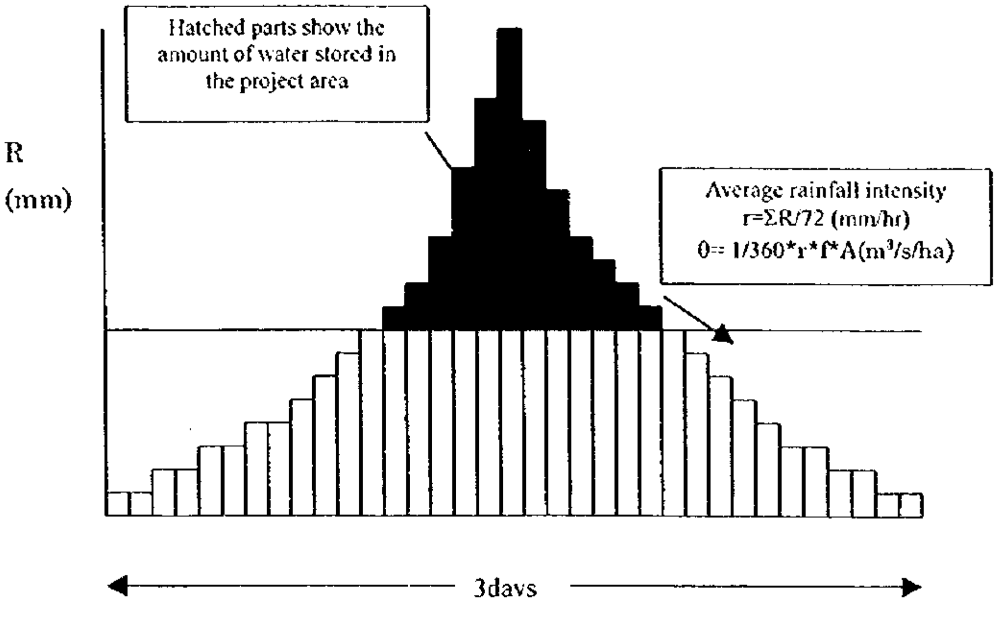
$r = \Sigma R / 72$ (mm/hr)

where:
r: average rainfall intensity (mm/hr)
ΣR: 3 days total rainfall (mm)
72: total hours of 3 days

Estimated unit drainage volume is calculated by the following formula

$0 = 1 / 360 * r * f * A$ (m^3/s/ha)

where:
0 :unit drainage discharge (m^3/s/ha)
r : rainfall intensity (mm/hr)
f : runoff coefficient
A: unit area (ha)



According to the result of hydrological calculation, three days rainfall for ten years return period for is estimated as 287.00 mm/hr. Also the runoff coefficient (f) was observed as 70%.

$r = 287 / 72 = 3.986$ (mm/hr)

$0 = 1/360 * 3.986 * 0.7 * 1$ (m^3/s/ha)

$=0.00775$(m^3/s/ha) = 7.75 (l/s/ha)

2) Hillside Area

The priority Project Area has some amount of runoff basins in the outside area. The basins consist of small hills, which are covered by forest or tree crops. The runoff system of this area has a difference with the paddy area. The rational formula method is applicable to the hill side catchment area located outside the Project Area, which will cause torrential runoff.

Estimated unit drainage discharge for this area is calculated by one hour average rainfall intensity for the ten years return period rainfall, runoff coefficient and unit area. The calculation formulae are as follows.

Average rainfall intensity (r_t) is calculated by Sharman's formula

$r_t = r_{24}$ x $(24 / T)^{0.5}$ (mm)

where: r_t: 24 hours total T hour rainfall
r_{24}: Ten years return period 24 hours rainfall
T: Runoff concentration time (one hour)

$r = r_t / T$ (mm/hr)

where: r: Average rainfall intensity

Estimated unit drainage volume is calculated by the following formula

0 =x r x f x A (m^3/s/ha)

According to the result of hydrological calculation, the 24 hours rainfall for 10 years return period was estimated 197.13 mm/hr. Also the runoff coefficient was observed as 30%.

r_t = 197.13 x $(24 / 1)^{0.5}$ (mm)
=965.74
r =965.74 / 24 = 40.24 (mm/hr)
0 = 1/ 360 x 40.24 x 0.3 x 1 (m^3/s/ha)
=0.03353 (m^3/s/ha) = <u>33.53 (l/s/ha)</u>

F.4.5 Drainage Improvement

(1) Drainage Canal System

Drainage canals were divided into two categories.

(a)	Primary Drainage Canal	Primary drainage canal is the trunk line of the drainage system in the priority area. The discharge of the canal ranges from 13.4 m^3/s to 6.0 m^3/s.
(b)	Secondary Drainage Canal	Discharge of the secondary drainage canal ranges from 4.7 m^3/s to 3.0 m^3/s.

(2) Route and Design Discharge

The present drainage channels should be improved by dredging to facilitate the drainage effects. The drained water of the north secondary drainage was removed separately to the San-Pédro river by constructing new drainage canal, and that of eastern part of the area was removed towards the Geranova river by improving the existing drains. The drainage water of the remaining areas was planned to be removed to the San-Pédro river directly. The drainage canals were categorized by discharge capacity. A discharge capacity of over 6.0 m^3/s was defined as Primary Drainage Canal and over 3.0 m^3/s was defined as Secondary Drainage Canal. The approximate distance of the proposed Primary Drainage Canal was 3.4 km and that of the Secondary Drainage Canal was 10.3 km. Plan and profile of the proposed drainage canals are shown in Fig.4.15.

(2) Canal Section

The existing drainage canals were formed by old San Pedro river stream as the river tracing way. The width of the canal is large but the depth is shallow because of sedimentation. The drainage canals were planned on the existing canal alignment following existing canal network except the North Secondary Drainage Canal. The construction works for the Primary and Secondary drainage Canals are the dredging works on the existing canal alignments.

(3) Related Structures

Following structures are planed on the Primary and Secondary Drainage Canals.

1)	Cross Drain	According to the canal network plan, proposed drainage canals cross the main and secondary project road. Culverts and cross drains for the drainage canals should be provided as required. The required number of such crossing structures on the primary and the secondary drainage canals are seven for road crossing.
2)	Sluice Gate	Drainage sluices are proposed to be constructed in order to facilitate the gravity flow in normal time as well as to prevent the flood water intrusion from the rivers during flood. These structures should be operated by farmer. Sluice gates were attached on the box culvert type cross drain.
3)	Flap Gate	Flap Gates are planned as the same purpose as sluice gates. These types of gates are controlled automatically by water surface level. Those gates shall be set on the box culvert cross drain under the secondary project roads and flood control dike.
4)	Flood Protection Dikes	There are some flood protection dikes along the San-Pédro and the Gonou rivers to prevent the area from the intrusion of flood water. To make such protection from the flood intrusion completely, it is proposed to provide some additional dikes especially along the Gonou river. The existing dikes shall also be repaired and heightened.

F.4.6 Farm Road Network

The designed roads are specified as follows.

(1)	Main Road	The farm road links between farm and village and/or main country road. The road has 6-m width, with 4.5-m gravel pavement. The elevation of this road surface from the irrigation canal water level is 50-cm plus canal free board.
(2)	Lateral Road	Lateral farm road links the main farm road and field block. This road has 4-m width. The elevation of this road surface from the irrigation canal water level is 50 cm plus canal free board.
(3)	Inspection Road	Grand canal (head race canal) has an inspection road. This road is not only for the canal inspection, but also acts as a trunk road for villages. The road width is 6 m, with 4.5 m of gravel pavement. The elevation of this road surface from the irrigation canal water level is also 50-cm plus canal free board.

F.4.7 On Farm Development

(1) On Farm Works

On-farm works include the tertiary canal and drains, diversion box, farm roads and land consolidation. Considering group cultivation especially land preparation by power tiller and the standard holding area of the farmers, the standard area of tertiary block is determined as 15 ha.

Most of the reclaimed paddy field in the Project Area is incomplete. Therefore, the land leveling works shall be implemented in all the paddy field in the Project Area. The leveling shall be implemented based on field survey in each lot, and the surface soil handling shall be applied to avoid uneven growth of rice at the initial cropping period. Considering the weed control, the ponding depth during paddy growing period is set at 7 cm. Therefore, the degree of leveling shall be ±7 cm in each plot.

According to the sample survey, the undulation of existing paddy field ranges between ±12.5 and ±20.5 cm after dividing into the proposed field lots of 0.3 ha. Therefore, careful survey shall be made for determining the field elevation during the detailed design stage.

The land readjustment plan was made in view of the shape and size of farm lot, layout of irrigation and/or drainage canals and farm road. The farmland was classified into three categories as (a) field lot, (b) field block and (c) farm block.

(a)	Field lot	Field lot is the smallest unit of farmland that is bordered by boundary ridges. The shape and size of the field lot were arranged by efficiency of farm machinery and adequate irrigation and drainage operation.
(b)	Field block	Field block is the largest unit of farmland that enables the adequate water management for successful paddy cropping. This is usually bordered by permanent structure like canal or road. Generally, a field block consists of 10 to 15 field lots.
(c)	Farm block	Farm block is rectangle in shape surrounded by farm roads or drainage canal on four sides, and is adopted as the unit for farm management, cultivation and land use to ensure uniform water management and work control in the block.

(3) Shape and Area of Field Block

The shape and area of field block was determined by the following ranges.

(a) The length of field block was decided within a range of 300 m to 600 m as allowable length for farm irrigation ditch.
(b) The width of field block was decided within a range of 100 m to 150 m in consideration of the effective distance from farm drains.

Priority project area has the high drainage canal density and can see several small hills on the paddy field. The morphological condition of the project area restricts the length of the field block but does not limit the width.

(4) Shape and Area of Field Lot

The shape and area of field lot was determined by the following factors.

1) Working efficiency of farm machinery to be introduced
2) Topographical condition
3) Convenience of irrigation and/or drainage water control

The shape and size of the field lot affects the working efficiency of plowing, leveling, harrowing, fertilizing, sowing, weeding, disease and pest control and harvesting with combine and/or tractor.

For the determination of field lot, the major work and time consuming by machinery in the field should be studied.

The working efficiency of the tractors is as follows.

1)	Walking type small size tractor	5 a
2)	Riding type 15 – 26 PS tractor	15 a
3)	Riding type 30 PS tractor	30 a

The most economical land leveling work for the field lot is to lay the length in parallel with contour lines and width in angle with it. The ground slope and geographical changes become respective factors to the area of farm lots, in particular, the width of field lot, mainly from the viewpoint of land leveling costs.

Irrigation and drainage control after land readjustment work should be executed for each field lot on the individual farm management basis, with field block on the large-scale farming or group-farming basis.

(5) Layout of Canal, Road and Farmland Block

Layout of irrigation and drainage canals, farm roads and farm land blocks should be made so as to fulfill the following conditions.

1) Easy accesses between farm and farmer's village
2) Independent operation control for irrigation and drainage system for each lot
3) Irrigation and drainage canal should be separated
4) Farm road should be set along the main/laterial canals or farm ditch

F.4.8 O&M of Irrigation and Drainage System

(1) Operation and Maintenance Works

O&M works for irrigation system consist of 1) water management, 2) facility maintenance and 3) administration as shown below, and locks for the opening at each gate of diversions and inlets shall be installed for the strict distribution of the irrigation water based on the irrigation rotation plan.

O&M Works	Items	Contents	Proposed Work Interval
Water Management	Decision of Water Distribution	To collect the information of water requirement from farmers and to decide the water distribution plan and water supply plan after adjustment of water amount and period	Every crop season
	Irrigation Water Supply	To operate the irrigation facilities based on the water supply plan	Every day during irrigation
	Observation	To observe the water use condition by a periodical patrol	Every day during irrigation
Maintenance of Facilities	Inspection	To inspect function, water leakage, facility injury, etc. and to make repair plan of facilities	One time each before and after irrigation period and every time for watching
	Repair /Replacement	To repair the facilities based on the repair plan	Proper time based on the necessity (basically once after the irrigation period)
Adminis-tration	Irrigation Fee Collection	To decide the water fee in consideration of required fund for O&M cost and farmers' payment capacity and to collect the irrigation fee	Every crop season

(2) Water Users' Association

All farmers' organizations (COOPs) in the Grand Canal command area shall formulate a Water Users' Association (WUA) for the O&M of irrigation and drainage under the supervision of the Project Office. Some parts of facility maintenance are to be carried out by private enterprises on contract basis. O&M of the irrigation and drainage system in the Project Area shall be implemented by member farmers under the control of the Irrigation Committee of COOP. Considering the extension of irrigation area at Fahé and Cpt. Colonel, the O&M of Grand Canal shall be made by the farmers employed and controlled by the WUA. The following repair costs for irrigation and drainage facilities, employment, and office expense are expected annually.

Item	Local 1.00% Currency	Foreign Currency	Non Taxed Amount	Taxes	Total
Maintenance Cost	11,831	19,707	31,538	3,871	35,408
Irrigation Facilities	3,147	6,215	9,363	1,195	10,558
Drainage Facilities	545	1,584	2,129	267	2,396
Road	392	711	1,103	149	1,252
Flood Protection Dike	71	593	664	79	743
Grand Canal	6,532	9,782	16,314	1,858	18,172
Inspection Road	1,037	394	1,431	250	1,681
Intake Facilities	107	427	534	73	607
Operation Expenses	32,612	850	33,462	1,631	35,092
Office Administration (Chief+4Admi.)	12,600	0	12,600	630	13,230
Gate Operator (5 operators)	8,640	0	8,640	432	9,072
Transportation (motor cycles & pick up)	5,000	0	5,000	250	5,250
Tools etc.(20%of labour costs)	4,248	850	5,098	212	5,310
Others Expenses (10% of Labour costs)	2,124	0	2,124	106	2,230
Total	44,443	20,557	65,000	5,501	70,501

These expenses shall be born by a water fee collected from all farmers.

Table F.2.1 History of the San-Pédro Paddy Project

Year	Supervision	No.of Farmers.	Exploited area.	Inputs.	Machinery	Pump.	GVC	Events
1972								Popo GVC area was developed by pump irrigation
1973	ARSO	Around 50	80ha (1.5ha/Farmer)	Credit	Manual (daba)	2 small pumps		Irrigated paddy cultivation starts with 3 Taiwanese experts.
1974								
1975								Training session of operation time by E.F.D.(1.5 years)
1976			650ha (2 to 3 ha/Farmer)	Fertilizers Seeds Free?	10 tractors to GVC	Creation of existing pump station	3 GVCs created	Young volunteers have started to successively settle themselves. Campus I was created.
1977	SODERIZ							
1978					2 Harvesters Tractors to GVC			
1979	SODEPALM RIZ	Around 200	to 450ha					
1980		185						Taiwanese expert left the Project./ First cocoa plantation started. Campus II was created with school, public wells, clinic, etc.
1981		130					13 GVCs	
1982		161						The boundary of activity area for C.A was staked off by MINAGRA.
1983		160		credit				
1984		158	a)					Drop of paddy price and severe inundation.
1985		127						CCGR was established as coordination structure of GVCs
1986		146			Inventory 1986*			Earth chiefs started selling pieces of upland in / around the Project area.
1987		141						
1988		145						BNDA was collapsed.
1989		114	330ha (2 or 4 ha/farmer)	Fertilizers seeds. free	38 tractors to the farmers			The rehabilitation project started with land redistribution. (4ha to farmers with machine or 2ha to farmers without machine)
1990	CIDV	105						Governmental subsidies for irrigated paddy cultivation stopped.
1991		91				3 has been renewed**	4 GVCs	Union of GVCs replaced CCGR
1992		96				Operation stopped		The supply of subsidized fuel oil for irrigation pump ceased.
1993		94				Operated (40 ha/1cycle)		Private company put commercial irrigated paddy production to trial.
1994						Small one set by OCTID		Discussion on land problems started (C/A, sub-prefecture, earth chief). CFA franc devaluation
1995	ANADER							4 GVCs were officially recognized by the State.
1996								
1997								
1998		69	About 110ha		12 tractors			

Notes : a) Reduction of the irrigated areas because of: the incomplete land leveling, poor drainage, poor water management, drop of the pump efficiency, etc.

*Inventory 1986: 50 tractors are managed by GVC (farmers cooperative), 30 threshing machines belong to the farmers / 3 harvesters and threshers donated or lent.

**Replaced by 3 set of pump/generator of 75kw and 70 lit/sec (Canadian grant)

Table F.2.2 Irrigation Pump Operation in Cite Agricole Area

Year	Month	No. 1 Pump	No. 2 Pump	No. 3 Pump	Total hours	Water Amount	Fuel Consumption (lit)	Irrigation Area (ha)	Lubricant (lit)	Unit Irrigation (m^3/ha)	Unit Irrigation discharge (lit/sec/ha)	Fuel Consumption (lit/hr.)	Lubricant (lit/hr.)	Irrigation Water (mm/day)
1981	Jan.	291	402	0	693.00	1,746,360	13,000	230.05	150	7,591	2.834	18.76	0.22	24.5
	Feb	192	0	178	370.00	932,400	8,400	230.05	50	4,053	1.675	22.70	0.14	14.5
	Mar	367	0	345	712.00	1,794,240	11,400	507.50	75	3,535	1.320	16.01	0.11	11.4
	Apr													
	May	239	0	260	499.00	1,257,480	11,800	236.82	100	5,310	1.982	23.65	0.20	17.1
	Jun	0	0	220	220.00	554,400	4,400	285.00	50	1,945	0.750	20.00	0.23	6.5
	Jul	0	0	340	340.00	856,800	6,800	285.00	75	3,006	1.122	20.00	0.22	9.7
	Aug	0	0	150	150.00	378,000	3,100	387.00	50	977	0.365	20.67	0.33	3.2
	Sep	310	322	215	847.00	2,134,440	13,200	219.53	125	9,723	3.751	15.58	0.15	32.4
	Oct	246	0	249	495.00	1,247,400	10,800	219.53	100	5,682	2.121	21.82	0.20	18.3
	Nov	244	0	245	489.00	1,232,280	10,000	219.53	100	5,613	2.166	20.45	0.20	18.7
	Dec	245	0	244	489.00	1,232,280	6,100	219.53	100	5,613	2.096	12.47	0.20	18.1
1982	Jan	98	0	93	191.00	481,320	2,700	219.53	50	2,193	0.819	14.14	0.26	7.1
	Feb	145	0	147	292.00	735,840	5,500	422.80	100	1,740	0.719	18.84	0.34	6.2
	Nov				0.00	0								
	Dec	0	148	209	357.00	899,640	9,600	437.42	75	2,057	0.768	26.89	0.21	6.6
1983	Jan				0.00	0								
	Feb				0.00	0								
	Mar	0	86	75	161.00	405,720	3,220	72.50	25	5,596	2.089	20.00	0.16	18.1
	Apr	0	219	280	499.00	1,257,480	9,980	241.00	75	5,218	2.013	20.00	0.15	17.4
	May	0	12	14	26.00	65,520	5,100	378.80	50	173	0.065	196.15	1.92	0.6
	Jun				0.00	0								
1993	Oct				0.00	0		*New Pumps Installed*						
	Nov	***	***	***	25.67	64,680						0.00	0.00	
	Dec				69.00	173,880						0.00	0.00	
1994	Jan				73.18	184,422						0.00	0.00	
	Feb				32.75	82,530						0.00	0.00	
	Mar				0.25	630						0.00	0.00	
	Apr				0.83	2,100						0.00	0.00	
	May				0.00	0								

Sources : Station de Pompage Nord Fonctionment, SODEPALM, Zone: San-Pédro

Table F.3.1 Comparison of Irrigated Paddy Development Project Areas

Item		San-Pédro Paddy Development Area	Cpt. Colonel Area	Fahé Area
Economic Aspects	Investment Cost	F.CFA 2,152 million	F.CFA 1,083 million	F.CFA 1,543 million
	IRR	15.0 %	6.4 %	13.2 %
	No. of Beneficiaries	360	60	200
Social Aspects	Potential	As for the villagers, they have experienced irrigated agriculture and (supposed to) have learned from the failure in the past. There is the accomplished fact of land expropriation by the government. Compared to other villages, no ethnic habitat demarcation has been observed so that assimilation among inhabitants seems to manifest itself in many ways.	The inhabitants have much trust in their earth-chief (called "Colonel") living with them, and it is possible to set up the firm organization led by Colonel. Most of the habitants are Burkinabé and Gouro, who are closely united, and the organization formation seems to be easy. The inhabitants of the classified forest have started immigrating to this hamlet and they can be considered as potential labor force.	There is a large village of Burkinabé (SCAF) near the site, and if their organized labor force can be mobilized, the high productivity is expected. However, the constraints regarding to the problems with earth-chiefs mentioned below should be solved.
	Constraints	There is a conflict with the concerned earth-chiefs regarding to the usufruct of the upland in and around the village. Households of aged and/or sickly people are comparatively large in number. The political leadership is seen, but no leadership which is necessary for the cooperative works is observed among the farmers. It is necessary to call for new settlers in consideration of small number of households. Provided that newcomers (including earth-chiefs) participate in the project, the organization formation will be complicated and needs taking much account of the relationship between the newcomers and the present inhabitants The redistribution of plots seems necessary and may bring about confusion as well as frustration among the inhabitants who have negative experiences from the previous cases.	The proposed project site should be expropriated by the government. But a part of it became a subject under conflict over its usufruct between indigenous families. And the expropriation of the parts of site located in the neighboring earth-chiefs' land will be also tough. Since these people who have already experienced the expropriation of land during San-Pédro Paddy Irrigation Project believe that the government broke the promise of compensation, they seem to have a distrust of the government.	Fahé is the typical village of type 1, and <the village-related matters> are decided by 7 indigenous families. Accordingly, matters against their interests (for example, the expropriation of their plantations) are difficult to be consented. In addition, as mentioned in the report, the distrust against the government is strong due to a few times of expropriation by the government. The negotiation on expropriation will take time and seems to be very tough.

Note: Investment cost of head race canal from San-Pédro Dam is not included.

Table F.4.1 Crop Water Requirment of the Project Area

1st Area in ha = 152.7
2nd Area in ha = 228.1
3rd Area in ha = 194.2
Irrigation Efficiency = 0.65

Maximum Diversion Requirment = 1.622 lit/sec/ha

Month	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
Decade	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
No. of Day	10	10	11	10	10	8	10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	10	10	11	10	10	10	10	10	11
Monthly Eto(mm)	3.88			4.29			4.41			4.48			3.89			3.19			3.24			3.17			3.42			3.99			3.94			3.55		
ETP(mm/day)	3.83	3.88	4.02	4.22	4.29	4.33	4.39	4.41	4.43	4.47	4.48	4.28	3.99	3.89	3.66	3.31	3.19	3.21	3.23	3.24	3.22	3.18	3.17	3.25	3.38	3.42	3.61	3.90	3.99	3.97	3.95	3.94	3.81	3.62	3.55	3.66
Effective Rainfall (mm/decade)	4.12	4.98	5.41	10.74	12.71	14.85	18.76	26.21	17.53	20.92	27.34	29.93	27.71	35.67	73.92	65.06	57.94	33.10	34.15	22.46	11.39	12.85	21.99	16.56	12.76	22.98	22.26	16.08	39.36	34.56	24.08	25.49	17.73	13.44	8.63	9.23
101 Saturation (mm)	0.00	0.00	0.00	0.00	0.00	0.00	75.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102 Ponding Depth(mm)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
103 Changes(mm)	-75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104 ETP(mm)	38.25	38.80	44.18	42.22	42.90	34.64	43.90	44.10	48.77	44.68	44.80	42.83	39.88	38.90	40.22	33.07	31.90	32.07	32.32	32.40	35.38	31.82	31.70	35.79	33.78	34.20	36.10	38.95	39.90	43.71	39.48	39.40	38.10	36.15	35.50	40.26
105 Crop Coef.(Kc)	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.55	1.10	1.10	1.10	1.10	1.15	1.25	1.25	0.95	0.95	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.55	1.10	1.10	1.10	1.10	1.15	1.25	1.25	0.95	0.95
106 ETM(mm) =(4)X(5)	36.34	0.00	0.00	0.00	0.00	0.00	0.00	24.26	26.82	49.15	49.28	47.12	43.87	44.74	50.28	41.33	30.31	30.46	30.70	0.00	0.00	0.00	0.00	0.00	0.00	18.81	19.86	42.85	43.89	48.08	43.43	45.31	47.63	45.19	33.73	38.25
107 Percolation(mm)	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
108 Required Depth(mm) =(1)+(3)+(6)+(7)	11.34	0.00	0.00	0.00	0.00	0.00	75.00	99.26	76.82	99.15	99.28	97.12	93.87	94.74	#####	91.33	80.31	80.46	5.70	0.00	0.00	0.00	0.00	0.00	75.00	93.81	69.86	92.85	93.89	98.08	93.43	95.31	97.63	95.19	83.73	88.25
109 Effective Rainfall(mm)	4.12	0.00	0.00	0.00	0.00	0.00	18.76	26.21	17.53	20.92	27.34	29.93	27.71	35.67	73.92	65.06	57.94	33.10	34.15	0.00	0.00	0.00	0.00	0.00	12.76	22.98	22.26	16.08	39.36	34.56	24.08	25.49	17.73	13.44	8.63	9.23
110 Net Water Requirement (mm) =(8)-(9)	7.2	0.0	0.0	0.0	0.0	0.0	56.2	73.0	59.3	78.2	71.9	67.2	66.2	59.1	26.4	26.3	22.4	47.4	0.0	0.0	0.0	0.0	0.0	0.0	62.2	70.8	47.6	76.8	54.5	63.5	69.4	69.8	79.9	81.8	75.1	79.0
111 Irrigation Efficiency(e)	0.65	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
112 Intake Water Req. (m3/ha/dec =(10)/(11)X10	111	0	0	0	0	0	865	1,124	1,003	1,204	1,107	1,034	1,018	909	446	404	344	729	0	0	0	0	0	0	958	1,090	732	1,181	839	1,075	1,067	1,074	1,229	1,258	1,155	1,337
113 Unit Intake Requirement (lit/s/ha)	0.129	0.000	0.000	0.000	0.000	0.000	1.001	1.301	1.056	1.393	1.281	1.196	1.178	1.052	0.469	0.468	0.398	0.843	0.000	0.000	0.000	0.000	0.000	0.000	1.108	1.261	0.847	1.367	0.971	1.131	1.235	1.243	1.423	1.456	1.337	1.407
114 Cultivation Area (ha)	152.7	0	0	0	0	0	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	0	0	0	0	0	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7	152.7
115 Intake water discharge (m3/s) 24hr operation	0.020	0.000	0.000	0.000	0.000	0.000	0.153	0.199	0.161	0.213	0.196	0.183	0.180	0.161	0.072	0.071	0.061	0.129	0.000	0.000	0.000	0.000	0.000	0.000	0.169	0.193	0.129	0.209	0.148	0.173	0.189	0.190	0.217	0.222	0.204	0.215
116 Total Amount (m3)	16,967	0	0	0	0	0	132,118	171,599	153,226	183,775	[illegible]	157,926	155,429	138,759	68,115	61,722	52,544	111,264	0	0	0	0	0	0	146,222	[illegible]	[illegible]	180,327	[illegible]	[illegible]	162,927	164,015	187,696	[illegible]	[illegible]	[illegible]
201 Saturation (mm)	0	0	0	0	0	0	0	75	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	75	0	0	0	0	0	0	0	0	0
202 Ponding Depth(mm)	75	0	-0	0	0	0	0	0	0	75	75	75	75	75	75	75	75	75	75	0	0	0	0	0	0	0	0	75	75	75	75	75	75	75	75	75
203 Changes(mm)	0	-75	0	0	0	0	-0	0	0	0	0	0	0	0	0	0	0	0	0	-75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
204 ETP(mm)	38.25	38.8	44.18	42.22	42.9	34.64	43.9	44.1	44.33	44.68	44.8	42.83	39.88	38.9	40.22	33.07	31.9	32.07	32.32	32.4	35.38	31.82	31.7	35.79	33.78	34.2	36.1	38.95	39.9	43.71	39.48	39.4	38.1	36.15	35.5	40.26
205 Crop Coef.(Kc)	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.0
206 ETM(mm) =(4)X(5)	36	37	0	0	0	0	0	0	24	25	49	47	44	43	46	41	40	30	31	31	0	0	0	0	0	0	20	21	44	48	43	43	44	45	44	38
207 Percolation(mm)	50	50	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50
208 Required Depth(mm) =(1)+(3)+(6)+(7)	86	12	0	0	0	0	0	75	99	75	99	97	94	93	96	91	90	80	81	6	0	0	0	0	0	75	95	71	94	98	93	93	94	95	94	88
209 Effective Rainfall(mm)	4.1	5.0	-0.0	0.0	0.0	0.0	0.0	26.2	17.5	20.9	27.3	29.9	27.7	35.7	73.9	65.1	57.9	33.1	34.2	22.5	0.0	0.0	0.0	0.0	0.0	23.0	22.3	16.1	39.4	34.6	24.1	25.5	17.7	13.4	8.6	9.2
210 Net Water Requirement (mm) =(8)-(9)	82.2	6.9	0.0	0.0	0.0	0.0	0.0	48.8	81.9	53.7	71.9	67.2	66.2	57.1	22.3	26.3	31.9	47.4	46.5	0.0	0.0	0.0	0.0	0.0	0.0	52.0	72.6	55.3	54.5	63.5	69.4	67.8	76.1	81.8	85.7	79.0
211 Irrigation Efficiency(e)	0.65	0.65	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
212 Intake Water Req. (m3/ha/dec =(10)/(11)X10	1,265	106	0	0	0	0	0	751	1,259	825	1,107	1,034	1,018	879	378	404	491	729	716	0	0	0	0	0	0	800	1,117	851	839	1,075	1,067	1,044	1,171	1,258	1,319	1,337
213 Unit Intake Requirement (lit/s/ha)	1.464	0.123	0.000	0.000	0.000	0.000	0.000	0.869	1.458	0.955	1.281	1.196	1.178	1.017	0.398	0.468	0.569	0.843	0.829	0.000	0.000	0.000	0.000	0.000	0.000	0.926	1.293	0.985	0.971	1.131	1.235	1.208	1.355	1.456	1.527	1.407
214 Cultivation Area (ha)	228.1	228.1	0	0	0	0	0	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	0	0	0	0	0	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1	228.1
215 Intake water discharge (m3/s) 24hr operation	0.334	0.028	0.000	0.000	0.000	0.000	0.000	0.198	0.332	0.218	0.292	0.273	0.269	0.232	0.091	0.107	0.130	0.192	0.189	0.000	0.000	0.000	0.000	0.000	0.000	0.211	0.295	0.225	0.221	0.258	0.282	0.276	0.309	0.332	0.348	0.321
216 Total Amount (m3)	288,537	24,154	0	0	0	0	0	171,209	287,255	188,277	252,448	235,758	232,176	200,449	[illegible]	[illegible]	112,073	166,204	163,349	0	0	0	0	0	0	[illegible]	[illegible]	194,193	[illegible]	245,200	243,376	[illegible]	267,007	[illegible]	[illegible]	[illegible]
301 Saturation (mm)	0	0	0	0	0	0	0	0	75	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	75	0	0	0	0	0	0	0	0
302 Ponding Depth(mm)	75	75	0	0	0	0	0	0	0	0	75	75	75	75	75	75	75	75	75	75	0	0	0	0	0	0	0	0	75	75	75	75	75	75	75	75
303 Changes(mm)	0	0	-75	0	0	0	0	0	0	0	0	0	0	0	0	-0	0	0	0	0	-75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
304 ETP(mm)	38.25	38.8	44.18	42.22	42.9	34.64	43.9	44.1	44.33	44.68	44.8	42.83	39.88	38.9	40.22	33.07	31.9	32.07	32.32	32.4	35.38	31.82	31.7	35.79	33.78	34.2	36.1	38.95	39.9	43.71	39.48	39.4	38.1	36.15	35.5	40.26
305 Crop Coef.(Kc)	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	1.1	1.1	1.1	1.1	1.2	1.3	1.3	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	1.1	1.1	1.1	1.1	1.2	1.3	1.3
306 ETM(mm) =(4)X(5)	36	37	42	0	0	0	0	0	0	25	25	47	44	43	44	38	40	40	31	31	34	0	0	0	0	0	0	21	22	48	43	43	42	42	44	50
307 Percolation(mm)	50	50	50	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50	50	50	50	0	0	0	0	0	0	0	50	50	50	50	50	50	50	50
308 Required Depth(mm) =(1)+(3)+(6)+(7)	86	87	17	0	0	0	0	0	75	100	75	97	94	93	94	88	90	90	81	81	9	0	0	0	0	0	75	96	72	98	93	93	92	92	94	100
309 Effective Rainfall(mm)	4.1	5.0	5.4	0.0	0.0	0.0	0.0	0.0	17.5	20.9	27.3	29.9	27.7	35.7	73.9	65.1	57.9	33.1	34.2	22.5	11.4	0.0	0.0	0.0	0.0	0.0	22.3	16.1	39.4	34.6	24.1	25.5	17.7	13.4	8.6	9.2
310 Net Water Requirement (mm) =(8)-(9)	82.2	81.9	11.6	0.0	0.0	0.0	0.0	0.0	57.5	78.7	47.3	67.2	66.2	57.1	20.3	23.0	31.9	57.0	46.5	58.3	0.0	0.0	0.0	0.0	0.0	0.0	52.7	80.3	32.6	63.5	69.4	67.8	74.2	78.1	85.7	91.1
311 Irrigation Efficiency(e)	0.65	0.65	0.65	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0	0	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
312 Intake Water Req. (m3/ha/dec =(10)/(11)X10	1,265	1,260	196	0	0	0	0	0	884	1,210	728	1,034	1,018	879	344	353	491	877	716	897	0	0	0	0	0	0	811	1,236	501	1,075	1,067	1,044	1,141	1,202	1,319	1,542
313 Unit Intake Requirement (lit/s/ha)	1.464	1.458	0.206	0.000	0.000	0.000	0.000	0.000	1.023	1.400	0.842	1.196	1.178	1.017	0.362	0.409	0.569	1.015	0.829	1.038	0.000	0.000	0.000	0.000	0.000	0.000	0.939	1.431	0.580	1.131	1.235	1.208	1.321	1.391	1.527	1.622
314 Cultivation Area (ha)	194.2	194.2	194.2	0	0	0	0	0	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	0	0	0	0	0	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2	194.2
315 Intake water discharge (m^3/s) 24hr operation	0.284	0.283	0.040	0.000	0.000	0.000	0.000	0.000	0.199	0.272	0.164	0.232	0.229	0.198	0.070	0.079	0.110	0.197	0.161	0.202	0.000	0.000	0.000	0.000	0.000	0.000	0.182	0.278	0.113	0.220	0.240	0.235	0.257	0.270	0.296	0.315
316 Total Amount (m3)	245,655	244,641	38,013	0	0	0	0	0	171,712	234,986	[illegible]	200,720	197,696	[illegible]	66,798	68,617	95,417	170,244	139,072	174,248	0	0	0	0	0	0	157,560	240,024	97,558	208,759	207,206	[illegible]	221,635	[illegible]	[illegible]	[illegible]
Total Intake discharge	638	.311	.040	000	000	.000	.153	397	692	.703	651	688	677	590	.233	.258	.301	518	350	202	.000	000	.000	000	169	404	607	.711	482	650	.710	700	783	825	849	851

Table F.4.2 Required Irrigation and Drainage Facilities for the Project

1. Irrigation Canal and Structure

Description	Specification	Unit	Grand Canal	Primary Canal				Secondary Canal						G-TOTAL
				Primary Canal	West Primary Canal	East Primary Canal	total	West Secondary Canal	Central Secondary Canal	East Secondary Canal	South Secondary Canal	North Secondary Canal	total	
Canal Length		m	18,200	1,400	2,800	1,500	5,700	1,700	2,000	1,300	1,400	1,100	7,500	31,400
Intake Works		nos.	1.0											1.0
Canal Lining	Concrete	m	18,200	1,400	2,800	1,500	5,700	1,700	2,000	1,300	1,400	1,100	7,500	31,400
Related Structure														
Diversion		nos.	3.0	7.0	10.0	6.0	23.0	5.0	3.0	3.0	3.0	2.0	16.0	42.0
Spillway		nos.	3.0	1.0	4.0	2.0	7.0	2.0	1.0	2.0	1.0	1.0	7.0	17.0
Cross Drain	Box Culvert	nos.	13.0	1.0	3.0		4.0							17.0
Cross Drain	Pipe Culvert	nos.	16.0		3.0	3.0	6.0	1.0	2.0	2.0	1.0	1.0	7.0	29.0
Siphon		nos.	8.0											8.0

2. Drainage Canal and Structure

Description	Specification	Unit	Primary Drainage Canal	Secondary Drainage					G-TOTAL
				West Secondary Drainage	Central Secondary Drainage	East Secondary Drainage	North Secondary Canal	TOTAL	
Canal Length		m	3,400	2,600	1,700	4,800	1,150	10,250	13,650
Related Structure									
Cross Drain	with Sluice Gate	nos.	1.0				1.0	1.0	2.0
Cross Drain	Box Culvert	nos.	1.0	2.0	2.0	3.0		7.0	8.0

3. Project Road

Description	Specification	Unit	Primary Road	Secondary Road	Inspection Road	Others	Total
Road Length		m	23,300	19,600	3,100		46,000
Flood Protection Dike		nos.				4.0	4.0
Related Structure							
Cross Drain	with Frap Gate	nos.	1.0	3.0		4.0	8.0

4. Farm Land Preparation

Description	Specification	Unit	1 Block 24 ha	Unit Quantity 1 ha	Total 574.5 ha
Land Reclamation		ha	24.0	1.0	574.5
Tertiary Canal	with Road	m	840.4	35.0	20,117
Irrigation Ditch		m	1,239.2	51.6	29,663
Drainage Ditch		m	1,394.1	58.1	33,371
Tertiary Drainage		m	840.4	35.0	20,117

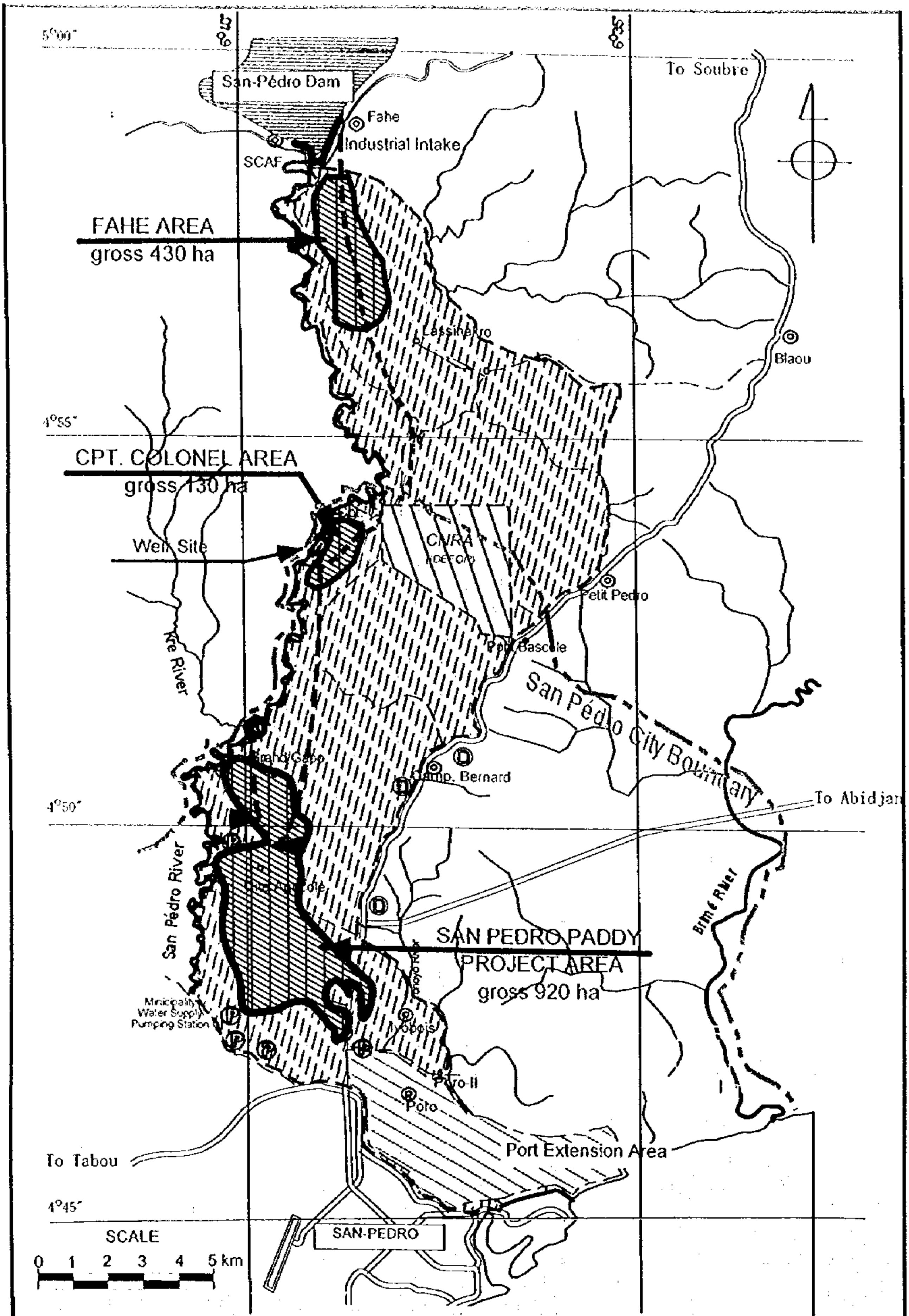


Fig. F.2.1 IRRIGATION DEVELOPMENT PLAN

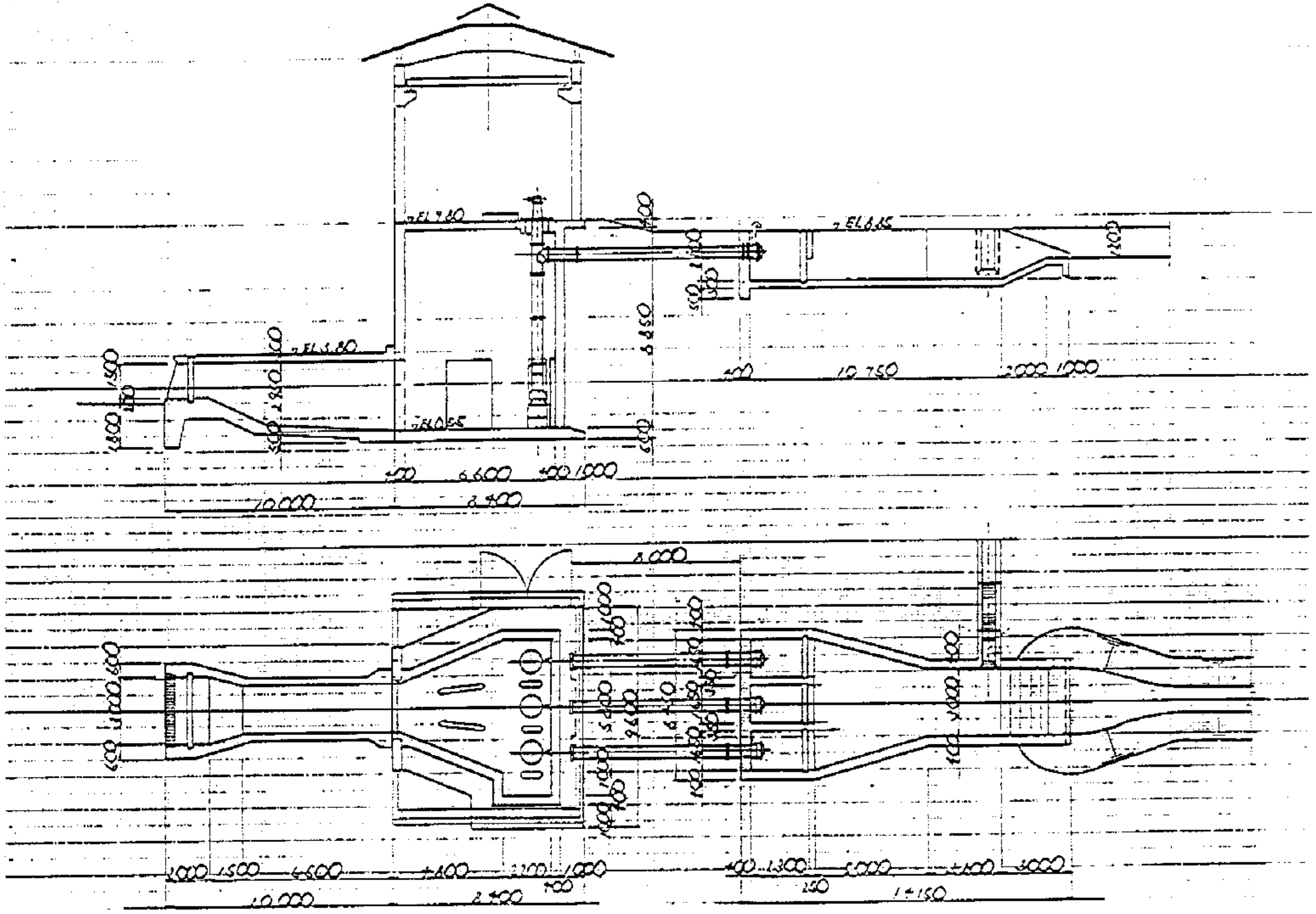


Fig. F.2.2 EXISTING PUMPING STATION IN CITE AGRICOLE

Source: Equipment Hydromecanique de la Station du Pompage du San-Pedro, ARSO, 1975

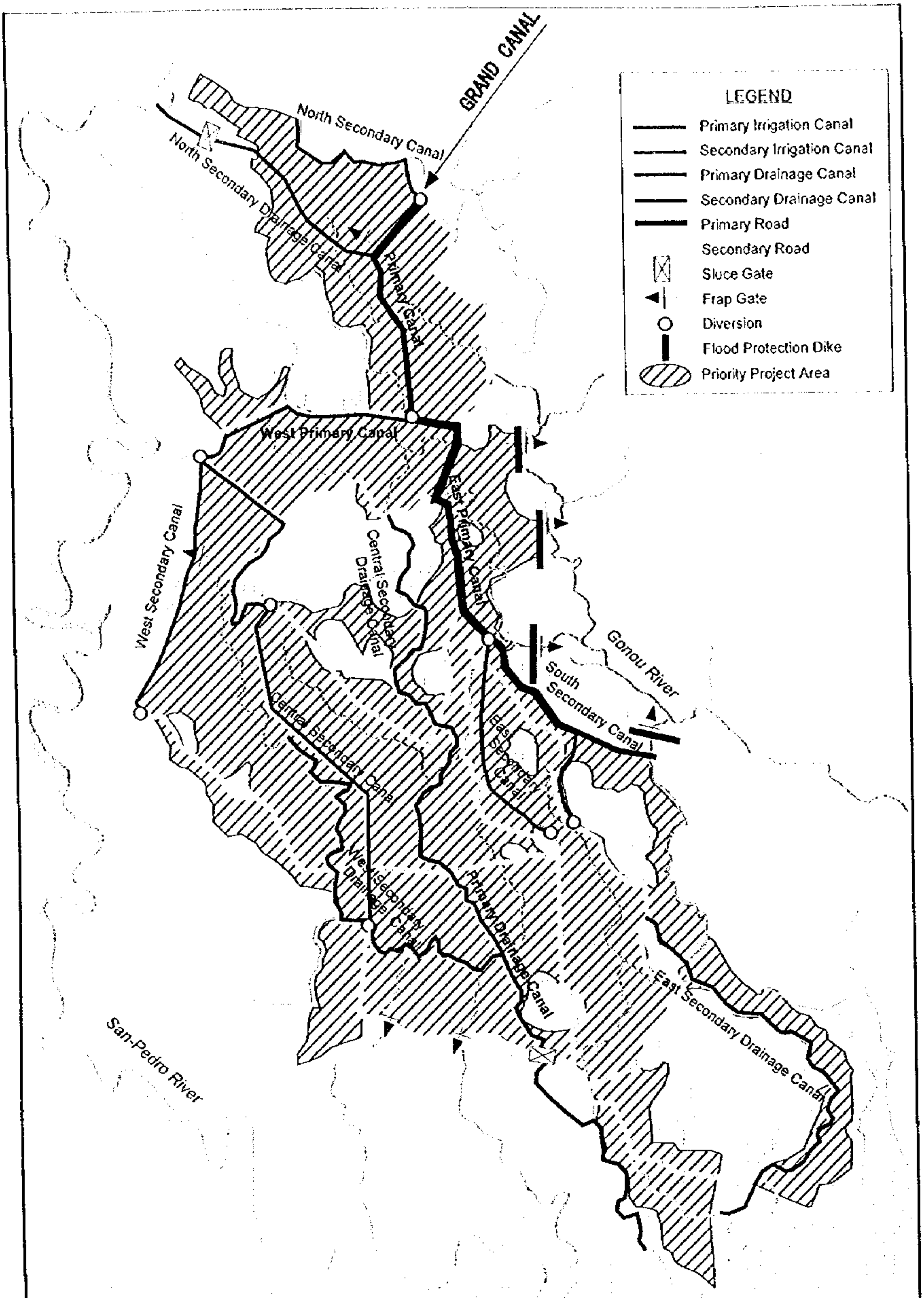


Fig. F.4.1 PROPOSED IRRIGATION AND DRAINAGE FACILITIES

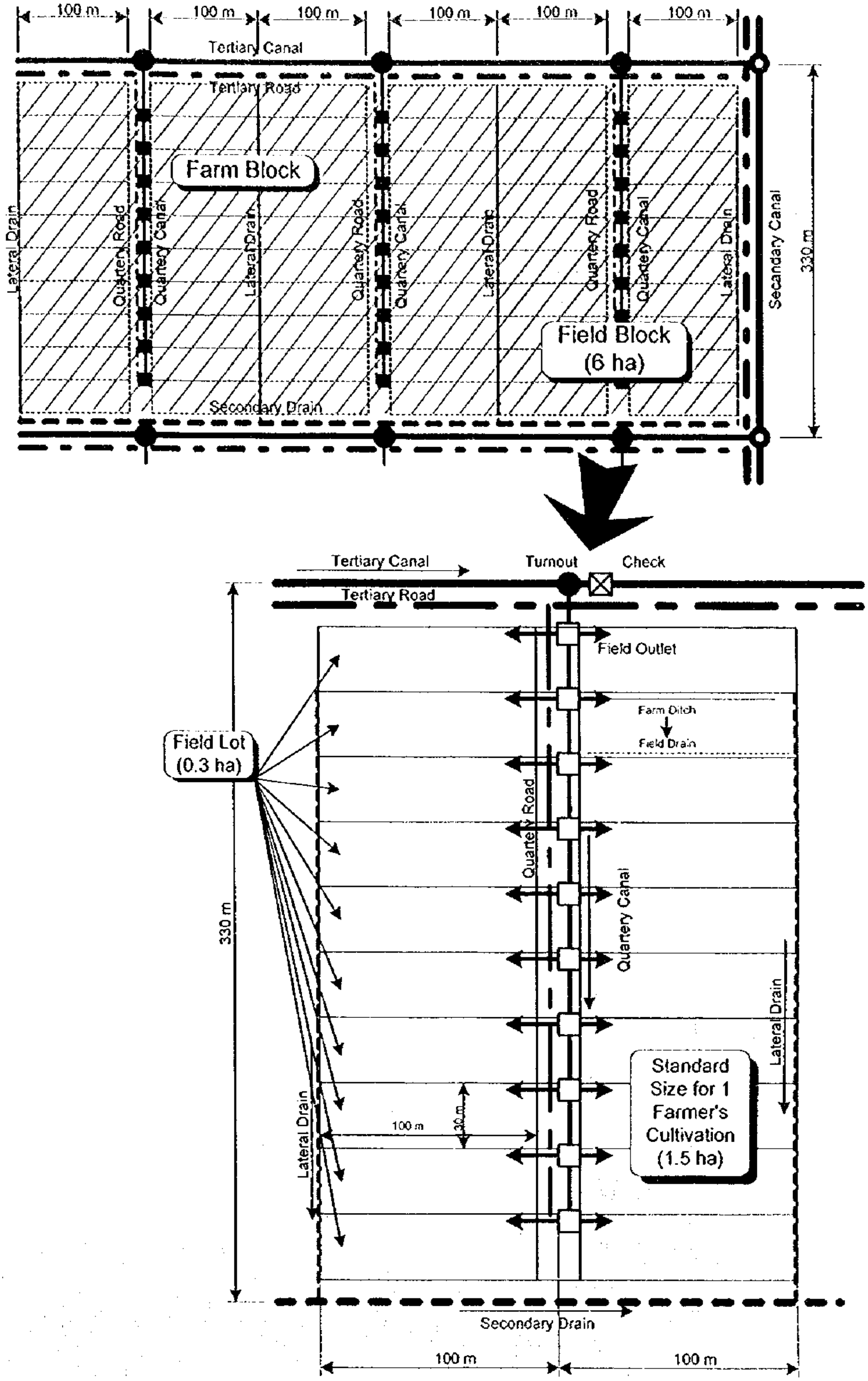


Fig. F.4.2   Arrangement Of Farm Land

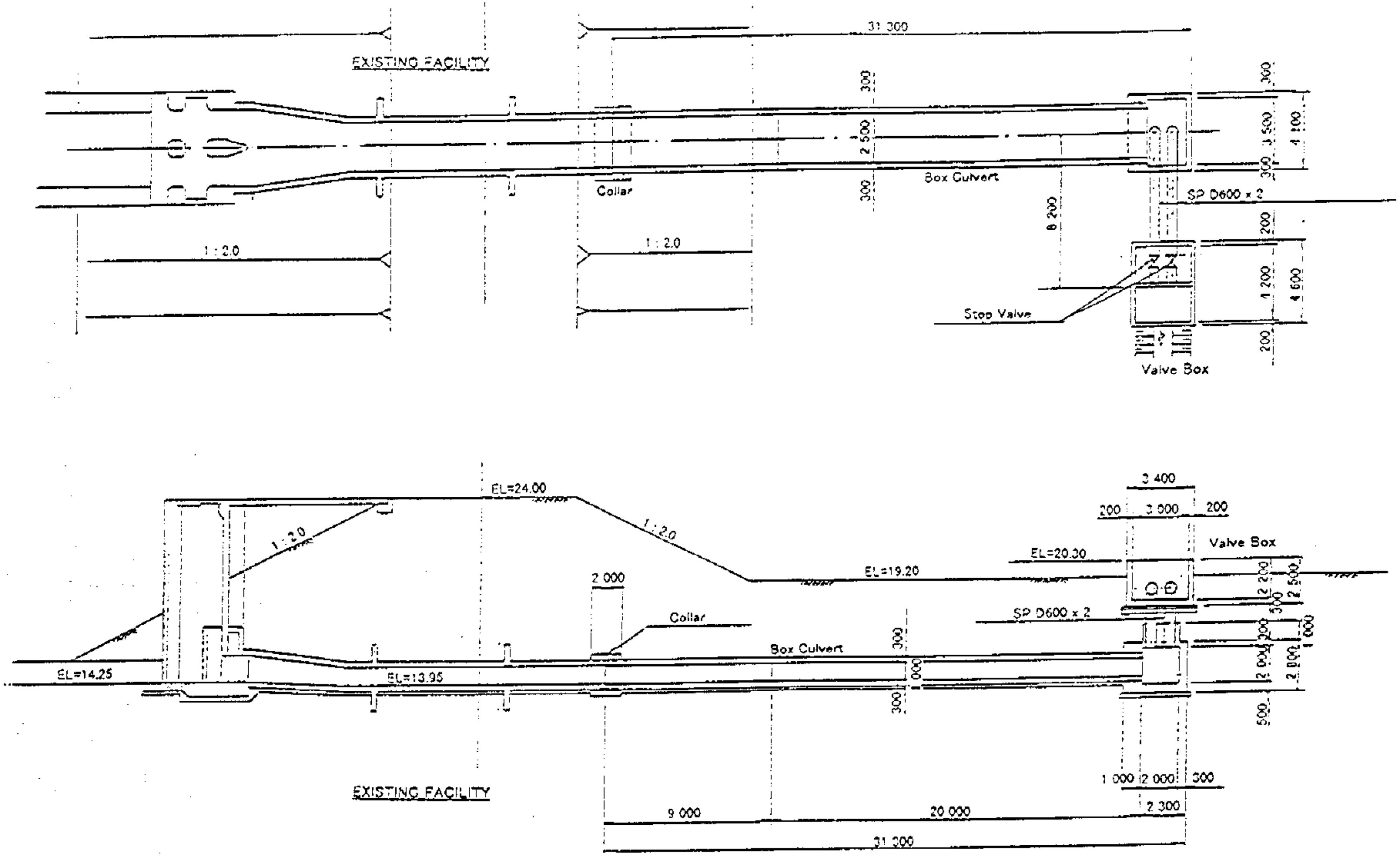


Fig. F.4.3 INTAKE STRUCTURE

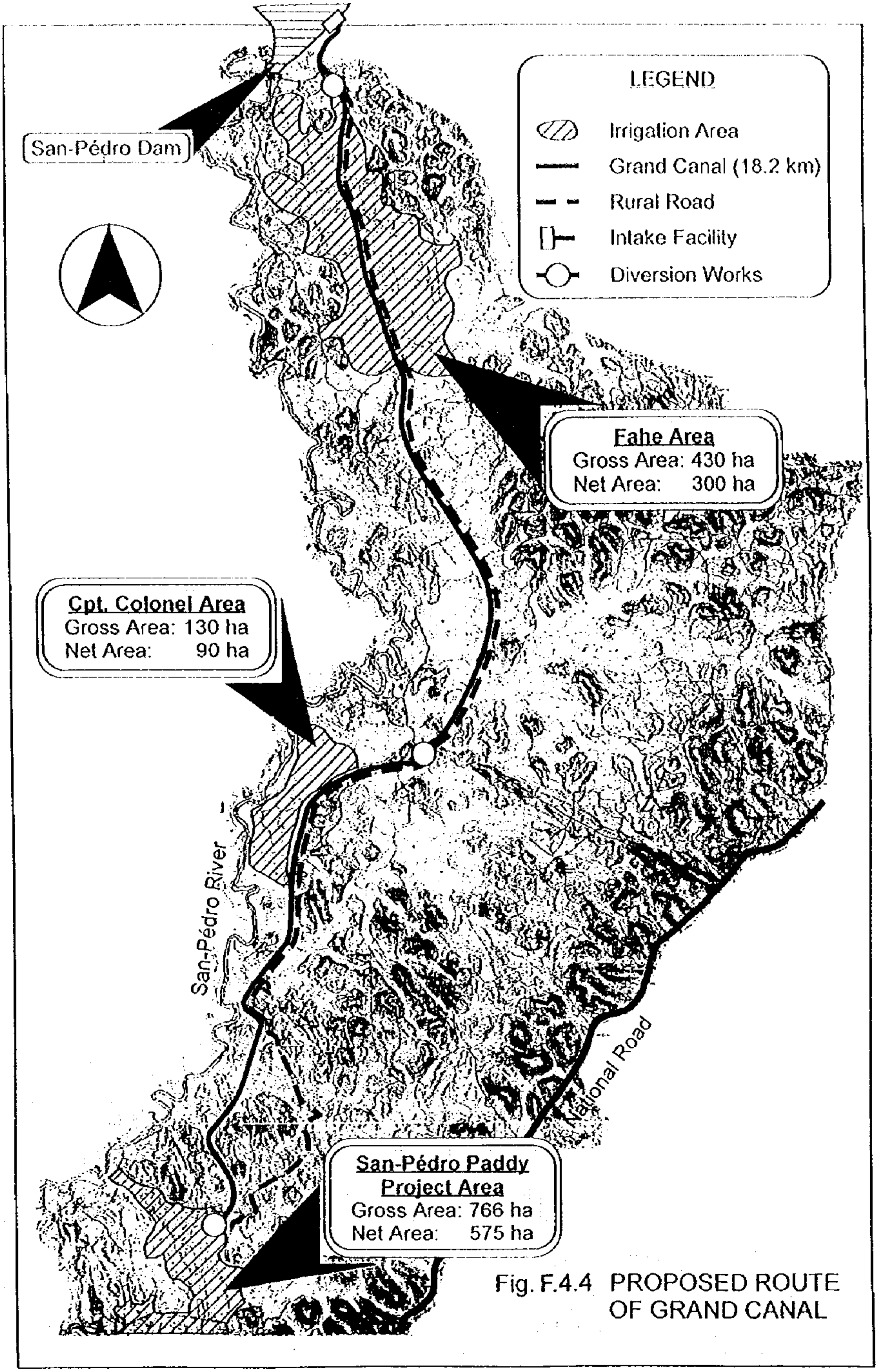


Fig. F.4.4 PROPOSED ROUTE OF GRAND CANAL

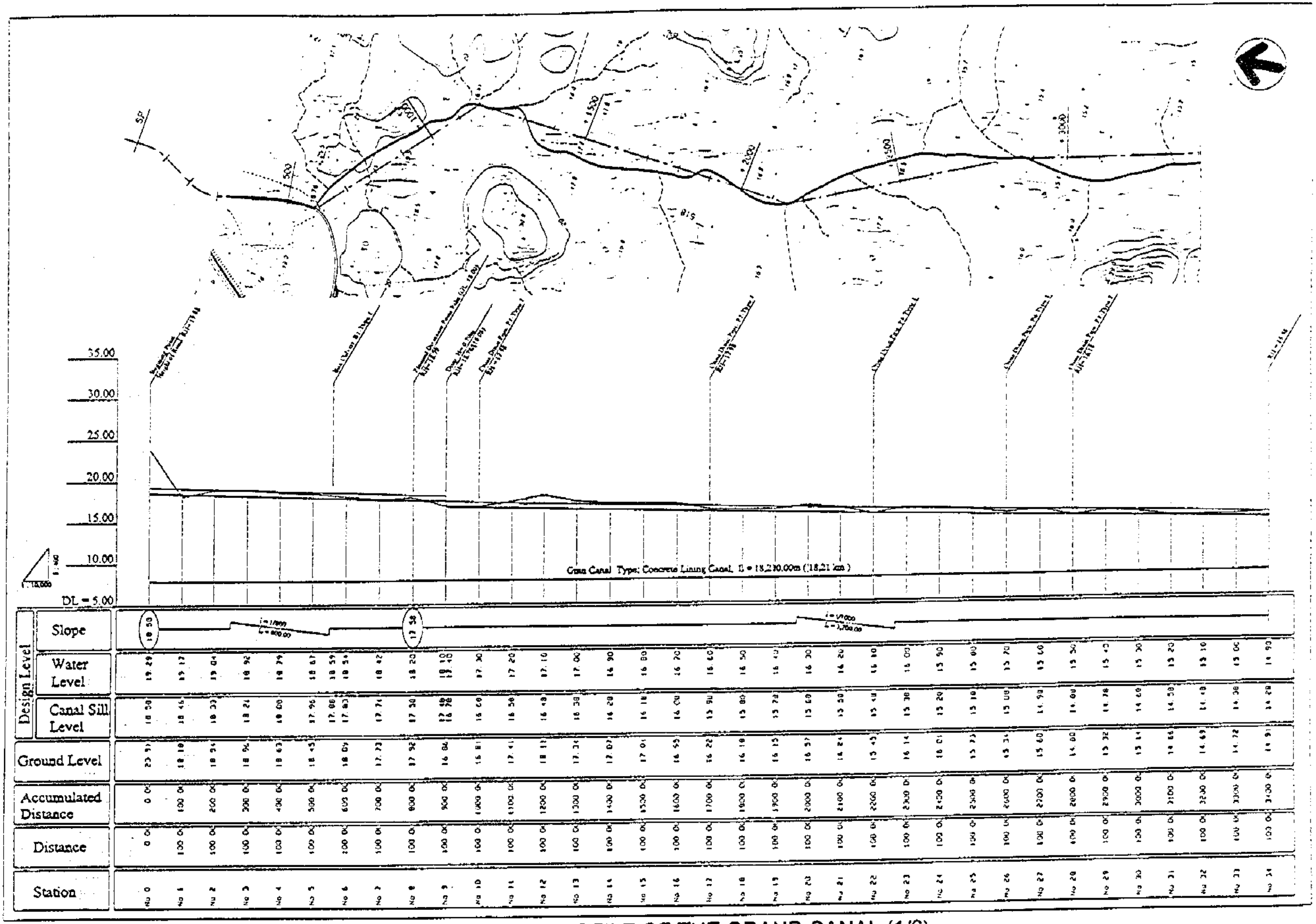
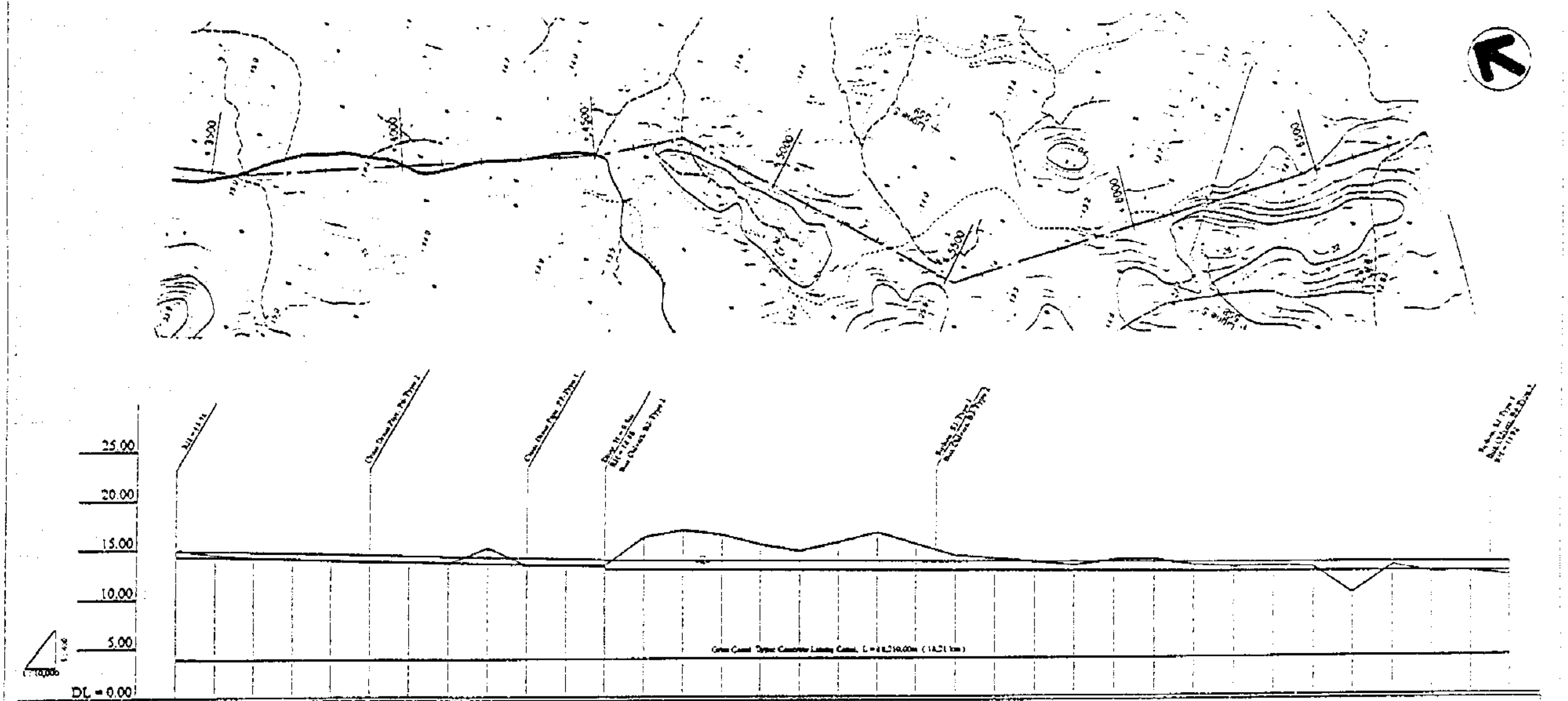


Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (1/6)



Station	Distance	Accumulated Distance	Ground Level	Design Level: Canal Sill Level	Design Level: Water Level
No 34	100.00	3400.00	14.91	14.28	14.90
No 35	100.00	3500.00	14.43	14.18	14.80
No 36	100.00	3600.00	14.14	14.08	14.70
No 37	100.00	3700.00	14.03	13.98	14.60
No 38	100.00	3800.00	13.87	13.88	14.50
No 39	100.00	3900.00	13.74	13.78	14.40
No 40	100.00	4000.00	13.73	13.68	14.30
No 41	100.00	4100.00	13.52	13.58	14.20
No 42	100.00	4200.00	15.07	13.48	14.10
No 43	100.00	4300.00	13.23	13.38	14.00
No 44	100.00	4400.00	13.40	13.28	13.90
No 45	100.00	4500.00	13.23	13.18 12.88	[illegible]
No 46	100.00	4600.00	16.06	12.84	13.75
No 47	100.00	4700.00	16.76	12.83	13.72
No 48	100.00	4800.00	16.26	12.81	13.70
No 49	100.00	4900.00	15.27	12.78	13.67
No 50	100.00	5000.00	14.61	12.76	13.65
No 51	100.00	5100.00	15.50	12.73	13.62
No 52	100.00	5200.00	16.45	12.71	13.60
No 53	100.00	5300.00	15.26	12.68 12.67	13.57 13.56
No 54	100.00	5400.00	14.11	12.66	13.55
No 55	100.00	5500.00	13.65	12.63	13.52
No 56	100.00	5600.00	13.46	12.61	13.50
No 57	100.00	5700.00	13.06	12.59	13.47
No 58	100.00	5800.00	13.63	12.56	13.45
No 59	100.00	5900.00	13.20	12.53	13.42
No 60	100.00	6000.00	13.09	12.51	13.40
No 61	100.00	6100.00	12.91	12.48	13.37
No 62	100.00	6200.00	12.98	12.46	13.35
No 63	100.00	6300.00	12.84	12.43	13.32
No 64	100.00	6400.00	10.19	12.41	13.30
No 65	100.00	6500.00	12.93	12.38	13.27
No 66	100.00	6600.00	12.23	12.36	13.25
No 67	100.00	6700.00	12.30	12.33 12.32	13.22 13.21
No 68	100.00	6800.00	11.81	12.31	13.20

Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (2/6)

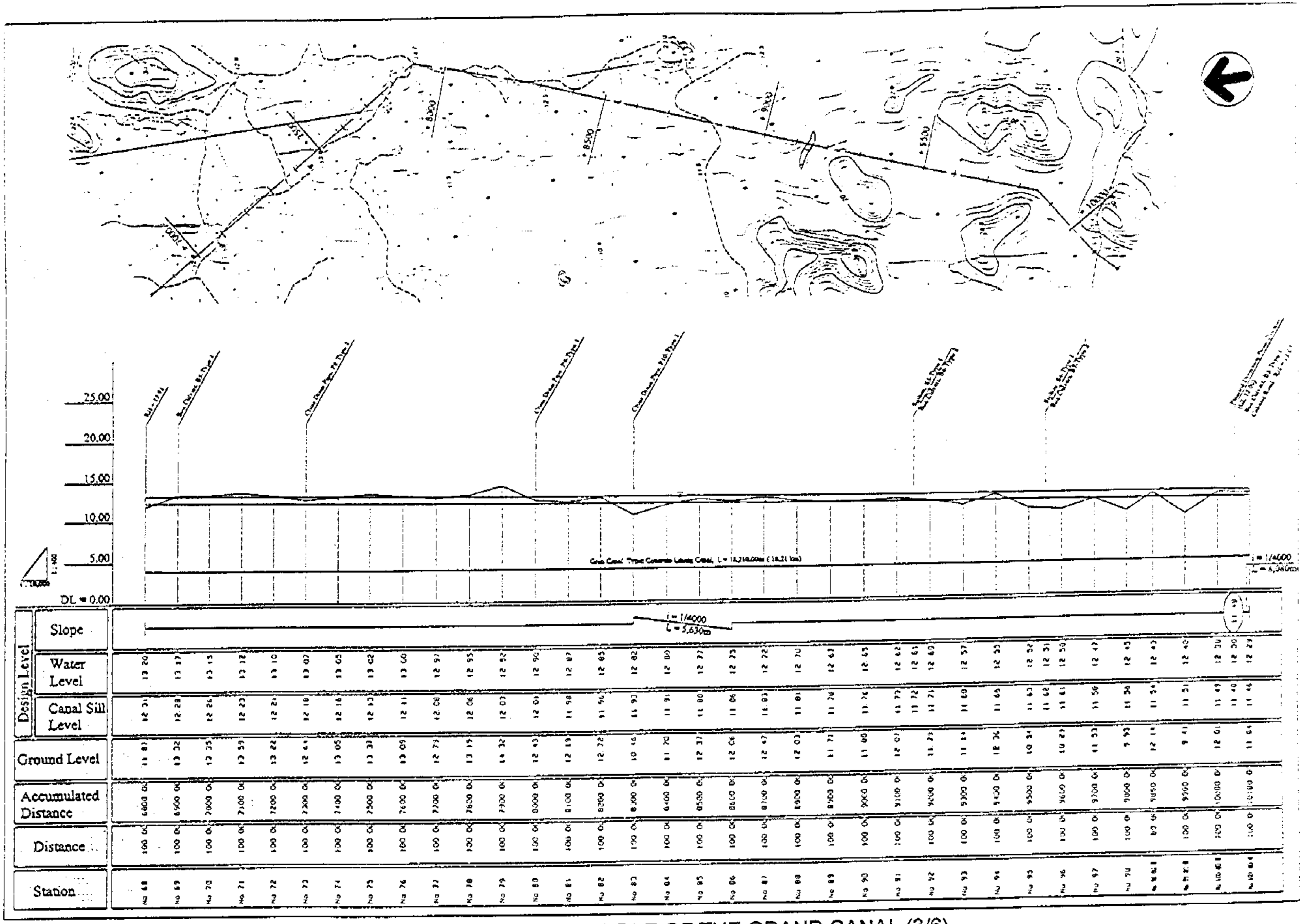


Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (3/6)

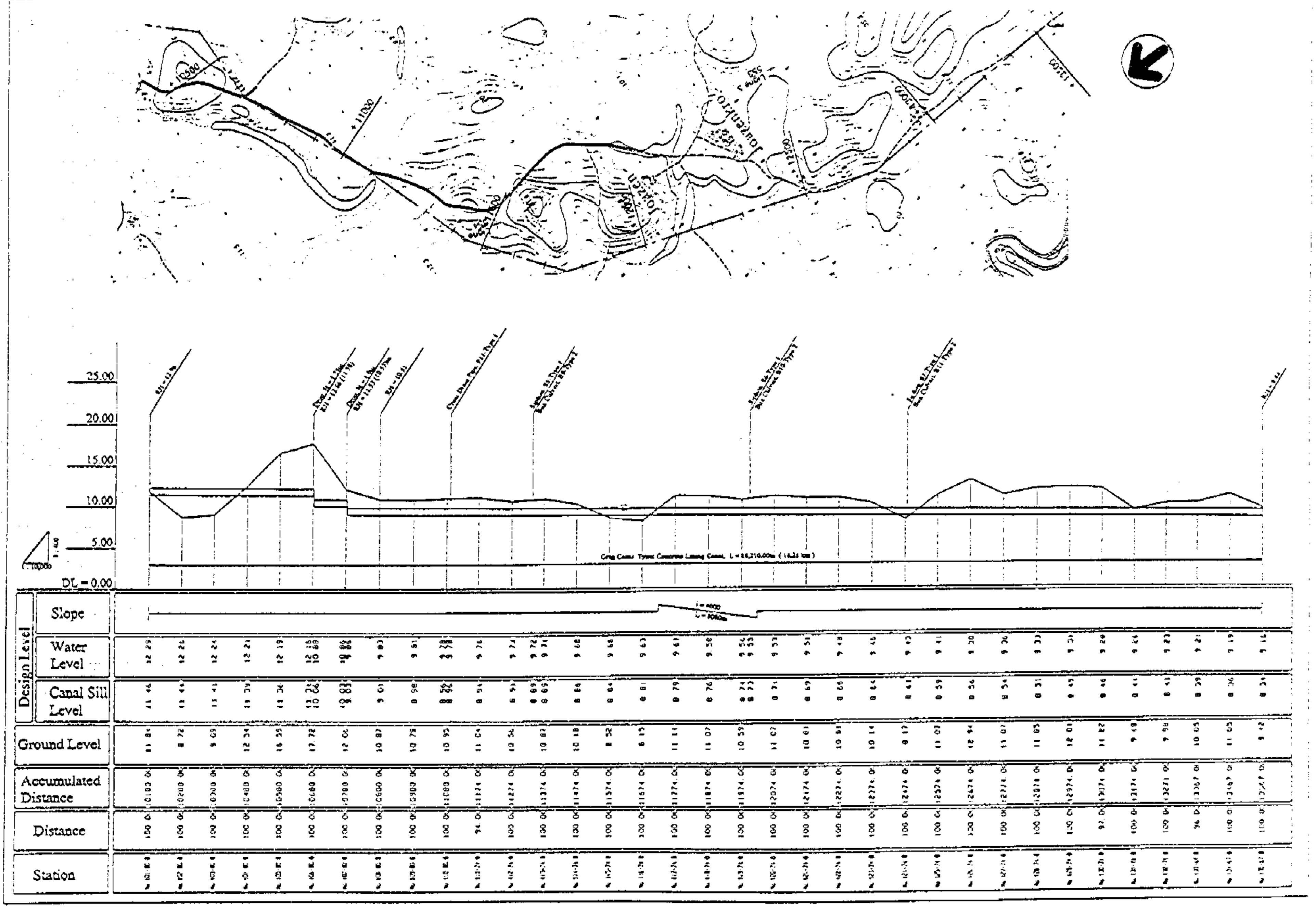


Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (4/6)

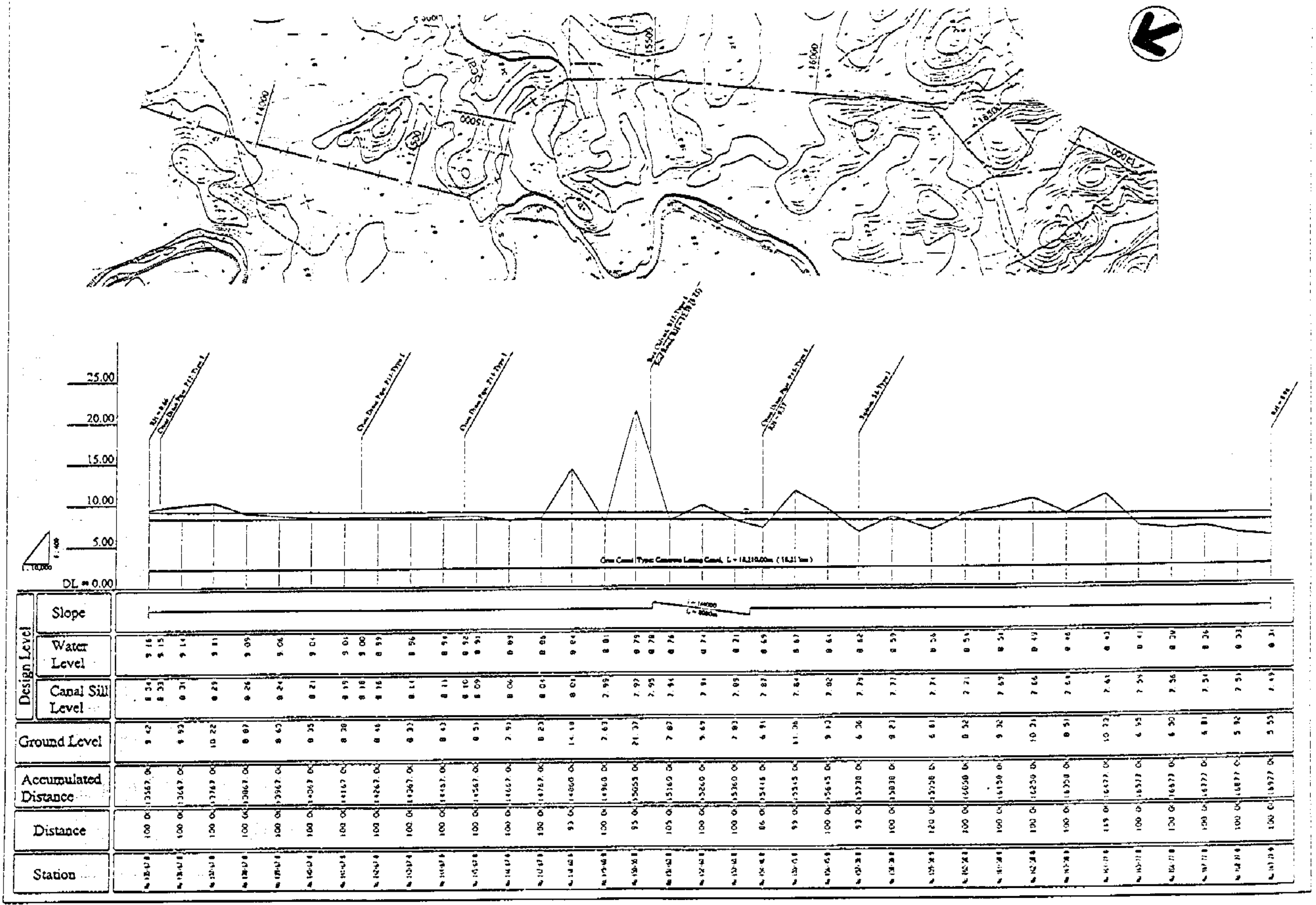


Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (5/6)

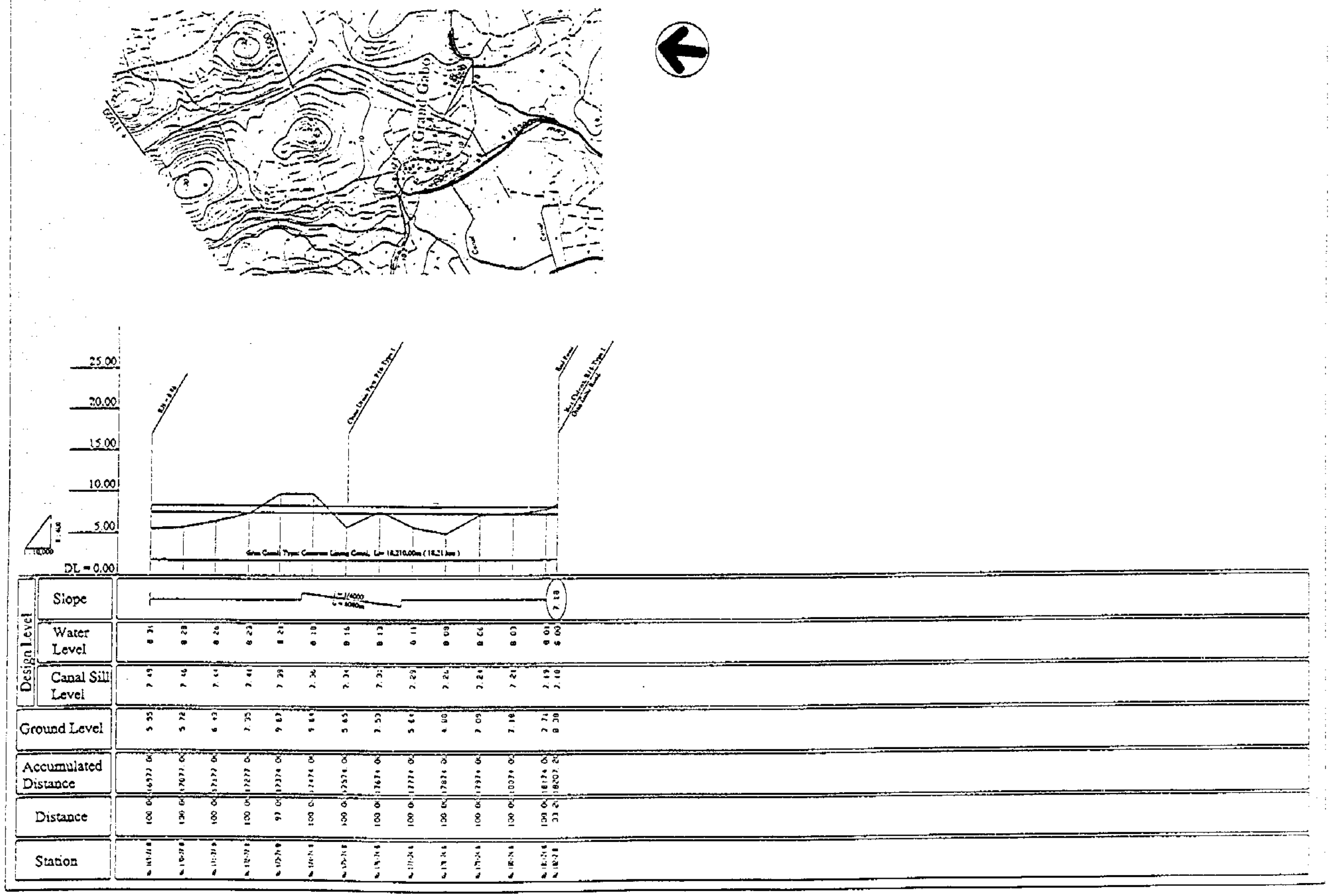
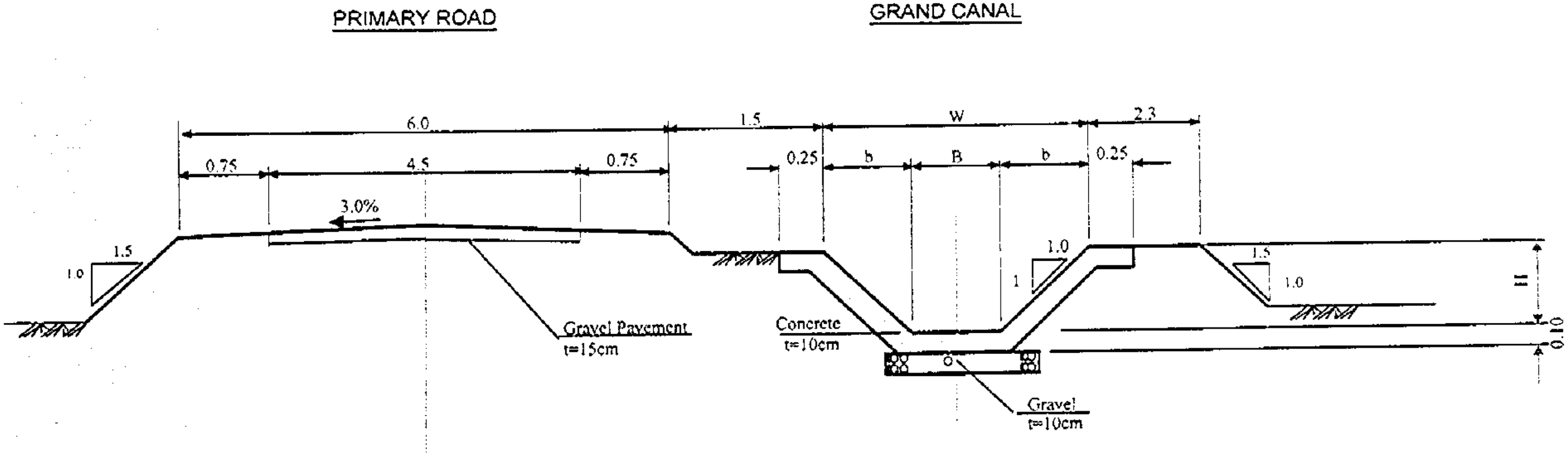


Fig. F.4.5 PLAN AND PROFILE OF THE GRAND CANAL (6/6)

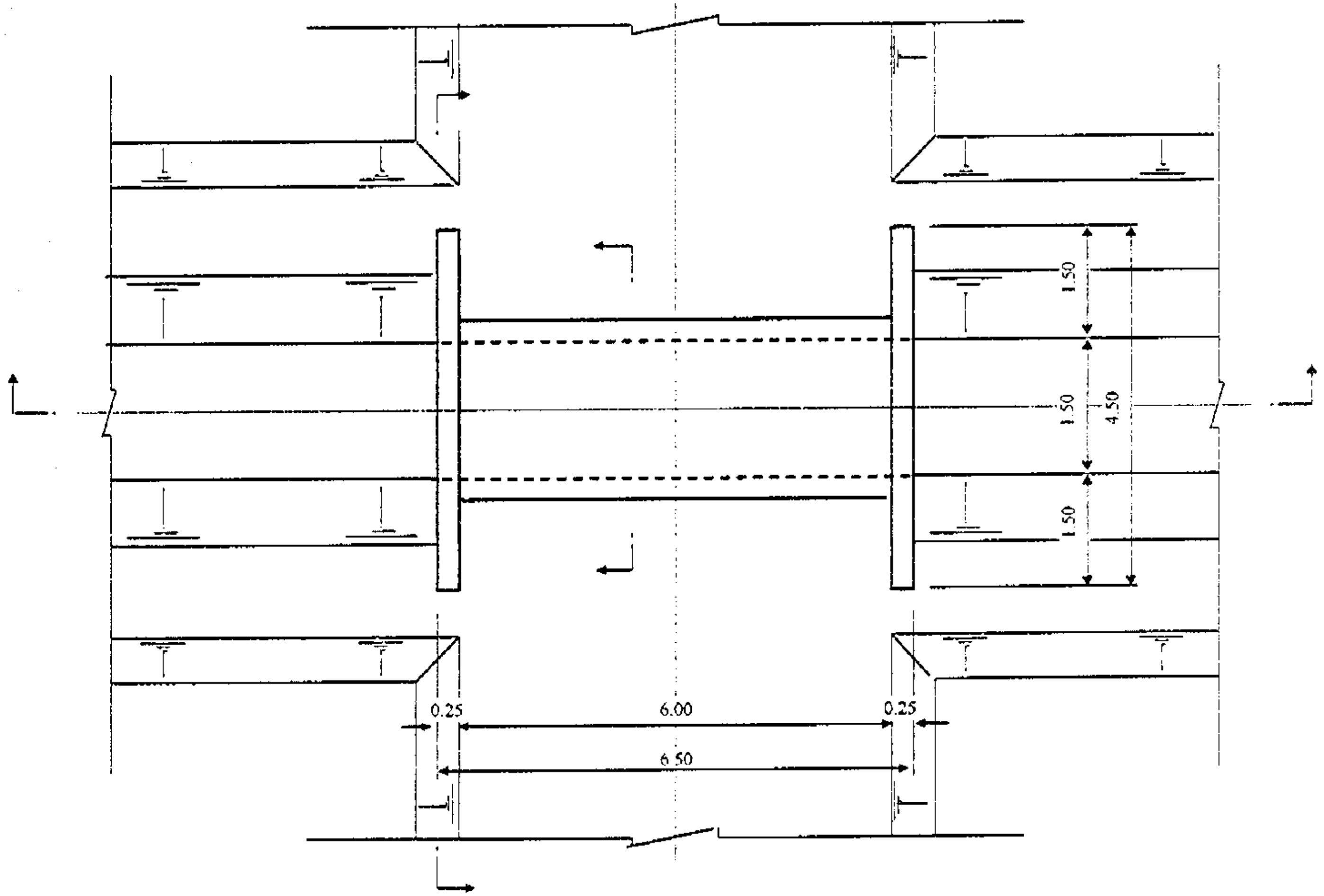


DIMENSION

Concrete Lining Canal Unit : m

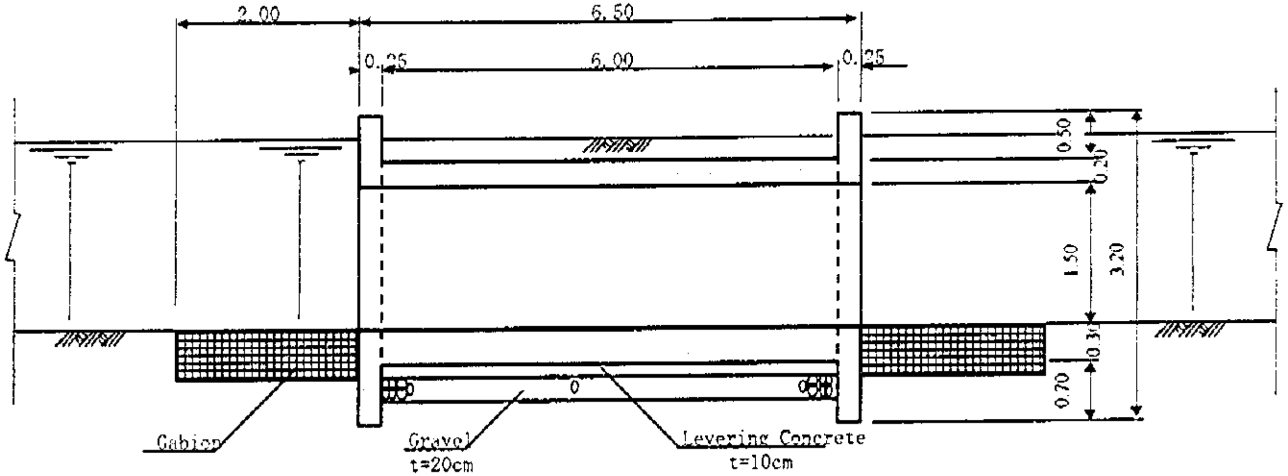
Canal No.	B	b	W	H	Length (m)	Slope
GC-A	1.00	1.00	3.00	1.00	8,080	1/4000
GC-B1	1.00	1.10	3.20	1.10	5,630	1/4000
GC-B2	1.00	0.80	2.60	0.80	3,700	1/1000
GC-C	1.00	0.90	2.80	0.90	800	1/800

Fig. F.4.6 TYPICAL CROSS SECTION OF THE GRAND CANAL

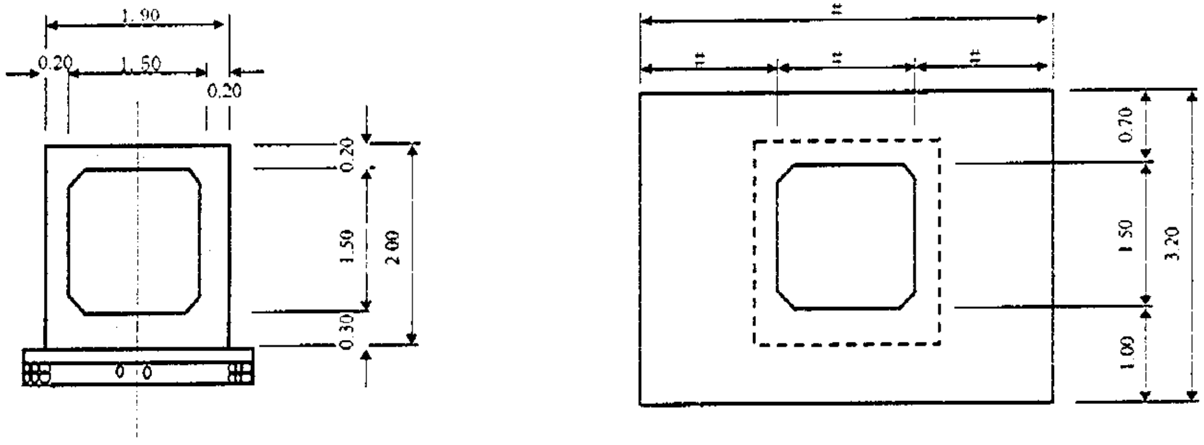


PLAN

Fig. F.4.7 BOX CULVERT TYPE-1 (1.5×1.5) - 1/2



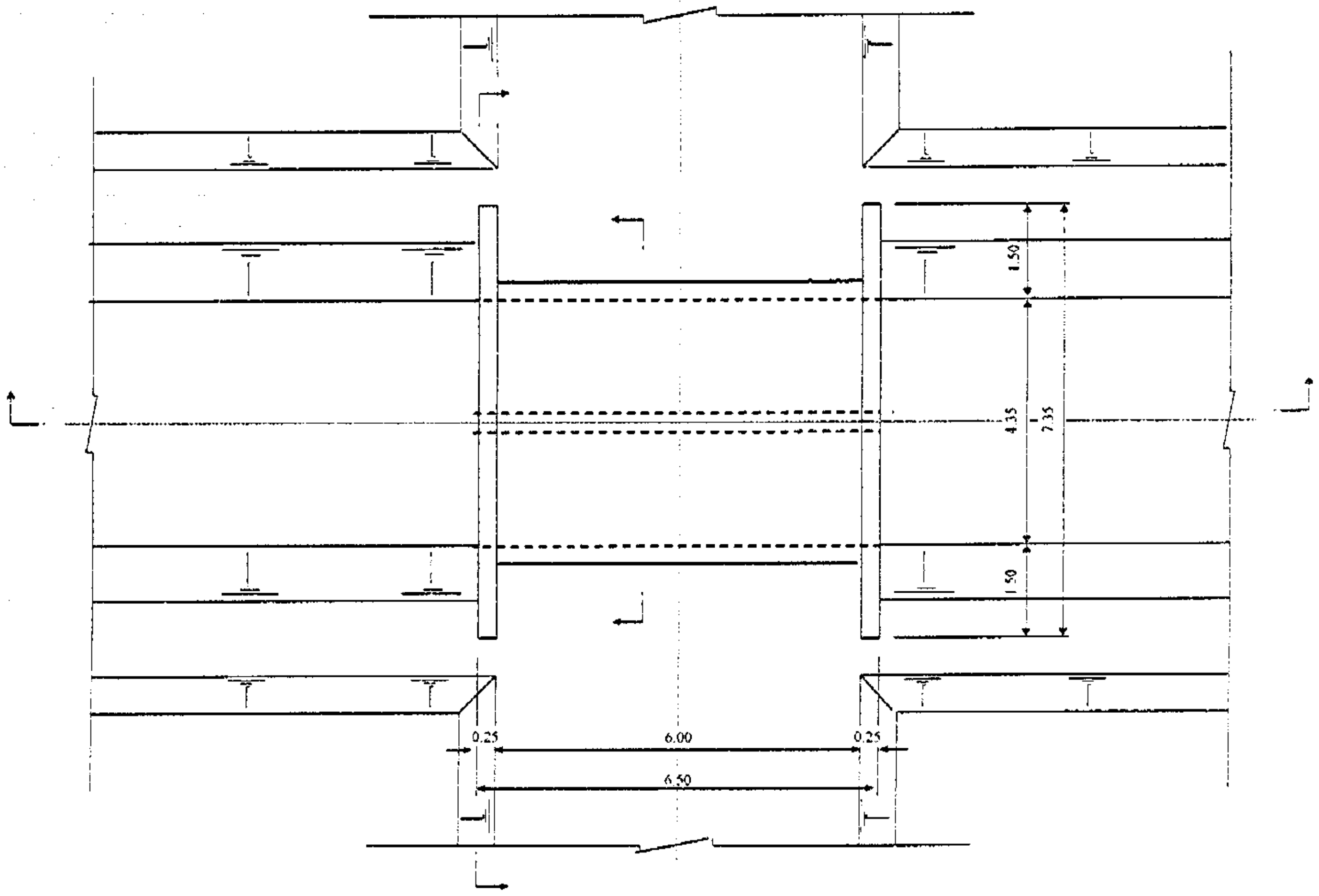
SECTION A - A



SECTION B - B

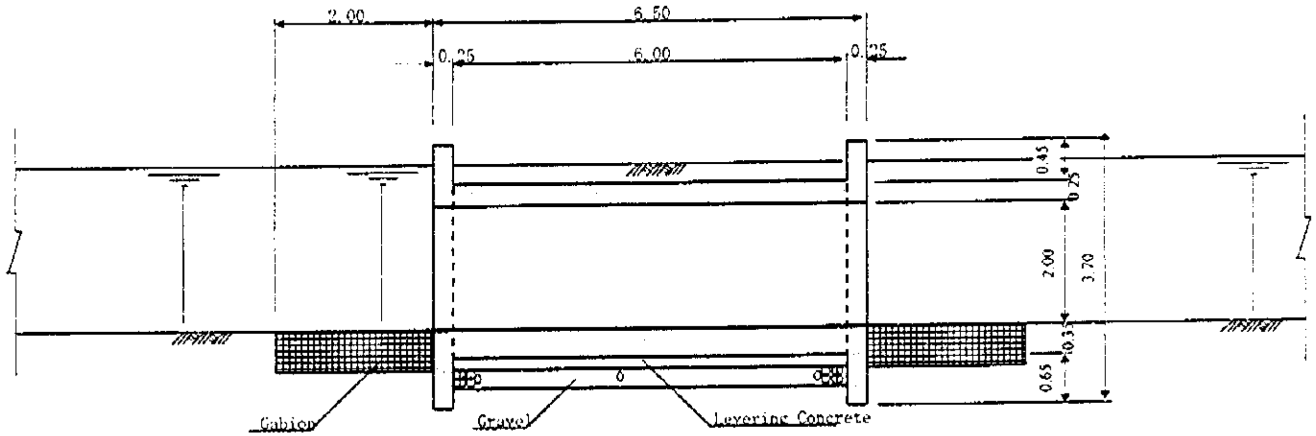
SECTION C - C

Fig. F.4.7 BOX CULVERT TYPE-1 (1.5×1.5) - 2/2

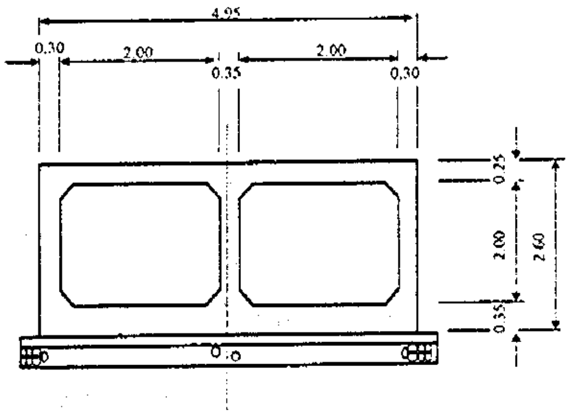


PLAN

Fig. F.4.8 BOX CULVERT TYPE-2 (2.0×2.0×2) - 1/2



SECTION A - A



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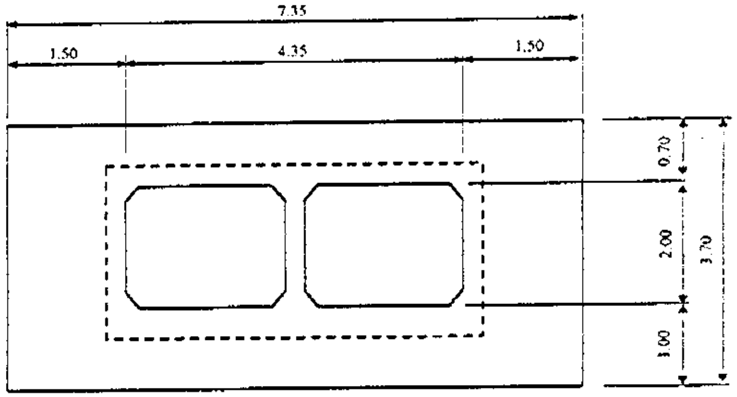
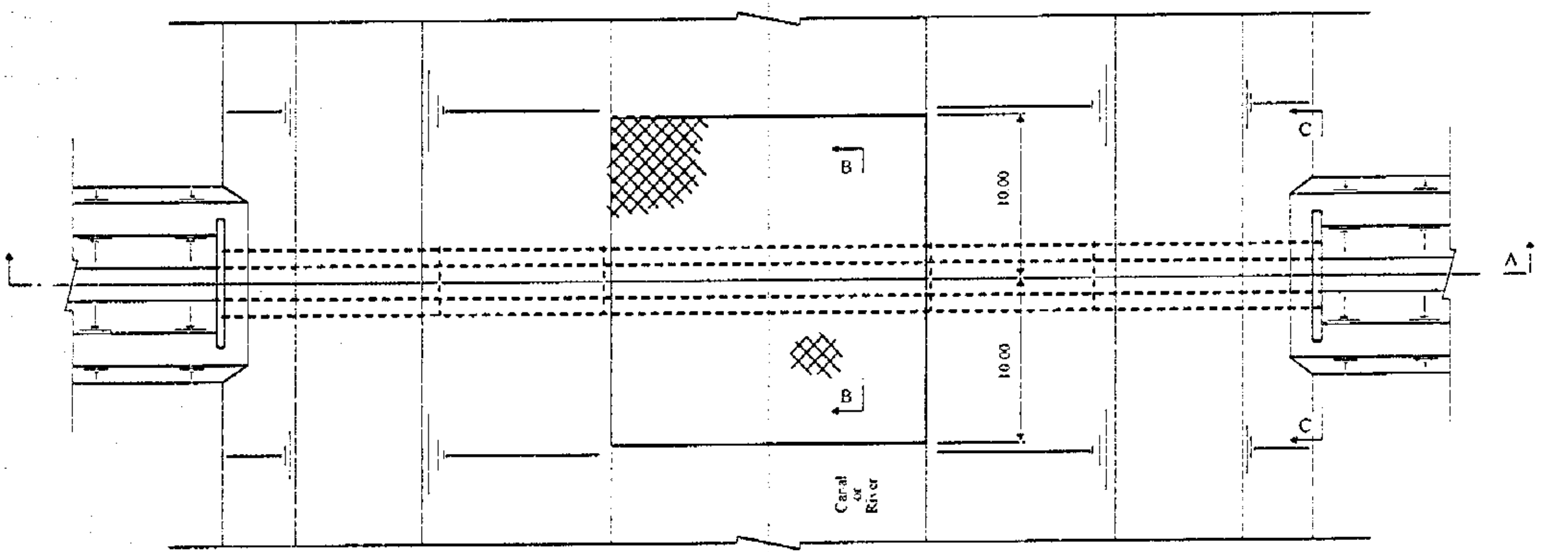
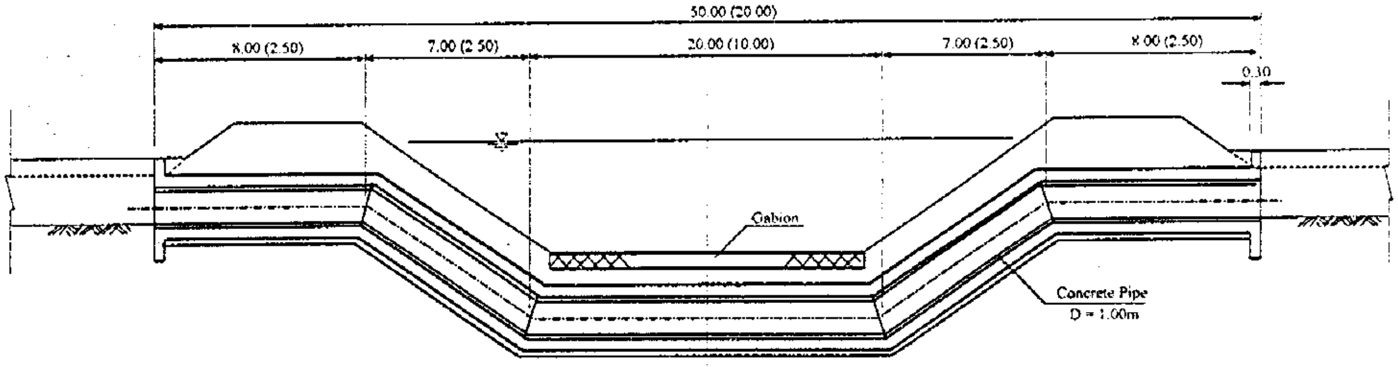


SECTION C - C

Fig. F.4.8 BOX CULVERT TYPE-2 (2.0×2.0×2) - 2/2



PLAN



SECTION A - A

Fig. F.4.9 SIPHON

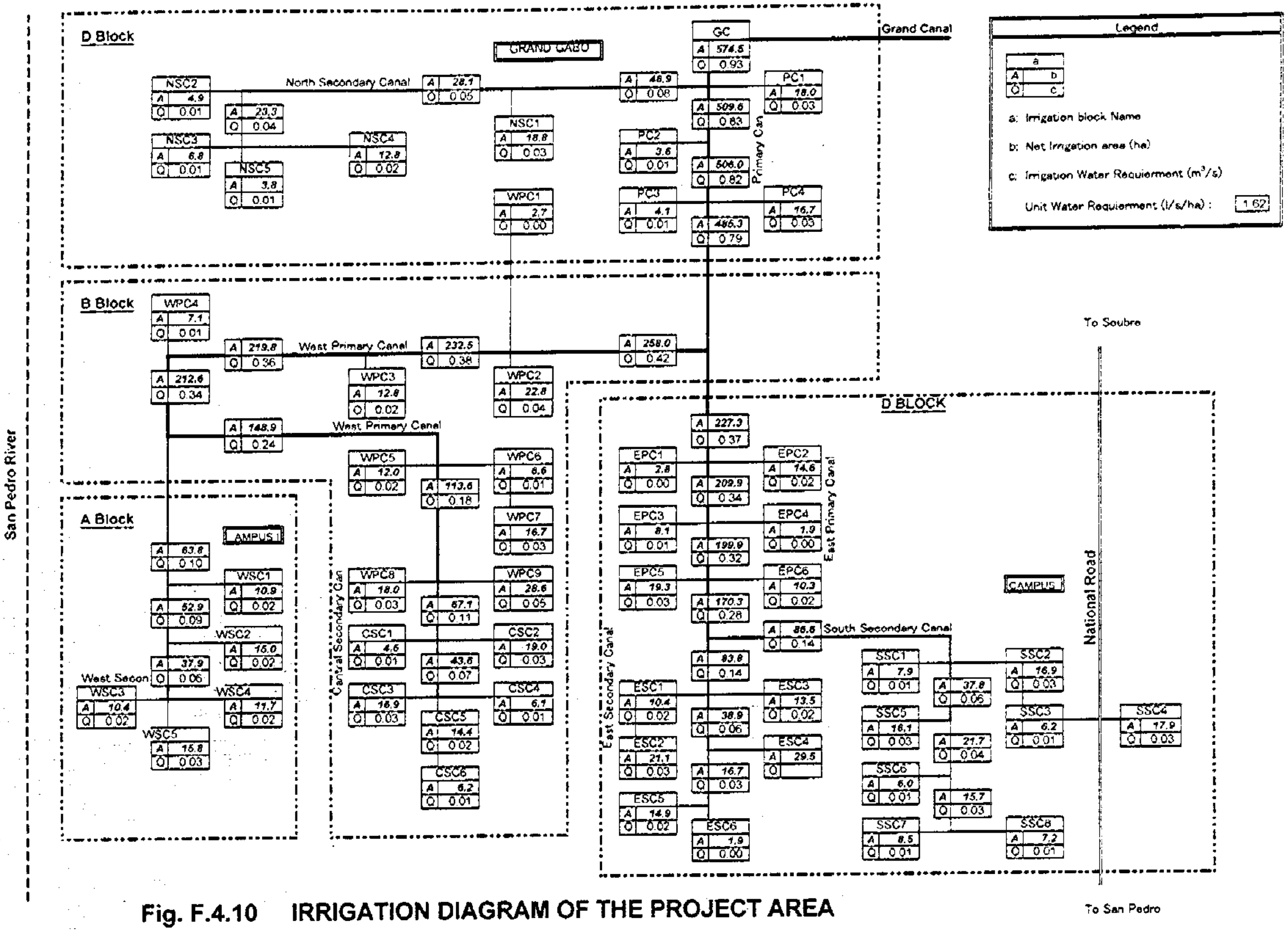


Fig. F.4.10 IRRIGATION DIAGRAM OF THE PROJECT AREA

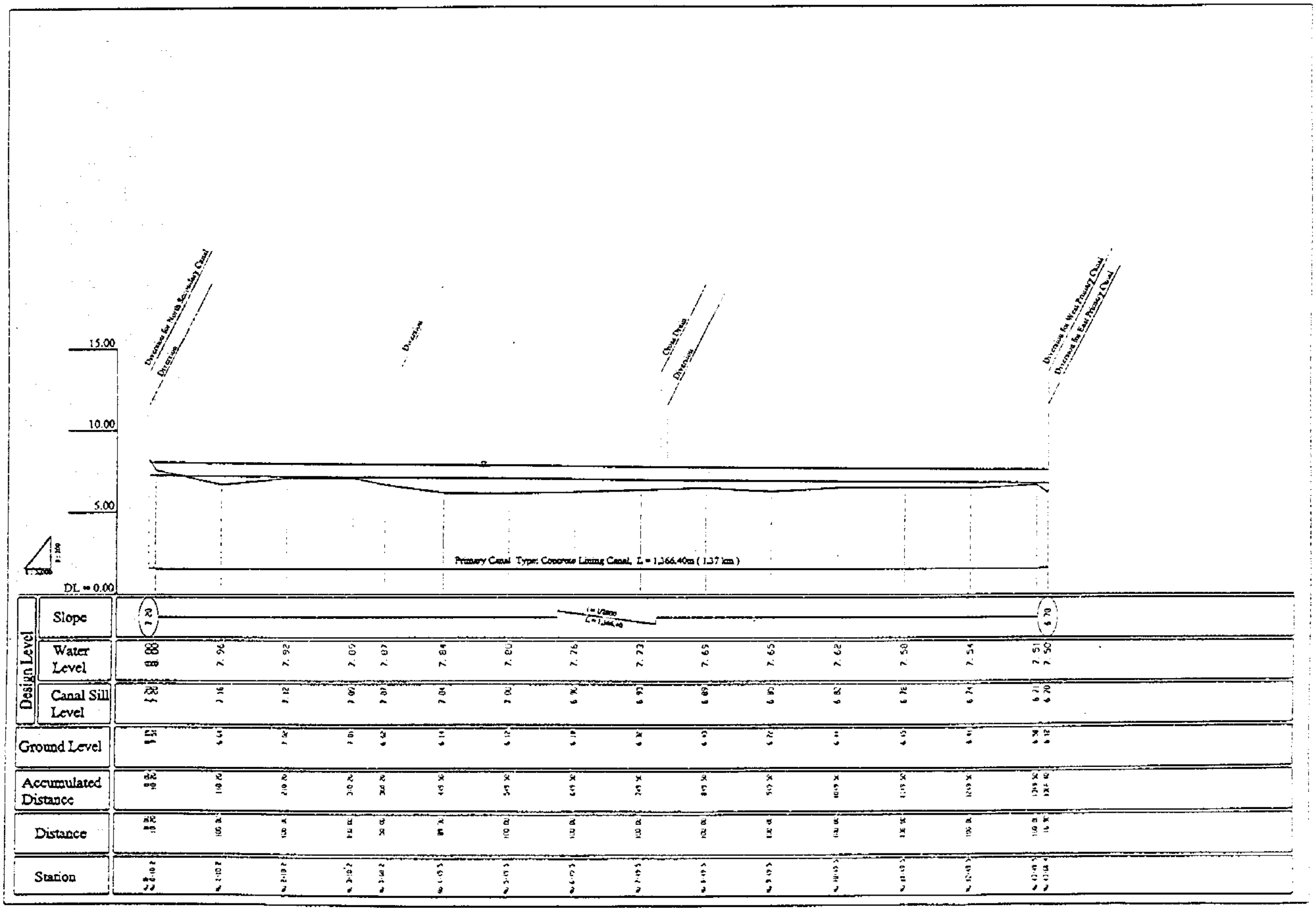


Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (1/9)

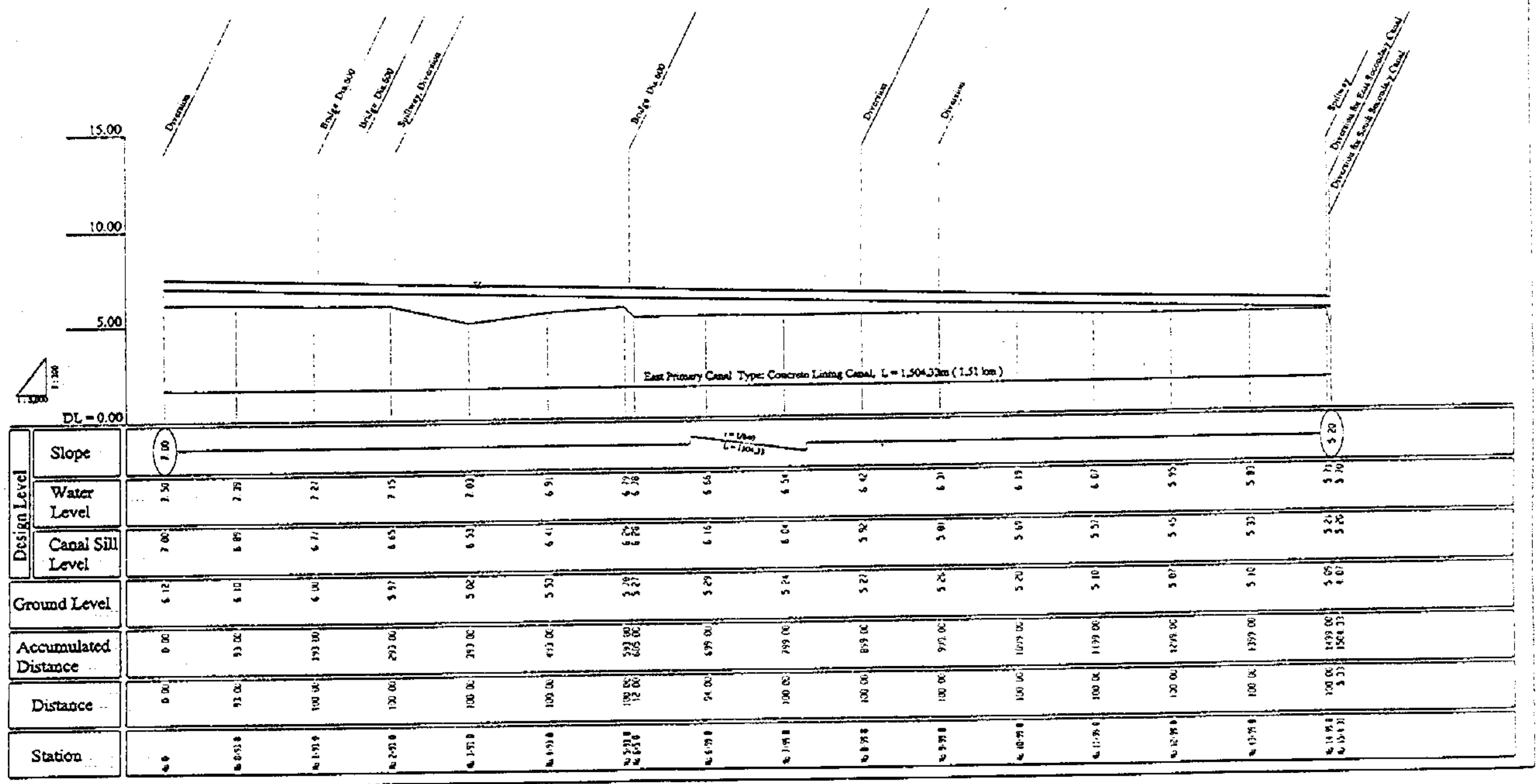
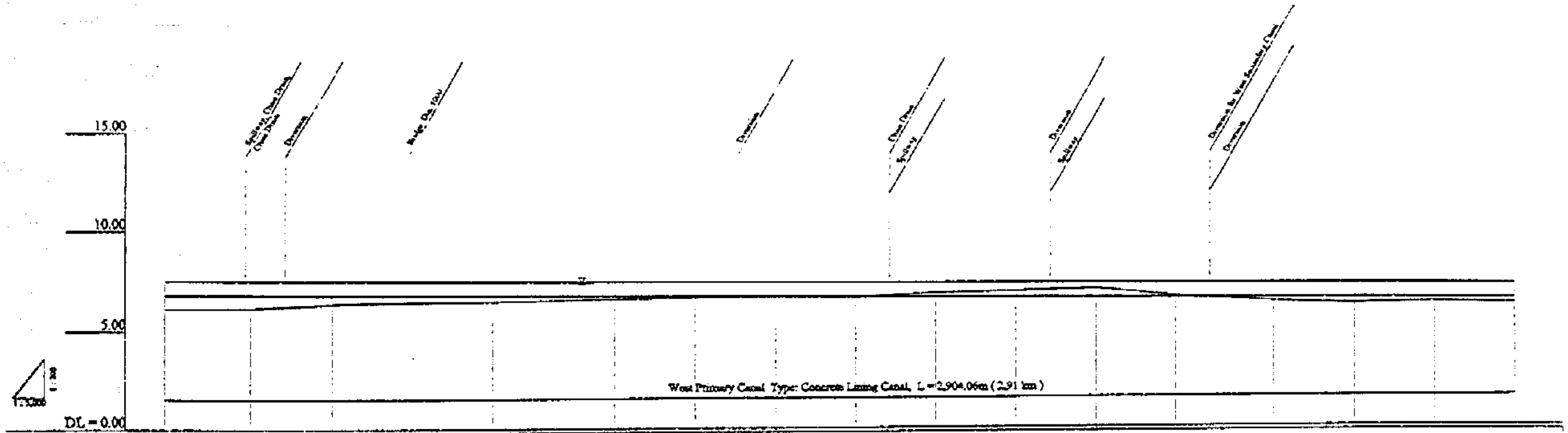
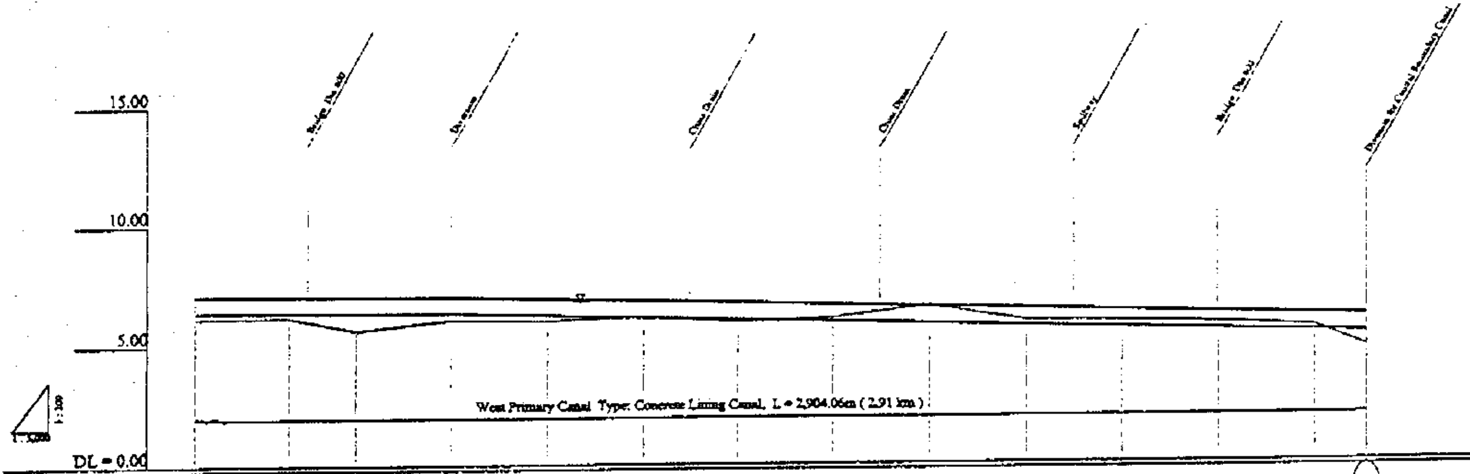


Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (2/9)



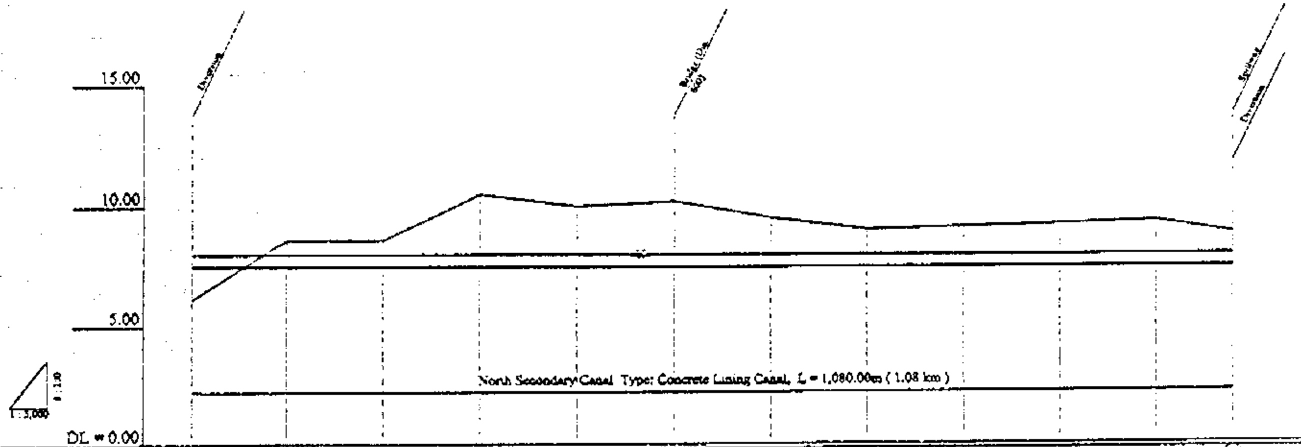
Design Level	Slope	6.80								I = 1/3600 L = 1990.4m								
	Water Level	7.50	7.47	7.45	7.42	7.40	7.36	7.33	7.31	7.28	7.26	7.23	7.20	7.18	7.15	7.12	7.10	7.07
	Canal Sill Level	6.80	6.77	6.75	6.72	6.70	6.66	6.63	6.61	6.58	6.56	6.53	6.50	6.48	6.45	6.42	6.40	6.37
Ground Level		6.14	6.14	6.30	6.42	6.40	6.51	6.57	6.64	6.59	6.75	6.81	6.92	6.56	6.26	6.13	6.21	6.15
Accumulated Distance		0.00	107.00	207.00	307.00	407.00	557.70	657.70	757.70	857.70	957.70	1057.70	1157.70	1257.70	1380.35	1480.35	1580.35	1680.35
Distance		0.00	107.00	100.00	100.00	100.00	150.70	100.00	100.00	100.00	100.00	100.00	100.00	100.00	122.65	100.00	100.00	100.00
Station		No.0	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.16

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (3/9)



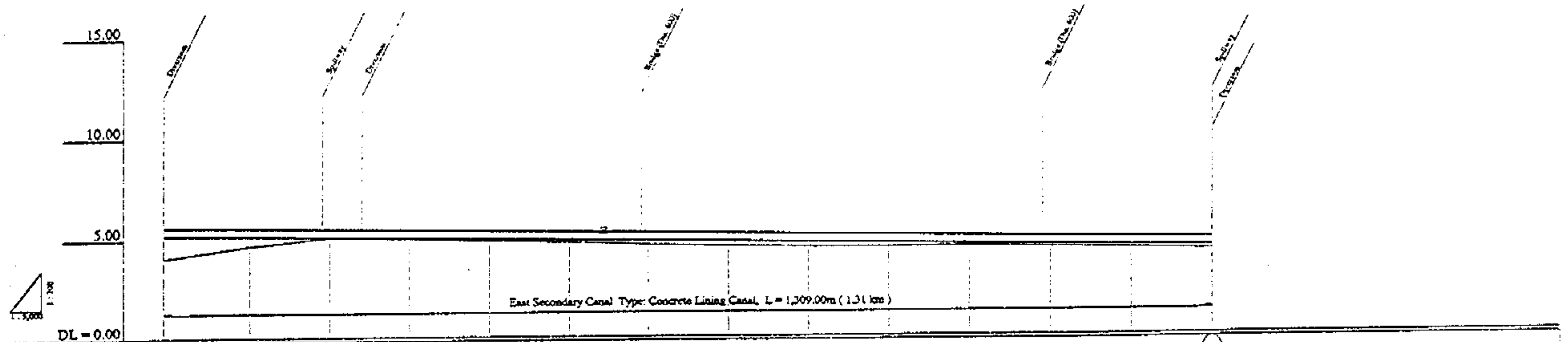
Design Level	Slope		I = 1/7900 L = 1950.66		6.30				I = 1/950 L = 953.70					5.30
	Water Level	7.02	7.01	7.03	7.00	6.90	6.79	6.69	6.58	6.48	6.37	6.27	6.16	6.06	6.00
	Canal Sill Level	6.37	6.34	6.33	6.30	6.20	6.09	5.99	5.88	5.78	5.67	5.57	5.46	5.36	5.30
Ground Level		6.15	6.16	5.61	6.04	5.96	6.14	5.98	6.03	6.51	5.87	5.83	5.73	5.55	4.70
Accumulated Distance		1680.35	1780.35	1850.66	1950.66	2050.66	2150.66	2250.66	2350.66	2450.66	2550.66	2650.66	2750.66	2850.66	2904.36
Distance		100.00	100.00	70.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	53.70
Station		No 16	No 17	No 18	No 19	No 20	No 21	No 22	No 23	No 24	No 25	No 26	No 27	No 28	No 29

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (4/9)



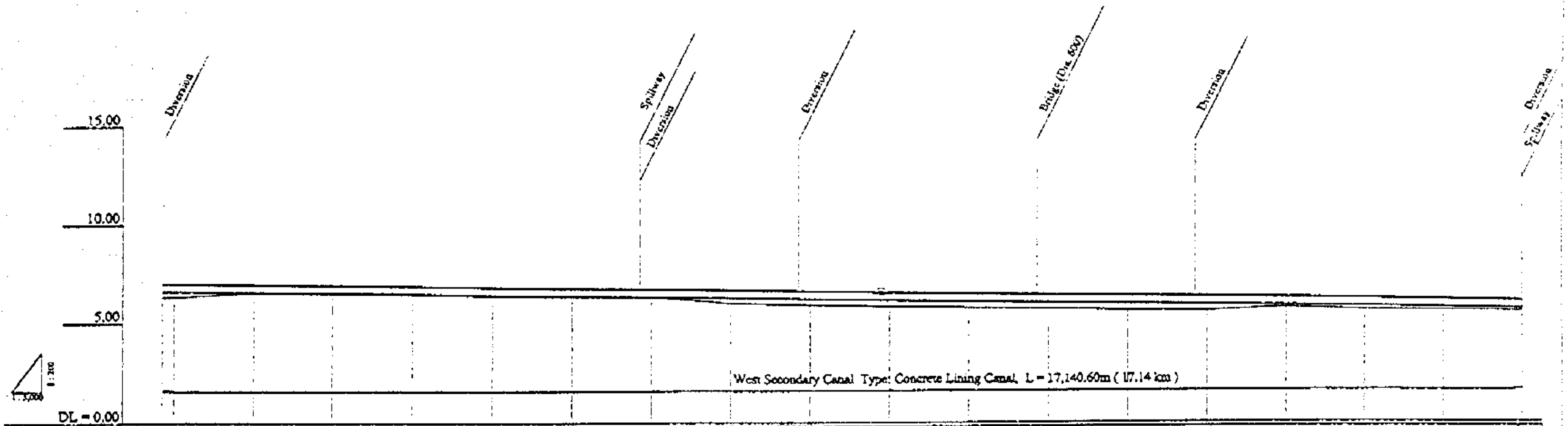
	Slope	7.50					i = 1/11000 L = 1080.00						7.40
Design Level	Water Level	8.00	7.99	7.98	7.97	7.96	7.95	7.94	7.94	7.93	7.92	7.91	7.90
	Canal Sill Level	7.50	7.49	7.48	7.47	7.46	7.45	7.44	7.44	7.43	7.42	7.41	7.40
Ground Level		6.12	8.60	8.60	10.50	10.00	10.20	9.50	9.00	9.10	9.20	9.30	8.80
Accumulated Distance		0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1080.00
Distance		0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	80.00
Station		No.0	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (5/9)



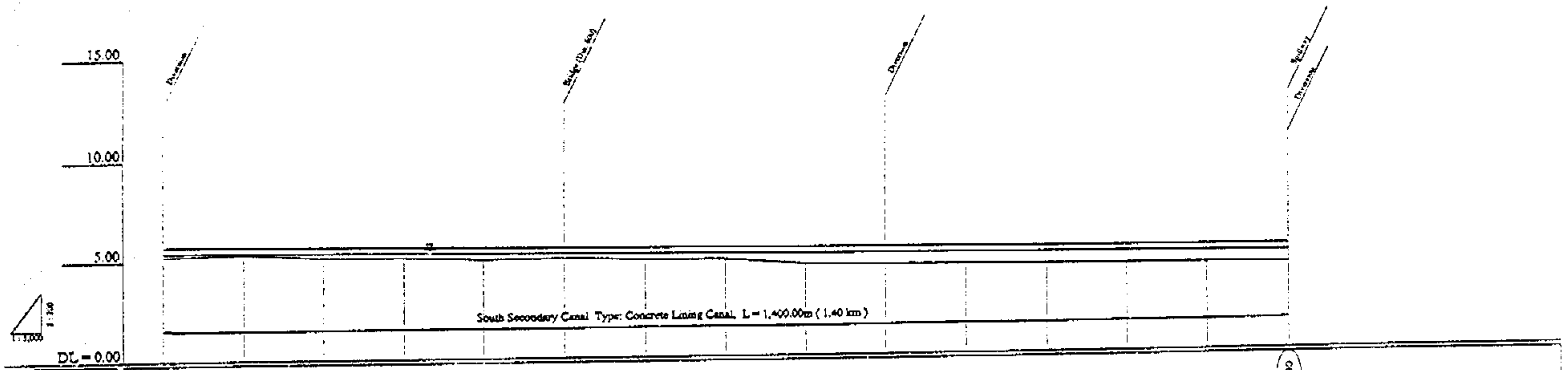
Design Level	Slope	5.20	I = 1/1500 L = 1309.00												4.40
	Water Level	5.60	5.53	5.47	5.41	5.35	5.29	5.23	5.17	5.11	5.04	4.98	4.92	4.86	4.80
	Canal Sill Level	5.20	5.13	5.07	5.01	4.95	4.89	4.83	4.77	4.71	4.64	4.58	4.52	4.46	4.40
Ground Level		4.07	4.65	5.05	4.90	4.65	4.76	4.63	4.55	4.49	4.44	4.42	4.40	4.31	4.19
Accumulated Distance		0.00	109.00	209.00	309.00	409.00	509.00	609.00	709.00	809.00	909.00	1009.00	1109.00	1209.00	1309.00
Distance		0.00	109.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Station		No 0	No 1	No 2	No 3	No 4	No 5	No 6	No 7	No 8	No 9	No 10	No 11	No 12	No 13

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (6/9)



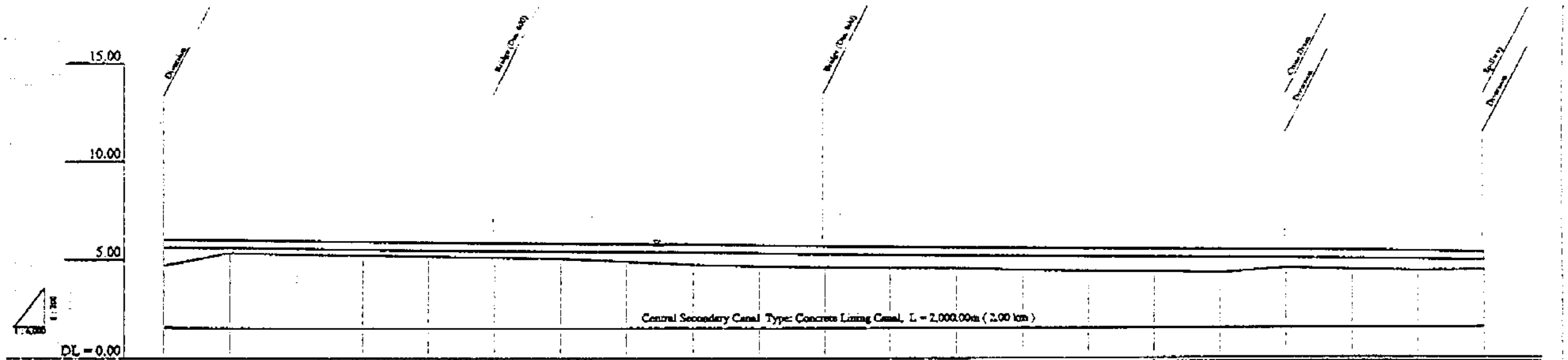
Design Level	Slope	6.60								i = 1/1700 L = 1714.60									5.60
	Water Level	7.00 6.99	6.93	6.88	6.82	6.76	6.70	6.64	6.58	6.53	6.47	6.41	6.35	6.29	6.23	6.18	6.12	6.06	6.00
	Canal Sill Level	6.60 6.59	6.53	6.48	6.42	6.36	6.30	6.24	6.18	6.13	6.07	6.01	5.95	5.89	5.83	5.78	5.72	5.66	5.60
Ground Level		6.31 6.31	6.52	6.52	6.45	6.31	6.32	6.26	5.93	5.85	5.75	5.69	5.64	5.56	5.53	5.47	5.53	5.50	5.45
Accumulated Distance		0.00 14.60	114.60	214.60	314.60	414.60	514.60	614.60	714.60	814.60	914.60	1014.60	1114.60	1214.60	1314.60	1414.60	1514.60	1614.60	1714.60
Distance		0.00 14.60	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Station		No 0	No 1	No 2	No 3	No 4	No 5	No 6	No 7	No 8	No 9	No 10	No 11	No 12	No 13	No 14	No 15	No 16	No 17

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (7/9)



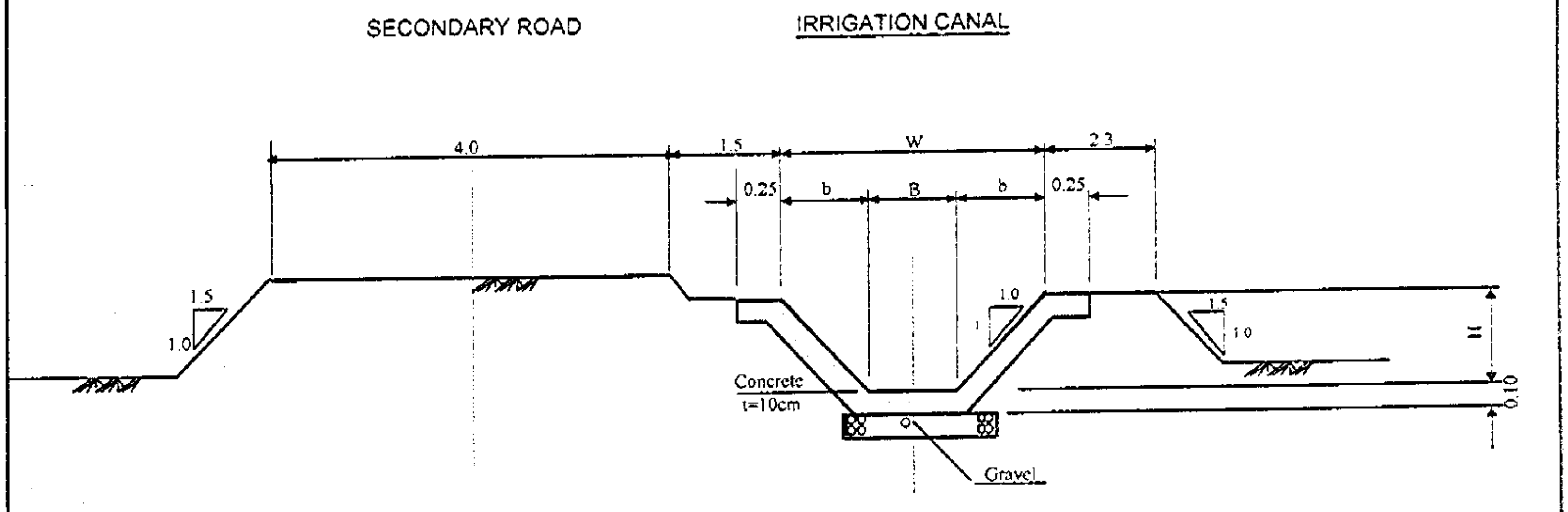
Design Level	Slope	5.40						I = 1/2800 L = 1400.00								4.90
	Water Level	5.70	5.66	5.63	5.59	5.56	5.52	5.49	5.45	5.41	5.38	5.34	5.31	5.27	5.24	5.20
	Canal Sill Level	5.40	5.36	5.33	5.29	5.26	5.22	5.19	5.15	5.11	5.08	5.04	5.01	4.97	4.94	4.90
Ground Level		5.21	5.28	5.19	5.08	4.96	5.00	4.87	4.83	4.55	4.48	4.44	4.40	4.36	4.34	4.27
Accumulated Distance		0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1400.00
Distance		0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Station		No 0	No 1	No 2	No 3	No 4	No 5	No 6	No 7	No 8	No 9	No 10	No 11	No 12	No 13	No 14

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (8/9)



Design Level	Slope	5.60										i = 1/3000 L = 2000.00										4.90
	Water Level	6.00	5.97	5.93	5.90	5.06	5.03	5.79	5.76	5.72	5.69	5.65	5.62	5.58	5.55	5.51	5.48	5.44	5.41	5.37	5.34	5.30
	Canal Sill Level	5.60	5.57	5.53	5.50	5.46	5.43	5.39	5.36	5.32	5.29	5.25	5.22	5.18	5.15	5.11	5.08	5.04	5.01	4.97	4.94	4.90
Ground Level		4.70	5.33	5.26	5.22	5.15	5.09	5.04	4.83	4.70	4.64	4.59	4.54	4.53	4.42	4.39	4.36	4.27	4.52	4.42	4.36	4.43
Accumulated Distance		0.00	100.00	200.00	300.00	400.00	500.00	600.00	700.00	800.00	900.00	1000.00	1100.00	1200.00	1300.00	1400.00	1500.00	1600.00	1700.00	1800.00	1900.00	2000.00
Distance		0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Station		No.0	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.16	No.17	No.18	No.19	No.20

Fig. F.4.11 PROFILE OF THE IRRIGATION CANAL (9/9)



DIMENSION

Primary Canal
Concrete Lining Canal (A=More than 100ha)

Canal No.	B	b	W	H
PC1	0.80	0.90	2.60	0.90
PC2	0.80	0.90	2.60	0.90
WPC1	0.40	0.80	2.00	0.80
WPC2	0.30	0.60	1.50	0.60
EPC	0.40	0.60	1.60	0.60

Secondary Canal
Earth Lining Canal (A=Less than 100ha)

Canal No.	B	b	W	H
WSC	0.30	0.50	1.30	0.50
CSC	0.30	0.50	1.30	0.50
ESC	0.30	0.50	1.30	0.50
SSC	0.30	0.40	1.10	0.40
NSC	0.40	0.60	1.60	0.60

Fig. F.4.12 TYPICAL SECTION OF IRRIGATION CANAL

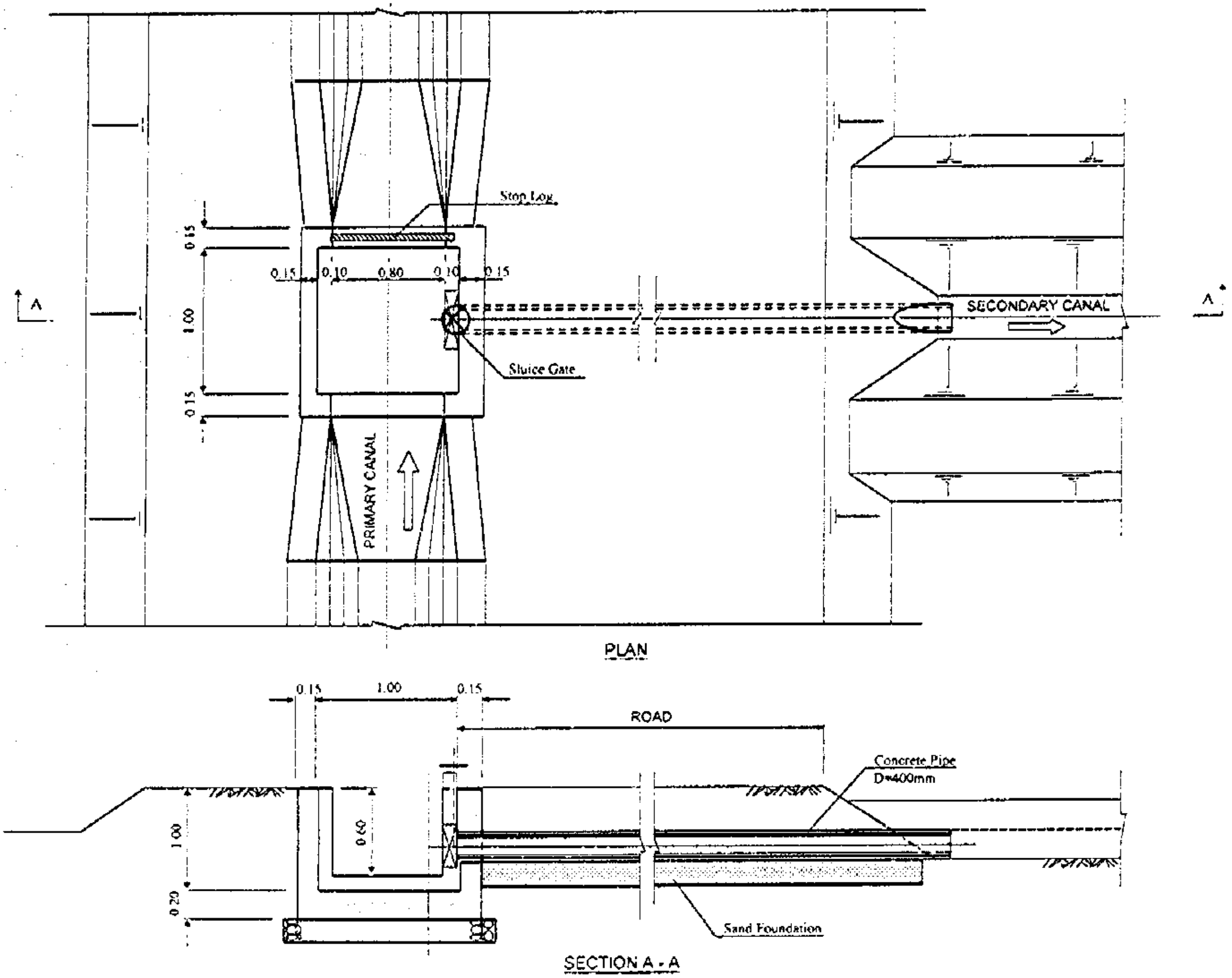


Fig. F.4.13 DIVERSION STRUCTURE

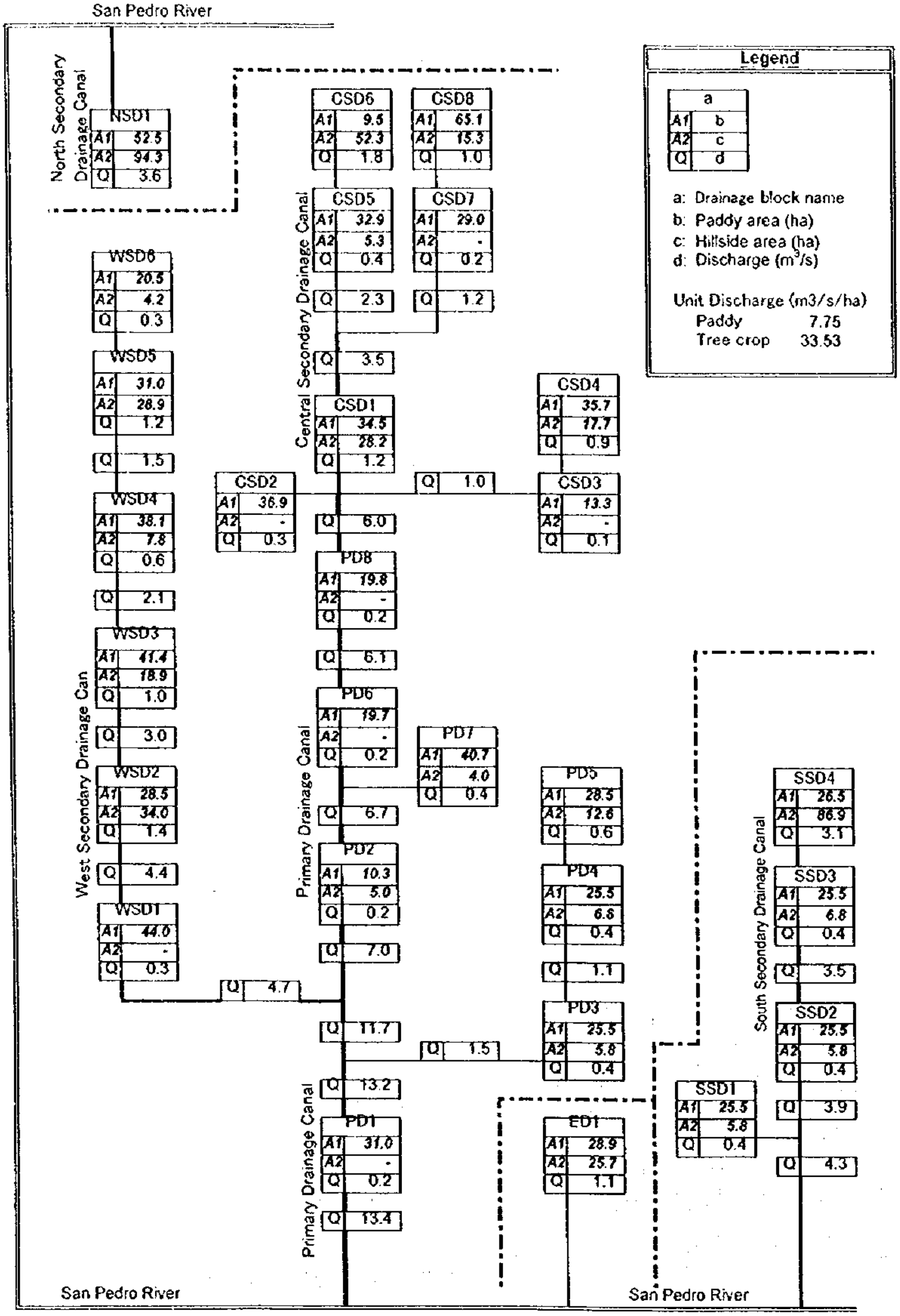


Fig. F.4.14 DRAINAGE DIAGRAM OF THE PROJECT AREA

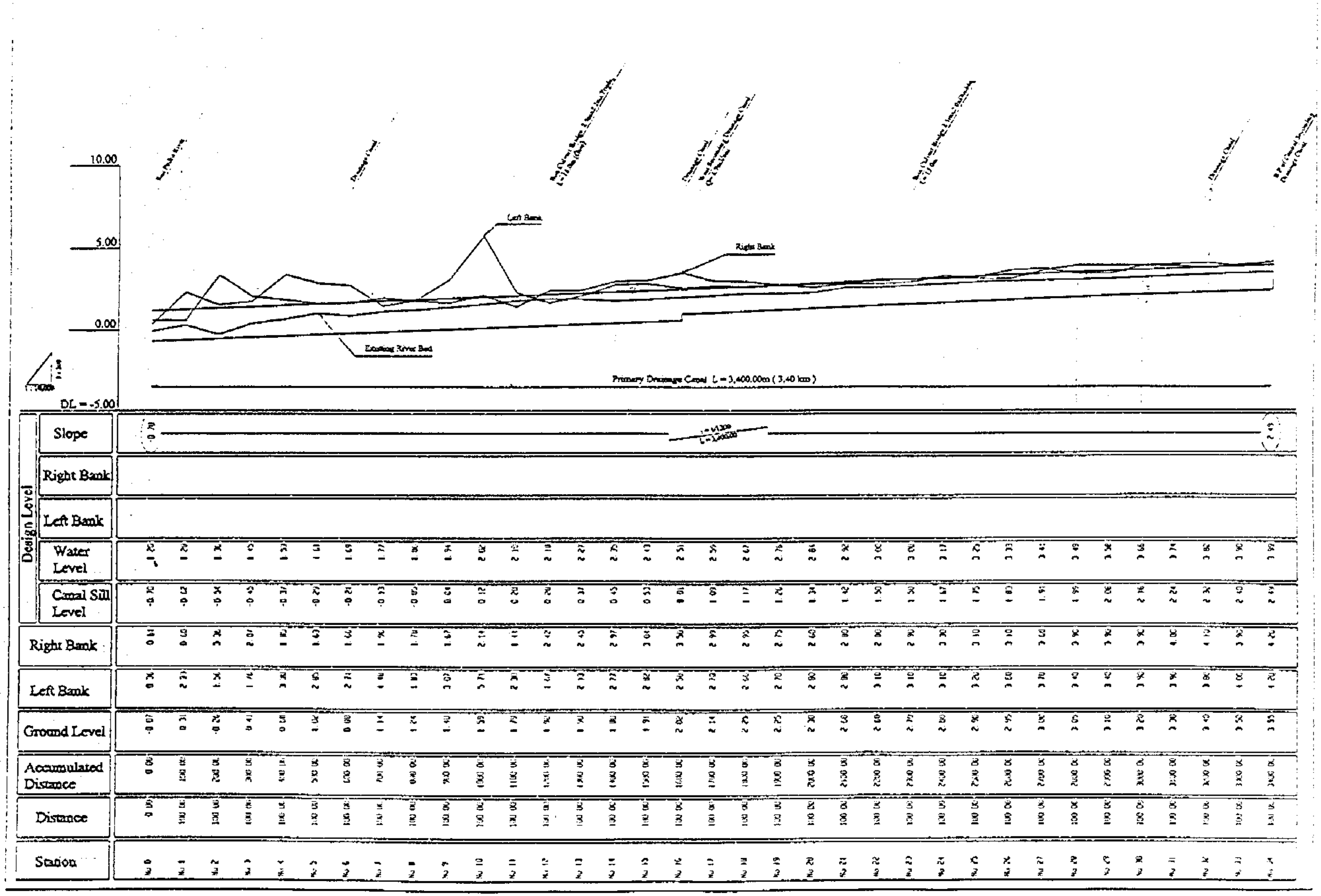
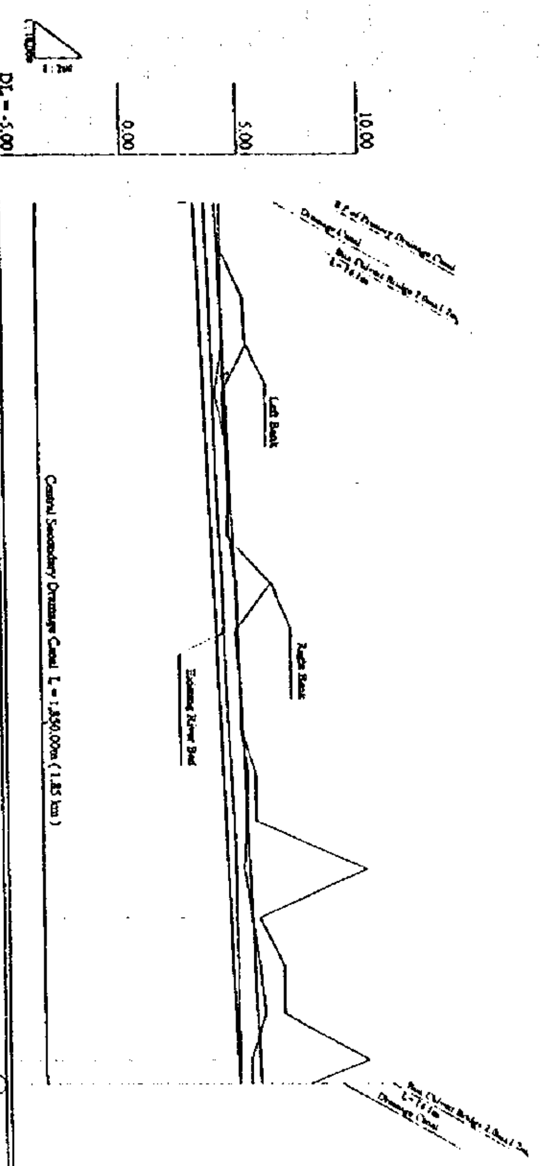
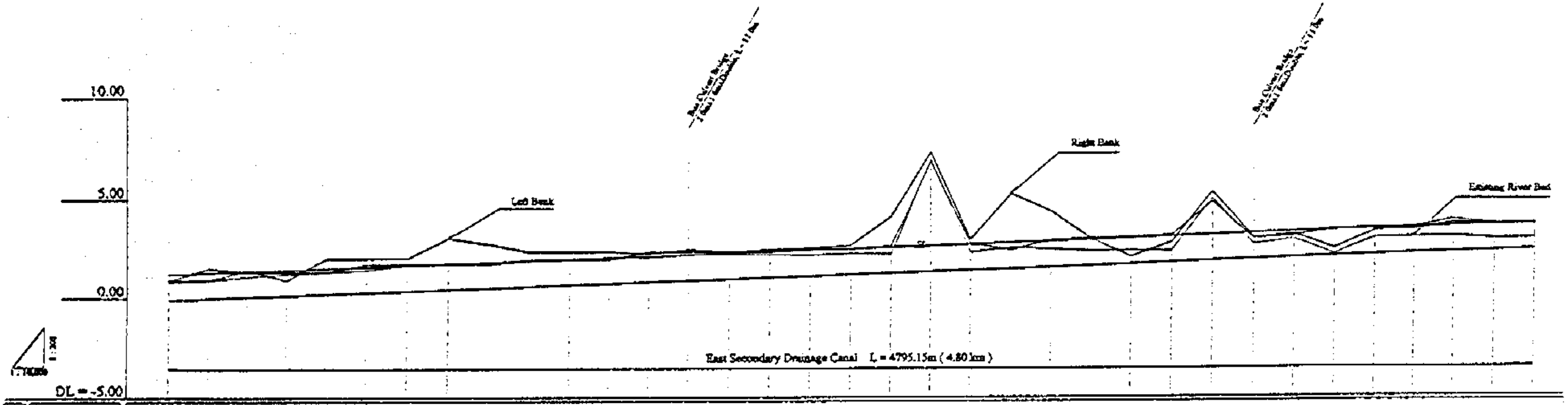


Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (1/6)



Station	Distance	Accumulated Distance	Ground Level	Left Bank	Right Bank	Design Level				
						Canal Sill Level	Water Level	Left Bank	Right Bank	Slope
No 0	0.00	0.00	3.55	4.20	4.20	3.09	3.97			3.09
No 1	100.00	100.00	3.60	4.20	4.20	3.17	4.07			
No 2	100.00	200.00	3.70	5.10	4.20	3.25	4.15			
No 3	100.00	300.00	3.72	5.20	4.20	3.33	4.23			
No 4	100.00	400.00	3.80	4.20	3.90	3.41	4.31			
No 5	100.00	500.00	3.85	4.70	4.30	3.49	4.39			
No 6	100.00	600.00	3.90	4.40	4.40	3.58	4.48			
No 7	100.00	700.00	4.00	4.40	4.30	3.66	4.56			
No 8	100.00	800.00	4.10	4.70	6.10	3.74	4.64			
No 9	100.00	900.00	4.15	4.70	4.60	3.82	4.72			
No 10	100.00	1000.00	4.20	4.80	4.80	3.90	4.80			
No 11	100.00	1100.00	4.30	4.80	4.90	3.99	4.89			
No 12	100.00	1200.00	4.40	5.10	5.40	4.07	4.97			
No 13	100.00	1300.00	4.50	5.00	5.40	4.15	5.05			
No 14	100.00	1400.00	4.55	4.90	10.00	4.23	5.13			
No 15	100.00	1500.00	4.55	5.20	5.50	4.31	5.21			
No 16	100.00	1600.00	4.60	5.50	6.50	4.40	5.30			
No 17	100.00	1700.00	4.60	5.70	6.50	4.40	5.30			
No 18	100.00	1800.00	4.65	5.10	10.00	4.56	5.46			
	50.00	1850.00	4.60	5.10	7.37	4.60	5.50			4.60

Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (2/6)



Station	Design Level: Slope	Design Level: Right Bank	Design Level: Left Bank	Design Level: Water Level	Design Level: Canal Sill Level	Right Bank	Left Bank	Ground Level	Accumulated Distance	Distance
No 0	-0.10			1.20	-0.10	0.90	0.90	0.80	0.00	0.00
No 1				1.27	-0.03	1.50	0.90	0.90	100.00	100.00
No 2				1.35	0.05	1.30	1.40	1.10	200.00	100.00
No 3				1.42	0.12	1.30	0.90	1.20	300.00	100.00
No 4				1.49	0.19	1.30	2.00	1.30	400.00	100.00
No 5				1.57	0.27	1.70	2.00	1.40	500.00	100.00
No 6				1.64	0.34	1.70	2.00	1.65	600.00	100.00
No 7				1.71	0.41	1.70	3.00	1.76	700.00	100.00
No 8				1.78	0.48	1.70	2.70	1.70	800.00	100.00
No 9				1.86	0.56	1.90	2.30	1.85	900.00	100.00
No 10				1.93	0.63	1.90	2.30	1.90	1000.00	100.00
No 11				2.00	0.70	1.90	2.30	2.05	1100.00	100.00
No 12				2.08	0.78	2.30	2.20	2.00	1200.00	100.00
No 13				2.15	0.85	2.30	2.40	2.18	1300.00	100.00
No 14				2.22	0.92	2.30	2.30	2.15	1400.00	100.00
No 15				2.30	1.00	2.10	2.30	2.15	1500.00	100.00
No 16	i=1/1400 L=4795.15			2.37	1.07	2.49	2.43	2.11	1600.00	100.00
No 17				2.44	1.14	2.60	2.39	2.20	1700.00	100.00
No 18				2.51	1.21	4.65	2.58	2.17	1800.00	100.00
No 19				2.59	1.29	7.25	6.79	6.89	1900.00	100.00
No 20				2.66	1.36	2.60	2.69	2.25	2000.00	100.00
No 21				2.73	1.43	5.18	2.34	2.30	2100.00	100.00
No 22				2.81	1.51	4.31	2.86	2.42	2200.00	100.00
No 23				2.88	1.58	2.91	2.95	2.30	2300.00	100.00
No 24				2.95	1.65	2.82	3.00	2.32	2400.00	100.00
No 25				3.03	1.73	2.71	3.07	2.25	2500.00	100.00
No 26				3.10	1.80	5.25	4.74	4.93	2600.00	100.00
No 27				3.17	1.87	2.94	2.88	2.61	2700.00	100.00
No 28				3.24	1.94	3.10	3.02	2.87	2800.00	100.00
No 29				3.32	2.02	2.37	3.32	2.10	2900.00	100.00
No 30				3.39	2.09	3.26	3.38	2.92	3000.00	100.00
No 31				3.46	2.16	3.47	3.34	2.97	3100.00	100.00
No 32				3.54	2.24	3.61	3.68	3.01	3200.00	100.00
No 33				3.61	2.31	3.61	3.63	2.97	3300.00	100.00
No 34				3.68	2.38	3.61	3.72	2.93	3400.00	100.00

Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (3/6)

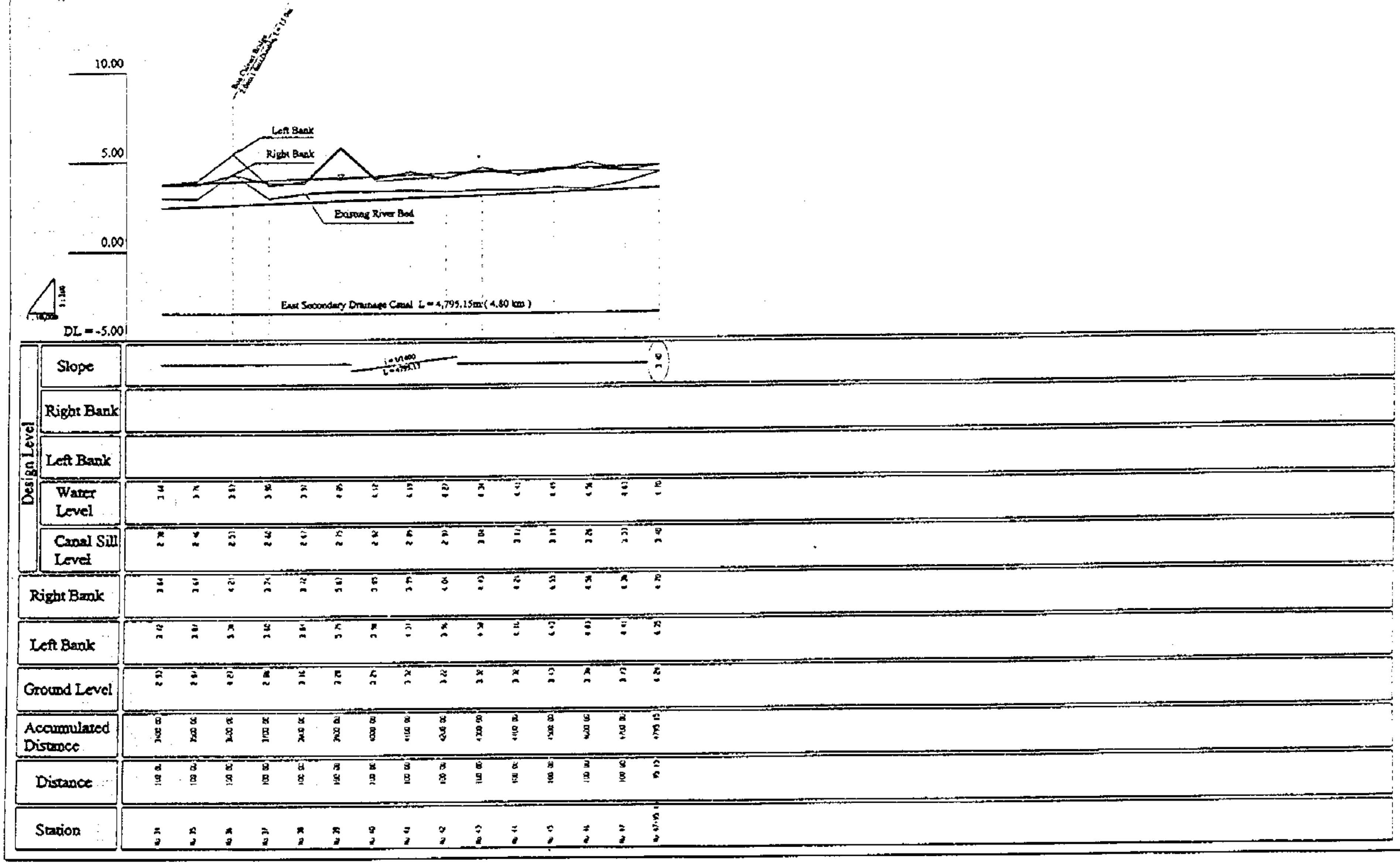
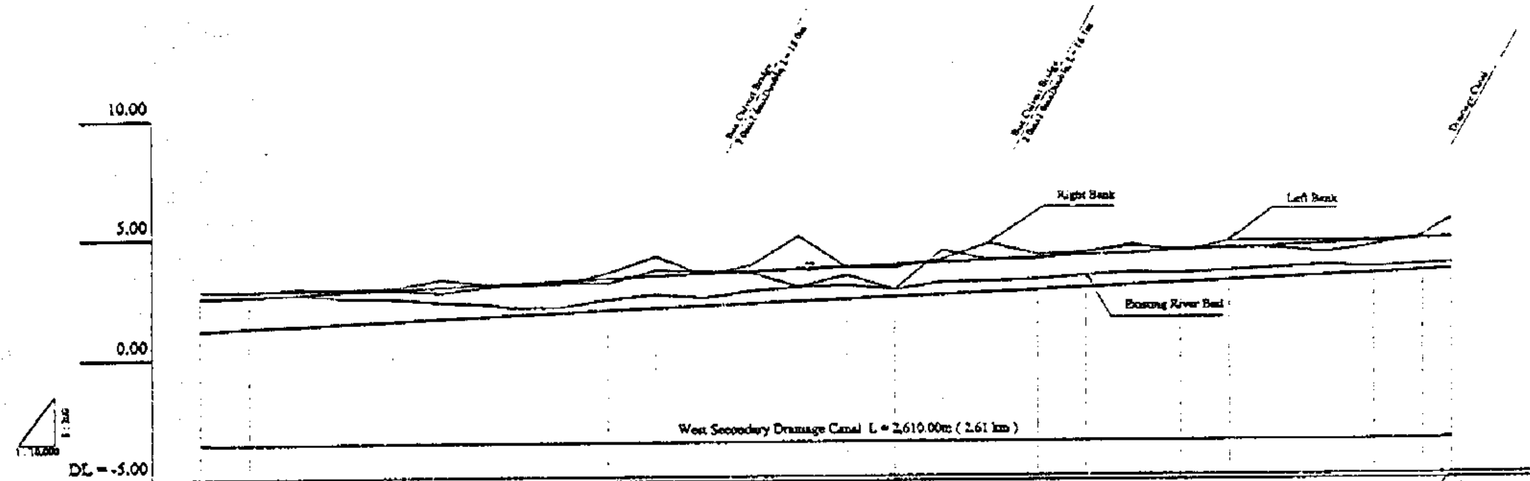
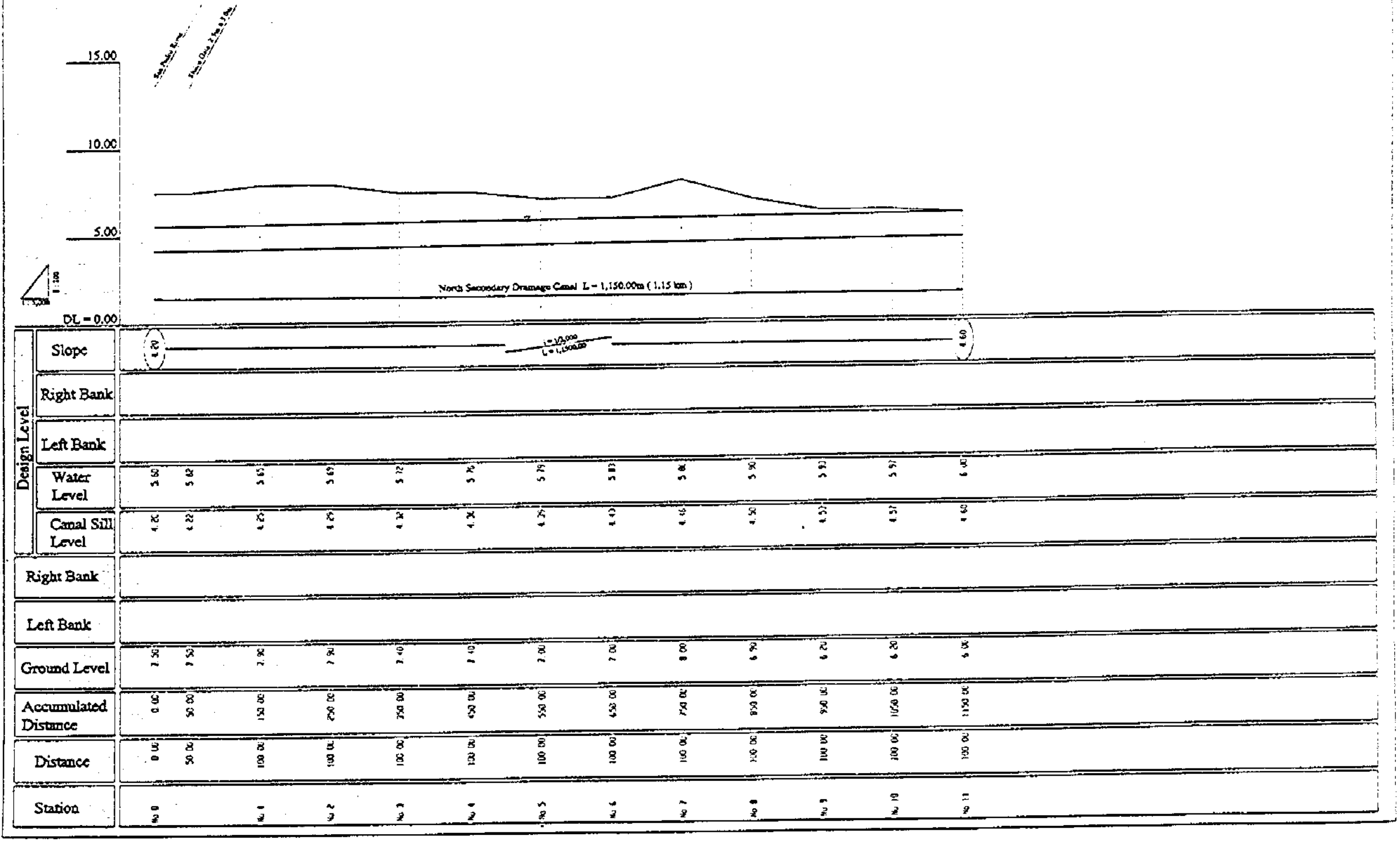


Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (4/6)



Design Level	Slope	1.20												i = 1/1,200 L = 2,610.00															3.40
	Right Bank																												
	Left Bank																												
	Water Level	2.50	2.58	2.67	2.75	2.84	2.92	3.01	3.05	3.13	3.22	3.30	3.39	3.47	3.55	3.64	3.72	3.81	3.89	3.98	4.06	4.14	4.23	4.31	4.40	4.48	4.57	4.65	4.70
	Canal Sill Level	1.20	1.28	1.37	1.45	1.54	1.62	1.71	1.75	1.83	1.92	2.00	2.09	2.17	2.25	2.34	2.42	2.51	2.59	2.68	2.76	2.84	2.93	3.01	3.10	3.18	3.27	3.35	3.40
Right Bank		2.80	2.80	2.80	2.95	2.90	3.20	3.03	2.95	3.20	3.40	4.05	3.33	3.70	4.91	3.60	3.60	3.93	4.50	4.10	4.20	4.40	4.30	4.38	4.36	4.11	4.40	4.77	5.50
Left Bank		2.80	2.76	2.90	2.90	2.82	2.70	2.90	2.93	3.04	3.03	3.53	3.40	3.41	2.81	3.30	2.70	4.30	3.90	3.90	4.20	4.50	4.20	4.60	4.60	4.60	4.60	4.70	4.70
Ground Level		2.63	2.60	2.65	2.56	2.45	2.36	2.20	2.06	2.05	2.36	2.55	2.41	2.45	2.82	2.96	2.70	3.00	3.05	3.10	3.25	3.35	3.30	3.40	3.50	3.60	3.50	3.55	3.65
Accumulated Distance		0.00	100.00	200.00	300.00	400.00	500.00	600.00	650.00	750.00	850.00	950.00	1050.00	1150.00	1250.00	1350.00	1450.00	1550.00	1650.00	1750.00	1850.00	1950.00	2050.00	2150.00	2250.00	2350.00	2450.00	2550.00	2610.00
Distance		0.00	100.00	100.00	100.00	100.00	100.00	100.00	50.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	60.00
Station		No.0	No.1	No.2	No.3	No.4	No.5	No.6	No.6+50.0	No.7+50.0	No.8+50.0	No.9+50.0	No.10+50.0	No.11+50.0	No.12+50.0	No.13+50.0	No.14+50.0	No.15+50.0	No.16+50.0	No.17+50.0	No.18+50.0	No.19+50.0	No.20+50.0	No.21+50.0	No.22+50.0	No.23+50.0	No.24+50.0	No.25+50.0	No.26+10.0

Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (5/6)



Slope													
Design Level – Right Bank													
Design Level – Left Bank													
Design Level – Water Level	5.60	5.62	5.65	5.69	5.72	5.76	5.79	5.83	5.86	5.90	5.93	5.97	6.00
Design Level – Canal Sill Level	4.20	4.22	4.25	4.29	4.32	4.36	4.39	4.43	4.46	4.50	4.53	4.57	4.60
Right Bank													
Left Bank													
Ground Level	7.50	7.50	7.90	7.90	7.40	7.40	7.00	7.00	8.00	6.90	6.20	6.20	6.00
Accumulated Distance	0.00	50.00	150.00	250.00	350.00	450.00	550.00	650.00	750.00	850.00	950.00	1050.00	1150.00
Distance	0.00	50.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Station	No 0		No 1	No 2	No 3	No 4	No 5	No 6	No 7	No 8	No 9	No 10	No 11

Fig. F.4.15 PROFILE OF THE DRAINAGE CANAL (6/6)