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PROJECT NOTE NO. 7

PILOT AREA 2
RIGHT MAIN CANAL AND
UNITS 15 - 17, LNO

OPERATIONS RESEARCH RESULTS
- 1982/83 DRY SEASON - LAM NAM OON
- ENGINEERING -

LAM NAM OON INTEGRATED RURAL DEVELOPMENT PROJECT

ISSUED BY

CENTER FOR RURAL DEVELOPMENT
LOUIS BERGER INTERNATIONAL, INC. U.S.A.
UNDER CONTRACT WITH MINISTRY OF
AGRICULTURE AND COOPERATIVES OF THE
KINGDOM OF THAILAND

WORK PERFORMED BY

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FORWORD AND INTRODUCTION

1. Background:

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 #7.

Currently, in 1983, the Center supports ten major rural development projects which are funded by the World Bank, the U.S. Agency for International Development, The Asian Development Bank, and other international 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 #7 (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.

2. Operations Research at Lam Nam Oon:

Details about the origins and content of Operations Research at Lam Nam Oon are explained in Project Note #5 'Operations Research Results - 1981/82 - Lam Nam Oon, of September, 1982.

Essentially, the consultant firm has been tasked to develop and operate a series of Operations Research activities in engineering agro-economics, and water user organization/operation.

In the first year of such work (1981/82) there were limitations in staff assigned as well as other priorities assigned to the consultant team. Hence the first-year results appear as a single Project Note #5 co-authored by William C. Bell as consulting engineer and Anthony M. Zola as consulting economist.

In this second year (1982/83) although staff shortages continued to limit the total amount of work that could be done, additional staff was assigned by the Project Field Director Vichai Snguanpaiboon, and priorities were sharpened.

The results are such that a separate Project Note (#7) appears for the engineering aspects of the Operations Research for the 1982/83 Dry Season. Mr. Somkiat Prajamwong deserves a special mention for his devotion to work, help in interpretation, and practical suggestions, without whose assistance this work would have been most difficult. Support and encouragement provided by the Project Field Director, Vichai Snguabpaiboon; Banjong Tanagsuangnern, the Chief of Operations and Maintenance at Lam Nam Oon, and Nukook Thongtawee, Director of Operations and Maintenance at the Royal Irrigation Department, Bangkok is gratefully acknowledged.

A. MANAGEMENT OF THE RIGHT MAIN CANAL

1. INTRODUCTION

Management of the distribution system on irrigated projects is at least as important, if not more so, than "on-farm" water management. Without control of water in the main and lateral canals there cannot be a reliable supply and management at lower levels. If the availability of water at the turnout (chak)[1] is uncertain then it will be used, by those with access, with no regard to anyone else. This exacerbates the traditional "head-ender vs tail-ender" problem, and the final result is a "law-of-jungle" system of water management. Without proper management of the distribution system, area irrigated during the dry season will never reach expectations. This is especially true when farmers are not totally dependent on irrigated agriculture for their livelihood.

Most attention, in many projects, is directed toward on-farm water management assuming that management of the main distribution system is being carried out. Unfortunately this is not usually the case. A number of factors affect this, including lack of trained personnel, complexity of the system, a lack of understanding of the importance of management at this level, the absence of a carefully thought out plan, and/or combinations of these.

During the 1981-82 dry season Lam Nam Oon experienced these difficulties with management of the Right Main Canal in conjunction with operations research in Pilot Area 2. Due to lack of management, water levels in the Right Main Canal varied over a wide range. At times levels were too low to get water out the Constant Head Orifices (CHO) and into the chaks. As a consequence, farmers were very uncertain about whether water would be available on any given day. There was, essentially, no management of the main system.

Recognizing this as a weak point in operations of the Lam Nam Oon system it was planned to manage the Right Main Canal in a more systematic way during the dry season of 1982/83. The remainder of this section describes the results of that exercise.

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(1) A chak is a physical area of 200 to 400 rai (30 to 70 hectare) of land served by a turnout (Constant Head Orifice) and a constructed earthen ditch on-farm water supply system.

2. PHYSICAL LAYOUT

The Right Main Canal and the associated laterals and structures at Lam Nam Oon are a complex hydraulic system. As with any system, a change in any part has an effect on others. For example; opening the gates to a lateral not only affects the lateral but decreases the water supply down stream and if checks in the main canal are not adjusted water levels will fall. It is this complexity that makes main system operation, at least if done manually, very difficult.

The Right Main Canal is about 45 km. long (the lower 6 km. is similar to a lateral) and has 16 laterals, see figure A1. There are 10 regulating gates about 4 km. apart and more than 60 Constant Head Orifice turnouts (CHO), (serving a chak area) on the Right Main Canal. Total area served is about 130,000 rai. The canal has a slope of 1:8000, initial bottom width of 5 meters and initial design capacity of 21.8 m^3/sec. During the 1982/83 Dry Season two laterals, R11L and R13L, off the Right Main Canal did not receive water due to construction of on-farm distribution systems in these areas.

3. BASIC PLAN

No water management system can properly function without a planned schedule of when, where and how much water will be delivered. Once established the schedule has to be strictly adhered to. The first decision in managing the Right Main Canal was to schedule changes in water delivery to laterals (and consequently gate changes) on a weekly basis. A weekly estimate of water needs for each particular lateral was made every Friday. Changes, if any, were then made on Saturday or Sunday.

From an estimate of the expected area to be irrigated along the Right Main Canal and low efficiencies the initial flow rate to begin operations was established at about 30% of design flow.

At the outset, it was also decided that all the operational laterals would receive water at about 20-50% of design capacity. Since there were really no means to measure water effectively either at the chak level, lateral turnout or wasteways (except for R-9L & R-14L, see section G, BCW (Broad-crested Weir Installations) themethod of operation was on a qualitative basis rather than quantitative. Thus zonemen and engineers made their estimates as "a little more than last week", "about half of previous flow", "open the gate about 10 cm.", etc. rather than stating needs in, say, liters/second. After some experience such estimates were satisfactory at present levels of management However, efforts toward a more quantitative approach should be pursued in future.

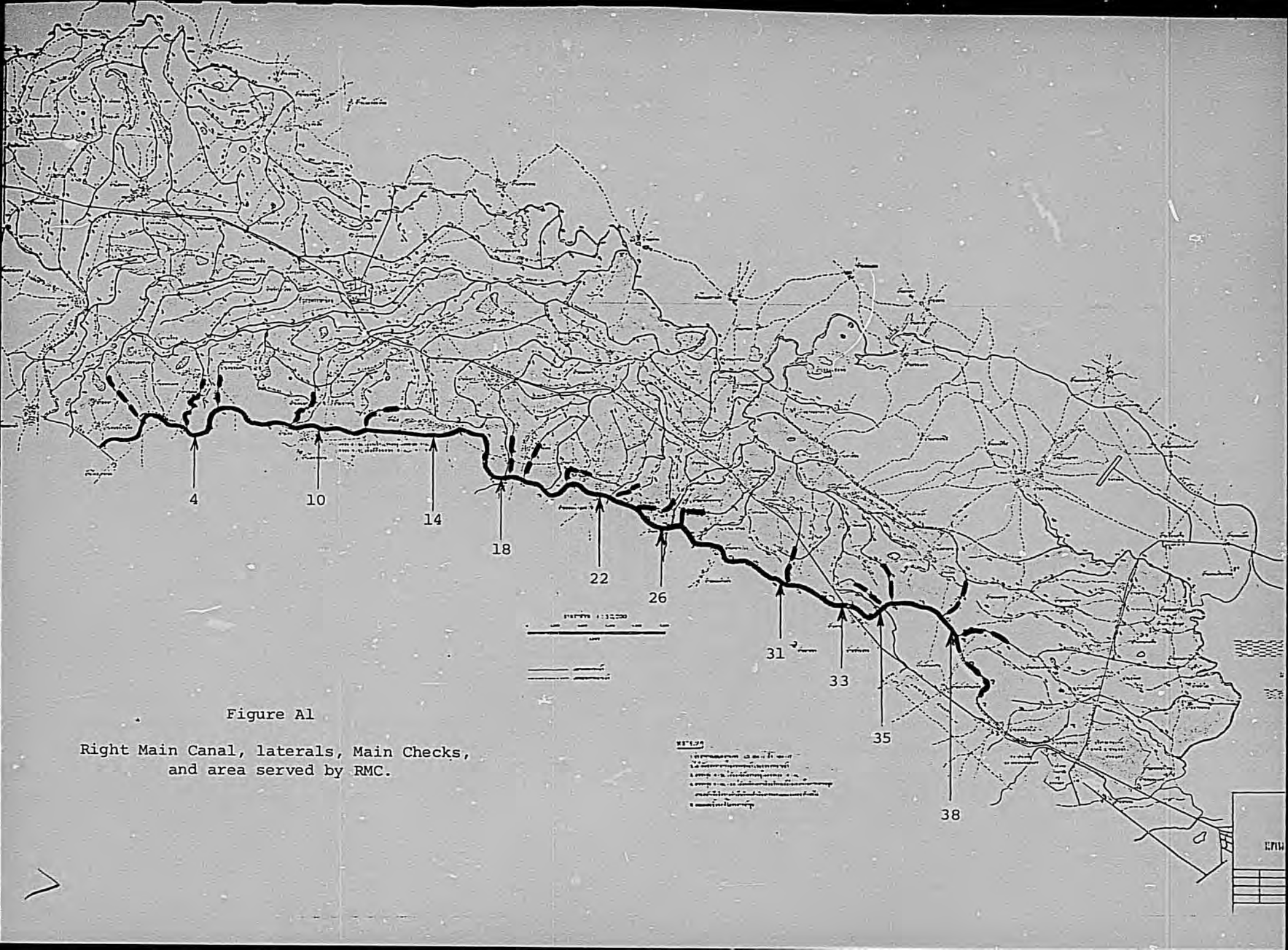

Figure A1

Right Main Canal, laterals, Main Checks, and area served by RMC.

In order to evaluate the past weeks' performance and establish target flows for the coming week a meeting of all zonemen and senior O&M personnel was held each Friday. At this time each zoneman presented his request for and amount of change in flow (if any) for each lateral he was responsible for. Any problems or unusual conditions were also reported. This information was then collected by the engineers in charge of Right Main Canal operation and decisions were made about any changes proposed. These adjustments, if any, were then made on Saturday or Sunday. Saturday was found to be more satisfactory as this gave two days for water levels to stabilize before Monday from any changes that were made.

One other basic objective of the plan was to try to hold water levels about 10-20 cm. above the full supply level (FSL) at each check in the Right Main Canal. This was necessary since the delivered flow was about 25-30% of design capacity and if water surface was at FSL at the check then in the upper part of the reach water level was too low for satisfactory delivery to laterals and CHO's.

It was also decided that the two engineers in charge of RMC operations would be the only ones to adjust or make changes in the RMC checks and lateral head gates. The zonemen, farmers or any other O&M official were not to adjust these gates. Any changes thought to be needed must be made to the engineer in charge. This policy was adopted because in a complex system such as the RMC, it cannot be operated properly if anyone and everyone goes about changing gate settings.

The two engineers assigned to operate the RMC were each assigned about half of the canal to be responsible for. The first section was from the headworks to the check at about km. 22, the second section from there to the check at km. 38.

4. OPERATION

It was fortunate that two dedicated Thai Royal Irrigation Department engineers were assigned to carry out the difficult assignment of managing the RMC.(1) Prior to the water being turned into the system these engineers assembled the necessary maps and became familar with the system. They also carried out a number of preliminary activities including, marking the FSL at each check, locating and numbering all the CHO's and laterals along the RMC and checking and adjusting the zero setting for all the gates.

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(1) Somsak Satiya; Nipon Mongkornkaew

Water was turned into the system on 15 December 1982. It took about three weeks to get the system fully under control. The main reasons for this were:

a) The complexity of the system itself.

b) Inexperience of the staff and the normal period of time to learn how the system operated. No-one at Lam Nam Oon had ever tried to operate the RMC on a systematic, controlled basis therefore no-one knew how it really functioned.

c) Unauthorized opening and closing of some gates. Due in part to lack of communication between farmers - chak leaders, zonemen and engineers.

Owing to the complexity of the system, the check gates could not be set at a precalculated flow rate and then left unattended. There were almost always some changes occuring in the flow rate in a particular reach, mainly due to the following:

a) many farmers did not irrigate at night thus CHO's along the RMC were open during the day and closed at night.

b) the same occured along laterals which in turn increased water levels in the laterals and, for some laterals, this backed up in the RMC increasing the flow in that reach.

c) any unauthorized opening or closing on any gate (many such actions are attributed to fishermen at night) had the same effect.

When any of this happened, it had the effect of increasing or decreasing the volume of water in a particular reach (water level either rose or fell). Since the check gates operate as submerged orifices any change in water levels on either side of the gate affects the flow through the gate. This in turn alters the flow and volume of water in adjacent reaches. If the water level in a particular reach gets too high (or too low) adjustments in gate settings must be made which in turn sets off another chain reaction of flow rates and water level changes. As a consequence of this complex interaction of the hydraulic characteristics of the RMC system almost constant changes in gate settings were required to maintain a steady water level in the RMC.

Since the changes were made manually during the day (there were however times when the engineers were in the field to wee hours of the night) there was more or less a constant rising or falling of the water level at any particular place.

The method the engineers employed to operate was to travel along the ca al several times during the day (and night) and record the water level at each check. By comparing a reading with previous ones it could be determined if the water level was rising or falling and how fast, then making an appropriate change in the gate setting. If the rise (or fall) was occuring rapidly then the gate was opened (or closed) more than if the change had not been so rapid.

The amount of change to make in gate settings for a given condition was probably the most difficult skill to acquire (more of a art rather than a science). For example, a gate setting could be made late in the day and next morning that reach could be much below (or above) what was expected. Learning to do this takes time, patience and good record-keeping.

Figures A2-A11 and Tables A2-A4 show the average daily water level at each check in relation to FSL. Figure A12 is a composite of all the checks. After the first week (on the graph) and except for a 14-day period of rotation (discussed below) the results were very favorable. The plan to maintain a level of about 10 cm. above FSL was in general achieved. There were numerous ups and downs but for the given operating conditions it was satisfactory. One measure of success was that the number of complaints by farmers about inadequate water supply was markedly less than previous years.

Tables A5-A7 summarizes the extremes and averages for water levels in cm. above or below the FSL. Table A5 includes the entire period from 3 January 1983 to 19 April 1983. Table A6 was for the irrigation period without rotation values accounted for. This was included because it shows more reasonably how the RMC was managed.

Average of the whole system was 12 cm. above FSL. The lowest below FSL was 59.5 cm. and highest above 31 cm. The lowest occured at check 26, this was mainly due to a malfunctioning gate that could not be closed properly. The average daily differences fell between 3 and 6 cm., while largest difference from one day to the next between 17 and 30 cm. It can be said that while there remains certainly room for improvement these figures show a reasonably controlled situation.

As noted above there was a period of about two weeks when it was decided to test the operation under a schedule for rotation of the laterals. The results were disasterous. Yet, from an overall systems management standpoint rotation by lateral is a sound objective. For one thing, it helps to minimize the problem of over irrigation and the attending problem of high water table (see Technical Note #7), and at some future point in Dry Seasons it may become necessary to rotate due to shortage of water.

The basic plan was to divide the flow in about half (according to lateral flows) and rotate on a weekly basis. Starting 26 February this was put into effect but due to the failure to maintain control of the water levels during two weeks of trial, the plan to rotate was ended.

The major reasons for failing to maintain control of water levels included:

a) There were some communication problems in getting word to the farmers about the rotation schedule and what it meant, and there could have been some farmers who simply did not want to abide by it thus causing some unauthorized gate tampering.

b) As noted previously, the system was operating at about 30% of design flow. Then, under rotation, this volume was cut even further, such low flows proved difficult to manage. Part of this was due to several gates that could not be closed sufficiently. At check 26 this was the case, for 10 days the water was below FSL, Figure A7, and only after the rotation was ended and flows increased did that water get back above FSL.

c) Associated with the low flows and attempt to maintain levels above FSL was a very low velocity of flow. This resulted in a long transient time through the system.

From Figures A2-A12 the erratic deviation from FSL can be observed from about day 57 to day 71, this is especially true of the lower half of the system. Table A7 shows the average of the system to be at the FSL during this time compared to 12 cm. above for times other than rotation and 10 cm. above FSL overall. All of the lowest levels were recorded during this time with lowest measured at check 26 at 1.13 m. below FSL. Average daily differences were from 2 to 5 time what they were during other periods. The composite in Figure A12 vividly illustrates the levels maintained before and after the attempt at rotation.

To attempt any future rotation of the laterals it would be advisable to do so only when at least 40% of the design flow can flow through the system, and farmers specifically get the message that they are on a rotation and <u>will</u> get water at the time promised. The first condition will be necessary to assure that the system can be operated on a rotational basis by the project. The second will be essential so that farmers may know and believe the water will be available. This will prevent them from illegally opening and closing gates thus disrupting operation of the system.

5. PROBLEMS

Since this was the first attempt at systematically managing the RMC system it is only natural that numerous problems would arise. The following are some of the major ones that affected management. Some are easily remedied others (as in design) will have to be coped with.

a) Design

Design of the System is essentially for full flow in the RMC. At this level the checks are located satisfactorily. At lower requirements, however, the checks are too far apart (as noted previously the need to operate above FSL at the check). One alternative could be to move enough water through the system and waste it somewhere near the lower end. Another design feature, that can be corrected, is the need for a wasteway near the lower end of each reach. This would serve as a "safety valve" to prevent overtopping of the canal, (as has happened numerous times at Lam Nam Oon). There should also be work done toward developing an effective, appropriate automatic upstream water level control device. Such a device would greatly assist in management of the system, given its complexity.

Another design feature that should be considered is a safety device at the upstream side of siphons and culvert road crossings. Presently, none exist therefore presenting a dangerous situation.

b) Unauthorized Operation

This is one of the more perplexing problems facing management of the system. If this is attributed to those farmers with irrigated crops, then a combination of training and good management of the distribution system will give them confidence that they will get the water when they need it. This will minimize their desires to tamper with the gates. On the other hand, if most of the problem stems from "fishermen" opening and closing gates then they will probably be unaware that their actions are causing a problem. In either case there has to be established some kind of sanctions to punish those that break the rules. Wheather this is done at the village level, project, amphoe(1) or combination should be determined then

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(1) Administrative district, or which there are three at Lam Nam Oon.

established and enforced. It has been noted in numerous other projects in Thailand that doing this is difficult but if the object of the project here is to provide water in an orderly, systematic manner then some action on unauthorized tampering with the system is a must.

c) Training

There should be regular training, especially for the zonemen, to increase their skills. This is particularly necessary in communicating with farmers - chak leaders. Other areas relevant to zonemen roles in management include training in the basics of hydraulics, soil-plant-water relationships, water requirements of major crops, and an understanding of salinity and high water table conditions.

At present only the engineers that were involved in this operation know how to manage the RMC. Others in the operations and maintenance division should be trained to operate it as well as they do.

d) Physical Improvements

As noted there was a problem with operation of some check gates. To be able to manage the system properly gates must function satisfactorily, (at least some of these are now being repaired). The canals should be cleaned of silt (and consequently eliminating the weed problem) to improve the hydraulic characteristics. A maintenance program should be established and equipment provided to carry out the necessary operations to prevent silt from entering canals in the first place, thus solving most of the problem of getting the silt out. Locks should be installed on all the gates. Some work could be done on developing a more efficient and easier-to-use locking device for the gates.

e) Communication - Transportation

There is an urgent need to provide the engineers with reliable transportation to properly manage the RMC system. Since the RMC is very long and there is no other means of communication, such as radio, they have to make several trips along the canal every day. Therefore they need a vehicle at their disposal 24 hours a day. There is also need for a communication system to better manage the system. Portable radios or a telephone system should be considered.

6. CONCLUSIONS

Systematic management of the Right Main Canal, a highly complex hydraulic system, was undertaken for the first time by new, inexperienced personnel and it was proved that it can be done. There is still room for improvement especially in project communications with the farmers and providing for sanctions against rule violators. The management of the Right Main Canal must continue, with improvements, for it to be possible to provide water management at lower levels in the system.

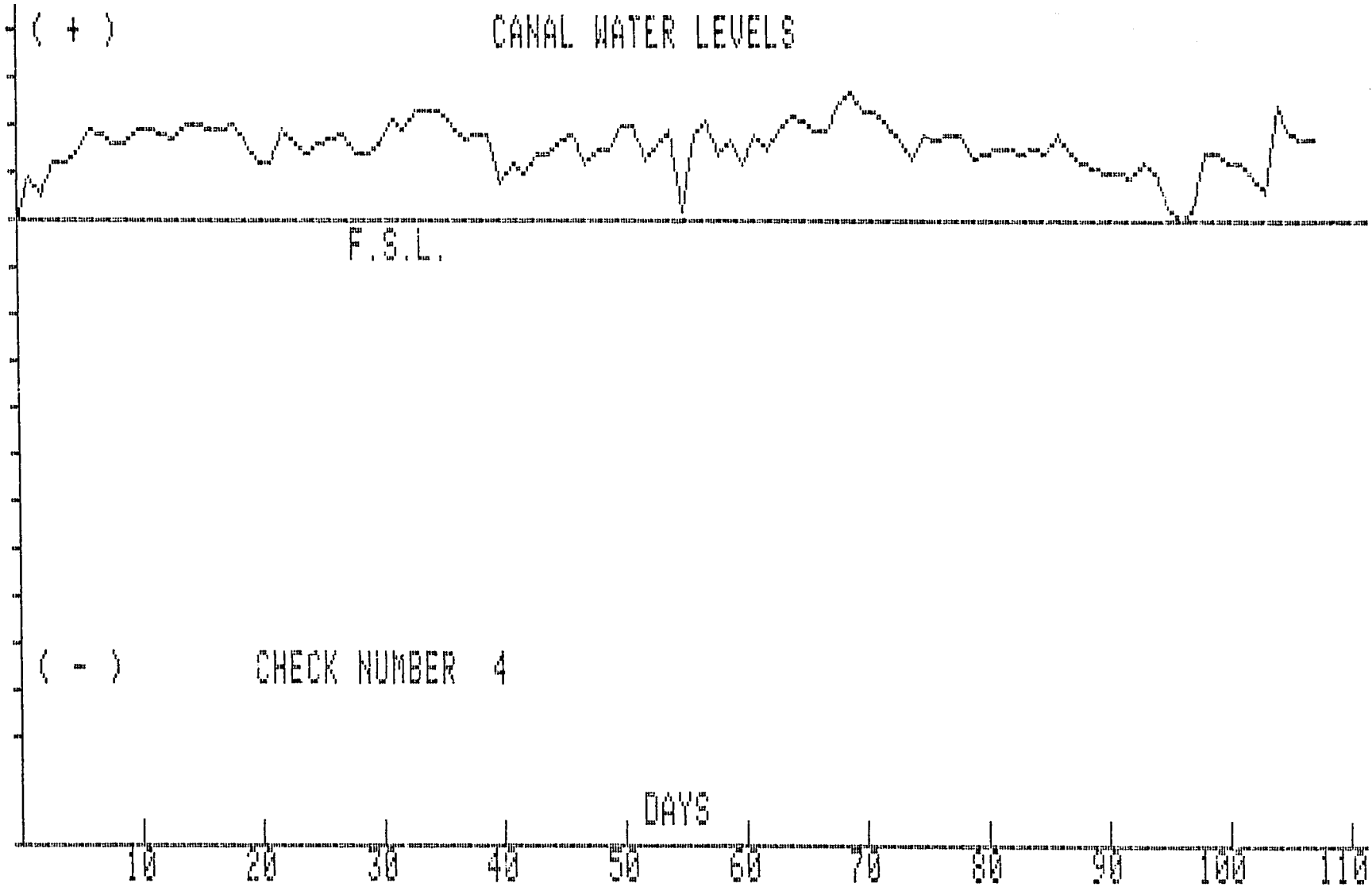
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Figure A2

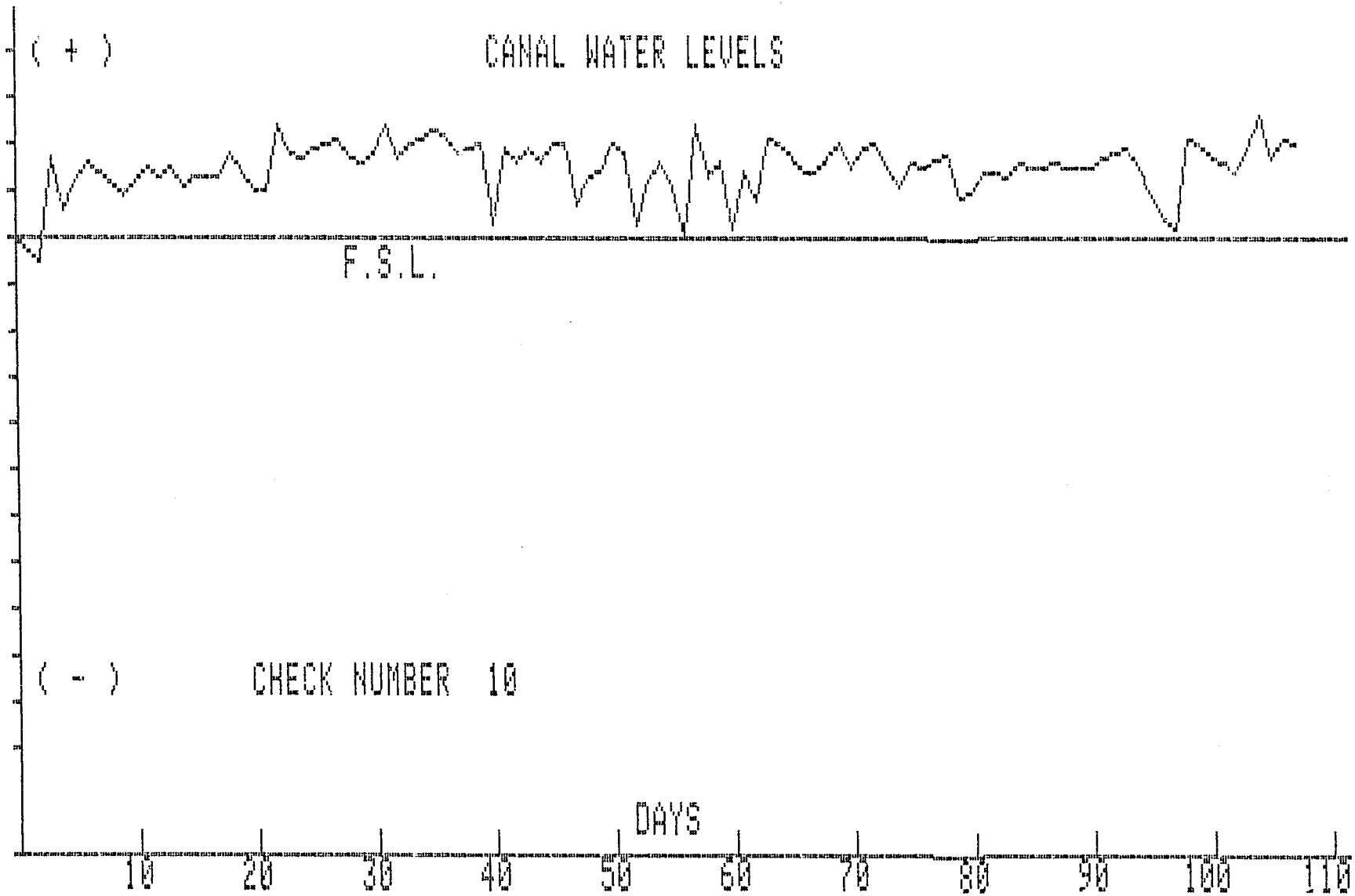
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Figure A3

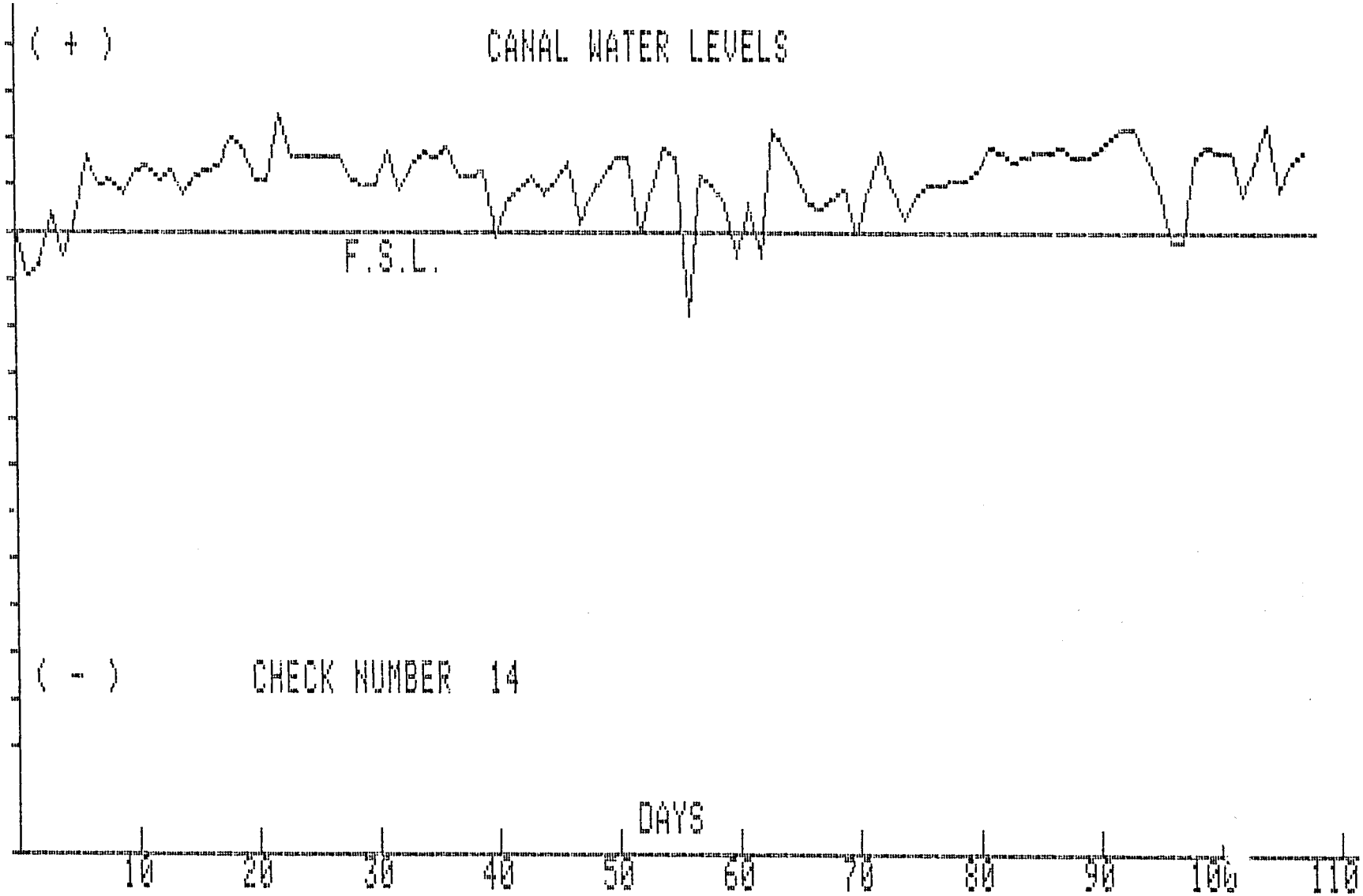
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Figure A4

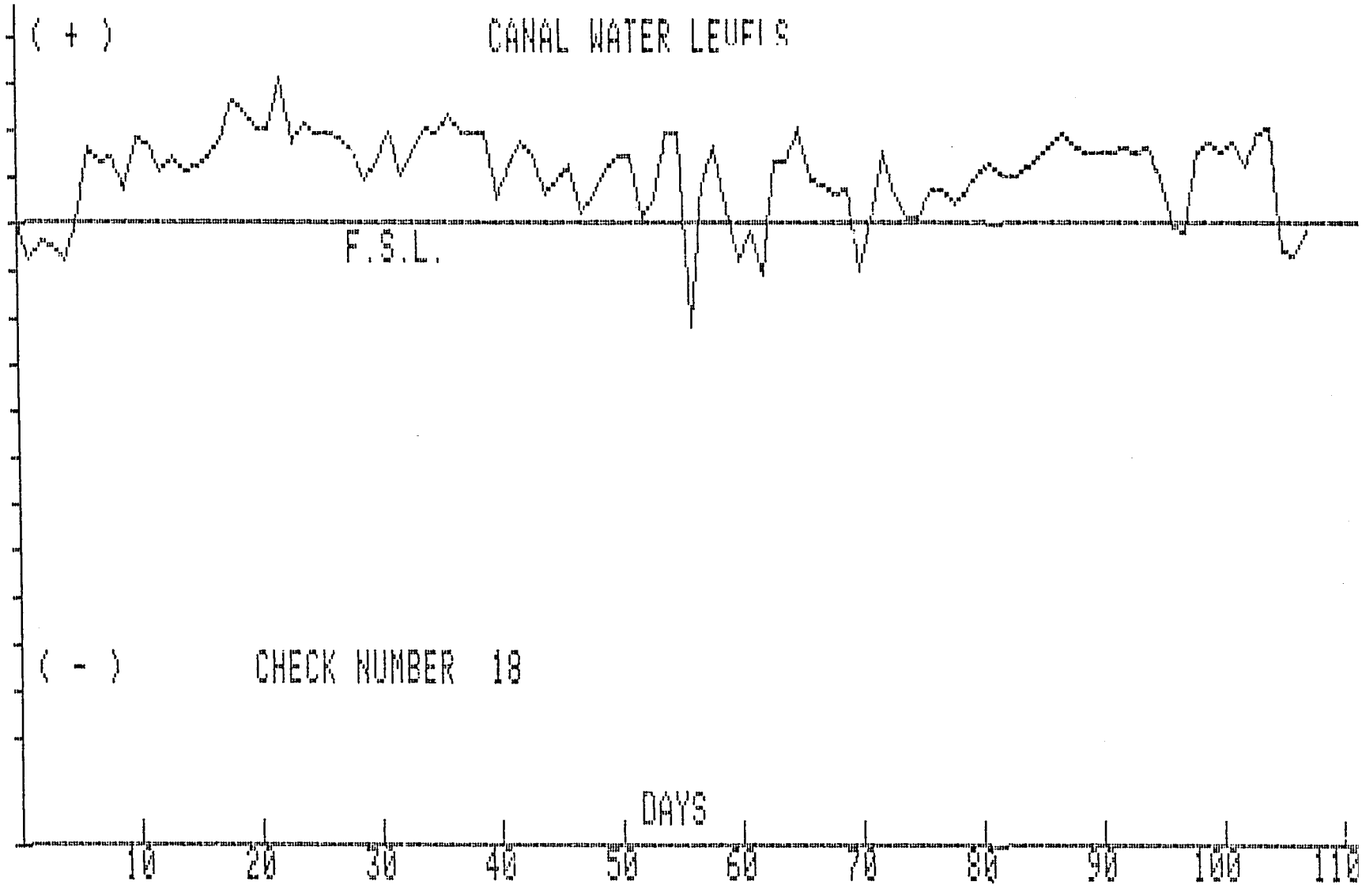
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Figure A5

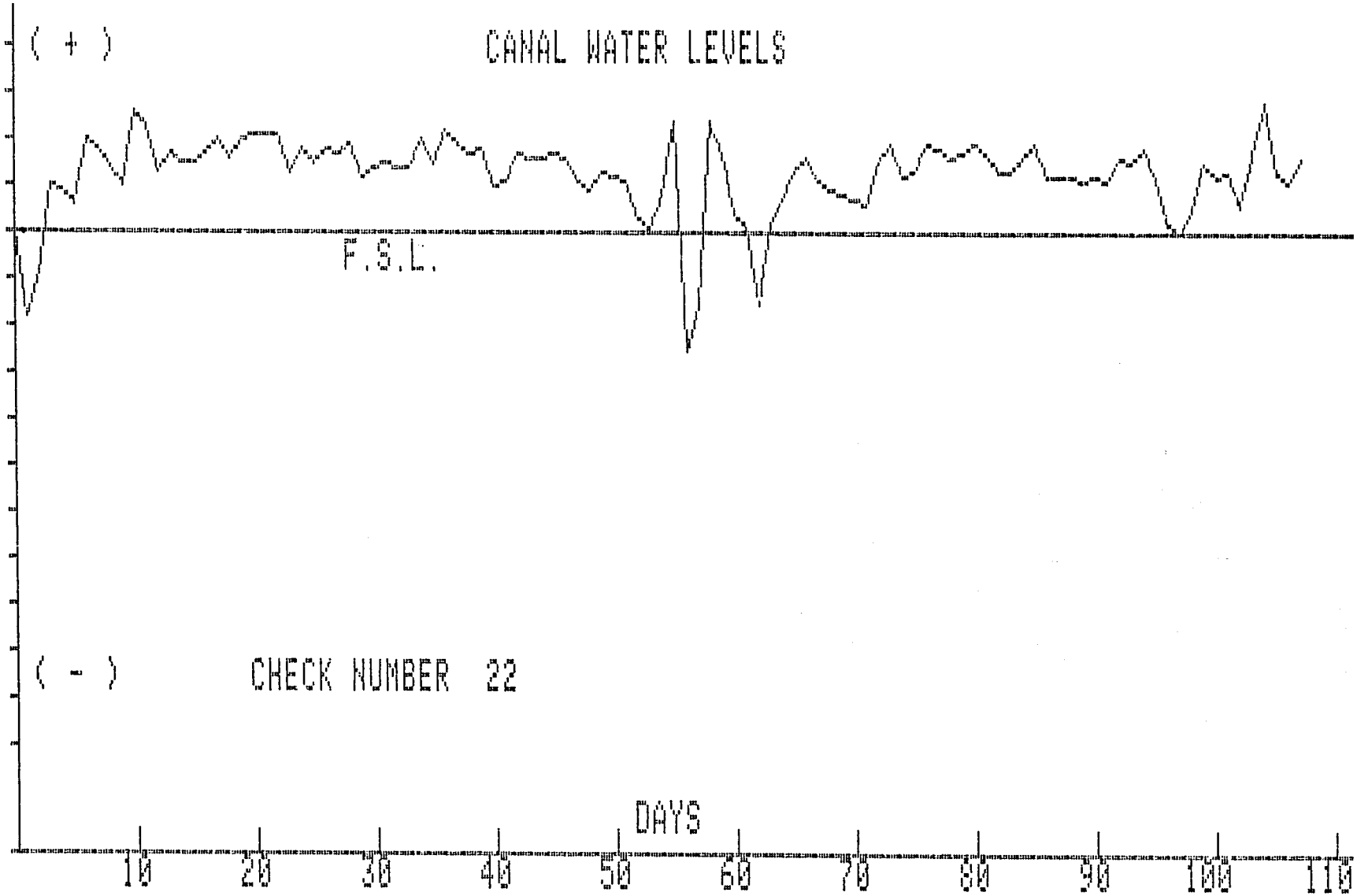
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Figure A6

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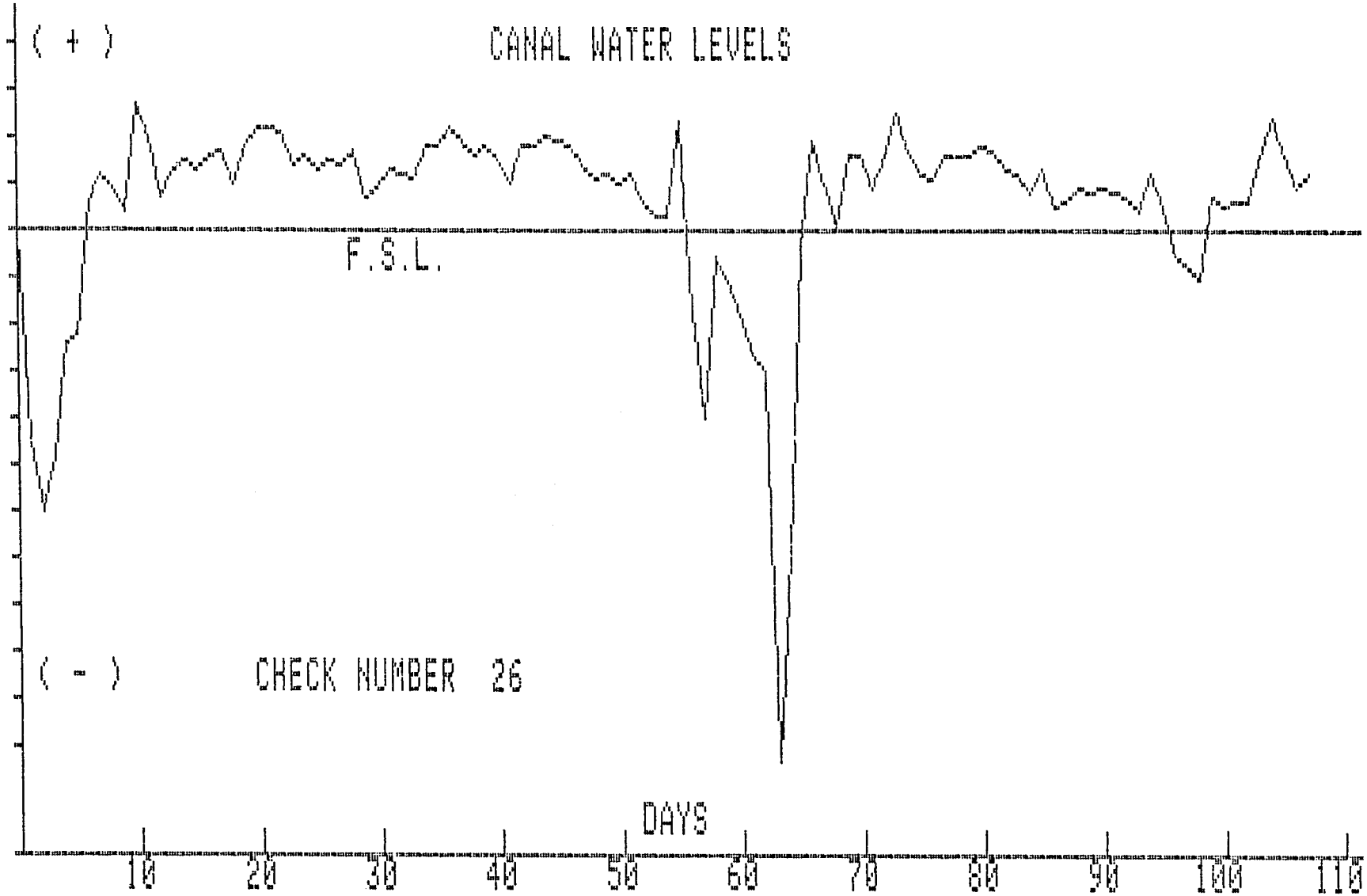
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Figure A7

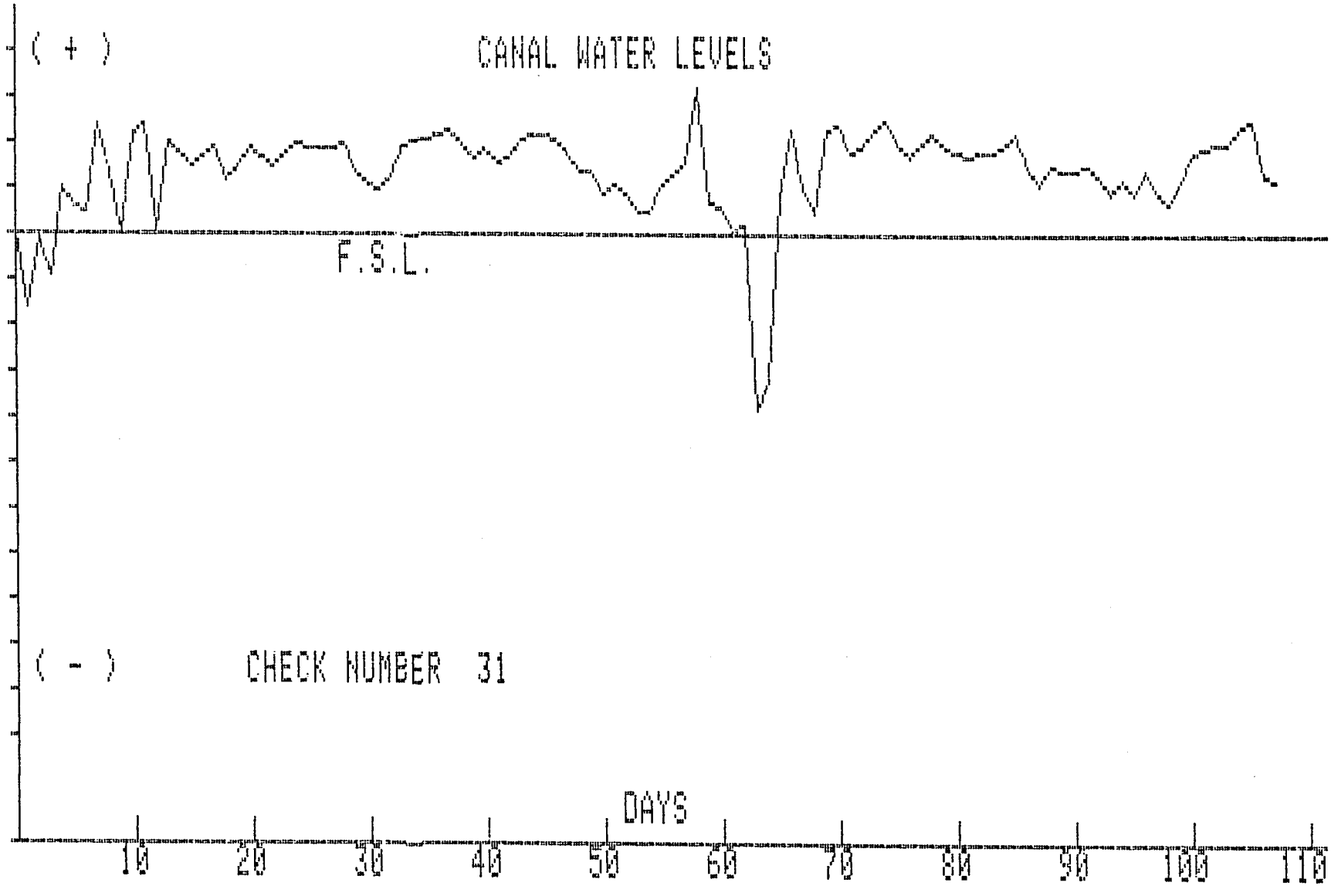
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Figure A8

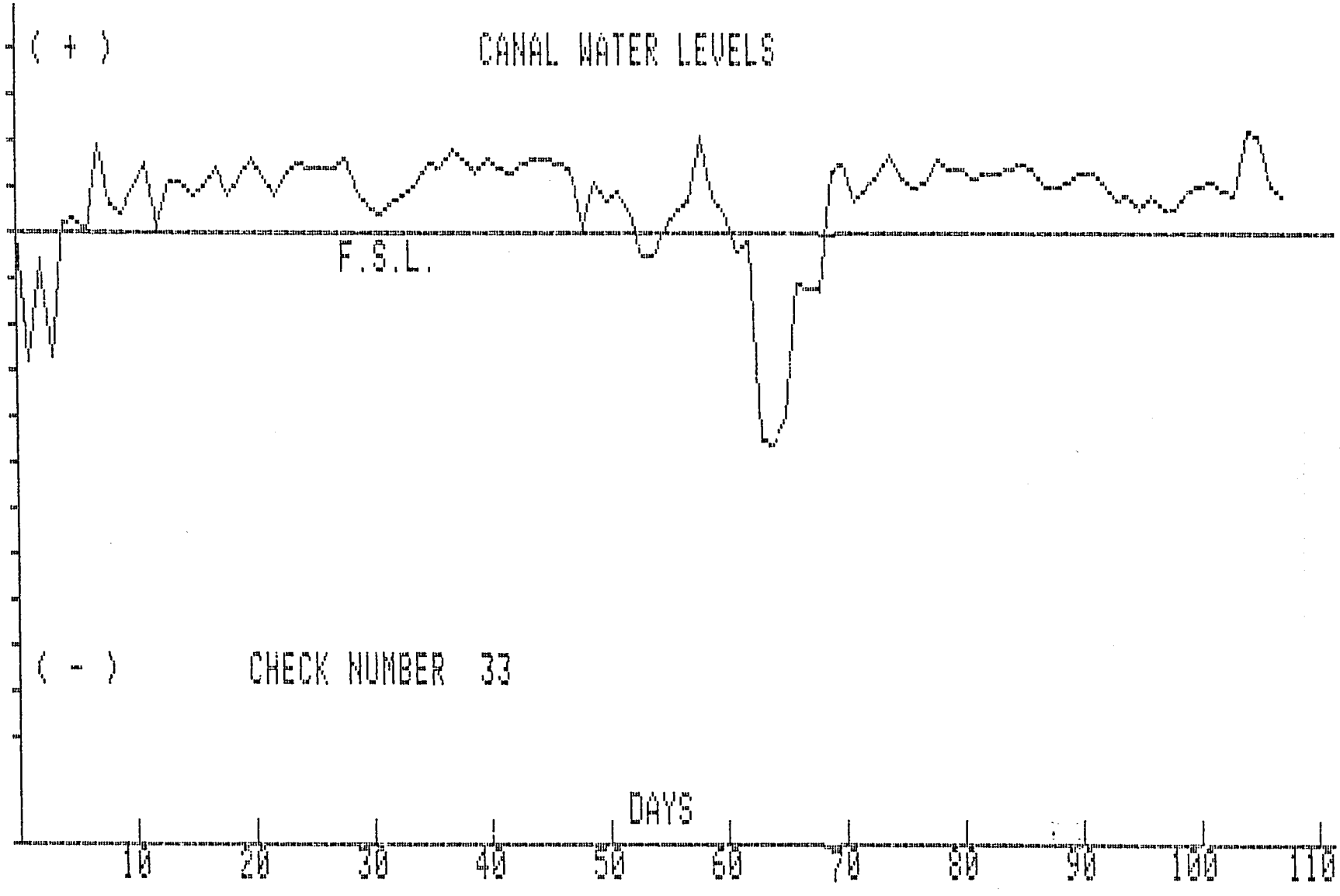
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Figure A9

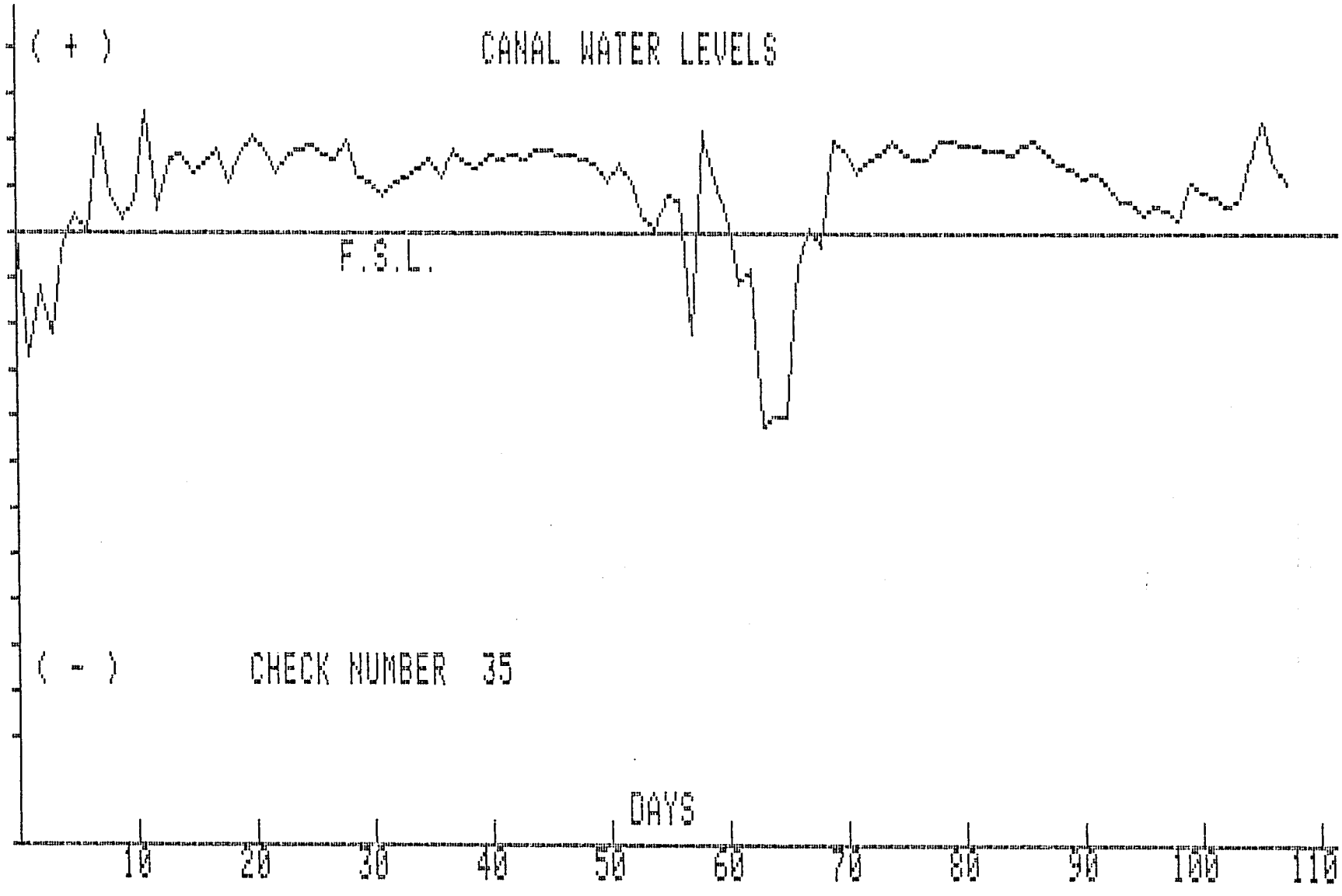
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Figure A10

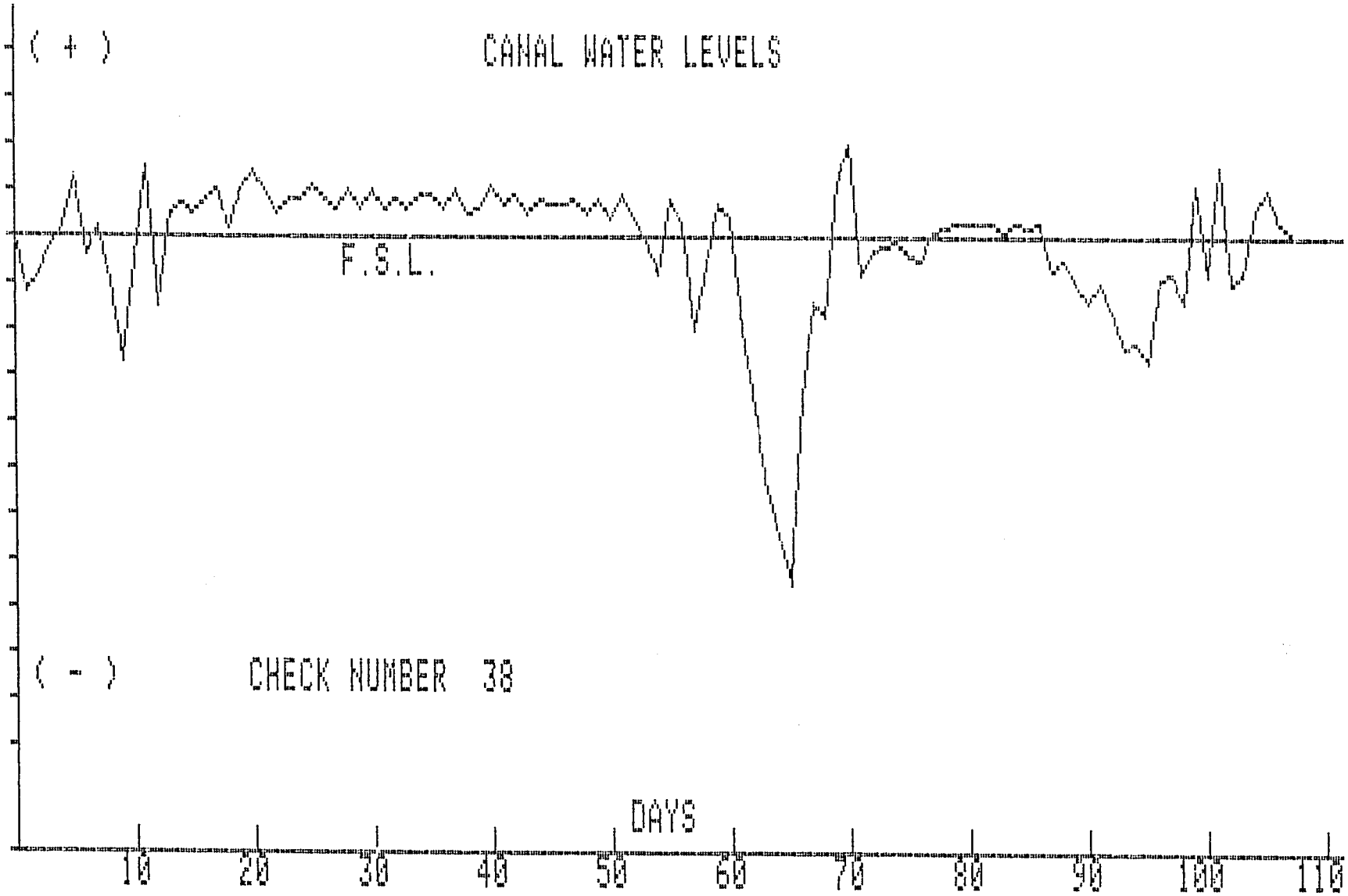
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Figure A11

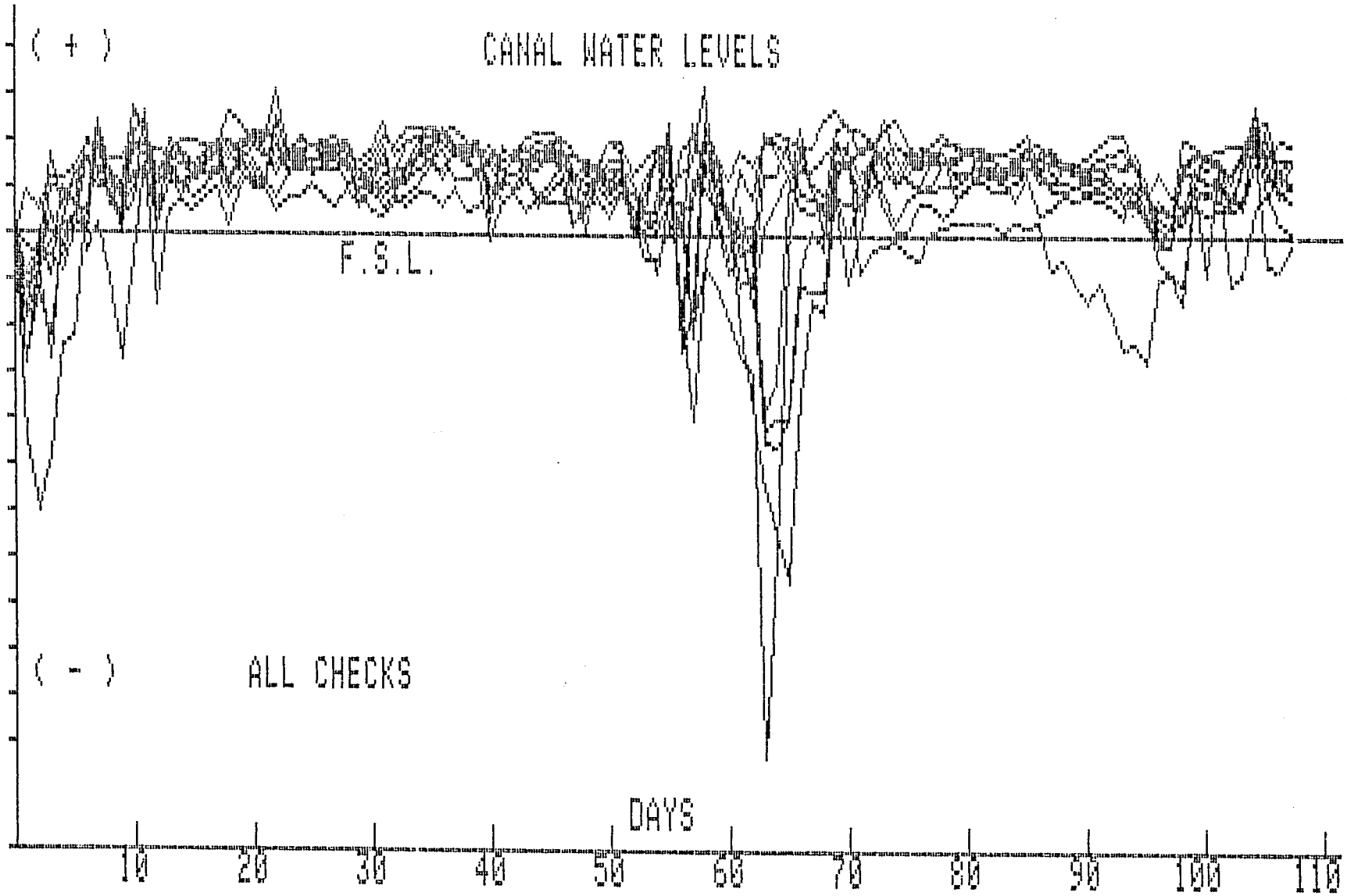
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Figure A12

TABLE A1

Daily water levels at each check in Right Main Canal
(+ or - from full supply level)

JANURARY 1983

Date	Check number 4	10	14	18	22	26	31	33	35	38
3	9.5	-2.5	-9.0	-7.5	-18.0	-44.8	-15.5	-27.9	-26.6	-12.0
4	5.0	-5.0	-7.0	-3.8	-9.0	-59.5	-1.0	-6.0	-12.0	-7.5
5	12.0	17.4	4.0	-4.4	10.1	-47.3	-8.5	-26.8	-21.3	-1.9
6	12.7	6.0	-5.0	-7.3	9.8	-24.0	10.0	2.8	-1.3	2.5
7	14.0	12.0	3.7	0.0	6.7	-22.0	6.5	3.9	4.5	13.3
8	19.8	16.2	16.3	16.3	20.8	6.0	5.7	0.9	0.7	-3.3
9	18.0	14.8	10.9	13.8	18.5	12.0	24.1	19.6	23.3	2.7
10	16.5	12.0	11.5	14.3	14.0	9.5	13.0	6.0	8.0	-10.0
11	16.5	9.0	8.0	7.0	10.8	4.3	0.3	4.3	3.5	-26.7
12	19.5	12.8	13.5	18.5	26.8	27.5	22.5	10.5	7.7	-5.0
13	19.7	15.7	14.8	17.1	23.9	20.4	24.1	15.4	26.1	15.9
14	18.0	13.8	11.5	11.2	13.9	7.3	1.0	1.0	5.4	-14.8
15	17.5	15.0	13.0	14.7	17.5	13.2	20.2	11.0	16.8	5.6
16	20.8	11.0	8.4	11.0	15.8	15.5	18.2	11.4	17.1	7.8
17	20.0	13.3	12.3	12.7	15.4	13.9	15.4	8.4	13.9	5.0
18	19.0	13.8	13.7	14.8	17.8	16.8	17.2	10.7	15.5	8.1
19	19.0	13.8	14.5	18.2	20.5	17.0	19.0	14.0	18.0	10.9
20	20.0	18.5	20.0	26.0	16.5	10.3	12.7	8.7	11.3	2.0
21	16.5	14.0	18.9	24.8	20.8	18.0	15.3	12.8	17.8	10.2
22	12.0	10.0	11.0	20.0	21.5	22.3	19.0	16.0	21.5	14.6
23	12.0	10.0	11.0	20.0	21.5	22.0	17.0	12.5	18.0	10.0
24	19.5	24.8	25.8	31.0	21.8	21.7	15.8	8.6	13.5	5.7
25	16.0	18.0	16.2	17.3	13.9	14.1	18.6	13.6	17.3	8.1
26	14.0	17.6	16.3	21.2	18.3	16.1	20.5	15.3	18.8	8.4
27	16.2	19.0	16.5	19.0	15.8	13.4	19.0	14.3	19.4	11.3
28	17.0	20.3	16.0	19.7	18.3	15.8	19.7	14.0	17.3	8.1
29	18.0	21.0	16.3	18.5	17.4	14.5	19.0	14.0	16.7	6.0
30	14.8	17.9	11.7	15.0	19.4	17.2	20.9	16.3	20.7	10.2
31	14.0	16.0	10.0	9.5	12.7	7.0	14.2	9.0	12.8	6.6

TABLE A2

Daily water levels at each check in Right Main Canal
(+ or - from full supply level)

FEBRUARY 1983

Date	Check number 4	10	14	18	22	26	31	33	35	38
1	16.5	18.1	10.2	13.1	14.7	9.6	11.8	5.9	11.2	10.1
2	21.0	24.0	17.9	19.5	15.9	13.4	10.5	4.0	8.3	6.0
3	19.3	17.2	9.4	10.9	14.6	12.1	13.2	7.8	11.5	8.9
4	23.0	20.3	14.8	15.3	14.8	11.5	20.3	8.9	12.0	6.9
5	23.3	21.0	17.3	20.3	20.5	18.9	21.1	11.8	14.3	9.0
6	23.8	23.3	16.2	19.0	15.9	18.1	21.9	15.3	16.7	9.9
7	20.4	22.4	18.3	23.7	22.3	22.2	22.0	14.3	12.0	6.4
8	17.0	18.7	12.4	19.5	19.2	19.5	23.0	18.3	18.2	10.5
9	18.1	19.4	12.6	19.2	17.1	16.3	20.0	16.3	15.4	5.6
10	18.5	20.5	13.7	19.9	18.9	18.0	17.8	13.5	14.3	6.5
11	8.8	3.0	-0.6	5.1	10.8	15.0	19.0	16.0	17.0	11.0
12	12.8	19.2	7.8	12.3	11.8	10.8	16.5	14.0	16.3	7.1
13	10.5	16.1	9.6	17.3	17.4	18.0	17.5	13.8	17.0	9.3
14	14.4	19.2	12.7	14.8	16.5	18.7	21.0	15.1	16.2	5.1
15	14.2	16.5	8.5	6.2	16.7	20.0	22.0	16.0	18.0	8.3
16	17.0	20.4	11.7	9.9	17.0	19.3	22.3	16.5	18.5	7.5
17	18.5	20.0	15.0	12.3	16.8	18.4	21.7	15.6	17.7	7.0
18	12.5	7.5	2.5	2.5	11.0	14.5	18.5	14.0	17.5	8.0
19	15.6	13.2	8.8	6.5	9.8	11.0	14.9	1.5	16.0	5.5
20	15.5	14.7	12.0	11.3	13.0	12.5	14.9	11.5	15.7	8.5
21	20.7	20.2	16.0	14.4	12.3	10.3	9.8	7.0	11.0	4.0
22	20.6	18.0	16.0	14.5	11.8	12.3	11.3	9.0	15.0	9.1
23	13.9	3.9	0.8	1.9	3.9	6.1	9.9	4.5	11.7	4.2
24	16.6	12.8	9.5	5.3	1.6	3.5	5.1	-5.0	3.8	-1.0
25	19.2	16.0	18.0	19.2	8.0	3.0	5.5	-4.5	1.7	-8.0
26	2.3	11.8	16.6	19.9	24.5	23.7	11.3	1.9	8.3	8.5
27	18.2	1.5	-16.8	-22.0	-24.7	-16.2	13.4	5.5	7.6	3.5
28	21.7	24.4	12.9	8.3	-16.0	-39.7	16.8	7.7	-21.7	-19.2

TABLE A3

Daily water levels at each check in Right Main Canal
(+ or - from full supply level)

MARCH 1983

Date	Check number 4	10	14	18	22	26	31	33	35	38
1	14.8	13.3	10.7	16.0	24.3	-5.8	32.5	21.5	22.0	-5.5
2	17.0	16.3	6.9	3.7	17.9	-10.5	7.6	8.3	11.4	7.8
3	12.0	2.6	-4.3	-8.0	4.1	-17.5	6.2	4.4	4.9	4.9
4	18.3	14.9	6.9	-1.8	1.0	-25.5	1.9	-3.3	-11.0	-19.5
5	15.0	8.0	-5.0	-11.0	-15.0	-30.0	2.5	-2.0	-8.0	-37.0
6	19.5	21.8	22.0	13.2	2.0	-113.0	-38.0	-45.0	-42.0	-55.0
7	22.6	20.5	18.1	13.0	7.8	-69.0	-31.8	-46.0	-40.0	-64.0
8	21.3	17.1	13.1	20.6	13.9	-3.7	8.7	-39.3	-39.3	-74.3
9	19.9	14.3	6.0	9.5	16.3	19.6	23.5	-11.0	-6.5	-35.0
10	19.0	14.3	5.7	8.7	11.1	10.1	10.8	-12.0	1.0	-14.0
11	25.0	17.0	7.5	6.5	9.2	1.5	5.0	-12.0	-2.5	-16.3
12	27.0	20.0	9.0	7.5	8.0	16.0	23.2	14.0	20.0	12.5
13	23.0	15.8	0.0	-10.0	7.5	16.0	24.0	15.0	18.0	20.0
14	23.0	19.0	9.0	0.0	6.5	9.7	18.4	7.4	13.8	-7.5
15	20.3	20.3	17.0	15.5	15.8	16.8	19.7	10.0	16.3	-2.3
16	17.3	15.6	9.2	6.0	19.9	25.5	23.5	13.0	17.7	-1.5
17	13.3	11.5	3.6	1.4	12.4	17.0	25.8	17.0	20.8	-1.0
18	18.0	16.3	8.4	1.8	13.3	12.7	20.0	12.8	17.5	-4.0
19	17.0	15.8	10.5	7.8	19.0	11.0	17.5	10.5	16.0	-5.0
20	18.3	17.8	10.5	7.3	18.5	16.6	20.5	11.5	16.1	1.5
21	18.5	18.5	11.2	4.0	16.0	16.8	22.8	16.8	20.8	2.0
22	13.5	9.3	11.5	7.6	17.5	16.8	19.0	14.8	20.5	3.8
23	14.5	10.5	13.8	11.4	19.3	18.0	18.5	14.0	19.8	3.8
24	15.5	14.5	18.3	13.2	17.9	17.0	17.8	12.0	19.8	3.8
25	15.0	14.5	17.0	10.2	13.5	13.2	18.5	13.5	18.2	3.5
26	14.5	13.5	15.8	10.5	13.2	12.7	18.5	13.5	18.0	1.0
27	15.0	16.0	16.5	12.0	16.5	8.5	19.0	14.0	17.5	3.5
28	14.8	15.2	17.8	14.3	19.5	13.0	22.5	15.3	19.6	2.5
29	18.2	15.0	17.0	17.5	12.8	5.3	15.0	14.9	20.8	3.3
30	14.5	16.0	18.0	19.3	12.5	6.5	11.0	10.5	17.0	-7.0
31	12.0	15.0	16.0	16.0	12.0	9.5	15.0	10.3	15.5	-5.0

TABLE A4

Daily water levels at each check in Right Main Canal
(+ or - from full supply level)

APRIL 1983

Date	Check number 4	10	14	18	22	26	31	33	35	38
1	11.5	15.2	16.0	15.0	11.3	8.2	14.4	11.3	14.9	-9.6
2	10.5	15.3	17.0	15.5	12.8	9.8	14.3	13.2	12.2	-14.0
3	10.0	17.0	20.0	15.0	11.0	8.5	15.5	13.0	13.0	-10.0
4	9.6	18.7	22.3	16.8	16.3	7.0	13.5	11.5	11.3	-16.0
5	12.7	19.9	22.0	15.3	15.8	4.5	9.0	7.5	7.5	-24.0
6	10.0	15.0	16.5	16.0	18.0	12.5	12.5	8.0	7.0	-23.0
7	3.8	9.5	10.1	10.3	12.8	5.0	9.0	5.5	4.5	-26.5
8	0.0	4.0	-2.0	-1.0	2.0	-5.0	14.0	8.5	6.0	-9.0
9	2.5	2.5	-2.0	-2.0	0.0	-8.0	9.0	5.2	5.0	-8.0
10	14.0	21.1	16.5	15.0	5.0	-9.1	7.3	5.0	3.7	-13.5
11	14.4	20.8	18.3	17.8	15.5	7.7	12.2	9.3	11.1	11.5
12	12.3	17.0	17.0	15.8	12.8	5.0	18.3	10.5	9.3	-8.0
13	12.0	16.5	17.0	17.0	13.0	6.0	19.0	11.0	8.0	15.0
14	9.5	14.2	8.4	12.3	6.8	6.8	20.8	9.8	6.7	-9.3
15	6.3	19.8	15.8	19.0	17.3	16.0	20.5	8.8	7.8	-7.5
16	24.0	26.0	23.5	20.8	28.9	24.5	24.0	22.0	16.3	6.5
17	18.0	17.0	9.0	-6.0	13.0	16.5	25.5	21.5	24.0	10.0
18	17.8	21.5	15.8	-6.5	11.3	9.5	13.4	10.5	15.5	3.5
19	17.9	20.4	17.5	-1.5	16.5	12.5	12.3	8.0	11.5	1.5

TABLE A5

Summary of Extremes and Averages

Totals for entire period

CHECK NO'S

	4	10	14	18	22	26	31	33	35	38
LOWEST =	2.5	-5.0	-16.8	-22.0	-24.7	-113.0	-38.0	-46.0	-42.0	-74.3
HIGHEST =	27.0	26.0	25.8	31.0	28.9	27.5	32.5	22.0	26.1	20.0
AVERAGE =	15.9	15.3	11.6	11.0	13.0	6.1	14.4	7.6	10.2	-1.5
LAR DIFF=	17.7	22.9	33.4	41.9	49.2	83.0	40.5	43.0	43.7	39.3
AVE. DAY DIFF.=	3.0	4.5	5.3	5.8	5.3	7.8	5.3	5.0	5.5	7.6

AVE. OF SYSTEM = 10

TABLE A6

Summary of Extremes and Averages

Totals for period without rotation

CHECK NO'S

	4	10	14	18	22	26	31	33	35	38
LOWEST =	2.5	-5.0	-9.0	-10.0	-18.0	-59.5	-15.5	-27.9	-26.6	-26.7
HIGHEST =	27.0	26.0	25.8	31.0	28.9	27.5	25.8	22.0	26.1	20.0
AVERAGE =	15.7	15.5	12.3	11.8	14.2	10.0	15.8	10.1	13.0	1.7
LAR DIFF=	17.7	22.4	18.5	26.8	19.1	28.0	23.1	29.6	22.6	30.7
AVE. DAY DIFF.=	2.8	4.0	4.5	4.9	4.1	5.0	4.0	4.1	4.0	6.3

AVE. OF SYSTEM = 12

TABLE A7

Summary of Extremes and Averages

Totals only for period of rotation

CHECK NO'S

	4	10	14	18	22	26	31	33	35	38
LOWEST =	2.3	1.5	-16.8	-22.0	-24.7	-113.0	-38.0	-46.0	-42.0	-74.3
HIGHEST =	25.0	24.4	22.0	20.6	24.5	23.7	32.5	21.5	22.0	8.5
AVERAGE =	17.6	14.1	7.2	5.5	5.5	-19.7	5.0	-8.7	-8.3	-22.5
LAR DIFF=	15.9	22.9	33.4	41.9	49.2	83.0	40.5	43.0	43.7	39.3
AVE. DAY DIFF.=	4.6	8.2	11.7	12.8	13.6	27.4	14.4	11.1	16.6	17.1

AVE. OF SYSTEM = -0

B. FLOW MEASUREMENTS IN THE RMC

Some flow measurements were made in the Right Main Canal (RMC) to try to determine the 'N' value for the channel as it actually operated. This value relates to roughness of the channel and is affected by such things as type of lining, silt, weed growth, etc. Different values of 'N' affects the velocity and depth of flow for given values of Q and channel geometry. Design value of 'N' for all lined channels at Lam Nam Oon is 0.014.

It was known that many sections of the RMC was heavily silted and that after about one month weed growth becomes thick. As a consequence the value of 'N' must be fairly high. Two measurements were made during the third week of January to assess this value. These measurements were carried out by using a pitot tube calibrated by RID's hydraulic lab. The pitot tube measures velocity, and by taking a number of measurements in the flow cross-section the average channel velocity can be calculated. Knowing this velocity and other channel dimensions the value for flow can be determined.

The following, table B1, shows the results of two measurements.

TABLE B1

Measurement	Average Velocity (m/s)	d(m)	b(m)	A(m^2)	Q(m^3/sec)	'N'
1	0.33	2.24	4	16.49	5.44	0.042
2	0.36	2.25	4	16.59	5.94	0.039

* A program written for the project's computer made analysis of many data points very easy.

These measurements show the value of 'N' to be about 3 times that of design, thus drastically affecting the channel hydraulics.

In using the pitot tube under field conditions at low velocities (probably $\leq$ 0.5 m/sec) it is doubtful if measurements are better than $\pm$ 10%. The calibration curves show a greater scattering of points at low flows. Also the physical reading to within maybe two millimeters, (while poised on a shaky bridge across the canal) is about all one can expect. Even with this margin of error the value of 'N' is still quite high.

This really means that silt and weed growth in the canal causes large changes in the hydraulic characteristics from those of design. It is doubtful if the canal can ever be operated at the value of 'N' used in design, but the elimination of silt and weeds will have very positive effects. In so doing the canal will function close enough to design for all practical purposes.

As far as is known no studies have been done to determine the coefficient of discharge for flow through the check gates. At some point, when a more quantitative way of RMC management can be carried out, this value will need to be known to properly operate the gates.

In conjunction with the above flow measurements a check of the coefficient of discharge for two sets of gates was made. These gates operate as submerged orifices and as such follow the general equation $Q = CA\ (2g\ \Delta h)^{\frac{1}{2}}$

Where Q = Flow in m^3/sec
C = coefficient of discharge
A = cross sectional area of gate opening, m^2
g = constant for gravity
Δh = difference in head across the gate; m

Table B2 shows the measurements and calculation of the coefficient of discharge; $C = \dfrac{Q}{A(2g\ \Delta h)^{\frac{1}{2}}}$

TABLE B2

Measurement	Q	A	Δh	$A(2g\ \Delta h)^{\frac{1}{2}}$	C
1	5.44	2.21	0.425	6.38	0.85
2	9.94	2.65	0.39	7.33	0.81

These values seem to be in the right range when compared to values used in other similar structures. Further tests should be conducted on all structures to arrive at a value for each one. There are two reasons for this. The first is that construction details affect the value of the coefficient. It has been observed that there are differences in construction details from one structure to another. The second is that the checks in some places are at a syphon crossing and others at culvert road crossings. The distance from the gate to downstream

outlet varies quite a bit. In measuring the difference in head across the gate the loss in culvert or syphon has to be taken into account also. The value of 'C' then takes into account the whole gate/culvert-syphon system. As such, every set of gates will in all probability have a different value for the discharge coefficients. Therefore, each should be determined individually.

C. WATER MEASUREMENTS IN PILOT AREA 2

1. Introduction

The 1982-1983 dry season is the second year that water measurements have been carried out in Pilot Area 2,(1) (PA 2). The original plans for this season was to study in more detail water use i.g. water use of a particular irrigated plot. Lack of sufficient personnel curtailed much of the proposed study. However, it was possible to continue measuring the total inflow to Unit 1 and 2 of the units within Pilot Area 2 (PA2). During 1981 construction was also completed in Unit 3 and a broadcrested weir (BCW) installed in lateral R-14L servicing that Unit to measure it's flow. This permitted research on Unit 3 during 1982/83. The remainder of this section presents the results of this study.

Each of the three units are served by only one constant head orifice turnout (CHO). Measurement into Units 1 and 2 continued to be made with previously installed cut-throat flumes. Unit 3 was measured with a newly installed broadcrested weir. (see Technical Note # 7 about this device) These measuring devices were read once a day by the RID engineer responsible for management of the Right Main Canal (RMC) in this area.

Since measurements were made only once daily they give only an estimate of total daily flows as levels in the flumes and BCW varied somewhat during the day. For the most part the CHO's were open during the day and closed at night as the farmers did not irrigate at night. Opening and closing times were not fixed. To arrive at a total daily flow a 10 hour-day was assumed.

2. Operation

Water was turned into the RMC on 15 December 1982 and was available to Pilot Area 2 (PA 2) about two days later. Systematic measurements began on 3 January 1982. During the intervening period ditches were cleaned and farmers prepared to plant. Water supply to the Pilot Area 2 (PA 2) system was closed on 19 April 1983 and measurements ceased. Water was thus measured over a 107 - day period.

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(1) The Lam Nam Oon Ditch/Dyke Water Delivery System Model designed by Louis Berger International, Inc. This system contains quaternary and tertiary water distribution channels, gated proportional division boxes, and is sub-divided into three Units of varying intensities of development.

Table C1-C3 show that the estimated daily flows for each unit during the season. In contrast to the 1981-1982 season there were hardly any times when water did not flow into Units 1 and 2.

During approximately 20% of the 1981-1982 season water was not available due to low water levels in the RMC. This occured for only about 4 or 5 days this season, (see section A; Management of the Right Main Canal). The systematic management of the RMC almost totally eliminated the uncertainty of water delivery that occured during the 1981-1982 season, therefore, the farmers were assured of water when needed. Unit 3 did have periods of no flow (14 days), primarily due to the very small area planted and the CHO being closed by the chak leader.

3. Analysis

Figures C1 and C2 show graphs of the daily flow rates for each unit. After the first month, Unit 1 shows a fairly continuous daily flow rate between 50-75 liters/sec. Unit 2 is highly irregular most of time with daily changes varying considerably. Unit 3, after the first month varies mostly between 25-50 leters/sec. All three graphs reflect the 4-5 days of low flow in the RMC during the first week of March.

Previously, Unit 1 had been operated continuously and Unit 2 on a 3 day on 14 day-off rotation, however during the 1981/1983 dry season all three units were operated on a more or less continuous basis by the farmers. The erratic daily flows in Unit 2 may, in part, be due to lack of experience by the farmers in operating the system or a number of people adjusting flows as they thought necessary.

Table C4 and Figure 3 shows the areas planted in all three units. Table C4 lists areas planted by tertiary and quaternary canal sub-units. Figure 3 shows the individual plot locations with shaded area approximately representing area planted. There was very little change in area planted from the previous year. The absolute area planted increased by about 24 rai, however, the percent of area planted of total available decreased almost 3% to about 8%.

Drainage outflow measurements were not made during the 1982-1983 irrigation season. The main reasons for this were: problems with the main drain serving Unit 2 and part of Unit 3 (much of the excess water accumulates in low areas making measurements of total outflow meaningless) and, as observed previously, outflow from Unit 1 was nil (again mainly due to accumulation in low areas).

In order to obtain a perspective about the amount of water delivered to each Unit compared to estimated crop water requirements the analysis shown in Table C5 was made. It should be noted that the assumptions used are, of necessity, rough. No attempt was made to get the kind of data required to arrive at a complete water balance. The figures are in the "ballpark", so to speak, and substantials observations over the past two dry season irrigation periods. Compared to the 1981-1983 season, efficiency for Unit 1 was slightly lower (22.4% vs 25%) and Unit 2 essentially the same (12.5% vs. 12%). Unit 3 for the 1982-1983 season had a low of 16% use efficiency.

It is a fact that, by far, the major contributing factor to low water use efficiencies at Lam Nam Oon continues to be the general lack of knowledge by farmer's concerning the water needs of dry season crops and management of water within the chak areas. This continues to be so, despite the already established training programs in the area. The situation vividly demonstrates that all training must be improved, intensified, and expanded. The various Departments concerned, including Department of Agricultural Extension, Royal Irrigation Department, Department of Agriculture, Department of Community Development and Department on Non-Formal Education must improve their demonstration and training.

4. Conclusions

Farmers in this project have little or no experience in irrigating dry season crops, they have only a long history of wet season rice cultivation. As such their concept of how much water should be applied to crops is taken from experience with rice. This unfortunately leads to applying far greater amounts of water than required for dry season crops.

Water management within the chaks has been unsatisfactory. Aerial as well as ground observations during the 1982/83 dry season reveals large areas covered by standing water. This is caused by poor management practices such as:

1) Farmers along a single ditch not irrigating at the same time. As a result water flows almost continuously with maybe one farmer taking part of the flow to irrigate while the rest flows out into unplanted fields.

2) Plots that are located some distance away from the supply ditch are served by water filling adjacent plots to a height where water will flow into the desired irrigated plot. This is in lieu of constructing a small ditch to deliver the water.

3) Cuts in ditch embankments and outlets to unused plots not closed properly thus allowing water to flow out into these areas.

4) Excess water from irrigated plots either allowed to stand or flow into adjacent unused plots. This is in lieu of constructing a small drainage channel to carry the excess to project drains.

All of these, and possibly more, causes not only result in low efficiencies but more seriously are resulting in high water tables with the dangerous potential of creating salinity problems for 10's of thousands of rai. In this regard a series of observation wells were installed during the 1982/83 any season and a number of salinity of groundwater measurements carried out. See Technical Note No. 8 for details of this study.

5. Recommendations

Given the very small percentage of area cropped during the 1982/83 dry season, the objective of assessing the operating characteristics of Pilot Area 2 could not be done. Therefore, it is recommended that studies continue until this goal can be reached.

An effort has been started to provide training to a project official to work on a day-to-day basis with the farmers in PA2 to help them with water management within each chak. Hopefully this will lead to eliminating the poor practices noted above. This should be a major objective for the coming dry season; and, if successfull, it should be expanded to the whole project area.

Management of the RMC during the 1982-1983 dry season provided an assured supply of water when needed at PA2. This should be continued so that farmers will have confidence in the system and be more receptive to new methods for managing water within their chaks.

A review of training (regarding who is trained, methods, subject matter, etc) by all concerned agencies should be conducted and work plans developed accordingly, since the present data and observations of chak operations show no improvement from last year.

TABLE C1

Daily Flow in L/Sec, 1982-1983
UNIT 1

JAN 1983

	48.9	68.5	39.6	30.3	65.0	88.7
76.8	89.3	67.9	70.2	144.2	100.5	102.6
89.3	76.8	81.7	104.6	89.3	63.9	83.0
0.0	125.3	144.2	66.2	70.8	70.8	76.2
113.7	66.2					

FEB 1983

		62.2	61.1	70.8	60.6	60.6
61.1	62.2	66.2	62.2	67.9	62.2	61.7
62.2	63.9	66.2	61.7	64.5	60.0	62.2
62.2	50.9	55.7	70.8	65.0	64.5	65.0
65.0	39.2					

MAR 1983

		51.5	57.8	55.7	65.0	43.9
22.4	0.2	0.2	34.6	48.9	47.9	54.1
76.8	53.0	56.7	54.1	54.1	56.7	56.7
76.8	86.1	70.8	65.0	65.0	65.0	59.5
67.9	70.8	70.8	70.8	70.8		

APR 1983

					67.9	65.0
70.8	73.8	54.1	59.5	54.1	56.7	56.7
56.7	59.5	73.8	70.8	65.0	73.2	70.8
131.2	135.0	146.6				

TABLE C2

Daily Flow in L/Sec, 1982-1983
UNIT 2

JAN 1983

	96.6	109.1	59.1	132.1	102.5	79.2
74.3	92.7	99.5	108.1	157.9	111.7	49.4
118.0	121.2	116.4	105.5	119.0	45.3	112.7
0.0	122.8	116.9	60.3	62.8	107.6	157.3
88.0	68.6					

FEB 1983

		61.5	63.6	116.9	122.8	66.1
32.8	70.8	132.1	129.8	132.1	130.4	45.3
95.1	63.6	63.2	120.1	55.5	42.8	136.5
107.1	54.8	69.9	108.1	191.3	35.7	118.0
61.5	19.0					

MAR 1983

		65.7	83.8	71.2	29.3	9.3
8.3	27.8	12.3	90.3	103.5	78.7	78.7
74.3	97.6	99.0	175.5	88.0	96.1	99.0
90.3	74.3	85.6	69.9	90.3	87.0	69.9
85.6	88.0	169.3	96.1	163.3		

APR 1983

					105.0	102.5
107.6	100.0	83.3	83.3	131.5	83.3	142.7
128.8	123.3	115.3	107.6	102.5	69.9	65.7
134.3	78.7	81.0				

TABLE C3

Daily Flow in L/sec, 1982-1983 Unit 3

January 1983

	40.3	38.3	4.7	86.2	15.1	12.3
30.0	0	0	21.4	30.4	66.0	43.5
30.4	42.5	66.0	63.4	67.3	68.5	30.4
0	66.0	69.8	76.5	72.5	76.5	73.8
72.5	53.7					

February 1983

		53.7	56.1	53.7	56.1	53.7
53.7	35.2	56.1	54.9	37.2	38.3	56.1
56.1	56.1	58.5	56.1	56.1	57.3	33.2
51.4	28.5	30.4	40.3	30.4	44.6	40.3
51.4	29.4					

March 1983

		35.2	35.2	25.8	0	0
0	0	0	0	0	0	0
0	17.4	0	4.7	27.6	45.7	40.3
35.2	30.0	21.4	25.8	35.2	25.8	21.4
37.2	35.2	40.3	10.3	10.3		

April 1983

					35.2	30.4
30.4	35.2	25.8	35.2	25.8	30.4	30.4
13.7	9.1	19.0	19.0	25.8	30.4	30.4
63.4	51.4	57.3				

TABLE C4

Planted Areas by Sub-Unit 1982-1983 Unit 1

T1.1			34.25	T1.2		39.875	74.125
	T1.1	9.75					
	QC 2.1	13.125			T1.2	5.5	
	QC 2.2	4.75			QC 1	14.0	
	QC 3.1	5.125			QC4.1	14.5	
	QC 3.2	1.5			QC4.2	5.875	

UNIT 2

T1.0			53.375	T1.1		25	55.875
	QC 1	20.25			QC7.1	1.5	
	QC 2	6.125			QC7.2	1.0	
	QC 3	5.75					
	QC 4.1	1.0					
	QC 4.2	1.75					
	QC 5	16.00					
	QC 5.1	0					
	QC 6.1	2.5					
	QC 6.2	0					

UNIT 3

T1			27.875	T1.1		0	27.875
	QC 1.1	5.25			QC 6.1	0	
	QC 1.2	1.00			QC 6.2	0	
	QC 2.1	12.375			QC 6.3	0	
	QC 2.2	9.25			QC 6.3	0	
	QC 2.3	0					
	QC 2.4	0					
	QC 3.1	0					
	QC 3.2	0					
	QC 4	0					
	QC 5.1	0					
	QC 5.2	0					

TOTAL FOR PA2 157.875

44(RMC)	13.75	
1L(R-15L)	21.00	31.75

TOTAL FOR 5 GROUPS 189.625

TABLE C4 (Cont'd)

	Total Area	Area Planted	% Cropped
Unit I	545.71	74.125	13.6
Unit II	692.96	55.875	8.1
Unit III	699.79	27.875	4
Total	1,938.46	157.875	8.14%

Figure C2

Daily Flows for Unit 3, 1982 - 1983

UNIT 3

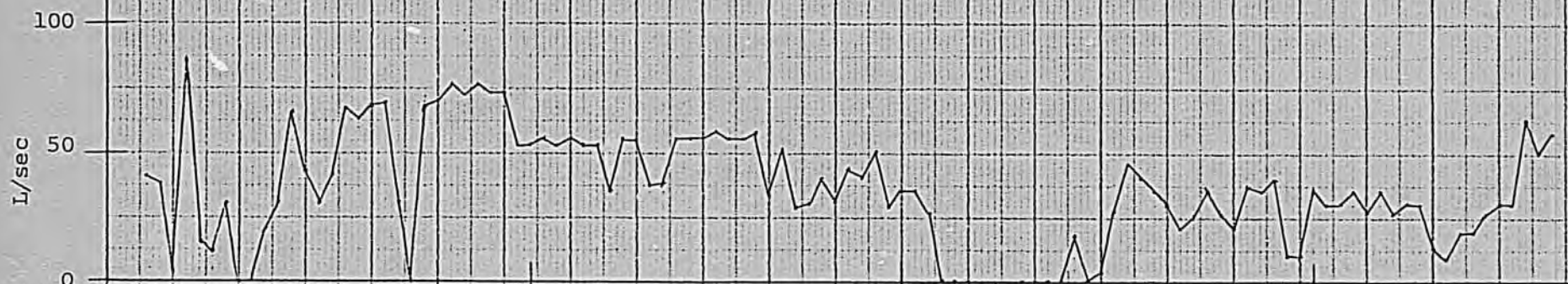

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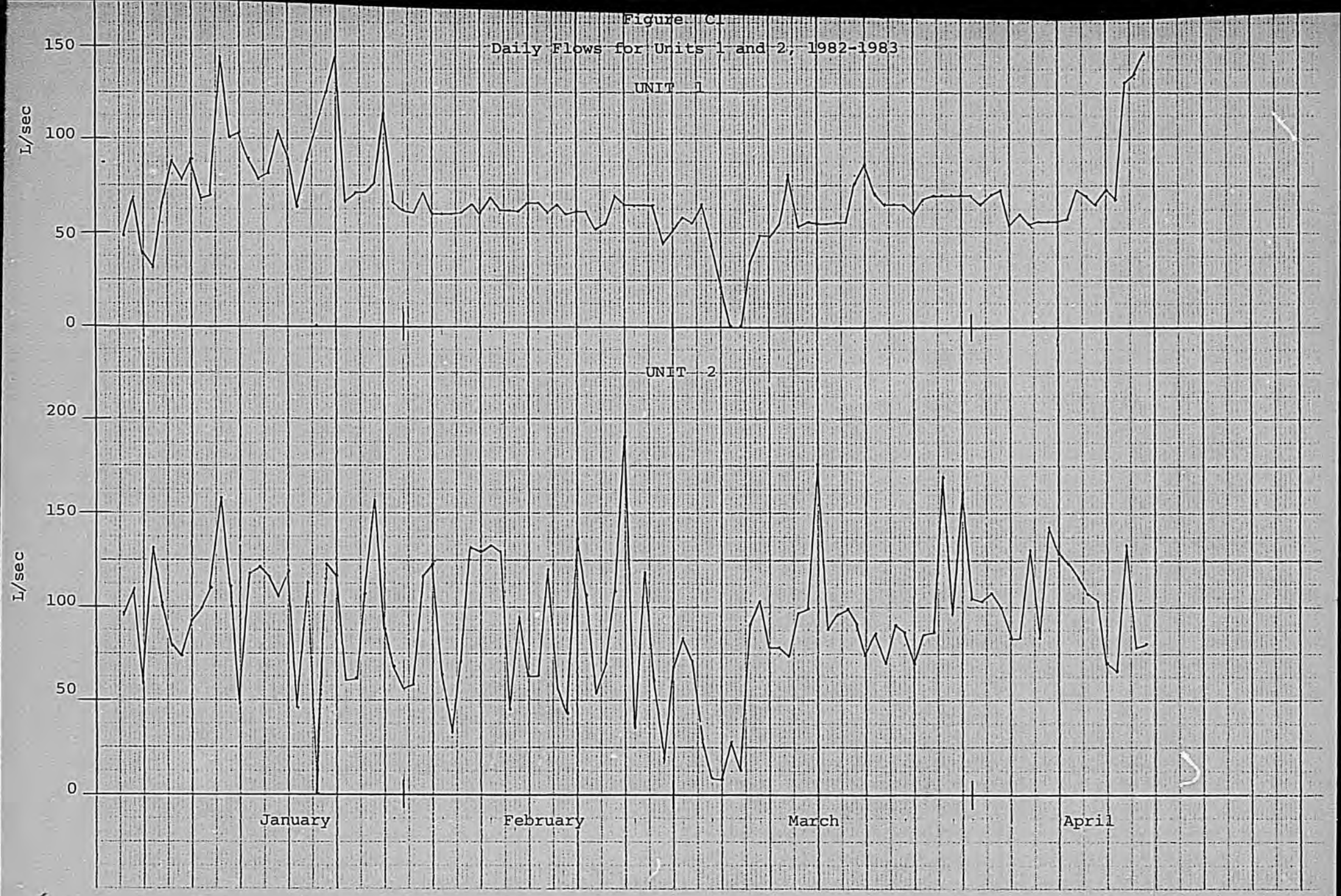
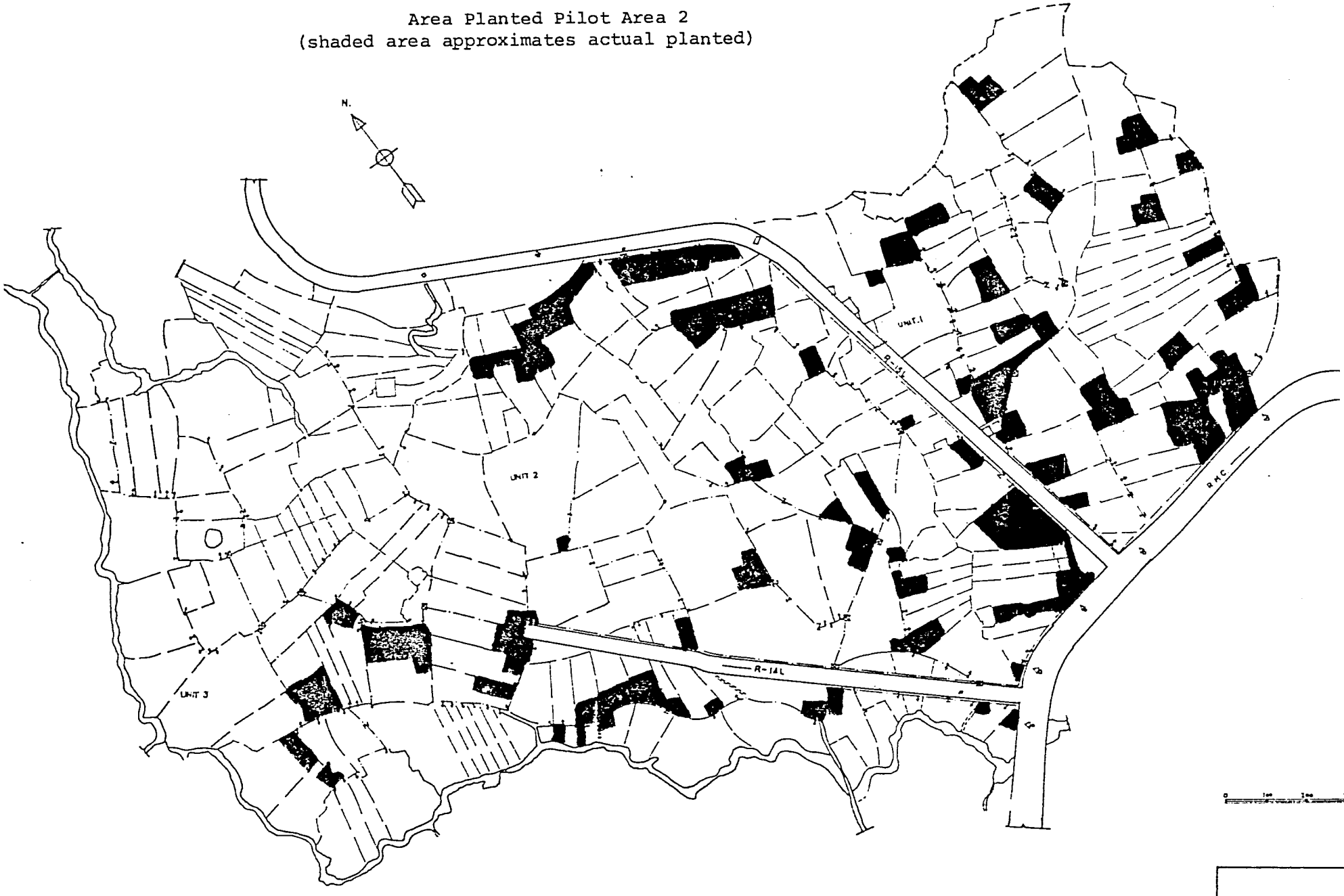
Figure C1

Daily Flows for Units 1 and 2, 1982-1983



Area Planted Pilot Area 2
(shaded area approximates actual planted)



PILOT AREA NO 2

MAP OF WATER COURSES

TABLE C5

ESTIMATE OF WATER USE EFFICIENCY 1982-1983

	Unit 1	Unit 2	Unit 3
Area cropped	74.1	55.9	27.9
Total water delivered	260,042	350,842	136,856
Water applied/rai	2,193	3,923	3,066
Assumed requirement	500	500	500
Effective rainfall	9	9	9
Required irrigation	491	491	491
Gross efficiency	22.4	12.5	16.0%

D. PONDING TESTS

1. INTRODUCTION

There has been some question concerning the seepage losses in unlined ditches in the Lam Nam Oon project. To the present time there were no studies or tests to help determine this. As a consequence, it was decided to do some ponding tests in Pilot Area 2, Unit 17, and others if time permitted. Three tests were conducted in PA2 and 3 in Unit 17, locations are shown in Figure D1 and D2.

2. METHOD

The ponding method of measuring loss in channels involves simply filling a section of the channel which is closed at both ends and measuring the rate at which the water seeps or leaks out. This gives precise results but only for a short section of the channel. Since loss rates are highly variable a number of tests must be conducted to give an accurate estimate of losses.

Two factors are critical in making the ponding loss measurements. The first is that the channel should be wet for a sufficient time before measurements are made to insure that losses are not higher due to infiltration into the dry ditch banks. The best time to make measurements is just after the ditch has been used. The second factor is to make the measurements when the water surface is about the same level as when the water flows normally. Since this level will fluctuate somewhat, depending on flow rates, an average level should be determined.

The goal is to estimate the losses in the channel so a representative section should be chosen. An unusually clean or straight section or one with no leaks will not give representative results. The length of section chosen will depend on the slope of the channel. Variation in ponded water level should not vary more than about 2-3 cm. Otherwise the sections should be as long as possible. A staff gauge is installed in the ditch and adjusted or marked for the operational level.

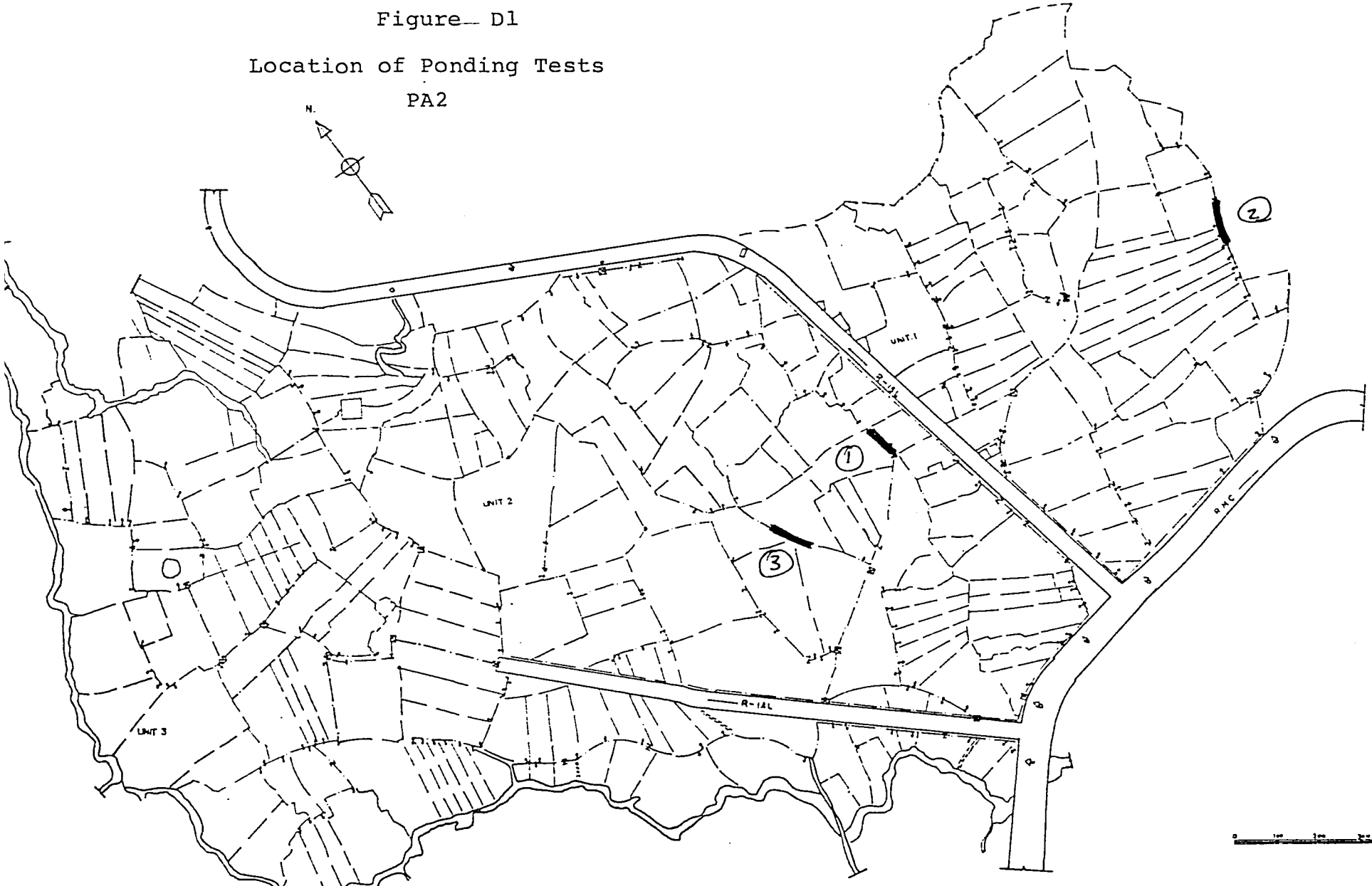
When ready to begin the test the downstream dam is installed while letting water fill the section to a few centimeters above operating level. When filled as desired the upstream dam can be installed. The dams can be earth, sheet metal, etc. and they must be leak-proof.

Figure D2
Location of Ponding Tests
Unit 17

Figure D1

Location of Ponding Tests

PA2



Section tested

PILOT AREA NO 2

MAP OF WATER COURSES

Readings of the staff gauge begin while the water level is above the operational level. Readings are made every few minutes initially as water drops more rapidly. As the water level change slows time between readings can be increased. Readings are continued until water level is below the operational level far enough to make calculations. Readings are recorded on individual data sheets, see sample sheet, Figure D3.

When the water level is at the operational level the average water surface top width should be determined. This can be done with a tape measure at several places along the test section. Figure D4 shows the setup for ponding tests. The loss rate is the rate at which water seeps out of the section. This is equivalent to the change in volume over time or the change in depth in a given times the water surface area. The change of depth over time is best determined by drawing a curve of time vs. reading and measuring the slope at the operating level, see Figure D5. When this is multiplied by average top width a loss rate per unit length is determined. The following equation shows this.

$$Q(L/S/100m) = \frac{\Delta d}{\Delta} \times T \times 0.00278$$

$\frac{\Delta d}{\Delta t}$ = Change in water level per unit time

T = Average top width

3. RESULTS

The following are the results of the tests at Lam Nam Oon during Feb-Mar 1983.

TEST #	LOCATION	LOSS (l/s/100m)
1	PA2	0.213
2	PA2	0.065
3	PA2	0.094
4	Unit 17	0.024
5	Unit 17	0.034
6	Unit 17	0.035

Average for PA2 is 0.124 l/sec/100m and for Unit 17 0.031 l/sec/100m. The values for PA2 then is about four times that for Unit 17. In either case the loss rates are somewhat lower than had been anticipated. It was expected that due to the rather sandy nature of the soils loss rates would be higher. One reason they are lower may be due to silt-clay particles settling out thus filling the pores in the more coarser sand and tending to "seal over". Other general observations of conditions prevailing are:

a) Bottoms of the ditches were fairly clear of grass, except in isolated spots, while sides were mostly grassed over.

b) Most ditches were not excavated down to design grade.

c) Most all cross sections were wider (in some places quite a bit) than design. Shape was irregular to somewhat parabolic rather than trapezoidal.

d) In some areas there were numerous small holes dug into sides of the ditch by villagers in search of frogs.

e) In most cases the farm inlets are closed only with straw and/or earth. This does not seal off completely so leakage occurs, (In these test they were sealed). Therefore the losses represent only losses in the soil and not leakage losses through outlets. The leakage through turnouts is quite extensive throughout the area.

These few tests probably are not enought to draw any final conclusions on the losses for each of these areas and certainly not for LNO as a whole. Time and personnel constraints prevented further tests during this dry season. Now that LNO personnel know how to conduct the test, additional studies should be carried out in all areas as they become operational. This data will be invaluable in helping to establish distribution efficiencies which in turn are necessary for properly managing the water supply.

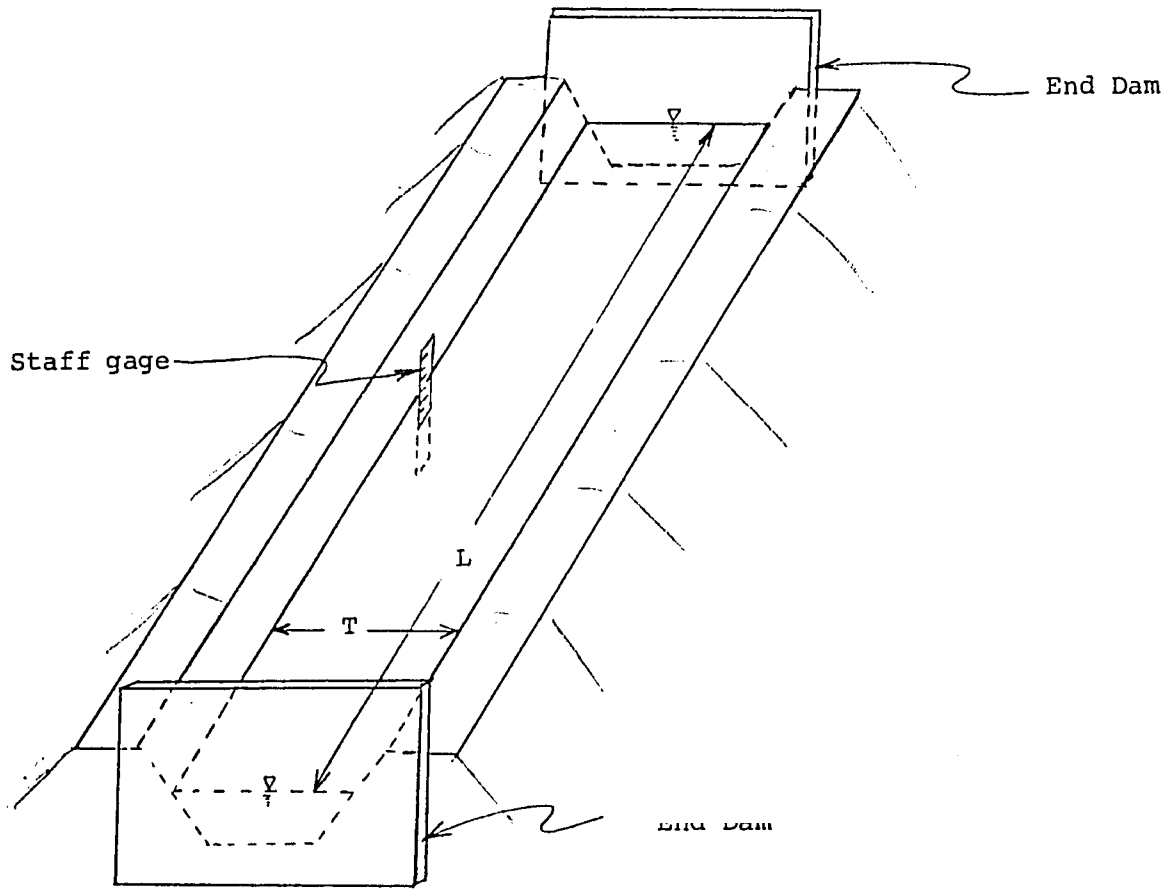
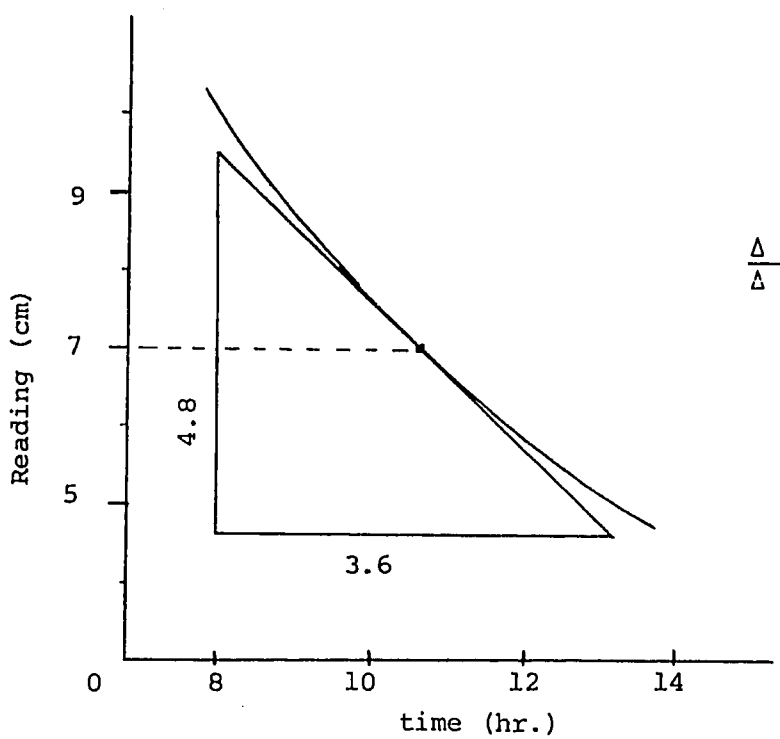


Figure D4
Setup for Ponding Test



$$\frac{\Delta d}{\Delta t} = \frac{4.8}{3.6} = 1.3 \text{ cm/hr}$$

(operational

Figure D5

Gage reading vs. time - calculation of $\frac{\Delta d}{\Delta t}$

Figure D3

Sample Data Sheet

PONDING TEST

LOCATION .....DATE.....

TEST SECTION .....

SECTION LENGTH.....

GAUGE READING AT FSL.....

TIME	GAUGE READING	TIME	GAUGE READING	TIME	GAUGE READING

WATER SURFACE WIDTH at .....

.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

AVE. TOP WIDTH.....

RATE OF LOSS (lps/100m = $\frac{dd}{dt}$ x AVE top Width x 0.00278

= _____ x _____ x 0.00278

LOSS = _____ lps/100m

E. COMPARISON OF CROPPED AREA 1982-1983 FOR PILOT AREA 2 (PA2)

1. ANALYSIS

The 1983 dry season is the second year for delivering water to PA2. This section of the report compares area cropped and kind of crops grown for the two years.

There are three Units in Pilot Area 2 and Table E1 compares the total area planted for each in rai and percentage of the total.

TABLE E1

	1981-82		1982-83	
UNIT	Area	%	Area	%
1	84.3	15.4	74.1	13.6
2	49.2	7.1	55.9	8.1
3	*	*	27.9	4.0
TOTAL	133.5	10.8	157.9	8.14

* Water not available due to construction

There was an absolute increase of 24.4 rai but a decrease in percent of area planted relative to total area that could receive water. Unit 1 decreased by about 10 rai and Unit 2 increased by about 7 rai.

Table E2 shows the number of farmers planting in each Unit and as a percentage of total farmers.

TABLE E2

UNIT	Number	%	Number	%
1	27	42.9	29	46.0
2	25	38.5	27	41.5
3	*	*	9	12.0
TOTAL	52	40.6	65	32.0

* Water not available due to construction.

Table E3 gives the area planted for each subunit in Units 1, 2, and 3.

TABLE E3

	1981-82	1982-83
UNIT 1		
T. 1.1	11.5	9.75
T. 1.2	0	5.5
Q.C. 1	10.8	14.0
Q.C. 2.1	13.8	13.1
Q.C. 2.2	5.3	4.8
Q.C. 3.1	4.5	5.1
Q.C. 3.2	3.5	1.5
Q.C. 4.1	25.0	14.5
Q.C. 4.2	10.0	5.9
UNIT 2		
Q.C. 1	10.5	20.3
Q.C. 2	4.0	6.1
Q.C. 3	1.5	1.0
Q.C. 4.1	0	1.0
Q.C. 4.2	4.0	1.8
Q.C. 5	15.5	16.0
Q.C. 5.1	0	0
Q.C. 6.1	3.8	2.5
Q.C. 6.2	5.0	0
Q.C. 7.1	2.0	1.5
Q.C. 7.2	3.0	1.0
UNIT 3		
Q.C. 1.1	-	5.3
Q.C. 1.2	-	1.0
Q.C. 2.1	-	12.4
Q.C. 9.3	-	9.3
Q.C. 2.3,2.4,3.1,4 5.1,5.2,6.1,6.2, 6.3	-	0

Table E4 shows the area for each of the different crops grown in Pilot Area 2.

TABLE E4

Crop	1981-82 Area	1981-82 %	1982-83 Area	1982-83 %
Groundnut	73.5	55.1	84.5	53.5
Corn	34.5	25.8	63.6	40.3
Chili	1)	-	2.9	1.8
Cucumber	1)	-	3.6	2.3
Other field crops	12.4	9.3	0.4	0.3
Other Veg.	9.5	7.1	2.9	1.8
Watermelons	2.3	1.7	0	0
Pumpkins	1.3	1.0	0	0
	133.5	100	157.9	100

1) included in other vegetables

Table E5 shows the number of farmers in Units 1 and 2 and their change of status from 1981-82 to 1982-83

TABLE E5

	UNIT 1	UNIT 2
Planted 81-82, did not plant 82-83	7	11
Did not Plant 81-82, Planted 82-83	9	13
Planted more in 82-83 than 81-82	5	6
Planted less in 82-83 than 81-82	12	7
Planted the Same	4	1

Then for PA2 as a whole for 1982-83, 18 farmers dropped out of irrigated cropping and 22, farmers started irrigated cropping. Eleven planted more and 19 planted less, with 5 remaining the same.

2. CONCLUSIONS

From the above analysis the following general conclusions can be stated:

1) The percent of area planted in PA2 decreased. Units 1 and 2 did not change very much. However, farmers in Unit 3 did not take advantage of the available water supply.

2. The same is true in regard to number of farmers planting. For Units 1 and 2 about 42% planted both years, for Unit 3 only, 12% planted in 1982-83.

3) For all of Pilot Area 2, then, about 32% of the farmers are planting 8% of area.

4) Area planted to groundnuts remained about the same while area planted to corn increased at the expense of other crops such as water-melons, pumpkins, and other field crops and vegetables.

5) There were 4 more new farmers planting than old ones that dropped out. Eight more farmers planted less in 82-83 than farmers that planted more.

3. RECOMMENDATIONS

Pilot area 2 has received considerable attention from project personnel over the past 2½ years, and it was expected that the area planted would increase rather rapidly. This has not happened. The big question then is why? The earlier problem of water supply has been removed with construction of the distribution system. It has been shown that marketing is not a constraint. At least these are the views of project personnel but are the farmers perceiving the problems the same way? They may see other serious constraints such as labor, access to credit, soil conditions (mainly salinity), more money to be made elsewhere, etc. as holding back increased production! This problem(s) needs to be identified as soon as possible so that corrective action can be taken.

F. WATER TABLE-SALINITY STUDIES

As part of the operations research a series of observation wells were installed in Pilot Area 2, Unit 15 and Unit 17. The water table-salinity results for PA2 are discussed in Technical Note #8. In general it was found that with only about 8% of the area planted, a high water table existed for a large part of the area. This together with a basic saline ground water condition in the area raises serious questions about potential soil salinization. Lack of proper water management both at the farm level (over-irrigation) and at the chak level seem to be the major causes contributing to the high water tables.

G. BROAD-CRESTED WEIR INSTALLATIONS

A full explanation of the Broad-Crested Weir, its design, and application is discussed in Technical Note #7. Two weirs were constructed in laterals R9L and R-14L to monitor their operation. The weir at R-9L was checked several times with a pitot tube measuring device. All measurements were within 3% predicted for the weir, well within experimental error. As noted in discussion on management of the RMC quantities of water flowing into the laterals were not measured, due to difficulties with use of the CHO type turnout for measuring. However, the weir was used at R-9L and R-14L to measure the water flowing into the laterals. Engineers in charge found it to be very easy to use and knew very accurately what flow was being diverted from the RMC. Considering the ease of design, simple construction and low cost it is recommended that a broadcrested weir be installed in each of all the LNO laterals.

AUTHOR

William C. Bell has been a member of a Louis Berger International, Inc. advisory team at the Lam Nam Oon Integrated Rural Development Project in Changwat Sakon Nakhon, Thailand since October, 1979.

He is assigned as an Irrigation Systems and On-Farm Water Management Engineer. As such, he has assisted in installing a number of water management innovations at Lam Nam Oon including the broadcrested weir, micro-computer-based water management, etc.

He is a member of the American Society of Agricultural Engineers. He is a graduate of North Dakota State University and the University of Idaho with degrees in Agricultural Engineering.

He has worked in the United States as a supervisory hydraulic engineer with the U.S. Bureau of Reclamation, and abroad in Brazil, Indonesia, and, currently Thailand.

Mr. Bell's other papers published at Lam Nam Oon to date (July, 1983) include:

- Hand Book, Channel Design, With Tables, for Varying Size Quaternary Canals Specific to Conditions at Lam Nam Oon.
- Project Note No. 2 Lam Nam Oon Preliminary Water Space and Integrated Rural Development Planning.
- Project Note No. 4 Dry Season Crop Production - 1981/82 - Lam Nam Oon.

- Project Note No. 5 Pilot Area 2 Operations Research Results - 1981/82 - Lam Nam Oon (in collaboration with Anthony Zola.

- Project Planning Note No. 7 Micro-computer based irrigation system management - Lam Nam Oon.

- Technical Note No. 7 - The Broad-Crested Weir a simple-accurate flow measuring device for irrigation channels - Lam Nam Oon, March, 1983.

- Technical Note No. 8 - Potential Salinity Problems at Lam Nam Oon and Results of Initial Investigations, June 1983.