II. Study matters on Land Consolidation in Thailand

1. Preface

Land Consolidation in Thailand aims at:

i) With irrigation and drainage facilities at the farm level established, every plot can be directly and timely irrigated and is directly drainable.
This is the main purpose of land consolidation: to introduce high yield varieties of rice.

ii) With farm roads built alongside the irrigation ditches, every plot is directly accessible.
Farm mechanization is also encouraged.

iii) The yield and cropping intensity can be expected to increase considerably, which will result in a sharp increase in the farmers' net income.

iv) Socio-economic and living conditions in the implemented areas will be improved.

As regards RID, they have already enough experience of land consolidation though some weak points have been found through my four years' experience.

They are:

1) Independent divisions are looking after only segments of an overall work, such a system prevents the bringing up of Generalist-type engineers.
2) The unification of the administrative organs is required.
3) To strengthen and to bring up a water users' group with subsidies and guidance from the Government.
4) To increase the number of officials in charge of land consolidation and its budget.
5) To reexamine the rates farmers pay on land consolidation.
6) Land use planning should be drawn up in order to give priority to the implementation of land consolidation.

2. To study the implementation method of Land Consolidation in Thailand

The Mae Klong Pilot Project No. 1 constructed by the Intensive method.

The MaeKlong Pilot Project No.2 : Extensive method.

The work of Land Consolidation is classified into various levels according to the situation and financial resources.

In the Intensive Development, many projects had already been established the same basis. However, some developments below the intensive level had already been undertaken but still do not have stipulation on a homogeneous basis. The developments would be designed as "Land Consolidation" but the method of development can be varied according to the situation and environment of each region.

The extensive development whichever Land Consolidation Act can be applied shall follow the approved basis. There must be an irrigation water system and a drainage system for all the farm land during all the seasons. The number of farms that received irrigation water directly must not be less than 70 % of the number of landlords in each project area. The other 30 % should receive water indirectly by other methods according to the topographic conditions and through the other farms.

Many intensive developments have been successful on this basis but extensive development may be classified into various levels which have not yet been designated for effective water management.

Owing to the budget and area requested for land consolidation, the Thai Government has decided to adopt the extensive development method for implementation of late.

Such being the case, it is hoped to compare the Intensive development method with the Extersive development method using pilot projects No.1 and No.2.

The study items will be as follows:

2.1 <u>Project cost and benefit evaluation</u>

Project cost should be considered as to which development method would best be adopted.
One of the factors is the roll of a project site, because the cost of land levelling will occupy nearly 40 % of the projects cost according to our experience at the MaeKlong Pilot Project No.1.
But in case of gentle rise and fall, land levelling is not required to the same extent, therefore, RID should set the design standard.

I am not sure, but it is said that 70 m^3 per ha. is the limit that can be adopted in the Intensive method.

2.2 A view of future prospects of mechanized farming and agricultural population.

Though energy problems can be fraught with misgivings, on the other hand, in the case of the consideration of the development of industry in Thailand in the near future, mechanized farming will be indispensable.

i) A decrease in population by birth control might cause a lack of labor force for farming such as has occured in developed countries.

ii) As human beings, farmers should be released from heavy labor.

iii) Expansion of the irrigated agriculture development will bring about much larger double cropping areas than exist at the present time.

Farming by farmers will become more and more severe but on the other hand the farmers' income will increase so they will be able to purchase the necessary agricultural machines.

2.3 To export various farming productions:

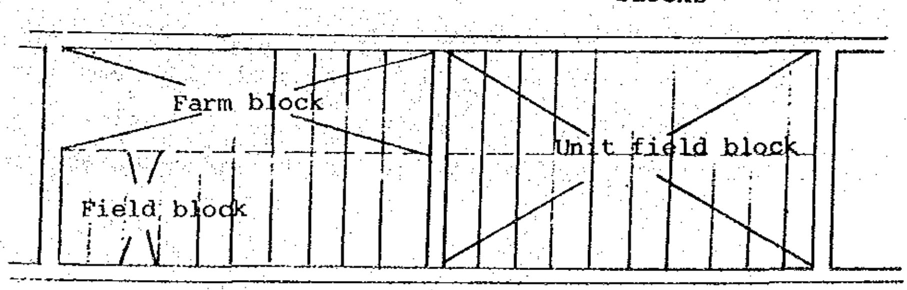
Cultivated fields should be developed for dual purposes.
Regarding this matter terminal facilities for irrigation, drainage and transportation, especially draining directly from each plot, are requested.
Only the intensive development method is able to answer these problems. (See the picture at page 2)

3. Detailed technical matters

As for the planning and design of the Mae Klong Pilot Project, the following items should be studied.

3.1 Study on the size of a field block, a farm block and a unit field block

Definition of the name of blocks



3.1.1 Design and Construction:

Standard field block	:	0.8 ha	(160 m x 50 m)
Standard farm block	:	9.6 ha	(12 x Standard field block)

Standard unit field block : 19.2 ha (2 x Standard farm block)

Note : Length of a standard field block is as long as 160 m but the width of it is changed in accordance with the acreage of the land owners.

Present situation after land consolidation as the result of the sampling survey.

In order to confirm that how farmers use their land after completion of land consolidation, two sample unit field blocks were selected from the area of the intake No.1 and the intake No.2.

(hereafter referred to as No.1 block and No.2 block)

NO.1 block :	design	actual
No. of the field block	24	53
Size of a field block	0.8 ha	max. 0.96 ha. min. 0.05 ha. Ave. 0.35 ha.

No.2 block:	design	actual
No. of the field block	24	70
Size of a field block	0.8 ha.	max. 0.68 ha. min. 0.03 ha. Ave. 0.27 ha.

(see the drawing attached)

In view of this fact, study on the block size after due consider on the following things are requested.

3.1.2 Deduction rate of land

According to the Land Consolidation Act, the site for irrigatior ditches, drainage and farm roads turns into national land from privat land automatically when the work is finished, so the essential point for guidance of Land Consolidation never allow the agency concerned to make such plans if the deduction rate is over 7 %.

On the occasion of making a plan of the Extensive development method, this item is very important because all the facilities mentioned above will be constructed along the borders. The extensive development method does not carry out block adjustment and the shape of each plot is so varied that unfairness as to this matter is unavoidable. In view of this matter, I think it is necessary to improve in order to expand projects all over the country.

3.1.3 Density of irrigation ditch, drainage and farm road

As compared with pilot No.1 and No.2.

	Pilot No.1	Pilot No.2	No.2/No.1 x 100
Density of ditch	53.6 m/ha	48.4 m/ha	90.3 (%)
Density of drainage	47.3	32.7	69.1
Density of road	76.9	30.8	40.1

The size of a field block and the density of On-farm facilities has a close connection so in view of this point the size of a field block, a farm block and a unit field block must also be considered.

3.1.4 The relationship between average manpower in a household and the size of a field block that is too large to operate, means farmers will construct some borders in thier fields.

3.1.5 The size of a field block is related to manuring management and water management.

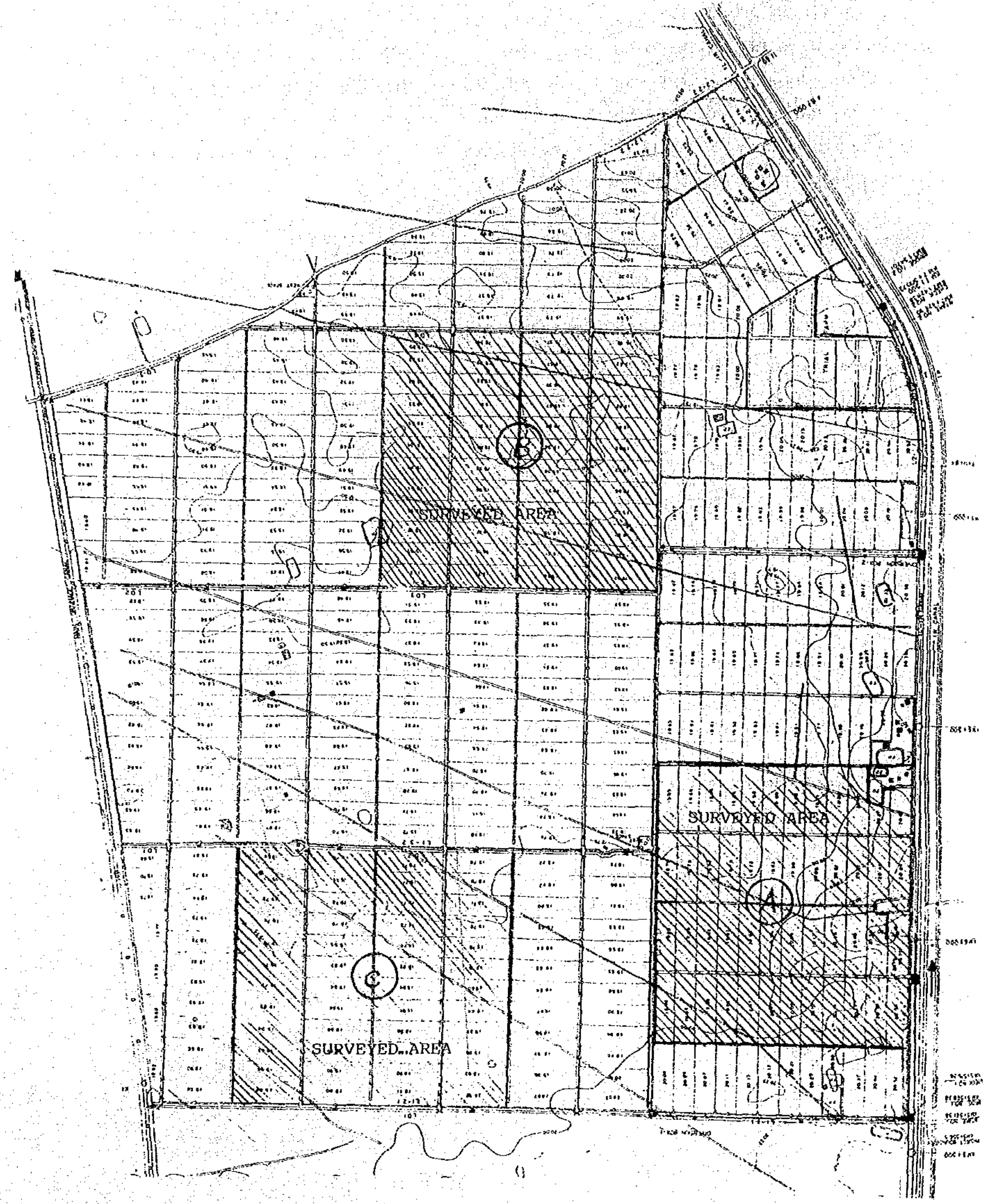
i) Spraying of chemicals

A standard field block is 50 m wide.
It is impossible to spray completely even if farmers used speed sprayers.

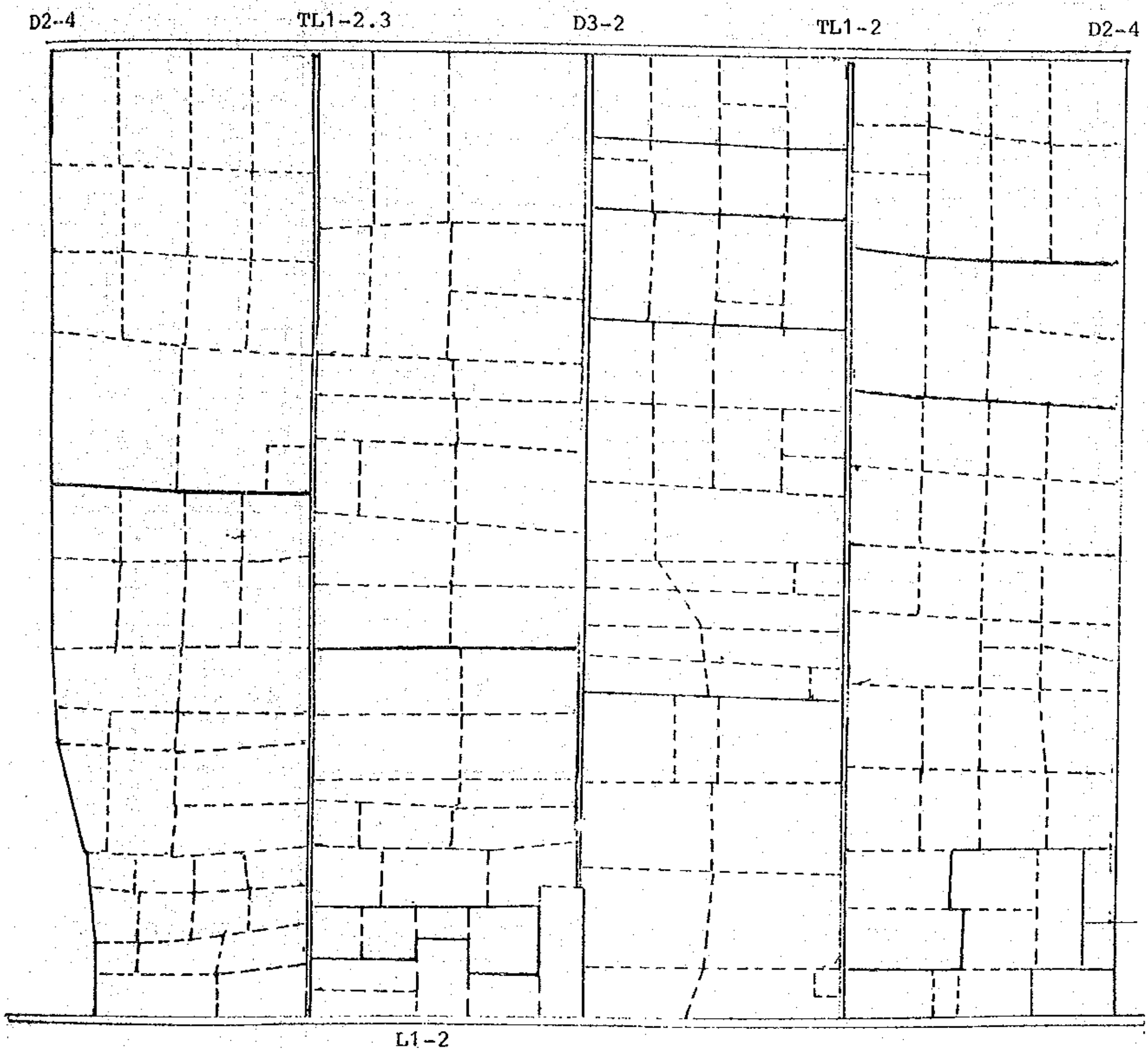
ii) The time occupied on irrigation and drainage

In order to study this matter, a fundamental survey was carried out at the Trial Farm field.
It took 12 hours to supply water to a field block even in good conditions.

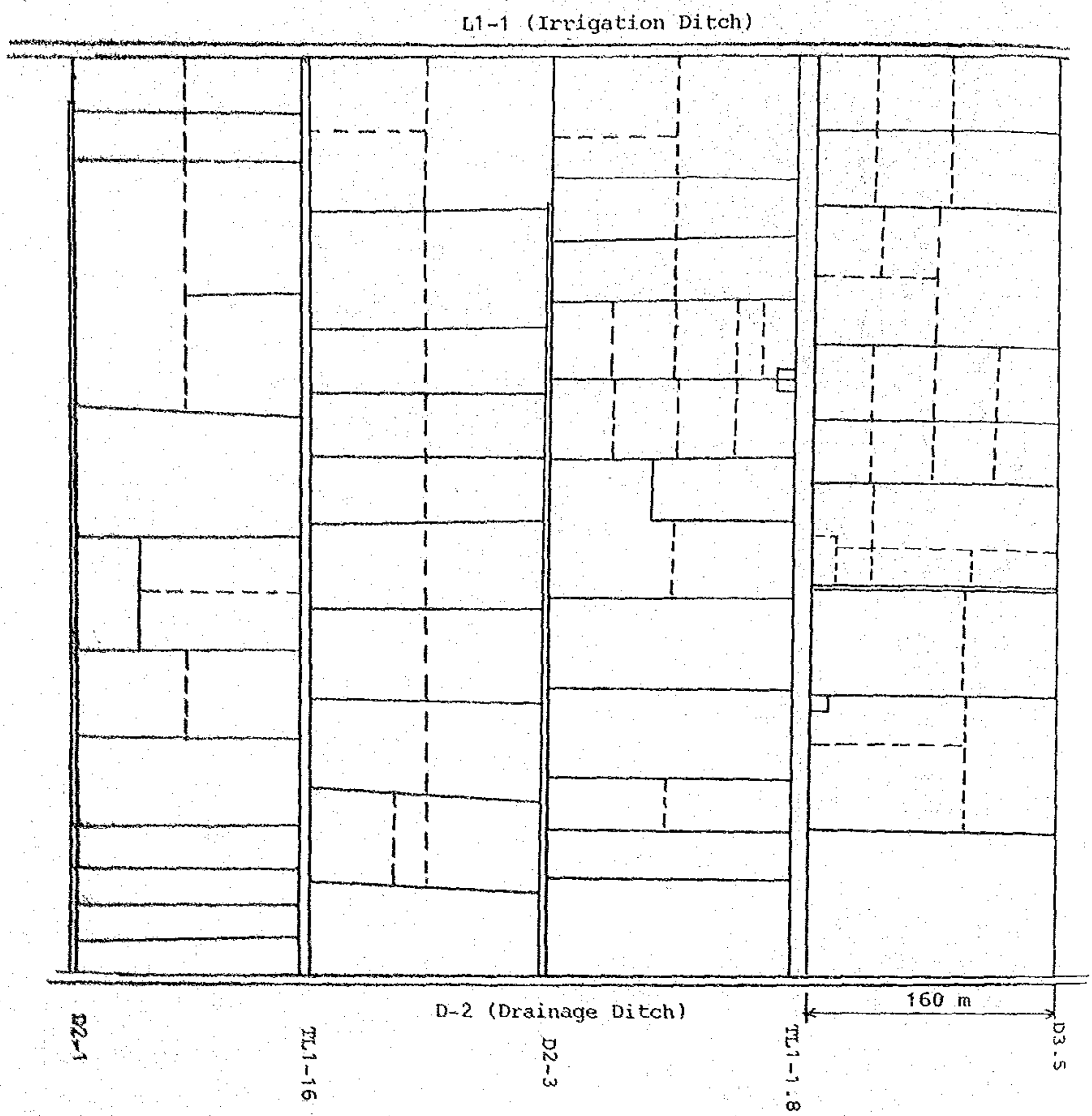
3.1.6 Present farm plots which farmers divided after completion of land consolidation



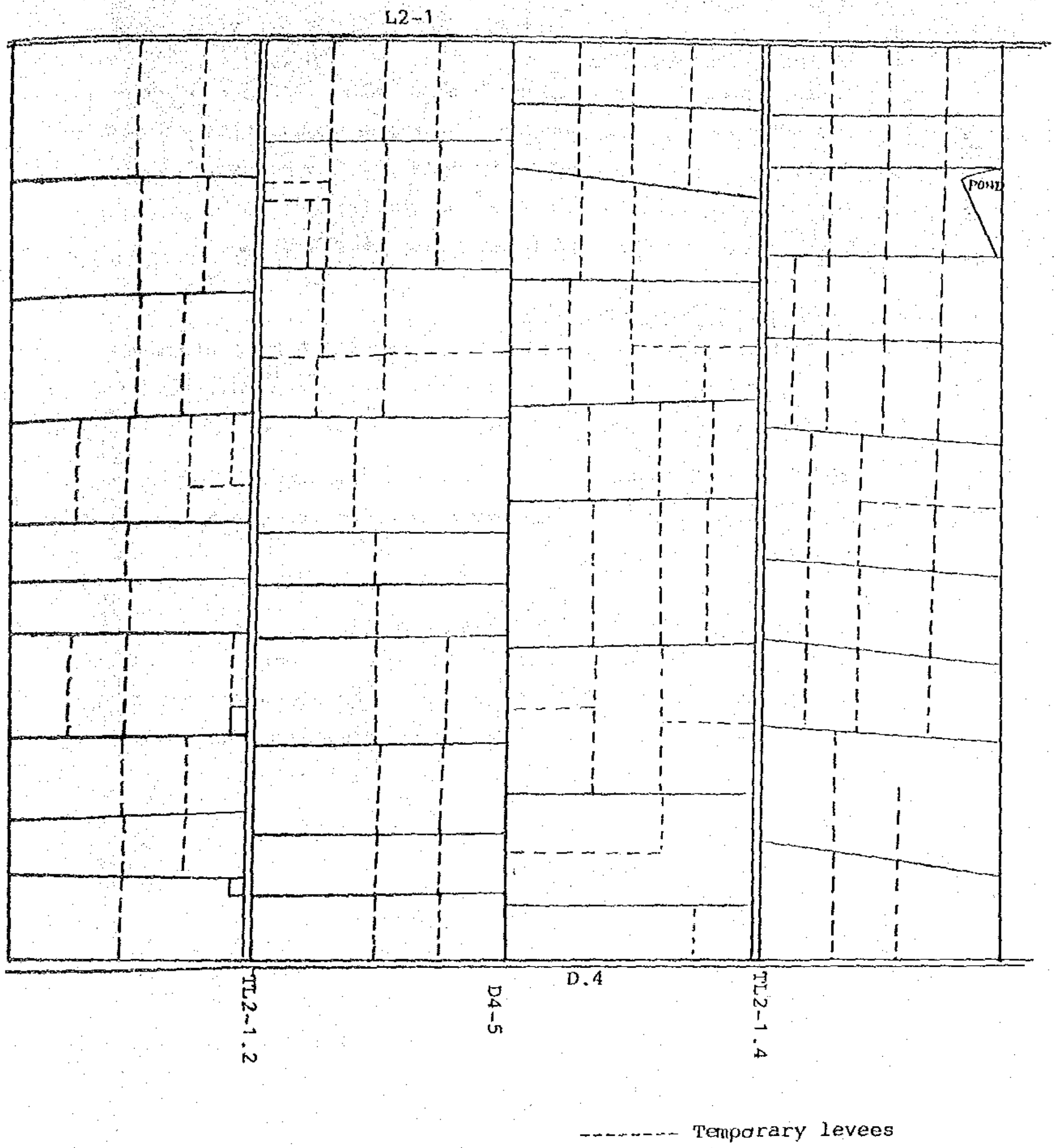
Present farm plots at Ⓐ block after completion of land consolidation



Present farm plots at (B) block after completion of land consolidation



Present farm plots at Ⓒ block after completion of land consolidation



3.1.7 Ground levelling costs and the Accuracy of land levelling

In case of only the intensive development method, these things should be considered.

i) Ground levelling cost

As the size of a field block become larger, this cost goes up and according to the results of the Mae Klong Pilot Project No.1, this cost amounted to 40 % of all the project's cost. This ground levelling cost is for the farmers to bear. That would make the burden too heavy on the farmers.

ii) Accuracy of land levelling

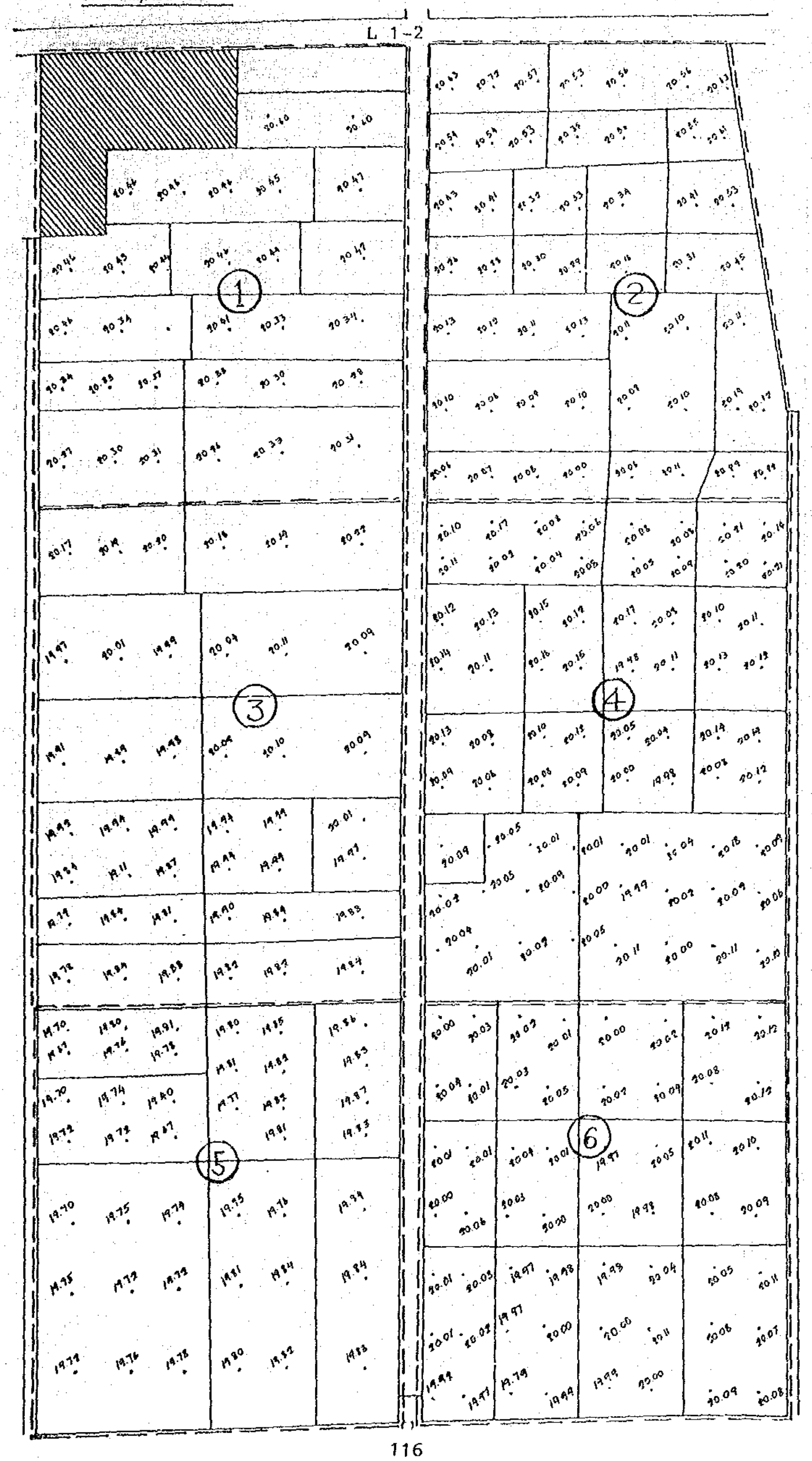
Paddy farming and accuracy of land levelling are inseparable though, to raise the level is a task of extreme difficulty. Direct sowing, which the government is now encouraging, requires high accuracy.

On the other hand, this accuracy is under the control of the size of a field block.

iii) Existing condition of land levelling

As an actual example, one of the farm block was picked up and surveyed in January 1984 at the Mae Klong Pilot Project No.1. It is 3 years since construction work finished. The result of the survey can be seen on the following pages.

A sample area



Existing condition of land leveling in the experimental block

※ Average Elevation = ① x ② / ①

Block No.	① Area of plot	② Average of EL	① x ②	Differential	Remarks
1	2,504 m^2	20.60 m	51,582.4	+ 0.24 m	Highest Lowest
	680	20.46	13,912.8	+ 0.10	+ 0.24 ～ - 0.17
	592	20.45	12,106.4	+ 0.09	
	1,139	20.47	23,315.3	+ 0.11	0.41 m
	939	20.47	19,221.3	+ 0.11	Difference
	2,779	20.44	56,802.8	+ 0.08	
	1,566	20.45	32,024.7	+ 0.09	
	1,680	20.42	34,305.6	+ 0.06	
	1,568	20.50	32,144.0	+ 0.14	
	2,088	20.36	42,511.7	+ 0	
	1,306	20.35	26,577.1	- 0.01	
	1,317	20.31	26,748.3	- 0.05	
	2,907	20.29	58,983.0	- 0.07	
	3,484	20.30	70,725.2	- 0.06	
	2,866	20.19	57,864.5	- 0.17	
	3,527	20.20	71,245.4	- 0.16	
Total	30,942	Av.20.36	630,070.5		
2	1,882	20.64	38,844.5	+ 0.39	
	2,182	20.57	44,883.7	+ 0.32	+ 0.39 ～ - 0.19
	1,408	20.57	28,962.7	+ 0.32	
	1,146	20.46	23,447.2	+ 0.21	0.58 m
	646	20.58	13,294.7	+ 0.33	
	828	20.42	16,907.8	+ 0.17	
	874	20.33	17,768.4	+ 0.08	
	1,020	20.34	20,746.8	+ 0.09	
	971	20.47	19,876.4	+ 0.22	
	988	20.27	20,026.8	+ 0.02	
	852	20.30	17,295.6	+ 0.05	
	932	20.16	18,789.1	- 0.09	
	795	20.38	16,202.1	+ 0.10	
	2,501	20.12	50,320.1	- 0.13	
	2,704	20.10	54,350.4	- 0.15	
	2,762	20.19	55,764.8	- 0.06	

Block No.	① Area of plot	② Average of EL	① × ②	Differential	Remarks
2	2,667	20.07	53,526.7	- 0.18	
	2,835	20.06	56,870.1	- 0.19	
	3,339	20.08	67,047.1	- 0.17	
	3,080	20.13	62,000.4	- 0.02	
Total	34,412	Av.20.25	696,925.3		
3	2,947	19.99	58,910.5	+ 0.00	
	3,349	20.08	67,247.9	+ 0.17	+ 0.18 - 0.10
	2,796	19.67	54,997.3	- 0.24	
	3,439	20.09	69,089.5	+ 0.18	0.28 m
	3,744	19.78	74,056.3	- 0.13	
	2,813	19.97	56,175.6	+ 0.06	
	1,326	19.99	26,506.7	+ 0.08	
	2,044	19.81	40,491.6	- 0.10	
	2,294	19.89	45,627.7	- 0.02	
	1,823	19.83	36,150.1	- 0.08	
	2,250	19.83	44,617.5	- 0.08	
Total	28,825	Av.19.91	573,867.7		
4	2,388	20.13	48,070.4	+ 0.05	
	2,018	20.15	40,662.7	+ 0.07	+ 0.07 - 0.06
	2,330	20.09	46,809.7	+ 0.01	
	2,256	20.12	45,390.7	+ 0.04	0.13 m
	1,.57	20.09	35,298.1	+ 0.01	
	1,597	20.10	32,099.7	+ 0.02	
	1,824	20.02	36,516.5	- 0.06	
	1,929	20.12	38,811.8	+ 0.04	
	6,703	20.04	134,328.1	- 0.04	
	7,316	20.06	146,795.0	- 0.02	
Total	30,118	Av.20.08	604,746.7		
5	2,661	19.75	52,554.8	- 0.03	
	3,948	19.81	78,209.9	+ 0.03	+ 0.07 - 0.12
	2,592	19.85	51,451.2	+ 0.07	
	3,250	19.66	63,895.0	- 0.12	0.19 m

Block No.	1 Area of plot	2 Average of EL	1 x 2	Differential	Remarks
5	7,757	19.74	153,123.2	- 0.04	
	5,047	19.80	99,930.6	+ 0.02	
	3,909	19.84	77,554.6	+ 0.06	
Total	29,164	Av.19.78	576,719.3		
6	4,526	20.02	90,610.5	- 0.02	
	2,183	20.02	43,703.7	- 0.02	+ 0.07 - 0.07 0.14 m
	2,009	20.11	40,401.0	+ 0.07	
	2,159	20.02	43,223.2	- 0.02	
	2,089	20.02	41,821.8	- 0.02	
	2,181	20.11	43,859.9	+ 0.07	
	2,374	20.10	47,717.4	+ 0.06	
	4,808	19.97	96,015.8	- 0.07	
	2,723	20.02	54,514.5	- 0.02	
	2,594	20.08	52,087.5	+ 0.04	
Total	27,646	Av.20.04	553,955.3		

3.2 Irrigation requirements

3.2.1 Water requirement for puddling

Detailed design:

Preparatory water	:	Dry season	30 mm
		Rainy season	15 mm
Puddling water	:		160 mm

Result of the investigation : (see the report)

i-i) As for preparatory water:

a) At the experimental plot No.1, 30 mm of scheduled preparatory water could cover only 27 % of the acreage of the plot.

b) At the experimental plot No.2, it could cover only 34 % of the plot.

c) As the result of this irrigation test, it is meaningless to separate preparatory water and puddling water.

i-ii) As for quantity of puddling water:

Plot No.1 (plowed field) and plot No.2 (non-plowed field) showed almost the same results.

Sufficient quantity of puddling water was 165.1 mm.

From this point of view, the estimated quantity of puddling water has something in reserve when we consider puddling water including preparatory water.

3.2.2 Irrigation discharge per service unit

Detailed design:

NWr = 3.97 + 1.00 = 4.97 mm

CU = Ep x K = 4.18 x 0.95 = 3.97 mm

P = 1.00 mm

$$(4.97 \times \frac{23}{24} + 150 \times \frac{1}{48}) \div 0.8 = 9.85 \text{ mm}$$

Dr = 9.85 ÷ 0.9 = 10.94 mm

Irrigation discharge per one farm ditch

(10.94 x 19.2 ha) - 86,400 = 0.024 m^3/s

in which

Net water requirement (NWr) = CU + Pe

Pe = Percolation loss

Water requirement (Wr) = (NWr + Lp - E)/Ef

Lp = Land preparation water

E = Effective rainfall

Ef = Field efficiency

Diversion requirement (Dr) = Wr/Ed

Ed = Conveyance efficiency

Irrigation efficiency was assumed as follows:

Field efficiency (Ef)	80 %
Conveyance efficiency	90 %
Overall efficiency	72 %

3.2.2.1 The result of measuring water requirement in depth. Maximum value in each month .

Period	Water requirement in depth	Evaporaiton	Temperature of water
The first half of Sep.	6 mm	4 mm	30 °C
The second half of Sep.	8	8	29
The first half of Oct.	8	6	29
The second half of Oct.	8	7	28
The first half of Nov.	6	5	27
The second half of Nov.	6	5	26

In view of the results achieved so far, we can say that the water requirement in depth in rainy season should be adopted at the value of 8 mm/day.

Note:

Peak irrigation requirements

Mae Klong Pilot Project	:	0.2 l/s/rai
Mae Klong Right Bank Project	:	0.23 l/s/rai
(9.0/(0.75 x 8.64 x 6.25))		
Nong Wai Pioneer Agriculture Project :		
Soil class I (Heavy soil)		0.16 l/s/rai
Soil class II (Loamy soil)		0.19 l/s/rai
Phitsanulok Irrigation Project:		
Land preparation period		0.25 l/s/rai
Growing period		0.19 l/s/rai
Pattani stage I Irrigaiton Project:		
Peak irrigation requirements		0.16 l/s/rai

3.2.3 Movement of irrigated water in paddy fields in case of consideration of irrigation method proposed in the detailed design.

Detailed design:

During the land preparation period of paddy fields, the rotational irrigation method is proposed to irrigate one distribution sub-system (24 farm plots) for a 48 day period, by supplying water at the rate of two days per farm plot.

In this paragraph, I would like to take up irrigation rotation by using the actual results of the investigation.

Refer to the next graphs.
The two graphs show the relationship between duration and condition of change of irrigated water.

Note:

Peak irrigation requirements

Mae Klong Pilot Project	:	0.2	l/s/rai
Mae Klong Right Bank Project	:	0.23	l/s/rai
			l/s/rai
			l/s/rai
			l/s/rai
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			l/s/rai

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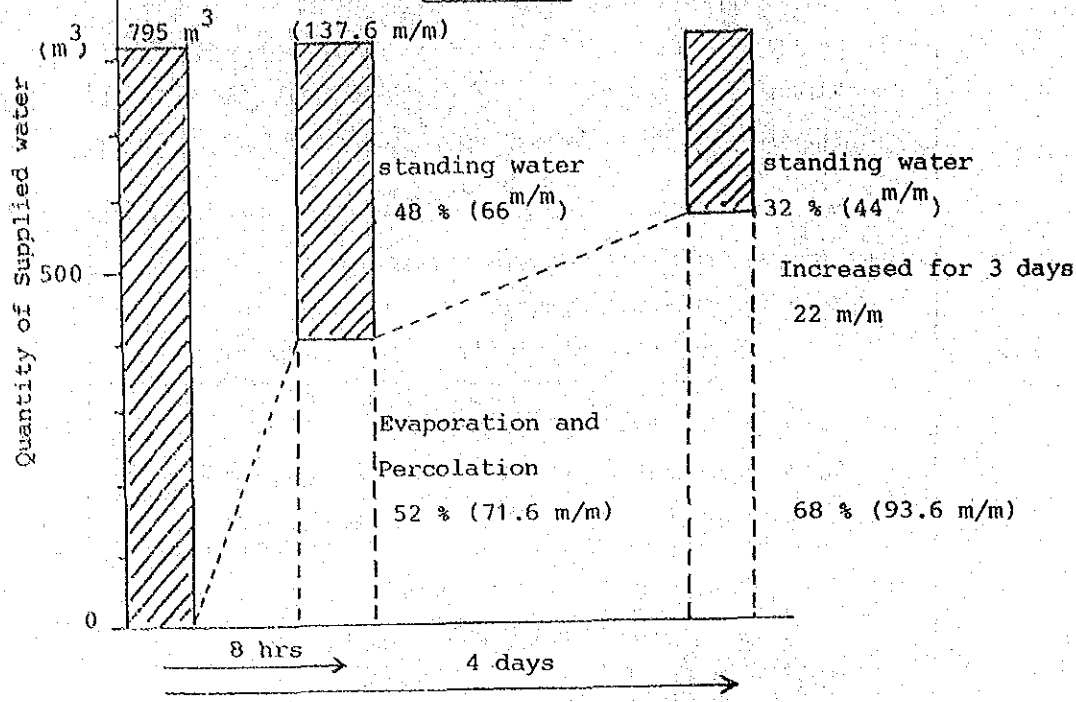
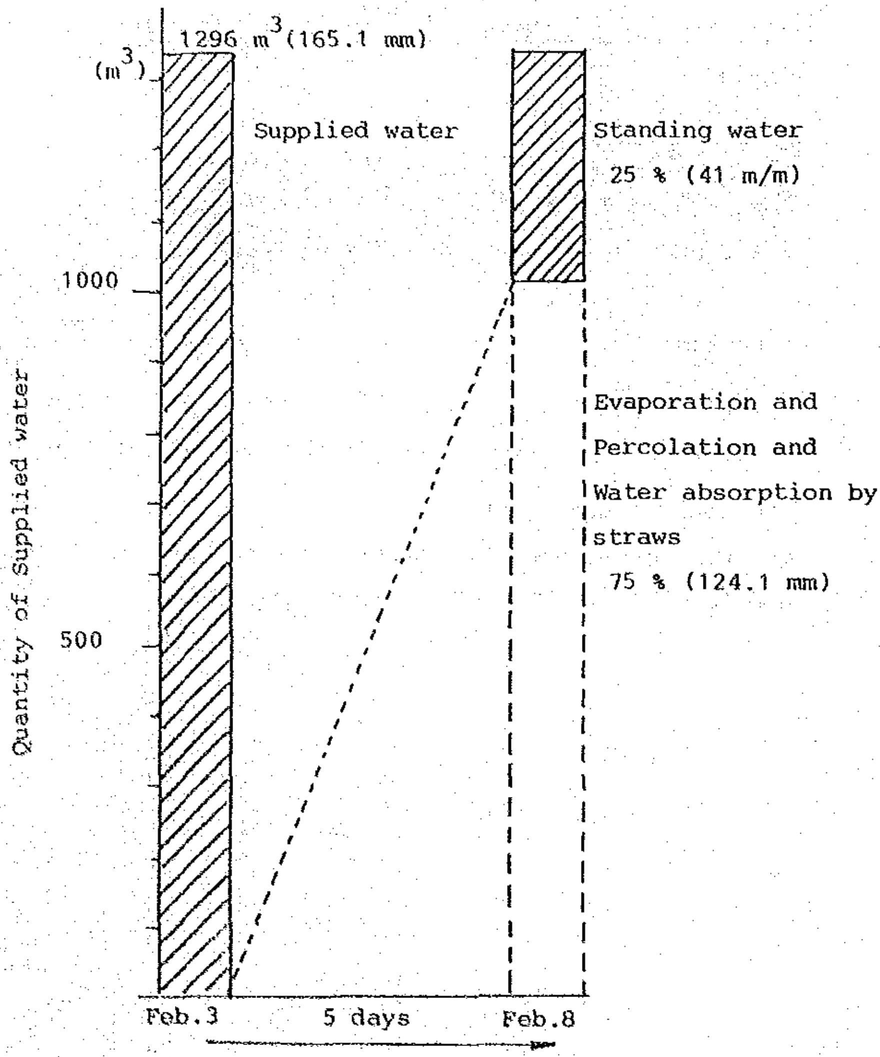
Block No.1

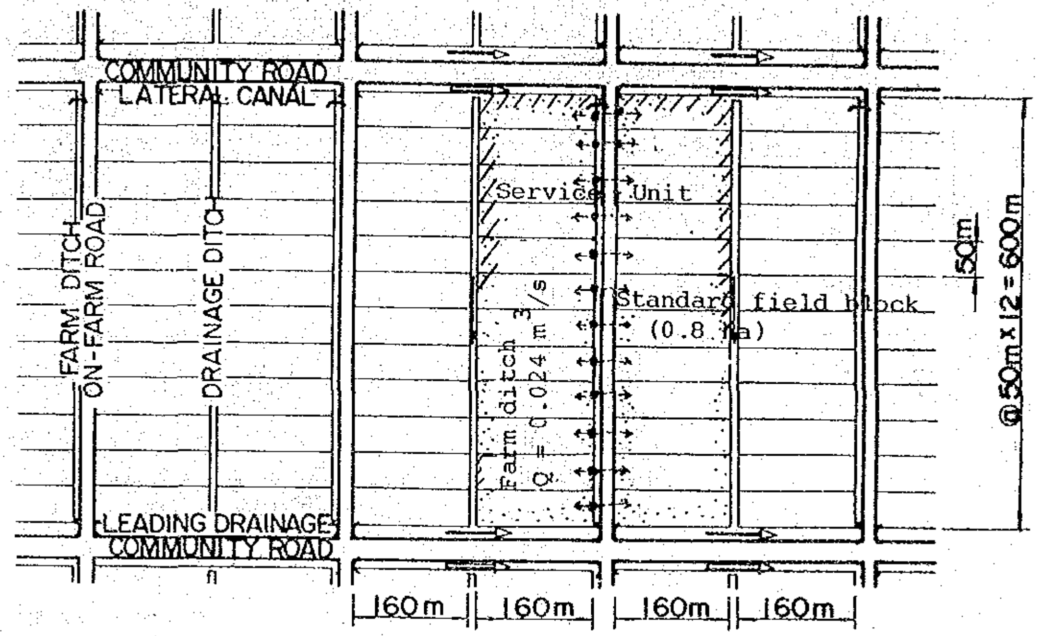


Block NO.2



The figure below shows the typical service unit.
The unit consists of 24 standard field blocks and each block has its inlet.

A farm ditch, whose capacity is 24 l/sec, runs along one side of a farm road.
Every field block in this service unit is supplied with water from this ditch.



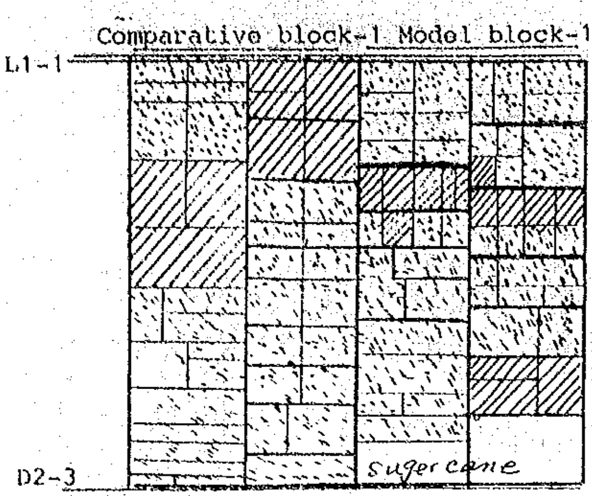
As shown in the graphs, four or five days later the standing water remaining is only about 30 % of the whole supplied water Of course, a week will hardly passed when this remaining standing water will also evaporate and percolate.

Therefore, the rotation for a 48 day period will be the minimum in theory in this case because of the capacity of the ditch.

3.2.4 Computation of the peak water requirement

The water requirement for the project is calculated on the basis of the proposed cropping pattern.

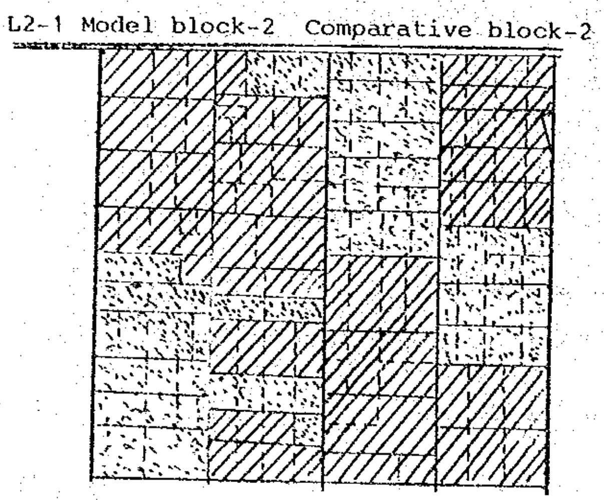
Peak water requirement was computed by expected transplanting; in detailed design, in these existing circumstances direct sowing has been extending as you can see the below figures.



Total area	35.4 ha
Direct sowing	27.9 ha[73%]
Transplanting	8 ha[21%]
Sugarcane	2.5 ha[6%]

Nursery
Plowing
Puddling
Direct sowing
Transplanting

About 60 % of the pilot No.1 area were direct sowing.



The computation of peak irrigation requirement should be modified in connection with this fact.

3.3 Size of a service unit and rotation block

The main irrigation system (main canals and laterals) provide a number of farm turnouts. The farm turnout is structurally a constant head Orifice/Roman weir gate which can regulate the diversion flow. One farm turnout command area is called a service unit. The service unit is the unit of on-farm works for planning design, implementation, and also for operation and maintenance.

In the case of implementing planning and design for the extensive land consolidation; the size should be considered because of operation and maintenance.

Rotation block:

Rotation irrigation is almost unavoidable during the land preparation period of paddy cultivation and the continuous irrigation method can be applied for the other period.

An area in which rotational irrigation is performed is called a rotation block.

In a rotation block the water supply will rotate from field to field. A specific field can draw water at a certain interval, therefore, the quantity of water to be supplied to the field should be sufficient to cover its requirements for the whole interval between irrigations.

In particular, when an extensive land consolidation scheme is planned and designed it is necessary to pay close attention to this item.

The capacity of supply ditches should be the same in a rotation block. The size of a rotation block could be as large as a service unit, a lateral command area or even the whole project area.

However, the larger the rotation block becomes, the greater the construction cost, as all canals in the rotation block ought to have the same capacity.

The small rotation block system of around 120-150 rai presents advantages not only in construction costs, but also in maintenance costs and loss of land.

One disadvantage is that it adds a few more complications in water management.

3.4 Boundary (Border)

Generally, boundaries are not constructed by constructors but are the rewponsibility of land owners.

Constructors only earth up along the proposed line, never build up and compact.

This causes leakage/seapage.

Stored water in paddy fields leaks through such poor boundaries to neighboring fields or the drainage canal/ditch.

This leakage is useless for rice cultivation, namely because the water becomes unusable.

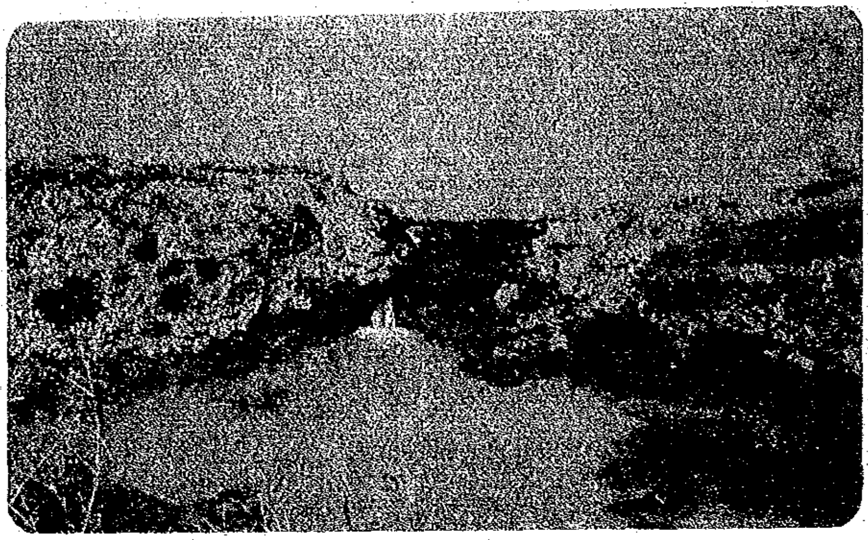
Leakage through boundary

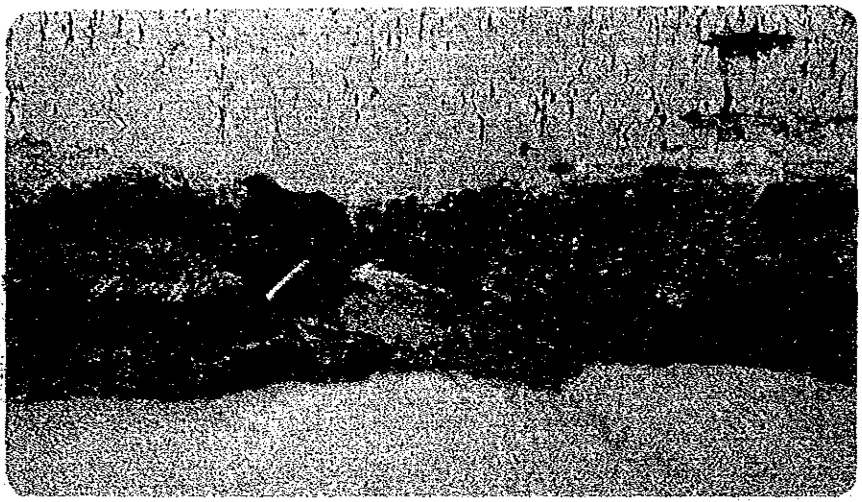
Crabs' and rats' holes dug in a boundary

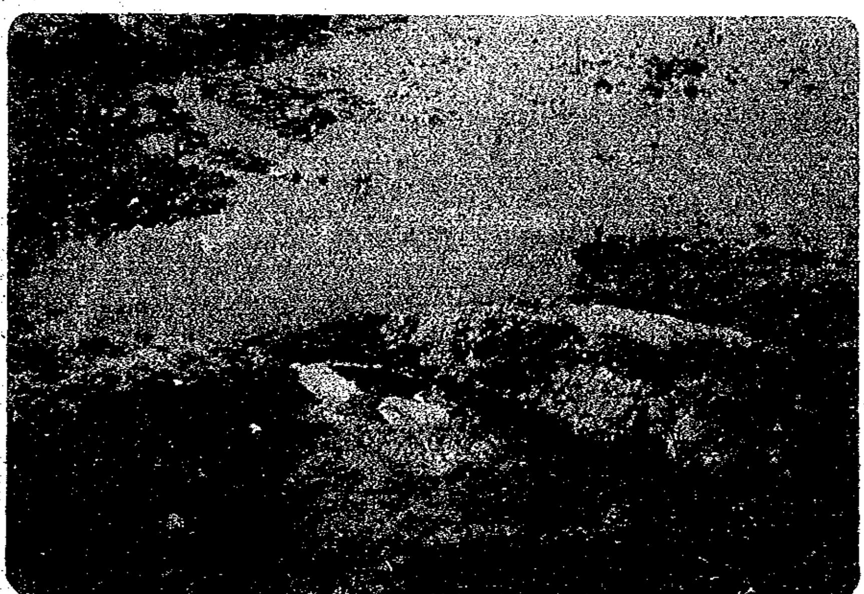
Consequently, the constructors ought to construct boundaries firmly, on the other hand, farmers must also maintain them and have to do border coating.

* Amount of leakage through boundaries should be investigated.

:- The wasteful use of valuable water through boundaries.





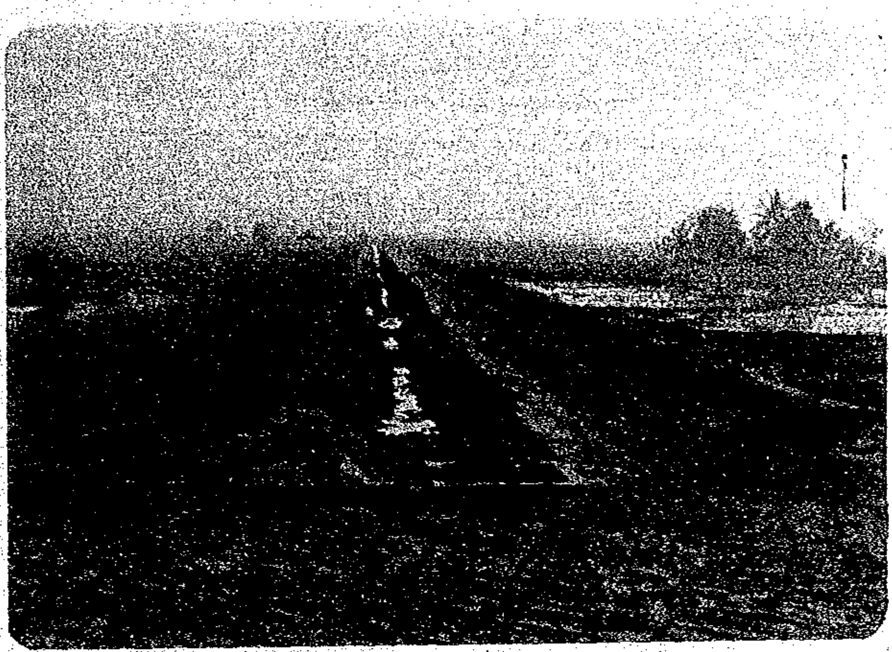


3.5 Problems as to irrigation ditch

The ditches constructed at the Mae Klong and the Chao Phya Pilot Project are all non-lined.

Consequently, it has caused lots of problems.

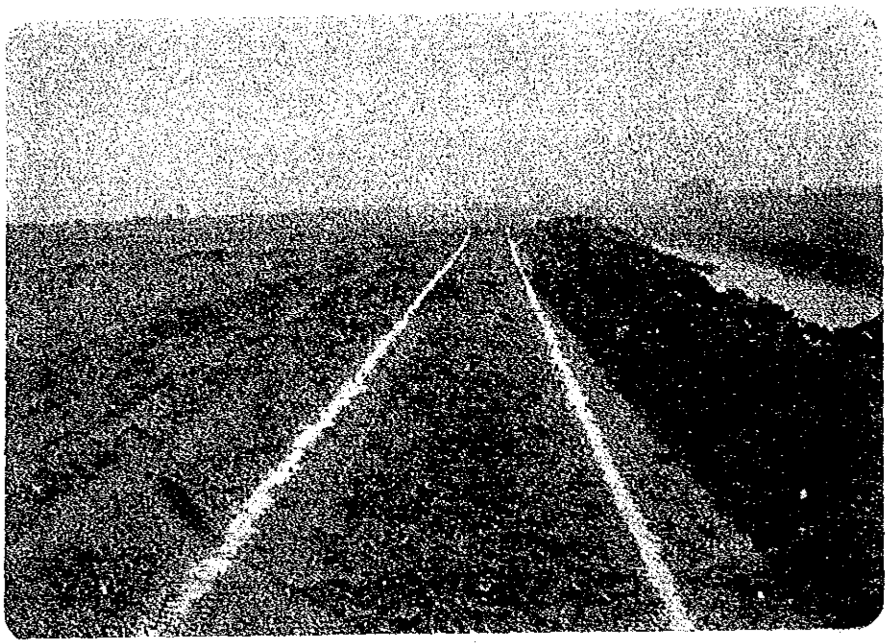
The overall view from the upstream of the L-1 feeder ditch (Intake No.1 area)



The present situation of a farm ditch

3.5.1 Construction method

As you can see from the following pictures, the procedure for constructing ditches is that first of all, ground surface along which a backfoe runs is levelled according to the planned longitudinal slope of the ditch, next two white lines are drawn on it to show the way for a backfoe, lastly a backfoe digs the ditch.

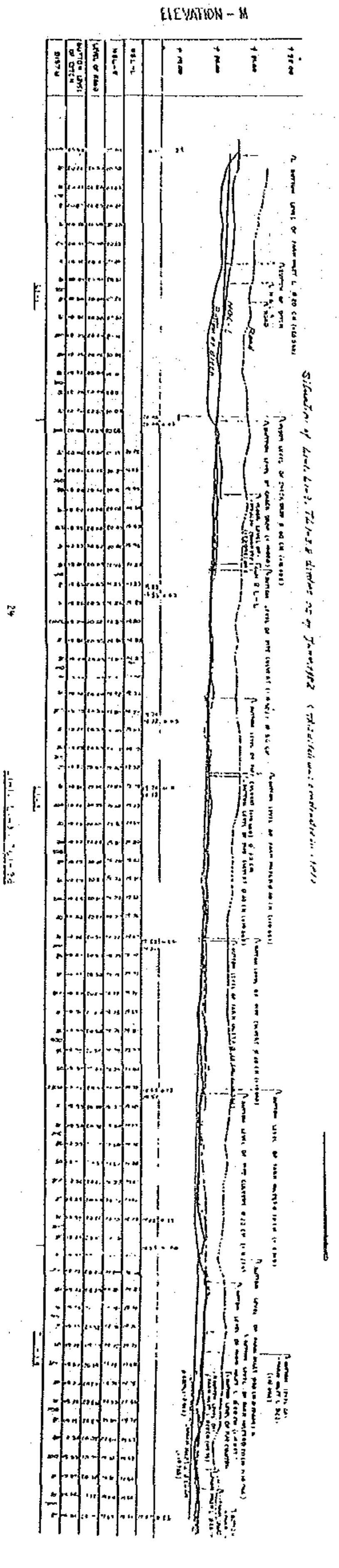


Owing to the soil property, a longitudinal slope is generally designed as 1/2,000 - 1/5,000.

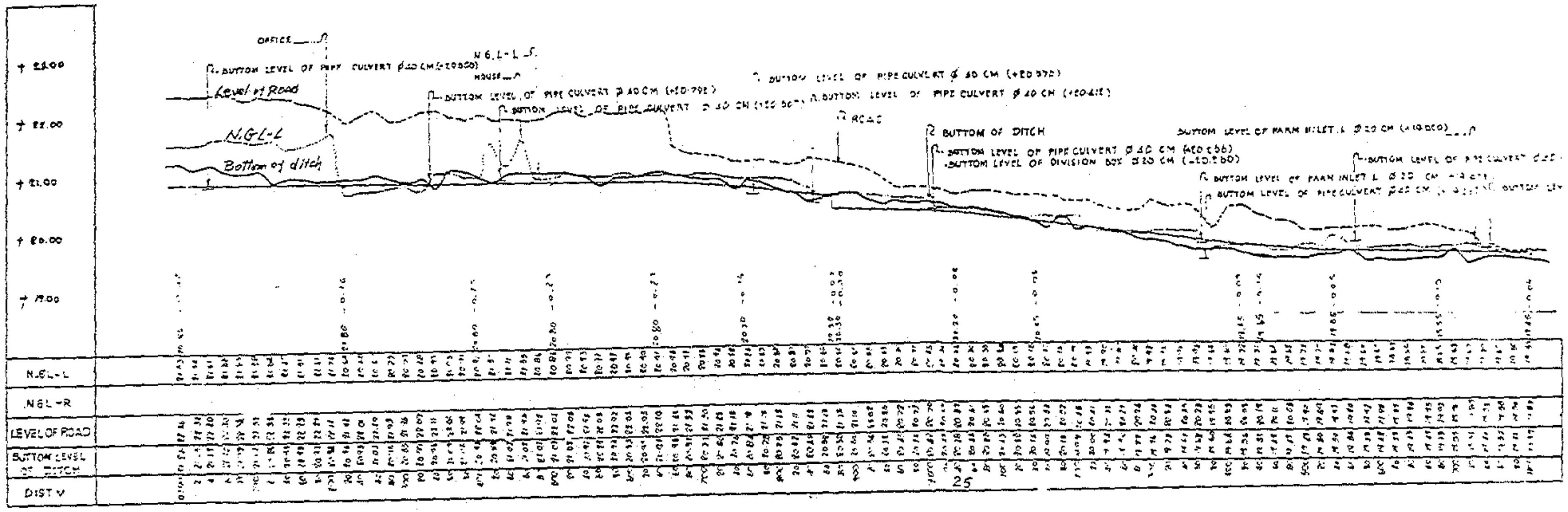
It is impossible to construct a ditch following the required design using only a construction machine.
Soon after the ditch has been dug, longitudinal surveying and readjustment work by manpower should be done.
Inaccurate longitudinal sloping of a ditch prevents smooth flow and in its turn influences the designed rate of flow.

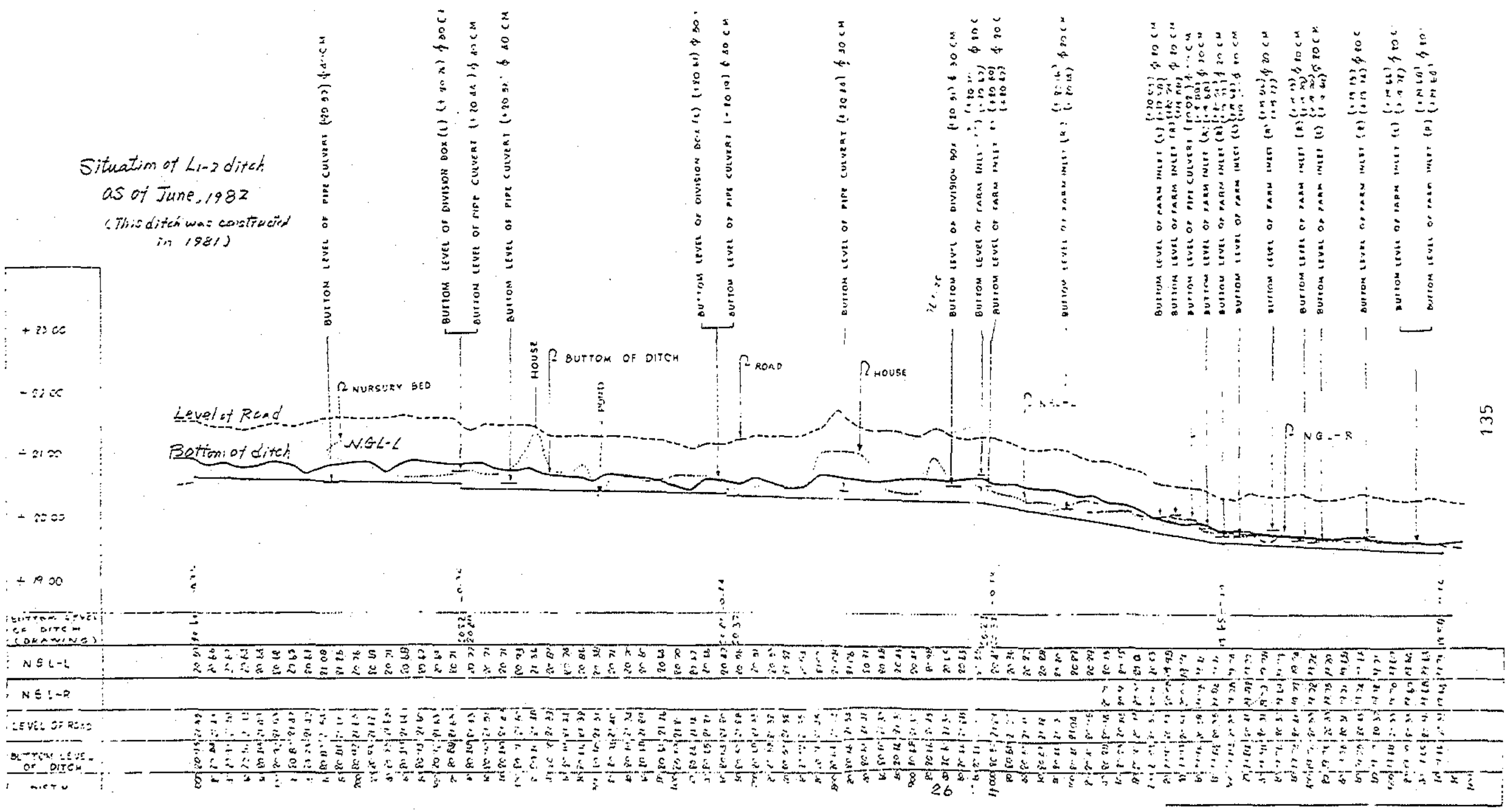
Some of the ditches constructed in the Mae Klong Pilot Project No.1 were surveyed as to longitudinal slope in June, 1983

Refer to the results attached.


ELEVATION - M
Road
Bottom of Ditch
LEVEL OF ROAD
BOTTOM LEVEL OF DITCH
DIST M

Situation of L2-2 ditch as of June, 1982 (This ditch was constructed in 1979)




Situation of Li-2 ditch
as of June, 1982
(This ditch was constructed in 1981)
+ 23.00
+ 22.00
+ 21.00
+ 20.00
+ 19.00
Level of Road
Bottom of ditch
N.GL-L
NGL-R
NURSERY BED
HOUSE
BUTTOM OF DITCH
POND
ROAD
HOUSE
BUTTOM LEVEL OF PIPE CULVERT
BUTTOM LEVEL OF DIVISION BOX
BUTTOM LEVEL OF FARM INLET
BUTTOM LEVEL OF DITCH (DRAWING)
NGL-L
NGL-R
LEVEL OF ROAD
BUTTOM LEVEL OF DITCH
26

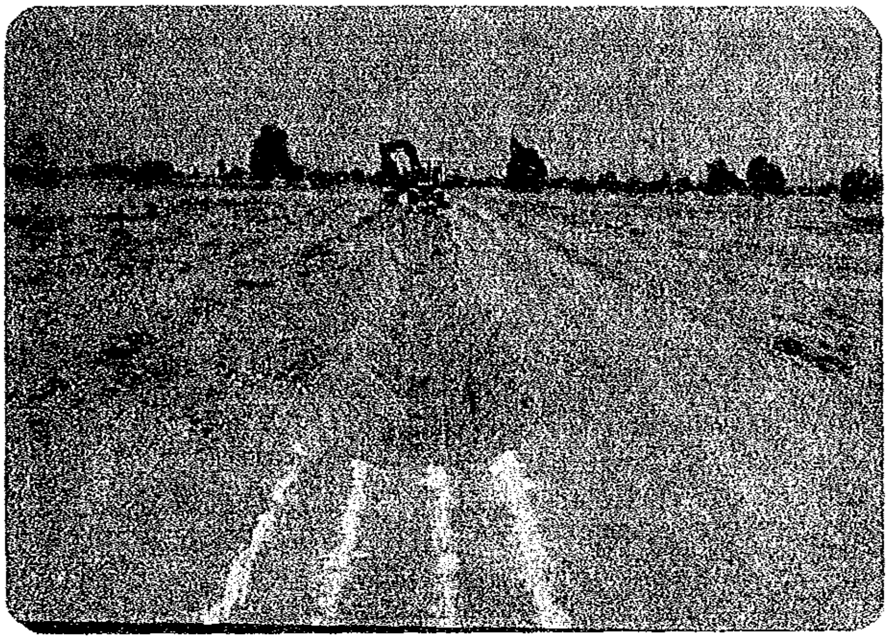
3.5.2 Lined ditch or Non-lined ditch (Earth ditch)

As I mentioned before, all ditches in our projects were planned by way of non-lined ditches.

3.5.2.1 Soil property

There are many factors in determining whether a non-lined ditch or a lined ditch should be constructed.
That is, longitudinal slope based on topography, velocity of flow, loss of land, difference of altitud between the canal and the cultivated field and so on.

Soil property is also an important factor.



The process of ditch construction is as follows:

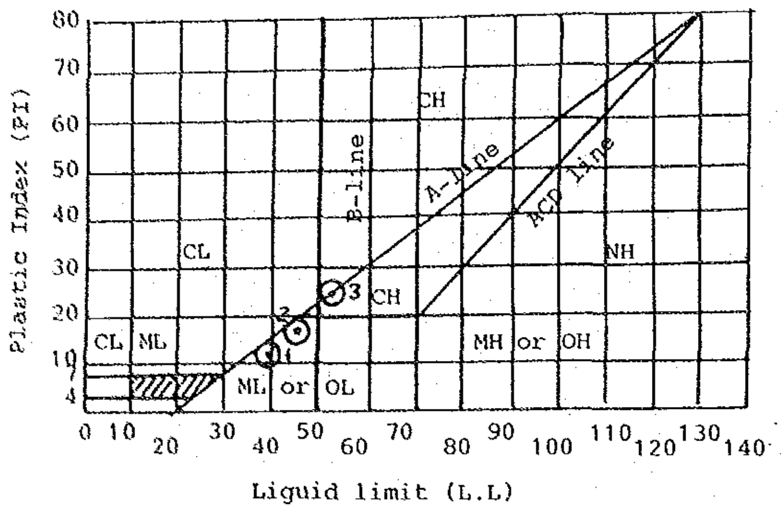
1. Excavation of higher levels of paddy field ⟶
2. Transportation to a road and ditch site ⟶
3. Banking (banking layer thickness: about 30 cm) ⟶
4. Water sprinkling by water motor ⟶
5. Compaction by bulldozer ⟶ repeat ⟶
6. ⟶ see 5. i) construction method.

So as to be clear about this matter, soil test was carried out: A sample was gatered from pilot project No.1 and two samples from pilot project No.2 .

The two samples from pilot project No.2 were soils carried from another place for reconstruction.

This soil can be classified as follows:

Plasticity chart



ML

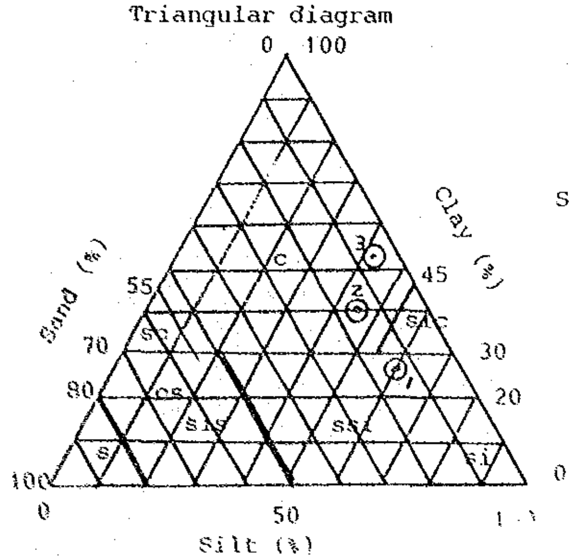
M : Silt

(MO : Swedish)

L : Low liquid limit

(L.L < 50%)

Triangular diagram



Silty clay

After due consideration of the results of the soil test the following things can be pointed out as to pilot project No.1.

a) Since this soil can be classified as ML, it is unsuitable as a material for filling.

b) Optimum moisture content cannot be expected bv using water motors.

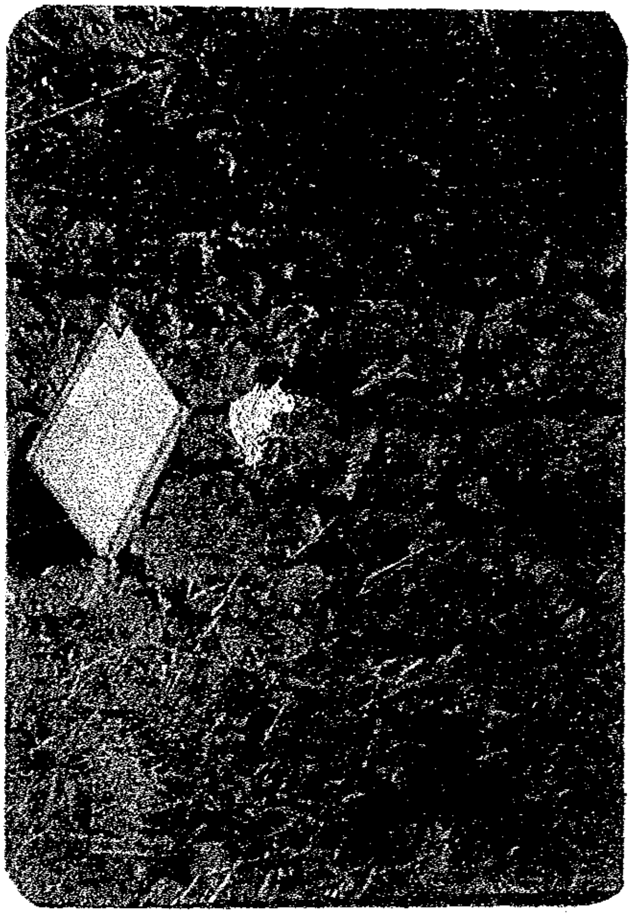
The approximate natural moisture content of the soil in the dry season is 5-10%, on the other hand, the optimum moisture content is 20%.

Moreover, the soil property is silt and therefore it is impossible to increase the moisture content by 10 % by sprinkling.

c) As for consistency, the liquid limit (L.L) is rather low, that is, this soil lacks a stability as far as water is concerned.

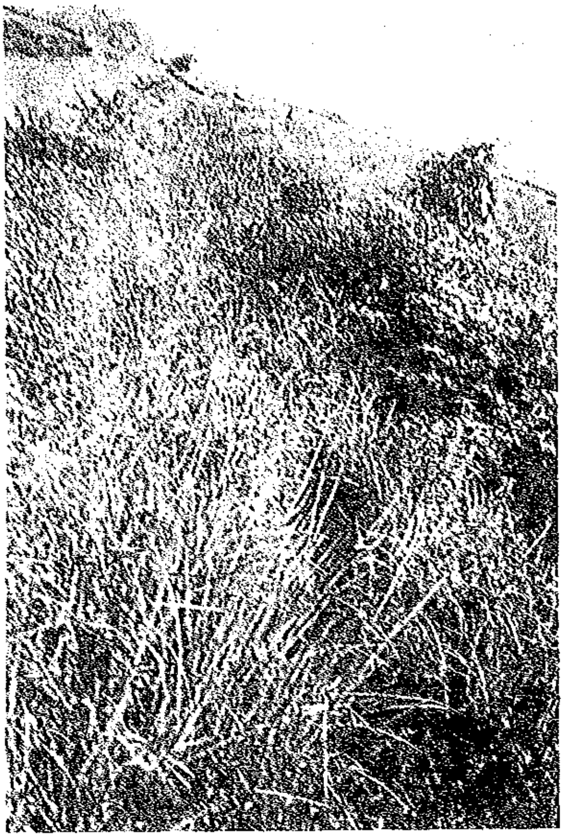
3.5.2.2 Occurence of cracks

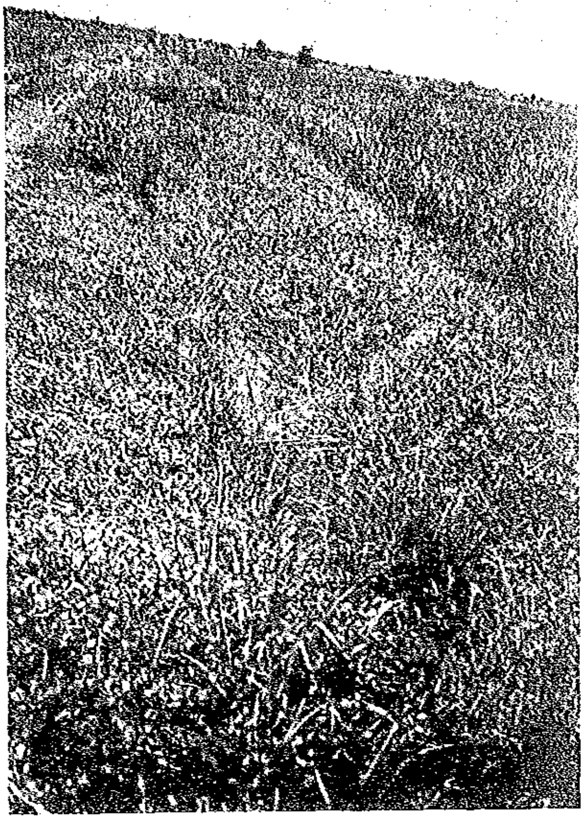
Cracks that have appeared in a ditch.

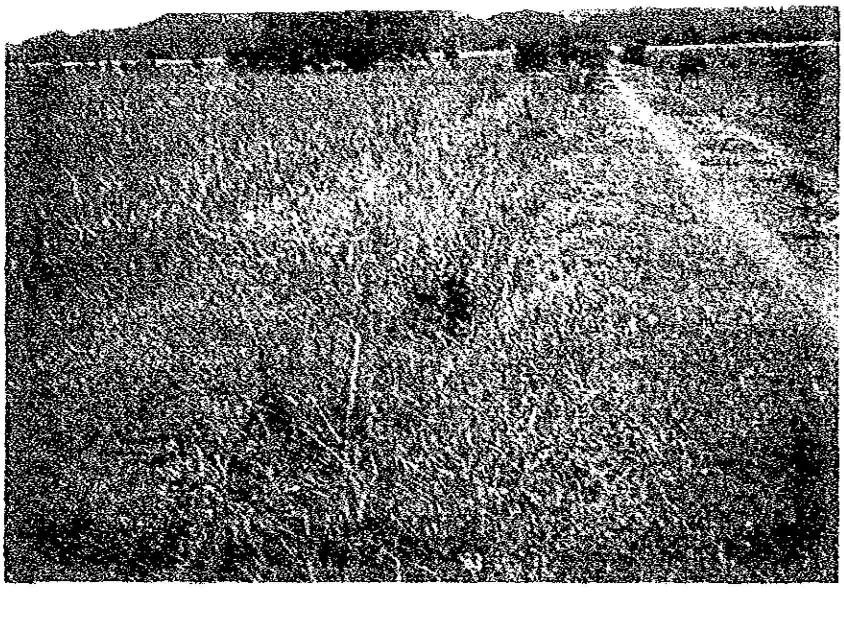


Due to the soil property, lots of cracks occur in ditches during non-irrigation periods.
They cause leakage.

3.5.2.3 Luxuriant growth of weeds







Luxuriant growth of weeds prevents smooth water flow and good water supply.

Only concrete lined ditches prevent the luxuriant growth of weeds.

3.5.2.4 <u>Transfiguration of cross-section</u>

Irrigation ditch and drainage are designed as follows:

$$Q = A.v$$

$$= \frac{1}{n} . R^{2/3} . I^{1/2} .A$$

In this formula, we cannot have any fixed figures.

n : coefficient of roughness

⟶ growth of weeds; undergoing a change

⟶ cracks and crab holes; undergoing a change

⟶ transfiguration of cross-section; undergoing a change

⟶ maintenance by human power

R : hydraulic mean depth = A/P

(P : wetted perimeter

A : cross-section area of flow)

⟶ growth of weeds : undergoing a change

⟶ transfiguration of cross-section: "

⟶ maintenance by human power

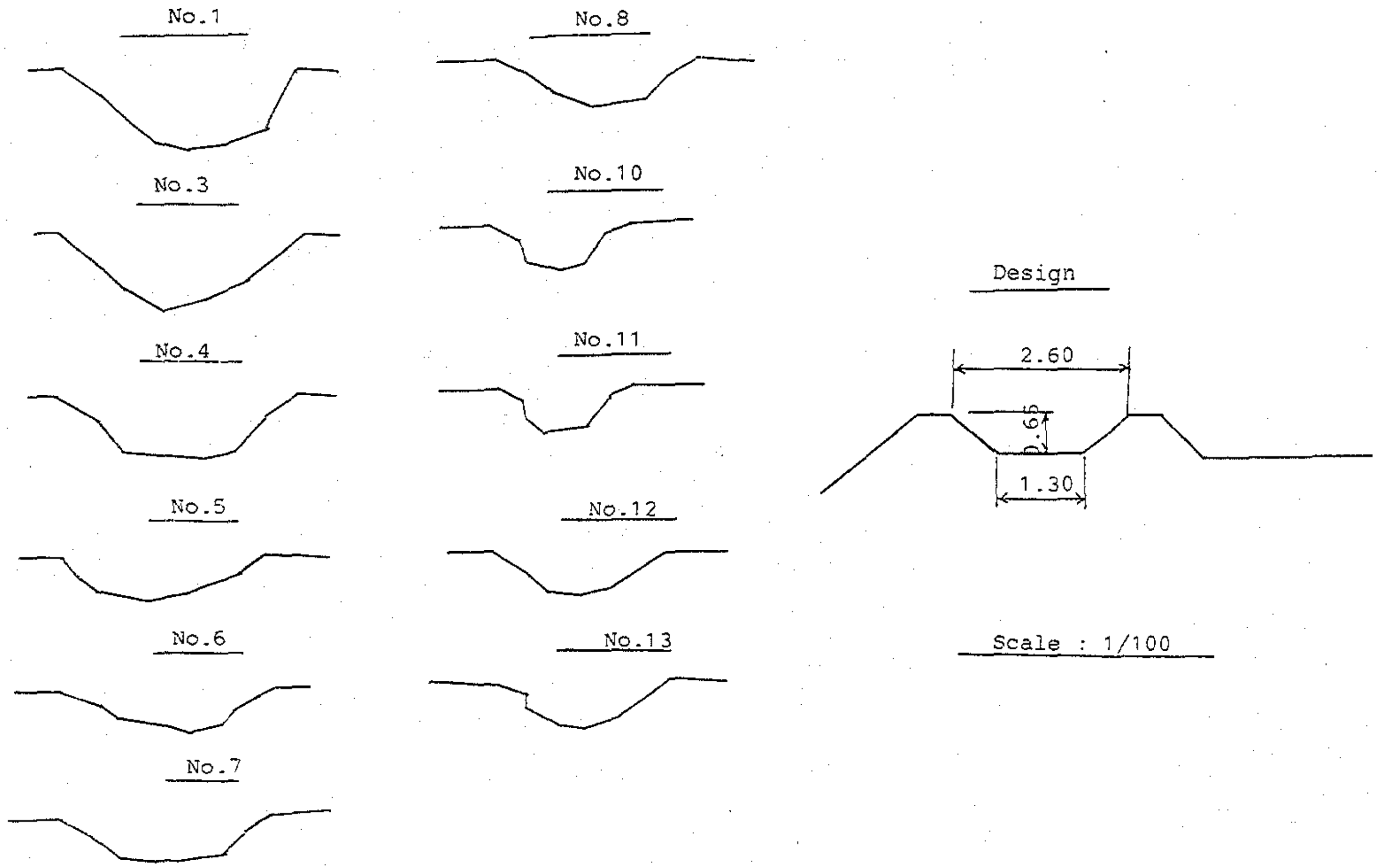
I : longitudinal slope of canal

⟶ construction error

⟶ erosion and accumulation ; undergoing a change

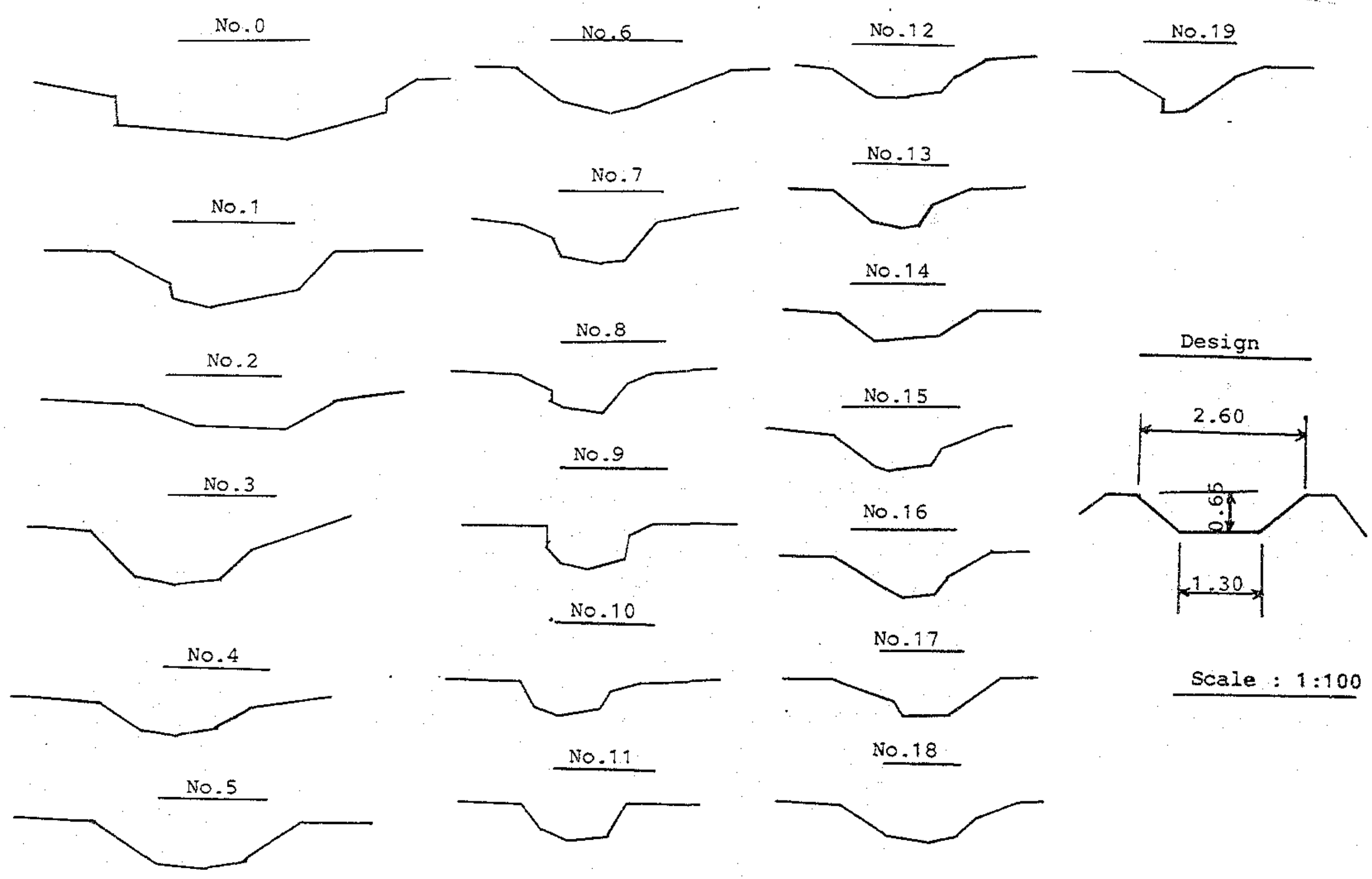
⟶ maintenance by human power;

Cross-section as of Feb.,1983 Feeder Ditch L1-1



Scale : 1/100

Cross-section L2-1 as of Feb.,1983



3.5.2.5 Maintenance of ditches

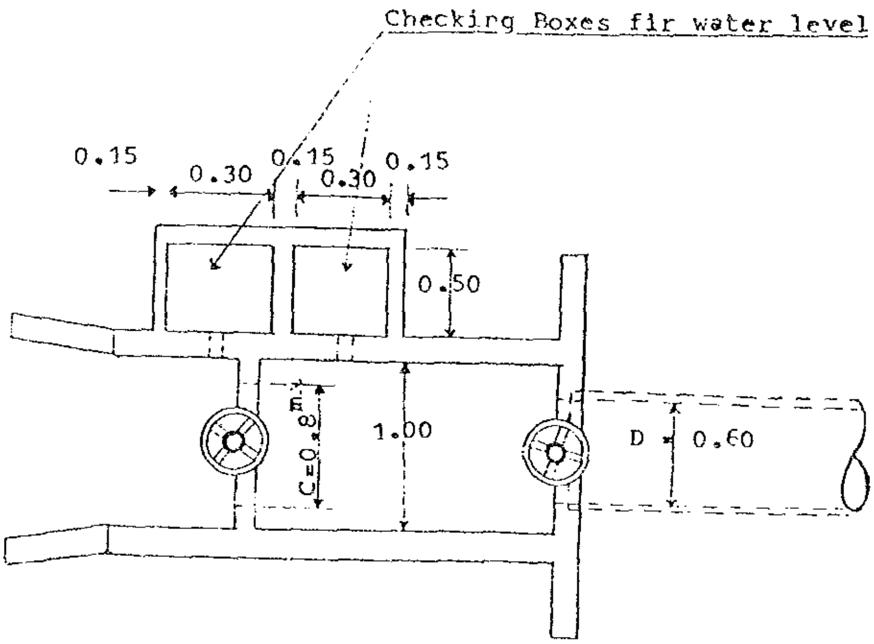
Operation and MAintenance is of course indispensable in maintaining its function, though the farmers who are engaged in the maintenance work only dig the bottom ditches as you can see in the picture below.

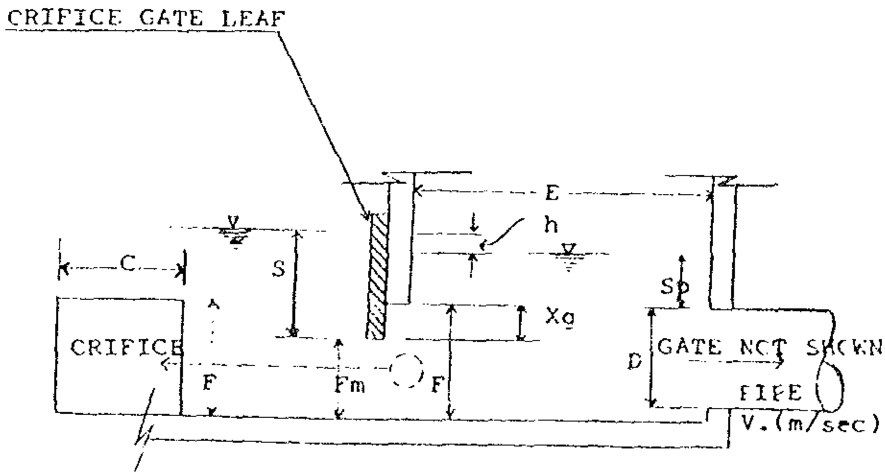
Because of their work, longitudinal slope and cross sections have been changed remarkably.
Fixed rulers should be placed for the farmers' refererce.

3.5.2.6 Measurement of discharge

a) Water management activities start with the measurement of discharge, so this plays a very important role. So as to achieve this purpose, the intake structures were constructed as a structure of constant head orifice.

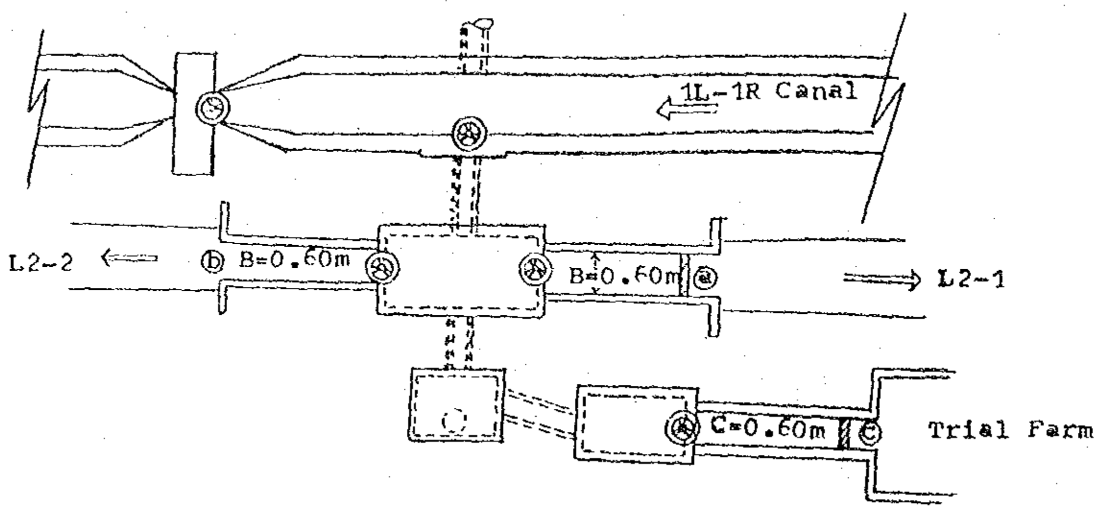
Structure of the Intake No.1

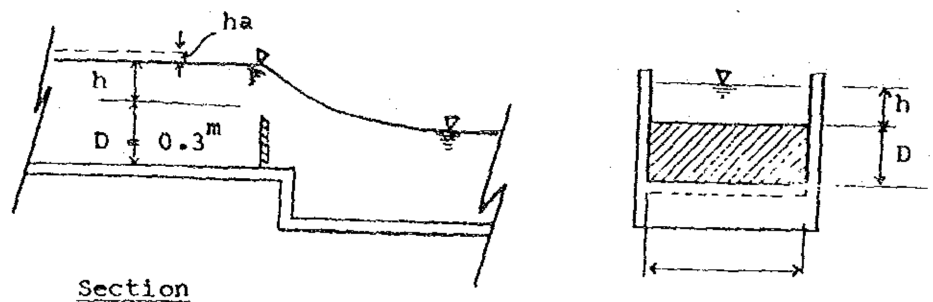




Structure of Intake No.2

Rectangular weir





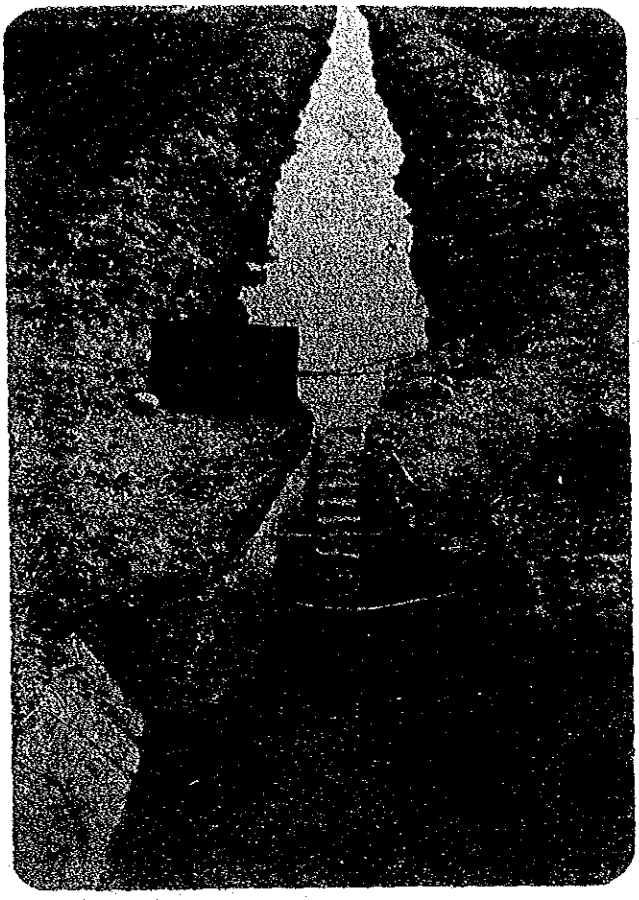
Section

But in these existing circumstances, the checking boxes are filled with soil, which means nobody measures the discharge.

b) Parshal flume

Some Parshal flume were placed in the ditches but because of gentle longitudinal slope it was impossible to measure discharge using this apparatus.

Installed Parshal flume



c) Current meter

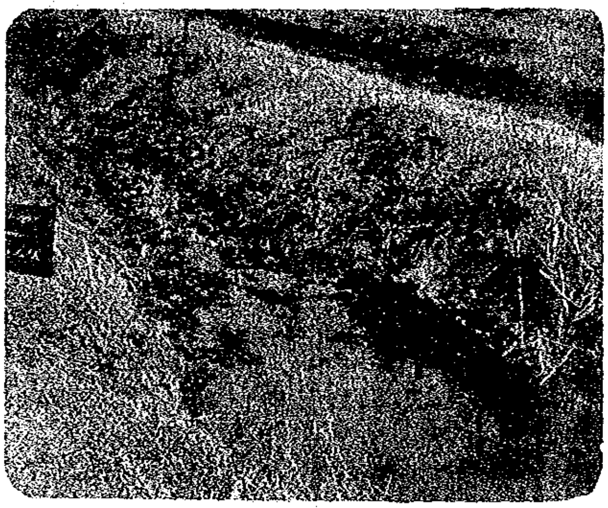
Me B fugel - current meter : type C_1
was used:
This current meter is suitable for measuring discharge in a small ditch but in a ditch which has grown weeds such as in the picture on page 33 it does not work.

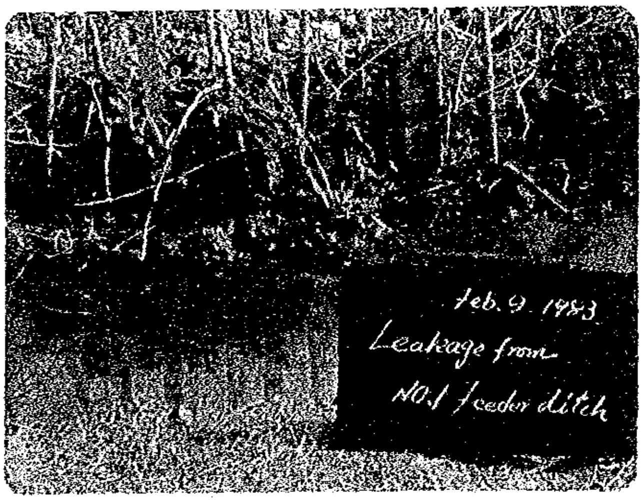
3.6 Design matters

3.6.1 Conveyance efficiency

In detailed design, 90 % of conveyance efficiency is adopted.
This value should be reconsidered.

	Field efficiency	Conveyance effic.	Overall effic.
Mae Klong pilot project	80 %	90 %	72 %
Phitsanulok Irri. project	75 %	85 %	63.75 %
Pattani project	60 %	85 %	51 %
Nongwai project	80 %	80 %	64 %
Mae Klong Right Bank project	75 %	95 %	71 %





3.6.2 Hydraulic computation

:- Coefficient of roughness (n)

In detailed design, the coefficient of roughness was assumed to be 0.035.
This value should also be confirmed at the project site.

Coefficient of roughness

	n
Mae Klong Pilot Project	0.035
Mae Klong Right Bank Project	0.030
Nong Wai Project	0.035
Phitsanulok Project	0.030
Pattani stage I Project	0.030

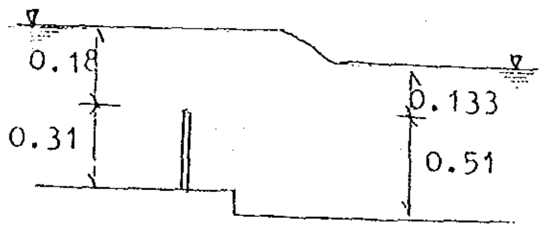
For the purpose of checking the coefficient of roughness (n), the following survey was carried out.

Earth Canal Coefficient of roughness

Place 12-2 Date 9 Aug. 1979

Condition thick growth of weeds

1. Water quantity of diversion weir



$$\frac{h_2}{h_1} = \frac{0.133}{0.18} = 0.74 > \frac{2}{3}$$

Therefore to become submerged weir.

In case of perfect overflow (form hydrulic P 254)

$$Q = CBh^{\frac{3}{2}} \quad (B = 0.90, h = 0.18, D = 0.31)$$

$$C = 1.785 + \left(\frac{0.00295}{h} + 0.237\,\frac{h}{D}\right)$$

$$= 1.785 + \left(\frac{0.00295}{0.18} + 0.237 \times \frac{0.18}{0.31}\right) = 1.939$$

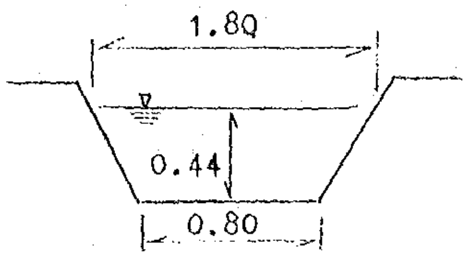
$$Q_1 = 1.939 \times 0.9 \times 0.18^{3/2} = 0.133 \; m^3/s$$

For submerged weir

$$Q = Q_1 \left\{ 1 - \left(\frac{h_2}{h_1} \right)^n \right\}^{0.385}$$

$$= 0.133 \left\{ 1 - \left(\frac{0.133}{0.18} \right)^{1.5} \right\}^{0.385} \quad = 0.09 m^3/s$$

2. Actual Survey Cross section



Slope 1/2,985 $\quad S^{\frac{1}{2}} = 0.0183$

$A = (0.80 + 1.80) \times 0.44 \times 1/2 = 0.572$

$P = 0.80 + 2 \times \sqrt{(0.44)^2 + (0.50)^2} = 2.132$

$R = 0.572/2.132 = 0.268, \; R^{\frac{2}{3}} = 0.416$

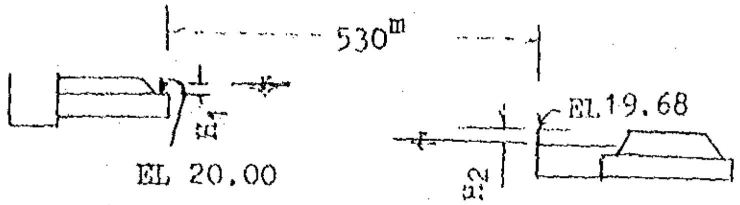
$V = 0.09/0.572 = 0.157$

$n = \frac{1}{V} R^{2/3} S^{1/2} = \frac{1}{0.157} \times 0.416 \times 0.0183$

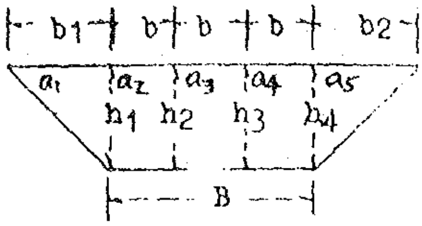
$= \underline{\underline{0.048}}$

Date 30 Oct. 1980

Place L2-1



H_1 = 28 WL_1 = 20.28 H_2 = 36 WL_2 = 19.32



$$\text{Slope} = \frac{0.96}{530} = 0.0018$$

$$P = (120 + 1.03)/2 = 1.12$$

$$A = (0.128 + 0.141)/2 = 0.135$$

$$R = \frac{0.135}{1.12} = 0.120 \qquad R^{\frac{2}{3}} = 0.243$$

NO.	B				H				A					
	b_1	b_2	b	B	h_1	h_2	h_3	h_4	a_1	a_2	a_3	a_4	a_5	Total
I	18	18	17.5	70	17	18	21	18	0.015	0.030	0.034	0.034	0.015	0.128
II	10	18	19	56	18	21	22	19	0.009	0.036	0.040	0.038	0.018	0.141

No.	V					Q					
	v_1	v_2	v_3	v_4	v_5	Q_1	Q_2	Q_3	Q_4	Q_5	Total
I	0.22	0.34 0.29 0.31	0.39 0.32 0.36	0.36 0.31 0.33	0.15	0.0033	0.0093	0.0122	0.0112	0.0022	0.038
II	0.19	0.29 0.32 0.30	0.32 0.28 0.30	0.29 0.28 0.28	0.15	0.0017	0.110	0.0120	0.0106	0.0027	0.038

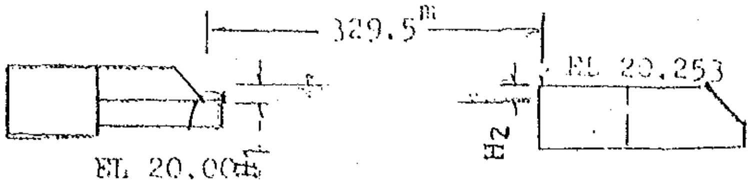
P_1 = 0.25 + 0.70 + 0.25 = 1.20 P_2 = 0.21 + 0.56 + 0.26 = 1.03

$Q = (0.038 + 0.038) \div 2 = 0.038$ $S^{1/2} = 0.042$

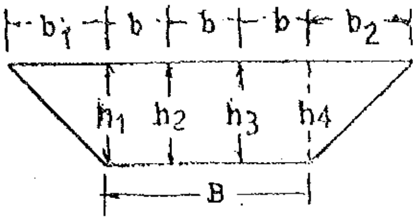
$V = Q/A = 0.038/0.135 = 0.281$ $\frac{1}{V} = 3.559$

$$n = \frac{1}{V} R^{\frac{2}{3}} S^{1/2} = 3.559 \times 0.243 \times 0.042 = \underline{0.036}$$

Place TL2-1.2 ~ TL2-1.4 (L2-1)　　　　Date 30 Oct, 1980



$H_1 = 5$　　$WL_1 = 20.05$　　$H_2 = 31.5$　　$WL_2 = 19.938$



$\text{Slope} = \frac{0.112}{329.50} = 0.0003$

$P = (1.35 + 1.18)/2 = 1.256$

$A = (0.190 + 0.173)/2 = 0.182$

$R = \frac{0.182}{1.256} = 0.144$　　$R^{\frac{2}{3}} = 0.275$

NO.	B				H				A					
	b_1	b_2	b	B	h_1	h_2	h_3	h_4	a_1	a_2	a_3	a_4	a_5	Total
I	20	33	24	73	15	22	22	18	0.015	0.044	0.053	0.048	0.030	0.190
II	25	22	19	56	20	25	23	21	0.025	0.040	0.043	0.042	0.023	0.173

No.	V					Q					
	v_1	v_2	v_3	v_4	v_5	Q_1	Q_2	Q_3	Q_4	Q_5	Total
I	0	0.16 0.15 0.15	0.19 0.17 0.18	0.19 0.17 0.18	0.16	0	0.0066	0.0095	0.0086	0.0048	0.030
II	0.10	0.22 0.18 0.20	0.23 0.20 0.21	0.20 0.14 0.17	0.80	0.0025	0.0080	0.0090	0.0071	0.0018	0.028

$P_1 = 0.25 + 0.73 + 0.37 = 1.35$　　　$P_2 = 0.32 + 0.56 + 0.30 = 1.18$

$Q = (0.030 + 0.028)/2 = 0.029$　　　$S^{1/2} = 0.0174$

$V = Q/A = 0.029/0.182 = 0.159$　　　$\frac{1}{V} = 6.289$

$n = \frac{1}{V} R^{\frac{2}{3}} S^{\frac{1}{2}} = 6.289 \times 0.275 \times 0.0174 = \underline{\underline{0.030}}$

: Permissible Velocity

Generally, in earth ditches it is necessary for the mean velocity to be kept as fast as 0.5 ~ 0.9 m/sec. The above mentioned mean velocity does not allow weeds to grow and prevents the precipitation of suspending silt.

Kennedy's formula

(in the case of muddy water) $Vs = C.H^{0.64}$

(in the case of clear water) $Vs = C.H^{0.50}$

in which

Vs = velocity never causes erosion and accumulation (m/s)

H = water depth (m)

light fine sand	: 0.46	heavy cosrse sand	: 0.51
sandy loam	: 0.56	silt	: 0.60

C = coefficient depends on soil property

Feederditch L1-1

$Vs = 0.60 \times 0.45^{0.64} \doteq 0.30$ m/s > Vd = 0.24 m/s

Vd = design velocity

Farmditch

$Vs = 0.60 \times 0.30^{0.64} \doteq 0.28$ m/s > Vd = 0.10 0.27 m/s

3.6.3 Permissible length of ditch

Natural phenomena, vegetation and animals spoil the function of ditches, even though the design and construction have been executed correctly. In view of the results so far achieved, the length of the earth ditch has its limits.

If its length passes the limit, the irrigation water would never get to the termination of its command area.

Length of ditch

MaeKlong Pilot Project No.1
max.L = 2,986 m

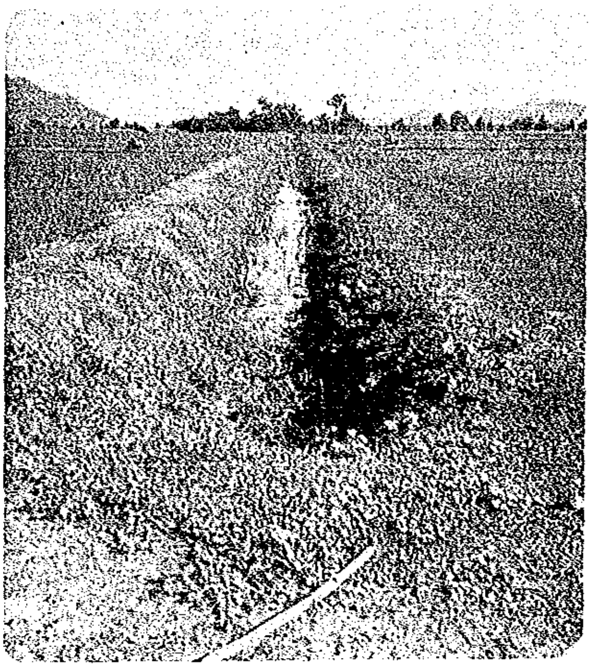
MaeKlong Pilot Project No.2
max.L = 2,520 m

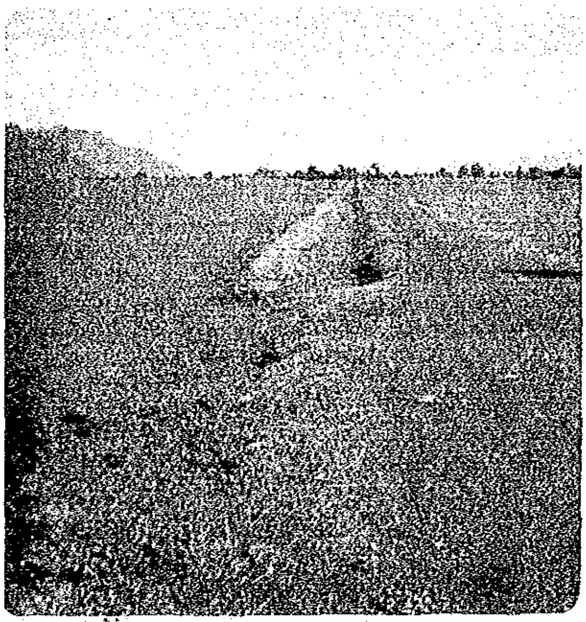
According to the design criteria of other projects;

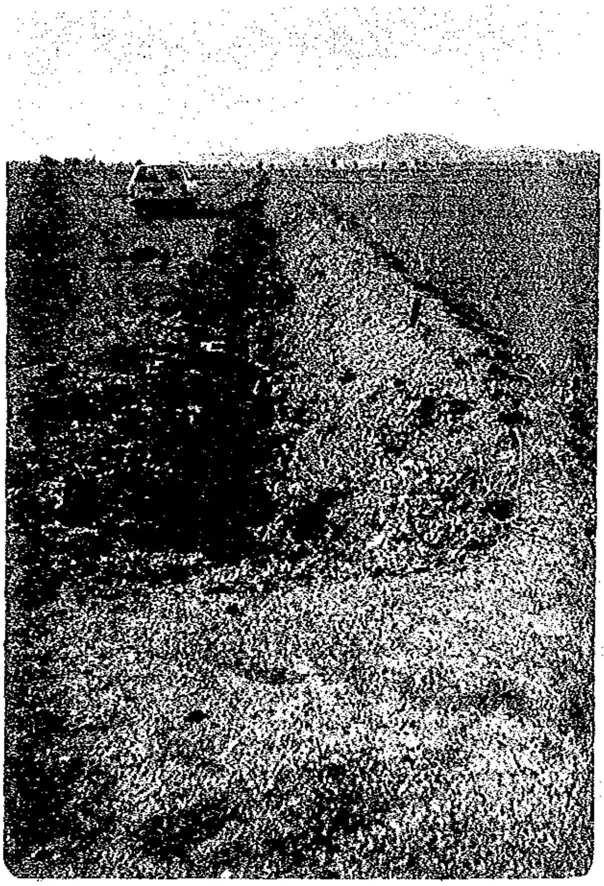
- Mae Klong Right Bank Project
  - Optimum length of irrigation ditch : 1,500 m
  - Optimum length of sub-ditch : 500 m

- Nong Wai Project
  - Optimum length of irrigation ditch : 1,200 m

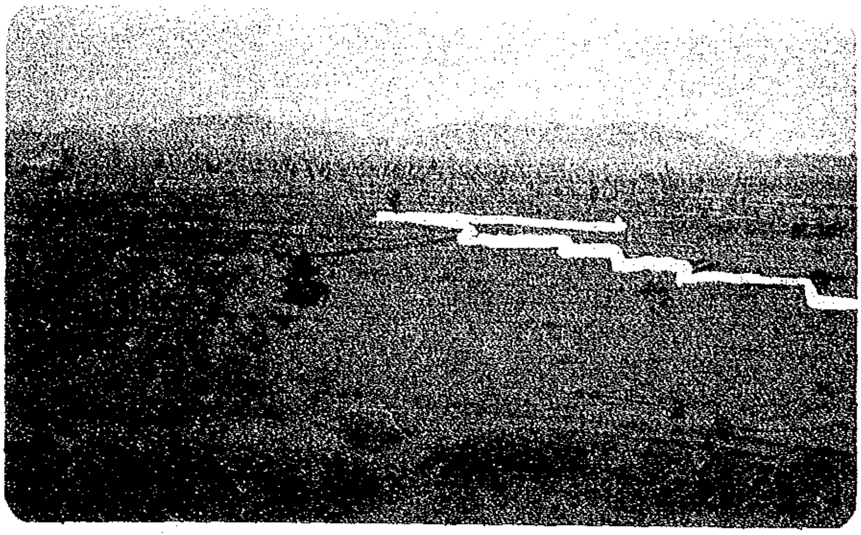
A ditch down which water has not yet flowed.



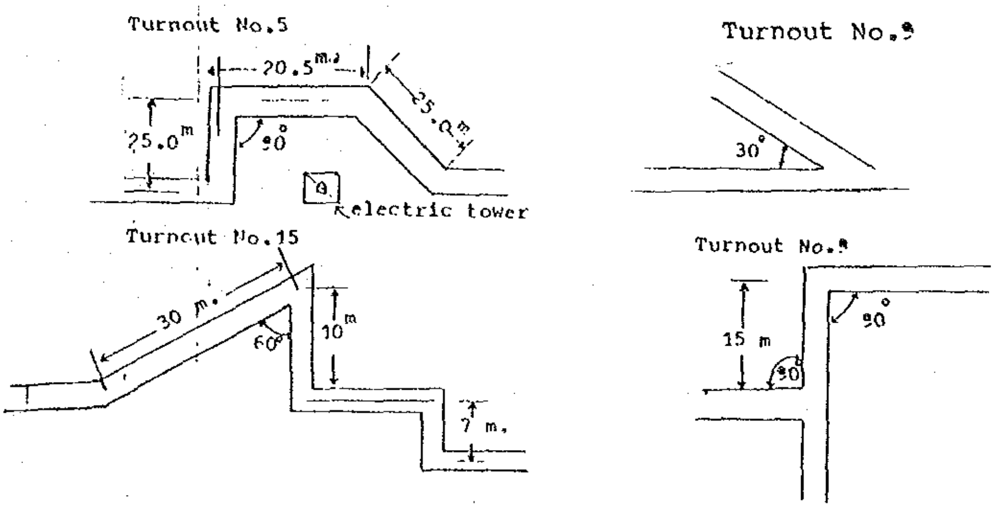




3.6.4 Route of irrigation ditch attached to farm road



As for extensive land consolidation, ditches have to follow existing plot boundaries as much as possible.

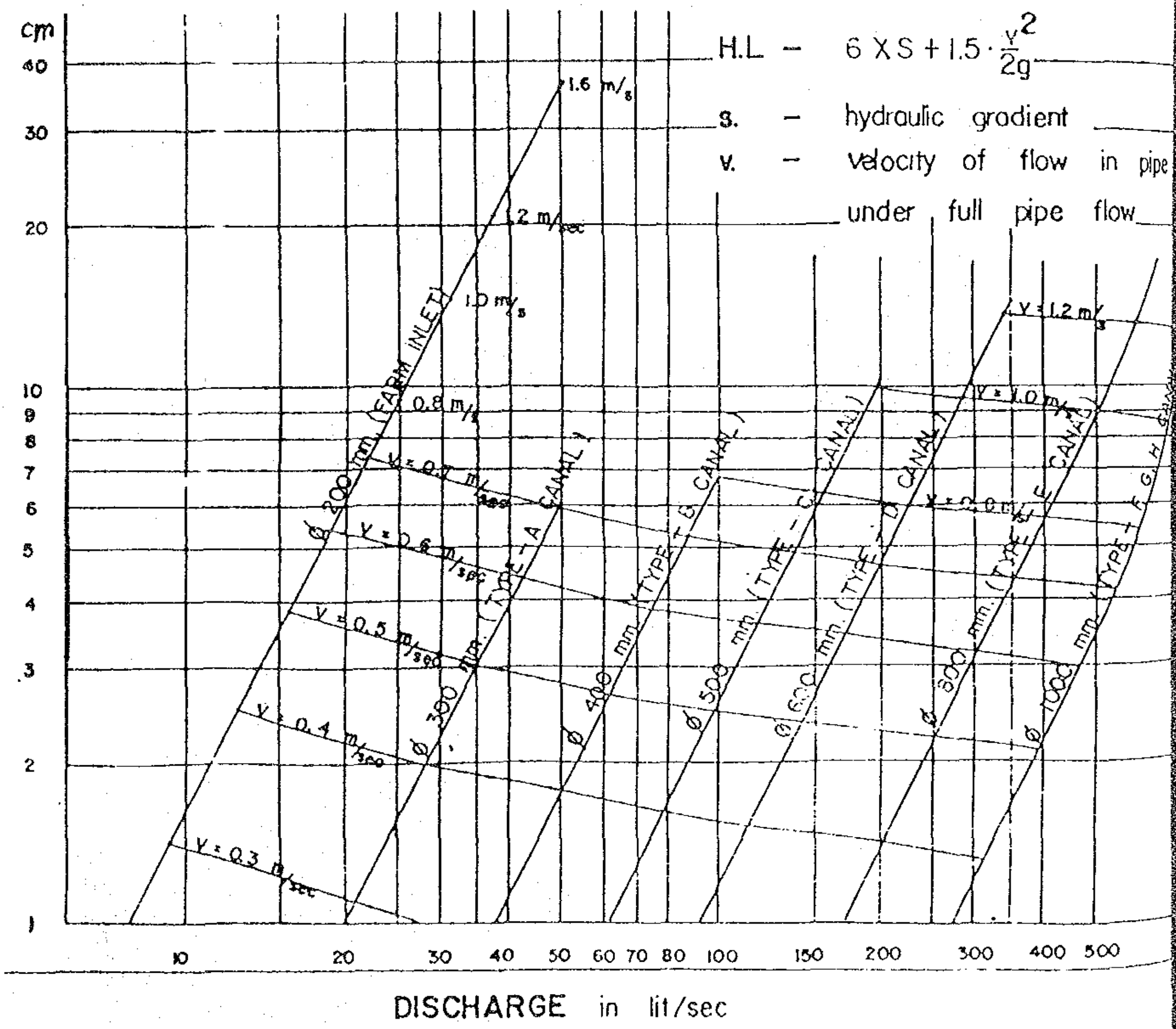


Owing to the zigzag route, irrigation water does not flow smoothly and only small cars can turn, as well.
The operation agency should find good methods so as not to leave anything that might be regretted in the future.

3.7 Culvert

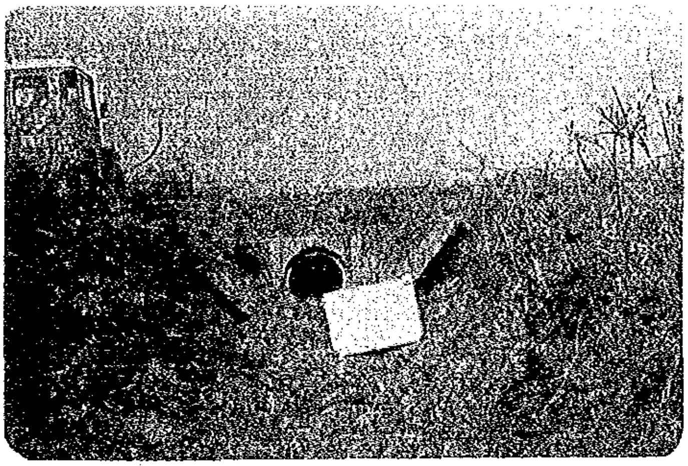
Prefabricated concrete pipes are used for culverts.
The standard length of a pipe is one meter for all diameters commonly used, which are 300, 400, 500, 600, 800, and 1,000 mm
Head loss in culverts 5 - 6 meters long is shown in the following chart though, in general the size of the pipe is small so that it is impossible to clean its inside and they are an obstacle to the flow of water.

HEAD LOSS IN CULVERT OF 5 - 6 M. LENGTH

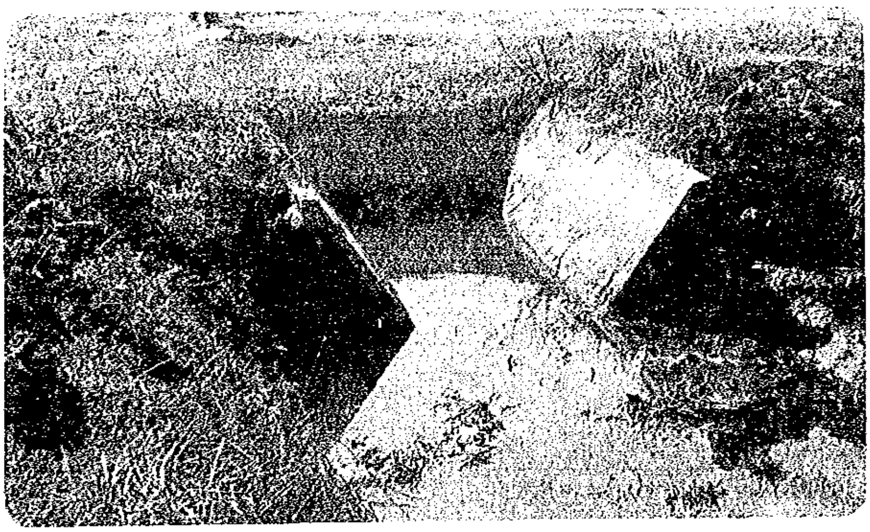


As compared with the cross-section of the ditch, you can see that it is too small.

3.8 Small concrete structures



Cut-off-wall should be constructed to protect erosion.



3.9 Drainage ditch

:- Unit area drainage discharge
No problem can be seen, so far.
(Refer to the following tables)

:- The time required for draining a plot
This should be surveyed.

:- Cofferdams constructed in drainage canals.

For the purpose of using drained water for irrigation using portable pumps, farmers who have their fields on the lower part of irrigation ditches have constructed some cofferdams in drainage canals.
We cannot see any problems in the dry season but in the rainy season these cofferdams have been obstructing draining.

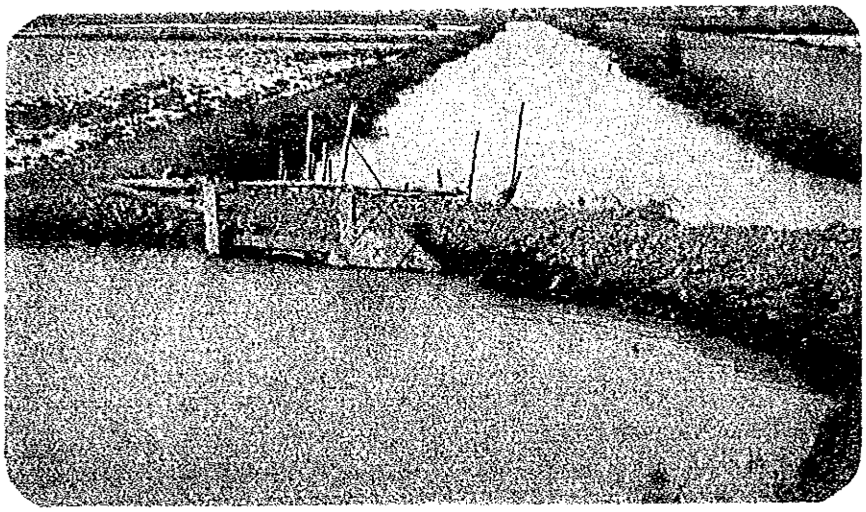


TABLE SHOWS DRAINAGE MODULUS IN THE IRRIGATION PROJECTS

Item No.	Projects	Sources of Discussion	Methodology	*Drainage	Drainage Modulus for Main Drain in L/sec/rai — For Drainage Area (rai): 2,000 to 5,000	5,000 to 10,000	10,000 to 20,000	20,000 to 50,000	50,000 to 100,000	100,000 to 200,000	200,000 to 500,000	500,000 to 1,000,000
1	Chao Phya Stage I	Ilsco-Nedeco	46 mm/24 hours Criteria and assumptions 1) No flooding depth 2) Maximum 5-day consecutive rainfall 3) 5-years return period 4) to drain within 5 days	0.85	-	-	-	-	-	-	-	-
					(0.95)*	(0.90)*	(0.87)*	(.85-.82)*	(.80-.78)*	(0.74)*	(.73-.69)*	(.68-.66)*
2	Phitsanulok	ELC-NK-SEATEC	Economic Optimization Technique Criteria and assumptions 1) Ponding depth in the field 100mm. 2) Max. 5-days consecutive rainfall 3) 6 and 17 years return period for Lower area and Upper area.	0.65	0.61	0.57	0.56	0.54-0.53	0.51	0.48	0.46-0.45	0.43
					(90)*	(85)*	(80)*	(75)*	(70)*	(65)*	(60)*	(55)*
3	Phisanulok (Feasibility Report)	U.S.B.R.	Criteria and Assumptions 1) No ponding depth 2) 7-days consecutive rainfall 3) 10-years return period	0.59	0.53	0.50	0.47	0.44	0.41	0.38	0.35	0.32
					(90)*	(85)*	(80)*	(75)*	(70)*	(65)*	(60)*	(55)*
4	Uttaradit (Feasibility Report)	U.S.B.R.	Criteria and Assumptions 1) No ponding depth 2) 7-days consecutive rainfall 3) 10-years return period	0.67	0.60	0.57	0.54	0.50	0.47	0.44	0.40	0.37
	Mae Klong Pilot Project			0.80								
	Chao Phya Pilot Project			0.64								