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PROJECT NOTES NO. 2

LAM NAM OON PRELIMINARY WATER SPACE AND INTEGRATED RURAL
DEVELOPMENT PLANNING

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Project Notes

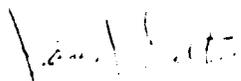
An Explanation

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

Reports, Policy Notes, and advisory memoranda are particular to the project at Lam Nam Oon - and they have only a limited circulation among interested policy-making and technical personnel.

Technical Notes may be based on analysis and systems particular to Lam Nam Oon; but the contents of the documents may be of interest to scholars and technical personnel around the world. These are issued as a part of the publication program of the Center for Rural Development, which is a Division of the Louis Berger Group of companies.

Project Notes are very specific to a particular set of problems at Lam Nam Oon. Their circulation may be restricted to just a few of the key personnel. Their content is based on study/analysis; but both the subject matter and the methodology is not judged to be of interest to anyone - except those most vitally concerned with the project.



James J. Dalton
Team Leader
LOUIS BERGER INTERNATIONAL, INC.

October 30, 1980

Foreword

Rural development planning and implementation, anywhere, demands careful adjustment to resource potentials and constraints. Integrated Rural development adds another dimension to this demand. It requires integration of measures to expand agricultural production, mobilize human resources, and broaden the rural economic base through stimulation of income-producing non-agricultural activities.

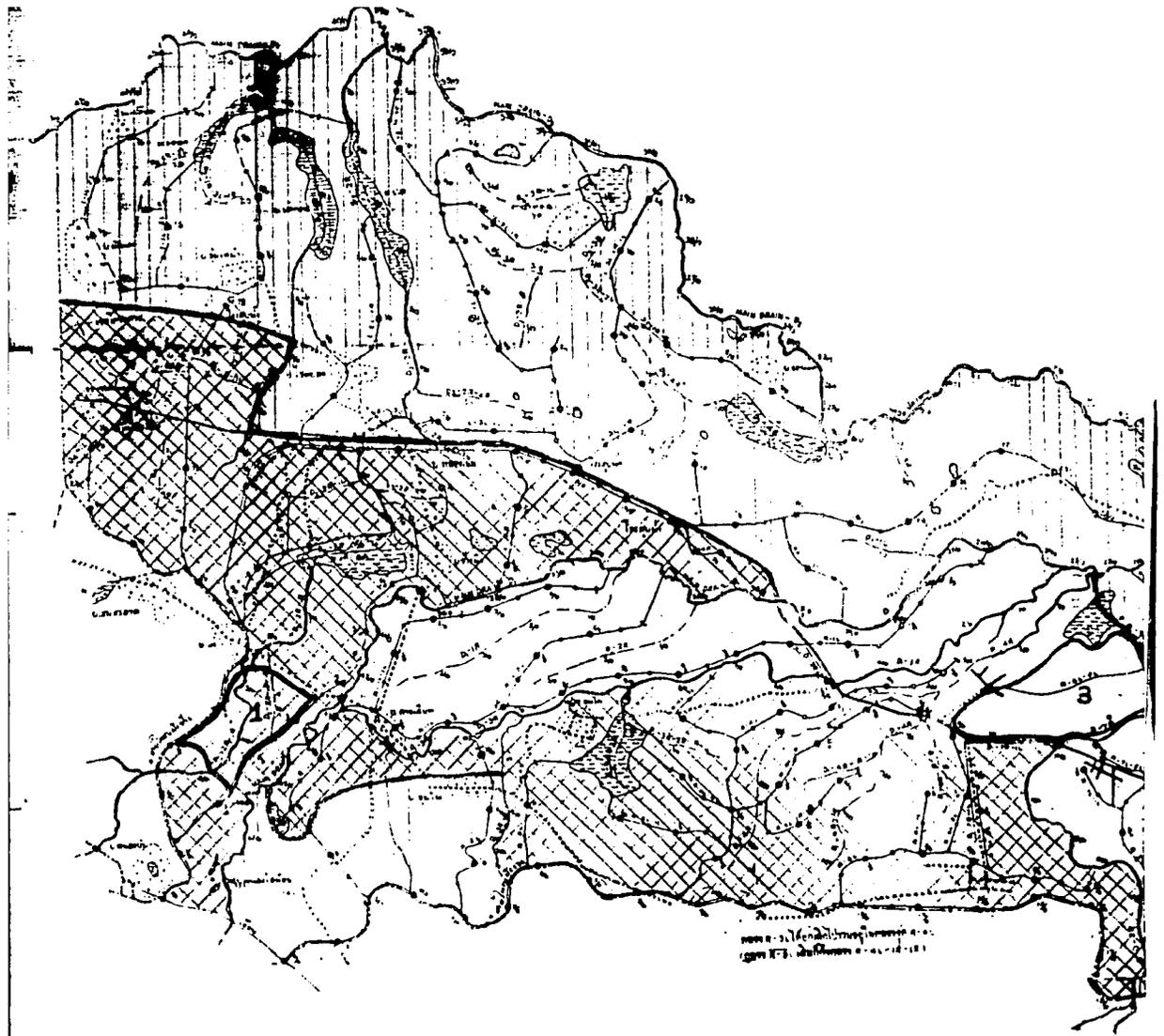
Agricultural and rural development activities in Northeastern Thailand confronts some special constraints. These are comprised of such matters as: erratic rainfall, poor soils, low productivity, subsistence cropping, remoteness from markets, a dearth of capital and credit, and very lightly scattered sources of technical and administrative support.

Integrated rural development, in this context, has to overcome some additional special constraints. Human resources development in the region is very limited. The populace is ethnically and linguistically separate from their Thai administrators, managers, and technicians. Capital development in the region is also very limited. Where it exists, it is concentrated in the hands of Sino-Thai commercial interests. External sources of capital from other parts of the country or abroad concentrate their attention on other less risk-prone and more productive non-agricultural prospects for investment in portions of the country other than the Northeast. Finally, the administrative and technical staffing strength as well as organizational layouts based on subject-matter responsibilities does not favor those inter-disciplinary measures, attitudes, and training essential to successful integrated rural development.

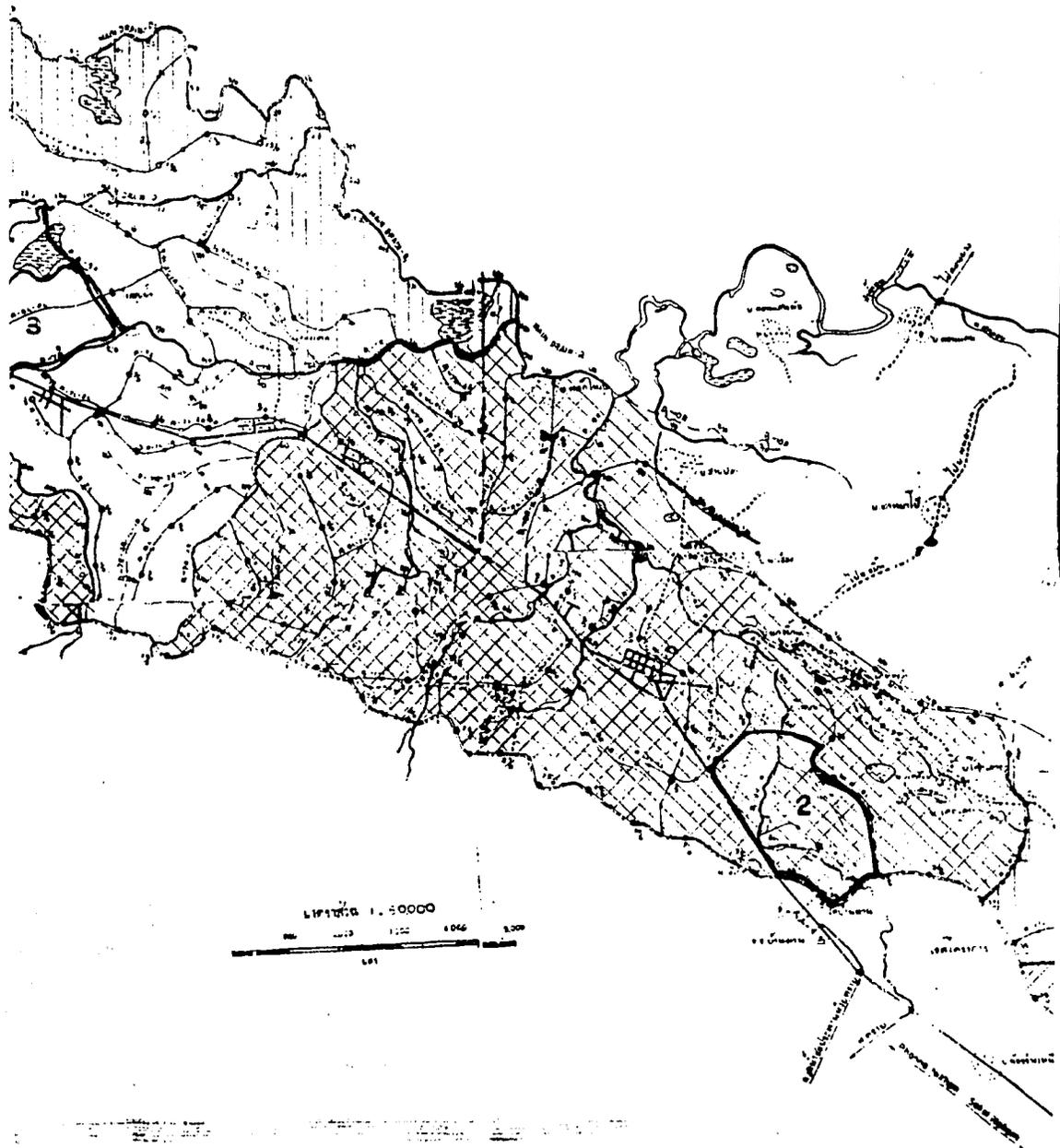
Lam Nam Oon has all of the foregoing constraints; but as a special area of water space in an otherwise rainfed region it also has extraordinary potentials which can be exploited if appropriate and effective planning and implementation occurs.

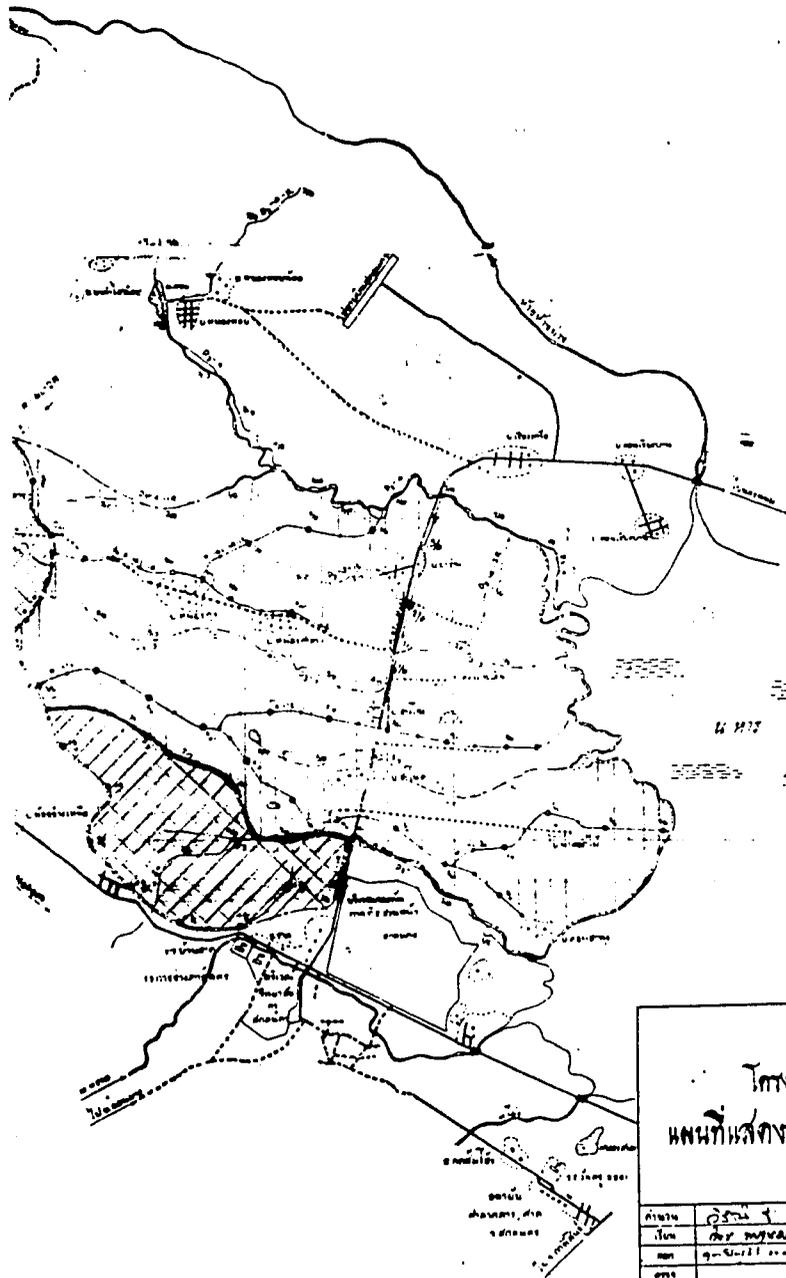
It is in this context, that Project Note 2, presents a first effort at planning for a set of actions related to the water space in the Lam Nam Oon area. As more facts are gathered, and data interpreted, various aspects of this Preliminary Plan will be altered and the content strengthened. In the meantime, this Preliminary Plan will be used as the initial guidance document for all participating agencies.

The attached Map depicts the areas which, under Preliminary Planning procedures, will be developed differently within the Lam Nam Oon water space.



- I  MOST INTENSIVE DEVELOPMENT.—WATER
- II  INTERMEDIATE DEVELOPMENT.—WATER
- III  LEAST INTENSIVE DEVELOPMENT.—WATER





กรมชลประทาน
โครงการสถานีสูบน้ำ ๑ สกลนคร
พื้นที่หลังระบบส่งน้ำและระบบระบายน้ำ

ปีที่ทำ	๒๕๓๑	๒๕๓๒	
วันที่	๑๕ มิ.ย. ๒๕๓๑	๑๕ มิ.ย.	
ชื่อ	๑-๒๕๓๑	๑-๒๕๓๒	
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Introduction

The Lam Nam Oon water space contains many physical areas. Each of these are affected by special factors common to the space, but differing from one area to another. An orderly, efficient, and economic plan of development must inventory these factors, assess their importance, and place them in some scale of priority. Since information about the various factors differs in content, it is necessary to constantly add to that information. Periodically, also it will be necessary to review planning assumptions and priorities in order to be certain that the full impact of assembled information and its interpretation effectively influences the content of current planning.

Among the various factors which should be considered, the following are only illustrative.

Soils are a key factor. They vary a great deal in type and character within the Lam Nam Oon water space. Some have very special problems such as salinity, low ph., and aluminum toxicity. They require careful study and the adoption of appropriate remedial measures. Groups of these soils can perform better under certain kinds of cropping and water regimen conditions than others. In preliminary planning, then, it is necessary to scale these various types and conditions into some development order.

Drainage is a critical matter. There are a number of problems, in which data availability and content is a key issue. These involve such matters as primary, secondary, and field drainage, crop demands for drainage, rainfall analysis, and estimation of runoff for the entire space as well as areas within the space and the watershed. As this data is being assembled and interpreted, preliminary planning has to rest upon such elements as costs of improving natural drainage, etc.

Land use exerts much effect upon development. Presently, a large area within the water space is occupied by forest and scrubby plant growth. Costs of clearing such areas will be high. The economic value of some of the current land usages may be higher than what may be obtained if the forest is cleared and irrigation substituted. Preliminary planning, in this case, will rest upon the assumption that land clearing should be discouraged as a major factor in Lam Nam Oon development plans.

Population density and distance of areas from markets provide factors which must also affect areas within water space like Lam Nam Oon. Labor availability as well as the transportation costs for crops and inputs are both related to these factors. Preliminary planning has to differentiate about the effects of these factors as between different locations in the area.

The efficiency as well as installation costs of water delivery systems at the on-farm level will affect development. When these are coupled to the administrative and managerial differences associated with the Ditch/Dyke Act and the Land Consolidation Act in Thailand, it is essential to constantly differentiate areas by intensity and type of water delivery system best installed.

Cropping efficiencies and returns comprise another set of factors affecting differentiation both by area and season. Unfortunately, in the case of Lam Nam Oon, there has been insufficient development of this kind of data to date. Preliminary planning, concerning these subjects, has to be stressed towards the organization and operation of more research rather than the use of extant data in the differentiation of areas or systems installations.

The ratio of credit to net returns, credit requirements generated by irrigation, and the availability/terms of credit comprise another factor of great importance. Again, unfortunately in the case of Lam Nam Oon there has been insufficient development of data on these subjects to date. Preliminary planning, concerning the many aspects of this subject, will have to foster the design and operation of tests as well as data - gathering.

Methodology

In this preliminary planning effort, the Lam Nam Oon water space was broken down into 23 Units. The criteria utilized in selecting the boundaries of the Units concerned estimated ease of management and control of water, as affected by the canal and lateral command areas. Each of the 23 Units also emerges out of consideration of drainage and road or access conditions related to it. The map, attached, Page 12 outlines the Units and assigns reference numbers to each.

Future reviews and additional relevant data will probably lead to somewhat different ways of determining the boundaries of Units; but, in general, it appears that this approach provides a logical basis on which to proceed with preliminary planning - pending development of better methods.

At least twelve different sets of factors were considered as possibly useful when trying to rate or evaluate the relative ranking of each Unit vis-a-vis others. Eventually, it appeared that only six factors are now accompanied by sufficient data to permit their use on a commonly applied basis to the entire water space. These are described elsewhere below.

These factors had to be relatively ranked, so that it might be possible to determine which Units possess the highest developmental potential in terms of ease of development, expected economic return, and levels of efficient technical operation. Again, the mode of ranking chosen may be improved upon in the future; but at this stage it was decided that the factors of best soils, lowest drainage improvement costs, least potential for flooding, lowest need for land clearing, largest populations, and greatest proximity to markets would be given the highest values. In certain cases, such as bad soils, heavy tree cover, etc. an additional weighted value is assigned.

Each Unit is studied with reference to each factor, and a value assigned. Thus, with all Units ranked from 1 to 23 for all factors - a summation of each ranking for each Unit results in an overall ranking for the Units with all factors considered. The lowest total goes to the Unit possessing the highest developmental potential and the highest total goes to the Unit possessing the lowest development potential.

Six sets of factors were selected for common application to all 23 Units. The content of these factors as well as assigned weights may be altered after further data is developed. Other factors may be introduced later. Currently, however, these factors were utilized as described below:

1. Soils Series Distribution:

Areas of each Soil Series distribution are currently shown on the maps prepared by Engineering Consultants, Inc. These have been used as referents in conjunction with a soil suitability map when considering the soil situation for each of the 23 Units.

The better soils for Upland or Field Crops were differentiated by Unit area. Similarly, those best suited for rice cultivation were differentiated. Distinctions were also made as between intermediate soils and those shown to be saline, shallow, swamp, etc.

Each of the 23 Units were ranked according to the amount of area of each soil inside the Unit. The Unit with the largest area of the best soils (Phimai in this case) was ranked at 1, that Unit containing the largest amount of saline, shallow, or swamp soils was ranked at 23. A system of rating the intermediate soils was applied to each Unit. Since the least productive soils required some adverse weighting relative to the others, they were given an additional negative value so as to make certain that the affected Units truly reflected a difficult situation concerning this subject.

2. Drain Improvement

Given present information about the drainage situation, this factor deals with the drainage improvement necessary to develop a particular Unit. Within each Unit, the total lengths of natural drain and project drains (as currently reported by R.I.D.) were determined. They were then ranked with a 1 assigned to the Unit requiring the least amount of natural drain and project drain improvement, and 23 assigned to that Unit requiring the greater amount of improvement. A weighting factor of 2 was used, (in all cases) concerning natural drain improvement because they will be more difficult to improve. (The difficulties will be less technical than obtaining farmer permission for rights of way, particularly in Ditch/Dyke Act areas)

3. Flood potential:

Parts of some Units may be subjected to flooding of scale in certain years. In order to rank this possibility in relation to each Unit's developmental potential, the areas along Huai Nam Oon and Huai Pla Hang, as well as their tributaries were evaluated against contour intervals,

aerial maps, field observation, and discussions with project personnel. The affected areas were assigned a 4 (the average of the first 7 rankings which were not affected) as least affected to 23 at the most affected Unit.

4. Land Clearing:

Aerial photos were carefully checked against the areas shown for each Unit. Those Units having the least tree and scrub cover were ranked from 1 downwards. Since this factor is considered to be an expensive item affecting preliminary planned implementation it was assigned a weight of 4 in each case.

5. Number of people affected:

Each Unit contains differing numbers of people. The location of each village was determined in each Unit and population figures supplied by Community Development were utilized in judging the size of each village. The Units were then ranked, with a value of 1 assigned to the largest population and 23 to the least.

6. Distance to Markets:

The distance from the center of each Unit to the nearest market (in this case nearest Amphoe center) was determined in Kms. One distance calculated was from the approximate center of the Unit to the nearest paved road, and the other from that point to the nearest Amphoe center. Units were then ranked from the value of 1, closest to the market to 23 - farthest away.

After wighting and applying these six factors, as described above, to each Unit there follows a Ranking of Units through a range of 1 to 23.

Break-out of Development Areas

The attached Table Page 13 shows how the 23 Units emerge in relative rank when all six factors are applied.

These ranked Units can be consolidated into contiguous Developmental Areas, and the effects of this consolidation are shown on the Map located on Page 3 of this Report.

When studying the attached Table, the following comments apply:

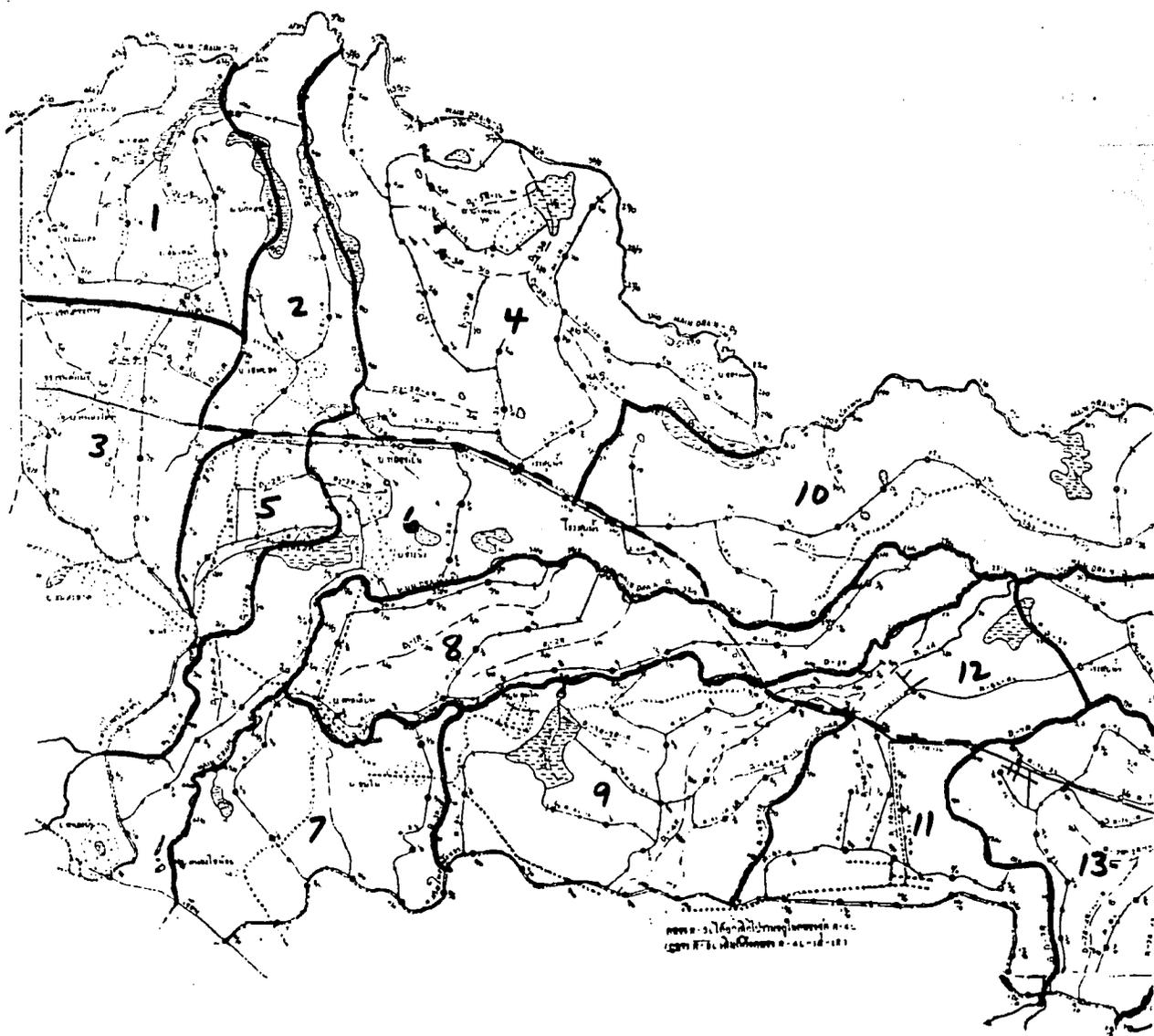
1. Column XI shows the rankings. Unit 8 has the highest developmental potential and Unit 4 the lowest.
2. Units with highest potential for development include:
 - a. A total of 6 Units - or Units 8,12,3,23,5,13.
 - b. Unit 8 is satisfactory, except that the lowest end of the canal is not extended properly in that Unit.
 - c. Unit 12 contains Pilot Area 3, and in that Unit also there is need for completion of two canals, while the development of an area containing about 400 Rai of tree-covered ground should be omitted.
 - d. Units 3,5, and 23 are at opposite ends of the Lam Nam Oon water space, and not adjacent to any other high potential Units.
 - e. Unit 13 contains the current 3,000 Rai Land Consolidation area for 1981. As the Unit now stands in terms of factor ratings it is somewhat low on some items. However, with the planned improvement of drainage for Pilot Area 3 and omitting the tree-covered area on the south side of the area, the Unit's overall rating improved.
 - f. These various Units appear to be best consolidated as a single contiguous area with the highest potential through combining Units 8,12, and 13. They are located on the best soils for the whole water space; and they would provide a net area of 25,000 Rai for most intensive development. They comprise a total of 3 Units.
3. Units with an intermediate or middle-range potential for development include:
 - a. A total of 11 Units - or Units 3,5,6,9,11,16,17,18,19,20,23.

- b. Units 9 and 19 have localised areas of trees that can be excluded from development. This would alter the scores upwards for these Units.
 - c. Unit 14 has a unique problem. It is served by a Pumping Station and it has relatively good soils. However, the area requires much land clearing. Because of the latter situation it is now included in the lower range of Units with developmental potential. However, if some land clearing is done, either through the work of individual farmer's over time or through a specific government - supported land clearing program, this Unit could be upgraded to a higher level.
 - d. Some parts of Unit 7 have fairly good soils and is clear of trees. This portion of that Unit should be split off and developed as a part of the contiguous Unit 9. The other portion of Unit 7 should not be developed in the near future.
 - e. Though it ranks 14 on the list, Unit 15 should be treated at the intermediate level because of it's contiguous position and ease of management/planning considerations vis-a-vis surrounding intermediate Units.
 - f. These various intermediate Units, then, appear to be best consolidated and treated as a block comprising the following: Units: 3,5,6,7,9,11,15,16,17,18,19,20 and 23 or a total of 13 Units.
4. Units with the lowest potential for development include:
- a. A total of 9 Units - or Units 1,2,4,7,10,14,15,21 and 22.
 - b. In this set of Units, those with the lowest potentials as affected by soils and amount of land to be cleared should be the prime candidates. In this connection, among the seven lowest ranking the following ratings occur with reference to these two factors:

Rank	Unit Rank on Land Clear- ing	Unit Rank on Soils	Units Located low on both factors
17	1	18	
18	19	22	15
19	14	1	1
20	7	21	21
21	9	2	2
22	4	4	4
23	10	15	

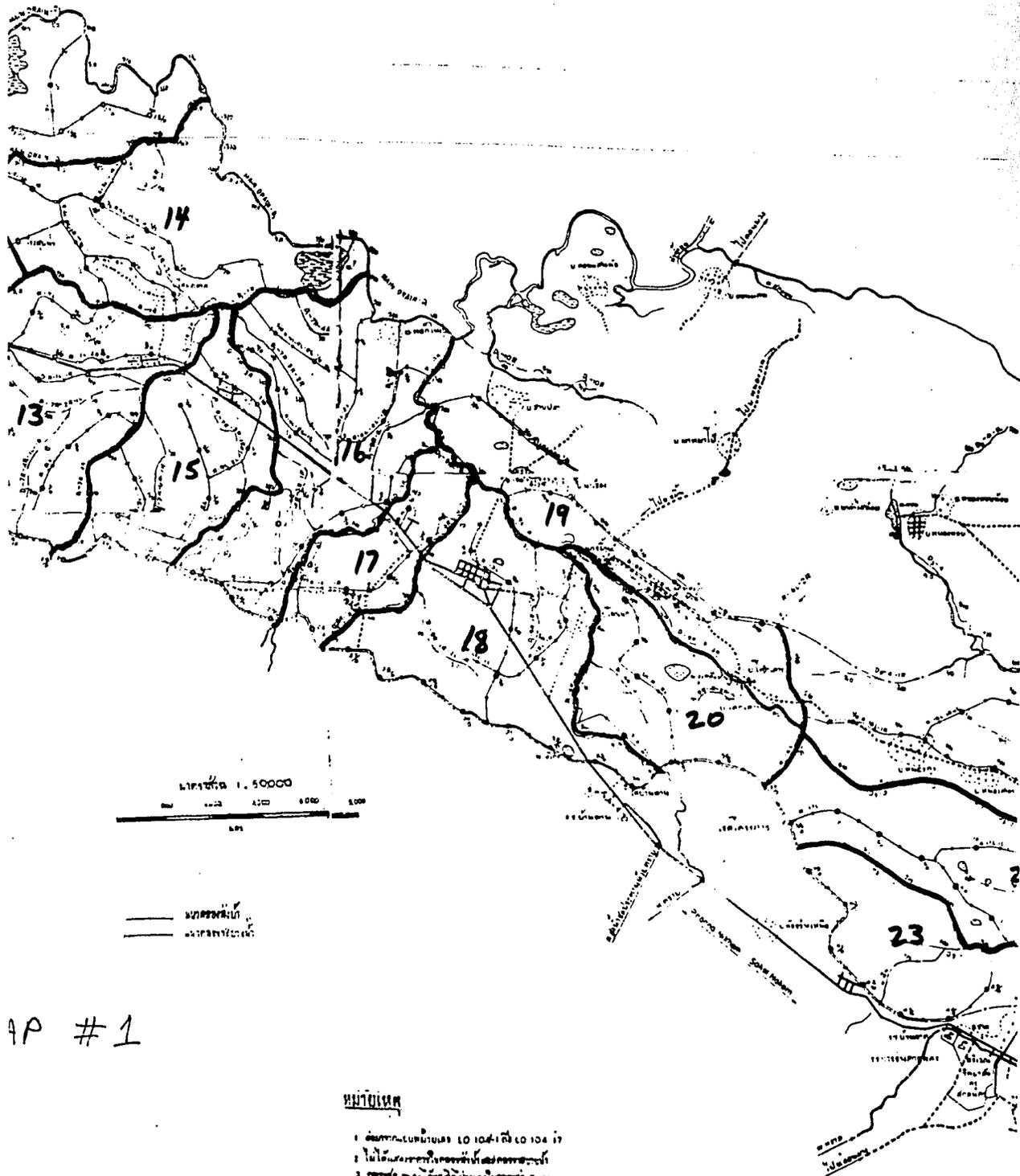
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- c. As has been noted elsewhere above, Units 15 and 7 and should be treated a special way because of circumstances very peculiar to each.
- d. The consolidated group of lowest potential development Units then appear to total 7 Units, or Units 1,2,4,10, 14,21,and 22.



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MAP :



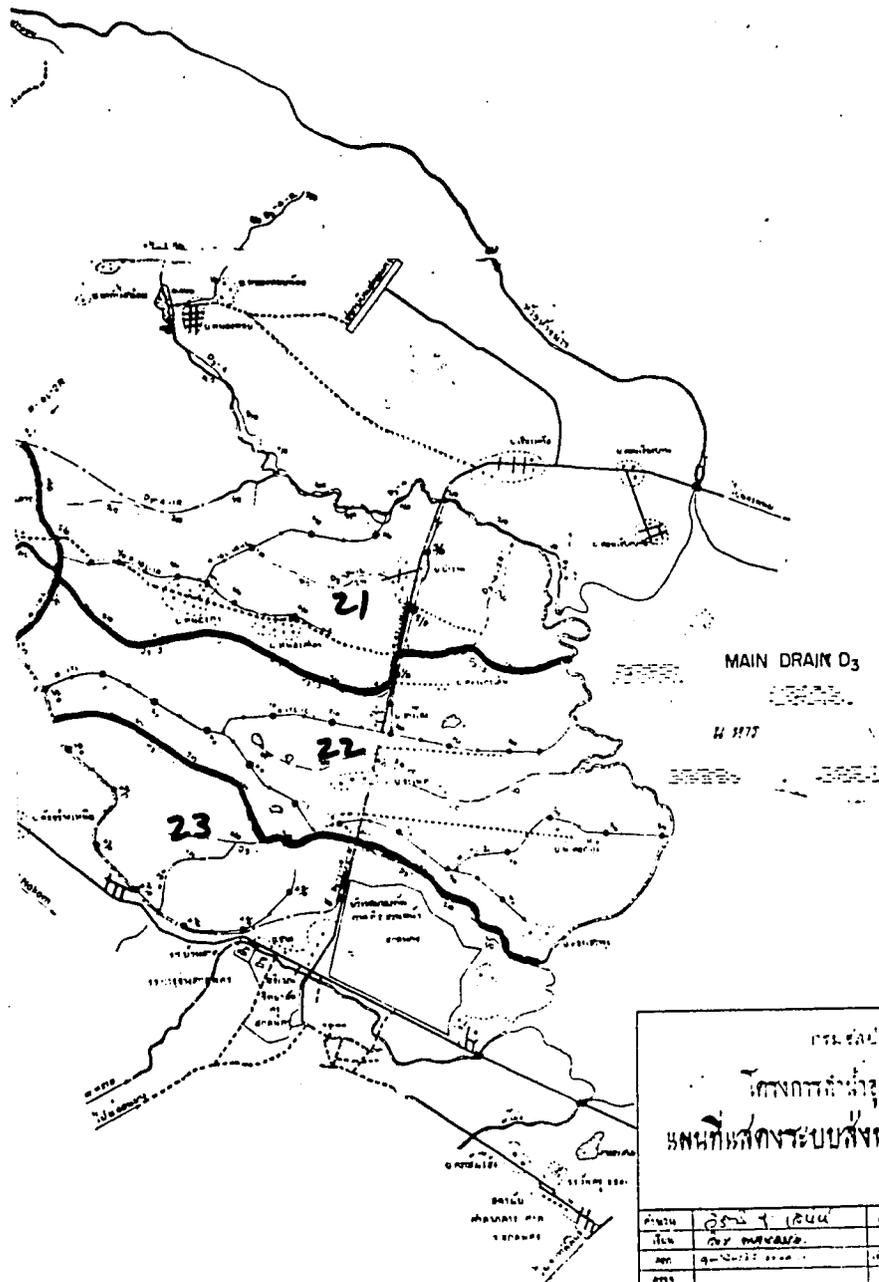
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အညွှန်း

- ၁ မြို့နယ်အကျယ်အဝန်း ၅၀ ကီလိုမီတာ ၅၀
- ၂ မြို့နယ်အကျယ်အဝန်း ၅၀ ကီလိုမီတာ ၅၀
- ၃ မြို့နယ်အကျယ်အဝန်း ၅၀ ကီလိုမီတာ ၅၀
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กรมชลประทาน
 สำนักงานชลประทานที่ ๑ จังหวัดสุพรรณบุรี
 หน้าที่ศึกษาและออกแบบระบบระบายน้ำ

วันที่	๒๕๖๓	เลขที่	
โดย	นาย ชัยวัฒน์	ชื่อ	
ที่	๑-๐๐๐๐๐๐๐๐	เลขที่	
แบบ	๐๐๐๐	ชื่อ	

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Ranking of each Unit for each Factor

I Unit	II Area in Rai	III SOILS												IV Drain Impro- ment	V Flood Poten- tial	VI Land Clearing W.F.	VII No. of People	VIII Dist. to Mkt.	IX Total	X Ascending Order	XI Unit Ranked Best to Worst		
		Classes 1 & 2		Classes 3 & 4		Classes 5,7,&9		Class 6		Classes 8,10,11			Rank								Unit		
		Area	%	Area	%	Area	%	Area	%	Area	W.F.	%	W.F.										
1	10,535	11	13	22	22	12	12.5	20	21	12	(2)	(2)	(2)	(4)									
2	6,800	14	13	22	22	10	17	11	12.5	14	(24)	12	(24)	4	11	17	(68)	4	6.5	275.0	107.0	1	8
3	8,470	6	4	20	19.5	19	21	8	8.5	7	(14)	7	(14)	6	13	14	(56)	13	9.5	286.5	148.5	2	12
4	20,500	3	13	15	18	23	19.5	21	17	18	(36)	10	(20)	12	17	6	(24)	18	1	187.0	187.0	3	3
5	4,700	19	15	12	6	5	12.5	5	5	10	(20)	19	(38)	15.5	4	2	(8)	23	8	316.5	197.0	4	23
6	11,400	16	19	6	8.5	21	19.5	15	12.5	13	(26)	12	(24)	15.5	4	11	(44)	3	9.5	197.5	197.5	5	5
7	8,550	20	20	11	13	2	1	22	23	8	(16)	8.5	(17)	11	4	20	(80)	20	11.5	245.5	204.0	6	13
8	12,000	23	23	1	1	4	2	1	1	2	(4)	2	(4)	2	15	3	(12)	11	3	275.0	210.5	7	17
9	13,400	1	2	10	14	16	11	19	15.5	5.5	(11)	4	(8)	23	4	21	(84)	12	3	107.0	214.5	8	14
10	18,900	9	18	2	4	15	6	23	22	19	(38)	12	(24)	1	21	23	(92)	9	3	233.5	216.5	9	20
11	7,100	10	5	13	10.5	8	9.5	13	15.5	11	(22)	15	(30)	22	10	16	(64)	19	6.5	290.5	233.5	10	9
12	5,500	15	9	5	2	3	4	7	10	2	(4)	2	(4)	9.5	16	10	(40)	15	3	254.5	245.5	11	6
13	10,900	2	1	7	8.5	11	8	9	6.5	9	(18)	8.5	(17)	21	8	14	(56)	17	5	148.5	252.5	12	16
14	11,130	4	3	4	3	7	5	16	14	5.5	(11)	5	(10)	3	20	19	(76)	22	14	204.0	254.5	13	11
15	7,100	17	16	17	15	9	15	14	19.5	17	(34)	20	(40)	13	14	4	(16)	7	16.5	214.5	264.5	14	15
16	11,700	5	6	9	12	20	17	10	6.5	16	(32)	14	(28)	20	18	12	(48)	2	18	264.5	274.0	15	18
17	3,875	18	10	14	7	1	3	2	3	20	(40)	21	(42)	7.5	9	5	(20)	14	19	252.5	275.0	16	1
18	9,700	7	7	16	16.5	14	14	17	19.5	15	(30)	16	(32)	15.5	12	9	(36)	16	20	210.5	275.0	17	7
19	6,900	13	11	18	16.5	6	7	3	3	22	(44)	22	(44)	7.5	19	18	(72)	8	21.5	274.0	283.5	18	21
20	6,200	12	9	22	22	17	22	6	8.5	2	(4)	2	(4)	15.5	4	7	(28)	21	23	295.0	286.5	19	2
21	12,375	22	22	8	10.5	13	9.5	4	3	23	(46)	23	(46)	19	22	8	(32)	10	21.5	216.5	288.0	20	22
22	17,400	8	17	3	5	22	17	18	11	21	(42)	17	(34)	18	23	13	(52)	5	16.5	283.5	290.5	21	10
23	5,380	21	21	19	19.5	18	23	12	18	4	(8)	6	(12)	5	4	1	(4)	1	11.5	288.0	295.0	22	19
																				197.0	316.5	23	4

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Immediate Usages of Preliminary Plan

a. Referent in Unified Work Planning - all agencies, FY 81.

There are three Areas for Development in this Preliminary Plan. They comprise areas that are differentiated, essentially, by reference to the extent that water delivery systems should be developed within each. They comprise:

I. Most Intensive Development	29,700	Rai
II. Middle Level or Intermediate Development	98,000	Rai
III. Least Intensive Development	125,000	Rai

Each of these Areas will have to be treated differently in terms of water delivery systems (types and levels of investment), crops, land use, infrastructure development, concentration of agricultural inputs, and analysis/study. All should be treated somewhat similarly in matters concerning social services, conservation and energy use, non-agricultural activities development, etc.

Unified Work Planning by the various agencies interested in Lam Nam Oon will begin to differentiate between these Development Areas in the FY 81 period. The agencies must first understand the essential differences between each Area so that the costing and justifications for various levels of activity within each Area can be developed for FY 82. Similarly, such understanding must precede adoption of integrated measures designed to solve specific problems or exploit certain potentials peculiar to each Area.

b. Guide for research efforts on soils, crops, economic returns, credit needs drainage, sociological studies, etc.

The content and validity of data concerning Development Area I will be very important when seeking to make correct decisions about levels of investment, types of water delivery systems to be installed, soil-cropping combinations, kinds of water user organization development to promote, etc. Similarly, Development Area II activities will be very much dependent upon the outcome of the research which must be initiated soon and carried through to completion as rapidly as possible.

Some of the necessary research can be carried on simultaneously. For example, investigation of salinity conditions as well as possible tendencies to salinize larger areas through dry season irrigation can be examined in differing Development Area sites. In other cases, research on problems that may be particular to one Development Area or another can be structured and applied in a Pilot Area, such as Pilot Area 2. In that case, for example, research and test of differing kinds of water user organizations can yield results applicable

to Development Areas throughout the Lam Nam Oon water space.

Nonetheless, the dimensions of the Preliminary Plan - in terms of local and projected levels of development - will generally be most useful in defining the nature and timing of the applied agronomic, cropping, soils, economic, and sociological research that will have to be done.

- c. Guide for R.I.D. in selecting Land Consolidation and Ditch/Dyke systems installations areas.

Presently, R.I.D. has a time-related, sequential, plan for intensive and extensive development of the Lam Nam Oon area. This is divided between Land Consolidation work and Ditch/Dyke systems installation. The plan does not differentiate areas on the basis of potentials as presented in this Preliminary Plan.

Obviously, it is essential that R.I.D. have some kind of a plan for development because it must schedule it's work, and it must seek budgetary support for the activities. Furthermore, preparation of farmers for participation in Land Consolidation takes time. Also, the necessary surveys and cadastral work must be initiated and carried forward steadily.

The Preliminary Plan will alter the existing R.I.D. plan in considerable degree. It introduces an intermediate level of development; and it prescribes the physical area where this should take place. It also alters the location of the areas presently judged best by R.I.D. for Land Consolidation work. If the Preliminary Plan is acceptable to R.I.D. as a basis on which to proceed, it will then be necessary to use it as a guide to scheduling the timing and location of the on-farm water delivery systems development. This will have to be accomplished during the first few months of 1981, so that future budgetary and work planning can be presented to the Bureau of the Budget on a timely basis, and necessary survey and Land Consolidation-related work initiated.

- d. Mobilization of agencies through defining scale, content, location of needed future developmental actions.

The Preliminary Plan, in stressing a locational bias which evolves out of basic resource and economic conditions, tends to high-light specific kinds of remedial needs. Thus, the condition of the soils in the Development Areas must become a matter of critical interest to the Department of Land Development. Similarly, the varieties of crops best suited to soil and water conditions in the various Development Areas must be a matter of interest to the Department of Agriculture. Once crops, soils, and water inputs are better understood for each Area - it is essential that the Department of Agricultural Extension place emphasis upon the knowledge that should only be extended to the farmers in the different Development Areas of the Lam Nam Oon water space.

Some Development Areas, notably III, will probably require very specific attention because of specialization of product. Livestock and Forestry comprise two possibilities in this case.

All of the Development Areas will also require human resources development. How this is to be done, in terms of meeting the job-centered needs of the population in some Areas as compared to others must be a matter of concern to the various elements of the Ministry of Education, including the Department of Non-formal Education. Similarly, some Development Areas will require more intensive attention from the Department of Public Health. For example, the incidence of liver fluke disease will probably be much higher in Development Areas I and II, where greater volumes of irrigation water will be supplied on a year-round basis, than in Area III. Thus, the Preliminary Plan - as a whole - will serve to mobilize multi-agency attention, if not action, through highlighting specific kinds of different opportunities and problems for each Development Area.

Preliminary Plan and Operations Room Utilization

The Preliminary Plan, used in conjunction with a Unified Work Plan, can contribute to the evolution of an Operations Room system at the Lam Nam Oon Integrated Rural Development Administration Center. Ideally, such a system - in an integrated project - should facilitate definition of goals, promote synchronization and focusing of performance among participating agencies, and involve rural families and local leaderships in the development.

At Lam Nam Oon, building towards such an ideal will have to take place in the context of on-going plans, substantive technical issues, and individual agency procedures which do not lend themselves readily to integration and focus. It is probable that, initially, an Operations Room approach will concentrate upon inventorying what is being done or projected by each agency and place them in some prioritized range for monitoring and follow-up. In this connection, the Preliminary Plan will be helpful in the prioritization exercises and the Unified Work Plan will assist in inventorying the range of actions advocated or supported by the various agencies.

Concurrently, the development of an Operations Room approach should promote a Program Planning strategy in which problems of the water space are comprehensively identified and defined, alternatives specified, current efforts evaluated, and detailed programs charted. The detailed programs will then have to be networked into plans for resource allocations, technology applications, training, organizational assignments, timing sequences, and monitoring.