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OPERATIONS RESEARCH RESULTS
- AGRO-ECONOMICS -
1982-1983 DRY SEASON

LAM NAM OON INTEGRATED RURAL DEVELOPMENT PROJECT

ISSUED BY

CENTER FOR RURAL DEVELOPMENT
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TABLE OF CONTENTS

		PAGE
	FOREWORD	
	INTRODUCTION	1
1.	METHODOLOGY	2
2.	ANALYSIS	4
	2.1 General	4
	2.2 Agricultural Inputs	5
	2.3 Labor Use	7
	2.4 Total Cash Input Costs	11
	2.5 Yield and Sale Price	11
	2.6 Net Returns	12
3.	SUMMARY AND CONCLUSIONS	14
4.	RECOMMENDATIONS	17
	LIST OF TABLES	
	Table 1: Summary of Samples	
	Table 2: Summary Evaluation - Headenders	
	Table 3: Summary Evaluation - Mid-ditch Cultivators	
	Table 4: Summary Evaluation - Tailenders	
	AUTHOR	

5. List of Maps:

	Map No.
Area of the Lam Nam Oon Irrigation Projec	
Sakon Nakhon	1
Land Consolidation Unit 6, Pilot Area 1	
Water User Group 1	2
Water User Group 2	3
Land Consolidation Unit 12, Pilot Area 3	
Water User Group 1	4
Water User Group 4	5
Water User Group 8	6
Land Consolidation Unit 13, Pilot Area 3-	
Water User Group 2	7
Water User Group 8	8
Water User Group 10	9
Land Consolidation Unit 15	
Water User Group 4	10
Water User Group 7	11
Water User Group 11	12
Land Consolidation Unit 17	
Water User Group 6	13
Water User Group 8	14
Water User Group 11	15
Land Consolidation Unit 20, Pilot Area 2	
Water User Group 2	16
Water User Group 3	17

AUTHOR

FOREWORD

The Louis Berger International, Inc. advisory team at Lam Nam Oon produces various kinds of informational and analytical data. These comprise Quarterly Reports; Technical Notes: Project Planning Notes; Project Notes; Reports and advisory memoranda.

We collaborate with Thai personnel at Lam Nam Oon. Their efforts are regarded by us as the foundation-stones for the future development of a prosperous Lam Nam Oon irrigated area.

We believe that some of the innovations introduced at Lam Nam Oon may make a contribution to the history of integrated rural development in an irrigation setting.

Accordingly, the Center for Rural Development, which is a Division of the Louis Berger Group of companies issues this Report as Project Note #8.

Currently, in 1983 the Center supports ten major rural development projects which are funded by the World Bank, the Asian Development Bank, the U.S. Agency for International Development, and other international and national agencies in Asia, Africa, the Middle East, and Latin America.

As a part of it's services to clients and the professional community of those engaged in rural development, the Center releases technical and project information on various aspects of individual projects.

For those interested in Project Note #8 (Lam Nam Oon) additional copies may be obtained from the Center for Rural Development, c/o Louis Berger International, Inc. 100 Halsted Street, East Orange, New Jersey 07019, U.S.A.

Introduction

The agro-economic component of the 1982-1983 irrigation operations research program at the Lam Nam Oon Irrigation Project, Sakon Nakhon was implemented in six land consolidation areas. Data collection was conducted during the dry season cropping period, beginning in December 1982, through June 1983.

The land consolidation areas were of two types:

1) Extensive development areas are those in which plot boundaries are not rearranged and there is no land leveling. The on farm water delivery system is designed to supply not less than 70% of all farmers in the system. In addition, title deeds are awarded.

2) Intensive development areas are those in which plot boundaries have been rearranged and land holdings of individual farmers consolidated. The design of the on farm delivery system is on a "block" basis and land in the intensive area is leveled. As designed, 100% of all land holders in the area will receive a regular supply of irrigation water. As in extensive areas, title deeds are awarded.

Thus, in this study, when references are made to extensive and intensive areas, it is this definition to which the reader should refer. Also, as a matter of clarification, the terms land development and land consolidation are used interchangeably at Lam Nam Oon. Although extensive development is not land consolidation in a pure sense, the construction of the on farm delivery system in extensive areas is being implemented under the 1974 Land Consolidation Act.

The construction of on farm delivery systems in land consolidation areas is still in progress at Lam Nam Oon. Construction is expected to be completed by September, 1985. At that time, 176,996 rai will have been developed under the extensive system, and 8,804 rai under the intensive system.

It is thus important that agro-economic research linked to irrigation water management continue in both land consolidation types. Each system is expected to have its strong points as well as its constraints. Identification of problems and solutions is often possible through an analysis of agro-economic data.

This report compares the inputs and output of a sample of 51 groundnut producers in the extensive and intensive land consolidation areas of Lam Nam Oon. The report also includes a preliminary analysis of input and output differences among headender, mid-ditch, and tailender farmer irrigators in both types of land consolidation areas. As many of the extensive producers were cultivating groundnuts for the first time, only preliminary conclusions can be drawn from the study.

Analysis was made possible through the efforts of the research assistant attached to the Louis Berger International consulting team, Mr. Dusit Chantharyhun, who was responsible for collecting field data. Also of great assistance was Mr. William Bell, the irrigation engineer on the Berger team, who prepared a computer program which greatly facilitated data processing and analysis.

1. METHEODOLOGY

1.1 The collection of agro-economic data from groundnut producers in the Lam Nam Oon area during the 1982/83 dry season was linked to the delivery of irrigation water in land consolidation areas. That is, a sampling of groundnut producers was selected based upon their location along ditches in both extensive and intensive land development areas. A sample size of 51 farmers, or 5% of all farmers cultivating groundnuts (993), was divided into three categories:

Category 1 - Headenders - those farmers whose plots were located at the head of an irrigation delivery ditch, nearest the farm turnout (CHO).

Category 2 - Mid-ditch cultivators - those farmers whose plots were located near the middle of an irrigation delivery ditch.

Category 3 - Tailenders - those farmers whose plots were located near the end of an irrigation delivery ditch, farthest from the farm turnout.

1.1.1 Samples within each category were divided between the two types of land development areas as follows:

CATEGORY	INTENSIVE	EXTENSIVE	TOTAL
Headenders	7	5	12
Mid-ditch	8	10	18
Tailenders	6	15	21
Total samples	21	30	51

1.2 The ditches or chak areas within each land consolidation area were selected based upon the following criteria:

1.2.1 Number of farmers cultivating: In order to be able to take a sampling of farmers in an area, it was necessary to select ditches which had a significant number of farmers cultivating groundnuts along all sections of a ditch.

1.2.2 Since most farmers in land consolidation areas had been organized into water user groups, it was assujmed that most ditches would have some minimum management of water. Thus, water delivery was not a factor which influenced the selection of one ditch over another.

1.2.3 Length of the ditches: It has been observed that the lengths of on farm irrigation delivery ditches in the extensive land consolidation (development) areas are frequently longer than those in intensive areas.

Thus, delivery ditches were selected in both intensive and extensive land consolidation areas which took into consideration the lengths of the ditches. The lengths of ditches from which a sampling of farmers was selected is summarized on Table 1. In the sample areas, on farm water delivery ditches in extensive areas were found to be approximately 22% longer than ditches in intensive areas.

1.3 In order to insure accuracy of the data, the LBII research assistant collected data during each phase of production. That is, data on land preparation and planting was collected while the farmer was engaged in these activities. Data on maintenance, harvesting and marketing of the groundnut crop was similarly, collected during those phases. Data was collected during the period 10 December 1982 through 31 May 1983.

1.4 Initially, the agro-economic analysis of irrigation operations research was to be concentrated in several areas in which water measurement was being conducted by the engineering component. Due to a staffing constraint however, water measurement was limited to three chak areas of pilot area 2 (Unit 20)* Agro-economic research was conducted in six land consolidation areas nevertheless, including pilot area 2.

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* A separate report (Project Note No.) prepared by the LBII irrigation engineer, Mr. William Bell, discusses the results of that work.

2. ANALYSIS

2.1 Analysis of agro-economic data from groundnut production will be approached in two ways:

(a) a comparison of inputs and output for headenders, mid-ditch cultivators, and tailenders; and,

(b) a similar comparison of inputs and outputs for the three categories of farmer-irrigators, based upon their location in intensive and extensive land development areas.

2.1.1 It is generally assumed that tailenders, or farmer-irrigators located near the end of an on farm water delivery ditch will have the most difficulty in obtaining an adequate supply of water. In most cases, this factor is less crucial during the wet season, when irrigation water is applied to supplement rainfall in cultivating rice. The tailender becomes more concerned about water delivery during the dry season, however, when the application of an adequate supply of water affects the yield and thus the net return of any dry season cropping effort.

2.1.2 The tailender's previous dry season experience or inexperience with water use will often influence the level of agronomic technology employed by him. The quality and quantity of such inputs as seed, fertilizer, credit, manpower and land (area planted), will be determined by the level of risk the farmer anticipates. As a tailender, the farmer has the aditional risk of an inadequate or inconsistant supply of water.

2.1.3 This analysis will study certain techniques employed by farmer-irrigators in the production of groundnuts at Lam Nam Oon during the 1982/83 dry season. The purpose of the analysis is to determine if there are significant differences in the willingness to invest in dry season groundnut production among farmers located at different positions along on farm irrigation ditches. Factors to be compared include:

- seed and fertilizer
- labor use
- total cash input costs
- net returns

2.1.4 The profitability of cultivating groundnuts in the dry season will be measured by three indices: yield per rai, net return per rai, and net return per manday of family labor.

2.1.5 All farmers sampled reported using the Tainan 9 variety of groundnut seed as recommended by the Lam Nam Oon project.

2.1.6 There was a significant difference in the area planted in groundnuts among the farmers sampled. The areas ranged from a low of 2.66 rai cultivated by mid-ditch cultivators in intensive areas, to a high of 4.18 rai planted by headenders in intensive areas. The average area planted by all producers was 3.36 rai.

Farmers in extensive areas planted significantly smaller plots of groundnuts than their counterparts in the intensive land consolidation areas. This may be due to the fact that the intensive areas, having been constructed before any of the extensive areas, had delivery systems which had been tested and found reliable by the farmers. Farmers in the older, more established intensive areas were thus more willing to cultivate larger areas of groundnuts.

In addition, in that the intensive areas have been designed for mechanised agriculture, tractor drivers may be more willing to provide commercial ploughing services to the intensive areas. This permits farmers with ready cash to pay for larger areas to be ploughed. Commercial ploughing also permits farmers to economise on the use of family labor, which may already be in short supply.

Also, tractor drivers may tend to prefer operating in intensive areas with which they are already familiar having provided services there in previous years.

2.2 Input Costs

Agricultural inputs consisting of groundnut seed and chemical fertilizer comprised the principal share of total input costs. Farm implements, generally consisting of a hand plough, harrow, and rake, were a minor portion of total input costs for all farmers sampled. The cost of hired labor, however, contributed to total cash input costs an amount nearly equal to the cost of fertilizer. For farmers sampled in all locations, the cost of seed comprised 42.5% of total cash input costs, fertilizer was 23%, and hired labor 22.5%

2.2.1 The cost of agricultural inputs in all areas ranged from a low of 386 baht per rai invested by headenders located in extensive land consolidation areas, to 575 baht per rai expended by farmers near the middle of water delivery ditches in intensive land consolidation areas.

2.2.2 Tailenders in both extensive and intensive areas tended to invest less in fertilizer than headenders and mid-ditch cultivators.

Tailenders applied fertilizer valued at an average of 105 baht per rai to their groundnut crop, while the value of fertilizer applied by farmers in the other two categories ranged from 125 to 205 baht per rai. When these figures are translated into volume of fertilizer, tailenders applied approximately 19.44 kilograms of fertilizer per rai to the groundnut crop versus a range of 23.15 to 37.96 kilograms per rai applied by cultivators in the other two categories. This is a range of 16% to 49% difference in the amount of fertilizer applied by tailenders.

This relatively significant difference in the amounts of fertilizer applied may be a demonstration of the tailenders' unwillingness to risk investing in dry season groundnut production. Although normal production risks include marketing constraints and pest infestations, tailenders also face the risk of an inconsistent supply of water for irrigating the crops.

2.2.3 Further analysis of investments in agricultural inputs reveals that the value of groundnut seed and equipment used by farmers in all categories was not significantly different.

2.2.4 When comparing the difference in input costs between headenders and mid-ditch cultivators in intensive and extensive areas, farmers in intensive areas tended to have higher expenditures on agricultural inputs. Cultivators in both categories in intensive areas had significantly higher expenditures per rai for both groundnut seed and chemical fertilizer.

However, fertilizer's share of total cash input costs were equal for the two categories of farmers in the extensive and intensie areas. That is, the expenditure for fertilizer was 25-26% of total cash input costs for both headenders and mid-ditch cultivators in both areas.

Thus, headenders and mid-ditch cultivators in intensive areas tended to have significantly higher expenditures for seed than their counterparts in extensive areas. Yet, when yields are analysed below, cultivators in intensive areas had lower total yields than those in extensive areas. The difference in expenditure for seed may be attributed to the need to use larger amounts of seed for planting in intensive land consolidation area in order to maintain yield levels.

Groundnut producers in intensive land consolidation areas may be required to invest significantly larger amounts of agricultural inputs to their crop to compensate for poor soils. In these intensive areas, land leveling was carried out as part of the land consolidation process, removing topsoil rich in organic matter, leaving the less fertile sub-soils as an agronomic medium.

2.2.5 None of the farmers sampled was required to apply pesticides to their groundnut crop.

2.3 Labor Use

Figures for labor use are based upon data collected for the three primary activities of groundnut production: land preparation and planting, maintenance, and harvesting (including post-harvest handling at the farm level). Labor use is measured in mandays, with one manday equivalent to approximately eight hours of production related activities. The cost of labor in the Lam Nam Oon area during the 1982/83 dry season was the same as in the 1981/82 season - 25 baht per day. Only infrequently were daily labor wages different for men and women.

2.3.1 As anticipated, manpower employed in all production activities was primarily family labor. Hired labor was employed mainly in soil preparation with the hiring of commercial ploughing services. Almost no hired labor was used to maintain the groundnut crop in all areas. In most cases, only an insignificant number of laborers were hired to work on harvesting.

2.3.2 Land preparation and planting.

Although headenders tended to use less family labor in land preparation and planting than mid-ditch cultivators and tailenders, they tended to invest more in hired labor than producers in the other two categories. Family labor use by mid-ditch cultivators and tailenders was nearly double that of headenders in land preparation and planting. This may be due to the greater dependence of headenders on hired labor.

In that the hired labor component consists primarily of commercial ploughing services, headenders may be seen benefiting from their locations at the head of an irrigation delivery ditch, having relatively easy access to irrigation canal service roads. It may be that tractor drivers are less willing to provide ploughing services to areas further down the ditch due to inaccessability. An additional factor to consider is that there may exist a shortage of tractors providing commercial ploughing services at Lam Nam Oon, thus giving the drivers the opportunity to select the plots to be ploughed. The areas selected are those with easy access, i.e., those nearest irrigation canal service roads, or headenders - those plots located near the farm turnout (CHO). Or, mid-ditch cultivators and tailenders may fear that they will be planting too late if they wait for the tractors to complete ploughing for headenders. They thus use family labor to prepare their soil.

When the total value of labor used for land preparation and planting is analysed, headenders are seen as using less than half of the labor used by mid-ditch cultivators. Headenders in extensive areas used a value equivalent of 291 baht of labor for land preparation and planting, while mid-ditch cultivators in intensive areas used 646 baht of labor (combined family and hired labor, average).

In comparing labor use for land preparation and planting between extensive and intensive areas, groundnut producers in extensive areas in all three categories tended to use less family and hired labor per rai than farmers in intensive areas, but not to a significant degree. However, cultivators in intensive areas invested significantly more in hired labor per rai for land preparation than those farmers in extensive areas. This may be due to several factors:

(a) familiarity of tractor drivers and owners with the more established (constructed at an earlier date) intensive land consolidation areas;

(b) the tractor drivers' preference to plough in intensive areas, which have been designed for mechanised crop cultivation;

(c) tractor drivers prefer operating in intensive areas in that plot sizes are easier to calculate due to rectangularisation of plots; and,

(d) the fact that there is a higher intensity of irrigation ditch service roads in intensive land consolidation areas than in extensive areas, thus facilitating movement of tractors within the intensiveaa areas.

An analysis of the impact of investment in labor for land preparation and planting reveals that only with mid-ditch cultivators does an increase in investment have a relatively positive correlation to increased yields:

Headenders: r = .23 (Correlation
Mid-ditch: r = .55 (Coefficients
Tailenders: r = .07 (

As a result, increased yields can be expected by mid-ditch cultivators with an increase in investment of family labor in land preparation and planting.

2.3.3 Maintenance

The maintenance activity consists of the following labor input factors: weeding, fertilizer application, application of pesticides, and water application.

Headenders in extensive land consolidation areas tended to have the highest family labor use per rai for maintenance. This may be attributed to having the lowest investment in agricultural inputs, thus requiring an increase in labor use for maintenance to compensate.

However, headenders in intensive areas invested the least amount of family labor per rai in maintenance of their groundnuts. This may be attributed to two factors:

i. the easeness in managing water through the intensive on farm delivery system; and

ii. the high investment in hired labor for land preparation.

As mentioned above, hired labor for land preparation consisted primarily of commercial tractor ploughing services. It is assumed that mechanised soil preparation is generally of a higher quality than hand ploughing using a buffalo, therefore less manpower was required to maintain the groundnut plots.

There was no significant difference in the value of labor use between tailenders and mid-ditch cultivators in both types of land development areas.

Expenditure on labor for maintenance had no significant impact on yield per rai, area revealed by these correlation coefficients:

Headenders	: r = 0.19
Mid-ditch cultivators	: r = 0.20
Tailenders	: r = -0.29

Nor did the manpower invested in maintenance have any affect on net return:

Headenders	: r = 27
Mid:ditch cultivators	: r = -.30
Tailenders	: r = .21

2.3.4 Harvesting

The harvesting and post-harvest labor use component consisted of several activities: harvesting, cleaning, grading, packing, drying, and transporting to a point of sale.

Headenders in both extensive and intensive areas tendend to invest less manpower in harvesting than both mid-ditch cultivators and tailenders, although only when compared to mid-ditch cultivators in intensive areas was the difference significant. This may be due to the fact that headenders expended less time in moving the groundnuts to a point of sale, due to their location nearest to the irrigation canal service roads.

Both headenders and tailenders in intensive areas hired labor to assist with harvesting. This may be related to the fact that both categories of cultivators planted an average of over four rai per farmer, approximately 2/5 rai (600 sq meters) larger than the next highest figure, 3.75 rai.

Mid-ditch cultivators in intensive areas expended the greatest amount of family labor among all categories on harvesting. The result was the highest yield per rai, but the lowest return on family labor use.

When comparing extensive and intensive land development areas, producers in the extensive areas tended to use significantly less total labor per rai for harvesting than those in intensive areas. This may be due to the fact that producers in extensive areas had smaller areas under cultivation. Producers in intensive areas, on the other hand, were cultivating larger areas and perhaps felt the need to expend more labor to attempt to bring the highest return on their overall investment, which was larger than that of farmers in extensive areas.

2.3.5 Total Labor Use

When comparing total labor use among headenders, mid-ditch cultivators, and tailenders, headenders are observed as using the least amount of mandays of family labor. In addition, headenders have the lowest baht equivalent expenditure for labor use.

For all categories of farmers, the labor investment in land preparation and planting was significantly greater than the expenditures on labor for maintenance and harvesting.

The total number of family labor mandays ranged from 18.09 mandays per rai for headenders in intensive areas, to 32.92 mandays per rai for mid-ditch cultivators in intensive areas. The average member of family mandays per rai in both intensive and extensive areas for all categories of farmers was 26.63.

The impact of family labor input on yield per rai is measured by the coefficients of correlation as follows:

Headenders : r = .21
Mid-ditch cultivators: r = .48
Tailenders : r = .07

Only with the mid-ditch cultivators would an increase in the use of family labor have a slight impact on increasing yields.

When comparing total labor use in extensive and intensive areas, the baht equivalent expenditure on labor was significantly higher in the intensive areas. This may be attributed to the willingness of producers in the intensive areas to invest in manpower, based upon several years previous experience with dry season crop production. Producers in extensive areas, however, having only recently been provided with a managed supply of irrigation water were less willing to invest manpower.

At the same time, producers in extensive areas tended to be more efficient with the use of labor. Extensive producers used an average of 28.79 mandays of labor to produce one rai of groundnuts, as opposed to 35.15 mandays per rai for producers in intensive areas. This is greater than 15.7 mandays per rai reported in a World Bank report on irrigated groundnut production in Northeast Thailand.

2.4 Total Cash Input Costs

The total cash investment made by groundnut producers consisted of expenditures for the following inputs: seed, fertilizer, equipment, hired labor and interest.

2.4.1 Groundnut producers in extensive land development areas expended significantly less per rai than those farmers in intensive areas. This is directly tributed to the smaller amount invested in hired labor by producers in extensive areas. Interest on production loand and depreciation on equipment were insignificant factors in total cash input costs.

2.4.2 When comparing total cash input costs among headenders, mid-ditch cultivators, and tailenders, the tailenders expended 20% less than headenders and 17% less than mid-ditch cultivators. The tendency for tailenders to invest less in a dry season groundnut crop may reflect a hesitancy on their part to risk investment capital. There may remain some doubt, real or anticipated, that being tailenders, they may experience an inconsistent supply of irrigation water.

2.5 Yield and Sale Price

2.5.1 The average yield of groundnuts at Lam Nam Oon for the 1982/83 dry season crop was 172.6 kilograms per rai, based upon a sampling of 165 producers, or 17% of all groundnut producers. The yields of the 51 farmers sampled for this study were lower than the average for the entire project area:

Headenders	=	159.49 kgs. per rai
Mid-ditch cultivators	=	166.07 kgs. per rai
Tailenders	=	144.57 kgs. per rai

As a group, tailenders had an average yield which was 9% less than headenders, and 13% less than mid-ditch cultivators. This lower yield may be attributed to:

i. the significantly lower amount of fertilizer applied by tailenders, when compared to producers in the other two categories;

ii. the lower expenditure for commercial ploughing services by tailenders in extensive areas, expressed as hired labor;

iii. an inconsistent supply of water for irrigating the groundnut crop.

It should be pointed out at this time that an inconsistent supply of irrigation water to the tailenders is probably the result of inefficient on farm and in-field water use management. Chak leaders and farmer irrigators who are unfamiliar with the system of on farm distribution, especially so in extensive areas, would have a tendency to mismanage irrigation water. This management constraint would have a direct affect on the yields obtained by tailenders.

2.5.2 There was no significant difference in yields obtained by producers in extensive and intensive areas.

2.5.3 The correlation between fertilizer application and groundnut yields was not significant:

Headenders	: r = .24
Mid-ditch cultivator	: r = .27
Tailenders	: r = .25

2.5.4 There was no significant difference in the sale price of groundnuts among the three categories of producers in the two areas. The average sale price was 9.23 baht per kilogram for dried, unshelled groundnuts, at the farmgate.

2.6 Net Returns

2.6.1 There was no significant difference in the net return per rai among the three categories of groundnut producers in the two areas. Although tailenders had slightly lower yields, they also had lower cash input costs, thus minimising the difference in net return per rai.

2.6.2 When comparing extensive and intensive areas, headenders and mid-ditch cultivators in extensive areas obtained significantly higher net returns per rai than their counterparts in intensive areas. This is accounted for by the fact that input costs were lower in extensive areas, although yield differences were insignificant.

Tailenders in extensive areas, however, obtained a net return per rai approximately 20% lower than their counterparts in intensive areas. This was due directly to significantly lower yields obtained by tailenders in extensive areas, and the slightly lower sale price obtained by them.

2.6.3 The lowest net return was obtained by headenders in intensive areas. This may be due to the fact that yields obtained by these producers were slightly lower than farmers in most other categories. In addition, total cash input costs of these producers were significantly higher than all but one other category of farmers sampled.

2.6.4 The figure for net return per manday of family labor is a measure of opportunity cost. As the local rate for daily labor is 25 baht per manday, the farmer must obtain a figure for net return per manday of family labor greater than 25 baht in order to make the cultivation of groundnuts an economically viable activity.

Data analysis here reveals that headenders obtained the highest net return per manday of family labor - 58.47 baht. This figure is 46% greater than that obtained by mid-ditch cultivators, and 42% greater than that for tailenders. This high return to family labor input reflects the low input of family labor by headenders, with a corresponding high input of hired labor, primarily for land preparation. As both mid-ditch cultivators and tailenders were heavily dependent on family labor in all labor activities, the return to family labor was lower.

The lowest return per manday of family labor was obtained by mid-ditch cultivators in intensive areas. This group of producers employed the highest number of family laborers among the three categories of producers, resulting in a low 25 baht net return per manday of family labor.

2.6.5 When comparing extensive and intensive land consolidation areas, headenders and mid-ditch cultivators in extensive areas obtained slightly higher returns per manday of family labor. Tailenders in the extensive areas obtained a slightly lower return than their counterparts in the intensive areas. This corresponds with the net return per rai obtained by farmers in each category.

3. SUMMARY AND CONCLUSIONS

For most of the thirty groundnut producers sampled in extensive areas, the 1982/83 dry season was the first in which a managed supply of irrigation water was available.

A significant number of mid-ditch cultivators and tailenders were cultivating groundnuts on their own land for the first time, as water was made easily available through the on farm delivery system. Previous to land consolidation (development), headenders, or farmer-irrigators nearest to the farm turnout (CHO), were the principal cultivators of dry season crops.

Thus, one can draw only preliminary conclusions from an analysis of data from one year's production experience.

3.1 The land area cultivated by each producer was not significantly affected by the farmers location along an irrigation delivery ditch. However, headenders tended to plant a slightly larger area than did mid-ditch cultivators and tailenders.

3.1.1 Farmers in intensive areas tended to cultivate a larger area of groundnuts than those in extensive areas. This may be due to several factors:

a) the fact that farmers in intensive areas have had more experience in cultivating groundnuts in that their on farm delivery system has been in place for several years;

b) the management of water in intensive areas may be more efficient due to the longer experience of chak leaders and farmer irrigators in using irrigation water for dry season management;

c) in that the topsoil in intensive areas was disturbed during land leveling, farmers may feel it necessary to cultivate larger areas in order to restore fertility to the soil, and/or to compensate for lower expected yields.

3.2 In analysing the use of agricultural inputs, tailenders tended to use less chemical fertilizer than headenders or mid-ditch cultivators. This may be due to several factors:

(a) hesitency to risk capital investment in fertilizer as they are uncertain of a consistent supply of water to irrigate the crop;

(b) lack of technical agricultural knowledge related to proper fertilizer application to groundnuts; and

(c) insufficient funds to purchase fertilizer.

3.2.1 Headenders and mid-ditch cultivators in intensive areas used significantly more fertilizer per rai than their counterparts in extensive areas.

This may be attributed to:

(a) an understanding of the benefits derived from proper fertilizer application; and,

(b) the need to compensate for the poor quality of soils in the intensive areas as a result of land leveling.

3.3 Headenders tended to have a lower input of labor overall due to a significantly lower rate of family labor use. At the same time, headenders had a significantly higher rate of hired labor use,, consisting primarily of the hiring of commercial tractor ploughing services. Headenders may have to engaged these services more frequently due to:

(a) the familiarity of the tractor drivers with the location and owners of headender plots;

(b) easier accessibility to headender plots due to their location near to irrigation canal maintenance roads;

(c) a lack of available family labor by headenders; and,

(d) a better understanding of the benefits of mechanised ploughing by headenders.

3.3.1 Mid-ditch cultivators tended to invest more labor in land preparation and planting than headenders and tailenders. An analysis of correlation coefficients for the impact of land preparation on yields indicated that mid-ditch cultivators would obtain higher yields from an increase of labor use for land preparation and planting.

Mid-ditch cultivators would also obtain higher yields from an overall increase in family labor use.

3.3.2 An examination of the figures on labor use indicated that producers in extensive areas were generally more efficient in using labor to produce groundnuts. The total cost of labor use per rai was significantly less for extensive producers than those in intensive areas. However, in two of the three categories of farmers, yields in extensive areas were somewhat lower than in intensive areas. The lower yields may, on the other hand, be due to a lower rate of fertilizer application by these extensive producers.

3.4 Tailenders generally had a lower level of total production expenditures than headenders and mid-ditch cultivators. This may be attributed to a hesitency on the part of tailenders to invest in dry season crop production as a result

of previous experiences with an inconsistent supply of water for irrigation.

3.4.1 Producers in intensive areas had significantly higher total input costs than their counterparts in extensive areas. Several reasons may account for this:

a) a willingness to make investments in dry season crops based upon previous high and/or positive experiences;

b) the need to compensate for poor soils due to land leveling by investing in agricultural inputs and hired labor to maintain profitable yield levels;

c) a good understanding of agriculture techniques associated with dry season irrigated groundnut production.

3.5 Tailenders experienced slightly lower yields in both extensive and intensive areas. This may be due to:

a) lower total cash investment by tailenders;

b) lower rates of fertilizer application;

c) either flooding or an inconsistent supply of water for irrigation at the tail end of the delivery ditch.

3.6 There were no significant differences in yield per rai between intensive and extensive land consolidation areas.

3.7 Producers in intensive areas tended to have a lower net return per rai. This may be due to the higher input costs of these producers, as there was an insignificant difference in yields in the two areas.

Tailenders in extensive areas did, however, experience a lower net return per rai when compared to tailenders in intensive areas.

3.8 In conclusion, evidence seems to indicate that tailenders may be unwilling to risk investing agricultural inputs and labor in producing a dry season groundnut crop. Headenders, on the other hand, are either more willing to invest, or are in a better physical position to benefit from irrigation system infrastructure (roads, canals, ditches).

4. RECOMMENDATIONS

4.1 It is recommended that either a Royal Irrigation Department economist or the Office of Agricultural Economics conduct a similar irrigation operations research program during the 1983/84 dry season at Lam Nam Oon. The purpose of such a program would be to follow up on the research analysis contained in this report. The objective of the program should be to determine if the conclusions drawn from this analysis are verified in a second year of observations of groundnut production by farmer-irrigators.

4.2 If the Louis Berger International Inc. advisory team assignment is further extended at Lam Nam Oon beyond September 30,1983 that team should also be tasked to continue work in support of 4.1 above.

4.3 The tambon agricultural extension agents should be made aware of the agronomic problems experienced by tailenders in producing groundnuts. Special attention should be given to these producers by agriculture field personnel regarding proper use of agricultural inputs and in-field water use management.

4.4 The Department of Agriculture's Field Crop Experiment Station at Sakon Nakhon should make a special effort to locate dry season groundnut seed multiplication plots with tailenders in land consolidation areas. This would insure that proper agronomic techniques were being introduced to farmers located in less readily accessable areas of the irrigation project.

4.5 Special Assignment Team personnel at Lam Nam Oon should conduct a survey of tailenders in extensive land consolidation areas to identify problems related to water delivery. Once these problems have been identified, special management techniques may need to be developed by the Operations and Maintenance Division of the Royal Irrigation Department to deal with the water delivery problems experienced by tailenders. Problem specific training for water user group leaders and tailenders should complement any special effort.

AUTHOR

Anthony M. Zola is a development economist and marketing specialist. He is a graduate of the University of Syracuse and George Washington University in the United States of America.

Mr. Zola has been employed as a development specialist in Laos, Upper Volta and Thailand. In the past, he has been employed to work abroad under contracts associated withthe World Bank, the Agency for International Development, Catholic Relief Services, and the Peace Corps.

Mr. Zola has been assigned on contract with Louis Berger International, Inc. at Lam Nam Oon since September, 1981. From that time until now he has published a number of studies and reports including:

Project Note #5 'Pilot Area 2 - Operations Research Results - 1981/82 - Lam Nam Oon' September co-authored with William C. Bell

Agro-Industrial Investment Opportunity Report 'Groundnuts' - Lam Nam Oon September, 1982

Several additional reports and studies by Mr. Zola on Lam Nam Oon are about to be published.

Lam Nam Oon Irrigation Project

Irrigation Operations Research

1982/83 Dry Season

TABLE 1

Summary of Samples

Location/ Unit No.	Pilot Area	Type of Land Development	No. of Samples	Water User Group No.	Length of Water Delivery Ditch (meters
20	2	Extensive	9	2 3 4	582 1,385 1,271
17		Extensive	12	8 11 12	1,200 1,152 1,190
15		Extensive	9	7 10 11	510 2,340 1,130
			Total: 30		Average: 1,195.56
12	3	Intensive	8	1 8 4	1,220 1,185 1,225
13	3-A	Intensive	8	2 8 10	1,020 1,230 1,030
6	1	Intensive	5	2 2 1	324 878 274
			Total: 21		Average: 931

TABLE 2

Headenders

All figures are averages

Summary Evaluation of
1982/1983 Dry Season
Groundnut Cultivation
Lam Nam Oon Irrigation Project
Sakon Nakhon

Sample Size	Crop Variety	Average Area Planted (rai)	Inputs: Item	Inputs: Baht per rai	Inputs: Total Baht	Labor use (mandays): Activity	Per rai: F.L.	Per rai: H.L.	Per rai: Cost (Baht)	Total: F.L.	Total: H.L.	Total: Cost (Baht)	Interest (Baht): Per rai	Interest (Baht): Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ext. Heads. 5	Groundnuts, Tainan 9	3.75	Seed	210	756	Land Preparation and Planting	8.17	3.45	291	29.2	38.8	1,118	9.34	60.90
			Fertilizer	125	471									
			Pesticides	-	-	Maintenance	6.94	.2	178	14.2	7	390		
			Equipment	51	116	Harvesting	6.14	.8	174	20.6	13.5	650		
			Total	386	1,343		21.26	4.47	643	64	22.32	2,158		
Int. Heads. 7	Groundnuts, Tainan 9	4.18	Seed	252	1,090	Land Preparation and Planting	9.85	8.90	469	39.64	61.87	2,317	21.17	140.27
			Fertilizer	205	943		2.11	-	53	7.04	-	176		
			Pesticides	-	-	Maintenance								
			Equipment	36	98	Harvesting	6.13	2.14	207	19.29	21,43	1,018		
			Total	493	2,131		18.09	11.04	728	65.95	74.46	3,511		

TABLE 2 (Continued)

Total Cash Input (Baht)		Out put					Net Return Excluding Family Labor (Baht)		Net Return per manday of Family Labor (Baht)		Remarks
		Yield (kg.)		Sale Price (Baht/kg.)	Gross Return						
Per rai	Total	Per rai	Total		Per rai	Total	Per rai	Total	A	B	
16	17	18	19	20	21	22	23	24	25	26	
507 Range = 325 to 737	1,938	169.13 Range = 140.36 to 190	636.6	9.44	1,586 Range = 1,740 to 10,855	5,943	1,078 Range = 814 to 1,328	4,006	61.52	68.69	A = Family labor use taken from column 8.
790 Range = 558 to 1,545	4,093	152.6 Range = 110 to 219	705.14	9.32	1,436 Range = 1,008 to 2,300	6,875	646 Range = 391 to 1,117	2,783	56.29	41.14	B = Standard labor use of 15.7 mandays per rai (IBRD, Pioneer Project for Tank Irrigation in Northeast Thailand, Vol.1, Sept., 1973, pp. 55-59).

Summary Evaluation of
1982/1983 Dry Season
Groundnut Cultivation
Lam Nam Oon Irrigation Project
Sakon Nakhon

TABLE 3

Mid-ditch Cultivators

All figures are averages

Sample Size	Crop Variety	Average Area Planted (rai)	Inputs: Item	Inputs: Baht per rai	Inputs: Total Baht	Labor use (mandays): Activity	Per rai: F.L.	Per rai: H.L.	Per rai: Cost (Baht)	Total: F.L.	Total: H.L.	Total: Cost (Baht)	Interest (Baht): Per rai	Interest (Baht): Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ext. Mids. 10	Groundnuts, Tainan 9	3.03	Seed	264	801	Land Preparation and Planting	17.84	1.77	490	46.85	27.81	1,380	21.07	87.55
			Fertilizer	132	464	Maintenance	4.08	-	102	12.10	-	303		
			Pesticides	-	-	Harvesting	6.08	.08	154	18	.15	454		
			Equipment	65	139									
			Total	461	1,404		28	1.84	746	76.95	8.49	2,136		
Ext. Mids. 8	Groundnuts, Tainan 9	2.66	Seed	334	797	Land Preparation and Planting	18.01	7.82	646	42.63	22.89	1,566	29.36	86.50
			Fertilizer	201	468	Maintenance	4.57	-	114	11.14	-	279		
			Pesticides	-	-	Harvesting	10.34	-	259	22.88	-	572		
			Equipment	40	86									
			Total	575	1,351		32.92	7.82	1,019	76.64	20.02	2,417		

TABLE 3 (Continued)

Total Cash Input (Baht)		Output					Net Return Excluding Family Labor (Baht)		Net Return per manday of Family Labor (Baht)		Remarks
		Yield (kg.)		Sale Price (Baht/kg.)	Gross Return						
Per rai	Total	Per rai	Total		Per rai	Total	Per rai	Total	A	B	
16	17	18	19	20	21	22	23	24	25	26	
528 Range = 373 to 706	1,640	160.96 Range = 120 to 184	508.5	9.08	1,461 Range = 1,099 to 1,685	4,617	933 Range = 424 to 1,271	2,977	36.73	59.41	A = Family labor use taken from column 8.
800 Range = 452 to 1,285	1,927	172.47 Range = 111 to 265	422.5	9.13	1,573 Range = 1,018 to 2,427	3,857	774 Range = 149 to 1,853	1,930	25.04	49.28	B = Standard labor use of 15.7 mandays per rai (IBRD, Pioneer Project for Tank Irrigation in Northeast Thailand, Vol.1, Sept., 1973, pp. 55 - 59).

TABLE 4

Tailenders

All figures are averages

Summary Evaluation of
1982/1983 Dry Season
Groundnut Cultivation
Lam Nam Oon Irrigation Project
Sakon Nakhon

Sample Size	Crop Variety	Average Area Planted (rai)	Inputs: Item	Inputs: Baht per rai	Inputs: Total Baht	Labor use (mandays): Activity	Per rai: F.L.	Per rai: H.L.	Per rai: Cost (Baht)	Total: F.L.	Total: H.L.	Total: Cost (Baht)	Interest (Baht): Per rai	Interest (Baht): Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ext. Tails. 15	Groundnuts, Tainan 9	3.13	Seed	251	772	Land Preparation and Planting	16.39	3.2	490	51.93	32.4	1,676	13.53	74.64
			Fertilizer	107	420									
			Pesticides	-	-	Maintenance	4.41	-	110	14.93	-	372		
			Equipment	57	131	Harvesting	6.81	-	170	20.8	-	520		
			Total	415	1,323		27.61	3.2	770	87.63	15.12	2,569		
Int. Tails 6	Groundnuts, Tainan 9	4.13	Seed	251	987	Land Preparation and Planting	16.92	5.95	572	68	35.48	2,439	22.60	112.81
			Fertilizer	103	569									
			Pesticides	-	-	Maintenance	3.3	-	83	10.36	-	259		
			Equipment	50	104	Harvesting	7.88	1.53	235	26.67	5	917		
			Total	404	1,660		28.11	7.48	890	105.02	39.57	3,615		

TABLE 4 (Continued)

Total Cash Input (Baht)		Output					Net Return Excluding Family Labor (Baht)		Net Return per manday of Family Labor (Baht)		Remarks
		Yield (kg.)		Sale Price (Baht/kg.)	Gross Return						
Per rai	Total	Per rai	Total		Per rai	Total	Per rai	Total	A	B	
16	17	18	19	20	21	22	23	24	25	26	
508 Range = 310 to 732	1,657	136.27 Range = 88.[illegible] to 188.75	433.33	9.18	1,254 Range = 813 to 1,827	3,971	747 Range = 300 to 1,228	2,314	32.20	47.55	A = Family labor use taken from column 8
614 Range = 417 to 725	2,553	165.31 Range = 113.33 to 296	602.33	9.38	1,531 Range = 1,099 to 2,694	5,700	917 Range = 468 to 1,924	3,147	38.97	58.42	B = Standard labor use of 15.7 mandays per rai (IBRD, Pioneer Project for Tank Irrigation in Northeast Thailand, Vol.1 Sept., 1973 pp. 55-59).

Map No. 1

Area of the Lam Nam Oon Irrigation Project

Sakon Nakhon

Locations of land consolidation areas:

Intensive areas

Unit 6, Pilot Area 1

Unit 12, Pilot Area 3

Unit 13, Pilot Area 3-A

Extensive areas

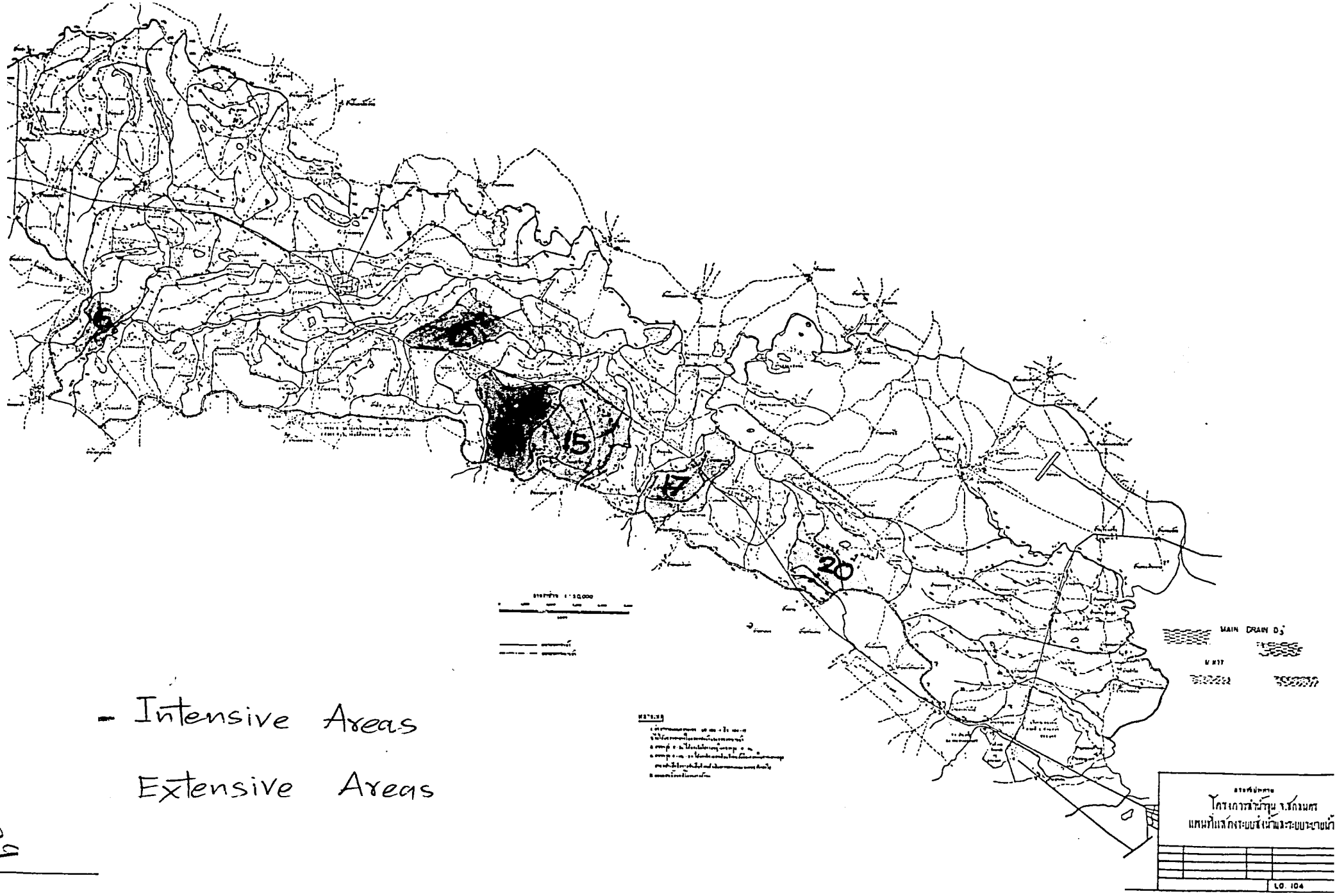
Unit 15

Unit 17

Unit 20, Pilot Area 2

Locations of Sample Farmers

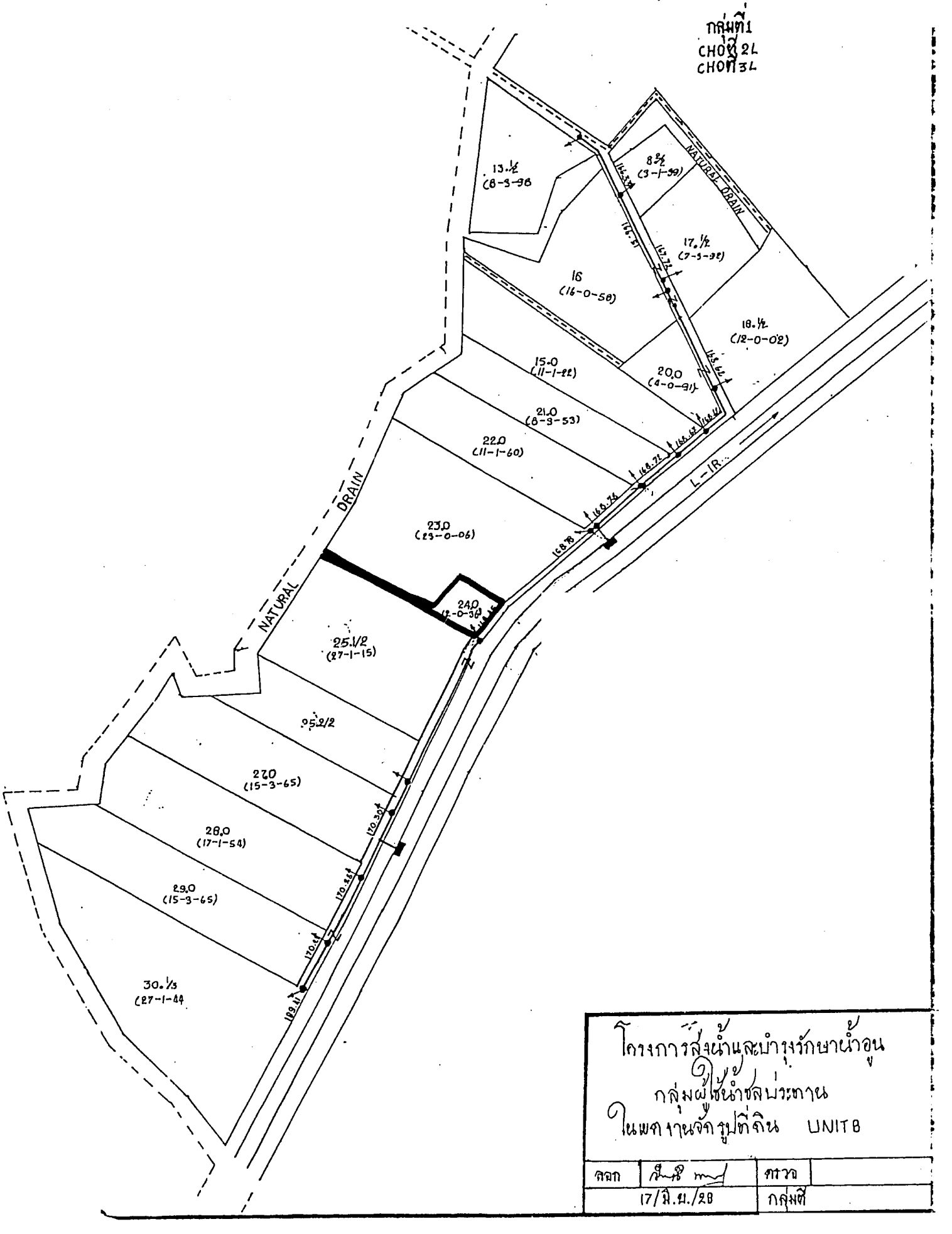
Unit	Water User Group Nos.	Headenders	Midditch	Tailenders
6	1	-	24	-
6	2	7, 9.1	5, 6	-
12	1	-	-	69,73,+80+84
12	4	31	27, 58	65
12	8	114 A	122	-
13	2	126	-	107
13	8	165	8	1/2
13	10	54	39/1	86/1
15	4	-	87, 93	116, 132
15	7	123	-	90
15	11	114	92	27
17	6	18	8	10
17	8	-	202	165,200,202.1
17	11	50	37,39,48,49,82	33
20	2	-	-	87, 90, 93
20	3	163,172	167, 170	208, 213



- Intensive Areas

Extensive Areas

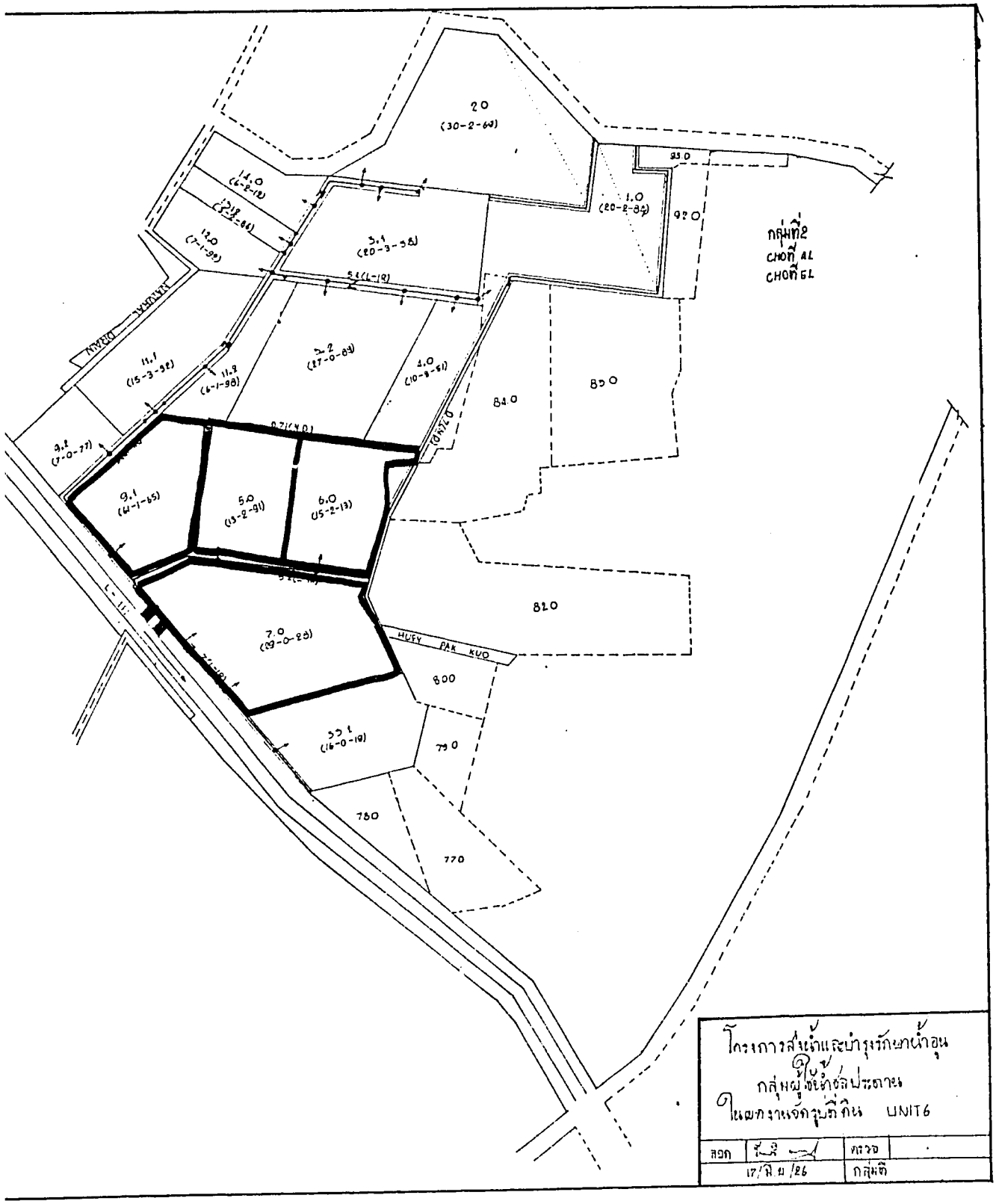
Map No. 2



โครงการส่งน้ำและบำรุงรักษาน้ำอูน
กลุ่มผู้ใช้น้ำชลประทาน
ในพื้นที่จังหวัดที่ดิน UNIT B

สอบ		ตรวจ	
17/มิ.ย./28		กลุ่มที่	

Map No. 3



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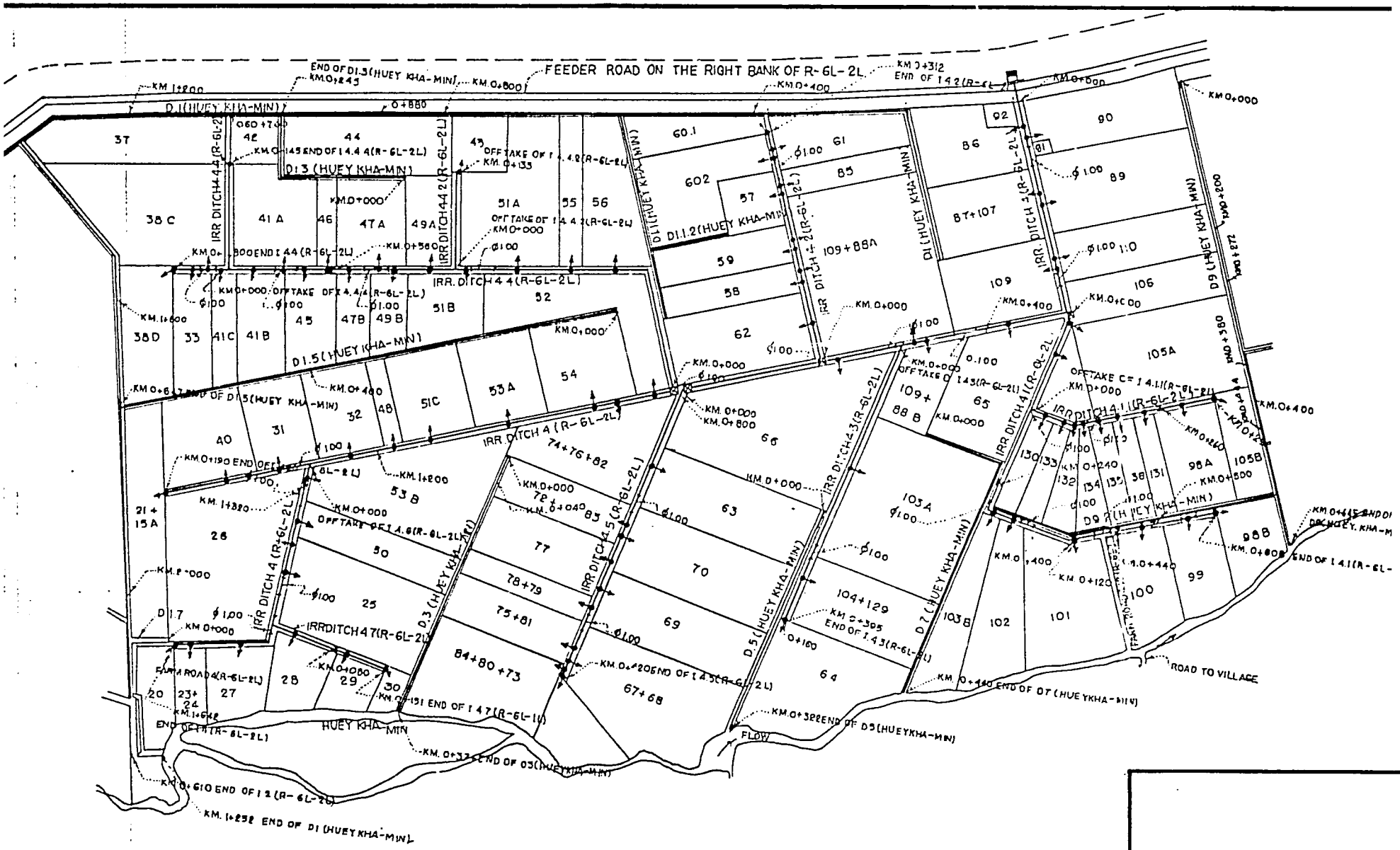
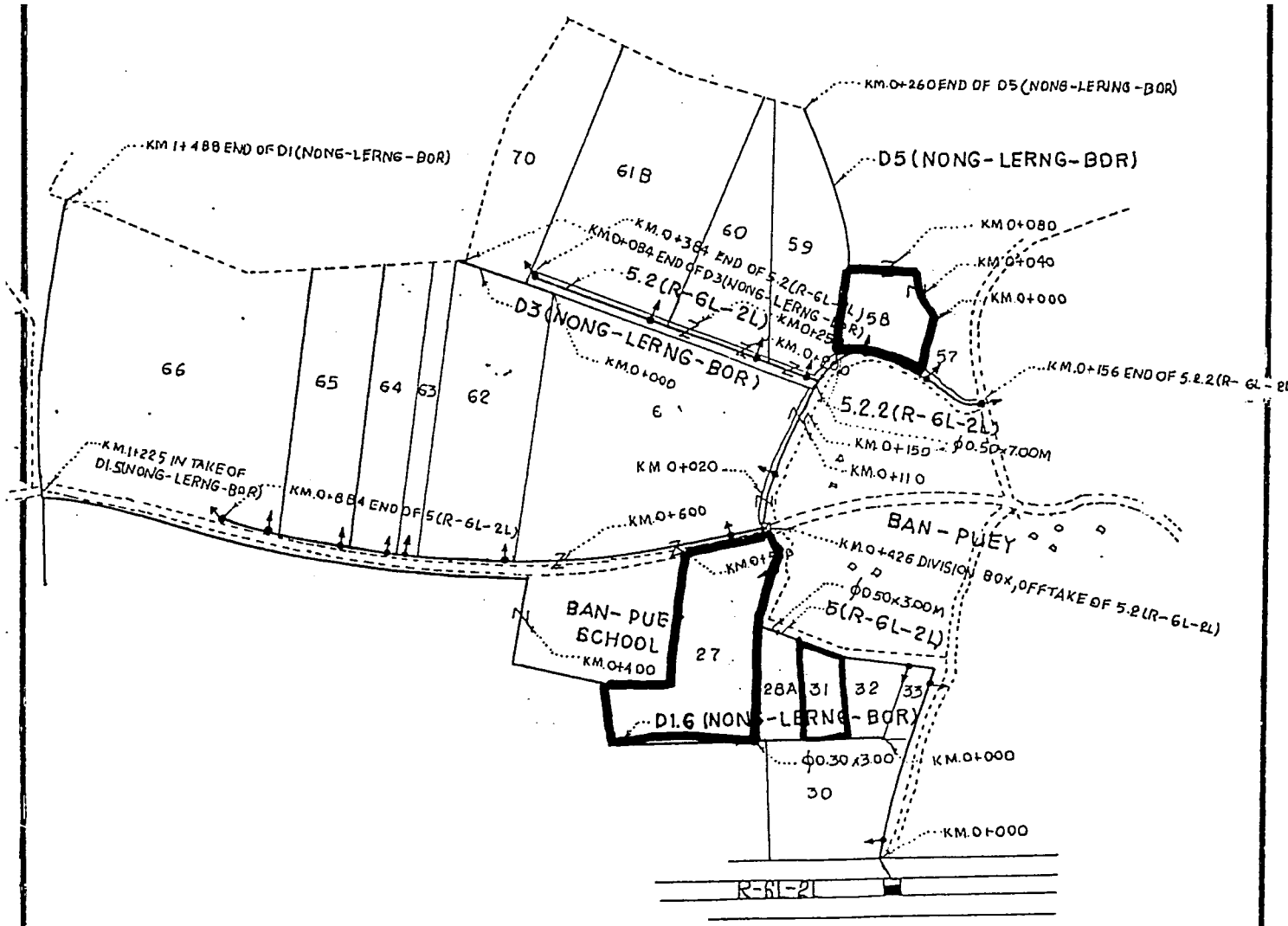
14.0
(6-2-12)
12.0
(7-1-99)
3.1
(20-3-58)
1.0
(20-2-84)
92.0
93.0
กลุ่มที่2
CHOที่ 4L
CHOที่ 6L
11.1
(15-3-32)
11.2
(6-1-98)
3.2
(27-0-89)
4.0
(10-3-51)
84.0
85.0
9.2
(7-0-77)
9.1
(61-1-65)
5.0
(13-2-91)
6.0
(15-2-13)
7.0
(29-0-28)
82.0
HUEY PAK KUO
80.0
79.0
78.0
77.0
โครงการส่งน้ำและบำรุงรักษาน้ำอุน
กลุ่มผู้ใช้น้ำชลประทาน
ในเขตงานจัดรูปที่ดิน UNIT6
สอด
ตรวจ
17/มิ.ย./26
กลุ่มที่


FEEDER ROAD ON THE RIGHT BANK OF R-6L-2L
D1 (HUEY KHA-MIN)
D1.3 (HUEY KHA-MIN)
D1.5 (HUEY KHA-MIN)
D1.1.2 (HUEY KHA-MIN)
D1 (HUEY KHA-MIN)
D9 (HUEY KHA-MIN)
D3 (HUEY KHA-MIN)
D5 (HUEY KHA-MIN)
D7 (HUEY KHA-MIN)
IRR. DITCH 4 (R-6L-2L)
IRR. DITCH 4.4 (R-6L-2L)
IRR. DITCH 4.2 (R-6L-2L)
IRR. DITCH 4.1 (R-6L-2L)
IRR. DITCH 4.3 (R-6L-2L)
IRR. DITCH 4.5 (R-6L-2L)
IRR. DITCH 4.7 (R-6L-2L)
HUEY KHA-MIN
ROAD TO VILLAGE
FLOW
UNIT 12
15.ก.ค.26

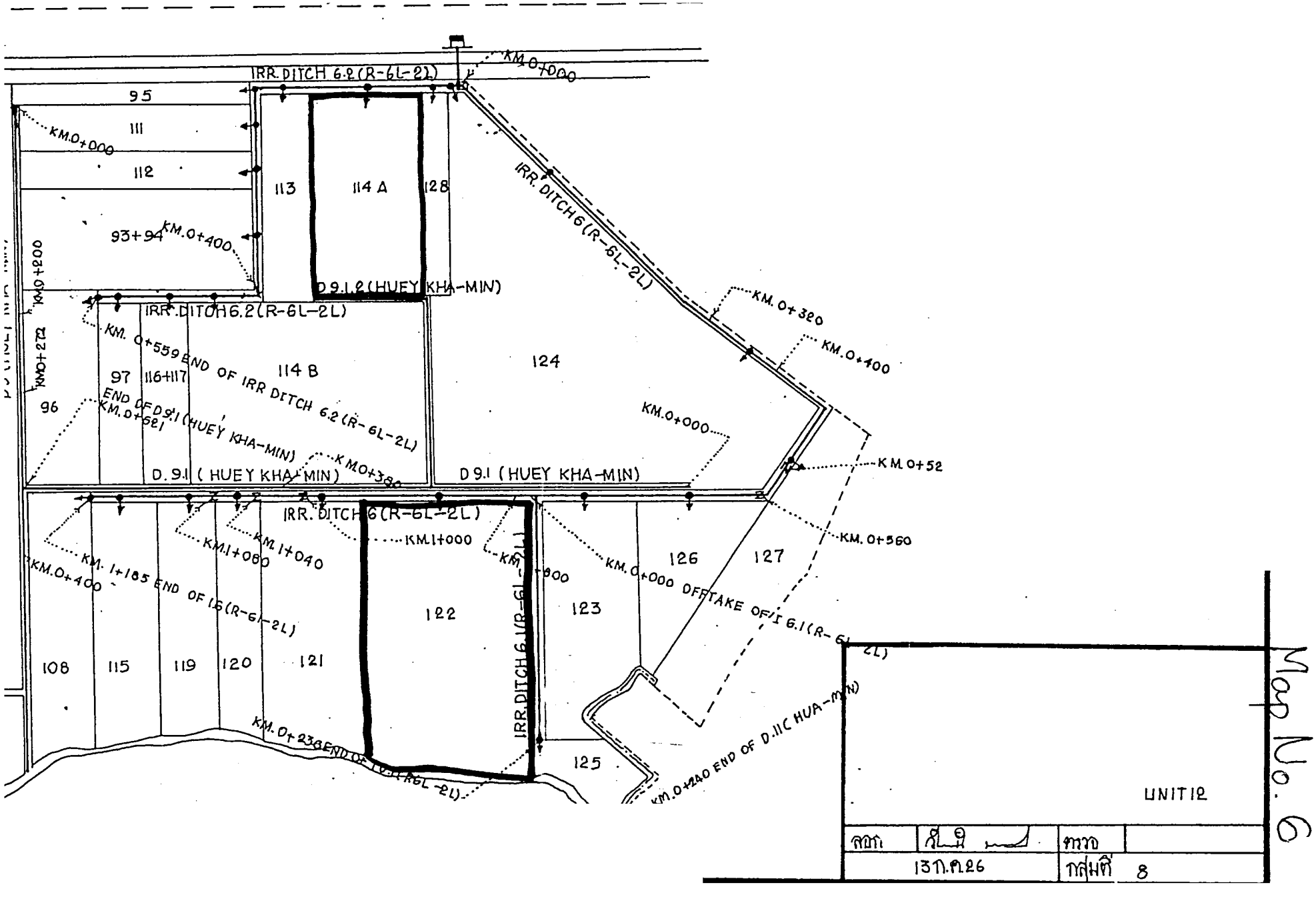
Map No. 4



โครงการส่งน้ำและบำรุงรักษาน้ำอูน
กลุ่มผู้ใช้น้ำชลประทาน
ในเขตจังหวัดสกลนคร UNIT12

ออก		ตรวจ	
22/ก.ค./26		กลุ่มที่ 4	

Map No. 5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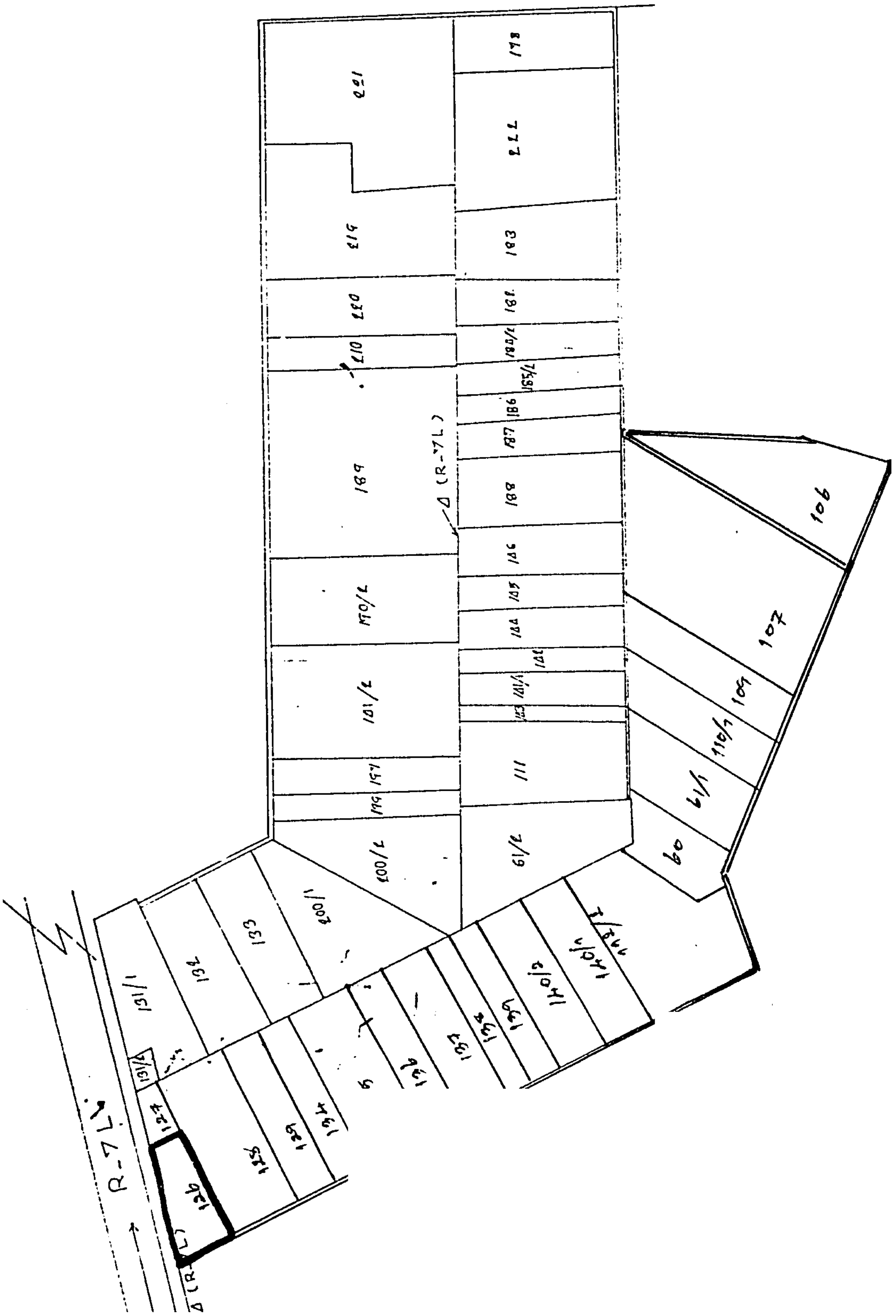
KM.0+000
95
111
KM.0+000
112
113
114 A
128
IRR. DITCH 6 (R-6L-2L)
93+94
KM.0+400
KM.0+200
D 9.1.2 (HUEY KHA-MIN)
IRR. DITCH 6.2 (R-6L-2L)
KM. 0+320
KM. 0+400
KM. 0+559 END OF IRR DITCH 6.2 (R-6L-2L)
114 B
124
97
116+117
96
END OF D 9.1 (HUEY KHA-MIN)
KM. 0+621
KM.0+000
KM.0+380
D. 9.1 (HUEY KHA-MIN)
D 9.1 (HUEY KHA-MIN)
KM. 0+52
IRR. DITCH 6 (R-6L-2L)
KM. 0+560
KM.1+000
KM.1+080
KM.1+040
KM.0+400
KM. 1+185 END OF 1.6 (R-6L-2L)
KM. 0+000 OFFTAKE OF I 6.1 (R-6L-2L)
126
127
122
123
108
115
119
120
121
IRR. DITCH 6.1 (R-6L-2L)
125
KM. 0+238 END OF I 6.1 (R-6L-2L)
KM. 0+240 END OF D.11 (HUA-MIN)
UNIT 12
ลงก.
ตรวจ
13 ก.ค. 26
กลุ่มที่ 8
Map No. 6

Map No. 7


R-7L
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127
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60
61/1
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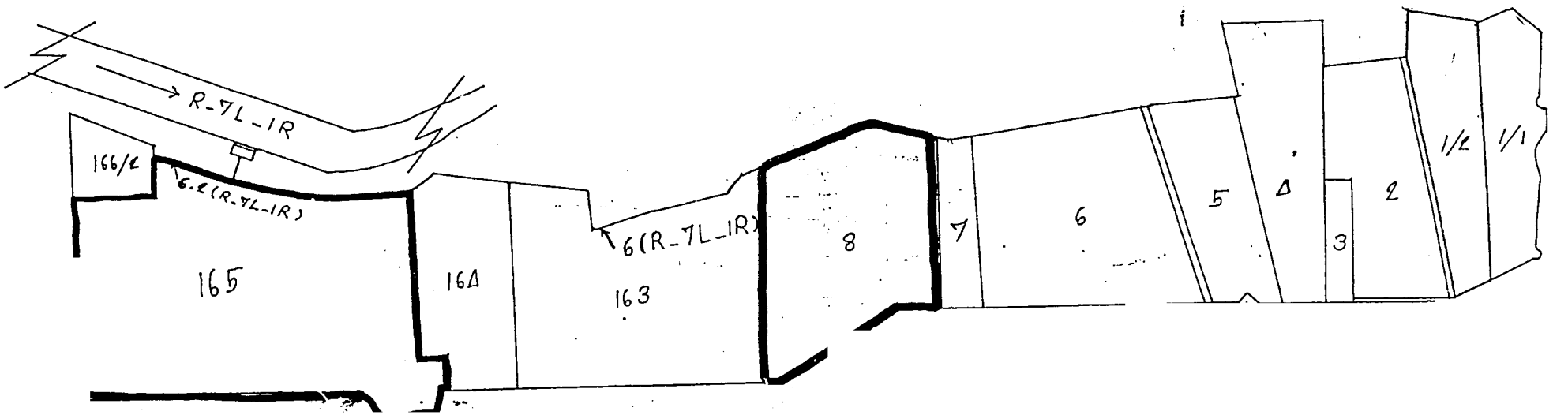
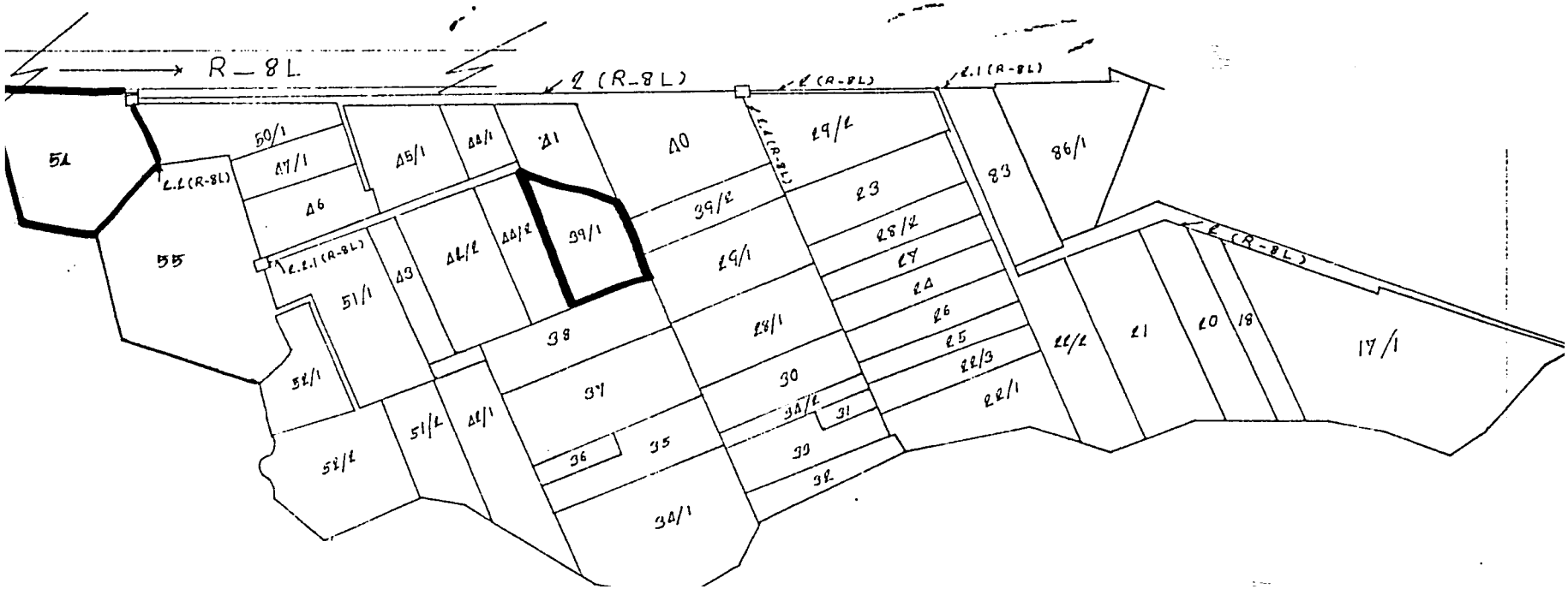
188
189
178

กล่มที่ 8



Map No.8

กลุ่มที่ 10


R – 8L
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2 (R-8L)
2.1 (R-8L)
2.2 (R-8L)
2.2.1 (R-8L)
2.2.1 (R-8L)
2 (R-8L)
51
55
50/1
47/1
46
45/1
44/1
41
40
39/1
39/2
29/1
29/2
23
28/2
27
24
26
25
22/3
22/1
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86/1
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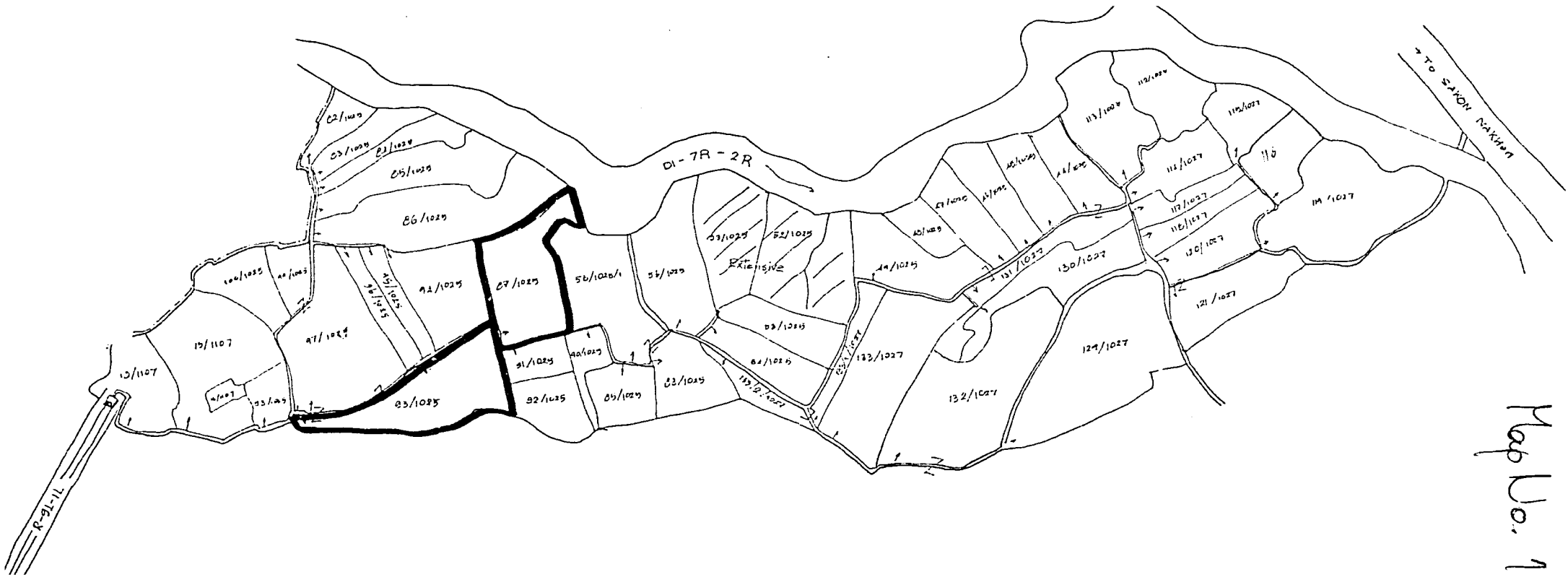
22/2
21
20
18
17/1



Map No. 10

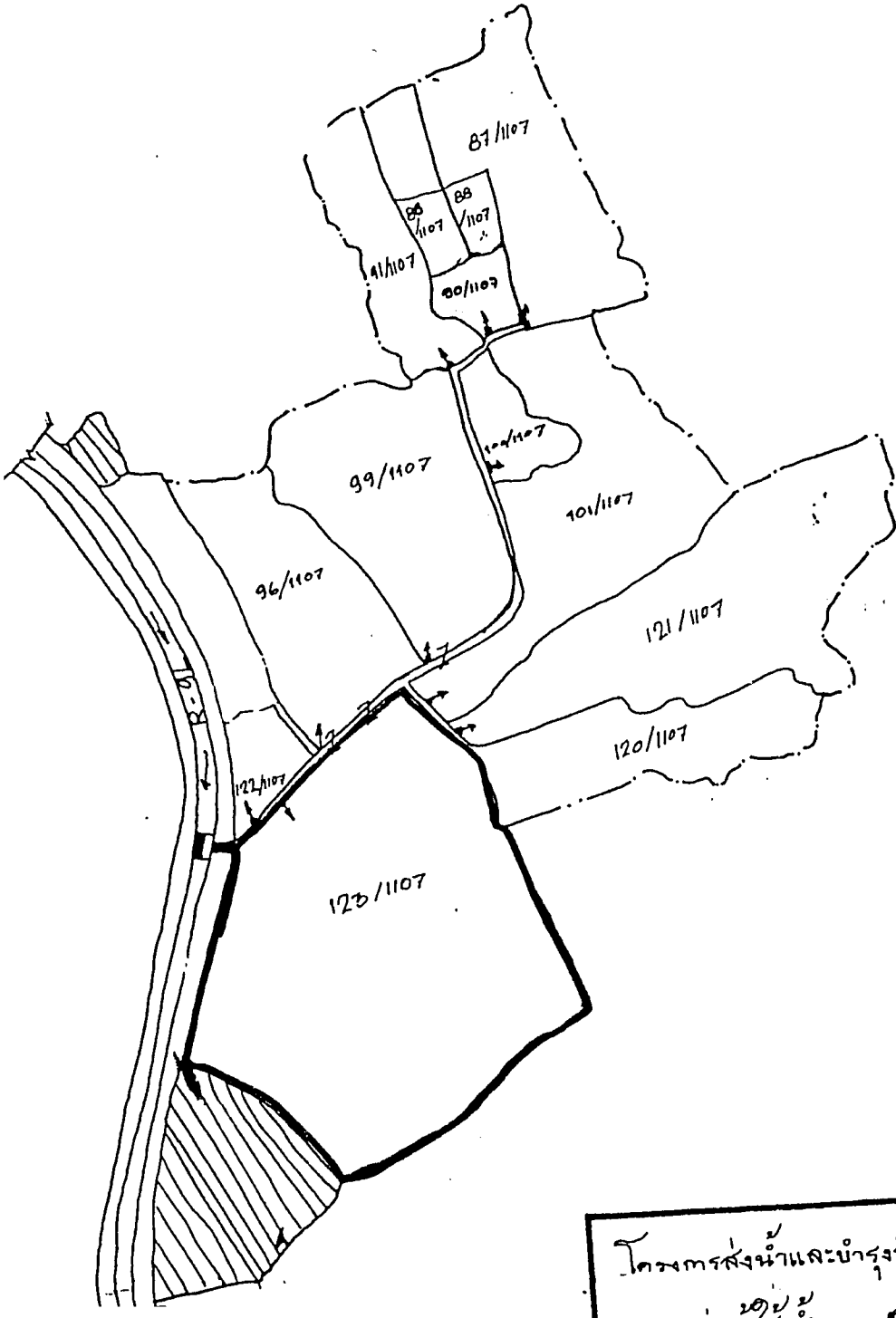
โครงการส่งน้ำและบำรุงรักษาน้ำอุ่น

กลุ่มผู้ใช้น้ำเบ็ดเปรงพล

ในเขตงานจัดรูปที่ดิน บทที่ 15

กลุ่มที่ 4

Map No.11

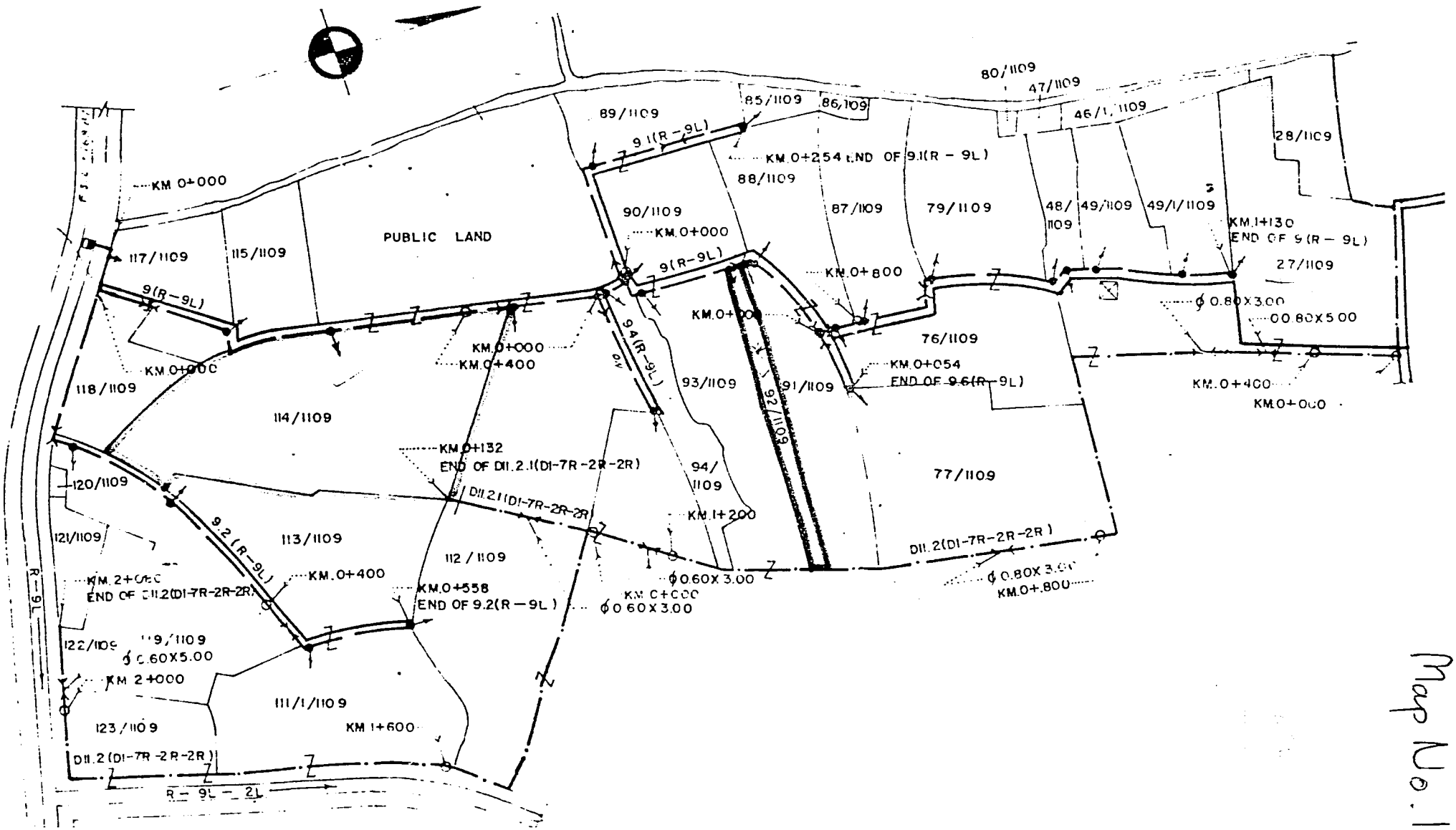


โครงการส่งน้ำและบำรุงรักษาน้ำอุน

กลุ่มผู้ใช้น้ำ สลประทาน

ในเขตงานจัดรูปที่ดิน unit 15

สอก		ตรวจ	
26/7/26		กลุ่มที่ 4	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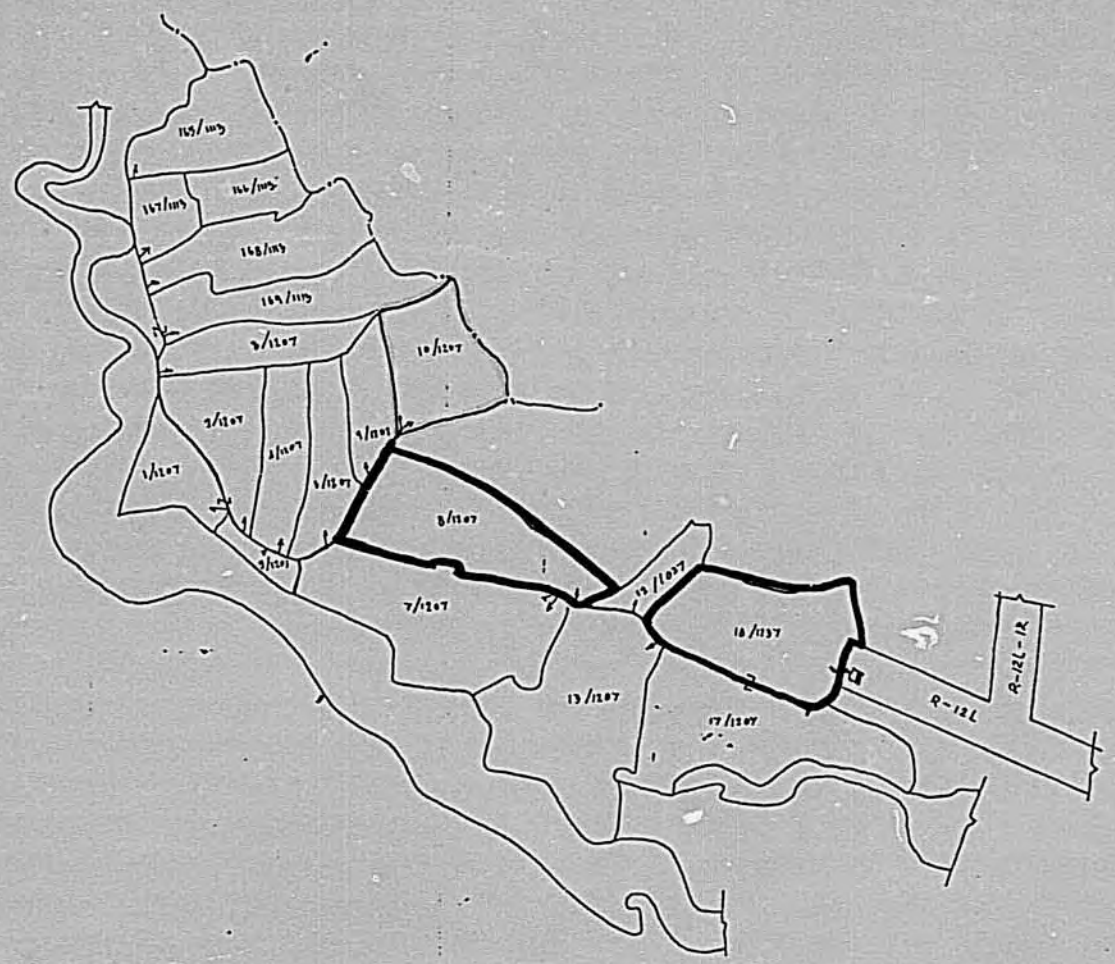
117/1109
115/1109
9(R-9L)
118/1109
114/1109
120/1109
121/1109
113/1109
9.2(R-9L)
KM.0+400
KM.0+558
END OF 9.2(R-9L)
122/1109
KM 2+000
123/1109
111/1/1109
KM 1+600
D11.2(D1-7R-2R-2R)
R-9L
R-9L-2L
KM.0+132
END OF D11.2.1(D1-7R-2R-2R)
D11.2.1(D1-7R-2R-2R)
112/1109
KM.0+000
KM.0+400
89/1109
9.1(R-9L)
85/1109
86/1109
KM.0+254 END OF 9.1(R-9L)
88/1109
90/1109
KM.0+000
9(R-9L)
94(R-9L)
93/1109
94/1109
KM.1+200
KM.0+000
ϕ0.60X3.00
KM.0+000
ϕ0.60X3.00
92/1109
91/1109
KM.0+800
KM.0+054
END OF 9.6(R-9L)
87/1109
79/1109
76/1109
77/1109
D11.2(D1-7R-2R-2R)
ϕ0.80X3.00
KM.0+800
80/1109
47/1109
46/1/1109
48/1109
49/1109
49/1/1109
28/1109
KM.1+130
END OF 9(R-9L)
27/1109
ϕ0.80X3.00
ϕ0.80X5.00
KM.0+400
KM.0+000

Map No. 12

Map No. 13



โครงการส่งน้ำและบำรุงรักษาน้ำอุ่น

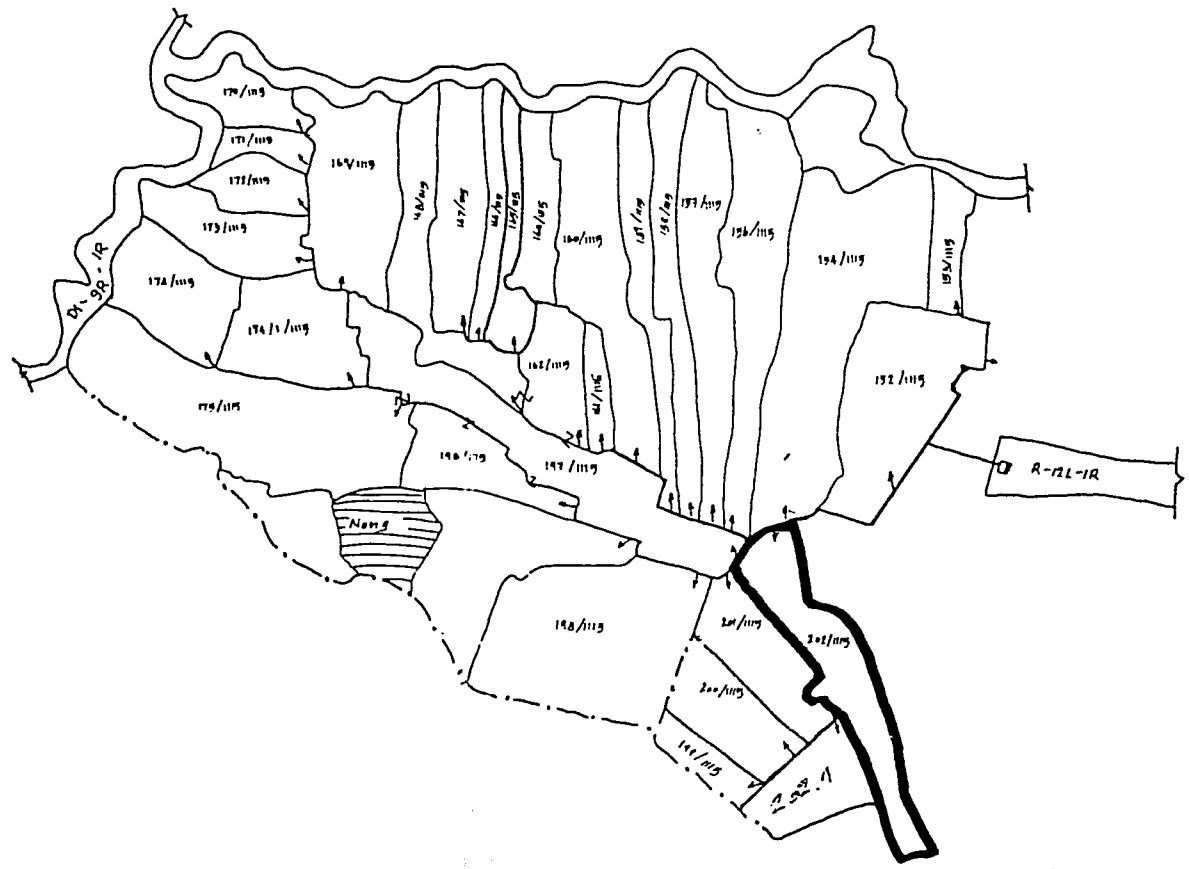
กลุ่มผู้ใช้น้ำ ชลประทาน

ในเขตชลประทานจักรูปที่ดิน | เลขที่ 17

ลอก	[illegible]	ตรง	
	26/กค/26	กลุ่มที่	6

41

Map No. 1A



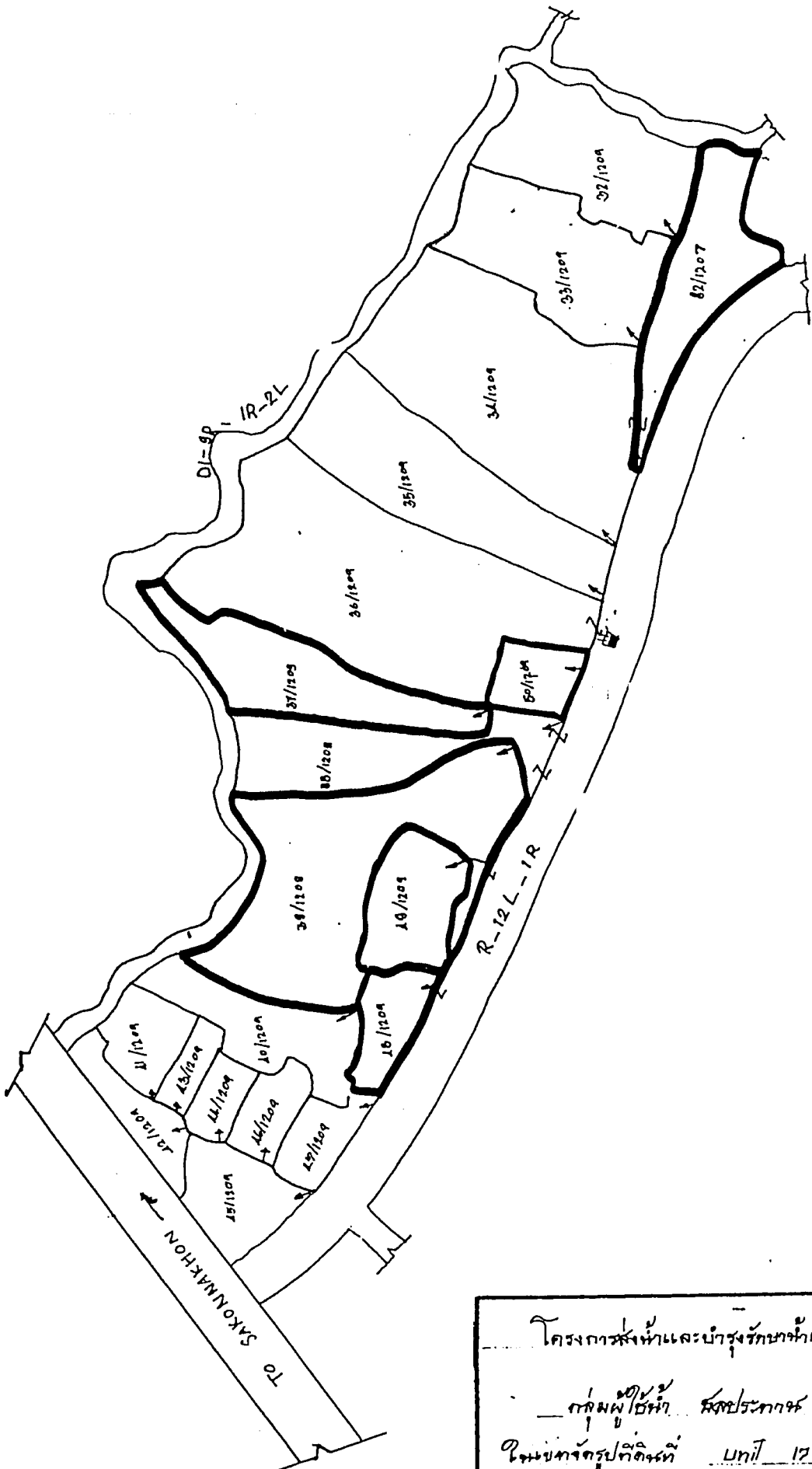
โครงการส่งน้ำและบำรุงรักษาน้ำอูน

กลุ่มผู้ใช้น้ำ ชลประทาน

ในเขตงานจัดรูปที่ดิน unit 15

ลงชื่อ		ตรวจ	
26/7/86		กล่มที่ 8	

Map No. 15

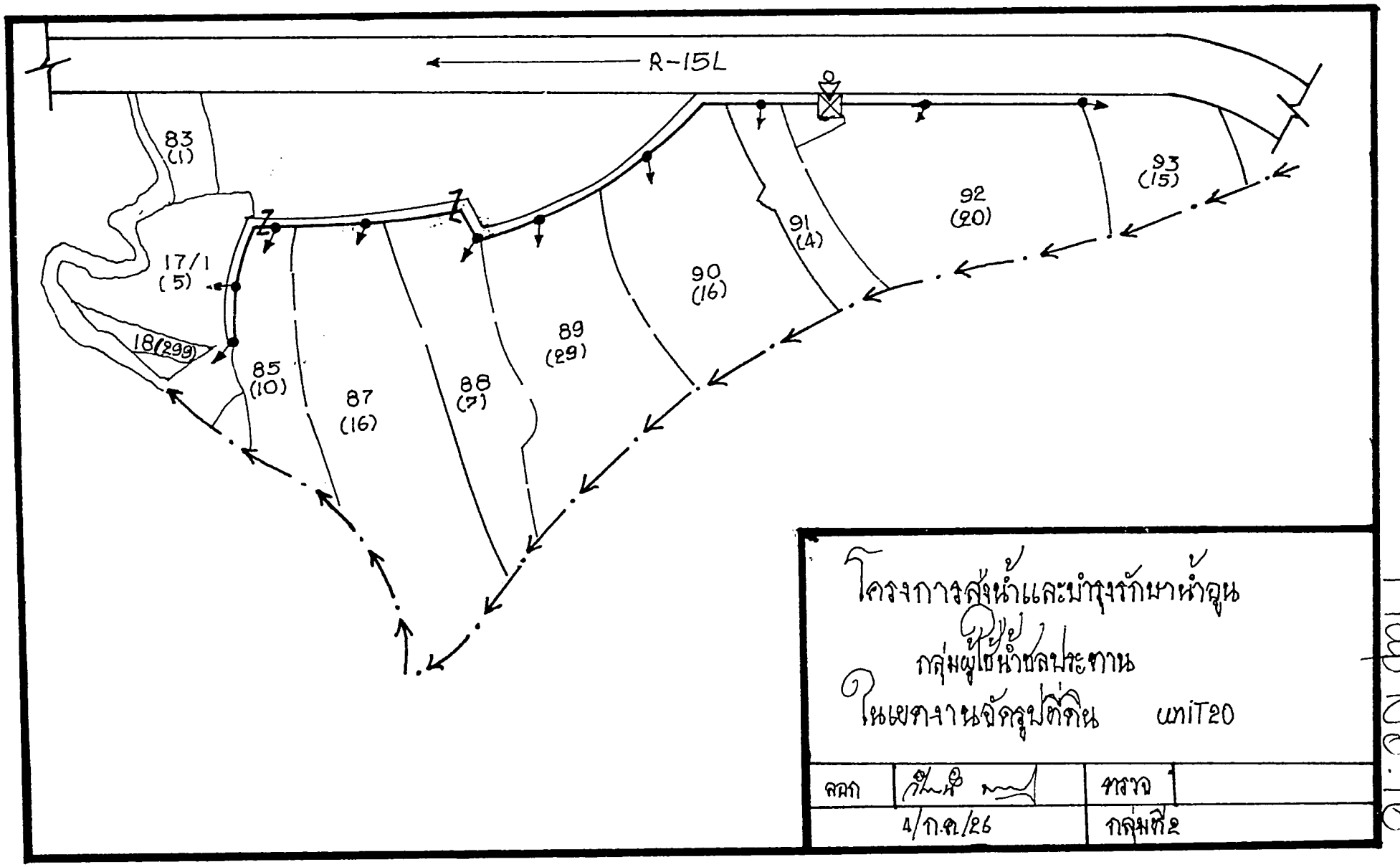


โครงการส่งน้ำและบำรุงรักษาน้ำอูน

กลุ่มผู้ใช้น้ำ สลประทาน

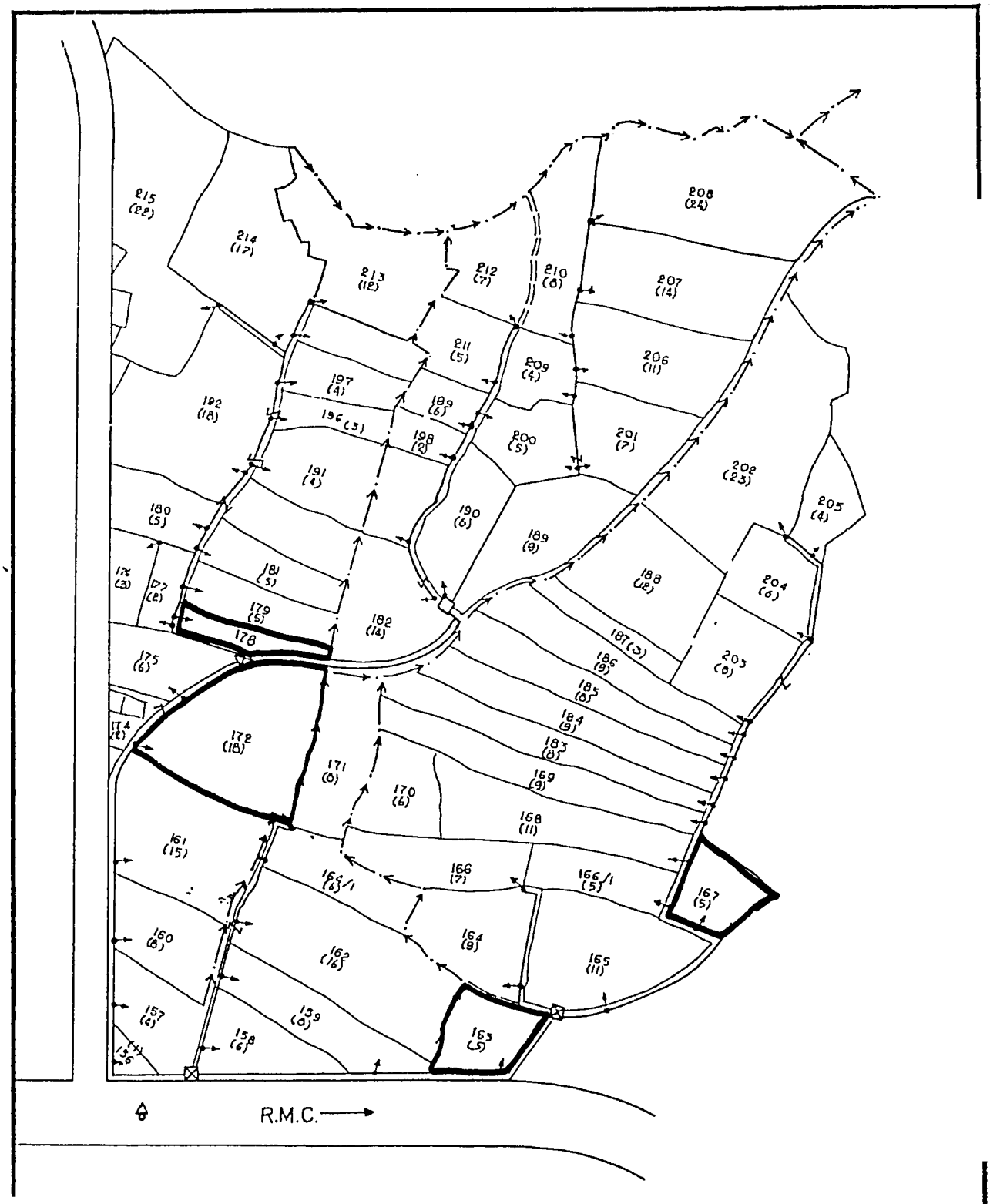
ในเขตจัดรูปที่ดินที่ บทที่ 17

ลอก	ตรวจ
26/5/26	กลุ่มที่ 11


R-15L
83
(1)
17/1
(5)
18(299)
85
(10)
87
(16)
88
(7)
89
(29)
90
(16)
91
(4)
92
(20)
93
(15)
โครงการส่งน้ำและบำรุงรักษาน้ำอูน
กลุ่มผู้ใช้น้ำชลประทาน
ในเขตงานจัดรูปที่ดิน unit20
ลอก
ตรวจ
4/ก.ค./26
กลุ่มที่ 2

Map No. 16

Map No. 17



โครงการส่งน้ำและบำรุงรักษาน้ำอูน
กลุ่มผู้ใช้น้ำชลประทาน
ในเขตงานจัดรูปที่ดิน UNIT20

ตอก	[illegible]	ตรวจ	
5/ก.ค./26		กลุ่มฟิล	