MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT – VIETNAM

IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
ADB LOAN No. 1259 - VIE (SF)

SUMMARY

of

BENEFIT MONITORING AND EVALUATION

FINAL REVIEW REPORT

Prepared by:

Consortium EXPERCO/KCC/ECI

April 2001

TABLE OF CONTENTS

List of Abbreviations

ADB	Asian Development Bank
BME	Benefit Monitoring and Evaluation
CONSORTIUM	Experco Ltd. in association with Klohn-Crippen Ltd. and ECI Inc.
CONSULTANT	International Consultants for Project supplied by Consortium
CPO	Central Project Office
DDMFC	Department of Dyke Management and Flood Control
EIRR	Economic Investment Return Rate
HD	Hanoi Dyke Sub-Project
ICB	International Competitive Bidding
IG	Irrigation Group
IFPRP or PROJECT	Irrigation and Flood Protection Rehabilitation Project
IMC	Irrigation Management Company
IPM	Integrated Pest Management
LCB	Local Competitive Bidding
MARD	Ministry of Agriculture and Rural development
NNA-IMC	North Nghe An Irrigation Management Company
NNAIS	North Nghe An Irrigation System
PARD	Provincial Agriculture and Rural Development Office
O&M	Operation and Maintenance
RRA	Rapid Rural Appraisal
SC-IMC	Song Chu Irrigation Management Company
SCIS	Song Chu Irrigation System
SPO	Sub-Project Office
TA	Technical Assistance
TOR	Terms of Reference
VIE (SF)	Vietnam Special Fund
WUA	Water User Association
WUC	Water User Co-operative

List of Tables

List of Figures

Consultant Team

The international consultants, who contributed to this report, were :

- Mr. Mihai Amza, Team Leader and Irrigation/Agricultural Specialist
- Mr. David James, Team Leader for IFPRP and Construction Specialist
- Mr. Alain Lamontagne, Economist
- Mrs. Sophie Lamontagne, Sociologist and Environmentalist

PREAMBLE

The benefit monitoring and evaluation (BME) system provides the Ministry of Agriculture and Rural Development, the Central Project Office, other government and local authorities and the Asian Development Bank (ADB) with information on current project performance and on the future sustainability of its economic and environmental benefits.

In accordance with the Terms of Reference of the IFPRP and the Guidelines of the ADB, the Consultant Consortium: Experco/KCC/ECI was entrusted with the survey for and production of the BME reports before, during and after the implementation of the project. The present report is the last one in this series of BME reports.

This Final BME Report concentrates on the final results of the project but also covers the main items encountered during the 6-year period since the project commenced in 1994. In order to produce this report, the efforts of the Consultant were supported by specialists from the CPO and local organizations and by other experts, who formed a multidisciplinary team. The report gives the findings and recommendations of water resources engineers, irrigation specialists, sociologists, agronomists, economists and environmentalists, who contributed to the field inquiries and to the analysis of the data.

The Consultant wishes to acknowledge all the participants involved in producing this report and to thank the CPO's staff for their support in providing information, expertise and logistics. They hope that the BME system and follow-up on the project will continue so that the benefits are improved or, at least, sustained at their current level.

Note: This Summary is dated April 2001 and has minor differences to the main text to reflect the situation at the expiry of the Loan Validity on June 30, 2001.

1. INTRODUCTION

This brief report summarizes information given in the Benefit Monitoring and Evaluation Final Review Report for the Irrigation and Flood Protection Rehabilitation Project prepared by Consortium: Experco/KCC/ECI and dated March 2001. If clarification or more detail is required than is provided by this Summary, reference should be made to the accompanying full Report and Appendices.

The Irrigation and Flood Protection Rehabilitation Project (IFPRP) was initiated by the Government of the Socialist Republic of Vietnam using Loan 1259 VIE (SF) and technical assistance from the Asian Development Bank (ADB). The loan became effective in March 1994 and this was the start of the implementation of the project.
The total project was originally divided into three separate sub-projects as follows:

Hanoi Dyke Sub-project.
The objective of this sub-project was to improve the capacity of a 45-km dyke section to protect Hanoi from flooding from the Red River. It consists of strengthening the dyke-body; improving its foundation and providing bank protection to lengths of the dyke, which have been subject to erosion by the river.

Song Chu Irrigation System.
Located 160km south of Hanoi, the irrigation system was constructed in the 1920s to supply water to 50,000ha of paddy. Neglect and war had severely reduced the capability of the system and the intention of the project was to return the system to its original design capacity. Work involved the completed rehabilitation of the headworks at Bai Thuong and remedial work on and lining of main and secondary canals.

North Nghe An Irrigation System.
This is a smaller irrigation system, located approximately 300km south of Hanoi. It was constructed in the 1930s to supply 30,000ha of paddy. This system had deteriorated in a similar way to that at Song Chu and similar work was undertaken.

During the execution of these works it became apparent that the total expenditures would be considerably less that had been estimated. Agreement was reached between MARD and the ADB that the resulting savings could be used to extend the scope of the project by:

- Extending the dyke upgrading and partial bank protection along an additional 16 km length of the Hanoi Dyke, located downstream and East of the Hanoi area.

- Repairing and limited upgrading of four irrigation systems in the North Central Provinces of Quang Binh and Quang Tri. These systems, which had been damaged in the floods of 1999, were Rao Nan in Quang Binh and Bau Nhum, Khe May and Nam Thach Han in Quang Tri, totaling more than 13,000 ha irrigated area..

The locations of the various sub-projects are shown on Figure 1.

The objective of the Final BME Review Report is to assess the technical, socio-economic and environmental conditions and the impact of the Project at the completion of its implementation (June 2001). The Final BME Review Report is part of the BME system of the IFPRP and comes

within the scope of the overall BME system. This includes a series of activities designed to supply the information necessary to ensure that the expected socio-economic results of each subproject are realised at the date of completion, and to form a main benchmark for further project monitoring.

At the date of reporting, the BME System for IFPRP has comprised of the following components:

(i) Comprehensive agriculture and socio-economic assessment review of the Song Chu and North Nghe An Irrigation Schemes at the commencement of the IFPRP (this report has been carried out in 1995 as the *Assessment Report on Agricultural and Socio-Economic Conditions);*

(ii) Comprehensive evaluation report which serves as mid-term review within two years from the commencement of the project (this report has been carried out in 1997 as the *BME Mid-Term Review Report);*

(iii) Yearly evaluation report (one report has been carried out in 1998-1999 as the *BME 1998 Review Report);*

(iv) *Final BME Review Report* at the project completion in 2001 (the present document represents the *Summary* of this report).

No attempt has been made, in this summary, to address the reasons for or the methodology used in the development of the Final BME Review Report. For this information, please refer to Chapters 1 and 2 of the main report and to the appendices.

In general terms, subsequent sections of this summary address the sub-projects individually, except where this would lead to unnecessary repetition because the statements or comments are identical for the different projects.

2. HANOI DYKE – ORIGINAL SECTION

2.1 General Description

The Sub-project covers a 45-km section of the dyke, between Km 40 and Km 85, which protects Hanoi from flooding by the Red River. Since 1971, failures involving seepage, sandboils and slips in the dyke body had been reported. In several locations, there was a risk of failure because of riverbank erosion being very close to the toe of the dyke. The rehabilitation of the dyke was a high priority for MARD/CPO, to ensure the safety of the 2 million residents and to prevent inundation of approximately 42,000 ha of agricultural land.

With the exception of the relief wells, the work will be completed by May 2001.

The additional length of dyke, between Km 85+300 and Km 101+300, which forms part of an extension to the project, is covered in Section 5.

2.2 Rehabilitation Work - Status and Performance

In 1994, when the project commenced, most of the 45-km length was considered to be deficient to some degree. The main problems identified for rehabilitation were:

- Toe erosion of the banks. This was as deep as 20 m below the dyke foundation and threatened the stability of the dyke where the erosion was close to the dyke toe. Integrity of the dyke body. The integrity and stability of the embankment has been affected by internal erosion, shallow slips, termite nests and cracks related to foundation deformation.
- Foundation conditions. The dyke foundation is poor where the clay layer, on which the dyke is founded, is thin and laying on fine sands or where there are deeper organic deposits. These conditions led to areas of sand boils during floods.
- Human activity on or near the dyke has damaged the dyke body and affected its stability.

The location of rehabilitation work, which has been carried out, is shown on Figures 2 and 3.

2.2.1 Bank Protection

This consisted of the protection of the bank toe with rockfilled dragons and gabions and the armouring of the bank slope with stone revetment along selected lengths, where the erosion was most threatening. The whole system was underlain with filter cloth to prevent fine material being removed from the bank under drawdown conditions.

The total length of bank protection is 7.4 km, in the following five sections namely : Ba Giang, Lien Tri, Thuy Phuong, Phu Gia, Thanh Tri, as follows :

- Ba Giang Section : km 41+250 to km 41+720 (470 m length);
- Lien Tri Section : km 44+280 to km 46+030 (2350 m length) in three in three stages : Lien Tri (1760 m), Lien Tri Extension (275 m), Lien Tri II (315 m);
- Thuy Phuong Section : km 52+850 to km 54+230 (950 m length in two sub-sections : km 52+850 to km 53+300 and from km 53+480 to km 54+230);

- Phu Gia Section : km 56 +300 to km 58+900 (2600 m length) in 3 three stages : 790 m, 1010 m and 800m;
- Thanh Tri Section : km 70+960 to km 71+740 (780 m length).

Performances
The bank protection has performed satisfactorily and is sustainable with correct monitoring and maintenance.

At Ba Giang deposition has occurred on the riverside. This has created new land for agriculture during the dry season. The other sections appear to have stabilised, but the work, below minimum water level, must be checked and bathymetric profiles drawn periodically. If there is evidence of erosion, this must be repaired.

Thuy Phuong, constructed under Local Competitive Bidding (LCB), is generally satisfactory, except at Km 54 (Pagoda). This location should be carefully monitored. As noted in 1997, the bank protection here could possibly be undermined by erosion of the slope toe and, if erosion occurs, the dragons should be replaced to ensure bank stability. The retaining wall has no weepholes through it and currently appears to be displaced towards the river. Relief drains should be drilled through the wall near its base.

2.2.2 Dyke body strengthening:

These works consist of berm or embankment filling, body enlargement, slurry grouting of the dyke body, land-side and riverside berms, the treatment of erosion and cavities and retaining walls. The works were implemented over virtually the whole 45-km length of the dyke. The dyke geometry is now rehabilitated to resist the 1/100-year flood water level and associated waves. Where the dyke is more than 6 m high, a berm of 4-m width has been provided on both sides. These, in village areas, have been concreted and serve as access roads. The dyke embankment in the Hanoi City area has been replaced with a masonry/concrete wall to facilitate transport.

Embankment filling

Filling and enlarging the dyke body and berms occurred in the following lengths of dyke:
- Km 39+875 – Km 48+000: (8125 m length)
- Km 48+000 – Km 55+000: (7000 m length)
- Km 70+700 – Km 76+400: (5700 m length)
- Km 76+400 – Km 79+900: (3500 m length)
- Km 79+900 – Km 85+750: (5850 m length)
- Km 78+000 – Km 78+750: (750 m length)

Slurry grouting

Slurry grouting improves the dyke structure to a depth of 10m, where the permeability of the dyke material was greater than 0.01 cm/s; where piping or cracks were found, or where there was a potential for erosion or termite nest cavities. Basically, the grouting technique consisted of injecting clay slurry into boreholes. Grouting was performed from:
- Km 40+300 – Km 48+000
- Km 80+100 – Km 82+350

- Km 83+100 – Km 85+110
- Km 73+700 – Km 74+400
- Km 81+050 – Km 81+700

Retaining walls

Other earth works, retaining walls and wave protection have been constructed in 25 sections.
- Km 48+000 – Km 55+000: (5 sections);
- Km 55+000 – Km 59+420: (4 sections);
- Km 63+850 – Km 68+490: (4 sections);
- Km 68+500 – Km 80+000: (12 sections);

Performances
The dyke body has been enlarged to the width of a provincial two-way road, the minimum design crest dimension. The enlargement of the dyke body was adjusted to suit existing conditions and to minimise the negative impacts, such as relocation, land occupancy and disturbance to economic activity. In cases where the dyke was narrow and there is no space for enlargement, a retaining wall was constructed on the crest (mainly in Hanoi City area and locally in Thanh Tri).

2.2.3 Dyke foundation strengthening

These works consist of river and landside blankets, pond filling and the treatment of sand boils with relief wells.

Blankets and Fillings

The blankets and fillings have been constructed as follows:
- Km 41+300 – Km 43+100: (100 m, river side impervious blanket);
- Km 46+660 – Km 47+100: (440 m, pond filling);
- Km 73+500 – Km 74+000: (500 m, land side and river side filling);
- Km 79+850 – Km 81+100: (1250 m, pond filling).

Performances
The performance of the blankets and pond filling on the river side are considered to be good, as demonstrated by the reduction of seepage and the lower level in domestic wells, during the flood season. However, there is no regular monitoring to quantify actual performance. The performance would have been improved if the earth material used for filling had been more impervious. Certain blankets (e.g. Km 83) were built with fine sand, which is unsuitable for this work.

The performance of landside berms and platforms are considered to be satisfactory. These berms increase dyke stability and facilitate maintenance and access to the dyke. There is a concrete road, which is almost continuous from Km 40 to Km 82. The material used for the landside berms was permeable in accordance with the technical specifications. However, in some locations, the berms were constructed without compaction (Km 83 - Km 84).

Relief Wells

Pressure relief wells were installed to control seepage and reduce groundwater pressures to prevent piping and sand boils in the foundation materials. These are essentially similar to water wells but they require a high degree of quality in their installation and careful monitoring after completion.

As of June 2001, the progress on the wells will be as follows:

Table 2.1 Relief Wells

Construction Package	Location (kilometre)	Designed Wells (no)	Installed Wells (no)	Wells of 65% Efficiency (no)	Percentage Reaching 65% Efficiency
1	48.0 to 52.5	31	31	7	23%
2	72.5 to 73.5	36	36	26	72%
3	81.5 to 82.5	25	25	25	100%
4	48.0 to 53.0	24	24	14	58%
5	72.0 to 72.5	15	15	5	33%
6	74.0 to 75.0	39	39	11	28%
7	80.5 to 82.0	30	30	17	57%
8	44.0	17	16	0	0%
Pilot	82.0	7	7	7	100%
Total	-	**224**	**223**	**112**	**50%**

Besides these new relief wells, there are 12 UNDP-type wells installed between km 81+800 and km 82+000 and 41 piezometers installed between km 40 and km 85.

Performance
Only 50% of the total of 224 wells have reached the 65% efficiency level and only 45% have reached the specified 70% efficiency level. Despite the relatively low levels of efficiency, the wells have had a marked effect on the number of sand boils occurring.

The wells, which were constructed under Package #1, have a very much lower performance than those do in other packages due the lack of experience of the contractor.

2.3 Implementation

2.3.1 Implementation Management

The implementation of the sub-project was the responsibility of the Central Project Office and Sub-project Office No. 401 (SPO 401). Under the TOR, the SPO is responsible to: (1) prepare and update the implementation schedule and budget, (2) supervise the construction work done by each Contractor and ensure quality control, (3) monitor the progress of sub-project implementation for every contract and manage the construction contract as well as the monitoring contracts and (4) manage the liaison with other relevant government agencies, mainly the DDMFC and Hydraulic Provincial Offices. The SPO was not instructed to collect data relevant to BME and no system for that was put in place.

SPO 401, headed by a Director and a Vice-Director, comprises four departments: Planning, Budgeting, Accounting and Construction Supervision and has a total staff is 23 persons, of whom 14 are permanent and 9 are temporary (field inspectors). It was equipped adequately with facilities, vehicles and office space.

2.3.2 Implementation Schedule

The works started in 1994 and were planned to finish at the end of 1998. The final completion date was revised several times and, with the exception of the relief wells, will actually occur in May 2001 (see Figure 2.1). At that time 97% of the relief wells will have been installed, but only 50% will have been tested and have met the specified level of efficiency.

The main problem, which delayed implementation of some works, lay in the resettlement and compensation issue. There were good reasons for the extension of the project:
- lack of familiarity of CPO with Bank's procedures and with competitive bidding;
- lengthy Vietnamese procedures for all approvals;
- unpredictable incidents during construction, mainly due to heavy rains;
- delay in design and works implementation for dyke body strengthening and dyke foundation treatment;
- delay in site clearance, lengthy procedures for land acquisition, resettlement and compensation;
- lately, to allow more time to complete the work for the Hanoi Dyke extension.

Some items of work had been handed over to the two concerned DDMFCs by the end of 2000 but there was a significant backlog of finished work, which had not been transferred for a variety of reasons:
- As-built drawings were not prepared;
- Changes had been made by the constructor;
- Works which were not considered acceptable for normal operation (relief wells and toe drain);
- SPO 401 has not yet asked for the transfer.

Despite this, the DDMFCs, as receivers of rehabilitated works, believe that the dyke system is now safe and will satisfy the requirements for flood protection.

HANOI DYKE REHABILITATION SUB-PROJECT - IMPLEMENTATION SCHEDULE

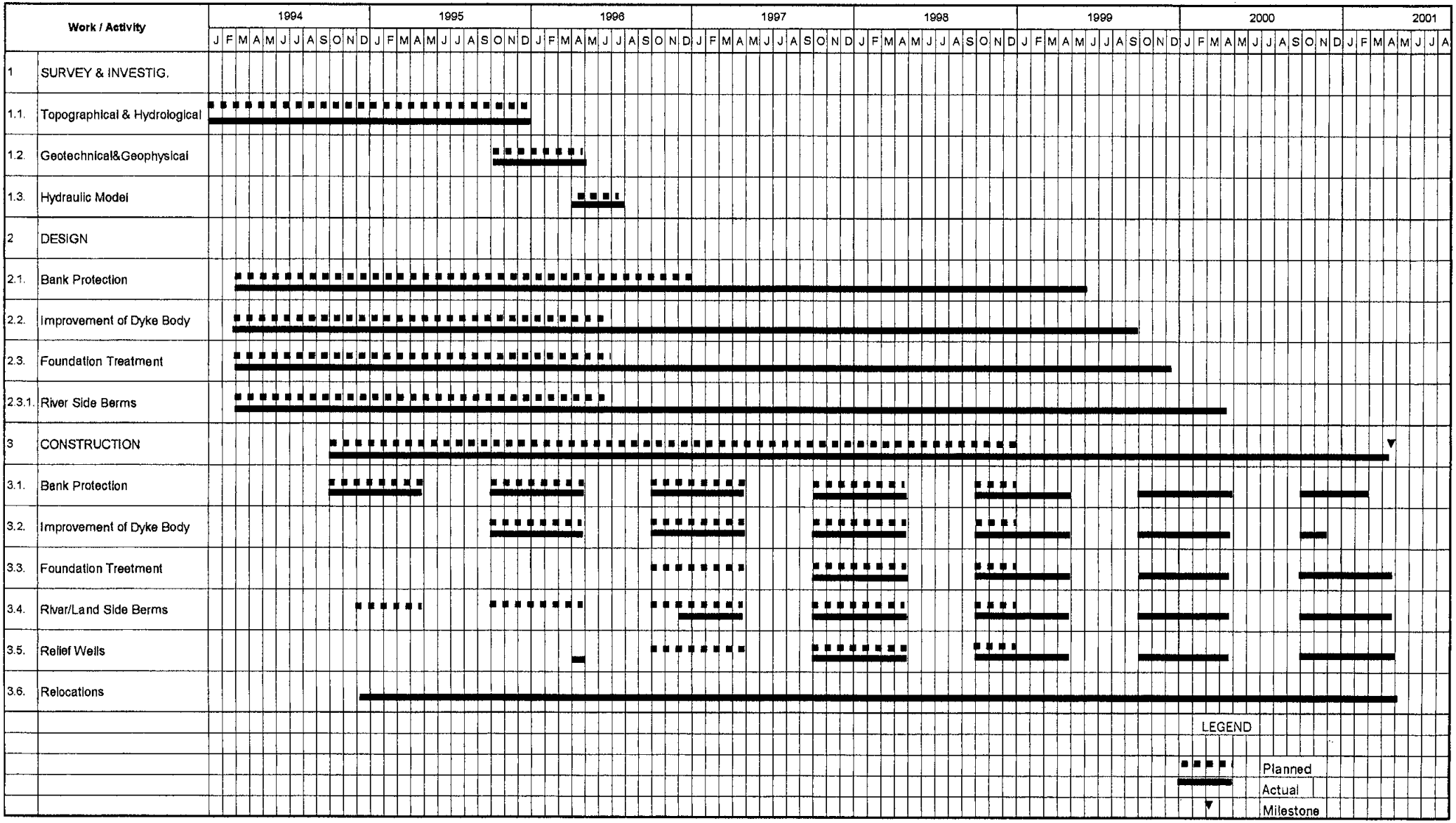


Figure 2.1

2.4 Costs, Financial and Economic Data

2.4.1 General

The costs associated with the project can be broadly divided into two types. The first and most obvious is the expenditure of money. However, there is also the cost associated with the inevitable socio-economic disruption caused by the rehabilitation works. This section briefly covers these costs and the actions taken to mitigate the latter.

2.4.2 Budget and Expenditures

A comparison of the approved budget for the implementation with actual expenditures is given below.

Table 2.2 Budget and Expenditures

VND x 10^6

Description	1994 Budget	Actual Expenditure
Bank Protection	133,206	131,206
Dyke body strengthening	163,677	175,075
Dyke Foundation Strengthening	18,639	18,779
Relief wells	26,708	26,708
Other Expenditures (design, compensations, SPO, etc)	155,770	127,096
Total:	**498,000**	**478,864**

The actual overall expenditure of 478,864 million VND is equivalent to the 501,762 Million VND in Year 2000 VND, used in the economic analysis (see Appendix F12).

The costs associated with rehabilitation include, apart from the civil engineering works; all compensation paid for the relocation of displaced people and buildings, as well as other related costs such as design, monitoring and bank service charges. General costs, such as consultancy, bank charges and other costs were prorated to Hanoi Dyke subproject and to the other two subprojects, in accordance with the capital costs. All costs are well documented by the Central Project Office (CPO) and were used in this analysis.

The disbursement period has covered a period of seven years from 1995 to 2001, and the rehabilitation costs of each year were valued in Year 2000 constant prices using the rate of inflation observed in Vietnam over that period.

2.4.3 Operation and Maintenance Costs

The other cost component, that of Operation and Maintenance (O&M), was obtained from the BME survey, mainly from the Provincial DDMFCs (Hanoi and Ha Tay) and the adjacent districts and communes. Actual costs do not include community or voluntary work or maintenance performed by the contractors and already included in the implementation costs.

In order to maintain the newly rehabilitated dyke in good condition, it is necessary to undertake regular major repairs that go beyond the normal yearly maintenance. For the purpose of this

analysis, it has been assumed that these repairs would be done every 5 years, at a cost equivalent to 20% of the original investment.

O&M costs from the inception report were used in this analysis, after their conversion to Year 2000 values.

2.4.4 Economic Benefits

Most assumptions used in the previous analysis, like probability of flood level, probability of break of diverse sections of the dyke, and the extent of physical damage resulting from each flood level and dyke section failure were also used in this analysis (Appendices F 1.1 – F 1.2).

Quantifying damages has been a much more difficult task as some of the assumptions used in the inception report are thought to be excessive. In particular the value of losses in infrastructure, at 75% of households and industrial losses appears extremely high, as does the value of losses to household assets.

To compensate for these high values, the analysis in this report has adopted an arbitrary reduction of 50% in the values used in the inception report, though adding 45% in converting the values to Year 2000 VND, resulted in the use of essentially the same numerical value.

2.4.5 Economic Analysis

The economic analysis has used the costs and benefits valued in Year 2000 constant prices and assumed a project life of 30 years.

Even with the largely reduced assumptions used for the evaluation of the net benefits (Appendix F 1.12), the project viability is very high. This is not surprising as benefits are kept in relatively the same range but the rehabilitation costs were 39% lower, in Year 2000 VND, than estimated in the inception report.

Furthermore, a close review of the calculations done in the inception report shows a reduction of 28% in the average losses saved used in the economic analysis. In fact, with the full value in average losses saved, the resulting EIRR should have reached 73.9 %, instead of the 53.5 % in the report.

The general conclusion is that the rehabilitation of the Hanoi dyke has generated a very high yield, much higher than the threshold value of 12% normally required, as a minimum, to justify the investment and is substantially in excess of the results expected at the planning stage.

2.5 Socio-economic Impacts

The construction results in impacts such as occupation of land, relocation of families and changes in the economic conditions. The main social impact was that of resettlement and compensation.

The land in the dyke area is an extremely valuable resource. During the project, some land was occupied on a permanent basis and other areas were used temporarily, for borrow pits, quarries or to provide access. In total, the length of zones affected was 48 km and an area of 188ha.

The housing affected fell into two categories; houses that had to be removed and the families relocated and houses that, though affected, did not require removal. The houses that had to be removed, and the families relocated, were those that were situated, actually on the dyke body or in the protection zone, which has been established along the dyke. To date, 307 houses have been relocated and a further 1309 have been affected to some degree.

Transportation and access along the dyke was also affected during construction, but was much improved after rehabilitation.

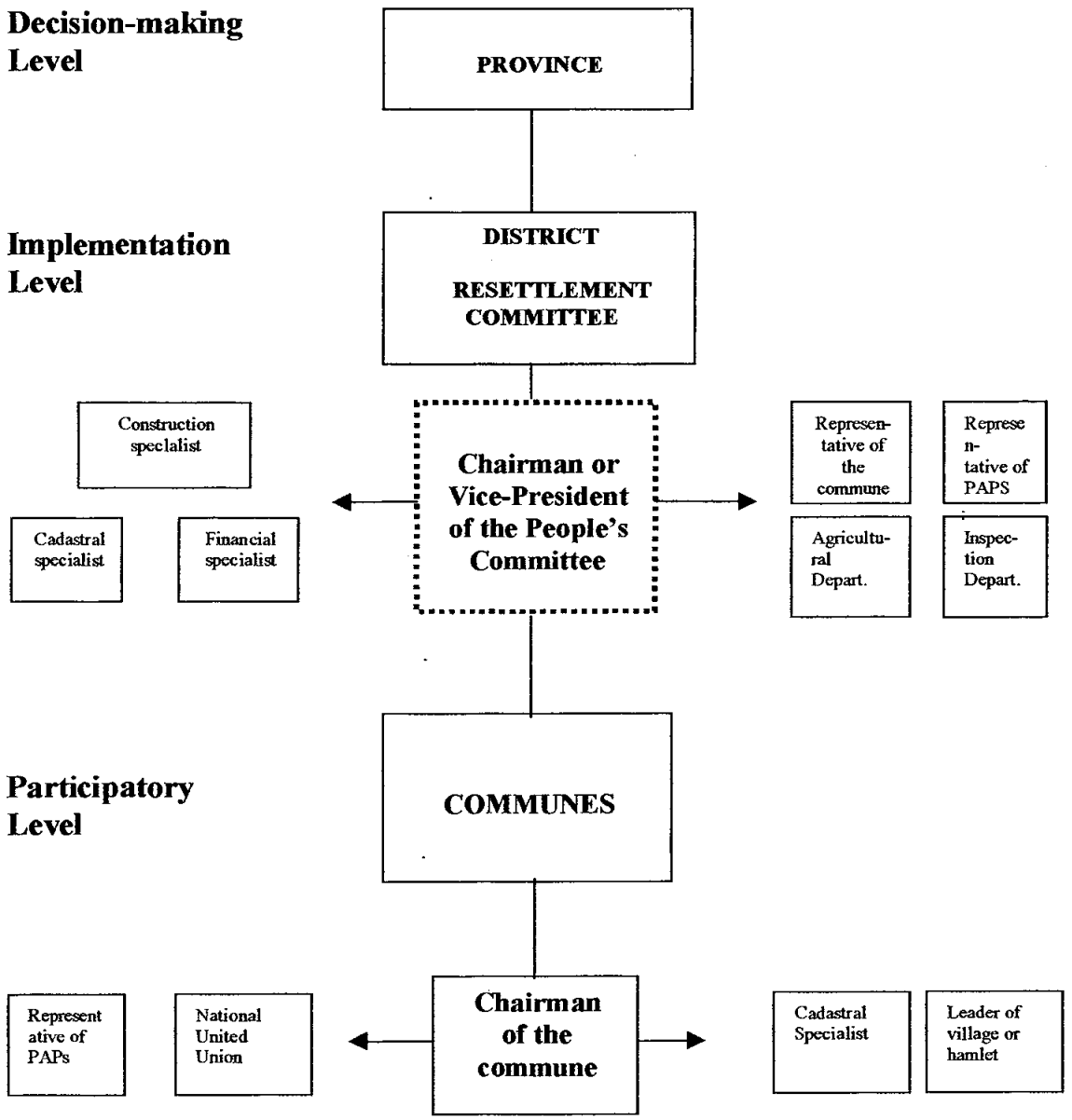
Any other changes in domestic water supply, landside waterlogging and sand boils have been generally positive.

Management of Resettlement

No Resettlement Action Plan (RAP) existed but Resettlement Committees were formed and played an important role in the resettlement process. They provided information and a support program for the affected people. Because there was no RAP, all the districts had to define their own frame of reference, and become the link between the Province and the Commune.

The following diagram shows the final composition of the Resettlement Committees for the project.

RESETTLEMENT COMMITTEE



The Resettlement Committee, at the District Level, had the appropriate expertise to order relocations and conclude agreements with the people affected, whether they were relocated or not. The cadastral, financial and construction specialists were involved in the identification of development sites, which received the relocated people. The agricultural and inspection specialists checked the land use within the site. All these activities were under the supervision and co-ordination of the Chairman of the People's Committee.

Representatives of communes and PAPS (affected people) helped relocated people in the process of resettlement. The main role of the members is in developing a consensus with the people directly affected by the project. The Chairman of the commune and the Representative of PAPs brought peoples' needs and problems to the district level.

In the communes where this procedure has been followed, participants in the Committee conducted individual and group meetings covering the inventory of assets, the fixing of market prices and values of lands, gardens or ponds, as well as the availability of water supply and electricity at the new site.

With the transfer of responsibility to the Resettlement Committee it was possible to obtain appropriate settlements, though there were many changes in the compensation scales (Decisions No. 1049 and 03) and, eventually, "replacement value" on a case-by-case basis was used to speed the process.

Despite the problems and delays, it is important to note that the number of families relocated or directly affected was impressive at 1894. This is roughly equivalent to 6,600 people.

Level of Satisfaction

Some understanding of the level of satisfaction with the compensation process can be gained from the total of 175 grievances received. Of the 175 grievances, only 28 were outstanding in November 2000.

Most of these relate to compensation for residential land in excess of $200m^2$. This is the ceiling for compensation paid by the government at the higher rate applicable to residential rather than agricultural land. This is a great loss to their owners, particularly on the outskirts of Hanoi where residential land value is very high. Other grievances relate to prices for assets, land rights and assistance allowances for moving from one job to another.

The resettlement due to the project was not simply the displacement of hundreds of families but it also led to a change in the life and customs and constituted a new start for many. Some dissatisfaction has been expressed at the loss of income of some families due to the reduction in some activities, such as fishing and grazing, allowed along the dyke. Incentives should be offered to encourage activities, which would still be permissible.

A RAP was drafted at the beginning of the project but was never approved. This has made the resettlement and compensation process long, complicated and not entirely equitable. On the whole, despite delays due to there being no RAP, much progress has been made in the resettlement process and several districts now have the necessary experience for incorporation in RAPs for future projects

2.6 Sustainability

2.6.1 General

As noted in Section 2.4.5, the economic analysis has been conducted on the basis of a project economic life of 30 years. In order to realise such a life for the project, it is necessary to institute a Benefit Monotoring and Evaluation (BME) System and an Operation and Maintenance Program (O&M), to ensure that there is no decrease in efficiency. This will ensure that any problem will be identified in the early stage of its development and will note any negative impacts, which are developing.

2.6.2 O&M Organisation

In 1998, the Operation and Maintenance policy changed, following the requirements of the *Law on Water Resources (1998),* to ensure the efficiency and success of new investments. The Law details the responsibilities of central organisations, local authorities and the people in preventing and fighting floods and in maintaining the flood protection works.

Constraints on the actual maintenance and monitoring of the dyke are that the institutional framework has remained unchanged for a long time, that practices have not kept pace with the newly implemented facilities and the changing environment, and that there is poor access to modem engineering techniques in planning and monitoring.

The on-going maintenance of the dyke is the permanent responsibility of Provincial MARD Offices (PARD) of Ha Tay Province and Hanoi City, under the direction of the MARD, through the Department of Dyke Management and Flood Control (DDMFC). The institutional framework for the dyke maintenance and monitoring has the following main features.

The DDMFC acts through Provincial DDMFCs and is charged, by MARD, with the maintenance and monitoring of the dykes. The Provincial DDMFCs report also to the Provincial Departments of Agriculture and Rural Development (PARD) but are supervised by the DDMFC. Provincial DDMFCs are responsible for management of the dyke system under their jurisdiction, for the implementation of rehabilitation works and for mobilising funds for the management and maintenance activities.

The Hanoi Dyke is under the responsibility of two provincial DDMFCs:
- Hanoi DDMFC for Km 48 to Km 85
- Ha Tay DDMFC for Km 40 to Km 48 (also for Km 85 to Km 101 in the project extension).

Details of the staffing, structure and budget of these two DDMFCs are provided in Chapter 3.4.2 of the main report.

Though the communities along the dyke are willing to participate in the O&M of the rehabilitated dyke, their participation, to date, has been limited to monitoring the dyke on a 24-hour basis during the flood season. However, they do provide an emergency source of labour if required.

2.6.3 O&M Procedures

Current operational procedures are basically the following:

- Routine maintenance of the dyke and bank protection works (usually in dry season of the year);
- Periodic inspection to detect and treat potential dangers to the dyke and bank protection works;
- Evaluating the dyke system before every flood season, to ensure the capacity of the dyke system to protect against floods;
- Monitoring the status of the dyke during floods; recording sand boils during every flood, recording other events, which occur such as cracks, collapses, sliding, settlements, recording flooded areas and damage, implementing treatment measures if necessary; planning and preparing resources (manpower, materials, facilities, etc) to be ready for mobilisation in emergencies;
- Monitoring the status of the dyke system after the floods, providing detailed maps of the river bank, reviewing previous plans and recommending an action plan for the following year; including both routine and major repairs.

Additional regulations are now required to cover maintenance of the newly rehabilitated works, specifically the relief wells, which have not yet been handed-over to the DDMFCs. These must cover routine maintenance, periodic repairs, emergency measures, the performance of maintenance activities and social-environmental aspects.

When the IFPRP has been completed, DDMFCs will take over the rehabilitated works and will carry out monitoring of the dyke.

2.6.4 Benefit Monitoring and Evaluation

To date, a Benefit Monitoring and Evaluation (BME) System has not been established in accordance with ADB recommendations.

The current system of monitoring is not integrated. The available data is sparse and individual organisations do not communicate or exchange information. In general, the system is not very different from that existing before the rehabilitation and is limited to recording the main events during the flood season and the planning of activities and resources. The main physical BME indicators, such as the evolution of erosion and deposition in the river at the location of bank protection works, gabion settlement, dyke and berm settlement, seepage through the foundation, are still not systematically measured and recorded. These indicators are essential to the evaluation of the performance of the works.

However, some elements of traditional monitoring were identified, mainly data collection for flood forecasting and for design and construction adjustments and relief well and piezometer readings. The establishment of a regular BME System, following the TOR of ADB, should be made a priority. Additional regulations are required to include the obligation to provide this system and to define the methods and the resources to be used to collect the necessary data, evaluate the results and provide periodic reports showing that the objectives have been sustained. Training courses should be held for the staff to be involved in the future BME System.

Some existing elements, such as O&M monitoring should be integrated into the BME System. Data should be collected and analysed on:
- dyke and bank protection physical performance;
- financial;
- social and environmental;
- institutional;
- events and changes.

Based on this, quarterly reports will be produced by the BME Unit. These reports will be used for current O and M and as a basis for Annual Evaluation Reports.

2.7 Other Impacts and Problem Identification

The implemented works have positive effects, especially:
- Good behaviour of the dyke during the 1996 and 1999 floods, which reached Alert Level III and was close to the highest historical flood on record;
- It was observed that seepage was less and the sand boils were less extensive and easier to treat (note that this is only an observation and not the result obtained by monitoring);
- Transportation along the dyke and access to the dyke is easier, due to the new access roads and space reserved for maintenance and right of way;
- Morphology of the river has apparently stabilised where the bank is protected;
- Environment is better protected and the general aspect, after rehabilitation, is improved.

Some negative effects are noted, as follows:
- Land necessary for site clearance, to build berms or to enlarge the dyke is compensated by the provision of equivalent areas; this causes an overall reduction in the available land and the related agricultural activity;
- Other economic activities are reduced (fisheries, trade) because of the restrictions necessary for protection of the dyke;
- Maintenance and monitoring of the works during the transfer period (from Contractor to the SPO 401 and from SPO401 to DDMDCs) were neglected, for instance, grazing or obstruction with materials not related to maintenance have been allowed on the dyke;
- Social impacts due to site clearance and housing relocation are discussed before.

Problem Identification

Among the problems and issues identified in report, the most important, are summarised below.
- The main problem encountered in the realisation of the Hanoi Dyke Sub-project was the delay in implementation of some works, mainly the dyke body enlargement and relief wells. There was also a delay in the application of resettlement and compensation. It was found that both delays are related and that these delays could not be solved separately;
- Quality of works, mainly the relief wells which are performing only 50%;
- Maintenance and Monitoring System which is still traditional and not responding to the new kind of works;
- Institutional framework were there is no clear definition of responsibilities nor co-ordination of parallel activities (DDMFCs, PARD, SPO, Local Administration (districts);
- The protection zone is still not respected and illegal activities still persist on the dyke body and berms, which are used for various economic activities, such as cropping and cattle grazing;
- Lack of a new regulation adapted specifically to the Hanoi Dyke.

3. SONG CHU IRRIGATION SYSTEM

3.1. General Description

The Song Chu irrigation scheme was built in the 1920s and is the largest gravity irrigation system in the Ma River Delta. It has a total gross area of about 70,000 ha, a population of 1 million and is the source of domestic water for Thanh Hoa City, with a population of 130,000 people.

Due to the long period of operation, a lack of proper maintenance, wars and natural calamities, the canals and structures had deteriorated severely. Originally, the system was designed to irrigate two paddy crops each of about 50,000 ha per year. Over the years, extensions have been undertaken and they covered an area of 50,933 ha. However, the system was so badly deteriorated that only one crop per year, over an area of 30,000 ha, was properly irrigated.

Before the project, the major headworks were evaluated to be at a high risk of failure, which, had it occurred, would have meant the total disruption of irrigation. The aims of the project were to restore the full capacity of irrigation to all the designed area. The rehabilitation mainly involved the following components (Figure No. 4):

- Bai Thuong Weir and Headworks. The works consisted of the rehabilitation of the deteriorated structures and mechanical parts of the weir, retaining wall, scouring sluice and intake gates and lock to ensure the stability of the structure and increase the discharge.
- Main Canal. The works consisted of the re-sectioning and lining of the 19-km section of the main canal.
- North Canal and South Canal. The works consisted in re-sectioning and partial lining of the 90 km of canal and the rehabilitation of the main structures.
- Secondary Canals. Each canal serving an area of more than 500 ha, in total 220 km canal length, was re-sectioned, partially lined and the structures rehabilitated.

The works are now completed and the performance and benefits, evaluated in this report, can be considered as final.

3.2. Irrigated Areas

The system serves a net area of 50,933 ha. This is the area actually irrigated, but the performance is not uniform. In order to assess changes in irrigation performance, categories of water regime have been established as follows :

- full irrigation : water is available all year and the irrigation system responds completely to crop requirements;
- partially irrigated : water is available with restrictions, especially in the dry season;
- rainfed : irrigation is very difficult or impossible.

A comparative analysis of irrigated areas before project commencement, at mid-term and currently, shows that rehabilitation has improved the global performance of the system, as follows:

Table 3.1 Irrigation Performance in SCIS

Irrigation Category	Performance before the Project (1995)		Performance at the mid-term (1997)		Final Performance at (2000)	
	Area (ha)	Percentage	Area (ha)	Percentage	Area (ha)	Percentage
Full irrigated	29 716	58%	32 877	64%	34453	68%
Partly irrigated	17 884	35%	17 556	35%	16480	32%
Rainfed	3 333	7%	500	1%	0	0
Total	**50 933**	**100%**	**50 933**	**100%**	**50933**	**100%**

The greatest evidence of progress lies in the elimination of rainfed areas, which have all become fully or partially irrigated. Some areas are still partly irrigated after rehabilitation but this is normal as areas irrigated by pumping are included in this category and the high cost of pumping does not encourage full water consumption. However, it should be noted that the rehabilitation of the Song Chu system cannot modify the availability of water nor the normal shortage in March and April, which is about 10% in terms of flow and could last up to 2 months.

In terms of hectares, the size of the partially irrigated area should be in the same proportions as the flow shortage. However, the area partly irrigated is larger (32%). The reason for this is that the rotation operation of the tertiary network is not consistent and water losses are not controlled. Hence, land situated at the downstream end of most secondary and tertiary canals can only be classed as partially irrigated.

3.3. Rehabilitation Works, their Status and Performance

3.3.1. Bai Thuong Weir and Headworks

The design solution, proposed by the International Consultants, using Roller Compacted Concrete (RCC) was quite new in Vietnam, but it was considered to be economical and well adapted to the existing economic conditions in Vietnam. However, during construction, at the request of the Contractor, conventional concrete was substituted for RCC.

The Bai Thuong complex is considered to be the most important of all the works carried out under this sub-project. The main components are :

- a concrete weir, 170 m in length, across the Chu river;
- a water intake, to divert 50 m^3/s; provided with 7 electrically operated gates;
- a bottom sluice for sediment flushing and emergency release of water;
- a navigation lock for small boats and rafts.

There were delays in the contracting procedures and the international Contractor (China International Water and Electricity Corporation - CWE), proposed, and substantially met, a new deadline for work completion of June 1999 instead of December 1998.

With the exception of the delay, which was beyond the control of the Contractor, the performance of the Contractor was considered to be good.

3.3.2 Main and Secondary Canals and Structures

The SCIS is an open canal network, which originally had been sized to meet the peak consumption of water of 0.8 l/s/ha. The rehabilitation aimed at restoring the main and secondary network to its original characteristics and adapting it to higher irrigation requirements of 1.0 l/s/ha.

The works rehabilitated are mainly the following.

Main Canals

Main Canal, starting at Bai Thuong headworks and ending at km 19.2, where the North Canal and South Canal begin. The main structure is the Ban Thach regulator and a hydropower station at Km 17.3. Its original capacity was 40 m^3/s, while the rehabilitated capacity is 50 m^3/s. The rehabilitation of this canal is currently completed, including :

- resectioning and lining on 16.2 km;
- grouting and equipping the Ban Thach regulator;
- bridges and secondary offtakes (named C0 to C10).

Before rehabilitation, the Main Canal was unlined and its embankments were eroded to a larger than original cross-section. After the rehabilitation, the bank erosion has been stopped. The enlarged sections have been maintained but the embankments have been heightened and the canal has been lined. The water levels are higher and secondary water off-takes are supplied with sufficient water to perform full irrigation. Performance is considered to be good.

During the field survey (November 2000), when the canal was emptied for annual maintenance, excessive sedimentation was noted on the canal invert

North Canal, from the end of Main Canal downstream to km 54. The discharge is controlled by four main regulators: Phong Lac, Qui Xa, Loc Giang and Quang Minh. The rehabilitation of this canal is currently completed. It included :

- resectioning and lining of 44.5 km;
- grouting and equipping 4 main regulators and 3 navigation locks;
- all the structures and the secondary off-takes (named B1 to B37).

Before rehabilitation, the North Canal was unlined and were eroded to a larger than original cross section. The designed water levels could not to be maintained and some secondary intakes were supplied at lower than design discharge. All the regulators and other structures were deteriorated, especially the mechanical parts of the gates.

The rehabilitation is now completed and the performance is considered to be good. However, excessive sediment was noted in this canal and garbage is being deposited inside its section. The access to canal and structures is difficult; a continuous maintenance road, which was noted, as a requirement, in the Mid-Term Review (1997), has still not been constructed along the canal.

South Canal, starting from Main Canal, going downstream to km 36. The flow is controlled by three main regulators: Phuc Nhu, Phuong Khe and Co Dinh. The rehabilitation works are now completed and include:

- heightening and enlarging the embankments of the whole canal;

- partial lining;
- all the regulators and secondary off-takes (named N1 to N27).

Before rehabilitation, the situation on the South Canal was similar to that on the North Canal. To further improve the performance of the South Canal, the lining should be completed to the downstream end; also a continuous maintenance road.

Secondary canals

The IFPRP includes only the canals serving more than 500 ha, namely:
- Supplied from Main Canal: C1a, C3 and C6 (3 canals);
- Supplied from North Canal: B9, B10, B15a, B19, B20, B22, B24, B28, B30 and B35 (10 canals),
- Supplied from South Canal: N4, N8, N11 and N15 (4 canals)

Before rehabilitation, all these canals were unlined and were eroded to a larger cross-section than the original. Design water levels could not be maintained and generally the tertiary intakes were supplied at lower discharges than the design. Most regulators and mechanical parts were missing, the control of discharges was impossible and the irrigation supply to the downstream end of the canals was, at best, partial.

The rehabilitation consisted of heightening the embankments to the original design height, the partial lining of 1 - 2 km of the upstream reach of each canal, repairing structures and replacing all mechanical parts of the gates.

Performance is generally improved, where the secondary canals have been rehabilitated, but the performance of the unlined secondaries does not match that of the main canals and lined secondaries. In some cases (for instance canal C6), the rehabilitation has not improved irrigation significantly because of the poor quality of construction, especially the earth fill. Some problems were noted, which need careful attention to improve the post-rehabilitation performance:

- The partial irrigation at the downstream of secondary canal C6 is now reported to be the same as before rehabilitation. This canal should be completely lined.
- The intake regulators are generally upstream sedimented, for instance B19; which seems not to be rehabilitated at all and the gate mechanism is missing. These works should be completed.
- All the rehabilitated tertiary off-takes should be provided with gates and measuring weirs, as some are still missing.

3.3.3 Tertiary and Quaternary Canals

The tertiary network, including the quaternary canals and farm ditches, were not included in the IFPRP but were in local programs of rehabilitation. Each of these canals serves an area less than 500 ha with most of them serving less than 150 ha. These smaller canals are important, as there are about 300 km of tertiaries and 1000 km of quaternaries. Some of these canals are being operated by several communes, which could create conflict due to any uneven distribution of water between upstream and downstream areas.

In general, design of the rehabilitation for these smaller canals was carried out by the Design Department of Irrigation Management Company, though some smaller canals were rehabilitated without any design. The construction was carried out by the farmers, under the management of the communes and with technical assistance from Hydraulic Enterprise and Irrigation Sub-stations.

The tertiary - quaternary network is the last link in the system, where rehabilitation demonstrates its effect. Its performance will, however, has to be improved to take full advantage of the rehabilitation upstream on the system, improve the irrigation efficiency and allow for the use of the rotation method of irrigation.

Approximately 70% of the surveyed network of 190.8 km, serving an area of 6,384 ha, has been rehabilitated and has been assessed as follows (see also Appendix E.2.1.):

- Rehabilitated canals:	Total	140.1 km
	Good performance:	124.9 km (89 %)
	Fair performance:	15.2 km (11 %)
	Poor performance	none

The 89% success rate for rehabilitated canals, as judged by the farmers, indicates the value of the rehabilitation. A lack of local funding delayed the rehabilitation of the tertiary canals and work, at the local level, started with the smallest canals. This resulted in a bottleneck in the system with rehabilitated main and secondary canals separated from rehabilitated quaternaries by the untreated tertiaries.

Pumping Stations

The pumping stations, which existed before the commencement of the Project, are still in service, but were not rehabilitated in IFPRP. These structures are considered a part of the irrigation system and determine its overall performance. In general, the pumping stations serve small areas with a higher elevation or are used to supplement the water supply during periods of shortage (less than 100 ha).

3.3.4 Drainage

The drainage system normally serves to maintain field drainage and to evacuate surplus irrigation water. During heavy rains, they serve to prevent flooding and to evacuate the water as rapidly as possible. The Song Chu system includes a dense drainage network but their rehabilitation is not included in IFPRP and the extent of waterlogged areas, estimated at 20% of the total area in normal years, has not been improveded. In 1996 and 1999, because heavy rains occurred, the flood affected 40% of the irrigated area and reduced the production of the second rice crop.

Some main drains are still used to supplement irrigation, by pumping, and they will remain for temporary use, during water shortage periods. There are four main drainage systems, with a total channel length of 450 km, within the limits of the irrigation system.

- Quang Chau Drainage System: 12,000 ha
- Truong Le Drainage System: 7,500 ha

- Song Ly Drainage System: 12,000 ha
- Song Hoang Drainage System: 25,000 ha

During the evaluation surveys (1997, 1998, 2000), the farmers and local representatives complained about the poor performance of the main drains, which were not able to evacuate the water resulting from heavy rains. The second rice crop is usually affected or delayed, and there is insufficient time for the third crop. The conclusion is that rehabilitation of the drainage is necessary to obtain full value from the investment in rehabilitation.

3.4 Implementation

3.4.1. Implementation Management

The implementation of the SCIS Sub-project was the responsibility of the Central Project Office and Sub-project Office No. 406 (SPO 406), located in Thanh Hoa City.

SPO 406 is an organisation headed by a Director and a Vice-Director, composed by four departments: Planning, Administration, Accounting and Construction Supervision. It is equipped adequately with facilities, vehicles and office space. The Director of SPO 406 reports to the CPO Project Manager and supports him in all activities related to Sub-project implementation.
Its tasks are defined by the TOR of IFPRP, as follows: (1) prepare and update the implementation schedule and the budget, (2) supervise the construction carried out by each Contractor and ensure its quality, (3) monitor the progress of sub-project implementation for every contract and manage the construction contract as well as the monitoring contracts and (4) manage the liaison with other relevant government agencies, mainly the PARD Office of Thanh Hoa.

During the peak construction period (1997-1999), the staff of the SPO 406 was composed of a 25 person permanent staff and 25 temporary staff. Presently, as the works are completed, the SPO employs only 8 persons for the monitoring and administration of ongoing contracts.

Besides the CPO and SPO 406, which have direct responsibility for sub-project implementation, other local organisations are involved. Their roles are interconnected as they co-operate on specific aspects, as follows:

- People's Committee of Thanh Hoa Province co-operates with MARD in the organisation of project implementation; co-operates in carrying out land compensation, resettlement and safety programs; contributes local funds.
- Provincial Agriculture and Rural Development Service (PARD): co-operates with SPO 406 in construction monitoring and quality control.
- Irrigation Management Company Song Chu (IMC): main operator of the irrigation system; supports SPO 406 to ensure irrigation during the construction period, participates in construction management and design of tertiary rehabilitation; takes over the rehabilitated works.
- Districts and Communes: assist SPO 406 with local security of works, labour, land acquisition or compensation.

3.4.2 Implementation Schedule

The works started in 1995 and were planned to be finished at the end of 1998. The completion date was reviewed on several occasions; the last revised schedule was to complete the works by June 2001 (see Figure 3.1). There were good reasons for this delay in the scheduled completion:

- unfamiliarity of the CPO with ADB's procedures and with competitive bidding;
- lengthy and complex Government internal procedures for approval of bids, notably the delay in signing the contract and giving the notice to proceed for the Bai Thuong Weir and Headworks rehabilitation;
- unpredictable incidents during construction, mainly due to heavy rains; one, of particular note, is the heavy rain, which occurred on 30 May 1998 at Bai Thuong. This damaged the cofferdam and resulted in an additional 3 months for re-excavating the foundation pit and rebuilding the cofferdam;
- extremely short periods available for reshaping and lining the canals. This amounted to only 50-60 days per year, during the maintenance period, when irrigation was suspended;
- most recently, to allow more time to complete the works for the IFPRP extension in Quang Binh and Quang Tri provinces, and well as for the Hanoi Dyke extension.

During the field survey in November 2000, the SPO 406 gave specific information on items, which caused delay:

- land acquisition and resettlement activities were difficult where canals ran through communes and villages, which encroached on the canal alignment;
- procedures for the import of equipment and materials for Bai Thuong (constructed by the International Contractor CWE, China) were very complicated and time consuming.

3.5 Costs, Financial and Economic Data

3.5.1 Budget and Expenditures

The table below compares the original budget in 1994 to the amount finally estimated for the original scope of work and the amount actually spent on the expanded sub-project.

SONG CHU IRRIGATION REHABILITATION SUB-PROJECT - IMPLEMENTATION SCHEDULE

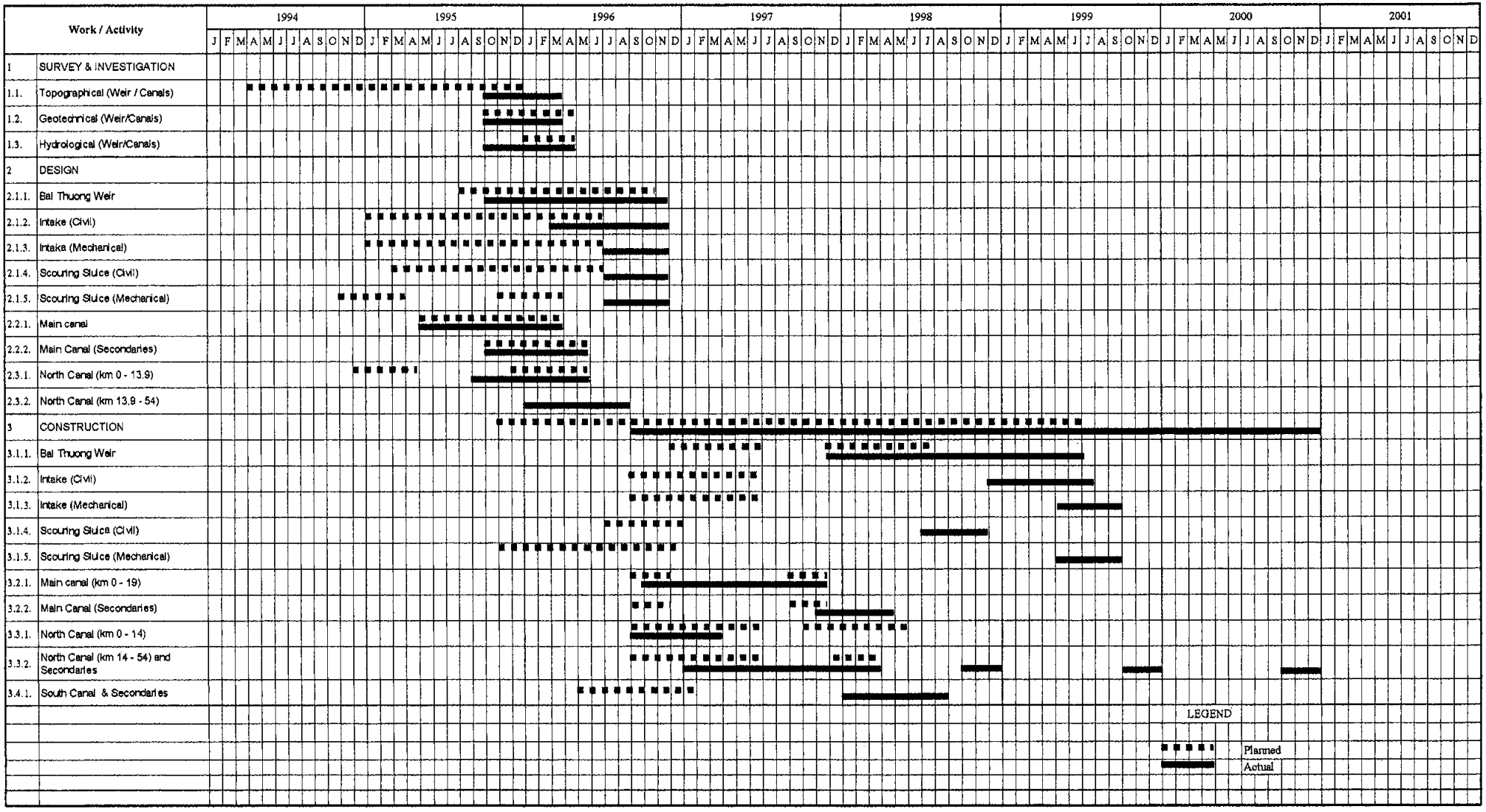


Figure 3.1

Table 3.2 Budget and Expenditures

VND x 10^6

Description	Original Scope	
	1994 Budget	2000 Actual Expenditures
Total	**281,413**	**218,192**
Civil Works	**227,628**	
Canals	138,000	
Bai Thuong Weir	89,628	
Other	**20,000**	
Compensation	**3,200**	
Contingency	**4,132**	
CPO Costs	**26,453**	
Total in 2000' VND		**294,596**

The savings of 63,221 million VND (281,413 – 218,192 = 22%) or about US$4.5 million between the original budget and the estimated cost of the original scope of work were approved for use:

- To increase the lined length on the North Canal, the South Canal and some secondaries (an additional 22.5 km);
- To install a control and monitoring system for irrigation operation;
- And together with savings from other sub-projects, to extend the IFPRP to rehabilitate irrigation systems and flood protection works, in other provinces, damaged by floods (see Section 5).

The cost of rehabilitation of the tertiary canals, which amounts to 25,903 million Dong per year, is not included in the investment cost above. Keeping the same work pattern, the rehabilitation of tertiary canals will take 6 more years to complete. The cost of the tertiaries has been included in the economic analysis.

3.5.2 O&M and Crop Costs

O&M costs for irrigation network, before rehabilitation, were calculated from the figures used in the inception report. The present level is 10,868 million 2000' VND per year, which is less than that planned in 1994, when data is compared on the same basis. This entire cost is covered by water fees paid by farmers, shared between main and secondary canals 56% and the smaller canals 44%.

No increase in O&M costs after year 2000 has been used and these costs have been assumed to increase with inflation.

For the purpose of the analysis, provision has been made for major repairs that go beyond normal annual maintenance. These major repairs are necessary to keep the rehabilitated sites in their present level of increased production as compared to the situation before rehabilitation. It

has been assumed that these major repairs would be conducted every five years and would cost 20% of the total investment.

The financial budgets for main crops were established for the with- and without-project cases. Data collected before rehabilitation and at the near-end of rehabilitation, from the BME survey, have been used.

Current economic crop budgets (Appendix F 2.4) were also established, based on economic and farm-gate market prices whenever possible and used for both the with and without rehabilitation cases. In this way the economic viability is dependant entirely on the areas cultivated and the yields obtained.

The financial crop budget shows that rehabilitation has had very positive effects on the gross margins per hectare, without a provision for labour. Gross margins have increased as follows:

Rice – winter	51%
Rice – summer	29%
Maize	22%
Sweet potato	30%

The overall situation is further enhanced by the increase in fully and partially irrigated areas made possible by the rehabilitation.

The average net income generated per hectare for paddy has increased 42 % after rehabilitation, while maize has increased 39 % and sweet potato 132 %. This confirms that rehabilitation has generated positive results per hectare cultivated.

The market prices at the end of 2000 are presented in Appendix E.2.9.

3.5.3 Economic Analysis

The EIRR for the project is 22.4%, using the capital expenditures, in Table 3.2, for the original scope of work (Appendix F 2.7). This compares favourably to the value of 15.9% projected in the inception report.

Sensitivity analyses are not as important at this stage in the project but it is necessary to recognise that there are factors, which could affect future results. For example, a minimal decrease in yield of 1% per year for paddy over the 30 year period would reduce the EIRR to 19.7%. This shows that the viability of the system is vulnerable to, among other factors, poor future maintenance.

3.6 Environmental Impacts

3.6.1 Soil and Water

The evaluation of these elements was not possible, in the absence of analysis. Some negative impacts have been detected in the field:

- More available irrigation without effective drainage could favor soil salinisation;

- More water than necessary affects the quality of soils and impoverishes it: the organic matter and natural nutrients are washed out with excessive flooding;
- The practice of monoculture (rice) and excessive use of fertilisers impoverishes the soil and reduces its agricultural potential.

The most obvious effect of rehabilitation is the availability of water in irrigation canals during the dry season. Positive impacts have been observed during the BME mission:
- Availability of water in general, creates a more pleasant, fresher microclimate;
- Availability of domestic water supply is increased (higher levels and capacity of domestic wells);
- Water quality, at least visually, is better than before rehabilitation (the water is clear of sediments or turbidity);
- Domestic water supply of Thanh Hoa City, from the North Canal, is improved and the periods of restriction (seasonal and daily) are shorter than before rehabilitation.

Fertiliser and herbicide use increased by 30 % between 1995 and 1997 and by a further 20% between 1997 and 2000. In terms of quantity, the fertilisers, used in 2000, were 1426 kg/ha (NPK), compared with 1193 kg/ha in 1997. More irrigation, without control of consumption, dilutes and washes out the fertilisers. Exclusive rice cropping needs more fertilisers than the other crops. Consequently, the farmers compensate for lower soil fertility by using more fertiliser. This caused negative impacts, which were observed during the survey:
- Contamination of underground water (see above);
- Contamination of water in ponds and drainage canals;
- Health problems (headaches, skin and eye diseases), especially for women;
- Contamination of aquatic fauna; danger of disappearance of aquatic resources;
- Soil contamination.

3.6.2 Impacts during Construction

The socio-economic issues during construction were minor and, basically, unavoidable. They were:

- Reduction of agricultural land for construction purposes;
- Compensation for land and loss of yield;
- Soil quality loss in borrow areas;
- Reduced periods of irrigation;
- Interruption of supply of domestic water during construction;
- Disruption to agricultural activities during construction.

3.7 Benefits

3.7.1 Irrigation and Production

A comparison of land use between 1995 and 2000 is shown on Table 3.3. This clearly shows the improvement in the cropping patterns. Average cropping intensity has increased from 1.74 to 2.18.

Table 3.3 Land Use In Song Chu Irrigation System

Area for agriculture (ha)	(*) 3 crops area (ha)		(**) 2 crops area (ha)		(***) 1 crop area (ha)		Designated area to be irrigated inside the system (ha)
	Before project (July 1995)	Oct. 2000	Before project (July 1995)	Oct. 2000	Before project (July 1995)	Oct. 2000	
57555	1458	16723	39244	34436	16853	6396	50933(****)
100%	3%	29%	68%	60%	29%	11%	

Notes:

(*) 3 crops : 2 rice crops and 1 upland crop: rice I, rice II and an upland (Autumn - Winter) crop; or 1 rice crop and 2 upland crops: rice I, upland crop I, upland crop II; (annual cropping intensity 300%)

(**) 2 crops: 2 rice crops: rice I and rice II; or 1 rice crop and 1 upland crop: rice I and an upland (Autumn - Winter crop) (annual cropping intensity 200%)

(***) 1 crop: One seasonal rice: rice I; or One upland crop (Autumn - Winter crop); or Perennial or Technical Crops (sugarcane, fruit trees, pasture) (annual cropping intensity 100%);

(****) This figure includes the area of 5,500 ha irrigated by interconnection with Muc System.

Though the land use index or cropping intensity has increased, it has not reached the expected level because frequent flooding makes it difficult to introduce the third crop (20 % of the cultivated area is flooded in normal years and 78 % was flooded in 1996). This emphasises the necessity to improve the drainage.

The cropping patterns have evolved in recent years, as the availability of water motivated farmers to introduce new varieties of rice, high yielding and early maturing, and to diversify into upland crops. Double cropping is already the rule. Further extension into triple cropping is still largely dependent on other factors, such as drainage system improvement.

Rice remains the main crop in every cropping pattern. The tendency is to maintain rice production at the highest level, though the availability of water offers conditions for crop diversification and intensified cropping patterns. So called upland crops, such as groundnuts, soyabean, maize, potatoes, sweet potatoes, fresh vegetables, sugarcane, as well as fruit trees and other high value crops, consuming less water, are still underdeveloped. These crops could, and probably will, be cultivated in parallel with or in place of rice, for economic reasons as well as for soil and water conservation.

In 2000, spring-rice was cropped on 92 % of the studied area and summer-rice on 87 %. The upland crops were cropped on 31% of the total area.

Rice yield for spring rice averages 4.95 to 5.50 tons/ha and that for summer rice 3.87 to 4.30 tons/ha. These are slightly more than they were prior to rehabilitation but the main gain has been in the intensity of cropping, which resulted in an increase in annual rice production of 20% from 339,000 tons in 1994/1995 to 404,000 tons in 2000.

The subsidiary upland crops need irrigation but their rates of production are less influenced by the improvement in irrigation than rice. However, production has increased from 78,000 tons in 1995 to 91,000 tons in 2000. This 17 % increase is due to the extension of cultivated areas.

The main upland crops in SCIS are: maize, sweet potatoes, potatoes, groundnut, soybean and sugarcane. The extension of upland crops is recommended, mainly as a third crop, to increase and diversify production and to help with soil regeneration, but this requires improved drainage.

3.7.2 Socio-economic

On the whole, there has been a clear improvement in living standards and a high level of general satisfaction. The improvement in yields and a beneficial agricultural diversification has generated trade in products. Stabilising the water distribution in main and secondary canals - in quantity and time - seems to have provided the expected effects.

Another target of the project was to ensure a fair distribution of water, so that all peasants could profit from the better yields and an improvement in income. For this reason, their financial participation of the equivalent of 5 kg/sao/year of paddy, over a 5-year period is fully justified. The principle of equity has been applied for the majority of the families to the greatest degree possible but the groups of peasants, which complained about a lack of water in 1997 are still the same today. It seems that this inequity can be explained by the fact that the communes, in question, are located at the downstream end of the canals and have, apparently, not profited from any improvement in water distribution. These inequities could have been anticipated and should have been reflected in differing contributions.

The previous evaluation noted that there was an improvement in the workload of women in terms of the number of days spent in the field. This is still true, as it relates to the "two-rice" crop situation, because hours are saved by better irrigation (which eliminates the need for transportation of water) and by the use of herbicides. However, these hours are now allocated to the third crop, which occupies 6% of the cultivated area of North Nghe An and 9% of Song Chu. In terms of gender, the proportion of time spent in the field has remains at 60% women and 40% men though some districts show a tendency to a 50/50 labour distribution. According to the current survey, explanation for this lies in the diversification of agriculture. As far as the rice crop is concemed, the higher proportion of hours spent in the field by women is largely due to manual work linked to this culture and usually allocated to them. Activities in the area correspond to the distribution below (see Appendix E2.12):

46%:	cultivating	Mainly located in the fully irrigated
24%:	breeding	Mainly in the fully irrigated
1%:	fishing	Mainly in the partly irrigated
28%:	other (non identified)	Mainly in the partly irrigated

This distribution shows a significant range of activities outside "cultivating" and indicates diversification from purely agricultural work.

Average annual income per household has increased from 8 million VND in 1997 to 12 million VND in 2000, (still calculated on 5 members to a family). The progress is reflected in a comparison of the number of households, which indicated a high level of revenue and a decrease

in poverty since the commencement of the project. The table below shows this change.

Table 3.4 Number of Households by Income Level Comparison 1995-1997-2000

Income level	1995	1997	2000	% Increase from 1995 (or decrease)
High	3,073	5,260	6,574	Increase: 114%
Middle	10,447	11,498	18,001	Increase: 72%
Low (poor)	6,620	5,582	3,345	Decrease: 49%

On average, the rice equivalent of the annual family income has changed from 2.62 tons in 1995 to 3.26 tons in 2000.

Other than a slow change in the administrative and management institutions, the improvement of living conditions and all socio-economic aspects have moved positively. The positive effects of the rehabilitation are confirmed in all the communes by the high rate of satisfaction.

Finally, with the large reduction in rainfed areas, compared with those in the mid-term report, collective wealth has now reached almost all the communes.

Most families have improved their living conditions since 1997 and the number of grass huts has dropped to 5%. The general improvement in housing is summarized below.

Table 3.5 Family housing 1995 –2000

Type	1995	1997	2000
Grass Hut	17%	11%	5%
Fourth Level	64%	67%	77%
Permanent	19%	21%	18%

With respect of other family property, there is an improvement of living conditions evidenced through the acquisition of goods, which a higher number of families can now afford.

3.8 Sustainability

3.8.1 General

The economic analysis of the project has been conducted on the basis of an economic life of 30 years. In order to realise such a life for the system, it is necessary to institute an on-going Operations and Maintenance program and a BME System to ensure that there is no decrease in efficiency. This will ensure that any problem will be identified in the early stages and will note any negative impacts, which are developing.

3.8.2. Operation and Maintenance Organisation

In 1998, the operation and maintenance policy changed, following the *Law on Water Resources (1998)*, to ensure the efficiency and success of new investments. The changes require the involvement of the farmers, who use the water, and are slowly being implemented.

Constraints on the actual maintenance and monitoring of the system are that the institutional framework has remained unchanged for a long time, that practices have not kept pace with the newly implemented facilities and the changing environment, that there is poor access to modern engineering techniques in planning and monitoring and a lack of involvement of the end-users in the operations.

A diagram showing the O&M relationships and the changes between 1995 and 2000 is shown on Figure 3.2. In this summary, description is limited to broad categories with an emphasis on the changes, which have taken place. For a more complete description of the organisation, reference should be made to Section 4.5 of the main report.

The Provincial People's Committee (PPC) currently manages the public irrigation and drainage systems. It provides policy advice and funds to PARD, sets water rates, decides on subsidies and local projects. PARD is the provincial government authority with overall responsibility for operating, maintaining and operating water resource facilities and for the survey, design and construction of minor works.

The local authorities, such as Districts and the Communes are the legal owners and operators of the portions of the system within their administrative boundaries and are directly involved in operations and maintenance. Unfortunately, the administrative boundaries do not normally coincide with the hydraulic ones. This creates problems relative to the equitable distribution of water and raises questions relative to the overall sustainability of the system if these administrative boundaries are maintained in the operation of the system.

The Song Chu Irrigation Management Company (SC-IMC) is a specialised state-owned company, managing the Bai Thuong Weir and Headworks, the main and secondary canals and related structures. The primary responsibility of SC-IMC is planning the water supply schedule, adjusting it, as necessary, and the timely, adequate and equitable delivery of water from the source to the communes' water intakes, which, generally, serve tertiary canals. The expertise of the staff is good, some of them have higher degrees in water resources and all the staff is trained every year.

Besides irrigation, the company maintains and operates 10 major drainage systems and 300 pumps. Operations are carried out through Hydraulic Enterprises and Irrigation Stations, which act over designated areas, corresponding approximately to administrative boundaries.

The SC-IMC sells and delivers water on a contract basis to clients, which are communes, co-operatives or Water User's Associations. The farmers themselves are not clients but are represented by one of these entities, which are entitled to sign the contracts. The main source of revenue to the SC-IMC is irrigation fees, collected from farmers for water delivery services.

IRRIGATION OPERATION & MANAGEMENT RELATIONSHIP IN SONG CHU AND NORTH NGHE AN IRRIGATION SYSTEMS

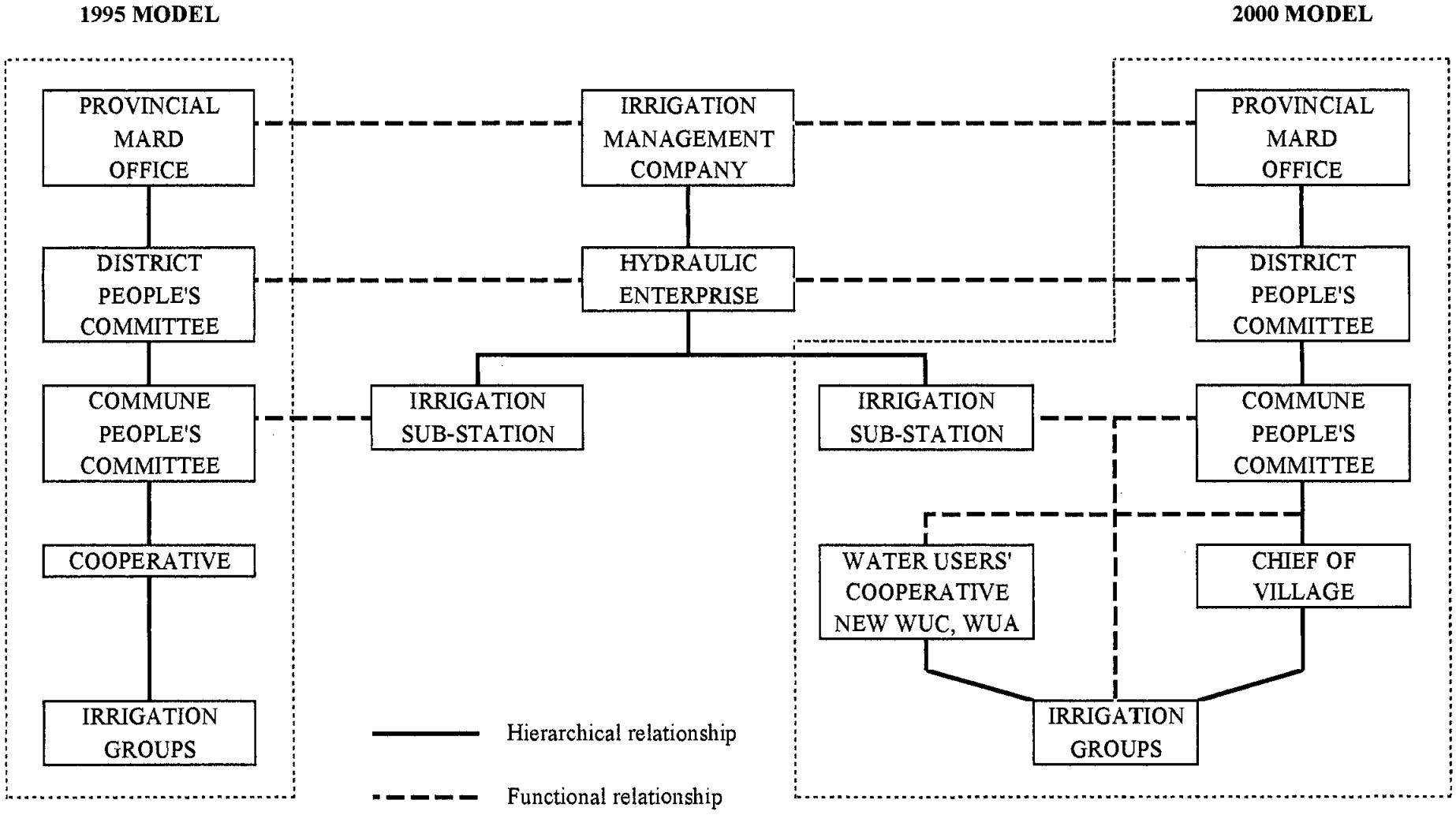


Figure 3.2.

In principle, the company does not receive subsidies from the State budget, except for electricity costs, used mainly for drainage pumping. The company budget for the period 1999 - 2000, is presented as follows.

Table 3.6 SC-IMC Budget 1999 - 2000

Description	1999 (million dong)	2000 (million dong)
Revenues :		
Subsidies	-	-
Water Fees paid by Farmers	23,160	22,115
Other revenues (service contracts)	203	393
Total Revenues	**23,363**	**22,508**

The SC IMC considers that its performance must be improved but it sees the main reason for inadequate performance as a lack of funds. In fact, it is true that the fees collected from farmers do not cover the actual expenses, and that these actual expenses are inadequate to cover all the necessary operations.

Besides resources, there are also some institutional aspects that SC-IMC must improve. The main problem is a lack of an integrated approach to operations and maintenance. The interface with water users must be changed, because there are discrepancies in methods, technical skills, priorities and interests at the farmer level.

The performance of SC-IMC cannot be considered adequate without strengthening the linkages within the complete institutional framework. These have an influence on socio-economic, political and environmental aspects. Since the performance of the company will be measured by the performance of the system as a whole, more attention should be paid to the following areas:

- Physical performance: by paying attention to the water demand/water supply gap, conflict identification and speedy resolution; being positive to the idea of the transfer of some of the assets and responsibilities to beneficiaries; and being open to an integrated approach to participatory management.

- Financial performance: close the gap between expenditures and revenue; fees are really low, but are commensurate with the present quality of service. It will not be possible to close this gap without State support to bring the service to a level, which would justify higher fees.

- Economic efficiency: This means that the fees charged must reflect the real water supply costs: incentives are also required to encourage good practice and the avoidance of the waste of water.

- Equitable Water Distribution: This has been an issue since the start of the project but it cannot be resolved without providing the appropriate gates and water metering and combining them with effective participation from the beneficiaries. After rehabilitation, this issue is less acute and is less extensive because water is abundant, at least at the upstream end of the canals. However, it must be noted that about 30% of the area is still partly

irrigated, and this is directly related to the inability to correctly limit flows to the upstream areas.

This does not diminish the fact that SC-IMC is gradually improving the operation and maintenance of the main and secondary canals. The main changes in the O & M organisation have been the change in the role of the co-operatives and the establishment, on a pilot basis, of Water Users' Associations. The latter were formed as a result of experience with the IFPRP and the ADB funded TA on O & M Strengthening.

Since 1997, there has been a rapid increase in the number of co-operatives and their role has changed from being the traditional co-operative of production to that of a co-operative of services. The co-operatives now support farmers with such services as programs of water distribution, advice on agriculture, education in plantation techniques etc. They also have a specific role in the allocation of responsibility for irrigation, because they interact with the production group and the sub-station. According to our field investigation, this new type of co-operative is appreciated, especially since membership is now voluntary. The necessity for such an organisation was noted in the Mid-term Report of 1997.

Two Water User's Associations (WUA) have been established, as pilot projects, with the support of the ADB TA Project:

- The B6/9 (this is also the name of the irrigation canal) WUA, covers an area of 645 ha and 3 Communes. The area operates on the basis of hydraulic boundaries, and not administrative ones. The irrigation canal operated by this WUA is 4.6 km long; there are 35 tertiary and quaternary off-takes and about 10 km of laterals. TA No. 2869-VIE previously evaluated the new management structure as poor because the water supply was unstable and because of upstream/downstream conflicts but the situation has now improved with the rehabilitation of gates and measuring weirs.
- The B8a WUA covers an area of 740 ha in 3 communes. The irrigation canal is 3.0 km long with 21 off-takes for laterals. The same remarks apply as those for the B6/9 WUA.

These entities were established to take over the irrigation responsibilities within the area. This involved the legal transfer of the responsibility from SC-IMC to the WUA. The results are remarkable. They have shown greater involvement of the farmers, careful irrigation planning, less wasted water and more equity between the users at the upstream and downstream ends of the canals. The canals are better maintained because of the direct interest of the Management Board of WUA.

However, the creation of more WUCs is difficult, because they need financial support for their establishment and farmers lack experience in managing such associations and require training and more technical assistance from the State, through the SC-IMC and the local administration.

3.8.3 Operations and Maintenance Support

Main and Secondary Canals

These canals are operated and maintained by the SC-IMC. The O&M methods have not changed since 1995, as there has been no significant change in funding. SC-IMC management knows that changes will be necessary to adapt to the newly rehabilitated system and to the requirements of the *Law on Water Resources.*

Some changes to be considered are:
- Reduce the number of staff and unskilled personnel;
- Improve the staff skills by training;
- Increase the productivity of workers and the efficiency of the whole O&M. system.

The main problem is the control of flow and its adjustment to actual water demand. Flows are only measured and recorded regularly at Bai Thuong and Ban Thach. Flows elsewhere are only estimated from fixed graduated scales with no follow up or record system. The alternate supply of North Canal and South Canal is still practiced and this has been facilitated by the shorter duration for canal filling after rehabilitation (water filling the 54km North Canal now takes three days instead of the four days required before rehabilitation).

Where the gated regulators have been rehabilitated, irrigation, by rotation, is applied. An example is Canal B9, where the WUA is now established.

Maintenance of these canals is still severely hampered by the lack of continuous maintenance roads, noted in the Mid-Term Review (1997), to access all points on these long canals. It was also noted that navigation on the canal causes damage to canal banks and to the lining. Wood is being stored on the canal embankment and even on its slopes (near Dong Son Centre) but should be discharged and stored only in specially designated places.

Tertiary Canals and Structures not included in the Project

This infrastructure belongs to communes and is maintained by the Irrigation Groups. They are operated and maintained in the traditional manner, even in the rehabilitated areas. The main method of irrigation is by continuous supply to plots as long as water is available though there has been an increase in supply by rotation since 1997. The continuous supply method is simple, but it does not equitably distribute water between the upstream and downstream reaches of the canals.

Most of the communes, where the tertiary canals and the control gates have been rehabilitated, have started to use the rotation method. Of the 19 communes surveyed, 13 apply the rotation method, regularly or occasionally, and 6 communes apply only continuous irrigation (see Appendix E.2.3.). The area irrigated by rotation is actually 59% of the total. This comprises 53% of the fully irrigated areas and 86% of the partly irrigated areas. The reason for this difference is that the supply of water to the partly irrigated areas is restricted, making the use of irrigation by rotation essential.

Even after rehabilitation, there are difficulties in applying rational, planned rotation of field irrigation due to the following constraints:

- Lack of appropriate check structures; most of rehabilitated tertiaries have simple openings instead gated turnouts;
- Lack of interest and communication between the farmers (water users) and the SCIC;
- IGs need more technical supervision, more knowledge and experience in farm irrigation planning;
- Excessive division of the land into small plots, under different crops or in different stages of crop development.

It is noted that the WUC Pilot Projects on Canals B6/9 and B8a promoted, tested and evaluated improved irrigation procedures, including the application of the rotation method. These pilot projects, funded by the ADB, included a complete technical, financial and institutional approach to irrigation O&M covering 3-4 communes each.

Some aspects of O&M on tertiary canals and farm irrigation were found, in 2000, to be unchanged from those noted during the Mid-term survey, as follows.

- Lack of understanding, by farmers, of the role of main canals, which are still considered as a direct source of water for field canals. They take care of small canals, considered 'their' canals and ignore the main canals, belonging to SC-IMC. There is a lack of information explaining the performance of the whole system and their rights and duties for each canal.

- Some rehabilitated tertiary canals still have no gates and water still flows continuously and is lost, as it was before rehabilitation. This situation severely reduces the performance of the system in the zones situated downstream. Gates should be provided at every tertiary off-take and water consumption should be controlled at the farm gates. Failure to do this will result in the rehabilitation of main canals having no effect for the farmers, located downstream.

The fragmentation of O & M responsibilities between IMC, Communes, Co-operatives and Irrigation Groups makes co-ordination difficult and is negatively affecting performance; thus the O&M components should be integrated.

3.8.4 Benefit Monitoring Evaluation

A Benefit Monitoring Evaluation (BME) system, included in the ADB's TOR, has not been implemented. The establishment of a BME system and reporting was supposed to be assumed by CPO and SPO 406; in fact they were responsible only for sub-project implementation. The data collected and managed by them was applicable to project implementation and cannot be used to monitor and evaluate O&M performance and the expected economic results.

The current SC-IMC system covers the O&M activities and such items as budget/expenditures, staff, labour, materials and equipment. Inspection reports concerning floods, emergency works, major repairs and metering are recorded. The water levels and flows are measured regularly (4 times/day) in Chu River and at Bai Thuong but only occasionally at other locations using portable instruments. There are no records of water quantities delivered to beneficiaries. Detailed irrigation programs, areas irrigated and their irrigation regime (full or partly), duration of services and maintenance works are not systematically measured and recorded. Other data collected and monitored by SC-IMC are irrigated areas and cropping schedule as the basis of water delivery contracts, concluded contracts and irrigation fees.

There is no record of principal agricultural inputs, use of fertilisers and other chemicals, crop budgets and agricultural production as farmers' organisations are considered to be recording this data and it is obtained from them when necessary. Agricultural production is monitored separately, by each commune and district and is not related, necessarily, to irrigation rehabilitation or to O&M performance.

Environmental monitoring was neglected altogether until 1997. Lately, the SC-IMC has installed four check points for monitoring water quality. Two are located on irrigation canals and two on main drains. Samples will be collected and analysed three times per year. Additional environmental monitoring is also required to cover soil quality, which can be adversely affected by the application of too much water, washing out nutrients and causing the onset of soil salinity. The SC-IMC is implementing now a new monitoring system but it has to move from its current manual system to a computerised system of data collection, analysis, monitoring and recording. The equipment has now been procured with the savings from the project. The scope of the new monitoring system, the training of the staff to operate the system and the start of operation are still in preparation.

A regular BME system should be established as soon as possible, to collect the necessary data, evaluate the results and produce periodic reports, with the information needed to confirm that the project continues to reach its objectives. An information campaign and training courses for the staff will also be required. The existing O&M monitoring should be integrated within the BME system. Regular BME reports should cover :

- system performance;
- agricultural production;
- financial;
- socio-environmental;
- institutional;
- changes;
- problem identification;
- recommendations for the next period.

There should be permanent BME Unit within SC-IMC with all the necessary facilities for communication, transport, computing and regular quarterly reporting. The BME Unit should be composed of a permanent staff inside the company and of external contacts established within Thanh Hoa PARD Office, SPO 406, local administration (districts and communes) and, occasionally, consultants.

The data to be collected and analysed for BME are as follows:

- Irrigation system performance: irrigated areas, irrigation regime (fully irrigated, partly irrigated, rainfed); records of discharges, status of canals and structures (main and secondary), irrigation schedule, interruption of services, records of O&M problems; O&M costs; fees collected and budget of the SCIC;
- Agricultural: land use, cropping patterns and calendars, cropped areas, yields and productions (districts and communes); fertilizers and pesticides; family income and expenditures; income per crop and hectare, status of tertiary network, field irrigation O&M procedures and costs; water fees;
- Social and environmental: farmers concerns and involvement in O&M, associations and co-operatives, water and soil quality, drainage, diseases, IPM program, related activities.

Quarterly reports should be produced by the BME Unit, including an appreciation of the results, the identification of problems and the proposed actions. These reports will be used for current O&M by the SCMC itself and by Higher Authorities and for continuing evaluation of the performance and benefits.

4. NORTH NGHE AN IRRIGATION SYSTEM

4.1 General Description

The North Nghe An irrigation scheme was built in the 1930s. It has a total gross area of about 36 000 ha and is 40 km north of the main urban centre of Vinh, the capital of Nghe An Province. The North Nghe An plain, with a population of more than 500,000 people, is one of the two most important agricultural zones in the province.

Due to the long period of operation, a lack of proper maintenance, wars and natural calamities, the canals and structures had deteriorated severely. Originally, the system was designed to irrigate about 30,000 ha of paddy crops, twice each year. Before the project, the system was still in partial operation but was so deteriorated that only one crop, over an area of 12,000 ha, was properly irrigated during the dry season.

Before the project, the major headworks were evaluated to be at a high risk of failure, which, had it occurred, would have meant a total interruption of irrigation. The aims of the project were to restore the full capacity of irrigation to all the designed area. The rehabilitation mainly involved the following components (Figure No. 5):

- Do Luong Weir and Headworks; these works consisted of the rehabilitation of the concrete weir, the scouring sluice and the mechanical parts of the gates, to increase the stability of the structure, to increase the discharge and to control the sedimentation upstream of the weir and the irrigation intake;
- Main Canal, 56 km length; the works consisted of re-sectioning, partial lining, the rehabilitation of main structures, including an existing tunnel and the construction of a new tunnel (500 m length) parallel to it;
- Secondary Canals each serving an area more than 500 ha. The total length is 89 km; the works consisted of resectioning, partial lining and the rehabilitation of structures;
- Vach Bac Drain, designed in two sections : Section I is 13 km in length; the works consisted of reshaping, dyking and constructing a new weir on Dinh River; and Section II, 4 km length; the works consisted of enlarging the drain section and Bau Ru sluice.

The works are now completed and the performance and benefits, evaluated in this report, can be considered as final.

4.2 Irrigated Areas

The system now serves a net area of 30,050 ha. This is the area actually irrigated, but the performance is not uniform. In order to assess changes in irrigation performance, similar to Song Chu, categories of water regime have been established as follows :

- full irrigation : water is available during all year and irrigation system responds entirely to crop requirements;
- partly irrigation : water is available with restrictions, especially in dry season;
- rainfed : irrigation is very difficult or impossible.

A comparative analysis of irrigated areas before the project commencement, at mid-term and currently, shows that rehabilitation has improved the global performance of the system, as follows:

Table 4.1 Irrigation Performance in NNAIS

Irrigation Performances	Performance before the Project (1995)		Performance at the mid-term (1997)		Final Performance (2000)	
	Area (ha)	Percentage	Area (ha)	Percentage	Area (ha)	Percentage
Full irrigated	11 786	39%	13 571	46%	18763	62%
Partly irrigated	10 113	34%	10 523	36%	11287	38%
Rainfed	7 631	25%	5 956	20%	0	0%
Total	**29 530**	**98%**	**30 050**	**100%**	**30050**	**100%**

The greatest evidence of progress lies in the elimination of rainfed areas, which have all become fully or partly irrigated. Some areas are still partly irrigated after rehabilitation but this is considered normal, as large areas (5697 ha or 19% of the total area), irrigated by pumping, are included in this category and the high cost of pumping does not encourage full water consumption. In NNAIS, the available discharge in the Ca River is always more than is necessary for irrigation. The main problem, causing a shortage of water, is massive sedimentation of the intake and the first reach of the Main Canal. This problem has been reduced but not eliminated by the rehabilitation.

The area classified as partly irrigated is still large (38%). The reason for this lies, not only in the high cost of pumping, but also in the post-rehabilitation performance and in operation and maintenance. The operation of the tertiary network, by rotation, is not universal, water losses are not controlled and the land situated at the downstream end of most secondary and tertiary canals remains partly irrigated.

4.3 Rehabilitation Works, their Status and Performance

4.3.1 Do Luong Weir and Headworks

Do Luong weir was built in the 1930s. At the commencement of the project, the weir was still functional and ensured a minimum water level for the intake of the irrigation system. The weir is 270 m long, divided into 12 sections and is submerged during floods. One section is concreted, the other 11 sections of the weir are mobile and are equipped with 11 steel gates, which are designed to function automatically by means of floats.

The water intake is located upstream of the weir on the left side, equipped with a bottom sluice 20 m wide to provide for flushing sediments, regulating the discharge and for safety purposes.

The rehabilitation of the complex is now completed and the operation is normal. However, the rehabilitation of the scouring gate of the weir did not solve the massive sedimentation process upstream of the weir and an island of river deposits has formed in front of the irrigation intake and threatens to obstruct the flow of water into the Main Canal. Despite running a hydraulic

model, dredging remains the only solution, but this will be to a lesser extent than before rehabilitation.

The works were planned for completion by1998 but were mostly completed in June 1999. Except for this delay, the implementation of the works carried out by the Contractors, are considered to be good.

4.3.2 Main and Secondary Canals and Structures

The NNAIS is an open canal network, which had been sized to meet a peak consumption of water of 1.0 l/s/ha. The rehabilitation design aimed at restoring the main and secondary network and adapting it to the present, higher irrigation requirements of 1.2 l/s/ha.

The works to be rehabilitated are mainly the following.

Main Canal.

The main canal starts at Do Luong headworks and ends at Km 56; rehabilitated capacity is 36 m^3/s. The first reach (about 10 km) is relatively deep, cut in heterogeneous material (clay or rock or a combination) was degraded, with sliding and unstable slopes. Rehabilitation is now completeed and the sliding has been stabilised with gabions (Km 3 – Km 4).

Between Km9 and Km10, water passes through a tunnel (Truong Khap Tunnel, 508 m length). The rehabilitation consisted of the repair and reinforcement of this tunnel and the construction of a new tunnel in parallel. The works were constructed by Da River Construction Co, who specialise in tunnels for hydropower projects. The rehabilitation is considered satisfactory.

The main structures rehabilitated were the regulators at Mu Ba, Hiep Hoa, Do Ly, Phuc Thanh and Yen Ly, syphons, spillways and many irrigation off-takes.

The canal is lined for 25 km. The remaining 31 km is lined on one slope only or is unlined. The performance of the canal has improved, the erosion has stopped and it meets design requirements. Despite the improvement in performance, some problems remain:

- The lining on only one side will eventually create erosion of the opposite, unlined earth side;
- There is no continuous maintenance road along the canal, as was recommended by the Consultant in the *Design Review Report (1996)* and the *Mid-term Review (1997);*
- The single measurement of discharge at the Mu Ba regulator is insufficient for flow control on a canal, 56 km long, distributing water through 66 water off-takes.

Secondary canals

The rehabilitation aimed at restoring the secondary network to its original characteristics and adapting it to the current, higher irrigation requirements of 1.2 l/s/ha. The IFPRP includes only canals serving more than 500 ha, namely:

- Van Tran Pumping Station and its canal network, 10 km length covering 2,700 ha;
- Khe Khuon Drain, rehabilitated as an irrigation canal to serve an area of 1,500 ha, the main works consist of earth works to enlarge and correct the section, 3 weirs and 16 lateral gates.

This is a deep canal, which normally discharges floods from heavy rains. Local authorities had undertaken, in the past, to connect this drain to the Main Canal and divert water for irrigation. This has now been done under the IFPRP but the slopes are still sliding. Irrigation by gravity is not possible; the area needs needs pumping any time from 24 small pumping stations; and

- Nine secondary canals as follows:

	Irrigated Area (ha)	Total Length (km)	Lined Length (km)
N2	4300	20.0	2.0
N8	3210	15.0	-
N13	2500	14.1	7.6
N14	550	5.0	2.2
N17	1020	5.2	2.0
N18A	1400	-	-
N20	2000	6.6	4.7
N24	660	4.8	3.2
N26	1000	7.6	6.5

At the date of commencement of the Project, all these canals were unlined and eroded to a cross-section, larger than the original. It was impossible to maintain the design water levels and, generally, the tertiary intakes were supplied at a discharge, lower than the design. Most of the regulators and mechanical parts were missing, the control of discharges was impossible and the irrigation supply to the downstream end of canals was partial or non-existent.

The rehabilitation of secondaries consisted in heightening the embankments to the original design, partial lining of 2 to 7 km of the upstream reach of each canal, repairing structures and replacing all the mechanical parts of the gates.

Irrigation performance is improved, where the secondary canals are rehabilitated. In general, the level of performance of secondaries is directly related to the lining of the canals and the rehabilitation of the gates. During the 2000's survey, some problems were noted along the secondary canals:

- Secondary canal N2 (20 km length), has been lined only 2 km at the upstream end. The remainder of the canal has only had the earthwork reshaped if anything has been done at all;
- Rehabilitation of Khe Khuon Drain as irrigation canal is inadequate in zones exposed to sliding. In general, its performance is not reliable in the long-term because of the frequent repairs. As the Consultant recommended in the *Design Review Report, 1996,* and the *Mid-Term BME, 1997,* this canal should be re-studied and rehabilitated for both drainage and irrigation, taking into account the rapid water level fluctuations during floods (about 4 -5 m in amplitude);
- The downstream ends of long secondaries are not carrying the design discharge and are not being rehabilitated by the communes, because they only rehabilitate the tertiary canals. Consequently, these downstream reaches are not rehabilitated and the areas that they service will remain partially irrigated. As at Song Chu, there are differences between the irrigation rates at the upstream and downstream ends of canals.

In conclusion, the performance of the secondaries is not equal over their whole length. It is obvious that more effort has been put into ensuring a good supply (main canal and the upstream ends of secondaries) but less in water distribution (secondary canals under 500 ha). To achieve a good, overall performance of the irrigation, a program should be undertaken, after the IFPRP, to complete the secondaries with the required lining and structures. This program should include the canals, which were not rehabilitated or only partly rehabilitated within IFPRP, because they supplied under 500 ha or simply because lack of funds. These canals are N2, N13, N17 and N18.

4.3.3 Tertiaries and Quaternaries

The rehabilitation of these canals, each serving an area less than 500 ha were not included in the IFPRP, but were in local programs of rehabilitation. These canals belong to communes or co-operatives and are operated and maintained by them, through the farmers' Irrigation Groups.

Though these are smaller canals, their length is important. There are about 200 km of tertiaries serving areas between 100 ha - 500 ha and some 500 km of quaternaries. Usually, such a canal belongs to a commune, but some are bigger and are being operated by several communes. This creates conflicts due to any uneven upstream - downstream water distribution.

The rehabilitated tertiary canals have a rectangular section of 0.50m x 0.40 m of concrete and brick, replacing earth fill with concrete flumes, masonry or brick lining. This was least costly, but extremely successful. Normally, a gate and a measuring weir are provided at the upstream end of each tertiary, but many of these gates are missing or have been replaced with simple openings, and the weirs were demolished. To date, about 40 % of the tertiary network has not been rehabilitated, which has a very negative effect on final results of the rehabilitation of the main and secondary canals.

In general, the design for the rehabilitation of these smaller canals was carried out by the Design Department of Irrigation Management Company though some smaller canals were rehabilitated without any design. The construction was carried out by the farmers, under the management of the communes and with the technical assistance of the Hydraulic Enterprise and Irrigation Sub-station.

The tertiary - quaternary network is the last link in the irrigation system, where rehabilitation demonstrates its effect. Its performance will have to be improved in order to reduce the maintenance effort, improve the irrigation efficiency and allow irrigation by the rotation method.

The results of the survey of the commune irrigation network, on an area of 4,125 hectares within 12 communes, are illustrated below (see Appendix E.3.1.). Of a total network length of 109.1 km, 62.0 km has been rehabilitated:

- Rehabilitated canals:	Total	62.0 km
	Good performance:	38.9 km (63 %)
	Fair performance:	20.3 km (33 %)
	Poor performance	2.8 km (4 %)

This data shows that the quality of rehabilitation, as judged by the farmers themselves, is good for 63 % of the rehabilitated canals. This could be considered a satisfactory result, still less than

in Song Chu. The overall, low level of secondary and tertiary rehabilitation is worrying, as the rehabilitation of main and part of secondary canals is now completed.

Below are comparable figures for Song Chu and North Nghe An.

	North Nghe An	Song Chu
- rehabilitated tertiaries	60%	70%
- good performance	63%	89%
- fair performance	33%	11%
- poor performance	4%	0%

A lack of local funding delayed the rehabilitation of the tertiary canals and work, at the local level, started with the smallest canals. This resulted in a bottleneck in the system with rehabilitated main and secondary canals separated from rehabilitated quaternaries by the untreated tertiaries.

4.3.4 Pumping Stations

The area irrigated by pumping is considerable (currently 5697 ha or 19 % of the total area). Most of this is situated in Do Luong district (4265 ha). The pumping stations, which existed before the Project, have been maintained and rehabilitated as follows:

- Pumping Stations for the irrigation of higher areas. The biggest of these are Van Tran Pumping Station I and Van Tran Pumping Station II (the second is re-pumping downstream of Station I. They are designed to irrigate 2700 ha. The rehabilitation of these stations was included in IFPRP.
- Smaller Pumping Stations at Nhan Son, Phanh Phong and N17. The rehabilitation of these stations was also included in IFPRP.
- Smaller pumping stations along the Main Canal to irrigate areas situated nearby, which are generally higher than the water level in canal; or located on the main drains to supplement the irrigation water. Only 5 of these pumping station are operated by the NNA-IMC, the others are the property of communes. None of these stations, equipped with horizontal pumps, were rehabilitated under IFPRP.
- Along the Khe Khuon drain there are 24 small pumping stations, all belonging to communes and consequently not included in IFPRP.

4.3.5 Drainage

The main drainage system consists of natural watercourses that are unable to evacuate the water rapidly after heavy rains, leaving large areas of low lying land flooded for weeks. There are several natural drainage basins in the NNAIS area:

- Song Bung, Bien Hoa and Song Dinh are natural streams in the central part of NNAIS. A gated weir was constructed after the intersection with the Main canal.
- Song Thai drain (syphon on Main Canal included in rehabilitation program).
- Coastal drains, such as Song Mo and Nga Le.

Some drains were included in IFPRP, as they are directly related to the irrigation water supply or to the protection of irrigation infrastructure, as follows:

- Khe Khuon Drain, a natural stream serving for both irrigation and drainage purposes in district Do Luong. This drain is included in IFPRP as an irrigation canal though it remains a drain at the same time. The drain section is deeper, after rehabilitation, and transports 1.4 m^3/s for irrigation, diverted from the Main Canal. The flood discharge is much higher, approximately 100 m^3/s.
- Vach Bac Drain, in two sections (I and II) protects the Main Canal against floods from the foothills and reduces the flooding effect over an area of 5,000 ha. This drain is not a natural watercourse. It was built 30 years ago for the same purpose and has been included in IFPRP. The works consist of deepening and correcting of the cross-section, the construction of a new, gated weir at the Dinh River and the enlargement of the Bau Ru sluice.

As in SCIS, the IFPRP does not include rehabilitation of the drainage system, generally, but there is no doubt that the drainage system needs improvement and rehabilitation. This should be the objective of a separate project.

If only the irrigation is rehabilitated, the waterlogged area (estimated at 20 % from the total area in normal years) will remain unchanged. In 1996, after the commencement of the Project, heavy rains occurred and the flood affected 72 % of the irrigated area and reduced the production of the second crop of rice.

Some main drains are still used to supplement irrigation, by pumping, but to a lesser extent than before rehabilitation. After rehabilitation, drains will be used for irrigation on a temporary basis, only.

During all the evaluation surveys, the beneficiaries complained about the poor performance of the main drains, which were not able to evacuate the water resulting from heavy rains. The second rice crop is usually delayed and there is no time for a third crop. The conclusion is that the rehabilitation of the drainage is necessary to obtain full value from the investment in rehabilitation.

4.4 Implementation

4.4.1 Implementation Management

The implementation of the NNAIS Sub-project was the responsibility of the Central Project Office No. 407 (SPO 407), located in Vinh City. During the peak construction period (1997-1999), the staff of the SPO 407 was managed by a Director and a Deputy-Director, supported by a Technical Team and a Planning/Accounting Department. The Chief of this department manages and maintains relationships with the construction companies, makes payments and keeps up with the implementation schedule. The Technical Team is composed of engineers and supervisors on the site (8 persons), under the authority of the Deputy-Director.

The inter-relationships and responsibilities are the same as those at Song Chu. (See Section 3.4.1).

4.4.2 Implementation Schedule

- The works started in 1995 and were planned to be finished at the end of 1998. Most of the works have been completed by the end of 1999. The overall completion date was reviewed several times and was finally planned for June 2001 (see Figure 4.1). There were good reasons for this delay in the scheduled completion. In addition to the procedural ones, listed for Song Chu, there were changes in design and construction methods, for instance : Son Thai syphon (more excavations to place steel pipes); Main canal Km 3 – km 4 (more gabions for sliding slopes); Bau Ru aqueduct (expanded piles); and others.

4.5. Costs, Financial and Economic Data

4.5.1 Budget and Expenditures

The table below compares the original budget of 1994 to the amount finally estimated for the original scope of work and the amount actually spent on the expanded sub-project.

Table 4.2 Budget and Expenditures

VND x 10^6

Description	Original Scope	
	1994 Budget	2000 Estimate
Total	**212,515**	**173,293**
Civil Works	**178,453**	
Do Luong Weir	2,976	
Truong Khap Tunnel	28,100	
Canals	147,377	
Other	**15,251**	
Compensation	**3,900**	
Contingency	**2,160**	
CPO	**12,751**	
Total in 2000' VND		**225,490**

NORTH NGHE AN IRRIGATION REHABILITATION SUB-PROJECT - IMPLEMENTATION SCHEDULE

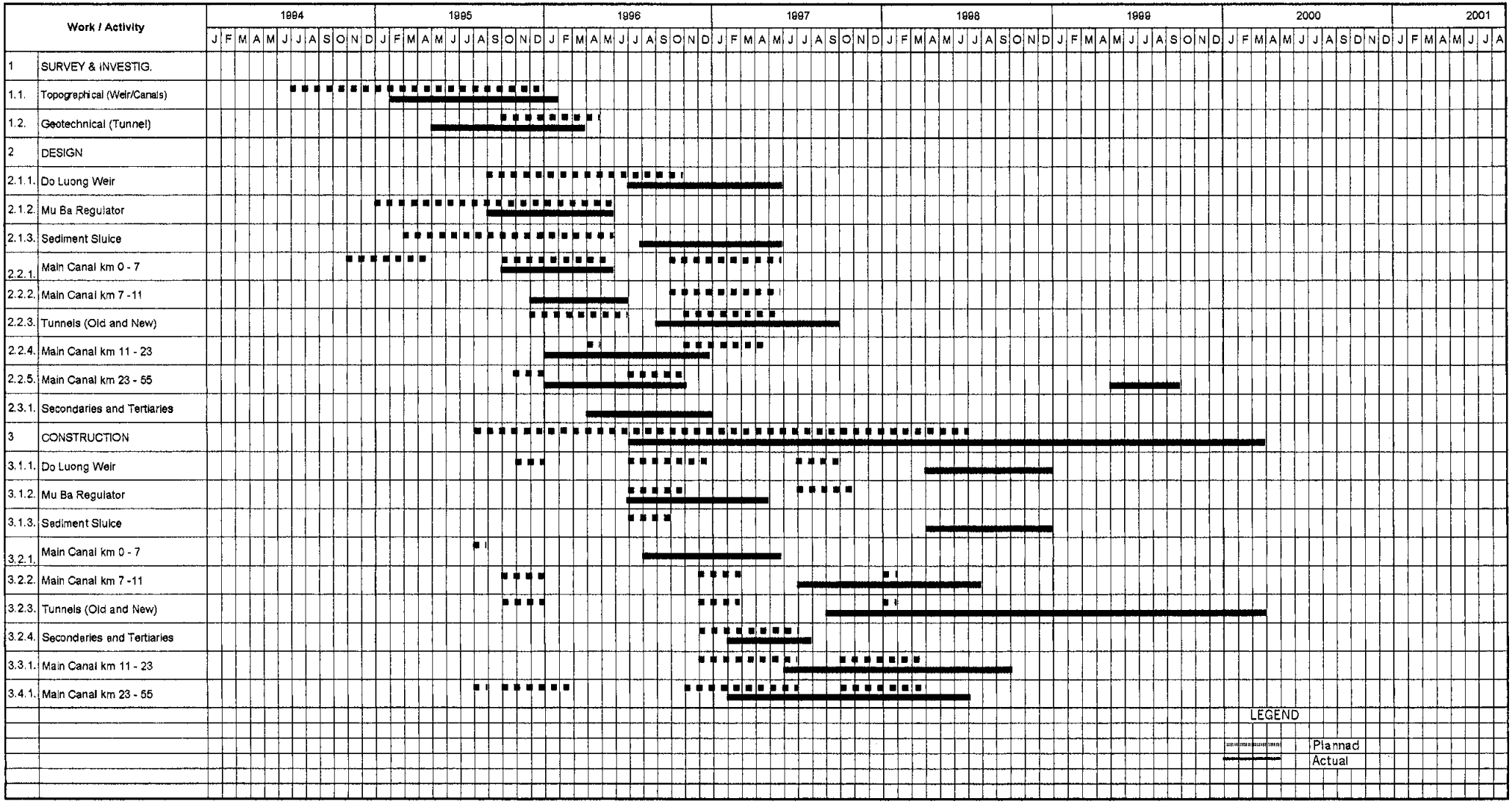


Figure 4.1

The savings of a total of 39,222 million VND (212,515 – 173,293 = 18%) or about US$ 2.8 million between the original budget and the estimated cost of the original scope of work were approved for use:

- To install a control and monitoring system for irrigation operations;
- And, together with savings obtained from other sub-projects, to extend the IFPRP to rehabilitate irrigation systems and flood protection works in other provinces, damaged by floods (see Section 5).

The cost of rehabilitation of tertiary canals, which amounts to 10,845 million Dong per year, is not included in the investment cost above. However, the cost of tertiaries has been included in the economic analysis.

4.5.2 O&M and Crop Costs

O&M costs before rehabilitation have been calculated from the figures used in the inception report. Their present level is 11,677 million Dong per year. When compared, at constant Year 2000 prices, this is slightly higher than amount before rehabilitation (9,000 million VND).

No real rate of increase in O&M costs, after Year 2000, has been used in this analysis, which leaves these costs, in the future, at par with inflation.

For the purpose of the analysis, provision has been made for major repairs that go beyond normal annual maintenance. These major repairs are necessary to keep the rehabilitated site at its present level of increased production as compared to the situation before rehabilitation. It has been assumed that these repairs would be conducted every five years and would cost 20% of the total project investment.

The financial budgets for main crops were established for the with- and without-project cases. Data collected in the field before and at the near-end of the rehabilitation, from the BME survey, have been used.

Current economic crop budgets were also established, based on economic and farm-gate market prices, whenever possible, and used for both the with and without rehabilitation cases. In this way, the economic viability is dependant entirely on the areas cultivated and the yields obtained.

The financial crop budget shows that rehabilitation has very positive effects on the gross margin per hectare, without a provision for labour. Gross margins have increased as follows :

Rice – winter	36%
Rice – summer	22%
Maize	12%
Sweet potato	47%

The overall situation is futher enhanced by the increase in the fully and partially irrigated areas made possible by the rehabilitation.

The average net income generated per hectare for paddy has increased 20 % after rehabilitation, while maize has decreased 10 % and sweet potato has improved by 172 %. This confirms that rehabilitation has generally, generated positive results per hectare cultivated.

4.5.3 Economic Analysis

The project EIRR is 27.6% using the capital expenditures, in Table 4.2, for the original scope of work (Appendix F 3.7). This compares favourably with the value of 22.0% projected in the inception report.

Sensitivity analyses are not as important at this stage in the project but it is necessary to recognise that there are factors, which could affect future results. For example, a minimal decrease in yield of 1% per year for paddy would reduce the EIRR to 24.8%. This shows that the viability of the North Nghe An irrigation scheme is vulnerable to soil salinity or poor maintenance in the future.

4.6 Environmental Impacts

4.6.1 Soil and Water

The same impacts have been assessed as at Song Chu (see section 3.6.1). The use of fertilisers is higher than before rehabilitation, nevertheless somehow less than in Song Chu (in 2000 farmers used 1372 kg/ha NPK, compared to 1426 kg/ha in Song Chu).

4.6.2 Impacts during Construction

Socio-economic impacts were limited and largely confined to those listed for Song Chu. Construction resulted in the necessity to resettle two households and to compensate a total of 958 affected families. A RAP was developed and used by SPO 407 to govern this activity.

4.7 Benefits

4.7.1. Irrigation and Production

A comparison of the land use between 1995 and 2000 is shown on Table 4.2. This clearly shows the improvement in the cropping patterns. Average cropping intensity has increased from 1.79 to 2.24. This increase is not as great as expected because of the flooding situation outlined in Section 4.3.5.

Table 4.3 Land Use in North Nghe An Irrigation System

Area for agriculture (ha)	(*) 3 crops area (ha)		(**) 2 crops area (ha)		(***) 1 crop area (ha)		Designated area to be irrigated inside the system (ha)
	Before project (July 1995)	Oct. 2000	Before project (July 1995)	Oct. 2000	Before project (July 1995)	Oct. 2000	
34700	0	13650	28692	15877	4670	5233	30050(****)
100%	0%	39%	83%	45%	13%	16%	

(*), (**),(***): See the definitions for Table 3.2
(****) : This figure includes an irrigated area of 550 ha supplied by interconnection with Vuc Mau Reservoir.

The cropping patterns are essentially the same as at Song Chu. The Spring and Summer rice were cropped both on 82 % of the studied area. The upland crops occupied in 2000, about 51 % of the total area.

Rice yield for spring rice rose from 4.76 tons/ha in 1995 to 5.37 tons/ha in 2000. A maximum of 6.00 tons/ha was reported. That for summer rice is generally 4.29 tons/ha but occasionally rises to 4.41 tons/ha. This lower production is due to the heavy summer rains. Though the yields are higher, the main gain comes from the the intensity of cropping, which has resulted in an increase of 26% in rice production from 190,000 tons in 1995 to 239,200 tons in 2000.

The subsidiary, upland crops need irrigation but their rates of production are less influenced by the improvement in irrigation than rice. However, production of these crops has increased by 126% between 1995, when production was 44,400 tons, to 100,800 tons in 2000. This increase, which was mainly in sweet potatoes, resulted from the increase in cultivated area.

The main upland crops in NNAIS are sweet potatoes, maize, potatoes, groundnut and soybean. The extension of upland crops is recommended, mainly as a third crop, to increase and diversify production and help with soil regeneration.

4.7.2. Socio-Economic

The general situation in North Nghe An was found to be similar to that at Song Chu, the main socio-economic aspects could be evaluated in parallel and statements and comments given in Section 3.7.2. are applicable to both systems.

Some differences are found in the institutional framework, mainly as it concerns the role of the Co-operative. This has evolved in Song Chu but remains basically the same as before rehabilitation, in North Nghe An and remains focussed on production.

Activities in the area correspond to the distribution below, which is related to the water regime (Appendix E.3.12):

47%: cultivating	Mainly located in full and partly irrigated
24%: breeding	With a proportion slightly higher in fully irrigated
2% : fishing	Mainly in partly irrigated
28%: others	More or less in full and partly irrigated

The structure shows that the main range of activities is still related to agriculture as breeding and cultivating account for more than 70%. However, the percentage of people engaged in "Other" activities is identical to that at Song Chu and indicates diversification from purely agricultural work.

The average annual income for a household (family of 5 persons) rose from 8 to 10 million Dong. The progress is reflected in a comparison of the number of households, which indicated a high level of revenue and a decrease in poverty since the beginning of the project. The table below shows this change.

Table 4.4 Number of Households by Income Level Comparison 1995-1997-2000

Income level	1995	1997	2000	Increase from 1995 (or decrease)
High	2,288	3,149	2,615	Increase: 14%
Middle	8,629	9,523	11,665	Increase: 35%
Low (poor)	4,473	3,824	2,378	Decrease: 47%

On average the rice equivalent of the annual family income has changed from 2.3 to 2.9 tons per family (appendix E.3.12).

In the area of economic development, one third of the communes have developed new activities, of which aquaculture is the most popular.

Analysis of the data shows that the communes located in the fully irrigated areas buy the most fertilisers, pesticides and other farm equipment. On the other hand, industrial products are more frequently bought in the communes located in partly irrigated areas.

The positive effects of the rehabilitation have been observed in all the communes due to better water distribution. However, the structure of incomes has not changed dramatically and the cost of pumping, in the partially irrigated areas, will undoubtedly slow the rate of increase in capital. The diversification of agriculture and into off-farm activities is a very important complement to rice cultivation, and is in the same proportion as that observed for the Song Chu system. Without rehabilitation, none of the present benefits would have been realised and there would be no hope for advances in the future.

Most families have improved their living conditions since 1997 and grass huts have been totally eliminated. The general improvement in houses is summarized below.

Table 4.5 Family housing 1995-2000

Type	1995	1997	2000
Grass hut type	19%	17%	0%
Fourth level type	69%	72%	100%
Permanent type	11%	11%	0%

The change is even more important than in Song Chu and clearly demonstrates a drop in poverty expressed by the elimination of the grass hut type, as well as a movement towards fourth level houses, a phenomenon also noted in Song Chu. Moreover, this seems to stress the interest in housing and for the well being of families, as soon as economic conditions permit.

4.8. Sustainability

4.8.1. General

As at Song Chu, the economic analysis of the project has been conducted on the basis of an economic life of 30 years. This makes it equally imperative that an on-going O&M and a BME system is established.

The situation in North Nghe An is essentially the same as that at Song Chu and, with the minor exceptions below, the comments concerning institutional frame for O&M and the procedures, as well as the Monitoring System (Sections 3.8.2 – 3.8.4) are the same and have therefore been omitted from this Section.

4.8.2 Operation and Maintenance Organisation

In principle, the NNA - IMC does not receive subsidies from the State budget, except for the electricity costs, used mainly for drainage pumping. The company budget in the period 1999 - 2000, is presented below.

Table 4.6 NNA-IMC Budget 1999 - 2000

Description	1999 (million dong)	2000 (million dong)
Revenus:		
Subsidies	-	-
Water Fees paid by Farmers	11,363	13,197
Other revenues (contracts)	160	-
Total Revenues	**11,523**	**13,197**

There were no other revenues in 2000 because the fees for IFPRP support (equivalent of 100 Kg-Paddy/ha/year were no longer paid. The cost of damage produced by human activities and illegal acts was about 300 million dong/year.

The co-operatives remain important and active in North Nghe An. Only two of the 12 communes surveyed have changed from the traditional co-operatives of production to the newer type, co-operatives of sevices. The establishment of these newer co-operatives is now encouraged by the Law on co-operatives, which facilitates smaller co-operatives, better adjusted to the needs and interests of farmers.

In two pilot areas, Water User's Co-operatives (WUC) have been established, with the support of an ADB TA Project, namely :

- The N4B (this is also the name of the irrigation canal) Water Users' Co-operative, covers an area of 230 ha in 3 communes. The area is operated, based on hydraulic boundaries, and not on administrative ones. The irrigation canal operated by WUC is 3.6 km long and there are 31 tertiary and quaternary off-takes for laterals. This new form of management was evaluated by TA No. 2869-VIE as poor, because of the unstable supply of water and upstream-downstream water supply conflicts. The situation has now improved thanks of the

support of the ADB-TA project and the NNA-IMC, which rehabilitated the gates and measuring weirs.

- The N6 WUC covers an area of 294 ha in 4 communes. The irrigation canal is 4.6 km long; there are 23 off-takes for tertiaries. The same remarks apply as for N4B.

These entities were established to take over irrigation responsibilities, within the area, from NNA-IMC. After 3 years, the results are remarkable. They have shown greater involvement of farmers, careful irrigation planning, less wasted water and more equity between users at the upstream and downstream ends of the canals. The canals are better maintained because of the direct interest of the Management Board of the WUC.

However, the creation of more WUCs is difficult, because they need financial support for their establishment and farmers lack experience in managing such associations and require training and more technical assistance from the State, through the NNA – IMC and the local administration.

5. Project Extensions

5.1. General

In 1999, savings of about 290 billion dong, from the total budget of 1,000 billion dong, were identified and re-allocated for the rehabilitation and improvement of additional water resource infrastructure.

These extensions to the IFPRP were undertaken, starting in 1999, after severe flood damage to water resources facilities in several locations in North-Central Vietnam. In addition to the original three sub-projects, there are now five additional subprojects, situated outside the original perimeter of the project:

- Extension of the Hanoi Dyke rehabilitation from km 85 to km 101 (16 km);
- Rehabilitation of the Rao Nan Irrigation System (1,600 ha irrigated area) in Quang Binh province, in Central Vietnam;
- Rehabilitation of three irrigation systems in Quang Tri province, namely: Bau Nhum Irrigation System, Khe May Irrigation and Water Supply System and Nam Thach Han Irrigation System, (in total more than 13,000 ha of irrigated area)

The object of these IFPRP extensions is to prevent the failure of these works and to improve the living conditions of hundreds of thousands people, dependent on agriculture and good irrigation.

5.2. Description of the IFPRP Extension

5.2.1. Hanoi Dyke km 85 – km 101

The Hanoi Dyke Extension, from km 85 to km 101, is the 16 km length of dyke immediately downstream of the Km 40 to Km 85, rehabilitated under the original Scope of Work.

The main problems requiring rehabilitation are:
- River bank erosion, in the vicinity of the dyke, threatening the dyke itself;
- Weak and narrow body in some sections and an uneven crest elevation;
- Poor condition of the crest surface because of traffic on the provincial road;
- Intense human activity on the dyke or in the vicinity.

Seepage control and relief wells are not provided for this sub-project. The rehabilitation works were designed to ensure protection from a flood with a probability 1/100. The main components of the sub-project are (Figure No. 6):

Bank Protection Works

The total length of bank protection, of similar construction to that in the original project, is about 3.7 km, consisting of five sections, namely:

- Xam Thi, Section 1 : Km 87+270 to Km 87+725 (455 m length);
- Xam Thi, Section 2 : Km 87+725 to Km 88+173 (448 m length);
- An Canh, Section 1 : Km 94+600 to Km 95+850 (1250 m length);
- An Canh, Section 2 : Km 95+850 to Km 96+575 (725 m length);

- An Canh, Section 3 : Km 96+575 to Km 97+400 (825 m length).

Dyke Body and Foundation Strengthening

These works are similar to those in the original Scope of Work. There are 8 construction contracts, each covering about 2 km of dyke.

Retaining walls and wave protection are constructed in discontinous sections, where the dyke passes villages. The retaining walls are used where the dyke is too narrow and there is no place to construct berms or to increase the dyke cross- section. The mission found that this solution is only suitable for walls less than 1.0 m high, because these walls are constructed with bricks. The retaining wall constructed at km 89 – km 90, which is more than 2 m high, will not assure the stability of the dyke at high flood levels. This is a serious concern for the dyke safety in this location and for the people living in proximity to the dyke.

Road Surfacing

The existing road on the crest is rehabilitated for its full length (16 km). The work includes the base preparation and asphalt pavement. There are two road contracts from km 85+300 to km 93+000 (7.7 km) and from km 93+000 to km 101+300 (8.3 km).

Compensation for land and houses on the site

The dyke does not generally extend too far outside the existing section, no houses were relocated and little compensation was paid for land affected during construction. Consequently, social impacts are limited to restrictions in the use of areas designated for access and to slower traffic during the construction period. On the whole, much progress has been made, in the compensation process, despite the delays and difficulties, due to the absence of a RAP.

Operation and Maintenance

After the completion, the work is taken over by the Ha Tay District Dyke Management and Flood Control (DDMFC), the Thuong Tin Sub-district Management Team. Comments on the operations and maintenance are given in Section 3, as they are common to the section covered by the original Scope of Work.

Environmental and social aspects

The experience with implementation upstream on the Hanoi Dyke, helped to limit the social impacts over this section. In this respect, the designer and the constructor paid more attention to limiting the areas for construction, access for equipment, areas affected by borrow pits (earth, gravel, sand), and in minimising the number of households and area of land affected.

Level of satisfaction

Generally the communes and householders recognize the benefits of the project in the increased stability of the dyke, easier transportation, access roads, improvement of safety for the people and in economic activity.

Despite a high rate of problem solving, grievances and dissatisfaction were still identified. They mainly relate to residential land greater than 200m². This is the ceiling rate for compensation paid by the government at the higher rate applicable to residential land. Compensation for areas in excess of that amount is paid at the lower rate applicable to gardens or other agricultural land. This is a great loss for their owners, particularly on the outskirts of Hanoi City, where the residential land value is very high. Grievances also address the prices given for the assets affected, for lands rights and in assistance allowances for moving from one job to another. There are many people unsatisfied, by reason of these grievances.

5.2.2. Rao Nan Irrigation System

The Rao Nan Irrigation System (Figure No. 7) is located in Quang Trach district, Quang Binh province and covers territory in 9 communes. This is an open canal system, constructed in the 1970s, to irrigate a net area of 1,600 ha. The population exceeds 50,000 inhabitants. The sub-project aims to rehabilitate the system, damaged by the 1999 flood. The damage was mainly in the headworks and the main/secondary canals and structures. It will also restore the irrigated area to1,600ha from the reduced area of 1,000ha before rehabilitation.

The water source for this irrigation is the Rao Nan River, a tributary of the Giang River. The main components of the subproject are as follows.

- Rehabilitation of the existing spillway across the Nan River, which is long 136 m. The concrete structure was damaged in 1999.
- Construction of a new pumping station equipped with 3 vertical pumps, having a capacity of 12,000 m³/h; the old pumping station is now out of service.
- Rehabilitation of an open canal system totaling 22 km, consisting of Main Canal, North Canal and South Canal (12 km) and secondary/tertiary canals (10 km). The rehabilitation of canals consists in re-sectioning and partial lining and the repair of damaged structures.

The capacity of the pumping station, which is 3.3 m^3/s for only 1,600 ha, is considered to be in excess of that necessary. This is a good reason to believe that the canal network could be extended in future.

Operation and Maintenance

As at Song Chu and North Nhge An, the operation and maintenance of the pumping station, main canal and secondary canals is the responsibility of an Irrigation Management Company. The tertiary network is the responsibility of Irrigation Groups within the Communes. The direct involvement of the beneficiaries themselves is limited.

The authorities in the district consider that this irrigation is an example or pilot to be developed to a larger scale, within the province and even throughout the country, in similar conditions. Discharge control in the system is assured by gated turnouts at every tertiary. This will permit correct management of water in all the system components. The pumped discharge is abundant. It is estimated at 2 l/s/ha, which is the double that allowed in Song Chu. To obtain the maximum benefit from this system, the beneficiaries should have a greater involvement in irrigation and drainage management.

Environmental and social aspects

The main source of income is agriculture. The main crop is rice with yields in a fully irrigated regime of 4.2 tons/ha (spring rice) and 3.9 tons/ha (autumn rice). The second crop is usually a highland crop as the soil offers very good conditions for growing sweet potatoes and groundnuts.

After rehabilitation, rice will remain the main crop for one season only. Thus, there will be no obvious effect on agricultural production, even with increased yields expected for rice. Nevertheless, the benefits of the project go beyond rice production and they may be more important in terms of the economic effects. Possible additional benefits are:

- water losses reduced by 25%, saving energy for pumping and allowing the extension of the irrigated area by 600 ha;
- canal lining and narrowing allowed the release of areas to agriculture;
- upstream and downstream areas will be equitably irrigated, using the gated turnouts;
- crop production will be increased using new hybrid seeds;
- time for irrigation operation and canal maintenance will be reduced, allowing the farmers more time for additional off-farm activities;
- project implementation employed local people and contributed to a rise in their income;
- quality of life and environmental conditions (drainage) are improved.

5.2.3. Nam Thach Han Irrigation System

The Nam Tach Han Irrigation System is located in the Quang Tri Province. This is an existing open canal system, which was able to irrigate an area of 10 000 ha, with restrictions, before rehabilitation. According to the information from local authorities, the sub-project creates substantial benefits for provincial development and for the population of 20 communes.

The local people are satisfied by the construction of the new An Tiem sluice, which will protect their lives and assets, saving the approximately 10 billion VND, spent annually on the repair of flood damage.

Water for irrigation comes from the Thach Han River, where a dam was constructed 20 years ago. The reservoir created by this dam has a capacity of 9 million m^3. The irrigation scheme is an open canal network, consisting of a main canal and 6 secondary canals, N1 to N6. The rehabilitation of this system included the following components:

- a new rubber dam/spillway on the Thach Han river, constructed on the crest of the existing dam; the new spillway is 136 m long, with an increase in crest elevation of 2m with the rubber dam fully inflated;
- rehabilitation of a concrete overflow section of the dam, 200 m in length;
- An Tiem sluice: a combined siphon on the irrigation canal N1 (capacity 5.5 m^3/s, length 140 m) and a gated sluice 120 m length (20 gates);
- Re-sectioning, repairing eroded sections and structures and the partial lining of the secondary canals N1 (6.3 km); N3 (3.7 km); N4 (4.7 km) and N6 (2.5 km), totaling more than 17 km of canal length.

Operation and Maintenance

The Quang Tri Irrigation Management Company is responsible for operation and maintenance of the dam, rubber dam, main canal, secondary canals and main structures. The works that IMC has to operate need a fairly high degree of skill and careful monitoring.

One of the most skill-demanding works is the Nam Thach rubber dam. This is quite a new solution in Vietnam. Correlating the desired elevation of the weir and the amount of water inside the dam cylinder is a delicate operation.

The main flood protection work is the An Tiem sluice. The structure will only regulate and minimize floods if the 20 gates are operated correctly. Flooding can occur from both the river-side and the land-side and, hence, upstream and downstream are relative, depending on the higher water level. A careful monitoring of these levels and a manual for the operation of the gates, dependent on these levels, is recommended.

To maximize the benefit from this irrigation system, more involvement of the beneficiaries in irrigation and drainage management is advisable.

Environmental and social aspects

There was unanimous agreement that the project creates substantial economic and social benefits, as follows:

- Increased capacity of the reservoir and the construction of the An Tiem sluice strongly reduces flood volume and limits the damage from floods;
- Increase in water storage and reduction in water losses (by lining) allows full irrrigation of 10,000 ha and possibility to irrigate additional areas;
- Active/controlled flooding allowed by An Tiem sluice improves, to a certain extent, the fertility of the soils;
- Irrigation discharges are regulated (gates provided) to ensure enough water and equitable distribution at the downstream end of long canals;
- Improvement of transportation along the canals;
- Living quality and environmental conditions (drainage) are improved.

The project required the acquisition of 10 hectares of agricultural land and the relocation of 6 households. The total cost of resettlement and compensation is 1 billion dong and there are no grievances.

5.2.4. Bau Nhum Irrigation System

The Bau Nhum Irrigation System is located in Vinh Linh district, Quang Tri province. This is an open canal system, supplied by a reservoir situated outside the irrigation area. The reservoir was built in 1959 with the capacity about 3 million m^3. The rehabilitation aims to increase the capacity for irrigation from the current 300 ha to 600 ha, by improving the water supply and the drainage system.

The system is simple, consisting of a single Main Canal about 15 km length, distributing water to tertiaries. The canal system has been operating for 40 years but, before rehabilitation, only the

headworks could operate normally. Irrigation discharge was not controlled due to a lack of gates. Rehabilitation included only the main canal from km 0 to km 6+112 (re-sectioning and partial lining) and the main drain (re-sectioning). To supplement the available discharge from the reservoir, the main canal is now interconnected with the Lai Binh River. At that location, a gated regulator has now been constructed, which allows a 300 ha extension of the irrigated area.

Environmental and social aspects

The main economic activities in the three communes are the cropping of rice and rubber trees. Other activities are in forestry and animal breeding, as well as in services or commercial activities. Land holding is 750 m²/person, which is much higher than in Rao Nan. However, the land is poor or sandy and only one third of the land is appropriate for rice. For this reason, with floods which occur every year, the average yield is only 1.5 – 2.0 tons/ha from only one crop/year. Under these conditions, drainage rehabilitation is essential to improving the physical characteristics of the soil and this will then allow irrigation to increase the area cultivated during the dry season.

The project is judged to bring social and economical benefits as follows:

- Reduction to flood damages of 1.5 – 2.0 bilion dong per year;
- Reduction of O&M costs due to lining and flood control;
- Allows crop intensification to 2 crops per year and diversification the cropping pattern;
- Improves the quality of life and environmental conditions (waterlogging is reduced).

As this is a small irrigation system where rice cropping is less suitable, a change of land use from rice to forage and high value crops, adapted to sandy soils, is recommended.

5.2.5. Khe May Irrigation System

Khe May Irrigation System is located in the outskirts of the town of Dong Ha, close to Quang Tri City, Quang Tri province. The sub-project aims to protect the downstream, densely populated area from flooding. Other objectives are to increase the fully irrigated area from 60 ha to 200 ha, to increase the supply of ground water and to improve the living and environmental conditions in the capital of the province. After rehabilitation, the capacity of the reservoir is increased to about 2 million m³.

The following works were completed for the system rehabilitation:

- Enlarged and heightened the existing dam by more than 2 m; the dam is 362 m long and the new crest road is 5 m wide;
- Constructed a new electrically operated sluice gate;
- Constructed a new discharge gate to regulate the floods; discharge capacity 63 m³/s;
- Constructed a new irrigation intake;
- Reshaped and lined the main canal, 1.5 km long.

Environmental and social aspects

The main benefit of this project is the control of floods downstream of the reservoir and protection of the population and assets in a densely populated area. The extension of irrigation is

certainly an advantage and creates conditions for high value cropping. Thanks to the flood regulation and its protection of the area, the local authorities intend to develop tourism and leisure facilities in the Khe May area and around the lake.

5.3. Implementation Status of Project Extension

5.3.1. Implementation Management Arrangements

The implementation of the IFPRP is the responsibility of the Central Project Office and the Sub-project Office (SPO) in each province or subproject, as follows :

- Hanoi Dyke km 85 – km 101: SPO 401
- Rao Nan Irrigation System: SPO Quang Binh
- Nam Thach Han Irrigation System: SPO Quang Tri
- Bau Nhum Irrigation System SPO Quang Tri
- Khe May Irrigation System SPO Quang Tri

SPO 401 has responsibility for the implementation of Hanoi Dyke from km 40 – km 101, thus the unit is the sole construction manager for both sub-projects on the dyke, namely from km 40 –km 85 and, the extension, from km 85 – km 101. For the extension subproject only, the SPO manages 17 construction contracts. The organisation and tasks of SPO 401 are presented in more detail in Section 2.

SPO Quang Binh is newly created, to implement the Rao Nan system. The unit cooperates closely with the PARD, IMC and the designer (HEC1). The staff is composed by 15 permanent employees, who include, besides the management and administration staff, a team of supervisors for the construction and a team for quality control. The SPO's team is in direct and permanent contact with the contractors for the 14 contracts, which comprise the rehabilitation.

SPO Quang Tri is also newly created, to implement the rehabilitation of the three irrigation schemes. The unit organisation is similar to that at Quang Binh, but the tasks cover the implementation of 20 contracts, as follows: Nam Thach Han (16 contracts), Bau Nhum (2 contracts) and Khe May (2 contracts).

Besides the CPO and SPOs, which have direct responsibility for sub-project implementation, other local organisations are involved. Their roles are interconnected as they co-operate for specific aspects, as follows :

- People's Committee of provinces where the sub-projects are located, namely: Ha Tay (Hanoi Dyke), Quang Binh and Quang Tri. The PPCs co-operate with MARD with the organisation of project implementation; co-operate to carry out land compensation, resettlement and safety programs; contributes local funds.
- Provincial Agriculture and Rural Development Service (PARD): co-operates with SPOs for construction monitoring and quality control.
- Irrigation Management Companies (IMCs) : main operator of the irrigation systems; supports SPOs 406 to ensure irrigation during the construction period, participates in construction management and the design of tertiary rehabilitation; takes over the rehabilitated works.

- Districts and Communes: assist SPOs with local security of works, labour, land acquisition or compensation.

5.3.2. Budget and Expenditures

The savings from the original scope of work were re-allocated, as a separate budget for the IFPRP extension. According to the data supplied by MARD/CPO, this budget was as follows:

-	Hanoi Dyke extension km 85 – km 101:	187,490 million VND (*)
-	Rao Nan Irrigation System:	32,780 million VND (**)
-	Nam Thach Han Irrigation System:	54,000 million VND (**)
-	Bau Nhum Irrigation System:	7,270 million VND (**)
-	Khe May irrigation System:	6,310 million VND (**)
-	Total:	287,850 million VND

(*): Using savings from original Hanoi Dyke Sub-project
(**): Using savings from Song Chu and North Nghe An Sub-projects

The ADB loan provides 75 – 78 % of the investment, or 217,753 million VND and the Government of Vietnam planned a contribution of 70,097 million VND.

During the sub-project implementation, the actual cost was less than the estimated budget and the final cost is now estimated at 259,366 million dong. Thus there will be savings of 28,484 million dong or about US$2 million.

5.3.3. Implementation Status

- The works started in 1999 and were planned for completion by the end of 2000. Delays in construction, partially due to floods, and disbursements required an extension of the final deadline to June 2001.

At the time of the Final Evaluation, completion (based on the disbursement situation of CPO) and data, collected at the time of reporting, is expected by the dates shown below:

-	Hanoi Dyke Extension km 85 – km 101:	May 2001
-	Rao Nan Irrigation System:	April 2001
-	Nam Thach Han Irrigation System:	December 2000
-	Bau Nhum Irrigation System:	December 2000
-	Khe May Irrigation System:	December 2000

6. Conclusions and Recommendations

6.1. General

All the original sub-projects have met or exceeded their originally anticipated EIRR and have improved their safety and/or efficiency. In this respect, the project can be classed as a success. There are some areas, where additional work will further improve the efficacy of the project and an apparent lack of any systems, presently in place, to monitor the continuing efficiency of the project and the possible negative effects, which may develop with time.

Subsequent sub-sections will cover areas, which require further improvement.

6.2 Hanoi Dyke

Bank Protection
In the Thuy Phuong Section, at Km 54 (Pagoda), the bank protection should be carefully monitored to ensure that the toe protection is not undermined and it should be repaired, if necessary. There is some evidence of outward movement of the retaining wall, which should be relieved by drains, drilled through the wall, near its base.

Dyke body strengthening:
After rehabilitation, the dyke body appears to be in good condition and satisfies the design requirements. As the performance of the dyke body depends mostly on the type and quality of materials used, monitoring of dyke settlement and changes in geometry is recommended.

Blankets, Berms and Fillings
The blankets, berms and pond filling, constructed on the river and land side, are performing well. However, there is no regular monitoring system to measure and quantify the data necessary to establish the true performance.

Relief Wells
The relief wells are assessed as being only 50% complete. These will require completion if the safety of the dyke against sliding is to be assured. This despite the obvious improvements in the virtual elimination of sand boils, even where the wells have not reached the specified efficiency.

BME System

A permanent BME Unit for Hanoi Dyke should be established, following the ADB Guidelines and recommendations of the Consultants (see details in main report and Appendices A and H). The unit should be equipped with all the necessary office facilities, co-ordinated by SPO 401 and DDMFCs, and charged with data collection, data analysis and reporting. The BME Unit should have all facilities for communication, transport, computing and regular quarterly reporting.

Sustainability
Population growth, increasing urbanisation and tourist development threatens the ability to maintain the dyke in its present, improved condition, as there is a risk that the regulations to

protect the dyke will not be applied. A BME system will provide a consistent follow-up and a realistic, periodic view of the situation along the dyke.

To maintain the advantages gained from the rehabilitation, the regular O&M activities should be completed as follows:

- Eliminate the accumulation of waste and public dumping near the dyke;
- Impose a clear limit to the extension of cultivation near the bank protection to ensure its stability;
- Enforce the regulations concerning the storage of wood or heavy construction material on the berms or slopes;
- Enforce the regulations concerning heavy transportation;
- Forbid cattle grazing or stalling along the dyke to avoid damage to the slopes and consequent soil erosion;
- Re-evaluate the decisions permitting houses and small shops to be located close to the dyke in areas designated for the dyke protection.

Districts, communal authorities and the community should be involved in the implementation of new regulations and in an awareness program. The revised regulations should be:

- Adjusted to take into account the rehabilitation;
- Sufficiently flexible to allow an acceptable level of utilization of the rehabilitated areas. This flexibility should help in avoiding illegal activities.

The lack of a RAP has slowed down resettlement, socioeconomic activities and probably, in some cases, construction of the dyke rehabilitation. Lessons for the future are that a complete RAP should be completed well in advance and should include a period of follow-up after the resettlement.

6.3. Song Chu and North Nghe An Irrigation Systems

The Song Chu irrigation scheme is the largest gravity irrigation system in the Ma River Basin. The gross area is about 70,000 ha, with an irrigated area, after rehabilitation, of about 51,000 ha. The North Nghe An scheme covers a gross area of 34,700 ha, with an irrigated area, after rehabilitation, of about 30,000 ha. The total rehabilitated area in both schemes is 81,000 ha irrigated land.

The main indicators, before and after rehabilitation, are compared in the following table.

Table 6.1 Result Comparison 1995-2000

Indicators	SCIS		NNAIS	
	Before Rehabilitation 1995	**After Rehabilitation 2000**	**Before Rehabilitation 1995**	**After Rehabilitation 2000**
Irrigated Area, total (ha):	50,933	50,933	29,950	30,050
- Full irrigation	29,716 (58%)	34,453 (68%)	11,786 (39%)	18,763 (62%)
- Partly irrigation	17,884 (35%)	16,480(32%)	10,113 (34%)	11,287 (38%)
- Rainfed	3,333 (7%)	0	7,631 (25%)	0
Cropping Intensity, or annual covered area (%)	174%	218%	179%	224%
Yields (tons/ha):				
- Spring Rice	4.3	5.0	4.7	5.4
- Summer Rice	4.0	4.9	3.5	4.3
Production:				
- Rice (tons/year)	339,120	404,290	189,950	239,250
- Other Crops (tons/year)	77,730	90,900	44,470	100,770
Economic Investment Return Rate (%)	-	22.1%	-	27.6%

Despite these positive results, there are problems, which should be rectified to improve these results.

The following problems relate to construction, physical performance after rehabilitation and social impacts. Some recommendations are given to solve or mitigate these problems, or for consideration as lessons for the future.

SCIS, Main and Secondary canals:
- Rehabilitation does not include all the necessary safety structures;
- Access roads are not continuous;
- Off-take structures are not complete, mechanisms and measuring weirs.

The performance of the rehabilitation will diminish if these works are not completed.

NNAIS, Main Canal
- Lining of only one side of the canal will eventually cause erosion of the opposite earth side;
- There is no continuous maintenance road along the canal;
- Measurement of discharges and the monitoring of water supply/distribution are insufficient for a canal 56 km long distributing water through 66 offtakes.

NNAIS, Secondary Canals
- Secondary canal N2 (20 km length), cannot be considered rehabilitated, as only 2 km at the upstream end has been lined;
- Rehabilitation of Khe Khuon Drain is not considered to be adequate in zones vulnerable to sliding; in general, the performance is not reliable because of the frequent requirement for repair;
- The downstream ends of long secondaries, which have not been rehabilitated within IFPRP because they serve less than 500 ha, cannot pass the design discharge;

- The quality of the earthworks on the secondary canals is very low, due to a lack of compaction. This it is more evident on the unlined reaches.

Drainage system:

The drains are unable to prevent flooding of the land in the wet season. Part of the production is lost and irrigation performance is severely restricted by the drainage system, which has not been rehabilitated.

Tertiary and quaternary canals:

The rehabilitation of these canals is not to the same technical level as that on the main and secondary canals. Construction has been delayed and was not coordinated with the whole irrigation complex. The performance of the rehabilitation is diminished and will remain that way if these works are not completed.

Specific problems related to the physical performance of the rehabilitation are as follows :

- The quality of earthworks on the secondary canals is very low, due to a lack of compaction. This is more evident on the unlined reaches. For instance, the rehabilitated downstream end of Secondary C6 is reported to be unchanged from that before rehabilitation;
- The quality of the lining (prefabricated slabs, installation and corner filling) is not consistent in different locations and is worse on the secondary canals.
- Unlined rehabilitated canals are much less resistant to degradation than lined canals and the design discharge and water levels after rehabilitation cannot be maintained in them for a long duration;
- Rehabilitation of small secondary canals and the tertiary network, each serving less than 500 ha, which were not included in IFPRP, did not follow the same schedule of rehabilitation. This situation now reduces the performance of the overall irrigation system.

Operation and Maintenance:

The Irrigation Management Company must increase productivity and the skill of the personnel. O&M, during the construction period, was neglected, justified by the Contractors' obligations. The control of discharges, irrigation scheduling and operation monitoring are still at the low level, which existed before rehabilitation. The performance of the rehabilitation will be diminished if the IMC does not improve its methods.

The physical rehabilitation of the infrastructure is finished, but management of the scheme must still be improved. This is a problem because, during the transition period when the institutional framework is being changed, operations and maintenance could be neglected. An irrigation system needs, continuously, not only regular maintenance but also minor and major repairs and replacement of parts, etc. A replacement budget does not seem to have been included in the actual policy. The fees paid by users will not cover such expenses and the Government has to ensure the sustainability of IMC using subsidies.

Local organisations have consistently advanced the mistaken idea that rehabilitation will reduce the costs of O&M and that even the replacement of amortized assets would not constitute a problem. This is not the case, as the works require maintenance to continue working at high efficiency.

The fragmentation of O&M responsibilities between IMC, Communes, Co-operatives, Irrigation Groups, makes it difficult to co-ordinate the different organisations and to integrate their efforts and is affecting the performance of the rehabilitated infrastructure. This problem of integration must be resolved.

Benefit Monitoring and Evaluation (BME):

The BME System has not been implemented and the current physical and socio-economic performance of the project is not being monitored. A regular system of data collection and reporting, for BME purposes, has not been established. The evaluation reports, such as the Mid-Term Evaluation Report and the Final BME Report, are milestones in this activity but do not replace it.

Regular monitoring and evaluation of performance must be completed within CPO and Irrigation Management Company, following the ADB Guidelines and recommendations of the Consultants (see details in main report and Appendices A and H).

Cropping Patterns :

One of the objectives of the rehabilitation is cropping intensification. Two rice crops are almost universal, combining the irrigation facility with the use of fertilizers, herbicides and gradually mechanization. The third crop is still considerd as a minor crop and many fields are not cultivated for 2-3 months per year, in September –November.

A positive effect should be crop diversification, but this is still largely an expectation and rice remains the priority. In favourable conditions of soil and irrigation, alternative crops are much more profitable than rice but the present tendency is to diversify only for the third cropping season and even this is not widespread, depite favourable conditions and the availability of water. Diversification in other seasons should be promoted, to avoid the pitfalls of single-crop farming (rice) and the possibility of a drop in the market price of rice. The main reason for this lack of diversification, besides the tradition of rice culture, is the inefficiency of the drainage and the soil characteristics. In addition to the economic advantages, the diversification of crops would help with soil regeneration and the preservation of agricultural potential.

Soil regeneration raises the problem of the increased use of fertilizers, pesticides and herbicides. The mid-term survey found that, to increase production to a maximum, there is excessive use of chemical products. More control should be exercised by MARD and the provincial agencies to protect the natural and human environment, before it is too late.

Related agricultural activities, husbandry, fishing, services and other out-of-farm activities generate up to 50 % of family income. Because the land area is too small for a family, cropping is not enough to ensure a decent income.

Socio-economic issues

This part of the report emphasises sustainability and equity issues because they are the key to the long-term success of the project. Hence, the positive results obtained to date cannot be allowed to push some of the problems into the background because these problems could seriously impact the positive results and reduce their effect. Some of those problems, which need resolution, are:

- The reduced performance of the tertiary canals;
- The behaviour of the beneficiaries with regard to rehabilitated canals;
- Irrigation fees that do not always correspond to the services received;
- A lack of environmental concem and follow-up
- The participation of all concemed, including beneficiaries, in the protection of canals and in water distribution.
- The rehabilitation has yet to produce major changes, either in the role of administrative management or in the activities of cooperatives or of irrigation groups. With the completion of works, a plan should be made and implemented as soon as possible to make required changes.
- Some beneficiaries use the rehabilitated canals as a public dump. Some pavings and gates are broken and stones block the entrance to secondary canals. This lack of respect for the rehabilitated works has two negative effects: one on the sustainability of the construction works, and the other on the equity of water distribution to farmers' plots. There should be a better follow-up and fines should be levied to stop these illegal activities.
- In addition to the problem of water distribution, the secondary and tertiary canals, which remain unrehabilitated in many places, do not encourage farmers in their protection and maintenance. An effort should be made to support the repair of the small canals as this is a "must" to ensure the socio-economic efficacy and the efficiency of the project.
- The principle of equity in the distribution of water should receive more attention at all levels of participation. This means that appropriate training should be given to management and to operations staff and that an awareness program relating to the farmers' responsibilities should be developed.
- The lack of environmental concem regarding the use of chemicals results in a danger of groundwater contamination and is detrimental to human and animal health. The use of chemicals continues to rise, despite the recommendations in our mid-term report, and a solution to this problem is urgent.

6.4 Project Extension

In 1999, savings from the IFPRP were re-allocated to the rehabilitation and improvement of the additional water resources infrastructure, outside the original geographic area of the project.

The extensions of the IFPRP were identified and the works undertaken recently after devastating floods, which occurred in 1999, severely damaged water resources facilites in several locations of North-Central Vietnam. In addition to the original 3 sub-projects, there are new 5 subprojects, situated outside the original perimeter of the project. The performances of the rehabilitation are evaluated only at the project completion.

In general, the comments given for the original scope of the project can be considered the same for the extention, because the nature of these works are the same. Nevetheless, the rehabilitation is carried out more rapidly and, in case of irrigation systems, concentrates in general on major repairs due to floods.

Hanoi Dyke km 85 – km 101

At the project completion, some problems related to construction and performance have been noted and following recommendations are given:

- Retaining walls and wave protection are constructed in discontinous sections, where the dyke passes villages. Retaining walls are used where the dyke is too narrow and there is no space to construct berms or to extend the earth section; the stability of the dyke at high flood levels is compromised by these brick walls. This is a serious concern for dyke safety.
- The bank protection works constructed under water should be carefully monitored by periodic bathymetric measurements, to prevent and correct future erosion.
- The dyke protection rules should be strictly observed and any illegal acts, which could endanger the dyke should be discouraged.
- Despite a high rate of problem solving, grievances and dissatisfaction were still identified during the 2000' mission. They mainly refer to residential land greater than 200m². This the ceiling for compensation paid by the government at the higher rate applicable to residential land. Compensation for areas in excess of that amount is paid at the lower rate applicable to gardens or other agricultural land. This is a great loss for their owners, particularly on the outskirts of Hanoi City, where the residential land value is very high. Grievances also address the prices given for the assets affected, for lands rights and in assistance allowances for moving from one job to another. There are many people unsatisfied, by reason of these grievances, and the damage they suffered has been counted in this evaluation as a "social cost".
- Provide continuous access along the dyke toe, where there are houses.

Rao Nan Irrigation System

After rehabilitation, the following problems related to construction, performance and benefits have been noted:

- The capacity of the pumping station is in excess of that necessary to irrigate 1,600ha. It could provide actual 3.3 m³/s/ha, which is double the irrigation rate at Song Chu and North Nghe An, it is recommended to extend this system and use the pumps at whole capacity.
- After rehabilitation, rice will remain the main crop with a single crop each year. Thus, there will be no obvious effect on agricultural production, even with the increased yields especially for rice.

Nam Thach Han Irrigation System

After rehabilitation, the following findings and recommendations related to construction, performance and benefits have been noted:

- One of the most skill-demanding works is the Nam Thach rubber dam. This is a new solution in Vietnam. The correlation between the desired elevation of the weir and the amount of water inside the dam cylinder is a delicate operation.
- The main flood protection work is the An Tiem sluice. The structure will only minimise floods, if the 20 gates are operated correctly. The flooding can occur from both the riverside

and the land-side and, hence, upstream and downstream are relative, depending on the higher water level. A careful monitoring of these levels and a manual for the operation of the gates, dependent on these levels, is recommended.
- In order to take the maximum benefit from this irrigation system, there should be more involvement of the beneficiaries in irrigation and drainage management.

Bau Nhum Irrigation System

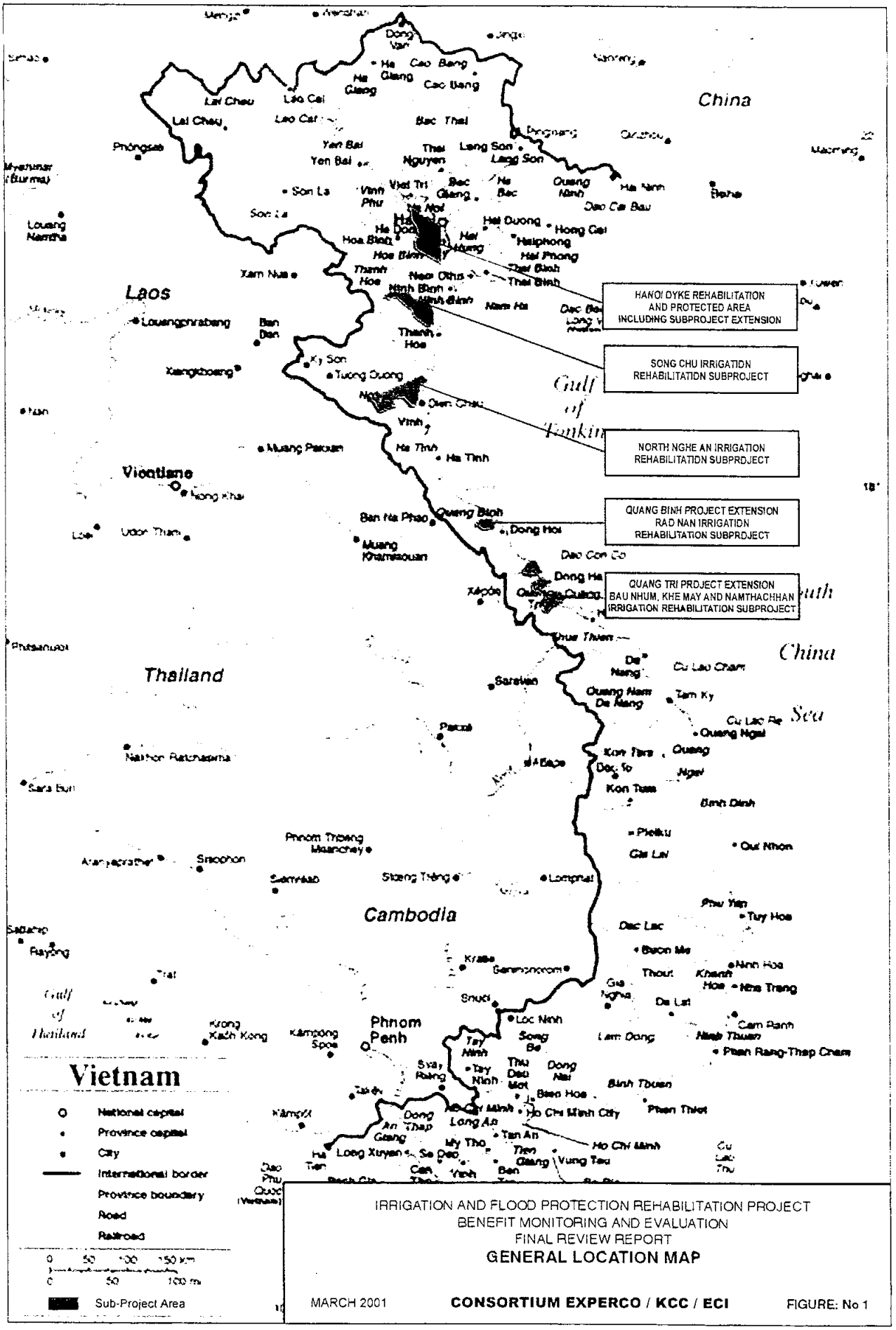
As this is a small irrigation system where the rice cropping is less suitable, a change of land use from rice to forage and high value crops, adapted to sandy soils, is recommended.

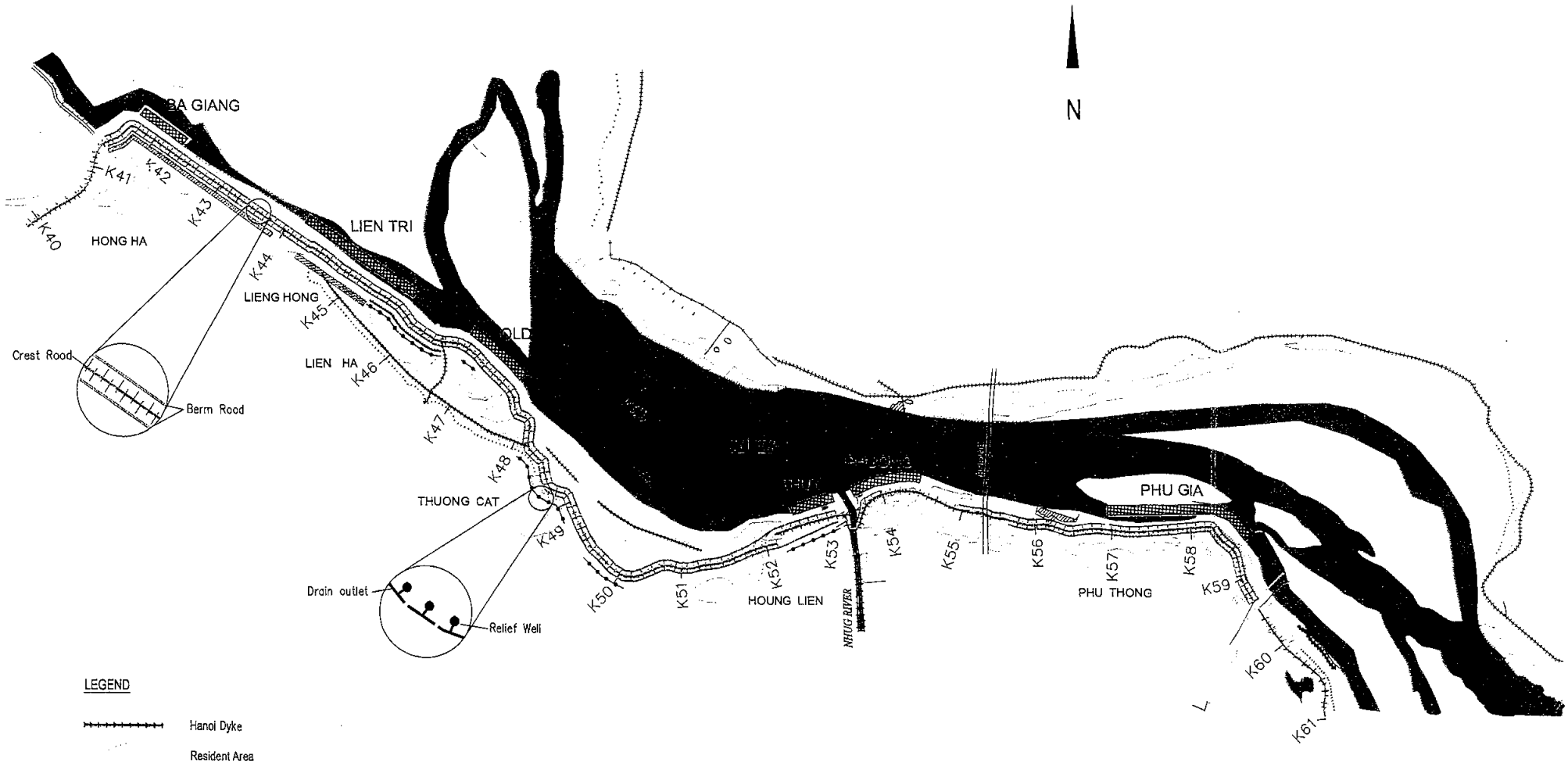
Khe May Irrigation System

No problems were noted. Recommendations are: (1) use the irrigated land for highly productive crops, and (2) develop the area for leisure and tourism purposes.

All the rehabilitated irrigation systems

- Monitor the floods and correctly operate the rehabilitated and new infrastructure (Nam Thach Han rubber dam, An Tiem gates, etc); it is recommended that a management information system should be installed in each IMC to record events and operations;
- Encourage the involvement of the beneficiaries in O&M of tertiary network of all irrigation systems;
- Change the cropping pattern from rice, as the main crop, to higher value crops, more adapted to soil and climate characteristics (Bau Nhum and Khe May irrigation systems);
- Develop complementary economic activities such as services, tourism and leisure (Khe May reservoir area).


China
Laos
Thailand
Cambodia
Gulf of Tonkin
Gulf of Thailand
South China Sea
Vientiane
Phnom Penh
HANOI DYKE REHABILITATION AND PROTECTED AREA INCLUDING SUBPROJECT EXTENSION
SONG CHU IRRIGATION REHABILITATION SUBPROJECT
NORTH NGHE AN IRRIGATION REHABILITATION SUBPROJECT
QUANG BINH PROJECT EXTENSION RAD NAN IRRIGATION REHABILITATION SUBPROJECT
QUANG TRI PROJECT EXTENSION BAU NHUM, KHE MAY AND NAMTHACHHAN IRRIGATION REHABILITATION SUBPROJECT
Vietnam
National capital
Province capital
City
International border
Province boundary
Road
Railroad
Sub-Project Area
IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT
GENERAL LOCATION MAP
MARCH 2001
CONSORTIUM EXPERCO / KCC / ECI
FIGURE: No 1



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT

HA NOI DYKE REHABILITATION MAP

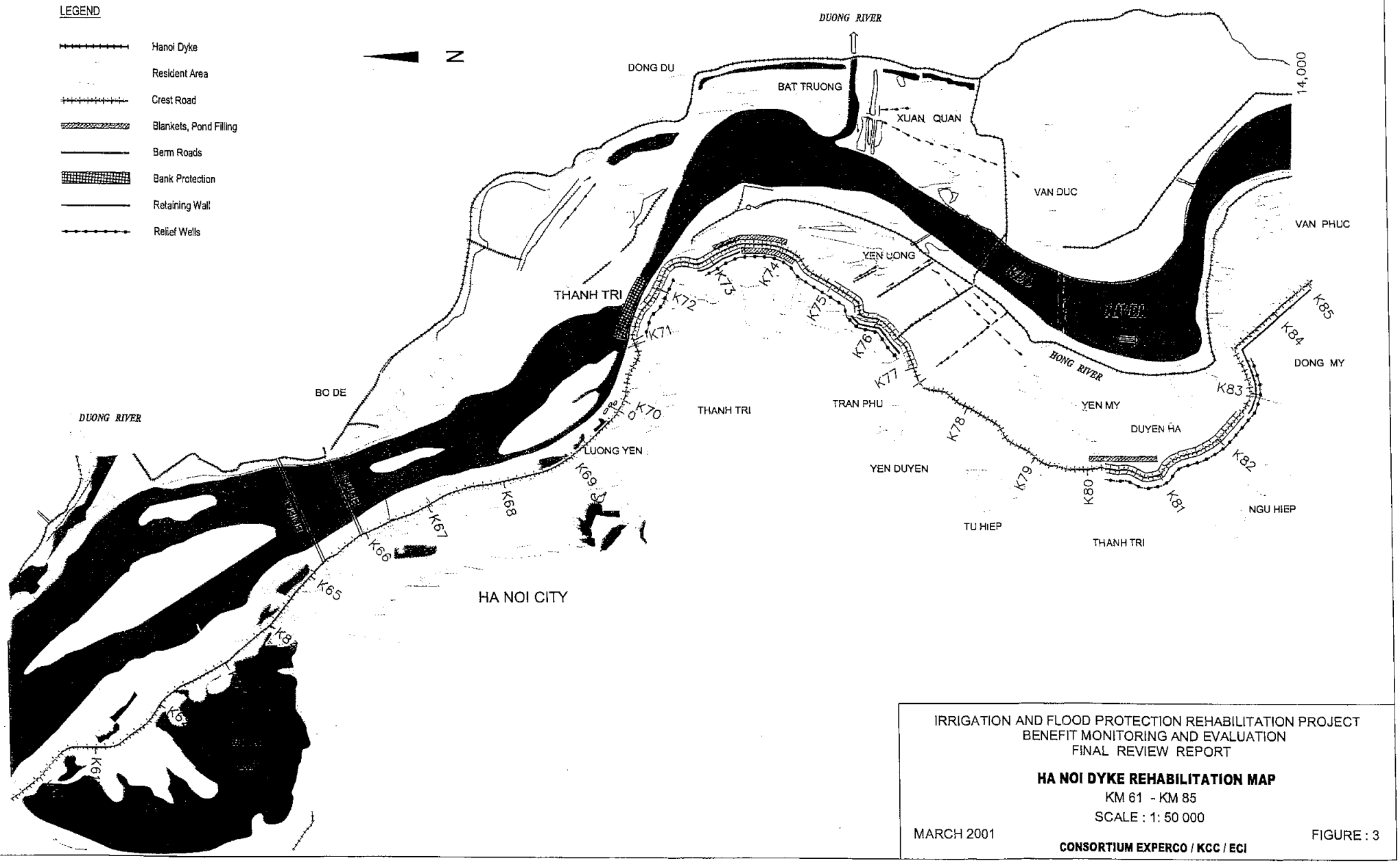
KM 40 - KM 61

SCALE : 1: 50 000

MARCH 2001

FIGURE : 2

CONSORTIUM EXPERCO / KCC / ECI



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT

HA NOI DYKE REHABILITATION MAP

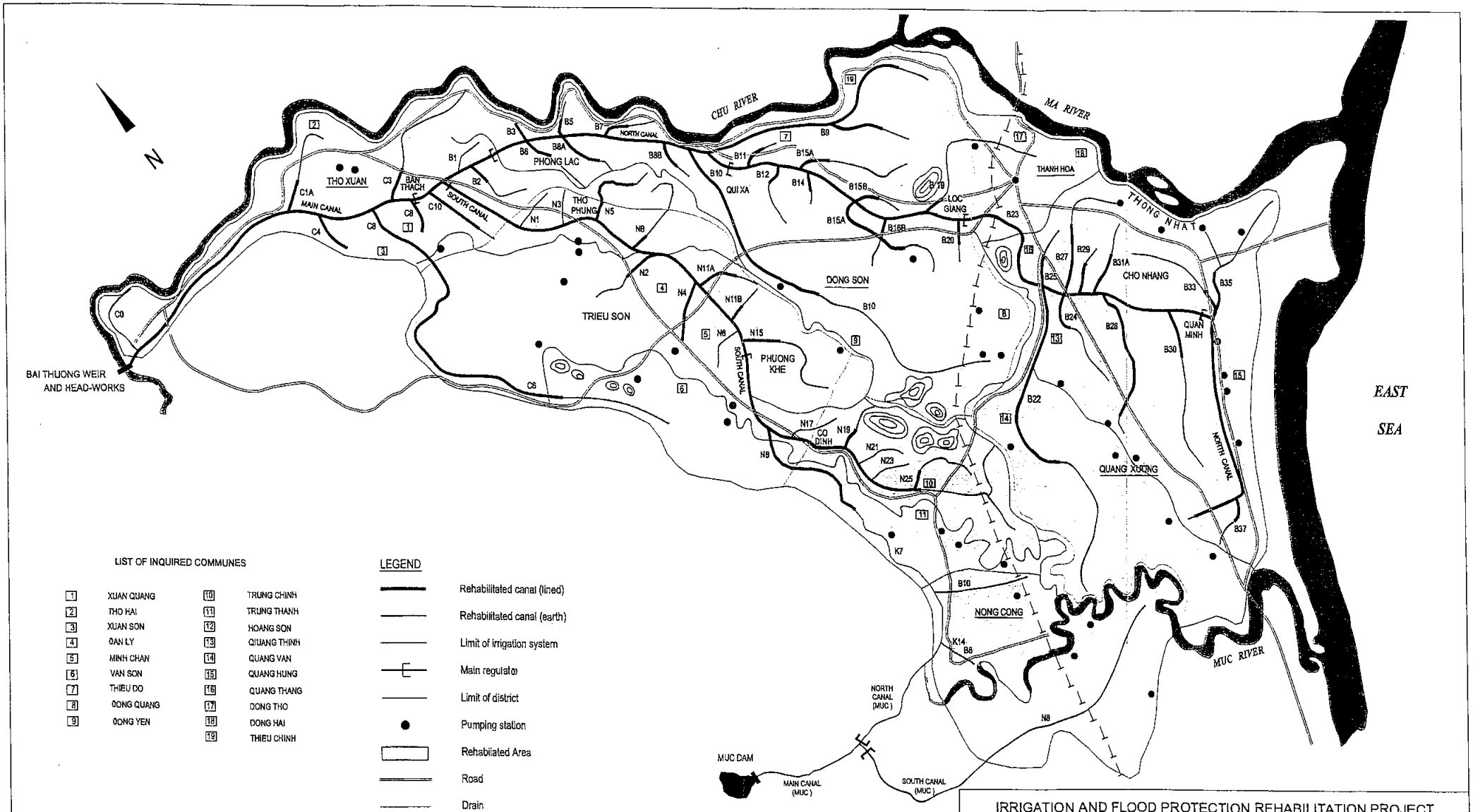
KM 61 - KM 85

SCALE : 1: 50 000

MARCH 2001

FIGURE : 3

CONSORTIUM EXPERCO / KCC / ECI



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT

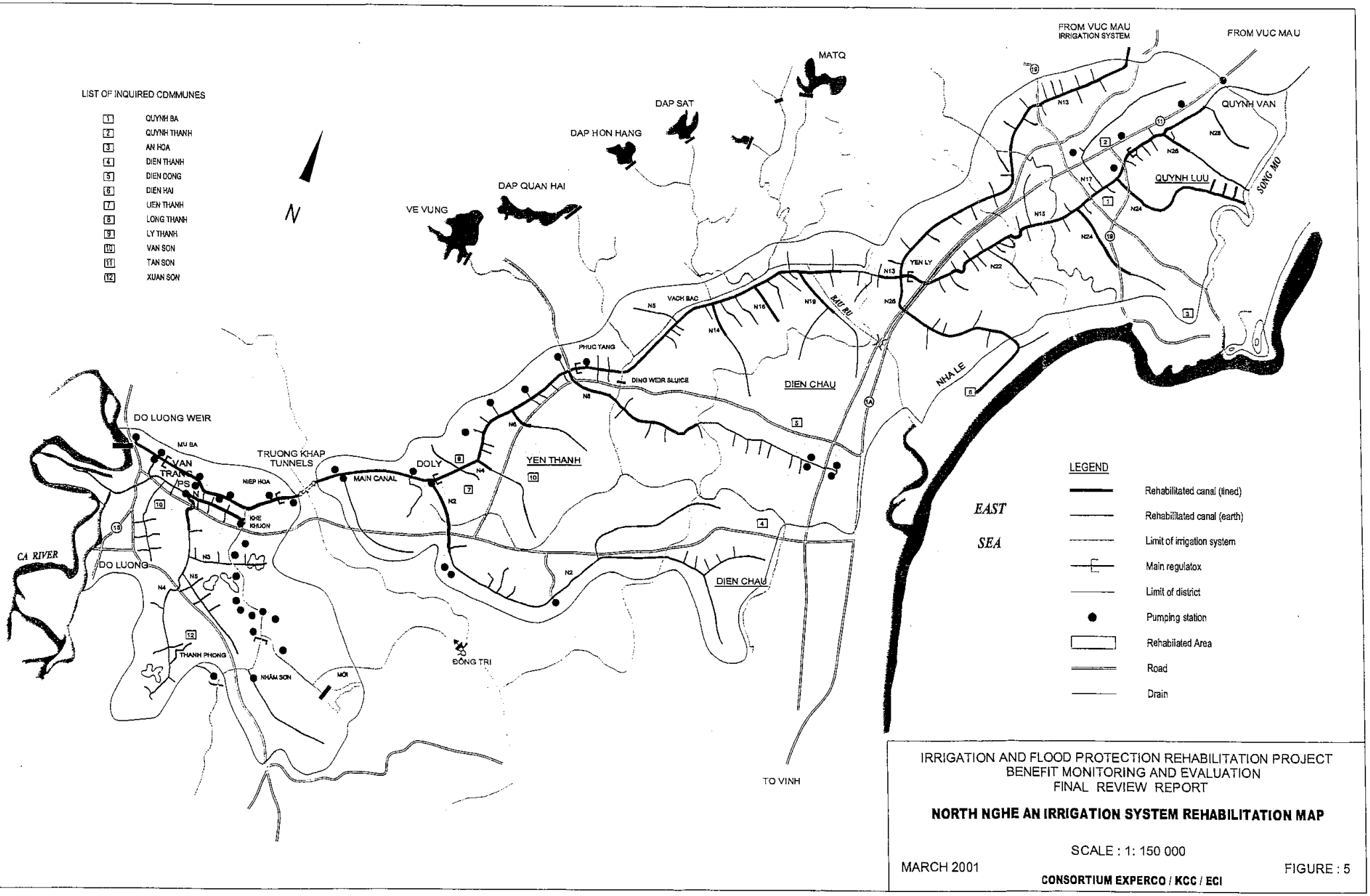
SONG CHU IRRIGATION SYSTEM REHABILITATION MAP

SCALE : 1: 150 000

MARCH 2001

FIGURE : 4

CONSORTIUM EXPERCO / KCC / ECI



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT

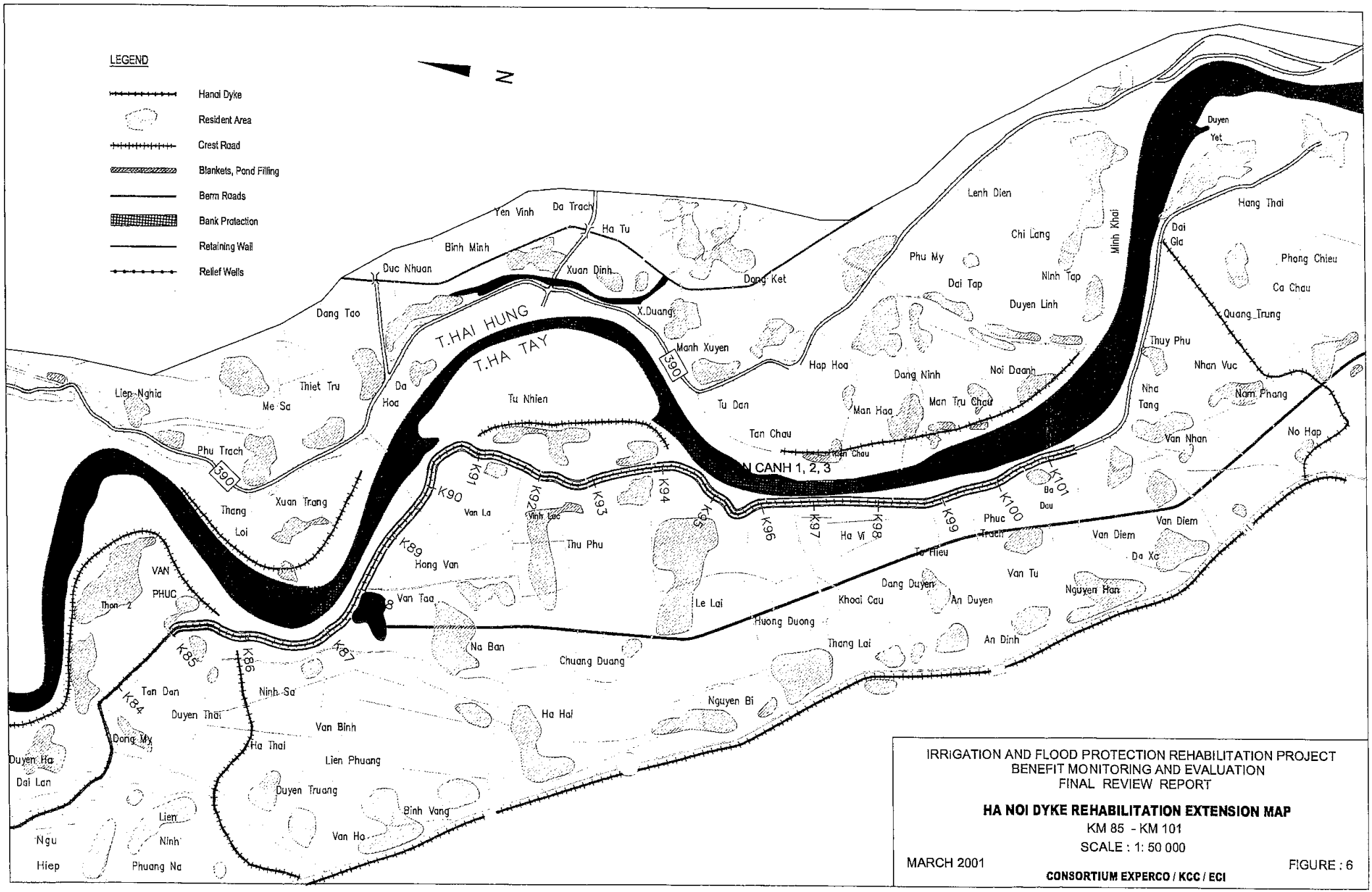
NORTH NGHE AN IRRIGATION SYSTEM REHABILITATION MAP

SCALE : 1: 150 000

MARCH 2001

FIGURE : 5

CONSORTIUM EXPERCO / KCC / ECI



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
BENEFIT MONITORING AND EVALUATION
FINAL REVIEW REPORT

HA NOI DYKE REHABILITATION EXTENSION MAP

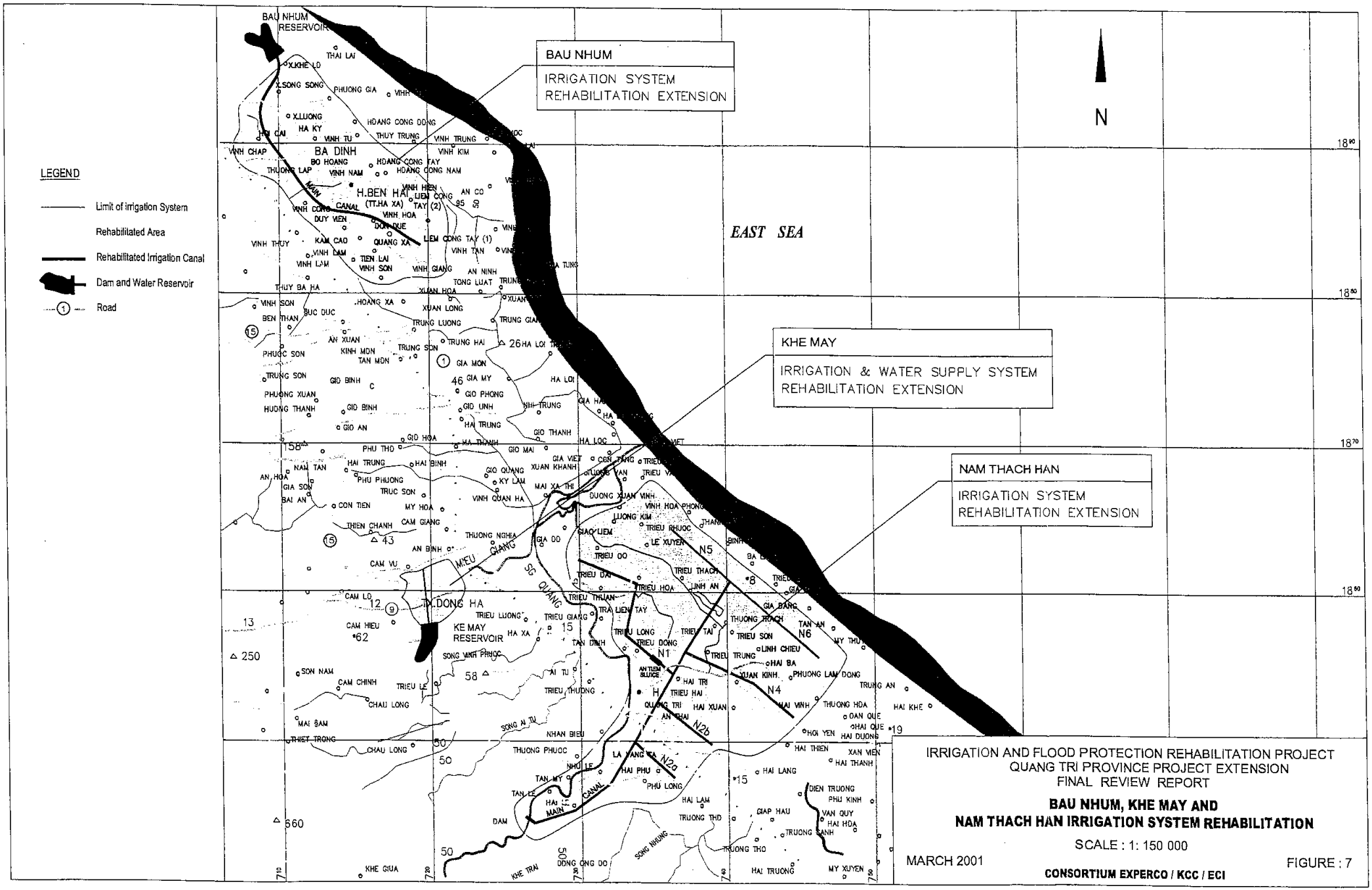
KM 85 - KM 101

SCALE : 1: 50 000

MARCH 2001

FIGURE : 6

CONSORTIUM EXPERCO / KCC / ECI



IRRIGATION AND FLOOD PROTECTION REHABILITATION PROJECT
QUANG TRI PROVINCE PROJECT EXTENSION
FINAL REVIEW REPORT

BAU NHUM, KHE MAY AND NAM THACH HAN IRRIGATION SYSTEM REHABILITATION

SCALE : 1: 150 000

MARCH 2001

FIGURE : 7

CONSORTIUM EXPERCO / KCC / ECI