No. = 202

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MASTER PLAN STUDY
ON
THE WATER MANAGEMENT SYSTEM AND MONITORING PROGRAM
IN
THE CHAO PHRAYA RIVER BASIN

MAIN REPORT
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JUNE 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND

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FINAL REPORT

ANNEX - 5 IRRIGATION AND DRAINAGE FACILITIES

JUNE, 1989

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CHAPTER 1 PRESENT IRRIGATION AND DRAINAGE

1.1 Outline and History

Rice subsistance farming has a very long history in Thailand. Rice has been grown by every farmer as the main crop wherever the land is capable of growing it. It is the most important crop and contributed to the economic growth of the country. Even through the yield per ha is relatively low among countries in Asia, the total rice production of Thailand is more than enough for domestic consumption and becomes a major export earning in foreign currency of the country. In fact, Thailand has been among the leading rice export countries and being known of the high quality rice, slightly aromatic and scented.

The irrigation development in Thailand was started several hundred years ago by farmers own initiative. Historically, people in the North has been familiar with the irrigation system for more than 700 years ago. The systems are mostly small scale of diversion type. The typical project consists of a weir together with irrigation canals serving the cultivated land of one or more villages. The structures are semi-permanent type using primitive technology and local materials. The projects were constructed and managed by the local farmers on their own initiative and expenses. The beneficiaries normally shared the expenses proportional to size of their land holding either at cost or in kind.

Direct Government involvement in irrigation began in 1902 when the Canal Department was organized to develop lowland waterways, control floods, and build and operate minor irrigation works. In 1927 the Canal Department was reorganized as the Royal Irrigation Department (RID) and given larger powers, including authority over drainage, land reclamation, and hydro-electric development (the latter power was subsequently transferred to the Electricity Generating Authority of Thailand (EGAT) when that agency was created in 1969).

From the 1930s to the 1960s, RID focused its efforts on the great Central Plain, the heartland of Thailand's commercial rice cultivation that lies mainly north of Bangkok on both sides of the country's largest internal river, the Chao Phraya. The Central Plain includes the Chao Phraya Delta, divided into the Northern Chao Phraya (or the Upper Chao Phraya) and the Southern Chao Phraya (or Lower Chao Phraya) areas and the Upper Central Plain (or lower North).

The land area comprises over one million hectares of flat, mainly heavy soils (increasingly heavy with clay as the river moves south), with an extremely low gradient south of Ayutthaya (only about 2 m of fall in 100 km). the low gradient, combined with Thailand's heavy wet season rainfall (1,200 - 1,500 mm) and the winding course of the Chao Phraya, causes annual flooding over large parts of the Central Plain. These flood waters, if not excessive and if they do not last long to interfere with harvesting, are good for paddy cultivation but not for other crops. Since flooding is naturally much heavier in the southern part of the Plain where the gradient is low, the Canal Department and later RID concentrated their initial activities on trying to minimize excess water problems in the Southern Chao Phraya.

The first decades of RID activity were devoted to adapting to the natural flood regime of the river over larger and larger areas and to providing drainage; no attempt was made to store the waters of the Chao Phraya until the 1950s. Canals were designed and built to spread the floods more evenly, and to promote drainage at the end of the wet season when excess water interfered with harvesting. These canals, generally referred to as "Conservation" canals, captured and stored water for use by nearby farmers during the dry season and provided a means of water transport over large areas not yet well served by roads.

In much of the central part of the Southern Chao Phraya, where wet season flooding is particularly severe, farmers grew primarily deep water flooded paddy in the wet season, in some areas installing pumps to take supplemental water from the drainage canals during gaps in the wet season rainfall. Through the 1930s more than 500,000 ha in the Southern Chao Phraya were developed through construction of such conservation canals for drainage and in the 1950s canals were built to serve some 200,000 ha in the adjacent Bang Pakong River Basin east of Bangkok.

In the 1950s and 1960s, RID turned its attention to the Northern Chao Phraya where drought was more often a constraint to paddy production than flooding. The need was to build a diversion dam and irrigation canals to provide the semi-controlled inundation needed for rice cultivation. In 1956 the Chao Phraya Dam, also called the Chainat Dam, was completed along with main irrigation canals and laterals. This permitted flood diversion and distribution of Chao Phraya River water but no storage. Construction of the large Bhumipol Dam (13.5 billion m^3) was completed in 1964 as the first step towards controlling the flow of the Chao Phraya's northern tributaries and providing reservoir storage. This was followed by the Sirikit Dam (9.0 billion m^3) in 1972. Construction of these two reservoirs greatly increased water availability for the Chao Phraya projects during the dry season.

In the 1960s and early 1970s, RID also began to develop other river basins and regions. A 120,000 ha first-stage gravity irrigation system and a 30,000 ha drainage system were constructed on the Mae Klong River which comprises the western part of the Central Plain. In the Northeast, seven large reservoirs and main canals were constructed. Numerous medium-scale and small-scale schemes were also built in the North, Northeast and South. The "extensive" gravity approach used in the Northern Chao Phraya system in the 1960s was widely applied in projects outside the Central Region. Dimensions and detailed information on major large reservoirs thus constructed in the Chao Phraya Basin and Mae Klong Basin are shown in Tables 1-1 (1) and (2) for reference.

1.2 Current Situation of Irrigation Development

1.2.1 Water Resources

Thailand has some 16.2 million ha of arable land of which some 3.1 million ha, or about 20%, are now irrigated during the wet season. Until the late 1970s, large-scale irrigation projects constituted the major form of irrigation investment and main source of incremental rice production. With the moratorium on new large-scale projects starting in 1981, only a few large-scale projects are currently under construction, while more stress has been given to medium- and small-scale projects.

Thailand has already taken advantage of a large proportion of the best opportunities for developing surface irrigation water supplies. However, some major opportunities exist for investment in supplementary dry season water sources for existing systems. This is particularly important in the Chao Phraya Basin. Three options for dry season water are water transfer from the Mae Klong Basin to the Chao Phraya, reservoir storage in the upper Chao Phraya Basin, and groundwater development.

The Mae Klong Water Transfer would, in its first stage, provide sufficient water in the Southern Chao Phraya to add some 50,000 ha of new irrigated land in the dry season. The Kaeng Sua Ten agricultural dam on the Yom River would also add 50,000 ha of dry season irrigation and, as the first stage of a potential four-stage Yom River development project, holds the key to future expansion of dry season irrigation in the Chao Phraya as well as large hydropower benefits. This is one of the last feasible sites for a major storage reservoir remaining in the upper Chao Phraya.

Groundwater appears to have good potential for development as a source of supplemental and dry season water supply. Although groundwater appears to have promise in selected parts of the country, it has played a surprisingly small role in agriculture to date. There are already two large experimental groundwater projects in operation (at Sukhothai and Pichit) and a growing number of farmers are investing in simple tube well installations. In almost all cases, groundwater would be used only in the dry season. The standard tube wells, now used by farmers whoever conditions permit, are highly profitable. No subsidies seem needed to expand private groundwater investments.

1.2.2 Irrigational Water Utility

Within the irrigated areas, rice cultivation predominates overwhelmingly with 90% of the irrigated land being planted to paddy during the wet season. The 30% of paddy land that is irrigated produces nearly 55% of the annual rice output and has provided 90 - 90% of the incremental production since the early 1970s and virtually 100% in recent years. (Much of the remaining 70% of Thailand's rice land will never be irrigated in the near future, since much of this land is in rainfed , deep-water or floating rice areas where improved water control would be technically very difficult and costly).

Because of water shortages, however, only one-quarter of the wet season irrigated land can be served during the dry season, when water is of course much more badly needed. Two-third of the land receiving dry season irrigation lies in the Chao Phraya plain. Without dry season water, double-cropping is impossible, and farmers are deprived of a second dry season paddy crop which has a higher yield potential than the wet season crop.

In view of the strong link between irrigation and rice output and of the unstable world prices of rice, Thai planners are naturally concerned about the strategy to adopt vis-a-vis rice production and further investments in irrigation. Additional rice yield increases, if they are desirable, would need to come from such sources as: (a) better controlled irrigation water and drainage; (b) more water for the dry season; (e) the spread of single-nutrient fertilizers (notably nitrogen-supplying area) in place of the mixed-nutrient fertilizers that have been traditional in Thailand; and (f) the development of more effective programs to control pests and diseases.

Of all these potential sources of yield increases, only three stand out as likely possibilities in the medium-term. These are an increase in dry season water availability, improved water control, and an expanded supply of urea at world market prices. The first two would facilitate the spread of high yielding varieties (HYVs), which currently cover only about 13% of Thailand's rice area.

One of the current objectives of the Government is to encourage greater diversification of crops, both to avoid over production of rice in a market and to increase production of crops (such as soybeans, mungbeans, and maize) which Thailand now imports or which appear to have good export markets. The key problem is that extension of dry season irrigation is much more economical and feasible in the Central Plain than elsewhere (because of the good potential there for added dry season water from water transfer, storage, and public and private wells), but in that area the soils are so much more suitable for rice than for any other crops that rice will inevitably be the crop most farmers plant when they get dry season water.

Possibilities for wet season and dry season diversification are quite different. The prospects for wet season diversification are very poor for two main reasons; (a) farmers prefer to grow rice in the wet season to assure their household food supply; and (b) in most irrigated areas, particularly with poor drainage, wet season water is excessive for upland-crops. Although upland crops need less water, they also require considerably better water control than rice and much better than most irrigation systems are presently providing. Thus, the potential for diversification within irrigated area is confined to areas with access to water in the dry season, or about 600,000 ha of Thailand's present 2.5 mill. ha of irrigated land.

During the dry season in these areas, paddy is the dominant crop, with 87% of the land under paddy and only 13%, under other crops. The strong dominance of paddy over other crops under dry season irrigation is partly a reflection of technical factors (mainly soils, drainage and lack of water control) and partly a reflection of economics. Even at the relatively low rice prices of 1984/85, farmers find it more profitable to grow two paddy crops (wet season plus dry season) than to follow their wet season paddy with an upland crop.

1.3 Current Irrigation and Drainage

1.3.1 Upper Basin

In the upper basin (say the basin in RID-regions No.1 & 2), flood plains developed along the Ping, Wang, Yom and Nan rivers and their tributaries are fertile and have long time been irrigated for centuries by use of diversion weir and canal systems constructed and O&M'ed by the local groups of farmers.

River runoff in dry season is so limited that irrigation had been only for wet season paddy and no substantial irrigation in dry season had been made. However, a number of large and many medium and small reservoirs and irrigation systems constructed/ rehabilitated with modern technologies in the recent decades have availed dry season irrigation.

Irrigation in wet season is for paddy and minimal upland crops for consumptive purposes, while in dry season irrigation is partly for some paddy but mostly for upland crops for both local consumption and sales. Due to small land holding and limited water resources for farming, farmers perform most intensive farming in the country by making full use of available water and with tight unity and good coordination among themselves.

No substantial drainage problem, generally speaking, is found due to appropriate land slope. Flush floods occasionally occur by local heavy rainfall along tributaries of the rivers. However flood damages are not so substantial that measures for flood water drainage are not herein discussed.

1.3.2 Middle Basin

In the middle basin, say the basin in RID-region No.3, a vast irrigated area lies in the flood plain along the Nan and Yom Rivers; so-called Phitsanulok Project (Phase I) area. Other small and medium sized irrigated areas are along tributaries of them and of the Ping.

Alike the upper basin, wet season irrigation is for paddy cultivation while dry season irrigation is for some paddy and mostly upland crops. It may be said that irrigated agriculture in the Phitsanulok Project areas are much stable whole year round due to controlled water release from Sirikit Dam while other areas are less stable.

Yom River basin does not have any substantial reservoir storages, and therefore it often causes flush floods along its lower reaches in Sukhothai. However floods down from Sukhothai can be drained to Nan River through drainage by-pass canal constructed under the Project. Considering scale of the flood damages, measures for flood drainage are not herein discussed.

Problems in irrigation/drainage in the middle basin may be, as same as in the upper basin, said shortage of water resources and their annual stability. As compared with in the lower basin, irrigation practices in the upper and middle basin is more intensive.

Irrigation of paddy is, in most cases of either old or new systems, practiced by continuous irrigation through canal and plot-to-plot distribution except in land preparation periods, while upland crop is by rotational furrow irrigation.

1.3.3 Lower Basin

Irrigated areas in the Lower Basin is concentrated in the Central Plain and its peripheries. The Upper Chao Phraya is characterized by gravity irrigation, while the Lower Chao Phraya by water conservation irrigation. Irrigation by pumping of surface water in the river/canal/creek is widely practiced to supplement irrigation water and re-use drained/conserved water.

Due to flat topography in the Lower Chao Phraya, irrigation has been practiced by controlling water level to cause shallow flooding over paddy field in wet season. And well-developed creek network has functioned not only for equitable flooding but also for drainage, water conservation in dry season, navigation, flood retention/dispersion/drainage, etc., and thus such areas are called as water conservation area.

The water conservation area (say Khlong Dan, Pra-ong Chaiyanuchit, Rangsit Tai, Rangsit Nua, Phasi Charoen, Phraya Phimon, Phraya Banlu and Chaochet-Bang Yihon Project areas) functions to catch and retain drained water from the upper area to re-use the water for irrigation and other purposes. Irrigation water demands of the area to the water resources are therefore considerably reduced and the cropping calendar is so programed to make full use of the drained water.

Paddy irrigation is dominant in wet season, and unlike in the middle and upper basin, some 500,000 ha (in 1985) is irrigated for dry season paddy so as to guarantee paddy production for farmers who cannot grow paddy in wet season due to annual floods.

Due to advantageous accessibility to the market of Bangkok, suburban farming has much been developed in the current years to grow various vegetables and fruits and other cash crops. Aside from these crops, water use for fish and shrimp culture is sharply increasing in recent years because of good economic return. This, in addition to demands for vegetables and fruit trees, is creating more year-round water demand and giving new stress to water sources and difficulties in water allocation in dry season.

Furthermore, urbanization around Bangkok is causing deterioration of water quality due mostly to sewerage from urban factories and residential area. Such water pollution also causes additional water demands to dilute or flush the polluted water for protection of agricultural/fishery benefits.

Urbanization has also caused development of artesian wells for industrial and domestic use and this caused severe land subsidence in and around Bangkok. In order to protect Bangkok Metropolis from flood, flood protection dike surrounding the metropolis was constructed since 1983 to stop flood water flowing thereinto. And this also caused deterioration of drainage around Bangkok.

Major irrigation and drainage system in the Chao Phraya Delta is shown in Figure 1-1.

CHAPTER 2 PRESENT SYSTEM OF IRRIGATION AND DRAINAGE

2.1 Irrigation Project in the Study Area

2.1.1 Project Category

Irrigation projects, except old and some of small ones, are mostly constructed by RID, and RID implement the construction in 3 categories, large-scale, medium-scale and small-scale project.

Large-scale projects cover about 3/4 of the total irrigable area and usually have service area exceeding 20,000 ha. Among them, some of the largest ones in the Study area are the Greater Chao Phraya Project comprising some 28 member-projects in the Upper Chao Phraya and Lower Chao Phraya areas and Phitsanulok comprising 4 member-projects along the Nan and Yom River.

Medium-scale projects are those costing 200 million Baht or less which can be implemented within 4 years. Their service area ranges from 1,000 - 2,000 ha in majority.

Small-scale projects are over 5,000 in number mostly located in rural remote area and cost 4 million Baht per project or less. Their primary purpose is not necessarily irrigation but other purpose such as domestic use.

As of 1986, national total irrigable area of large and medium-scale project completed or under construction amounts to 3.45 million ha, while small scale projects 0.75 million ha. In the Study area, 1.81 million ha (52%) is irrigable by 192 large- and medium-scale projects.

2.1.2 Irrigation Project in the Study Area

Number of large- and medium-scale projects in the Study area by component basin are quite characteristic. Among totals of 192 projects, 1.81 million ha of irrigable area, 55 reservoirs and

23,781 MCM of storage in the whole basin, the upper basin has 77 projects (40%), 0.36 million ha (20%) of irrigable area, 31 reservoirs (56%) and 787 MCM of storage (3%).

In the middle basin, they are 58 projects (30%), 0.28 million ha (15%) of irrigable area, 9 reservoirs (16%) and 22,549 MCM (95%) of storage, while in the lower basin they are 57 projects (30%), 1.27 million ha (70%) of irrigable area, 15 reservoirs (27%) and 445 MCM (2%) of storage, respectively.

Among them, Bhumipol Reservoir and Sirikit Reservoir in the middle basin are outstanding ones whose total storage amounts to 22,462 MCM (94% of the total in the Study area) to serve for hydropower, irrigation and flood control. The two reservoirs are contributing much to the lower basin in flood prevention and stable water supply to the all irrigation projects in the Chao Phraya delta all through the year.

It must be noted that a number of outstanding-sized irrigation projects of Phitsanulok Projects and the Greater Chao Phraya Project in the middle and the lower basin are heavily dependent on the two huge reservoirs in water supply and their total amounts to 1.28 million ha (71%) of irrigable area in the Study area. Details of the above are presented in Table 2-1, while chronology of major projects are in Figure 2-1.

2.2 Engineering Design of Irrigation System

Until the early 1970s, canal systems were primarily used for supplemental wet-season irrigation and they generally achieved this objective. More recently, RID designs were patterned on the design standards of the U.S. Bureau of Reclamation, but were less comprehensive. The RID designs are acceptable in a situation of abundant water during the wet season, but pose several operational problems for dry season irrigation.

2.2.1 Canal

Until the early 1970s the main and lateral canal systems were designed for peak demand during the wet season. The design capacity in the Lower Chao Phraya was 0.13 liter/s per rai (0.81 liter/s/ha) for the canals and 0.14 liter/s per rai (0.91 liter/s/ha) for the structures. This is only about half the capacity needed to accommodate the 0.24 liter/s per rai (1.4 liter/s/ha) required to achieve a 100% cropping intensity for paddy during the dry season.

The present capacities thus constrain the allocation of dry season water. Without remodeling part of the main and lateral systems, it would not be possible to supply enough water for dry season irrigation of paddy over the planted area (assuming use of an annual rotation method which provides water for one dry season out of two or three, on half or one third of the total project area).

The most recent projects have been designed to avoid this problem, and capacities have been calculated on the basis of the average dry season cropping pattern. A margin of additional capacity is even provided to allow flexibility in the choice of cropping patterns. In the Mae Klong Project the design capacity of about 1.7 liter/s/ha is adequate for cultivation of rice and sugarcane on 80% of the project area.

Until recently the canal systems including the tertiary systems were designed to be operated only at or near full capacity with a minimum of control structures. The result is that at flows below the design capacity, water levels in the canals may not be high enough to ensure demand of the entire service area and to provide full supply to the subsequent order canals. In principle, the solution is to build additional control structures to ensure a minimum water level at the diversion points independent of the flow in the parent canal.

2.2.2 Control Structure

Operational staff are needed to control the water levels and flows of all structures built in the irrigation canal system. With the exception of some main regulators in the Upper Chao Phraya area which are electrically controlled, all structures are manually operated and any significant variation in supply of demand of water in the system requires readjustment.

Almost no form of automation has been built into the design of these structures. The maneuverability of gates of head and cross regulators is in some cases limited and any change in their setting is time consuming. The determination of flows through each structure requires calibration of the gates and frequent measurement of water levels in the absence of automation. In recent years, RID has initiated a program of gate calibration.

2.2.3 Farm Turn-out

The last water distribution control point is the farm turnout delivering water to service areas averaging 30 to 60 ha. Until the late 1960s, farm turnouts were equipped only with simple gates. This prevented any flow measurement, which was in any case unnecessary at that time because the systems were intended for wet season irrigation only. Constant head orifice (CHO) gates and movable weirs (Rominj type) were introduced in the late 1960s and 1982, respectively, to control and measure flows through the farm turn-outs.

These two devices, especially the movable weirs, are sensitive to variations in the upstream water level and therefore require frequent adjustments to maintain constant flow deliveries to the service units. Both devices are designed to measure the flows at a given time but are not self-flow-complexity of operation and need for frequent readjustment with the result that CHO gates are rarely used properly. The Rominj weir has so far been introduced only in the Mae Klong Project. Although simpler to operate, its use is limited to canal sections with strict control of water levels.

2.3 Water Use Facilities

Water use facilities may be categorized into 4; water storage, water control, water conveyance and other facilities. Other facilities include those for safety of facilities, prevention of various damages, navigational conveniences, water measuring structures, etc.

2.3.1 Storage Facilities

This category includes reservoir, tank and pond to store excessive water in wet time and release in dry time. Storage volume depends much on topography and they are therefore located in the hilly area of the Upper and Middle Basins.

Most of reservoirs and tanks are fill-type dams; either rock-fill, zoned earth-fill or homogeneous earth-fill type. For large dams, rock-fill dam is more popular, while earth-fill dam for small ones. Concrete dam is rather exceptional type and Bhumipol Dam is the sole large concrete dam (arch-type) in Thailand. Large ones in the Study area with gross storage exceeding 100 MCM are only 7 in number as shown in Table 2-2 for reference.

2.3.2 Control Facilities

This category includes most type of hydraulic structures equipped with gate structure to pass, stop and regulate water flow and/or water level. They are distributed at any level of irrigation and drainage systems and are operated to perform efficient delivery/removal of water. The largest ones are diversion dams/barrages and the smallest ones are those in tertiary canals such as division box, farm inlet/outlet, etc. Among large ones in the Study area, the outstanding sized and the most important ones are the following three structures.

Naresuan Dam, at 30 km north of Phitsanulok, was constructed in 1985 across Nan River to divert water released from Sirikit Reservoir and other own watershed to the Phitsanulok Irrigation Project Phase I (approx. 0.1 mill. ha). The dam is equipped with 12.5 m-wide 5 radial gates of electric drive.

Chao Phraya Dam, at about 4 km east of Chainat, was constructed in 1957 across Chao Phraya River to divert water from the four major tributaries and Skae Krang basin to the Greater Chao Phraya area (the whole Chao Phraya Delta). The dam is equipped with 12.5 m-wide 16 radial gates of electric drive.

Rama VI Barrage, at about 30 km upstream of Ayutthaya in Pasak River, was constructed 1924 across the river to divert water of the river and Chao Phraya River through Chainat-Pasak Canal and to serve for downstream reaches of the left bank area of Pasak and Chao Phraya River as much as 0.4 mill. ha. The barrage is equipped with 12.5 m-wide 6 slide gates of manual drive.

Next to the above, important ones are the following 6 regulators to take river flow into canal/channel elevated by Chao Phraya Dam and Rama VI Barrage.

Key Head Regulators in the Delta

Regulator Name	Gate Size	Upstream	Downstream
Manorom	6-6.00 m	Chao Phraya R.	Chainat-Pasak C.
Makamtao-Uthong	6-1.75	-do-	Makamtao-U.C.
Phonlathep	4-6.00	-do-	Suphan R.
Borommathat	4-6.00	-do-	Noi R.
Maharaj	3-4.00	-do-	Chainat-Ayut. C.
Phra Narai	8-4.00	Pasak River	Raphiphatana C.

In addition, a large number of regulators with various sized area distributed along or across main, lateral, tertiary and other canal networks. Among them, key regulators for diversion of water in the main canal/channel are as follows.

Key Regulators across Main Canal/Channel in the Delta	
Canal/Channel Name	Name of Regulator
Chainat-Paska Canal	Chong Kae, Koke Kathiem & Roeng Rang
Suphan River	Thabote, Samchook & Pho Phraya
Noi River.	Chanasutr, Yang Manee & Phak Hai
Raphiphatana Canal	Phra Sri Sril, Phra Sri Saowaphak, Phra Thammaracha, Hokwa & Khlong 13 Tail

(Location of above regulators in Figures 1-1 and 2-2)

Several types of gate are employed; slide gate is most popular in smaller size and new structures, white radial gate is popular for large one. It must be noted that most of them are manually operated except the outstanding and some of key regulators and those recently constructed for flood protection around Bangkok and along tide-affected reaches of Chao Phraya River, Tachin (Suphan) River and Bang Pokong River.

2.3.3 Conveyance Facility

This category includes canal/channel and of those attached such as siphon, culvert, flume, tunnel, pipeline, farm ditch, etc. to lead water to the required place.

In the Chao Phraya Delta, there exists approximately 4,000 km of irrigation canals, 2,600 km of drainage canals and uncountable length and number of natural rivers/creeks. Distribution density in the gravity area in the Delta 5.2 m/ha for irrigation canal and 3.6 m/ha for drainage canal. Among those in the delta, outstanding ones are the following 4 canal/channel.

Chainat-Pasak Canal conveys water from Chao Phraya River to Pasak River for 11 of 12 projects in the east bank of Chao Phraya River. This is an unlined canal with 133 km of total length, 210 - 130 CMS of flow capacity and trapezoidal cross-section.

Noi River is a natural river and by-passes water of Chao Phraya River at Chainat to serve for 4 projects along the course in the west bank of Chao Phraya River and release excessive/drained flow back to Chao Phraya River at Bang Sai. Flow of the river is controlled by Borommathat Regulator at the head and other 3 regulators across it.

Raphiphatana Canal conveys water of Pasak River and that from Chainat-Pasak Canal to the water conservation area to serve for 6 projects in the lower east delta. This is an unlined canal with 96 km of total length, 100 - 20 CMS of flow capacity and trapezoidal cross section.

In the gravity irrigation area, a large number of main, lateral and sub-lateral canals are diverged from the above courses and from themselves. Tertiary canals after FTo are well equipped only in land consolidated area. In other areas, tertiary canal are so short that plot-to-plot irrigation is popularly applied.

While in the water conservation area, canals are densely distributed if a large number of natural and artificial canal/channel/creek network are counted into. However, land consolidation has not been implemented yet and water delivery/drainage to/from farm plot are mostly made by plot-to-plot method. Canals are, generally speaking suffering much from deterioration of flow capacity by not only sedimentation but also water weeds. In the urban area, illegal buildings in/above canals are also causing hindrance of flow and dredging.

2.3.4 Other Facilities

This category includes various structures such as drop, spillway, measuring structure, wasteway, overchute, protection dike, pumping station and the relevance. They are located at required places in the canal system, while the following two structure types are of current importance.

(1) Pumping Station

Pumping irrigation by fixed (non-movable) station is practiced in Bang Ban Project area and a part of Chaoched-Bang Yihon Project in the Delta. Pumping irrigation by movable/portable pump is commonly practiced by many private farmers everywhere.

Pumping drainage is recently introduced in order to protect Bangkok Metropolis from floods. A number of drainage pumping stations along Chao Phraya River across drainage/communication canals have been constructed. Water weeds and litter in canals are always causing operational difficulties in trash screening.

(2) Flood Protection Dike

After the severe flood in 1983, construction of flood protection dike along Chao Phraya, Suphan (Thachin), Noi, Lopburi, Pasak and Bang Pakong Rivers, around Bangkok Metropolis and along the gulf coast, was much intensified. Dikes around the Metropolis and along Bang Pakong River have been completed while others are under annual implementation.

2.4 Maintenance and Repair

Water use facilities are operated and maintained by the concerned agencies and beneficiaries. Hydro-power facilities are solely managed by EGAT while irrigation facilities are managed by construction agencies and beneficiaries.

Except small and old irrigation systems, irrigation facilities are managed by RID or other similar agencies until at farm turn-out

(FTO) level and by farmers' organization at on-farm level. Being the largest construction agency for irrigation systems, RID controls all major irrigation systems in the country. They are managed by each project O&M office which belongs to RID-Regional Office.

2.4.1 Regular Maintenance

Regular maintenance of irrigation, drainage and relevant water use facilities is programed and practiced by each responsible project O&M office through the same channel of water operation from on-farm level to main system level. Common irrigator maintains FTO and on-farm facilities in coordination and cooperation with water users. Project manager, water master and zoneman are responsible for programing and performing regular maintenance of facilities in their responsible area.

At main and lateral system levels, regular maintenance is steadily performed by use of RID's own annual budget even though the budget allocation may not be sufficient as much as the field office wants. On the other hand, accomplishment at FTO and on-farm level differ much in one area to another, since it much depends on water availability, quality of farmers' unity and ability of RID's field staff. Generally speaking, land consolidation areas are maintained much better than the other area.

2.4.2 Repair and Improvement

RID is annually repairing and improving superannuated and/or outdated facilities by use of the budget alone; no cost is borne by beneficial farmers. In the current budgetary scale, such expenditure per irrigable area for the purposes is some 40 Baht/rai in whole the country.

In the Chao Phraya Delta, either the upper or lower, it has been observed that many old water use facilities are in good use and well maintained though the functional capabilities may be deteriorated and/or in need of improvement.

For instance in the Delta, most of large regulator gates except Chao Phraya Dam are driven not by electricity but by manual hoist, and this creates difficulties in precise and timely gate operation. In addition, most of gate structures for water control and distribution such as regulator, check, siphon, ETO, etc., either large or small or made of steel or lumber, are manually operated except small number of key structures and currently rehabilitated/newly constructed ones.

Functional deterioration of canal network by sedimentation, weed growth, weathered canal banks, scoring, etc., are often observed.

In drainage/communication canal network, most of regulator gates are operated not by gear or winch hoist but by chain hoist except key and new ones. Small-sized gate structures such as FTO and similar ones are often observed damaged/abandoned due probably to insufficient functional capacity.

It may be said that, due to budgetary constraints, budget allocation for repair and improvement is far below the field requirement to maintain these facilities at satisfactory level. And it may also be said that O&M of the outdated systems requires much budget and resultantly give more stress onto budget allocation for repair and improvement.

2.5 Public Agencies Concerned

A number of government agencies in several ministries are concerned with water resources development and related activities in Thailand as shown in Figure 2-3. As irrigation and drainage projects are so far concerned, the concerned agencies other than RID are Agricultural Land Reform Office (ALRO), Office of Accelerated Rural Development (ARD), National Energy Administration (NEA). In addition, Electricity Generating Authority of Thailand (EGAT) is inevitably involved since it controls hydro-power plants constructed at large storage dams which are multi-purpose including irrigation.

2.5.1 Royal Irrigation Department (RID); M. of Agri. & Coop.

RID is the sole and largest agency among them specialized in integrated fields of irrigation and drainage and other related activities. Its major responsibilities are;-

- Water resources development primarily for agriculture, but also for industry, domestic water, hydroelectric power, and navigation.

- Flood protection and flood area improvement.

- Master planning for water resources development in Thailand.

- Geographic, hydrographic, soils, geologic, and economic surveys for preparing feasibility reports.

- Planning and design of irrigation projects.

- Construction of diversion dams, storage dams, and water distribution systems.

- Operation and maintenance of irrigation and drainage systems.

The organization chart for the Royal Irrigation Department is shown in Figure 2-4. Operation, maintenance and improvement of irrigation and drainage facilities are under responsibility of Regional Irrigation Office to which each project O&M Office belong. Organization chart the offices are shown in Figure 2-5.

2.5.2 Electricity Generating Authority of Thailand (EGAT)

EGAT has the authority to:-

- Construct and operate dams and reservoirs or other equipment relevant to electric power generation and to develop water resources with a view to expanding such opportunities

- Construct thermal, hydro, nuclear and other types of power plants

- Improve and expand substation and transmission systems including associated equipment for electric power transmission systems and distribution

- Specify standards, type and size of substation, transmission systems, power plants, lignite chemical plants, and fuels for power production as well as associated equipment

- Formulate policy in connection with production of power and sales of electricity, lignite, and lignite by-products.

The EGAT Act provides for interagency coordination in the control of reservoir water in order to maximize basin-wide benefits. EGAT and the Royal Irrigation Department are required to jointly prepare regulations concerning the fixation of the volume of water to be retained in or to be released from reservoirs. An organization chart for EGAT is presented in Figure 2-6.

2.5.3 Land Reform Office (ALRO); M. of Agri. & Coop.

The authorities, duties, and responsibilities of ALRO are:

- Providing state-owned land to be used for agricultural purposes.

- Designating land reform areas, purchasing or expropriating land, and establishing the sizes of farms to be made available to farmers or farmer institutions on the basis of long-term lease of hire-purchase.

- Determining layouts and allocation of lands within the land reform areas.

- Evaluating and approving land reform plans and projects and preparing the ALRO budget for submittal to the Minister.

- Developing plans for the marketing of farm products produced within the land reform area in order to increase the incomes and protect the interests of the farmers or farmer institutions.

- Developing agricultural extension and promotion plans within the land reform area including land consolidation for agriculture; improvement of productivity and farm product quality; and improvement of welfare, public utilities, education, and public health services for the farmers.

- Establishing criteria, methods, and conditions for the selection of farmers and farmer institutions eligible for the lands allocated under the agricultural land reform program, as well as establishing the contract format for the lease and hirepurchase agreements to be made with the farmers or farmer institutions.

- Establishing procedures to be used by farmers and farmer institutions in association with the utilization of the land and in compliance with farm production and marketing plans.

- Establishing criteria and procedures for loans to be secured from the ALRO by the farmers and farmer institutions within the land reform area.

- Establishing regulations concerning the management of assets and liabilities of the farmers and farmer institutions to whom land has been allocated.

- Conducting reviews of the ALRO's operations to make sure they are carried out in accordance with the plans and projects as approved, as well as establishing measures for resolving any problems arising from the operations.

- Establishing other activities and regulations associated with the ALRO's operations or in connection with the objectives of agricultural land reform.

The organization chart for the ALRO is presented in Figure 2-7.

2.5.4 Office of Accelerated Rural Development (ARD); M. of Interior

The purposes of the ARD programs are as follows.

- To provide the rural population with necessary grass-roots level infrastructure such as rural roads, domestic water supplies, and supplementary irrigation, so that rural people will have sufficient occupational opportunities and conveniences.

- To provide services to assist rural people in agricultural and other occupations so they can increase productivity and incomes above their present subsistence level.

- To organize agro-business activities and services so that rural agricultural producers themselves can participate and have sufficient capability and volume to deal effectively with established traders.

- To provide fundamental social services, such as medical care and health services, to the rural population.

- To prepare young rural adults for future occupations and, thus, for better citizenship.

- To create a peaceful and productive atmosphere in the rural areas in order to better protect the population from subversion and unrest.

- To coordinate, mobilize, and deploy other governmental and public agencies and their resources in an integrated rural development service program for the people.

- To introduce private business institutions and concerns such as commercial banks, farm suppliers, processors, and exporters to a program of promoting productivity and additional income for rural people.

- To introduce modern and practical technology and investments suitable for rural areas.

- To accommodate the Thai constitution and government policies of promoting local authority and responsibility in the rural areas and among the rural people down to the grass-roots level.

An organization chart for ARD is presented in Figure 2-8.

2.5.5 National Energy Administration (NEA)

The authorities and duties of NEA are:-

- To procure and establish energy sources for development of the country and for the welfare of the people.

- To carry out research, experiments, inspections and surveys, and to compile statistics concerning suitable locations for generating hydroelectric power, or places from which materials for the production of electricity and other energies could be derived.

- To lay down policies and devise controls for all production of energy.

- To provide, control, construct, purchase, sell, lease, or close down an energy production works and transmission and distribution systems.

- To lay down the regulations and controls for the safety of energy production plants.

- To establish standards and prescribe rates for the sale of energy.

- To aid and promote the utilization of energy in economic development programs such as agriculture, handicrafts, industry, commerce, and communications.

- To bring about other benefits jointly associated with energy works, such as irrigation, flood control, and navigation.

An organization chart of NEA is shown in Figure 2-9.

CHAPTER 3 STUDY ON PRESENT IRRIGATION AND DRAINAGE SYSTEM IN THE DELTA

3.1 Irrigation System Network

There are a number of irrigation project areas which are operated and managed by each respective project O&M office , among which 25 project areas are seved with water by Chao Phraya River system in the delta. The upper parts of the areas are equipped with gravity irrigation and drainage systems, while the lower parts are with well developed canal/creek networks for water conservation and various other purposes including flooding/pumping irrigation. Figures 3-1 (1)-(25) show irrigation system diagrams of each of the 25 project areas in the delta.

3.2 Inventory of Major Irrigation and Drainage Structures

In order to formulate various plans for further improvement and/or development of irrigation and drainage systems, identification and quantification of their facilities is the primary importance. Among them, canals and regulators are the most important components of the systems that their numbers and dimensions have been identified from inventories of facilities and maps/drawing/lists in each project O&M office.

3.2.1 Canal

In order to quantify canal network, classification of whole canals in the Delta has been made into irrigation canal, drainage canal, major communication canal and other canal. For irrigation canal, classification by flow capacity has also been made, while a large number of natural creeks have not been counted. In the gravity area, many canals function two a more purposes that they were classified by their major purpose.

In the 25 project areas in the Delta total canal length has been found as shown in the following table. It indicates clear difference in canal distribution by canal purpose between gravity irrigation area and water conservation area.

Summary of Canal Length (unit: km)

Canal		Gravity Irr. Area	Water Conserv. Area	Total
	- 1 cms	1,606.8	0	1,606.8
Irrig. Canal	1 - 10 cms	1,361.5	422	1,783.5
	10 - 30 cms	227.9	35	262.9
	30 - 100 cms	126.8	52	178.8
	100 - cms	166.9	0	166.9
Sub-total		3,489.9	509	3,998.9
Drainage Canal		2,387	216	2,603
Maj. Communi. Canal		0	780	780
Other Canal		0	3,914	3,914
Total		5,876.9	5,419	11,295.9

Table 3-1 shows summary of inventories for irrigation, drainage and other canals in each of the 25 projects in the delta. Hydraulic and dimensional information on major irrigation and drainage canals are presented in Tables 3-2 (1)-(3). Breakdowns of component irrigation canals are shown in Tables 3-3 (1)-(11). Summary of inventories for drainage canals by component drainage canals and their further breakdowns are presented in Tables 3-4 and 3-5 (1)-(7).

3.2.2 Regulator

Whole regulators have been identified and classified by size and structure type. Three types are employed; regulator (ordinary type), pipe-regulator and farm turn-out (FTO). FTOs are usually steel-made spindle gate with concrete culvert pipe (0.30 - 0.50 m in dia.). Pipe-regulators (To-Ro-Bo in Thai) are usually steel-made slide gate with one or more concrete pipes (1.50 m in dia. or less). Regulator (ordinary type) are usually larger than pipe-regulator and equipped with steel-made slide or radial gate and with/without box-culvert (1.00 m x 1.00 m or larger). Summary of their numbers are in the following table, which also shows clear difference in gravity irrigation area and water conservation area.

Summary of Regulator and FTO (unit: Place)

Item	Gravity Irr. Area	W. Conserv. Area	Total
Regulator			
Width 5m	96	148	244
5 - 15 m	45	120	165
over 15 m	26	11	37
Total	167	279	446
Pipe Regulator	1,028	98	1,126
Farm Turn-out	6,138	227	6,365

Breakdowns of the above table by project are shown in Table 3-6. Dimensions and design capacities of major regulators are shown in Tables 3-7 (1)-(4), while Tables 3-8 (1)-(5) show dimensions of gates of all ordinary-type regulators in each project.

3.3 On-going System Improvement 5-year Plan

Since Thai fiscal year 1987, RID is implementing a 5-year (FY1987-1991) plan for improvement of existing irrigation and drainage systems so as to recover and improve system functions and to meet current and new requirements to the systems.

3.3.1 Implementation Budget

The plan is implemented through the whole country by 12 RID-Regional Offices with a total cost of some 4,000 million Baht in the 5 years or 800 mill. Baht/year, in which some 1,200 million Baht (30%) is allocated to 25 projects in the Delta (see Table 3-9).

Work components of the plan are various in type and volume and are summarized in Table 3-10 and 3-11, which indicates that construction/improvement of irrigation canal has the largest budget (32%) in the gravity irrigation area while regulator (53%) in the water conservation area. In the both areas, about 20% of the budget is allocated to dike construction/improvement due probably to protection of flood which is currently paid much attention to.

3.3.2 Work Volume

Volumes of works under the plan in the 25 projects in the Delta have also been worked out as shown in Tables 3-12 (1)-(3) and Tables 3-13 (1)-(2) for gravity irrigation area and water conservation area respectively. In combination with implementation budget scale, average unit cost for each work component has therefore been worked out as shown in Table 3-14.

3.4 Questionnaire Survey on Operation and Maintenance of Project Facilities

3.4.1 Outline

A questionnaire survey on operation and maintenance of project facilities has been conducted in 1987 by the Study Team with assistance of O&M Division and Regional Offices. The survey aims to identify O&M situations in the field and needs for improvement. Two questionnaire formats have been prepared for questions; one to 27 project managers and another to 86 water masters of 25 projects in the Greater Chao Phraya area (in the delta and 2 adjacent projects). The two formats are as shown in Forms 3-1 and 3-2, while surveyed projects are listed in Tables 3-15 (1)-(2).

Answered formats have successfully been all collected, and compiled into a condensed data file for computer processing. Statistical analysis has been applied to the field and the followings has been found.

3.4.2 Answers of Project Managers

The 27 surveyed projects consist of 19 projects under gravity irrigation in the upper part of the Delta and 8 projects under water conservation irrigation in the lower Delta.

Characteristics of each project have been found from the answers. Summary table of the answers is presented in Tables 3-16 (1)-(3), which indicates distinct natures of projects in the gravity irrigation area and water conservation area.

- Number of water masters per project is 2-4 (average 3.1) in the GI (gravity irrigation) area while 2-5 (average 3.5) in the WC (water conservation) area.

- Completion of project construction in GI area is 1961 in average while 1935 in WC area; difference is 26 years.

- Average irrigation service area per project is 62,000 rai in WC area while 38,000 rai in GI area (60% of the former).

- Average service area per RID field officer is 2,700 rai/pers. in GI area while 3,100 rai/pers. in WC area; 10% difference.

- Average service area per employees is 139 rai/pers. in GI area while 304 rai/pers. in WC area; more than double in GI area for field O&M of the system.

- Average year of experience of project manager served for RID is 26-27 years; same in both GI and WC areas.

- Water shortage in wet season occurs once in 5 years in 11 projects in GI area while once in 3 years in 1 project in WC area; almost no shortage in WC area in wet season .

- Water shortage in dry season occurs almost every year in 12 projects in GI area while all projects in WC area.

- Problem in water salinity and water pollution occurs only in WC area.

- Annual budget for repair of structures in 1984-1986 in ฿ 341/rai in GI area whole ฿224/rai in WC area (2/3 of the former)

- Degree of damage on canal and canal structures in WC area is higher than that in GI area.

- In both areas, needs for qualified staff, transportation vehicle, communication and office equipment and staff training are strongly reported.

- For improvement of canal, dredging is the most popular method in both areas. However, improvement of communication canals and natural channel in WC area is much more than in the GI area.

- Reconstruction and new construction of canal structures in both areas are wanted. Among them new construction of regulators is much wanted. Meanwhile damage on a large number of gate and hoist for FTO is reported mostly in GI area.

3.4.3 Answers of Water Masters

The surveyed 86 water master sections (areas) consist of 58 sections in GI area and 28 sections in WC area. Characteristics of the sections in both GI and WC areas are also significant as shown in Table 3-17 to indicate followings .

- Average service area of a water master is 85,000 rai in GI area, while 124,000 rai in WC area; 1.5 times of the former.

- Average service area per zoneman is 13,500 rai in GI area while 31,000 rai in WC area; 2.3 times of the former.

- Average service area per gate tender is 5,100 rai in GI area, while 9,800 rai in WC area; 1.9 times of the former.

- Average years of experience of water master served for RID is 21 years in GI area and 18 years in WC area to imply little difference.

- Water shortage in dry season occurs 28 sections (47%) in GI area while 17 sections (60%) in WC area.

- Flood damage occurs 35 sections (60%) in GI area, while 19 sections (68%) in WC area to indicate evenly dispersed flood damage.

- Problem in water quality is answered only one section in GI area while 18 sections (64%) in WC area to indicate severe water pollution in the lower Delta.

Further results of analyses on requirements for improvement of existing project facilities wanted by field staff are presented in the following Section.

3.5 Improvement Works Wanted by Field Office

3.5.1 Outline

The survey questionnaire includes questions to project manager (Q-8; Form 3-1) and to water master (Q-4; Form 3-2) to inquire problems, necessary measures and work volume for improvement of major components of project facilities of 4 types of canal (irrigation, drainage, communication and natural canals), 4 types of dike (flood dike, canal dike, road and other dike), regulator, siphon, pumping station, navigation lock and FTO.

The answers have been processed to produce totals of work volumes by work type and subject structures in order to quantify various needs for improvement wanted by the field office staff.

3.5.2 Work Volume for Improvement wanted by the Field Office

Answers of 25 project managers and their water masters in the Delta have been totaled by RID-Region and GI/WC area as shown in Tables 3-18 and 3-19 while breakdowns by each project area is shown in the Appendix. Comparisons of the totals with the total quantities of existing ones have been made as shown in Table 3-20, which indicates that:-

- in GI area, some 2,300 km (65%) of irrigation canals and some 1,700 km (71%) of drainage canals are wanted for repair, rehabilitation and/or improvement. In total areas, some 11,000 km of canals of either type are wanted some measures.

- in total area, some 3,900 km of dikes/roads of either type are wanted for some measure among which some 3,000 km (77%) is in GI area and only some 900 km (23%) in WC area.

- 92% of existing regulators (of ordinary type) are wanted for some measure in GI area while 74% in WC area. This indicates that most regulators need some measures but more in GI area.

- regarding pipe-regulator, 34% of the number is wanted for some measure in GI while 90% in WC area. This indicates that most pipe-regulators in WC area need some measure while one-third in GI area.

3.5.3 Estimation of Costs Wanted for Improvement

Totals of work volumes given in Tables 3-18 and 3-19 and unit costs given in Tables 3-12 and 3-13 have been employed for estimation of costs for improvement wanted by the field offices in the 25 projects. Calculation tables for each project are shown in Tables 3-21 (1)-(25) and summarized into Tables 3-22 (1)-(2) and 3-23.

Table 3-22 shows totals of each answers from each project. The results have been adjusted by supplementing incomplete/ screened-out answers. Then per-rai costs and their order have been worked out as shown in Table 3-23, which indicates much variance among projects. Table 3-24 shows comparison of the total cost for improvement in the on-going 5-year improvement plan with that wanted by the field offices. It has been found that;-

- altogether some 5,800 mill. Baht is wanted by the 25 field offices in the Delta while the on-going 5-year plan programed only some 1,200 mill. Baht/5-year (1987-1991).

- per-rai cost wanted in GI area is 570 Baht while in WC area 890 Baht in WC area; 700 Baht/rai in overall average.

- the lowest per-rai cost wanted is 150 Baht in Yangmanee Project while the highest is 3,005 Baht in Phasi Charoen Project to show much difference among projects depending much on questionees.

In order to generalize the cost for improvement, projects have been arranged in descending order by per-rai cost in each GI and WC areas, then averages of the per-rai costs of all, upper-half, middle-half and lower half projects have been worked out in which 10% of the cost is added for miscellaneous facilities improvement. (See Table 3-25).

Averages of the upper-half, middle-half and lower-half projects have been named to be intensive request, moderate request and conservative request, respectively. Per-rai average costs for improvement thus worked out are herein treated as unit costs for improvement at lateral level; neither including on-farm facilities after FTO nor main system before laterals. It resulted as follows.

Unit Cost for Improvement at Lateral Level

Case	In Gravity Irr. Area	Water Conserv. Area
Intensive Request	Baht 1,200 /rai	Baht 1,700 /rai
Moderate Request	600	800
Conservative Request	270	550

3.6 Other Studies

3.6.1 Examination of Regulator Sill Elevation along Major Water Course

In order to examine whether sill elevation of regulator can secure enough water depth to pass water through, profiles of major water courses, water levels and regulator sill elevations have been compared at Chao Phraya Dam and Rama VI Barrage and along Chainat-Pasak Canal, Suphan River and Noi River and 4R-1R of Borommathat Project as shown in Figures 3-2 till 3-7.

It has been found no substantial problems in sill elevations of major regulators. However, project offices report that some of minor regulators along them cannot secure enough water depth when water level of main water course becomes low in dry periods in dry years.

3.6.2 Examination of Cross-sections of Major Canals

In order to identify whether sedimentation or scoring of canal bed has been emerged, cross-sections of major canals in the delta have been surveyed and compared those at design/construction stage.

12 cross-sections in Chainat-Pasaka Canal, 4 and 3 in Raphiphatana Main and South Branch Canals respectively, 4 in Khlong 13 Canal, 2 in Chainat-Ayutthaya Canal and 2 in Makamtao-Uthong Canal, are examined. For each cross-section, water area at FWL has been measured and compared with that in the design drawings. Table 3-26 and Figures 3-8 (1)-(29) show list of measured sites and their cross-sections, while Table 3-27 shows the survey results. Brief of the comparison is shown below.

Canal	No. of X-sec.	Max. Scoring	Max. Sediment	Mean	Remarks
Chainat-Pasaka C.	12	+24.2%	-13.8%	+ 9.3	Scored
Raphiphatana C.*	4	+49.1	none	+30.4	(See N.B.)
Raphiphatana South Branch Canal	3	+ 3.5	-18.0	- 8.1	Sedimented
Khlong 13 Canal	4	+ 8.5	-36.6	-12.5	Sedimented
Chainat-Ayutthaya C.	2	+38.7	none	+24.7	Scored

N.B. * .. Canal excavated in 1978, but new x-sections not available.

Both scoring and sedimentation have been found to some extent in Chainat-Pasak Canal. Sedimentation in Raphiphatana South Branch Canal and Khlong 13 canal has been found, while scoring in Chainat-Ayutthaya and Makamtao-Uthong Canals has also been found.

CHAPTER 4 EVALUATION OF NEEDS FOR IMPROVEMENT

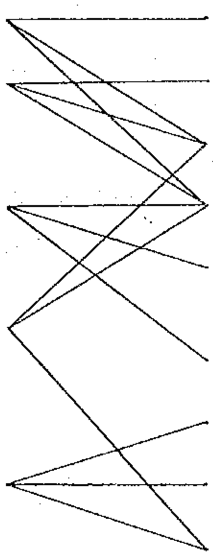
4.1 Method of Evaluation

Upon formulation and planning for improvement of functions and capacities of irrigation and drainage systems, programing of work subjects and their work order have to be made and require evaluation of some factors in each subject system. Followings are five evaluation factors and 9 indices herein proposed; the latter are independent variables to define the former as shown below.

(EVALUATION FACTOR)

1. Degree of importance
2. Degree of agricultural advancement
3. Operational easiness
4. Economic justifiability
5. Degree of functional satisfaction

(RELATION)



(INDEX)

1. Service area
2. Land consoli. rate
3. Cropping intensity
4. Crop diversifi. rate
5. Water behavior stability
6. Oldness of facili.
7. Functional degree
8. Necessity for improve.
9. Cost for improvement

N.B. Methods for quantification of the indices in Table 4-1 and their values in Table 4-2 (1)-(2).

Values of indices have been converted into those divided by the sample mean to yield 1.00 as a sample mean, and values of the evaluation factors are calculated by the following formula to yield zero-values as a sample mean.

$$(\text{Evaluation factor value}) = 1/3 \sum_{1}^{3} ((+/-)\ (\text{Index value} - 1.00))$$

where, (+) for affirmative index to the factor and,
(-) for negative index.

4.2 Evaluation of Each Index

Answers/data of index variables have been collected and compiled into a summary table as shown in Tables 4-2 (1)-(2) to indicate following features.

- Index of service area size shows much larger area in WC area as compared with those in GI area

- Index of land consolidation rate shows consolidation only in some part of project areas in the northern upper Delta; no project area in the middle and lower Delta. This implies high potentiality for further land consolidation in adjacent areas of existing ones.

- Index of cropping intensity varies with a range of 0.8 - 1.7 and shows a mean value of 1.20. A little difference in WC and GI areas and rather equitable cropping intensity among project areas are seen.

- Index of crop diversification rate shows very low values in most project areas except Phase Charoen and Rangsit Nua areas (N.B. Rangsit Tai areas as much diversified as Rangsit Nua but data not reported). This indicates crop diversification is more popular in the areas near Bangkok, while it is practiced in some project areas in the upper delta. It may be said that crop diversification in more areas all over the Delta has much potentiality.

- Index of water behavior stability varies arbitrary by project area that the value may be interpreted into difficultness in controlling water for irrigation and drainage.

- Index of oldness of project facilities shows much older projects in WC area as compared with those in GI area.

- Index of functioning of project facilities shows almost similar among all project areas. Difference among project areas may be interpreted reverse way into functional deterioration.

- Index of necessity for improvement/repair also show almost similar among all project areas. Difference among project areas may be interpreted into urgency for measures.

- Index of cost for repair/improvement shows much difference in WC and GI areas as well as among, project areas. Differences between projects may be interpreted into budgetary requirement.

4.3 Comprehensive Evaluation

Evaluation of each factor of the systems of 25 project areas separately in GI area and WC area in the delta has been made, and an addition factor for comprehensive evaluation has been assumed to imply "Goodness" of systems by calculating an average value of 4 evaluation factors except "Degree of importance". The outcomes are shown in Table 4-3. It has been found as follows.

- The "Goodness" differs much among those in the gravity irri. area while rather equitable in the water conservation area.

- Sam Chuk is the highest "Goodness" outstandingly while Bang Ban and Chong Kae are ranked low "Goodness".

- Phasi Charoen is the highest "Goodness" outstandingly, while Chaochet-Bang Yihon is ranked lowest in the water conservation area.

In right columns of the Table, an example application case for determining work implementation priority order is presented, wherein priority is assumed to be given to the project areas of (1) not satisfactory functioning, (2) not easy operation, (3) good economic justifiability and (4) not advanced farming. Therefore, a comprehensive evaluation factor of "Priority for Implementation" is defined as follows.

(Priority for Implementation) = 1/4 (Degree of functional satisfaction) x (-1) + (Operational easiness) x (-1) + (Economic justifiability) + (Degree of agri. advance) x (-1))

Consequently, priority number in descending order of the evaluated values are given in the right column of the Table.

CHAPTER 5 FORMULATION OF IMPROVEMENT PROJECT

5.1 Standards for Improvement

5.1.1 Irrigation Projects Completed in the Past

Number of and total irrigable area of large and medium scale projects constructed and O&M'ed by RID and completed in the past before 1970 have been worked out on decade basis in order to quantified their oldness and coverage in the whole country and in each region as shown in Table 5-1. the table indicates that:-

- About a half of the total irrigable area at present was developed before 1971 (49%, 1.7 mill. ha, 108 projects).
- Irrigable areas developed before 1951 amount to about 20% of the total while 10% during the next decade and 20% during the decade after next.
- Among irrigable areas developed before 1971, about 3/4 are in the Study area (1.2 mill. ha).

List of the project names of the above is presented in Tables 5-2 (1)-(5). 5.5.1.

5.1.2 Standard for Structural Improvement

Standard for structural improvement needs to be carefully formulated for each category of structure in meeting with its role such as purpose, function, dimensions/capacity, etc. to form a huge system complex. For application to the field, however, the standard shall be flexible enough to take social, economic and engineering constraints into account. It will be practical if some standard conditions to be equipped for each category of structures are firstly defined and then the standard is adjusted in flexible ways.

Examples of defined standard for some typical structures such as regulator, open canal, siphon, dike, pumping station and bridge are presented in Forms 5-1 till 5-7 for reference.

5.1.3 System Level Component

- Basic system: (Level-1) — Bhumibol Dam, Sirikit Dam, Naresuan Dam, Kiu Lom,Dam, Yom Weir, Chao Phraya Dam & Rama VI Barrage
- Main system : (level-2) — Canal system with design capacity over 10 CMS and regulators with total gate width over 10 m.
- Lateral system: (Level-3) — Canal system with design capacity below 10 CMS until FTO.
- On-farm system: (Level-4) — On-farm facilities after FTO.

5.2 Unit Costs

5.2.1 Basin Level (Level-1)

Improvement of only Chao Phraya Dam and Rama VI Barrage by installation of automatic gate control system is proposed with an estimated cost of 20 mill. Baht each on lump-sum basis.

5.2.2 Main Canal System (Level-2)

From Table 3-20 and 3-22 (1), total length of irrigation canal and cost wasted by field offices in the delta are about 4,000 km and 1,000 mill.Baht to result 0.25 mill. Baht/km for improvement at lateral level. In comparison with cost for new canal construction at the same level as 0.8 mill. Baht/km, a rate for improvement against new construction comes to about 0.3 at lateral level. Then it has again been assumed that a half of the rate (=15%) is applied to canals at main canal system (level-2).

As for regulators, from the same tables, about 440 regulators for improvement at a cost of 600 mill. Baht to result 1.4 mill. Baht/place. Against new construction cost 4.7 mill. Baht/place, it again comes to 0.3. Then assume the same as above, 15% is applied to regulators at this level.

5.2.3 *Lateral System (Level-3)*

See Section 3.5.3.

5.2.4 On-farm System (Level-4)

Considering the past records of implementation of land consolidation in the delta and other areas, unit costs per rai have been assumed from viewpoints that target level of improvement in "moderate case" be so-called extensive consolidation but the assumed cost be an half or less of the ordinary one because of expected participation/involvement by beneficiaries in financial or labor term. Unit costs at system levels and by cases are as shown in Table 5-3.

5.3 Cost Estimate

By use of unit costs and work volumes in Table 5-3 (detailed B/Q for Level-2 in Tables 5-4 (1)-(4)), estimated costs by levels and cases have been worked out as shown in Tables 5-5 till 5-8. Estimated total costs are shown as follows.

ESTIMATED COST FOR IMPROVEMENT

(Unit: Mill. Baht)

System Level		Case		
		Intensive	Moderate	Conservative
Basin System	(Level-1)	40	40	40
Main	(Level-2)	1,828	915	915
Lateral	(Level-3)	11,056	5,361	3,055
On-farm	(Level-4)	14,567	7,269	3,626
Total		27,491	13,585	7,636

Table 1-1 (1) INVENTORY OF KEY STORAGE DAMS (1/2)

Item	Units	Bhumibol Dam	Sirikit Dam	Kiu Lom Dam	Sri Nakarindra Dam	Khao Laem Dam
1. Reservoir					(Ban Chao Nen)	
River Name	-	The Ping River	The Nan River	The Mae Wang Riv.	The Quae Yai Riv.	The Quae Noi Riv.
Completion Year	-	1964	1972	1972	1980	1984
Purpose	-	P,I,FI,Fi,etc.	P,I,FI,C,Fi,etc.	P,I,FI, etc.	P,I,FI,S,Fi,etc.	P,I,FI,W,etc.
Catchment Area	Km^2	26,386	13,130	2,700	10,800	3,720
Average Annual Rainfall	mm	1,060	1,200	1,000 - 1,200	1,300	1,564(at Thong Pha Bhum 4,960(at Pilok Mine)
Average Annual Inflow	MCM	6,456 (1953-75)	5,973 (1952-75)	574	4,500	5,500
Max. High Water Level	MSL	262.2	166.0	–	182.4	160.5
Normal High Water Level	MSL	260.0	162.0	285.0	180.0	155.0
Min. High Water Level	MSL	213.0	128.0	270.0	159.0	135.0
Available Drawdown	m	47.0	34.0	15.0	21.0	20.0
Storage at Normal H.W.L.	MCM	13,462	9,510	112.0	17,745	8,860
Storage at Min. H.W.L.	MCM	3,800	2,850	6.0	10,275	3,011
Effective Storage	MCM	9,662	6,660	106.0	7,470	5,849
Water Surface Area	Km^2	318.0	259.6	16.0	419.0	388.0
2. Dam						
Type	-	Concrete arch Gravity-Type	Earthfilled Type	Concrete Gravity	Rockfill with impervious core	Rockfill with rein-forced concrete facing slab
Height	m	154.0	113.6	42.0	140.0	92.0
Crest Elevation	MSL	261.0	169.0	286.5	185.0	161.75
Crest Length	m	486.0	800.0	142.0	610.0	1,019.0
Crest Width	m	6.0	12.0	5.35	15.0	10.0
Volume	MCM	0.97	9.80	0.048	12.064	8.10
3. Spillway						
Type	-	Tunnel Type	Tunnel Type	Ogee Type	Open Channel Chute Type	Open Channel Chute Type
Crest Elevation	MSL	242.9	150.5	277.4	171.0	270.0
Gate	m	4 Radial (11.00 x 17.40)	2 Radial (11.85 x 15.00)	5 Radial (13.00 x 8.00)	3 Radial (10.00 x 9.50)	2 Radial (14.00 x 9.80)
Capacity	m^3/s	6,000.0	3,250.0	2,900.0	2,420.0	3,200.0
4. Outlet						
Type	-	Use No.8 Penstock	1 Tunnel,Circular Sec.	2-Steel Conduits	Tunnel	Concrete-lined Conduit
Gate	-	Hollowcone free discharge value		through Dam	1 high pressure slide gate	2 filxed-wheel gates
Capacity	m^3/s	200	400	25	160	270
5. Intake						
Gate	-	8 Fixed Wheel Gates	1 Fixed Wheel Gate	1 Wheel Gate	5 Roller Gates	3 Fixed-Wheel Gates
		8 - 4.2 x 6.7	6.0 x 8.5	1.25 x 2.00	3-6.00 x 8.00 2-7.00 x 9.00	3-4.00 x 8.00

Table 1-1 (2) INVENTORY OF KEY STORAGE DAMS (2/2)

Item	Unite	Bhumibol Dam	Sirikit Dam	Kiu Lom Dam	Sri Nakarindra Dam	Khao Laem Dam
6. Turbine						
Type		Francis, Vertical Shaft	Francis, Vertical Shaft	Francis Vertical Shaft	Francis, Vertical Shaft	Francis, Vertical Shaft
Speed	rpm	150	125	750	166.7 (Units 1-3) 150.0 (Unit 4)	150
Capacity	kw	70,000 (Units 1-6) 133,000 (" 7)		300	125,000 (units 1-3) 205,000 (unit 4)	102,000
7. Generator						
Type		Vertical shaft, A.C.	Umbrella type Closed circuit sel cooling	Vertical Shaft	Umbrella Type (unit 1-3) Semi-umbrella (unit4)	Vertical shaft, Umbrella Type
Speed	rpm	150	125	750	166.7 (Units1-3) 150.0 (Unit 4)	150
Rating	KVA	88,421	132,000	—	140,000 (units 1-3) 220,000 (Unit 4)	111,000
Voltage	KV	13.8	13.8	—	13.8	13.8
8. Transformer						
Type		TSD 9300 (ASEA) Flow cooled	Brosed	3PH 4W	Outdoor, 3-Phase	Outdoor, 3-Phase
Rating	KVA	58,000	50,000	450	140,000 (unit 1 - 3) 220,000 (unit 4)	115,000
Voltage	KV	13.2/230.0	13.8/230.0	11.0	13.8/230.0	13.8/230.0
9. Power Production						
Annual Energy Production	Mkwh	1,600	965	—	360 (units 1 - 3) 180 (unit 4)	777
10. Others			Saddle Dike			
			Max. height 30 m			
			Crest EL. 168 MSL			
			Crest length 5 km			

Note : P = Power Generation
I = Irrigation
Fl = Flood Control
Fi = Fishery
C = Communication
S = Salinity Control

Table 2-1 LARGE & MEDIUM SCALE PROJECTS IN THE STUDY AREA

Reg. No. Basin	No. of Project	Irrigable Area (ha)	No. of Res.Proj.	Total Gross Storage (MCM)	
(Region No.1)					
Ping	36	182,600	17	624.4	
(Region No.2)					
Wang	8	25,872	5	125.7	
Yom	10	41,200	2	20.4	
Nan	23	19,424	7	16.1	
Sub-Total	(41)	(86,496)	(14)	(162.2)	
(Region No.3)					
Ping	19	72,832	2	13,463.4	
Yom*	10	25,440	2	4.8	
Nan	26	170,496	4	9,062.3	
Upper Pasak	3	8,256	1	18.7	
Sub-Total	(58)	(277,024)	(9)	(22,549.2)	
(Region No.7)					
Sakae Krang	7	44,800	1	160.0	
Suphan River	5	170,240	0	0	The Greater
Noi River	4	197,600	0	0	Chao Phraya
Bang Ban	1	21,920	0	0	Project
West Bank	4	209,600	0	0	
Outside of G. Chao Phraya	4	21,200	3	243.1	
Sub-Total	(25)	(665,360)	(4)	(403.1)	
(Region No.8)					
Chainat-Pasak Canal	8	139,785	0	0	
Chainat-Ayutthaya Canal	1	67,520	0	0	
South Pasak	2	108,800	0	0	
Nakhon Luang	1	35,200	0	0	
Chiangrak-Khong Dan	2	132,000	0	0	
East Bank of Chainat-Ayutthaya Canal	8	4,496	7	24.8	
Upper Pasak River	9	25,560	4	17.5	
Sub-Total	(31)	(513,361)	(11)	(42.3)	
(Region No.9)					
Chiangrak-Khlong Dan	1	81,600	0	0	
Total	192	1,806,441	55	23,781.2	

N.B * Including 4 projects in Phitsanulok Project (Phase I) (total irrigable 111,153 ha)

Table 2-2 RESERVOIRS OVER 100 MCM OF STORAGE IN THE STUDY AREA

Region/Name	Gross Storage (MCM)	Construction Year
Region No.1		
Mae Ngat Dam	265	1976 - 1985
Mae Kuang Dam	263	1976 - 1988
Region No.2		
Kiu Lom Dam	112	1964 - 1981
Region No.3		
Bhumipol Dam	13,462	1958 - 1964
Sirikit Dam	9,000	1963 - 1972
Region No.7		
Thap Salao Dam	160	1984 - 1987
Kra-Sieo Dam	240	1966 - 1982
Region No.7 and 9	none	
Total 6 Project	23,502 MCM	

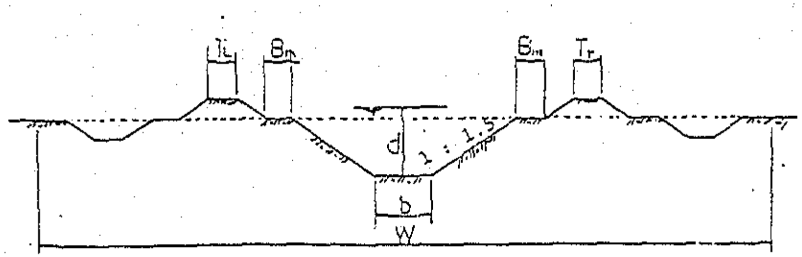
Table 3-1 SUMMARY OF CANAL INVENTORY (Unit . Km)

Project Name	Irrigation Canal < 1 cms	1-10 cms	10-30cms	30-100	>100cms	Total	Drainage Canal	Maj.Navi.Canal	Other Canals	Total
Phonlathep	61.3	44.0	0.4	21.1	0	126.8	84	0	0	210.8
Thabote	94.9	52.1	29.6	3.7	0	180.3	89	0	0	269.3
Samchuk	65.7	141.7	16.4	0	0	223.8	165	0	0	388.8
Don Chedi	78.3	28.3	29.1	0	0	135.7	126	0	0	261.7
Pho Phraya	81.5	114.5	1.7	10.3	0	208.0	123	0	0	331.0
Borommathat	121.5	158.4	27.8	0	0	307.7	230	0	0	537.7
Chanasutr	178.5	194.1	33.9	6.0	0	412.5	333	0	0	745.5
Yangmanee	78.0	102.0	18.0	0	0	198.0	68	0	0	266.0
Phak Hai	17.6	10.1	0	15.1	0	42.8	100	0	0	142.8
Bang Ban	108.0	14.8	0	0	0	122.8	77	0	0	199.8
Chaoched - B.Y.	0	75	0	0	0	75.0	0	83	831	989.0
Pharaya Ban Lu	0	109	0	0	0	109.0	0	30	695	834.0
Phra Phimon	0	30	0	0	0	30.0	0	47	345	422.0
Phasi Charoen	0	13	0	0	0	13.0	0	62	1,019	1,094.0
Sub-total	885.3	1,087.0	156.9	56.2	0	2,185.4	1,395	222	2,890	6,692.4
Manorom	113.0	63.9	0	0	45.6	222.5	136	0	0	358.5
Chong Kae	106.6	66.2	0	0	39.7	212.5	164	0	0	376.5
Koke Kathiem	92.6	73.2	3.2	0	36.7	205.7	42	0	0	247.7
Roeng Rang	51.7	75.2	0	0	12.9	139.8	243	0	0	382.8
Maharaj	173.5	102.7	35.0	53.0	0	364.2	166	0	0	530.2
Pasak Tai	77.1	58.7	0	17.6	32.0	185.4	114	0	0	299.4
Nakhon Luang	107.0	61.6	32.8	0	0	201.4	127	0	0	328.4
Rangsit Nua	0	195	35	27	0	257.0	216	76	0	549.0
Rangsit Tai	0	0	0	25	0	25.0	0	222	335	582.0
Khlong Dan	0	0	0	0	0	0.	0	137	360	497.0
Pra Ong Chaiya.	0	0	0	0	0	0.	0	123	329	452.0
Sub-total	721.5	696.5	106.0	122.6	166.9	1,813.5	1,208	558	1,024	4,603.5
Total	1,606.8	1,783.5	262.9	178.8	166.9	3,998.9	2,603	780	3,914	11,295.9

Table 3-2 (1) IRRIGATION AND DRAINAGE CANALS IN THE DELTA (1/3)

Canal Name	Location	Hydraulic Properties						Dimension						E.L.			
		A	V	Q	R	N	S	b	d	Bm	TL	Tr	W	Bottom	F.S.L.	Dike	G.L.
Klong Makamthao-Uthong	0+000	59.375	0.584	34.675	2.046	.0225	.000006	20.00	2.50	–	5.00	10.00	100.00	13.600	16.100	16.940	17.000
L = 104.550 km.	56+100 -62+844	34.000	0.490	16.660	1.603	.0225	.000006	14.00	2.00	–	0.70	1.00	–	10.300	12.300	13.300	
	96+600 -104.55	5.500	0.294	1.617	0.723	.0225	.0000714	4.00	1.00	–	0.70	1.00	–	8.268	9.268	10.268	
Klong Chainat-Ayutthaya	0+474 -22+500	69.840	0.799	55.802	2.588	.0225	.000083	14.00	3.60	–	5.00	10.00	100.00	11.880	15.480	16.480	15.30
L = 120.394 km.	52+000 -52+200	48.240	0.736	35.505	2.299	.0225	.000083	8.00	3.60	–	4.00	10.00	–	7.010	10.610	11.610	9.320
	120+000 -120+320	1.540	0.560	0.323	0.407	.0225	.000083	1.00	0.76	–	1.00	–	–	2.986	3.746	3.980	
Klong Chainat-Pasak	0.500	248.000	0.843	209.064	3.450	.0225	.00006	54.00	4.00	–	5.00	10.00	240.00	11.842	15.842	L19.10 R18.10	17.40
L = 132.879 km.	64.795	216.000	0.832	179.712	3.381	.0225	.00006	46.00	4.00	–	5.00	10.00	200.00	8.052	12.052	L15.05 R14.05	11.00
	129+700 -132+879	148.780	0.879	130.778	3.289	.0225	.0000714	26.00	4.30	–	5.00	10.00	–	3.377	7.677	11.10	8.50
Klong Raphiphatana	0+500 1/	129.199	0.774	100.00	2.543	.0225	.000074	40.00	3.00	–	6.60	–	140.00	4.16	7.16	16.85	9.63
L = 33.000 km.																	
Klong Raphiphatana South Branch	0+500	136.000	0.592	80.512	3.206	.0225	.0000286	28.00	4.00	–	10.00	–	90.00	0.120	4.120	5.00	
L = 62.576 km.																	
Klong 13	0+300	84.240	0.519	43.720	2.719	.0225	.00004	18.00	3.60	3.00	10.00	–	–	(-) 0.962	2.638	3.638	
L = 25.520 km.	25+720	84.240	0.519	43.720	2.719	.0225	.00004	18.00	3.60	3.00	10.00	–	–	(-) 2.259	1.341	2.341	

Note : 1/ This canal was excavated in 1978. But there is not this drawing



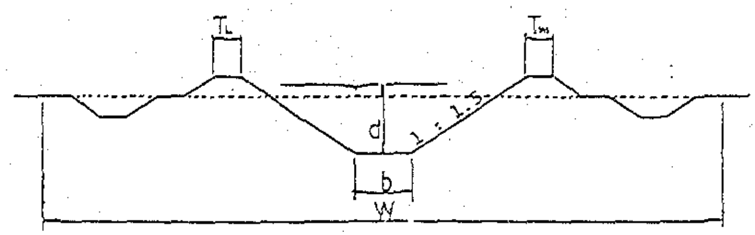
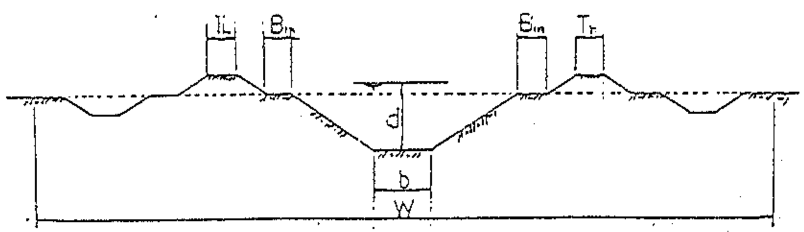


Table 3-2 (2) IRRIGATION AND DRAINAGE CANALS IN THE DELTA (2/3)

Canal Name	Location	Hydraulic Properties						Dimension						E.L.			
		A	V	Q	R	N	S.	b	d	Bm	TL	Tr	W	Bottom	F.S.L.	Dike	G.L.
Chainat Pasak Main Drain 1	28+349	37.740	0.712	26.871	2.067	0.0225	.000091	6.00	3.40	7.00	-	3.50	61.00	8.720	12.120		15.41
Dwg. 41791 L = 28.349 km.																	
Chainat Pasak Main Drain 2	20+100 27+810	37.440	0.688	25.759	2.082	0.0225	.000830	5.00	3.60	6.00R 3.00L	-	-		4.530	8.130		11.80R 12.70L
Dwg. 41613 L = 27.810 km.																	
Chainat Pasak Main Drain 3	52+400 65.900	195.840	0.833	163.055	3.160	0.0225	.000075	49.00	3.60	7.00	-	-	68.00	1.838	5.338		4.8R 4.2L
L = 65.900 km.																	
Maharaj Main Drain 1	19+284 22+923	32.835	0.630	20.686	1.943	0.0225	.000077	5.00	3.30	7.00	-	-	55.00	(-) 0.340	2.960		
Dwg. 44806 L = 22.923 km.																	
Maharaj Main Drain 2	53.340	48.240	0.736	35.505	2.299	0.0225	.000083	8.00	3.60	7.00	-	-	80.00	(-) 1.080	2.514		
Dwg. 72840 L = 53.340 km.																	
Roeng Rang Main Drain	54.800	41.040	0.767	31.478	2.162	0.0225	.000100	6.00	3.60	7.00	-	-	80.00	(-) 3.680	(-) 0.080		3.30R 2.90L
Dwg. 57855 L = 54.800 km.																	
Pasak Main Drain	35.200	60.375	0.455	27.450	2.452	0.0225	.000025	12.00	3.50	7.00	-	-	80.00	(-) 2.414	1.086		2.21
Dwg. 47725 L = 35.200 km.																	
Noi River Main Drain 1	11+100 16+900	31.185	0.702	21.892	1.902	0.0225	.000100	4.50	3.30	7.00	7.00	7.00	70.00	6.927	10.227		12.10R 13.00L
Dwg. 42513 L = 16.960 km.																	
Noi River Main Drain 2	50.420	44.640	0.688	30.712	2.234	0.0225	.000075	7.00	3.60	7.00	7.00	7.00	64.00	2.330	5.930		7.00
Dwg. 43390 L = 50.420 km.																	
Noi River Main Drain 3	41.746	46.375	0.725	33.622	2.249	0.0225	.000083	8.00	3.50	7.00	3.00	6.00	64.00	0.670	4.170		6.90
Dwg. 40514 L = 41.746 km.																	
Noi River Main Drain 4	16.524	20.160	0.773	15.684	1.546	0.0225	.000167	1.50	3.20	6.00R 3.00L	-	-	53.00	0.130	3.330		0.10R 0.40L
Dwg. 46321 L = 16.524 km.																	
Noi River Main Drain 5	23.000	19.035	0.544	10.351	1.495	0.0225	.000083	3.00	2.70	6.00R 3.00L	-	-	51.00	1.091	3.791		
Dwg. 48607 L = 23.000 km.																	



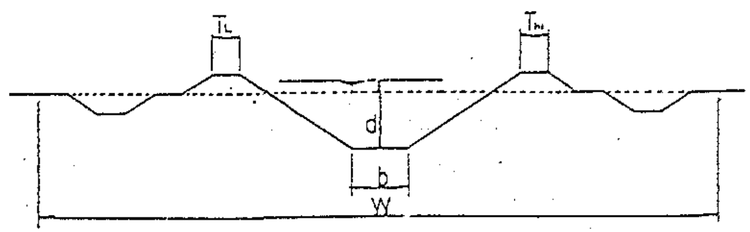
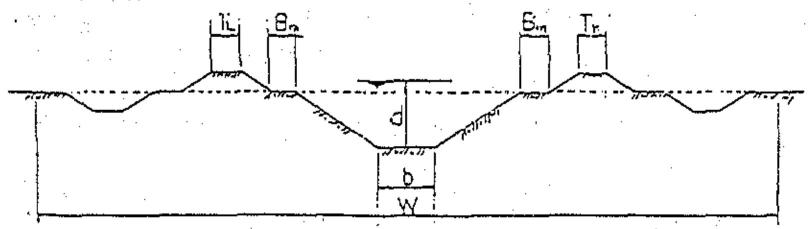


Table 3-2 (3) IRRIGATION AND DRAINAGE CANALS IN THE DELTA (3/3)

Canal Name	Location	Hydraulic Properties						Dimension						E.L.			
		A	V	Q	R	N	S	b	d	Bm	TL	Tr	W	Bottom	F.S.L.	Dike	G.L.
Noi River Main Drain 6	9+870	13.685	0.485	6.610	1.268	0.0225	.000083	2.50	2.30	6.00R 3.00L	-	-	45.00	0.781	3.081		3.50
Dwg. 51403 L = 9.870 km.																	
Noi River Main Drain 7	12+820	18.000	0.556	10.008	1.362	0.0225	.00010	6.00	2.00	3.00L 6.00R	-	-	55.00	(-) 0.482	1.518		3.20
Dwg. 51333 L = 12.820 km.																	
Bang Ban Main Drain 1	12+136	16.335	0.491	8.024	1.391	0.0225	.000075	2.00	2.50	3.00L 6.00R	-	-	-	(-) 1.110	1.390		-
Dwg. 55819 L = 12.136 km.																	
Bang Ban Main Drain 2	7+892	10.815	0.421	4.559	1.130	0.0225	.000075	2.00	2.10	3.00L 6.00R	-	-	-	(-) 0.692	1.408		3.802R 4.102L
Dwg. 55070 L = 7.892 km.																	
Bang Ban Main Drain 3	14+375	19.215	0.497	9.550	1.416	0.0225	.000075	6.00	2.10	3.00L 6.00R	-	-	-	(-) 1.078	1.022		1.80
Dwg. 55192 L = 14.375 km.																	
Bang Ban Main Drain 4	12+700	24.375	0.629	15.332	1.623	0.0225	.000100	6.00	2.50	3.00L 6.00R	-	-	-	(-) 2.020	0.480		0.60L 1.10R
Dwg. 57463 L = 12.700 km.																	
Suphan Main Drain 1	26+268	46.375	0.788	36.543	2.249	0.0225	.000100	8.00	3.50	7.00	-	-	-	6.140	9.640		
Dwg. 42185 L = 26.268 km.																	
Suphan Main Drain 2	65+584	67.375	0.626	42.200	2.531	0.0225	.000500	14.00	3.50	7.00	7.00	7.00	98.00	1.444	4.944		7.80R 8.20L
Dwg. 44513 L = 65.584 km.																	
Suphan Main Drain 3	61+940	62.640	0.675	42.282	2.508	0.0225	.000060	12.00	3.60	7.00	-	-	74.00	(-) 1.696	1.904		2.30R 2.20L
L = 61.940 km.																	
Suphan Main Drain 4	24+255	138.935	0.541	75.164	3.064	0.0225	.000025	32.00	3.70	7.00	-	-	90.00	(-) 2.306	1.394		
Dwg. 56428 L = 24.255 km.																	
Samchook Main Drain 1	88+880	69.840	0.762	53.128	2.589	0.0225	.000075	14.00	3.60	7.00	-	-	86.00	(-) 3.328	0.272		1.00R 1.70L
Dwg. 50233 L = 88.880 km.																	
Samchook Main Drain 2	39+430	39.375	0.756	29.767	2.115	0.0225	.00010	6.00	3.50	7.00	-	-	70.00	(-) 2.393	1.107		1.90L 2.00R
Dwg. 50818 L = 39.430km.																	
Maharaj Main Drain 3	25+480	28.500	0.621	17.698	1.802	0.0225	.000083	5.00	3.00	7.00	-	-	70.00	(-) 1.761	1.239		1.32
Dwg. 49068 L = 25.480 km.																	



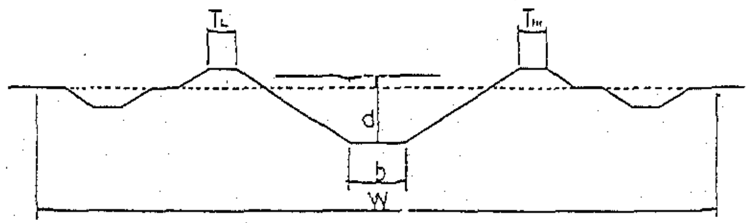


Table 3-3 (1) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (1/11)

(Project Name) Canal Name		Design Cap. (cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
			km	km	km	km	km	km
(Phonlathep)								
M-U Canal		35.0	-	-	-	21.1	-	21.1
	1L	0.3	2.4					2.4
Phonlathep	1R	1.5	13.1	6.7	-	-	-	19.8
	1L	0.6	9.3	-	-	-		9.3
	2L	3.8	3.1	18.5	-	-	-	21.6
	1L-2L	0.5	3.2	-	-	-	-	3.2
	2L-21	0.3	2.4	-	-	-	-	2.4
Tung Rahan		11.0		9.8	0.4	-	-	10.2
	1R	0.7	8.6	-	-	-	-	8.6
	1L	1.8	3.0	4.0	-	-	-	7.0
	1R-1L	0.6	4.0	-	-	-	-	4.0
	2L	0.8	4.7	-	-	-	-	4.7
	3L	2.5	3.5	5.0	-	-	-	8.5
	1L-3L	0.7	4.0	-	-	-	-	4.0
Total			61.3	44.0	0.4	21.1	-	126.8
(Thabote)								
M-U Canal		32.9	-	-	29.6	3.7	-	33.3
	2L	0.2	3.3	-	-	-	-	3.3
	2L-1	0.2	2.5	-	-	-	-	2.5
	3L	4.3	6.6	19.0	-	-	-	25.6
	1R-3L	0.2	3.7	-	-	-	-	3.7
	2R-3L	0.2	1.7	-	-	-	-	1.7
	4L	1.0	6.7	0.3	-	-	-	7.0
	5L	0.7	3.5	-	-	-	-	3.5
	6L	0.7	5.6	-	-	-	-	5.6
	7L	1.3	5.5	1.8	-	-	-	7.3
	8L	0.6	5.3	-	-	-	-	5.3
	1R	0.8	8.8	-	-	-	-	8.8
	1L	6.8	7.3	31.0				38.3
	1L-1L	0.7	4.4	-	-	-	-	4.4
	2L-1L	0.2	1.2	-	-	-	-	1.2
	3L-1L	0.3	3.1	-	-	-	-	3.1
	4L-1L	0.3	2.6	-	-	-	-	2.6
	5L-1L	0.9	5.4	-	-	-	-	5.4
	6L-1L	0.3	3.0	-	-	-	-	3.0
	7L-1L	0.4	3.9	-	-	-	-	3.9
	1R-7L-1L	0.4	2.9	-	-	-	-	2.9
	8L-1L	0.4	4.2	-	-	-	-	4.2
	1R-1L	0.2	3.7	-	-	-	-	3.7
Total			94.9	52.1	29.6	3.7	-	180.3

Table 3-3 (2) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (2/11)

(Project Name) Canal Name	Design Cap. (cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
(Samchuk)		km	km	km	km	km	km
1L	18.8	2.6	19.2	3.2	-	-	25.0
1R-1L	1.5	2.5	5.0	-	-	-	7.5
2R-1L	7.3	2.4	29.2	-	-	-	31.6
1L-2R-1L	1.0	5.6	-	-	-	-	5.6
2L-2R-1L	0.8	7.5	-	-	-	-	7.5
3R-1L	0.7	6.2	-	-	-	-	6.2
4R-1L	1.9	5.0	3.5	-	-	-	8.5
1R	13.4	2.4	19.8	13.2	-	-	35.4
1R-1R	0.8	7.0	-	-	-	-	7.0
1L-1R	2.9	6.4	7.6	-	-	-	14.0
2L-1R	1.6	4.7	4.3	-	-	-	9.0
3L-1R	1.6	5.6	6.6	-	-	-	12.2
2R	9.5	3.3	46.0	-	-	-	49.3
1L-2R	1.1	4.5	0.5	-	-	-	5.0
Total		65.7	141.7	16.4	-	-	223.8
(Pho Phraya)							
1R	34.7		2.8	-	10.3	-	31.1
1L-1R	0.7	5.1	-	-	-	-	5.1
2L-1R	9.5	9.5	21.0	-	-	-	30.5
1R-2L-1R	3.4	4.0	6.5	-	-	-	10.5
1R-1R-2L-1R	0.7	6.0	-	-	-	-	6.0
1R-1R	11.5	3.4	14.1	0.7	-	-	18.2
1L-1R-1R	4.3	4.7	14.0	-	-	-	18.7
1L-1R-1R (1)	0.7	6.5	-	-	-	-	6.5
3L-1R	10.0	4.4	25.0	-	-	-	29.4
1L-3L-1R	2.0	3.3	6.0	-	-	-	9.3
1R-3L-1R	0.9	7.3	-	-	-	-	7.3
1L	15.4	5.1	13.0	1.0	-	-	19.1
1L-1L	6.8	2.8	10.0	-	-	-	12.8
2L-1L	0.8	4.5	-	-	-	-	4.5
1R-1L	1.0	7.3	-	-	-	-	7.3
1R-1L-1L	1.3	7.7	2.1	-	-	-	9.8
Total		81.5	114.5	1.7	10.3	-	208.0
(Don Chedi)							
M-U Canal	19.6	6.2	14.8	29.1	-	-	50.1
9L	0.5	4.2	-	-	-	-	4.2
10L	0.3	2.6	-	-	-	-	2.6
11L	0.5	4.1	-	-	-	-	4.1
12L	0.5	4.4	-	-	-	-	4.4
13L	0.4	3.6	-	-	-	-	3.6
14L	0.6	3.8	-	-	-	-	3.8
15L	0.5	4.0	-	-	-	-	4.0
16L	0.7	3.6	-	-	-	-	3.6
17L	0.7	4.2	-	-	-	-	4.2

Table 3-3 (3) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (3/11)

(Project Name) Canal Name	Design Cap. (cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
		km	km	km	km	km	km
18L	1.7	5.5	0.5	-	-	-	6.0
1L-18L	0.6	3.0	-	-	-	-	3.0
1R-18L	0.3	3.4	-	-	-	-	3.4
19L	1.3	5.2	1.1	-	-	-	6.3
20L	1.2	3.0	3.8	-	-	-	6.8
21L	0.5	4.9	-	-	-	-	4.9
22L	0.4	4.8	-	-	-	-	4.8
23L	2.7	2.8	8.1	-	-	-	10.9
24L	0.7	4.9	-	-	-	-	4.9
Total		78.3	28.3	29.1	-	-	136.7
(Borommathat)							
1L	14.0	5.2	50.8	6.7	-	-	62.7
1R-1L	1.2	5.4	2.0	-	-	-	7.4
2R-1L	0.8	2.8	-	-	-	-	2.8
3R-1L	0.7	5.9	-	-	-	-	5.9
4R-1L	0.6	4.6	-	-	-	-	4.6
2L	12.0	8.8	16.0	3.6	-	-	28.4
1L-2L	4.6	3.5	15.5	-	-	-	19.0
1L-1L-2L	0.4	2.4	-	-	-	-	2.4
1R-1L-2L	0.7	4.5	-	-	-	-	4.5
2L-2L	0.4	4.1	-	-	-	-	4.1
3L-2L	0.8	5.4	-	-	-	-	5.4
4L-2L	0.8	6.7	-	-	-	-	6.7
1R	27.0	2.7	20.0	17.5	-	-	40.2
1R-1R	0.5	5.8	-	-	-	-	5.8
2R-1R	0.5	5.3	-	-	-	-	5.3
3R-1R	3.5	6.9	16.8	-	-	-	23.7
4R-1R	2.0	1.7	7.0	-	-	-	8.7
1L-4R-1R	0.4	2.7	-	-	-	-	2.7
5R-1R	0.5	3.8	-	-	-	-	3.8
6R-1R	3.1	3.2	12.5	-	-	-	15.7
7R-1R	0.5	3.8	-	-	-	-	3.8
8R-1R	1.2	4.1	2.5	-	-	-	6.6
1L-1R	3.3	7.7	12.8	-	-	-	20.5
2L-1R	0.5	4.7	-	-	-	-	4.7
3L-1R	0.5	4.7	-	-	-	-	4.7
4L-1R	1.1	5.1	2.5	-	-	-	7.6
Total		121.5	158.4	27.8	-	-	307.7
(Chanasutr)							
1L	5.1	3.8	4.0	-	-	-	7.8
1L-1L	1.3	3.0	3.1	-	-	-	6.1
1R-1L	2.5	8.3	9.0	-	-	-	17.3
1L-1R-1L	0.3	5.8	-	-	-	-	5.8
2L	1.6	-	15.0	-	-	-	15.0

Table 3-3 (4) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (4/11)

(Project Name) Canal Name	Design Cap.(cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
		km	km	km	km		km
1R	55.0	3.2	36.5	33.9	6.0	-	79.6
1L-1R	7.3	7.5	22.2	-	-	-	29.7
1R-1L-1R	0.4	5.0	-	-	-	-	5.0
2R-1L-1R	2.6	6.9	10.0	-	-	-	16.9
1R-2R-1L-1R	0.4	1.8	-	-	-	-	1.8
2L-1R	2.1	2.6	10.0	-	-	-	12.6
1R-2L-1R	0.2	4.1	-	-	-	-	4.1
3L-1R	6.7	2.0	22.5	-	-	-	24.5
1L-3L-1R	0.3	4.0	-	-	-	-	4.0
2L-3L-1R	0.2	3.2	-	-	-	-	3.2
1R-3L-1R	1.6	2.9	2.7	-	-	-	5.6
1R-1R	2.1	6.6	7.0	-	-	-	13.6
1R-1R-1R	0.5	5.2	-	-	-	-	5.2
2R-1R	2.2	3.1	5.6	-	-	-	8.7
4L-1R	1.8	7.0	5.2	-	-	-	12.2
5L-1R	7.4	4.5	12.0	-	-	-	16.5
1L-5L-1R	0.4	1.5	-	-	-	-	1.5
2L-5L-1R	0.5	4.1	-	-	-	-	4.1
3L-5L-1R	1.5	4.8	-	-	-	-	4.8
1L-3L-5L-1R	0.8	3.7	-	-	-	-	3.7
1R-5L-1R	0.4	3.7	-	-	-	-	3.7
2R-5L-1R	0.5	5.1	-	-	-	-	5.1
3R-5L-1R	0.8	5.7	-	-	-	-	5.7
6L-1R	0.9	7.8	-	-	-	-	7.8
7L-1R	1.6	4.3	-	-	-	-	4.3
1R-7L-1R	1.0	6.4	-	-	-	-	6.4
8L-1R	0.3	4.4	-	-	-	-	4.4
9L-1R	0.7	4.2	-	-	-	-	4.2
3R-1R	3.2	-	14.8	-	-	-	14.8
1R-3R-1R	1.1	3.4	-	-	-	-	3.4
4R-1R	2.2	5.9	9.0	-	-	-	14.9
5R-1R	0.3	3.7	-	-	-	-	3.7
6R-1R	1.8	6.2	2.5	-	-	-	8.7
1R (Left B)	1.5	3.4	-	-	-	-	3.4
1R-1(Right B)	1.9	2.5	3.0	-	-	-	5.5
1R-1R-1		1.5	-	-	-	-	1.5
1R-2 (Left)	1.3	5.8	-	-	-	-	5.8
Total		178.5	194.1	33.9	6.0	-	412.5
(Yangmanee)							
1L	2.3	9.7	1.4	-	-	-	11.1
1L-1L	1.1	8.0	-	-	-	-	8.0
2L	0.6	4.2	-	-	-	-	4.2
3L	18.5	12.4	8.6	18.0	-	-	39.0
1L-3L	2.3	6.6	13.6	-	-	-	20.2
2L-3L	0.2	2.2	-	-	-	-	2.2
3L-3L	4.7	-	12.7	-	-	-	12.7

Table 3-3 (5) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (5/11)

(Project Name) Canal Name	Design Cap.(cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
		km	km	km	km	km	km
1R-3L-3L	0.6	5.2	-	-	-	-	5.2
1R-3L	1.5	4.9	7.5	-	-	-	12.4
2R-3L	3.8	7.7	13.3	-	-	-	21.0
3R-3L	0.2	1.6	-	-	-	-	1.6
1R	9.5	7.7	35.0	-	-	-	42.7
1R-1R	0.5	2.6	-	-	-	-	2.6
2R-1R	3.2	5.2	10.0	-	-	-	15.2
Total		78.0	102.0	18.0	-	-	198.0
(Phak Hai)							
1L	2.7	7.8	6.6	-	-	-	14.4
2L	0.8	4.2	-	-	-	-	4.2
3L	2.3	5.6	3.5	-	-	-	9.1
K. Phak Hai-Chaochet	68.2	-	-	-	15.1	-	15.1
Total		17.6	10.1	-	15.1	-	42.8
(Bang Ban)							
1R No.1	0.5	8.4	-	-	-	-	8.4
1L No.1	1.4	8.1	3.0	-	-	-	11.1
1R No.2	0.1	1.4	-	-	-	-	1.4
1L No.2	0.6	3.4	-	-	-	-	3.4
No.3	0.8	4.2	-	-	-	-	4.2
No.4	0.9	5.4	-	-	-	-	5.4
1R No.5	0.8	7.3	-	-	-	-	7.3
1L No.5	0.4	5.4	-	-	-	-	5.4
1R No.6	0.8	6.1	-	-	-	-	6.1
1L No.6	0.5	5.4	-	-	-	-	5.4
No.7	2.3	4.0	5.3	-	-	-	9.3
1R No.7	0.6	1.9	-	-	-	-	1.9
2R No.7	0.5	3.5	-	-	-	-	3.5
No.8	1.6	5.8	3.6	-	-	-	9.4
1R No.8	1.0	8.1	-	-	-	-	8.1
1R No.9	0.7	4.7	-	-	-	-	4.7
2R No.9	0.5	4.7	-	-	-	-	4.7
1L No.9	1.0	3.2	-	-	-	-	3.2
No.10	0.5	4.4	-	-	-	-	4.4
1R No.10	0.4	4.5	-	-	-	-	4.5
No.11	0.8	4.9	-	-	-	-	4.9
No.12	1.9	3.1	2.8	-	-	-	5.9
Total		108.0	14.8	-	-	-	122.8

Table 3-3 (6) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (6/11)

(Project Name) Canal Name	Irrig. km	Drainage km	Maj.Navi. km	Other km
(Chaochet-B.Y.)				
K. Yipun Nua	18	-	-	-
K. Bang Sai-Lad Bua Luang	20	-	-	-
K. San	18	-	-	-
Chaochet-B.Y. No.4	19	-	-	-
K. Khanomchin	-	-	20	-
K. Chaochet-B.Y. No.1	-	-	23	-
K. Phraya Banlu	-	-	40	-
Total	75	-	83	831
(Phraya Banlu)				
K. Yipun Tai	19	-	-	-
K. Kunsri	20	-	-	-
K. Lak Khon	24	-	-	-
K. Khut Mai	24	-	-	-
K. Phra Udom	22	-	-	-
K. Phra Phimon	-	-	30	-
Total	109	-	30	695
(Phra Phimon)				
K. Thawi Wattana	22	-	-	-
K. Nara Phirom	8	-	-	-
K. Jeg	-	-	11	-
K. Bang Yai	-	-	18	-
K. Maha Sawat	-	-	18	-
Total	30	-	47	345
(Phasi Charoen)				
K. Thawi Wattana	13	-	-	-
K. Phasi Charoen	-	-	25	-
K. Siwa Mahasawat	-	-	13	-
K. Nam Juad	-	-	11	-
K. Phrayachamonti	-	-	13	-
Total	13	-	62	1,019

Table 3-3 (7) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (7/11)

(Project Name) Canal Name	Design Cap. (cms)	0-1	Flow Capacity in cms 1-10	10-30	30-100	100-	Total
(Manorom)		km	km	km	km	km	km
K. Ban Lek	3.3	2.7	7.9	-	-	-	10.6
1R	0.7	6.4	-	-	-	-	6.4
1L	0.8	4.9	-	-	-	-	4.9
K. Chainat-Pasak	210.0					45.6	45.6
1R	1.2	4.8	-	-	-	-	4.8
1L-1R	0.3	2.6	-	-	-	-	2.6
2L-1R	0.4	3.6	-	-	-	-	3.6
2R	2.1	4.5	2.7	-	-	-	7.2
1L-2R	0.5	3.7	-	-	-	-	3.7
3R-1	0.4	2.4	-	-	-	-	2.4
3R-2	0.6	2.5	-	-	-	-	2.5
3R	2.3	5.4	4.0	-	-	-	9.4
4R	1.7	3.7	3.4	-	-	-	7.1
5R	2.4	6.2	3.4	-	-	-	9.6
6R	3.2	5.3	8.4	-	-	-	13.7
7R	1.7	3.3	3.2	-	-	-	6.5
8R	1.8	5.6	4.6	-	-	-	10.2
K. Thamanun	2.2	5.6	9.8	-	-	-	15.4
K. Ban Kram	0.9	5.6	-	-	-	-	5.6
Kao Kaeo Main	2.9	10.7	13.5	-	-	-	24.2
1R	1.3	5.8	3.	-	-	-	8.8
2R	1.0	7.8	-	-	-	-	7.8
1L	1.0	10.0	-	-	-	-	10.0
Total		113.0	63.9	-	-	45.6	222.5
(Chong Kae)							
K. Chainat-Pasak	180					39.7	39.7
9R	12.4	5.3	12.9	-	-	-	18.2
1R-9R	1.4	5.6	2.4	-	-	-	8.0
2R-9R	1.3	2.0	3.0	-	-	-	5.0
3R-9R	1.7	3.9	2.8	-	-	-	6.7
1L-9R	0.3	5.6	-	-	-	-	5.6
2L-9R	2.6	5.6	8.0	-	-	-	13.6
10R	0.5	3.7	-	-	-	-	3.7
11R	1.0	3.0	-	-	-	-	3.0
12R	1.0	4.4	-	-	-	-	4.4
13R	1.2	3.7	1.0	-	-	-	4.7
14R	1.4	5.1	4.3	-	-	-	9.4
15R	0.7	3.7	-	-	-	-	3.7
16R	8.9	2.9	13.0	-	-	-	15.9
1R-16R	0.9	9.1	-	-	-	-	9.1
2R-16R	1.1	3.2	4.8	-	-	-	8.0
3R-16R	0.5	5.1	-	-	-	-	5.1
1L-16R	2.3	9.2	4.0	-	-	-	13.2
17R	2.0	5.2	4.0	-	-	-	9.2
1L	0.2	3.4	-	-	-	-	3.4

Table 3-3 (8) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (8/11)

(Project Name) Canal Name	Design Cap. (cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
		km	km	km	km	km	km
2L	0.8	7.0	-	-	-	-	7.0
3L	0.5	5.0	-	-	-	-	5.0
3L-9R	0.9	5.0	6.0	-	-	-	11.0
Total		106.6	66.2	-	-	39.7	212.5
(Koke Kathiem)							
K. Chainat-Pasak	158.0					36.7	36.7
18R	1.7	4.9	2.5	-	-	-	7.4
19R	3.3	3.2	3.2	-	-	-	6.4
1L-19R	1.1	6.0	-	-	-	-	6.0
1L-1L-19R	0.3	2.4	-	-	-	-	2.4
20R	0.4	1.2	-	-	-	-	1.2
21R	12.8	8.2	26.8	3.2	-	-	38.2
1R-21R	4.7	4.6	16.0	-	-	-	20.6
1R-1R-21R	0.7	5.8	-	-	-	-	5.8
2R-1R-21R	1.8	7.2	7.0	-	-	-	14.2
1L-21R	0.6	3.4	-	-	-	-	3.4
2L-21R	0.8	6.6	-	-	-	-	6.6
3L-21R	2.6	4.0	10.0	-	-	-	14.0
1R-3L-21R	0.3	5.0	-	-	-	-	5.0
2R-3L-21R	0.1	3.5	-	-	-	-	3.5
4L-21R	0.6	5.8	-	-	-	-	5.8
22R	5.2	4.8	7.7	-	-	-	12.5
1R-22R	1.3	3.3	-	-	-	-	3.3
1L-1R-22R	0.4	2.5	-	-	-	-	2.5
2R-22R	0.6	3.7	-	-	-	-	3.7
3R-22R	0.9	2.9	-	-	-	-	2.9
4R-22R	0.9	3.6	-	-	-	-	3.6
Total		92.6	73.2	3.2	-	36.7	205.7
(Roeng Rang)							
K. Chainat-Pasak	140.0					12.9	12.9
23R	6.6	1.0	16.8	-	-	-	17.8
1R-23R	0.7	5.0	-	-	-	-	5.0
2R-23R	1.4	3.6	3.2	-	-	-	6.8
3R-23R	0.8	5.0	-	-	-	-	5.0
4R-23R	0.8	3.7	-	-	-	-	3.7
24R	13.2	5.5	39.0	-	-	-	44.5
1R-24R	2.4	4.4	4.8	-	-	-	9.2
2R-24R	1.4	3.1	4.3	-	-	-	7.4
3R-24R	0.6	2.0	-	-	-	-	2.0
4R-24R	0.7	5.2	-	-	-	-	5.2
5R-24R	0.3	2.6	-	-	-	-	2.6
1R-24R	0.8	5.6	-	-	-	-	5.6
25R	1.3	5.0	7.1	-	-	-	12.1
Total		51.7	75.2	-	-	12.9	139.8

Table 3-3 (9) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (9/11)

(Project Name) Canal Name	Design Cap.(cms)	Flow Capacity in cms 0-1	1-10	10-30	30-100	100-	Total
(Maharaj)		km	km	km	km	km	km
K. Chainat-Ayutthaya	55.0	16.4	16.0	35.0	53.0	-	120.4
1L	0.5	3.2	-	-	-	-	3.2
2L	2.0	5.1	4.0	-	-	-	9.1
3L	6.0	9.6	14.7	-	-	-	24.3
4L	1.1	5.0	3.7	-	-	-	8.7
5L	0.4	2.6	-	-	-	-	2.6
6L	1.0	3.8	-	-	-	-	3.8
7L	3.8	13.5	6.0	-	-	-	19.5
1L-7L	2.1	6.9	4.2	-	-	-	11.1
8L	10.5	12.4	21.6	-	-	-	34.0
1L-8L	2.4	6.1	4.6	-	-	-	10.7
1L-1L-8L	0.4	2.2	-	-	-	-	2.2
2L-8L	3.5	16.7	11.1	-	-	-	27.8
1R-8L	1.0	9.8	-	-	-	-	9.8
9L	0.7	4.7	-	-	-	-	4.7
10L	0.5	4.8	-	-	-	-	4.8
11L	0.7	2.0	-	-	-	-	2.0
12L	1.7	5.8	-	-	-	-	5.8
1L-12L	0.7	1.4	-	-	-	-	1.4
13L	0.9	11.8	-	-	-	-	11.8
1R	4.4	10.2	14.8	-	-	-	25.0
1L-1R	0.8	5.3	-	-	-	-	5.3
2R	0.5	7.3	-	-	-	-	7.3
14L	1.7	6.8	2.0	-	-	-	8.8
Total		173.5	102.7	35.0	53.0	-	364.2
(Pasak Tai)							
K. Raphiphatana	150.0					32.0	32.0
1R	2.9	1.8	2.8	-	-	-	4.6
2R	3.0	3.1	7.4	-	-	-	10.5
3R	3.0	2.7	8.2	-	-	-	10.9
4R	0.2	1.7	-	-	-	-	1.7
5R	2.5	2.8	10.0	-	-	-	12.8
6R	0.6	3.6	-	-	-	-	3.6
7R	3.4	3.8	8.2	-	-	-	12.0
8R	6.6	4.1	13.4	-	-	-	17.5
9R	1.0	4.2	-	-	-	-	4.2
10R	0.3	1.6	-	-	-	-	1.6
11R	2.8	2.2	2.0	-	-	-	4.2
1L-3R	0.6	4.8	-	-	-	-	4.8
2L-3R	0.4	4.0	-	-	-	-	4.0
3L-3R	1.0	7.2	-	-	-	-	7.2
1L-5R	0.4	3.3	-	-	-	-	3.3
2L-5R	0.3	2.9	-	-	-	-	2.9
1R-7R	0.3	2.5	-	-	-	-	2.5
2R-7R	0.8	4.6	-	-	-	-	4.6
1L-7R	0.3	3.0	-	-	-	-	3.0
2L-7R	0.7	4.5	-	-	-	-	4.5

Table 3-3 (10) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (10/11)

(Project Name) Canal Name	Design Cap. (cms)	0-1	1-10	10-30	30-100	100-	Total
		km	km	km	km	km	km
1R-8R	1.0	3.1	3.0	-	-	-	6.1
2R-8R	1.5	2.1	3.7	-	-	-	5.8
1L-8R	0.5	3.7	-	-	-	-	3.7
K. Raphiphatana West Branch	38.0	-	-	-	11.0	-	11.0
K. Raphiphatana South Branch	80.0	-	-	-	6.6	-	6.6
Total		77.1	58.7	-	17.6	32.0	185.4
(Nakhon Luang)							
K. Nakhon Luang	30.0		23.1	32.8	-	-	55.9
1R	3.7	8.1	10.1	-	-	-	18.2
1L-1R	1.3	4.0	2.0	-	-	-	6.0
2R	1.8	6.1	-	-	-	-	6.1
1L-2R	0.9	5.9	-	-	-	-	5.9
3R	4.6	12.1	5.8	-	-	-	17.9
1L-3R	0.5	4.0	-	-	-	-	4.0
2L-3R	0.9	7.0	-	-	-	-	7.0
3L-3R	0.7	7.0	-	-	-	-	7.0
4R	2.3	5.6	10.0	-	-	-	15.6
5R	4.0	6.4	10.6	-	-	-	17.0
1R-5R	0.8	6.0	-	-	-	-	6.0
6R	0.6	4.8	-	-	-	-	4.8
1L	0.8	11.1	-	-	-	-	11.1
1R-1L	0.3	3.5	-	-	-	-	3.5
2R-1L	0.4	3.2	-	-	-	-	3.2
3R-1L	0.3	1.2	-	-	-	-	1.2
7R	0.7	7.0	-	-	-	-	7.0
K. Nakhon Luang (new)	0.8	4.1	-	-	-	-	4.1
Total		107.0	61.6	32.8	-	-	201.4

Table 3-3 (11) INVENTORY OF IRRIGATION CANAL BY PROJECT IN THE DELTA (11/11)

(Project Name) Canal Name	Irrig. km	Drainage km	Maj.Navi. km	Other km
(Rangsit Nua)				
K. Raphiphat. West	30	-	-	-
K. Hokwa Sai Bon	6	-	-	-
K. 6 & K. 33	12	-	-	-
K. 11 to K. 9L	158	-	-	-
1W-R & 1E-1R	4	-	-	-
1W & 1E	4	-	-	-
2W-1R & 2E-1R	4	-	-	-
2R & 2E	4	-	-	-
K. 11	13	8	-	-
K. 13	22	-	-	-
K. 2 to K. 10	-	172	-	-
K. 12	-	21	-	-
K. 14	-	15	-	-
K. Prem Prachakorn	-	-	21	-
K. 1	-	-	20	-
K. Rangsit	-	-	35	-
Total	257	216	76	-
(Rangsit Tai)				
K. 13	25	-	-	-
K. 1	-	-	30	-
K. 6-K. Sam Wa	-	-	23	-
K. Hok Wa Sai Lang	-	-	54	-
K. Saen Saep/K.B. Kanak	-	-	62	-
K. 16	-	-	29	-
K. Prem Prachakorn	-	-	24	-
Total	25	-	222	335
(Khlong Dan)				
K. 3 & K. Lam Hin Tai	-	-	13	-
K. Phra Khanong	-	-	29	-
K. Samrong	-	-	29	-
K. Hua Talae & K. Praong	-	-	19	-
K. Bang Pla	-	-	10	-
K. Nong Ngu Hao	-	-	13	-
K. Sua Thao	-	-	10	-
K. Jorakae Yai	-	-	14	-
Total	-	-	137	360
(Phra Ong Chaiya.)				
K. Bang Bo	-	-	14	-
Bang Hier River	-	-	8	-
K. Chaiyanuchit	-	-	19	-
K. Preng & K. Kwang	-	-	23	-
K. Nakhon Noeng Ket	-	-	18	-
K. Pravadi Burirom	-	-	22	-
K. Sam Rong	-	-	19	-
Total	-	-	123	329

Table 3-4 SUMMARY OF INVENTORY FOR DRAINAGE CANAL IN GRAVITY IRRIGATION AREA

Drainage System	No.of Canal Component	Total Length(km.)	Drainage Area (ha)	m/ha
Noi Main Drain 1	4	26	8,500	3.1
Noi Main Drain 2	14	119	28,900	4.1
Noi Main Drain 3	9	95	32,900	2.9
Noi Main Drain 4	4	28	8,700	3.2
Noi Main Drain 5	1	14	4,500	3.1
Noi Main Drain 6	1	10	2,400	4.2
Noi Main Drain 7	3	28	4,500	6.2
Noi Main Drain 8	1	11	*	
Suphan Main Drain 1	15	95	21,800	4.4
Suphan Main Drain 2	17	153	36,000	4.3
Suphan Main Drain 3	13	189	57,800	3.2
Suphan Main Drain 4	8	67	14,900	4.5
Samchuk Main Drain 1	11	157	36,900	4.3
Samchuk Main Drain 2	14	102	30,600	3.3
Suphan River	10	131	*	
(in Phak Hai Project)	4	66	*	
(in Bang Ban Project)	13	77	*	
Makamthao Drain	4	27	*	
Chainat-Pasak Main Drain 1	6	56	14,800	3.8
Chainat-Pasak Main Drain 2	7	82	26,000	3.2
Chainat-Pasak Main Drain 3	26	230	70,200	3.3
Maharaj Main Drain 1	5	47	11,000	4.3
Maharaj Main Drain 2	7	71	20,300	3.5
Maharaj Main Drain 3	3	28	9,400	3.0
(in Maharaj Project)	2	26	*	
(in Kao Kaeo Project)	7	45	*	
(in Roeng Rang Project)	18	166	*	
(in Nakhon Luang & Pasak Tai Prj)	20	241	*	
(in Rangsist Nua Project)	12	216	*	
Total		2,603		

N.B. Lengths and areas measured from 1:200,000 map.

Table 3-5 (1) INVENTORY OF DRAINAGE CANALS IN THE DELTA (1/7)

(unit : km)

Drain System	Canal Name	Manorom	Maharaj		Total
Chainat-Pasak Main Drain 1 (14,800 ha)	Main course	16	8		24
	Bung Thap Pla	4			4
	D1R-1L	14			14
	D1L	9			9
	D1L-1L	2			2
	D1R		3		3
Total		45	11		56
		Manorom	Maharaj		Total
Chainat-Pasak Main Drain 2 (26,000 ha)	Main course		24		24
	D1L	6			6
	D2L	7			7
	D3L	12			12
	D4L	14			14
	D1L-4L	7			7
	D1R		12		12
Total		46	36		82
		Chong Kae.	Maharaj	Koke Kathi.	Total
Chainat-Pasak Main Drain 3 (70,200 ha)	Main Course	44		13	57
	D1L	8			8
	D2L	2			2
	D3L	4			4
	D4L	18			18
	D1L-4L	6			6
	D1R-1L-4L	6			6
	D1R-1R-1R-1L-4L	8			8
	D1L-1R-1R-1R-1L-4L	2			2
	D1R-1R-1L-4L	4			4
	D2L-4L	6			6
	D1R-2L-4L	4			4
	D3L-4L	10			10
	D5L	6			6
	D6L	4			4
	D7L	10			10
	D1R-7L	12			12
	D2R-7L	10			10
	D8L			6	6
	D9L			4	4
	D10L			3	3
	D1R		16		16
	D1L-1R		10		10
	D1R-1R		6		6
	D2R-1R		4		4
	D3R-1R			4	4
Total		164	40	26	230
		Maharaj	Koke Krathi		Total
Maharaj Main Drain 1 (11,000 ha)	Main Course	18			18
	D1L		4		4
	D2L		12		12
	D1R	3			3
	D2R	10			10
Total		31	16		47

Table 3-5 (2) INVENTORY OF DRAINAGE CANALS IN THE DELTA (2/7)

(unit : km)

Drain. System	Canal Name	Maharaj			Total
Maharaj Main Drain 2 (20,300 ha)	Main Course	37			37
	D1L	6			6
	D2L	11			11
	D1R	4			4
	D2R	3			3
	D3R	4			4
	D4R	6			6
Total		71			71
		Maharaj			Total
Maharaj Main Drain 3 (9,400 ha)	Main Course	20			20
	D1R	6			6
	D2R	2			2
Total		28			28
		Borommathat.			Total
Noi River Main Drain 1 (8,500 ha)	Main Course	14			14
	D1R	8			8
	D1R-1R	2			2
	D2R	2			2
Total		26			26
		Borommathat.	Chanasutr.	Yangmanee.	Total
Noi River Main Drain 2 (28,900 ha)	Main Course	6	30	4	40
	D1L	2			2
	D2L	5			5
	D3L	4			4
	D1R	18			18
	D1L-1R	6			6
	D1R-1R	4			4
	D2R-1R	6			6
	D2R	6			6
	D3R		4		4
	D4R		6		6
	D5R		4		4
	D6R		8		8
	D7R		6		6
Total		57	58	4	119
		Borommathat.	Chanasutr.	Yangmanee.	Total
Noi River Main Drain 3 (32,900)	Main Course		34		34
	D1L		25		25
	D1L-1L		4		4
	D1R-1L		12		12
	D2L		8		8
	D1R		2		2
	D2R		4		4
	D3R		2		2
	D4R		4		4
Total			95		95

Table 3-5 (3) INVENTORY OF DRAINAGE CANALS IN THE DELTA (3/7)

(unit : km)

Drain. System	Canal Name				Total
		Borommathat.	Chanasutr.	Yangmanee.	Total
Noi River	Main Course		14		14
Main Drain 4	D1L		2		2
(8,700 ha)	D2L		4		4
	D1R		8		8
Total			28		28
		Borommathat.	Chanasutr.	Yangmanee.	Total
Noi River	Main Course			14	14
Main Drain 5					
(4,500 ha)					
Total				14	14
		Borommathat.	Chanasurt.	Yangmanee.	Total
Noi River	Main Course			10	10
Main Drain 6					
(2,400 ha)					
Total				10	10
		Borommathat.	Chanasutr.	Yangmanee.	Total
Noi River	Main Course			14	14
Main Drain 7	D1L			8	8
(4,500)	D1L-1L			6	6
Total				28	28
		Phak Hai			Total
Noi River	Main Course	11			11
Main Drain 8					
Total		11			11
		Phonlathep	Borommathat.	Thabote.	Total
Suphan Main	Main Course	12	14		26
Drain 1	D1L		7		7
(21,800 ha)	D1R-1L		4		4
	D1R	6			6
	D1L-1R	2			2
	D2R	4			4
	D3R	2			2
	D4R	12			12
	D1R-4R	2			2
	D2R-4R	8			8
	D1L-2R-4R	4			4
	D1L-4R(ex)	6			6
	D2L-4R	8			8
	D5R			2	2
	D6R			2	2
Total		66	25	4	95
		Borommathat.	Thabote.	Sam Chuk.	Total
Suphan Main	Main Course	36		14	50
Drain 2	D1L	2			2
(36,000 ha)	D2L	8			8
	D3L	4			4
	D4L	34			34
	D1R-4L	4			4
	D2R-4L	4			4
	D3R-4L	4			4

Table 3-5 (4) INVENTORY OF DRAINAGE CANALS IN THE DELTA (4/7)

(unit : km)

Suphan Main Drain 2		Borommathat	Thabote	Sam Chuk	Total
(cont'd)	D4R-4L	6			6
	D5R-4L	14			14
	D1L-5R-4L	4			4
	D1R	2			2
	D2R		4		4
	D1R-2R		2		2
	D3R		5		5
	D4R		2		2
	D5R		4		4
Total		122	17	14	153
		Chanasutr	Sam Chuk	Pho Phya	Total
Suphan Main Drain 3 (57,800 ha)	Main Course	66			66
	D1L	12			12
	D2L	18			18
	D1R		30		30
	D1L-1R		4		4
	D2L-1R		6		6
	D1R-1R		3		3
	D2R		6		6
	D3R		6		6
	D3L	12			12
	D1L-3L	4			4
	D4L	8			8
	D4R			14	14
Total		120	55	14	189
		Chanasutr	Phak Hai	Yangmanee	Total
Suphan Main Drain 4 (14,900 ha)	Main Course		23		23
	D1R			12	12
	D2R	20			20
	D1R-2R	8			8
	D2R-2R	4			4
Total		32	23	12	67
		Thabote	Sam Chuk	Don Chedi	Total
Sam Chuk Main Drain 1 (36,900 ha)	Main Course	24	48		72
	D1R	6			6
	D1R-1R	1			1
	D2R	6			6
	D3R	7			7
	D4R	7			7
	D1L-4R	8			8
	D5R			18	18
	D1R-5R			6	6
	D1L		9		9
	D2L		17		17
Total		59	74	24	157

Table 3-5 (5) INVENTORY OF DRAINAGE CANALS IN THE DELTA (5/7)

(unit : km)

Drain. System	Canal Name	Thabote	Sam Chuk	Don Chedi	Total
Sam Chuk	Main Course			32	32
Main Drain 2	D1R			4	4
(30,600 ha)	D2R			5	5
	D3R			5	5
	D4R			4	4
	D5R			8	8
	D6R			8	8
	D7R			9	9
	D1L-7R			5	5
	D8R			5	5
	D8R(ex)			5	5
	D9R			6	6
	D1R-9R			3	3
	D1R-1R-9R			3	3
Total				102	102
(Rangsit Nua Project)					Rangsit Nua
	Khlong 2				17
	khlong 3				18
	Khlong 4				19
	Khlong 5				19
	Khlong 6				19
	Khlong 7				20
	Khlong 8				20
	Khlong 9				20
	Khlong 10				20
	Khlong 11 (partly)				8
	Khlong 12				21
	Khlong 14				15
Total					216

Table 3-5 (6) INVENTORY OF DRAINAGE CANALS IN THE DELTA (6/7)

(unit : km)

Drain. System	Canal Name	Pho Phraya	Sam Chuk	Total
(Suphan River)	D1L-Supan	8		8
	D1L-2R Suphan	12		12
	D2R Suphan	12		12
	Khlong Slid	13		13
	D3R Suphan	4		4
	Khlong Kokensu Hao	8		8
	D4R Suphan	10		10
	D1L	12		12
	D2L	30	8	38
	D1L-2L		14	14
Total		109	22	131
(Phak Hai Project)				Phak Hai
	Chao Ched Canal			30
	Phak Hai Main Drain			12
	Khlong Tang Luang			9
	Khlong Nong Chado			15
Total				66
(Bang Ban Project)				Bang Ban
	Bang Ban Main Drain 1			10
	Bang Ban Main Drain 2			8
	D1R			3
	D1R(ext)			3
	Bang Ban Main Drain 3			8
	D1R			8
	D1R-1R			2
	Bang Ban Main Drain 4			10
	D1R			8
	D1L			2
	D2L			4
	D3L			6
	D4L			5
Total				77
(Nakhon Luang & Pasak Tai Projects)		N. Luang	Pasak Tai	Total
	Pasak Main Drain	12	28	40
	D1L	12		12
	D1R-1L	2		2
	D2R-1L	4		4
	D3R-1L	16		16
	D1R-3R-1L	6		6
	D2L	20		20
	D1R-2L	7		7
	D2R-2L	6		6
	D1L-2L	7		7
	D3L	10		10
	D4L	5		5
	D5L	20		20

Table 3-5 (7) INVENTORY OF DRAINAGE CANALS IN THE DELTA (7/7)

(unit : km)

(Nakhon Luang & Pasak Tai Projects)		N. Luang	Pasak Tai	Total
(cont'd)	Pasak Main Canal		10	10
	Khlong Sambandita		10	10
	Khlong Lamdang		10	10
	Khlong 28		6	6
	Khlong 27		8	8
	Khlong 26		32	32
	Khlong Suai Kluai		10	10
Total		127	114	241
Makamthao Drain		Phonlathep	Thabote	Total
	D1R-Makamthao	17	7	24
	D1R-1R	0		0
	D2R-1R	1		1
	D3R-1R		2	2
Total		18	9	27
(Kao Kaeo Project)				Manorom
	Kao Kaeo Main Drain Canal			12
	D1L			4
	D1R-1L			6
	D2L			5
	Bang Lek Main Drain Canal			10
	D1L			5
	D2L			3
Total				45
(Maharaj Project)				Maharaj
	D1L-Lopburi			12
	Khlong Bang Kaeo			14
Total				26
(Roeng Rang Project)				Roeng Rang
	3DL-Lopburi			10
	Roeng Rang Main Drain 1			40
	D1L			4
	D1R-1L			4
	D2L			5
	D3L			8
	D4L			10
	D1R-4L			6
	D1L-4L			6
	D5L			7
	D1R-5L			7
	D6L			3
	D7L			14
	D8L			8
	D9L			8
	D1R			12
	D1R-1R			10
	D1R-1R-1R			4
Total				166

Table 3-6 SUMMARY OF REGULATOR AND FTO IN THE DELTA

(Unit : place)

Project Name	FTO	Reg. with: ○-Culvrt	Regulator with □-Culvert < 5 m	5-15 m	> 15 m	Total
Phonlathep	150	49	0	1	1	2
Thabote	249	62	0	3	1	4
Samchuk	567	38	14	2	1	17
Don Chedi	202	58	0	2	0	2
Pho Phraya	470	38	5	4	2	11
Borommathat	695	99	0	2	1	3
Chanasutr	750	133	20	1	2	23
Yangmanee	299	58	10	4	4	18
Phak Hai	51	8	6	7	2	15
Bang Ban	208	40	0	0	0	0
Chaochet-Bang Y.	0	35	34	20	1	55
Phraya Ban Lu	0	0	42	10	1	53
Phra Phiman	0	2	16	5	0	21
Phasi Charoen	0	16	14	2	0	16
Sub-total	3,641	636	161	63	16	240
Manorom	284	83	0	0	1	1
Chaong Kae	267	62	8	2	1	11
Koke Kathiem	275	71	4	1	1	6
Roeng Rang	186	32	2	1	2	5
Maharaj	730	93	5	9	0	14
Pasak Tai	451	59	15	4	3	22
Nakhon Luang	304	45	7	2	4	13
Rangsit Nua	227	15	21	15	0	36
Rangsit Tai	0	0	16	35	1	52
Khlong Dan	0	11	2	3	4	9
Pra Ong Chaiya.	0	19	3	30	4	37
Sub-total	2,724	490	83	102	21	206
Total	6,365	1,126	244	165	37	446

Table 3-7 (1) MAJOR REGULATORS IN THE DELTA (1/4)

River and Canal System	Name of Structure	Dimension Number x width x Height	Design Discharge	Draw. No.	E.L. Sill	E.L. Gate	Water Level Dry U/S	Water Level Dry D/S	Water Level F.S.L. U/S	Water Level F.S.L. D/S	Type of Gate	Radius	Remarks
Nan River	Phitsanulok Diversion Dam	5x12.5x7.3	1,600.0	PI-HG-2	40.50	47.80	-	-	50.35	49.75	Radial		Max.51.00 MSL
Chao Phraya River	Chao Phraya Dam	16x12.50x7.50	3,300.0	30634	9.00	16.50	16.00	7.50	-	-	Radial	10.00	Max. U/S18.00 U/S17.50
		1x 14.00									Miter		
Pasak River	Rama VI Barrage	6x12.50x10.40	1,800.0	3490	0.10	10.50	7.50	-	9.59	-	Slide	-	
Klong Chainat-Pasak	Manorom Reg.	6x6.00x3.80	210.0	30635	12.80	16.60	16.472	14.600	20.00	16.142	Radial	5.10	
" "	Chong Kae Reg.	5x6.00x5.50	180.0	31471	9.50	15.00	14.600	10.850	14.600	13.150	Radial	6.50	
" "	Koke Kathiem Reg.	4x6.00x4.90	158.0	31465	6.29	11.19	10.850	8.290	10.850	10.590	Radial	6.88	
" "	Reong Rang Reg.	3x6.00x4.90	140.0	31167	3.97	8.87	8.290	7.50	8.853	8.270	Radial	7.04	
Klong Chainat-Ayutthaya	Maharaj Reg.	3x4.00x3.10	75.0	32063	11.60	14.40	16.00	15.50	18.000		Radial	4.50	
		3x4.20x2.50											Box Culvert
Noi River	Borommathat Reg.	4x6.00x6.30	260.0	30637	9.60	15.90	16.00	11.60	18.24	16.20	Radial	10.70	
"	Chanasutr Reg.	4x6.00x6.20	260.0	30633	5.72	11.92	11.60	7.50	11.84	11.40	Radial	7.878	
"	Yang Manee Reg.	4x6.00x5.80	260.0	30636	2.32	3.12	7.50	3.50	7.74	6.16	Radial		Max. U/S7.74 D/S7.30
"	Pakhai Reg.	3x6.00x6.00	150.0	29490	(-)2.00	4.00	3.50	2.00	3.50	3.30	Radial	7.00	
Suphan River	Phonlathep Reg.	4x6.50x7.30	320.0	31493	7.50	14.80	16.00	13.50	16.50	13.90	Slide		
"	Thabote	4x6.00x5.20	318.0	30634	8.75	13.95	13.50	9.15	13.50	9.80	Radial	6.13	Max. U/S14.09 D/S13.68
"	Samchook Reg.	2x12.50x7.00	318.0	18905	2.50	9.50	9.15	6.00	9.15	6.30	Slide	-	
"	Phophya Reg.	2 x 12.50	318.0	12502	0.20		6.00		6.00		Slide	-	
Klong Makamthao-Uthong	Makamthao-Uthong Reg.	6x1.75x2.00	35.0	36768	13.60	15.60	-	-	16.10	15.95	Slide	-	Max.U/S19.37
		6x2.00x2.00			13.75								Box Culvert

Table 3-7 (2) MAJOR REGULATORS IN THE DELTA (2/4)

River and Canal System	Name of Structure	Dimension Number x width x Height	Design Discharge	Draw. No.	E.L. Sill	E.L. Gate	Water Level Dry U/S	Water Level Dry D/S	Water Level F.S.L. U/S	Water Level F.S.L. D/S	Type of Gate	Radius	Remarks
Phophaya 1L	Phokoi Reg.	1x4.00x2.25	17.0	15794	2.72	4.97	-	-	4.72	3.732	Slide		
K. Pakhai-chaochet	Pakhai-chaochet Reg.	2x6.00x4.50	50.0	37115	(-)0.50	4.00	2.50	-	3.50	0.50	Radial	5.25	Max.W.L.5.05
K. Dang Khee	Bang plama Reg.	3x7.00x4.80	75.0	16977	(-)1.00	3.80	3.60	-	4.40				
K. Chaochet	Bang Yihon Reg.	1x6.25x4.024		27922	(-)0.976	5.00	1.29	0.995	2.50	2.15	Slide		
					(-)1.226				4.55		Miter		
K. Chaochet	Chaochet Reg.	1x6.00x3.00		41377	(-)1.00	4.00	3.60	-	-	-	Radial	6.13	
K. Phraya Banlu	Phraya Banlu Reg.	2x6.00x6.00		27868	(-)2.00	4.00	2.30	(-)0.60	3.70	2.30	Stoplog		
K. Phraya Banlu	Singhanat Reg.	2x6.00x6.00		27868	(-)2.00	4.00	2.30	(-)0.60	3.70	2.30	Stoplog		
K. Phra Pimon	Phra Pimon Reg.	1x6.00x5.30		25286	(-)2.00	3.30	0.50	-	1.50	-	Stoplog		
K. Phra Pimon	Bang Buathong Reg.	2x6.00x4.50		20640	(-)2.00	2.50	0.50	-	1.50	-	Stoplog		
K. Maha Sawat	Maha Sawat Reg.	1x6.00x5.00		54681	(-)2.50	2.50	1.80	-	2.27	-	Slide		
K. Maha Sawat	Chimphli Reg.	1x6.00x6.00		28516	(-)3.00	3.00	-	-	1.50	-	Slide		
K. Phasi Charoen	Krathum Baen Reg.	1x7.00x4.40		27771	(-)2.07	2.33	-	-	2.17	1.25	Stoplog		
K. Phasi Charoen	Pasi Charoen Reg.	1x6.00x3.70		16136 40710	(-)2.00	1.70	-	-	-	-	Slide		
K. Yipun Nua	Yipun Nua Reg.	2x6.00x6.50		28602	(-)1.50	5.00	3.50	-	4.83	-	Stoplog		
K. San	Klong San Reg.	2x6.00x6.50		28602	(-)1.50	5.00	3.50	-	4.83	-			

Table 3-7 (3) MAJOR REGULATORS IN THE DELTA (3/4)

River and Canal System	Name of Structure	Dimension Number x width x Height	Design Discharge	Draw. No.	E.L. Sill	E.L. Gate	Water Level Dry U/S	Water Level Dry D/S	Water Level F.S.L. U/S	Water Level F.S.L. D/S	Type of Gate	Radius	Remarks
Klong Raphiphatana	Phra Narai Reg.	8x4.20	150.0	3490	4.20	7.76	-	-	7.80	7.500	Slide		
K. Raphiphatana	Phra Sri Saowaphak Reg.	4x2.44x3.10	80.0	39109	1.81	3.10	-	-	4.385	4.120	Slide		
South Branch													
" "	Syphon Phrathammaracha	2x3.50x3.50	45.0	39862	(-)1.35	2.15	-	-	3.000	2.650	Slide		
Klong 13	Klong 13 Tail Reg.	1x6.00x4.20	25.0	40316	(-)2.28	1.92	-	-	1.570		Radial		
Klong Nakhon Luang	Nakhon Luang Reg.	6x1.75x1.75	35.0	35430	4.33	6.08	-	-	6.91	6.73	Slide		
		6x2.00x2.00											Box Culvert
K. Raphiphatana	Phra Sri Sril Reg.	4x2.44x3.10	80.0	39109	1.81	3.10	-	-	4.385		Slide		
West Branch													
" "	Phra Intharacha Reg.	3x3.00x3.50	-	11702	(-)0.50	3.50	-	-	3.00	2.25	Slide		
K. Nakhon Nuang Khet	Tha Khai Reg.	2 x 4.00	-	21452	(-)2.521		-	-	1.650	-	Slide		
K. Phra Kanong	Lard Krabang Reg.	1 x 6.00		75969	(-)2.00	2.60	-	-			Slide		
K. Prawet Burirom	Phra Khanong Reg.	2x5.00x4.35 1x7.00x4.35	-	74541	(-)3.318		-	-	-	-	Radial Radial		
K. Prawet Burirom	Tha Thua Reg.	2x6.00x5.00	-	30875	(-)5.10	(-)0.10	(-)3.85	-	1.84	-	Slide		Max.U/S-0.60

Table 3-7 (4) MAJOR REGULATORS IN THE DELTA (4/4)

River and Canal	Name of	Dimension	Design	Draw.	E.L.		Water Level				Type	Radius	Remarks
System	Structure	Number x width	Discharge	No.	Sill	Gate	Dry		F.S.L.		of		
		x Height					U/S	D/S	U/S	D/S	Gate		
Chainat-Pasak	Bang Chom Sri Reg.	3x4.00x6.50	120.0	61649	7.00	13.50	-	-	13.50	-	Slide		
Main Drain 2													
Chainat-Pasak	Wad Mani Reg.	3x6.00x6.00		56352	3.20	8.00	-	-	7.50		Radial		
Main Drain 3		2x11.25			7.00								Spillway
Maharaj Main Drain 2	Wad U-Rom Reg.	2x4.00x7.00		62367	(-)1.58	5.42	-	-	5.12		Slide		
D1L Pasak	Klong Kao Maw Reg.	3x6.00x4.20		15343	(-)1.50	4.50	-	-	3.00	-	Stoplog		
D2L Pasak	Ban Phoe Reg.	5x6.00x4.20		15271	(-)1.50	2.70	-	-	-	-	Stoplog		
Reong Rang Main Drain1	Ban Kum Reg.	3x6.00x6.00		75716	(-)0.50	5.50	3.25	-	5.00	-	2Vertical 1Radial		
Noi River Main Drain2	Lum Chuade Reg.	3x6.00x5.16		34615	3.30	8.46	-	-	8.107	7.300	Radial	6.90	
Noi River Main Drain3	Klong Sa Rai Reg.	2x4.00x4.80		62797	3.00	7.80	-	-	6.50		Slide		Max.W.L.7.591
Klong Darn	Chonlahan Phichit Reg.	6x4.00x4.70		58069	(-)3.50	1.90	-	-	1.82	-	Radial		
K. Phra Kanong	Lard Krabang Reg.	1x6.00x4.60		75969	(-)2.00	2.60	-	-	-	-	Vertical		
K. Nakhon Nuang Khet	Tha Khai Reg.	2x4.00x4.00		21452	(-)2.52		-	-	1.650		Slide		
K. Bang Kanag	Bang Khanak Reg.	1x6.00x3.80		21454	(-)1.71	2.09	-	-	-		Vertical		
K. Samrong	Pakthakong Reg.	1x6.00x3.45		20913	(-)2.15	1.30	-	-			Slide		
K. Rangsit	Chularongkorn Reg.	4x3.00x5.00		16414	(-)2.00	3.00	-	-	2.00		Roller		
K. Phasi Charoen	Pasi Charoen Reg.	1x6.00x3.70		16136 46710	(-)2.00	1.70					Sluice		
K. Phasi Charoen	Krathum Baen Reg.	1x7.00x4.40		27771	(-)2.07	2.33	-	-	2.17	1.25	Stoplog		
K. Maha Sawat	Mahasawat Reg.	1x6.00x5.00		54681	(-)2.50	2.50	-	-	1.80	-	Slide		Max.W.L.2.27
K. Maha Sawat	Chimphli Reg.	1x6.00x6.00		28516	(-)3.00	3.00	-	-	1.50	-	Slide		Max.W.L.2.642

Table 3-8 (1) INVENTORY OF REGULATOR (1/5)

Name	Dimension	plc
(Phonlathep)		
Phonlathep Reg.	4-6.50x10.00	1
Khem Sap Reg.	1-4.00x6.50	1
Total		2
(Thabote)		
Suphan river	4-6.00	1
Bang Khian	2-6.00	1
Makhamthao D.1R	1-6.00	1
Suphan Main-D.1	2-6.00	1
Total		4
(Sam Chuk)		
Samchuk Reg.	2-12.50	1
1R Check Reg.	1-2.50x2.90	1
1R	1-2.00x2.40	1
1R	2-2.00x2.00	1
1R	1-2.00	1
1R	2-1.25x1.25	1
1L-1R	1-1.75x1.50	1
1L	1-4.00	1
2R	1-1.50x1.50	1
2R	1-1.75x1.75	1
2R	2-1.75x1.50	1
2R	2-1.50x1.50	1
2R	2-1.75x1.75	1
2R	2-2.25x2.00	1
2R	2-2.25x2.00	1
2R-1L	2-3.00	1
Krasiew-Tharakum	4-3.00x4.00	1
Total		17
(Don Chedi)		
Khlong Makham - Thao U Thong	1-6.00	1
Khlong Makham- Thao U Thong	1 pl.	1
Total		2
(Pho Phraya)		
Suphan River	2-12.50	1
Khlong 3L-1R		1
Khlong 1L-1R	1-1.50	1
Khlong 2L-1R	1-4.00	2
Main irr.Canal	1-6.00, 1-4.01	2
K.Song Phi Nong	1-6.00	1
Suphan Main-D.4	3-6.00	1
D2R-Suphan river	1-6.00	1
D3R-Suphan river	1-6.00	1
Total		11
(Borommathat)		
Noi River	4-6.00 x 6.00	1
Bang Sava	2-3.50 x 3.50	1
Suphan 1	2-2.50	1
Total		3

(Po-To-Ro)

Name	Dimension	plc
(Chanasutr)		
Noi River (Bang Rachan)	4-6.00	1
Khlong 1R	3-6.00x2.00	1
Khlong 3L-1R	2-1.75x1.75	1
Khlong 5L-1R	2-1.75x1.75	1
Khlong 3R-1R	1-1.25x1.25	1
Khlong 1R	2-4.00	1
Khlong 1R	3-1.60x2.00	1
Khlong 1R	2-1.75x1.75	1
Khlong 1R	2-1.50x1.50	1
Khlong 1R	2-2.00x2.00	1
Khlong 1L-1R	2-1.50x1.50	1
Khlong 1L-1R	2-1.50x1.50	1
Khlong 1L-1R	2-1.50x1.50	1
Khlong 3L-1R	2-1.50x1.50	1
Khlong 5L-1R	2-1.50x1.50	1
Noi Main D2-3R	1-1.75x1.75	1
Noi Main D2-6R	1-2.00x2.00	1
Noi Main D3-2L	2-1.50x1.50	1
Noi Main D4-TR	1-4.00	1
Suphan Main D2-4L	2-2.00x2.00	1
Suphan Main D3-2L	1-4.00	1
Noi Main D3-1R-1L	2-1.50x1.50	1
Noi Main D3-1R-1L	1-2.00x2.00	1
Total		23
(Yangmanee)		
Khlong Pho Prajak	2-4.00	1
Khlong Phai Dam		1
Khlong Lam Chuad	3-6.00	1
Noi River	4-6.00	1
Khlong Sarai	2-4.00	1
Khlong Saladean	1-4.00	1
Suphan 4 D1R	1-4.00	1
Khlong Si Roi - Khlong khanak	1-4.00	1
Phra Ngam	3-6.00	1
Muang Teai	1-6.00	1
Lad Nai	1-4.00	1
Khlong Charakae	1-4.00	1
Tha U-Tai	1-4.00	1
Khlong Ta Thiang	1-4.00	1
Suphan Main D4.1R	1-4.00	1
Suphan Main D4.1R	1-6.00	1
Suphan Main D.4	3-6.00	1
1L-3L Chaiyo	2-1.00	1
Total		18

Table 3-8 (2) INVENTORY OF REGULATOR (2/5)

(Po-To-Ro)

Name	Dimension	plc
(Phak Hai)		
Noi River	3-6.00	1
khlong Phak Hai	2-6.00	1
Khlong Bang Kod	1-6.00	1
Khlong Bang Kung	1-6.00	1
Phak Hai Main D.8	1-6.00	1
Khlong Wat Bai Bua	1-4.00	1
Khlong Ku-Dee	1-6.00	1
K.Rang Jara-khe	1-4.00	1
Khlong Lad Chado	3-6.00	1
Khlong Makhamthet	1-3.00	1
Khlong lad Chid	1-4.00	1
Khlong Bang Kaeo	1-4.00	1
Khlong Sai 1 TR	1-6.00	1
Khlong Chao Chet	1-6.00	1
Khlong Ta Nun	1-4.00	1
Total		15
(Bang Ban)	none	
(Chaochet-Bang Yihon)		
Khlong Sing Hanat	2-6.00	1
Mai Tra	1-4.00	1
Khlong Ban Khaek	1-4.00	1
Khlong Bang Kae	1-4.00	1
khlong Phai Phra	2-6.00, 1-4.00	2
khlong Jek Lai	1-6.00	1
Khlong Chang Lek	1-6.00	1
khlong Tha Chang	1-4.00	1
Khlong Bang Kayang	1-4.00	1
Khlong Nai Chat	1-4.00	1
Khlong Khanom Chin	1-6.00	1
Irr.Canal No. 4	1-6.00	1
khlong Nam Thom	1-6.00	1
Khlong Sai	1-6.00	1
Khlong Khu Mak Mao	1-2.00	1
Khlong Hua Mangwan	1-2.00	1
Khlong Pin Kaew	1-3.00	1
Khlong U-Taphao	1-2.00	1
Khlong Nai Waen	1-2.00	1
Khlong Lad	1-2.00	1
khlong San	2-6.00	1
Khlong Nong Or	1-4.00	1
Khlong Wo	1-2.00	1
Khlong Mek-khala	1-2.00	1
K. Kra Phang khon	1-2.00	1
khlong Bang Sai-Lad Bua Luang	1-6.00	1
Khlong Wat Tachang	1-2.00	1
Khlong Mu Kong	1-2.00	1
Khlong Lak Chai	1-2.00	1
khlong kum	1-4.00	1
Khlong Nua Tai	1-2.50	1
Khlong Yipun Nua	2-6.00	1
Khlong Tep Mongkon	1-2.50	1
Khlong Phaeng Loi	1-2.50	1
Khlong Bang-Krathiam	1-2.50	1
Khlong Charakhae	1-6.00	1
Khlong Sali	1-6.00	1
	3-6.00	1
Khlong Ong Kharak	1-3.00	1
Khlong Ban Hong	1-3.00	1
Khlong Ban Khok	1-6.00	1
K. Rim Khan Sai 2	1-3.00	1
Khlong Lam Krala	1-2.00	1
Khlong Nai Song	1-2.00	1
Klong Lam Rang Lek	1-2.00	1
Khlong Rang Wai	1-2.00, 1-3.00	2
Khlong Bang So	1-6.00	1
Khlong Tha Kham	1-3.00	1
khlong Bang Pla Ra	1-6.00	1
Lam Rang Krasa	1-3.00	1
Khlong Ban Khum	1-2.00	1
Khlong Sop Phleang	1-6.00	1
Khlong Dab Ngean	1-4.00	1
Total		55
(Phraya Banlu)		
k. Phraya Banlu	2-6.00x2, 1-6.00, 1-4.00, 1-3.00	5
k. Phra Phimon	1-6.00	1
Dike No. 1	1-3.00, 1-4.00x2, 1-6.00	4
Dike No. 2	1-3.00	1
Khlong Bua Wan	1-4.00	1
Khlong Nin Phet	1-4.00	1
Khlong Yipun Tai	2-6.00	1
Khlong Khun Sri	3-6.00	1
Khlong Pison	1-3.00	2
Khlong Lak Khon	2-6.00	1
Khlong Khud Mai	1-4.00, 1-6.00,	

Table 3-8 (3) INVENTORY OF REGULATOR (3/5)

(Po-To-Ro)

Name	Dimension	plc
	1-3.00	3
Klor Bang Luang	1-3.00	2
Klong Bang Sakae	1-3.00	1
Khlong Lam Ree	1-2.00	1
K. Lum Thong Lang	1-2.00	1
Khlong Ban Ma	1-4.00	1
Khlong Sra	1-3.00	1
Khlong Khwai	1-3.00	1
Khlong Khayaed-Bang Tei	1-4.00	1
K. Bang Pho Nua	1-2.00	1
Khlong Yo-Tha	1-2.00	1
K. Lad Lum Kaeo		1
Klong Bang Sakae	1-2.00	1
Klong Chao Muang	1-3.00	1
Khlong Phra Udom	2-6.00, 1-6.00	2
Khlong Lad Sawai	1-2.00	1
Khlong Phai kaeo	1-3.00	1
Khlong Ma-Thai	1-4.00	1
Khlong Yai Hom	1-3.00	1
Khlong Pi Liang	1-3.00	1
Khlong Jek	1-2.00	1
Khlong Sib Soak	1-2.00	1
K. Khwang Thai	1-2.00	1
Klong Bang Luang Wai Phra	1-4.00	1
K. Bang Pho Tai	1-3.00	1
Khlong Kaman Yok	1-2.00	1
Khlong Kha Yang	1-4.00	1
Khlong Bang Dua	1-4.00	1
Khlong Trong		1
K.Bang Khu Wat Tai		1
K. Bang Bua Thong	2-6.00	1
Total		53
(Phra Phimon)		
Nakhon Chaisri	1-6.00	4
	1-4.00	8
	wooden Reg.	2
K. Tawee Watthana	1-4.00	1
		2
Khlong Bang Phai	1-4.00	1
Khlong Ta Chom		1
Khlong Bang Yai	1-6.00	1
K. Bang Buathong		1
Total		21
(Phasi Charoen)		
K. Thawi Watthana	1-4.00	1
K. Phasi Charoen	1-6.00	1
Khlong Phraya	1-4.00	1

Name	Dimension	plc
Ratchamontri		
K. Ladnongchid		1
Khlong Bang Bon	1-3.00	1
Khlong Si Baht	1-2.00	1
Khlong Rang Pho	1-2.00	1
K. Bang Nam Chued	1-4.00	1
K. Siwa Mahasawad	1-3.00	1
Khlong Ta Phet	1-2.50	1
Khlong Bang Krud	1-2.50	1
Khlong Hai Lam	1-2.50	1
Khlong Prom Daen		1
Khlong Tha Sao		1
Khlong Bang Phra		1
K. Kra Thum Baen	1-7.00	1
Total	16 plc.	16
(Manorom)		
Chao Phya River	6-6.00	1
Total	1 plc.	1
(Chong Kae)		
Chong Kae	5-6.00	1
Khlong Ban Mee	1-6.00	1
Chainat-P 9R	2-2.00x2.00	1
	2-1.50x1.75	1
	2-1.50x1.75	1
2L-9R	1-1.75x1.75	1
16R	2-2.00x2.00	1
	2-1.75x1.75	1
	2-1.25x1.25	1
1L-16R	1-1.25x1.25	1
Huai Haeng 1l-4R	1-6.00	1
Total		11
(Koke Krathiem)		
Khlong Tha Khae	4-6.00, 1-1.50, 2-0.80	3
K. Anusasananan	2-2.25, 2-1.50	2
Maharaj Main D.1	1-6.00	1
Total		6
(Roeng Rang)		
Roeng Rang Main	3-6.00	1
Roeng Rang M.D	3-6.00	1
Khlong Bang Phoeng	1-4.00	1
Chainat-P. 24R	1-4.00x3.50	1
Khlong Ko Loeng	1-6.00	1
Total		5

Table 3-8 (4) INVENTORY OF REGULATOR (4/5)

(Po-To-Ro)

Name	Dimension	plc
(Maharaj)		
Chainat-Ayuthaya	2-4.00	1
Chainat-Ay HR	3-2.50x4.00	1
Chainat-Ay Ban Tuek	2-6.00x6.00	1
Bang Chom Sri	3-4.00x6.50	1
K. Bang Rai	2-4.00x4.00	1
Chainat-Ay Check	1-6.00	1
C-A Bang Kao Chang	2-4.00x5.50	1
Chainat-Ay Check	1-4.00	1
Chainat-Ay Check	1-4.00	1
Chainat-Pasak 1R TR	1-6.00	1
C-P 1L-1R TR	1-2.00x2.00	1
Maharaj Main D2 TR	2-4.00	1
Maharaj Main D3 TR	1-3.90	1
Maharaj 8L	1-4.50	1
Total		14
(Pasak Tai)		
Phra Narai	5-3.00/8-4.20	1
Nong Suang	4-2.75	1
Phra Mahin	6-5.50/1-6.00	1
Phra Ekathotsarot	12-3.30	1
Huai Pa	1-2.75x2.40	1
Nong Hualing	1-2.10x1.40	1
Nong Kae	1-2.00x2.00	1
Nong Ru	1-2.44	1
Phra Mahin	1-4.00x4.30	1
Khlong 26	1-6.10	1
Khlong 27	1-4.00x4.30	1
Phra Sri Sril	4-2.44	1
Phra Sri Saowaphak	4-2.44	1
3L-3R	1-1.20	1
2L-3R	1-1.00	1
1L-3R	1-1.20	1
4R	1-0.90	1
1L-5R	1-0.90	1
2L-5R	1-0.85	1
1R-7R	1-0.96	1
2R-7R	1-1.00	1
2L-7R	1-0.95	1
Total		22
(Nakhon Luang)		
Bang Sakae	2-1.00	1
Khlong Nakhon-Luang HR	6-2.00	1
Khlong Bang Hong	5-3.00	1
Khlong Ban Pho	5-6.00	1
Khao Mao	3-6.00	1
Bang Lean	1-4.00	1
Sawad	1-6.00	1
Bang Wo	1-4.00x5.00	1
Bang Pat	1-4.00x5.00	1
Khlong Chik	3-6.00	1
K.Nakhon Luang	2-1.50, 2-2.50 2-4.00	3
Total		13
(Rangsit Nua)		
Khlong 1	1-6.00x5.00, 1-4.00	2
Khlong Bang Khan	2-3.00x3.00	1
Khlong 9L	1-3.00x2.50	1
Khlong 8L	1-3.00x2.50	1
Khlong 7L	1-3.00x2.50	1
Khlong 6L	1-3.00	2
Khlong 5L	1-3.00	2
Khlong 4L	1-3.00	1
Khlong 3L	1-3.00x2.50	1
Khlong 2L	1-3.00x2.50	1
Khlong 10	2-4.00x4.60	1
1R-South Rapipat	1-6.00, 1.40	2
Khlong 2E	1-6.00	1
K.Phra Intharacha	3-3.00	1
K.Phra Thamaracha	2-3.00	1
Prem Nua-bang Pain	1-6.00	1
Bueng Plara	1-4.00	1
K. Lam Rua Taek	1-4.00	1
Khlong Bang Lad	1-4.00x4.95	1
Khlong Saraphan	1-4.00	1
Prem Nua-Rangsit	1-6.00	1
Khlong 26 Drain	1-4.00, 1-4.00	2
Khlong Wang Noi	1-5.00, 1-5.00	2
Khlong Drain 1	1-6.00	1
Khlong 1L	1-3.00x2.30	1
Khlong Sara Kru	1-6.00, 1-6.00	2
Khlong Nong Mhu	1-6.00	1
K.Chiang Rak Yai	1-6.00	1
K.Chiang Rak Noi	1-6.00	1
Total		36

Table 3-8 (5) INVENTORY OF REGULATOR (5/5)

(Po-To-Ro)

Name	Dimension	plc
(Rangsit Tai)		
Khlong Rangsit	4-3.00	1
	1-6.00/2-2.5	1
Khlong Prapa	2-4.00	1
Khlong Prem Prachakorn	1-6.00	4
Khlong Song	1-6.00	3
Khlong Bang Khen	1-6.00	1
Khlong Bang Sue	1-6.00	1
Khlong 7	1-6.00	1
Khlong 8	1-6.00	1
Khlong 9	1-6.00	1
Khlong 10	1-6.00	1
Khlong 11	1-4.00	1
Khlong 12	1-6.00	1
	1-4.00	1
Khlong 13	1-3.50	1
	1-6.00	1
Khlong 14	1-4.00	2
khlong 15	1-6.00	2
Khlong 16	2-6.00	1
	1-6.00	1
khlong 17	1-6.00/2-2.50	1
Khlong 18	1-4.00	1
Khlong 19	1-6.00	1
Khlong 21	1-6.00	1
Khlong 22	1-6.00	1
Khlong Bang Krajik	1-6.00	1
Khlong Phra Achan	1-6.00/4-3.50	1
Khlong Moe Taek	1-4.00	1
Khlong Phaya Suren	1-6.00	2
Khlong Khi Suea	1-4.00	1
Khlong 1E	1-4.00	1
Khlong 2W	1-4.00	1
Khlong 3W	1-4.00	1
Khlong 4W	1-4.00	1
khlong lam Baen	1-4.00	1
Khlong Sam Wa	1-6.00	1
khlong Bang Chak	1-6.00	1
Khlong Lam Chala	1-3.00	1
Khlong Lam Singhto	1-4.00	1
K. Lam Bueng Khohoi	1-4.00	1
Bueng Monthong	1-5.00	1
Bueng Sakae	1-5.00	1
Bueng Lam Sai	1-6.00	1
Bueng Sam Sen	1-4.00	1
Total		52

Name	Dimension	plc
(Khlong Dan)		
Bang Na		1
Phra Khanong		1
Sam Rong		1
Bang Ping		1
Bang Thamru		1
Bang Plara	4-6.00	1
Bang Pla	4-6.00	1
Khlong Dan 2		1
Khlong Dan 1		1
Total		9
(Phra Ong Chai)		
Bang Khanak	1-6.00	1
Prachamrang	1-4.00	1
Bang Rong	1-4.00	1
Pluem-pheo-pha	3-6.00	1
Prong Krathin	3-6.00	1
Bang Khanak Noi	3-6.00	1
Tha Khai	1-8.00	1
Bang Phra	1-6.00	1
Kung Thawon Dike	2-6.00	1
Nearby Kung Thawon Dike	1-6.00	1
Bang Lampu	1-6.00	1
Tha Thua	1-6.00	1
Bung Theppayada	3-6.00	1
Pak-ta-khlong	1-6.00	1
Thep Rangsan	1-6.00	1
Phraya Wisutr	1-6.00	1
Nang Hong	1-6.00	1
K. Bang Chak	2-6.00	1
K. Krachaeng-tei	1-6.00	1
K. Peek Keo	1-6.00	1
K. Bang Phlee Noi	1-6.00	1
K. Samrong	1-6.00	1
K. Thong-khung	1-4.00	1
K. Chai-talay	2-6.00	1
K. Lat Ta Pom	2-6.00	1
K. Bang Phlee	2-6.00	1
K. Bang Samak	2-6.00	1
K. Lam Wai Ling	1-6.00	1
K. Lord Pla-duk	2-6.00	1
K. Bang Samak Kao	2-6.00	1
K. Hom Sin	2-6.00	1
K. Bung Bang Yai	2-6.00	1
K. Kanya	2-6.00	1
K. Bang Wua	2-6.00	1
K. Khwang Preng	2-6.00	1
K. Phraya Samut	2-6.00	1
Chai-talay Protec. Dike		1
Total		37

TABLE 3.9 5-YR IMPROVEMENT PLAN (1987-1991) FOR IRRIGATION AND DRAINAGE SYSTEM

(as of Feb. 1988) (Unit : Mill. Baht)

Region No.	2530 (1987)	2531 (1988)	2532 (1989)	2533 (1990)	2534 (1991)	Total
1	25	27	40	49	58	199
2	25	38	40	46	60	209
3	39	48	75	63	75	300
4	33	60	60	67	73	293
5	51	59	74	60	66	310
6	68	50	60	66	72	316
7	70	88	148	170	172	648
8	95	86	105	180	187	653
9	90	65	85	93	99	432
10	34	33	70	63	86	286
11	26	28	40	44	47	185
12	47	42	40	46	57	232
Total	603	624	837	947	1,052	4,063

Table 3-10 5-YR IMPROVEMENT PLAN (1987-1991) FOR IRRIGATION AND DRAINAGE SYSTEM OF 25 PROJECTS IN THE DELTA

(as of Feb., 1988) (Unit : Mill. Baht)

Structure	Gravity Area	Wat.Consv.A	Total
Irri. Canal & Appt. Struc.	237 (32 %)	6 (2 %)	243 (21 %)
Regulator	83 (11 %)	228 (53 %)	311 (26 %)
Drainage Structure	124 (17 %)	26 (6 %)	150 (13 %)
Concrete Bridge	68 (9 %)	42 (10 %)	110 (9 %)
Dike and Appt.Structure	165 (22 %)	76 (18 %)	241 (21 %)
Others	67 (9 %)	49 (11 %)	116 (10 %)
Total	744 (100%)	427 (100%)	1,171 (100%)
	(64 %)	(36 %)	(100 %)

Table 3-11 COST COMPONENTS OF 5-YEAR IMPROVEMENT PLAN

(Unit : Mill. Baht)

Project Name	Canal Lining & Appt	Irrig. Canal & Appt.St	Regu-lator	Improve Regu-lator	Drainag Canal & Appt.St	Drainage Struct.	Improve Drain Struct.	Ditch Lining	Improve Pump Station	R.C. Bridge	Dike & Appt.St	Improve Hoist & Gate St	Scoring Protection	Others	Total
Phonlathep	18	3	-	1	-	2	-	8	-	-	-	-	-	-	32
Thabote	23	4	-	-	-	6	-	-	-	2	-	-	-	-	35
Sam Chuk	13	9	4	5	-	12	-	-	-	4	-	1	-	2	50
Don Chedi	20	-	-	-	-	13	-	-	-	-	-	-	-	-	33
Pho Phraya	-	4	-	1	-	10	-	-	-	12	4	4	-	-	35
Borommathat	2	26	-	-	-	1	-	4	-	3	-	-	10	-	46
Chanasutr	10	1	1	-	2	4	-	1	-	4	-	1	-	7	31
Yangmanee	-	16	-	4	-	6	-	-	-	2	-	-	-	1	29
Chaochet-B.Y.	-	6	26	-	-	2	-	-	-	6	6	1	-	-	47
Phraya Banlu	-	-	12	-	-	-	-	-	-	19	12	11	-	-	54
Phra Phimon	-	-	28	-	-	1	-	-	-	-	-	-	-	3	32
Bang Ban	12	-	-	-	-	-	-	-	-	2	48	1	-	-	63
Phak Hai	-	6	6	-	-	2	-	-	-	3	21	1	-	6	45
Phasi Charoen	-	-	7	-	-	5	-	-	-	-	3	3	2	1	21
Manorom	4	8	1	-	-	5	1	-	6	1	-	-	-	-	26
Chong Kae	-	-	-	-	-	11	2	-	-	6	-	-	-	2	21
Koke Kathiem	-	1	-	-	-	12	6	-	-	6	36	-	-	1	62
Maharaj	-	14	5	-	-	6	-	-	-	7	42	-	-	-	74
Roeng Rang	-	17	13	12	-	6	1	-	7	9	14	-	-	-	79
Pasak Tai	-	5	12	-	-	8	3	-	-	4	-	-	-	2	34
Nakhon Luang	-	21	18	-	-	3	2	-	-	3	-	-	-	2	49
Rangsit Nua	-	-	35	10	-	-	7	-	-	5	-	6	-	1	64
Rangsit Tai	-	-	74	-	-	2	3	-	-	8	4	-	-	2	93
Khlong Dan	-	-	25	4	-	-	5	-	-	-	26	1	-	11	72
Pra Ong Chaiya	-	-	7	-	-	1	-	-	-	4	25	4	3	-	44
Total	102	141	274	37	2	118	30	13	13	110	241	34	15	41	1,171

Table 3-12 (1) IRRIGATION SYSTEM IMPROVEMENT 5-YEAR PLAN IN THE DELTA (GRAVITY IRRIGATION AREA) (1/3)

Project Name	Canal Lining & Appt. St.		Irri. Canal & Appt. St.		Irri. Canal Dredging		Construct. of Regulator (Po-To-Ro)		Improve. of Regulator (Po-To-Ro)		Large Drainage Structure		Small Drainage Structure	
	km	MB	km	MB	km	MB	plc	MB	plc	MB	plc	MB	plc	MB
Phonlathep	19.3	17.5	8.8	3.0	-	-	-	-	1	0.6	-	-	9	1.6
Thabote	22.0	22.8	-	-	20.0	4.1	-	-	-	-	-	-	30	6.4
Sam Chuk	16.6	13.0	13.2	9.0	-	-	1	3.8	2	4.5	3	11.0	8	0.8
Don Chedi	14.2	19.8	-	-	-	-	-	-	-	-	1	8.0	18	4.7
Pho Phraya	-	-	-	-	8.5	3.8	-	-	1	0.8	-	-	75	10.1
Borommathat	-	-	12.2	25.6	-	-	-	-	-	-	-	-	12	1.2
Chanasutr	* 7.0	3.9 6.0	*	0.3	*	0.5	1	0.6	1	0.1	-	-	41	4.1
Yangmanee	-	-	24.4	16.3	-	-	-	-	1	3.6	-	-	34	6.4
Phak Hai	-	-	8.5	5.6	-	-	1	6.0	-	-	-	-	23	1.6
Bang Ban	* 5.4	7.9 4.2	-	-	-	-	-	-	-	-	-	-	-	-
Manorom	2.4	4.0	13.8	6.0	-	-	1	1.0	1	1.0	6	6.0	2	0.2
Chong Kae	*	0.3	-	-	-	-	-	-	2	2.0	5	6.5	21	4.4
Koke Kathiem	0.7	0.3	-	-	-	0.8	22	12.5	1	0.2	5	6.1	-	-
Roeng Rang	-	-	23.8	11.1	-	-	3	30.5	-	-	4	4.6	9	1.3
Maharaj	0.3	0.4	30.2	14.3	-	-	1	4.7	-	-	2	3.0	20	2.8
Pasak Tai	-	-	24.9	5.0	-	-	-	-	-	-	2	12.0	35	8.1
Nakhon Luang	-	-	92.4	21.3	-	-	7	18.0	5	2.3	3	3.1	2	0.2
Total	87.9	100.1	252.2	117.5	28.5	9.2	38	77.1	15	15.1	31	60.3	339	53.9
Total with B/Q		88.3		117.2		8.7		77.1		15.1		60.3		53.9
Unit Cost	1.00/km		0.46/km		0.31/km		2.0/plc		1.0/plc		1.9/plc		0.16/plc	

Note : * Work volume not specified
Source : Irrigation System Improvement 5-Year Plan, RID (as of Feb. '88)

Table 3-12 (2) IRRIGATION SYSTEM IMPROVEMENT 5-YEAR PLAN IN THE DELTA (GRAVITY IRRIGATION AREA) (2/3)

Project Name	Dike & Appt. St.		Lining at D/S of FTO		Improve/Install Hoist & Gate		RC Bridge		Scoring Protection		Pumping Station		Navig. Lock	
	km	M฿	plc	M฿	plc	M฿	plc	M฿	km	M฿	plc	M฿	plc	M฿
Phonlathep	-	-	143	6.8	2	0.1	-	-	-	-	-	-	-	-
Thabote	-	-	-	-	-	-	4	1.6	-	-	-	-	-	-
Sam Chuk	-	-	-	-	1	0.7	3	3.5	-	-	-	-	-	-
Don Chedi	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pho Phraya	*	3.7	-	-	4	4.1	12	12.3	-	-	-	-	-	-
Borommathat	-	-	-	-	-	-	6	2.7	(2 plc) 0.6	9.8	-	-	-	-
Chanasutr	-	-	89	1.3	3	0.6	10	4.2	-	-	-	-	-	-
Yangmanee	-	-	-	-	-	-	5	2.3	-	-	-	-	-	-
Phak Hai	15.5	21.4	-	-	2	0.4	3	3.1	-	-	1	5.7	-	-
Bang Ban	* 23.4	22.5 25.4	-	-	28	0.8	7	2.2	-	-	-	-	-	-
Manorom	-	-	-	-	-	-	5	1.7	-	-	5	6.0	-	-
Chong Kae	-	-	-	-	4	0.1	8	5.9	-	-	-	-	-	-
Koke Kathiem	17.8	35.5	-	-	-	-	10	6.1	-	-	-	-	-	-
Roeng Rang	8.5	14.0	-	-	-	-	13	9.2	-	-	1	6.5	-	-
Maharaj	41.9	41.5	-	-	-	-	12	7.0	-	-	-	-	-	-
Pasak Tai	-	-	-	-	2	2.2	5	3.8	-	-	-	-	1	0.6
Nakhon Luang	-	-	-	-	-	-	2	2.5	-	-	-	-	-	-
Total	107.1	164.0	232	8.1	46	9.0	105	68.1	0.6	9.8	7	18.2	1	0.6
Total with B/Q		141.5		8.1		9.0		68.1		9.8		18.2		0.6
Unit Cost	1.32/km		0.035/plc		(L) 1.1/plc (S) 0.07/plc (Ave) 0.20/plc		0.65/plc		16/km		2.6/km			

Note : * Work volume not specified
Source : Irrigation System Improvement 5-Year Plan, RID (as of Feb. '88)

Table 3-12 (3) IRRIGATION SYSTEM IMPROVEMENT 5-YEAR PLAN IN THE DELTA (GRAVITY IRRIGATION AREA) (3/3)

Project Name	Others		Total		Baht/rai									
		M฿		M฿		M฿		M฿		M฿		M฿		M฿
Phonlathep		0.7		30.3		316								
Thabote		0.4		35.3		197								
Sam Chuk		1.1		47.4		155								
Don Chedi		0.0		32.5		226								
Pho Phraya		0.2		35.0		95								
Borommathat		5.9		45.2		124								
Chanasutr		7.9		29.5		62								
Yangmanee		0.7		29.3		126								
Phak Hai		0.4		44.2		215								
Bang Ban		0.4		63.4		440								
Manorom		0.8		26.7		113								
Chong Kae		1.6		20.8		71								
Koke Kathiem		1.2		62.7		285								
Roeng Rang		1.4		78.6		430								
Maharaj		0.0		73.7		155								
Pasak Tai		1.9		33.6		139								
Nakhon Luang		1.7		49.1		184								
Total		26.3		737.3		3,333								
Total with B/Q														
Unit Cost														

Note : * Work volume not specified
Source : Irrigation System Improvement 5-Year Plan, RID (as of Feb. '88)

Table 3-13 (1) IRRIGATION SYSTEM IMPROVEMENT 5-YEAR PLAN IN THE DELTA (WATER CONSERVATION AREA) (1/2)

Project Name	Irri. Canal & Appt. St.		Construction of Regulator (Po-To-Ro)		Improve. Requlator (Po-To-Ro)		Large Drainage Structure		Small Drainage Structure		Dike & Appt. St.		Install/Imp. Hoist & Gate	
		MB		MB		MB		MB		MB		MB		MB
Chao Chet-B.Y.	*	5.9	7	26.0	-	-	3	1.5	-	-	4.2	5.5	1	0.7
Phraya Ban Lue	-	-	2	11.5	-	-	-	-	-	-	* 3.9	5.7 6.3	10	11.4
Phra Phimon	-	-	10	28.0	-	-	-	-	-	-	-	-	-	-
Phasi Charoen	-	-	1	6.5	-	-	4	4.9	-	-	3.5	2.5	6	3.0
Rangsit Nua	-	-	7	35.2	2 23	9.5 7.1	-	-	1	0.4	-	-	5	6.4
Rangsit Tai	-	-	13	73.9	-	-	-	-	16	1.9	*	3.5	-	-
Khlong Dan	-	-	4	25.0	2	4.0	-	-	-	-	* 3.3	13.7 12.0	-	-
Pra Ong Chaiya.	-	-	1	6.6	-	-	1	1.3	-	-	*	25.0	14	4.5
Total	-	5.9	45	212.7	27	20.6	8	7.7	17	2.3	14.9	74.2	36	26.0
Total with B/Q		-		212.7		20.6		7.7		2.3		26.3		26.0
Unit Cost	-		4.7/plc		0.76/plc		0.96/plc		0.14/plc		1.8/km		0.72/plc	

Note :: * Work volume not specified

Source : Irrigation System Improvement 5-Year Plan, RID (as of Feb.'88)

Table 3-13 (2) IRRIGATION SYSTEM IMPROVEMENT 5-YEAR PLAN IN THE DELTA (WATER CONSERVATION AREA) (2/2)

Project Name	RC Bridge		Scoring Protection		Others		Total		Baht/rai					
	plc	MB	plc	MB		MB		MB		MB		MB		MB
Chao Chet-B.Y.	2	6.0	-	-		-		45.6		112				
Phraya Ban Lue	6	19.2	-	-		-		54.1		124				
Phra Phimon	-	-	-	-		3.2		31.2		120				
Phasi Charoen	-	-	1	1.6		1.2		19.7		99				
Rangsit Nua	3	5.5	-	-		-		64.1		141				
Rangsit Tai	4	7.5	-	-		4.4		91.2		158				
Khlong Dan	-	-	1	1.4		15.6		71.7		136				
Pra Ong Chaiya.	1	3.9	1	3.6		-		44.9		88				
Total	16	42.1	3	6.6		24.4		422.5		978				
Total with B/Q		42.1		6.6										
Unit Cost	2.6/plc		2.2/plc											

Note :: * Work volume not specified

Source : Irrigation System Improvement 5-Year Plan, RID (as of Feb.'88)

Table 3-14 SUMMARY OF COST FOR 5-YEAR PLAN IN THE DELTA BY WORK ITEM

(Unit : Mill. Baht)

Work Item	Gravity Irrigation Area		Water Conservation Area		Total (%)
	Unit Cost	Cost (%)	Unit Cost	Cost (%)	Cost
Canal Lining & Appt. St.	1.00 /km	100.1 (13.6)	-	-	100.1 (8.5)
Irri. canal & Appt. St.	0.46 "	117.5 (15.9)	-	5.9 (1.4)	123.4 (10.5)
Irri. canal dredging	0.31 "	9.2 (1.2)	-	-	9.2 (0.78)
Regulator (Po-To-Ro)	2.0 /plc	77.1 (8.8)	4.7 /plc	212.7 (50.3)	282.5 (24.1)
Improve Regulator (Po-To-Ro)	1.0 "	15.1 (3.7)	0.76 "	20.6 (4.9)	48.5 (4.1)
Large drainage St.	1.9 "	60.3 (8.2)	0.96 "	7.7 (1.8)	69.0 (5.9)
Ordinary drainage St.	0.16 "	53.9 (7.3)	0.14 "	2.3 (0.5)	56.3 (4.8)
Dike & Appt. St.	1.32 /km	164.0 (22.2)	1.8 /km	74.2 (17.6)	240.0 (20.4)
Lining at D/S of FTO	0.035 /plc	8.1 (1.1)	-	-	8.1 (0.7)
Imp./install. Hoist & Gate St.	0.20 "	9.0 (1.2)	0.72 /plc	26.0 (6.2)	35.7 (3.0)
RC Bridge	0.65 "	68.1 (9.2)	2.6 "	42.1 (10.0)	112.8 (9.6)
Scoring Protection	16 /km	9.8 (1.3)	2.2 "	6.6 (1.6)	18.6 (1.6)
Pumping station	2.6 /plc	18.2 (2.5)	-	-	18.2 (1.6)
Navigation lock repair	-	0.6 (0.08)	-	-	0.6 (0.05)
Others	-	26.3 (3.6)	-	24.4 (5.8)	50.7 (4.3)
Total		737.3 (100)		422.5 (100)	1,173.7 (100)

Sorce : Irrigation System Improvement 5-Year Plan (as of Feb. '88), RID.

Table 3-15 (1) QUESTIONNAIRE SURVEY PROJECT LIST (1/2)

Project Name	No. of Water Master	Service Area (rai)	No. of Zoneman Officer	No. of Zoneman Employee	Remarks
(Region No.7)					
1. Phonlathep	3	10,000	1	5	Gravity
(118,700 rai)		30,000	1	2	Irrigation
		78,700	–	1	Area
2. Thabote	2	61,888	–	3	– do –
(218,356 rai)		156,468	3	6	
3. Sam Chuk	4	110,190	–	7	– do –
(372,100 rai)		83,300	2	2	
		94,950	1	3	
		83,660	1	4	
4. Don Chedi	2	79,600	1	7	– do –
(162,500 rai)		82,900	1	5	
5. Pho Phraya	4	118,021	2	5	– do –
(415,938 rai)		120,892	–	8	
		113,890	2	5	
		63,135	2	–	
6. Borommathat	4	83,340	–	5	– do –
(369,077 rai)		92,292	1	8	
		110,959	1	9	
		82,486	–	5	
7. Chanasutr	7	56,700	–	6	– do –
(527,000 rai)		84,900	1	6	
		60,300	–	5	
		84,000	1	5	
		63,500	–	6	
		81,600	2	6	
		96,000	2	7	
8. Yangmanee	3	81,122	1	3	– do –
(233,689 rai)		71,163	–	7	
		81,402	–	8	
9. Phak Hai	4	44,000	–	–	Gravity
(206,000 rai)		66,000	1	–	Irrigation
		50,000	–	3	Area
		46,000	–	–	
10. Chao Chet-Bang	3	145,660	1	1	Water Con-
Yihon		116,420	1	2	servation
(406,000 rai)		143,920	3	1	Area
11. Phraya Ban Lu	5	–	–	–	– do –
(437,500 rai)		117,700	1	3	
		93,940	2	1	
		111,630	3	–	
		114,230	–	2	
12. Phra Phimon	2	127,550	4	1	– do –
(277,560 rai)		150,010	1	2	

(to be continued)

Table 3-15 (2) QUESTIONNAIRE SURVEY PROJECT LIST (2/2)

Project Name	No. of Water Master	Service Area (rai)	No. of Zoneman		Remarks
			Officer	Employee	
13. Phasi Charoen	2	120,500	-	4	- do -
(287,850 rai)		167,350	-	5	
14. Bang Ban	2	82,530	1	4	Gravity
(160,000 rai)		77,470	1	1	Irrigation
					Area
15. Kra-Sieo	3	-	1	-	- do -
(130,000 rai)		46,500	-	3	
		83,500	-	3	
(Region No.8)					
16. Manorom	3	88,653	-	8	Gravity
(264,110 rai)		97,917	5	6	Irrigation
		77,540	-	7	Area
17. Chong Kae	2	120,321	2	6	- do -
(238,739 rai)		118,418	-	10	
18. Koke Kathiem	2	101,330	1	8	- do -
(228,300 rai)		126,970	1	9	
19. Roeng Rang	2	98,080	-	5	- do -
(203,780 rai)		105,700	-	8	
20. Maharaj	6	106,500	-	7	- do -
(501,800 rai)		80,900	1	7	
		78,000	-	7	
		78,580	-	7	
		77,570	1	7	
		80,250	-	7	
21. Khlong Prieo-Saohai	2	70,360	1	4	- do -
(135,260 rai)		64,900	1	-	
22. Pasak Tai	2	119,060	1	3	- do -
(272,000 rai)		152,940	1	5	
23. Nakhon Luang	3	102,210	-	9	- do -
(301,795 rai)		112,655	6	4	
		86,930	2	5	
24. Rangsit Nua	3	155,000	1	10	Water Con-
(445,500 rai)		137,350	2	10	servation
		153,150	3	8	Area
25. Rangsit Tai	5	100,000	3	-	- do -
(526,000 rai)		105,000	3	1	
		110,000	2	1	
		96,000	3	1	
		115,000	2	1	
26. Khlong Dan	4	-	-	-	-
do -					
(569,020 rai)		209,150	8	2	
		186,490	5	1	
		173,380	5	-	
(Region No.9)					
27. Pra Ong Chaiya-nuchit	4	133,000	1	5	- do -
		132,900	-	3	
(510,000 rai)		95,400	1	3	
		148,700	1	6	

Table 3-15 (1) SUMMARY OF QUESTIONNAIRE ANSWERS BY PROJECT MANAGERS (1/2)

No.	Item	Gravity Irrigation Area (GIA) (19 projects)	Water Conservation Area (WCA) (8 projects)
1.	No. of water master	2-7 water masters; ave. 3.1	2-5 water masters; ave. 3.5
2.	Year of const. completion	1961 in average	1935 in average
3.	Service area	38,000 rai	62,000 rai: 1.6 times of in GIA
4.	Service area per officer	2,700 rai/pers.	3,100 rai/pers.; 10% difference from in GIA
5.	Service area per employee	139 rai/pers.	304 rai/pers; over 2 times of in GIA
6.	Experience of project Manager	14 yrs as manager, 27 yrs served for RID, 52 yrs of age	13 yrs as manager, 26 yrs served for RID, 51 yrs of age; no difference from GIA
7.	Water shortage in wet season	once in 5 yrs in 11 projects, Ave. 12,000 rai/prj.	once in 3 yrs in 1 project, 7,000 rai
8.	Water shortage in dry season	twice in 3 yrs in 15 projects, Ave. 29,000 rai/prj.	7 projects yearly, Ave. 88,000 rai/prj ; almost whole area
9.	Flood damage	twice in 5 yrs in 16 projects, Ave. 21,000 rai/proj; 46% of whole area	once in 16 yrs in 8 projects Ave. 101,000 rai; whole area
10.	Salinity problem	none	4 projects yearly, Ave. 41,000 rai
11.	Acid soil problem	3 projects yearly, Ave. 6,000 rai/prj.	once in 6 yrs in 2 projects, 32,000 rai/prj.
12.	Water quality problem	2 projects yearly, 1,000 rai/prj.	twice in 3 yrs in 8 prj, Ave.39,000 about a half of whole area

(to be continued)

Table 3-16 (2) SUMMARY OF QUESTIONNAIRE ANSWERS BY PROJECT MANAGERS (2/2)

13.	O & M cost in last 3-yr	฿341/rai ; 13.0 M฿/yr				฿224/rai ; 2/3 of GIA, 13.9 M฿/yr				
14.	Maintenance condition (points)	Function (1-3)	Damage (1-5)	Needs for Measure (1-5)	No. of Ans.Prj.	Function (1-3)	Damage (1-5)	Needs for Measure (1-5)	No. of Ans.Prj.	
	Irr./Drain. canal	2.6	4.0	3.9	19	2.5	3.6	4.0	8	(High point
	Natural canal	2.7	4.0	3.8	15	2.4	3.6	4.3	8	good condi-
	FTO	2.4	3.5	3.6	18	-	-	-	1	tion)
	Dike	2.9	4.5	4.6	13	2.8	3.4	3.8	5	
	Regulator	2.8	4.2	4.1	19	3.0	3.6	4.2	7	
	Navigation lock	2.9	4.4	4.3	13	2.9	4.4	4.1	8	
	Pumping station	2.9	4.8	4.2	8	3.0	4.7	4.7	3	
	Siphon	2.7	4.3	4.2	17	2.5	3.0	4.1	3	
	Road	2.5	3.4	2.9	19	2.3	3.7	3.9	7	
		2.8	4.2	4.2	19	2.6	3.3	3.5	8	
15.	Reinforcement wanted (point)	Degree (1-5)	No. of Answered project			Degree (1-5)	No. of Answered project		(High point for	
	Quality staff	1.8	19			1.1	8		no reinforcement,	
	Vehicle	1.8	19			1.4	8		low point for	
	Communi. equipment	2.2	19			2.8	8		high needs for	
	Office equipment	2.6	19			2.5	8		reinforcement)	
	O & M equipment	2.4	18			3.3	8			
	Training	2.4	19			2.4	8			
	Office building	4.8	17			3.4	8			

Table 3-17 SUMMARY OF QUESTIONNAIRE ANSWERS BY WATER MASTERS

No.	Item	Gravity Irrigation Area (GIA) (19 Projects; 58 Water Master Secs.)	Water Conservation Area (WCA) (18 Projects; 28 Water Master Sections
1.	Service area	85,000 rai/section	124,000 rai/section; 1.5 times of in GIA
2.	Number of staff:		
	Zoneman	6.3 pers. (13,500 rai/pers.)	4.0 pers. (31,000 rai/pers.; 2.3 times of in GIA)
	Gate tender	16.6 pers. (5,100 ")	12.6 pers. (9,800 " ; 1.9 ")
	Other staff	39.9 pers. (2,100 ")	21.5 pers. (5,800 " ; 2.8 ")
3.	Experience of water master	8.6 years as water master 21 years serving for RID 44 years of age	6.6 years as water master 18 years serving for RID 41 years of age
4.	Water shortage in wet season	once in 2 years in 27 sections; Ave. 11,000 rai	once in 2 years in 4 sections; Ave. 4,200 rai
5.	Water shortage in dry season	twice in 3 years in 35 sections; Ave. 17,000 rai	3 times in 4 years in 21 sections; Ave. 36,000 rai
6.	Flood damage	once in 3 yrs in 39 sections; Ave. 8,000 rai	once in 4 yrs in 22 sections; Ave. 25,000 rai
7.	Salinity problem	30 rai in 1 section	twice in 3 yrs in 3 sections; Ave. 7,100 rai
8.	Acid soil problem	3 sections yearly; Ave. 5,400 rai	1 section yearly; 30,000 rai
9.	Water quality problem	7 sections yearly; Ave. 2,500 rai	18 sections yearly; Ave. 15,000 rai

Table 3-18 SUMMARY OF IMPROVEMENT WORK WANTED BY FIELD OFFICES IN GRAVITY AREA IN THE DELTA

	Reg.7	Reg.8	Total	Reg.7	Reg.8	Total	Reg.7	Reg.8	Total	Reg.7	Reg.8	Total	Reg.7	Reg.8	Total
Canal (km)	Irrigation Canal			Drainage Canal			Communicat. Canal			Natural Canal			Total Canal		
Dredging	609	523	1132	635	665	1300	86	22	108	272	153	425	1602	1363	2965
Widening	4	135	139	38	26	64	0	0	0	0	12	12	42	173	215
Removal of structr	7	1	8	1	32	33	0	0	0	0	0	0	8	33	41
Slope protection	160	163	323	40	201	241	0	0	0	10	20	30	210	384	594
New construction	18	134	152	21	12	33	0	0	0	0	0	0	39	146	185
Lining	357	65	422	0	0	0	0	0	0	0	0	0	357	65	422
(Major Repair)	50	28	78	14	0	14	0	0	0	0	0	0	64	28	92
Sub-total	1205	1049	2254	749	936	1685	86	22	108	282	185	467	2322	2192	4514
Dike (km)	Flood Protec Dike			Canal Dike			Road			Other Dikes			Total Dike		
Hightening	170	175	345	286	259	545	36	109	145	90	10	100	582	553	1135
Widening	74	67	141	148	171	319	0	7	7	70	0	70	292	245	537
Paving	50	191	241	197	84	281	108	0	108	0	0	0	355	275	630
Slope protection	62	108	170	205	91	296	0	15	15	1	5	6	268	219	487
New construction	103	15	118	0	20	20	6	0	6	36	0	36	145	35	180
(Major Repair)	0	0	0	30	0	30	0	0	0	0	0	0	30	0	30
Sub-total	459	556	1015	866	625	1491	150	131	281	197	15	212	1672	1327	2999
Other Struc. (plc)	Regulator (Po-To-Ro)			Regulator (To-Ro-Bo)			Siphon/Culvert/Flume			Pumping Station			Navigation Lock		
Bigger gate	3	3	6	10	7	17	1	1	2	0	0	0	0	0	0
Stop water leak	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0
New construction	56	7	63	96	35	131	25	4	29	14	2	16	8	4	12
Repair gate/hoist	2	2	4	34	76	110	0	7	7	0	1	1	1	1	2
Repair other struc	4	13	17	41	21	62	5	5	10	1	0	1	2	1	3
Remove sedi./weeds	41	13	54	0	0	0	0	0	0	12	2	14	1	0	1
(Major repair)	7	0	7	25	0	25	20	0	20	0	0	0	0	0	0
Sub-total	114	39	153	206	139	345	51	17	68	27	5	32	12	6	18

N.B. Work volumes are only those answered in the questionnaire; some were not answered.
One project in Reg. 9 is counted in Reg. 8.

Table 3-19 SUMMARY OF IMPROVEMENT WORK WANTED BY FIELD OFFICES IN THE DELTA

	Gravi	Consv	Total	Gravi	Consv	Total	Gravi	Consv	Total	Gravi	Consv	Total	Gravi	Consv	Total
Canal (km)	Irrigation Canal			Drainage Canal			Communicat. Canal			Natural Canal			Total Canal		
Dredging	1132	988	2120	1300	1089	2389	108	489	597	425	2218	2643	2965	4784	7749
Widening	139	0	139	64	0	64	0	0	0	12	970	982	215	970	1185
Removal of structr	8	170	178	33	3	36	0	0	0	0	0	0	41	173	214
Slope protection	323	10	333	241	140	381	0	25	25	30	25	55	594	200	794
New construction	152	0	152	33	13	46	0	20	20	0	0	0	185	33	218
Lining	422	289	711	0	0	0	0	0	0	0	0	0	422	289	711
(Major Repair)	78	0	78	14	0	14	0	0	0	0	0	0	92	0	92
Sub-total	2254	1457	3711	1685	1245	2930	108	534	642	467	3213	3680	4514	6449	10963
Dike (km)	Flood Protec Dike			Canal Dike			Road			Other Dikes			Total Dike		
Hightening	345	108	453	545	294	839	145	13	158	100	0	100	1135	415	1550
Widening	141	93	234	319	91	410	7	0	7	70	0	70	537	184	721
Paving	241	70	311	281	135	416	108	12	120	0	0	0	630	217	847
Slope protection	170	5	175	296	0	296	15	0	15	6	0	6	487	5	492
New construction	118	88	206	20	0	20	6	0	6	36	0	36	180	88	268
(Major Repair)	0	12	12	30	0	30	0	0	0	0	0	0	30	12	42
Sub-total	1015	376	1391	1491	520	2011	281	25	306	212	0	212	2999	921	3920
Other Struc. (plc)	Regulator (Po-To-Ro)			Regulator (To-Ro-Bo)			Siphon/Culvert/Flume			Pumping Station			Navigation Lock		
Bigger gate	6	11	17	17	3	20	2	0	2	0	0	0	0	0	0
Stop water leak	2	16	18	0	5	5	0	0	0	0	0	0	0	0	0
New constructure	63	38	101	131	94	225	29	0	29	16	3	19	12	6	18
Repair gate/hoist	4	43	47	110	4	114	7	1	8	1	0	1	2	3	5
Repair other struc	17	15	32	62	19	81	10	0	10	1	3	4	3	1	4
Remove sedi./weeds	54	29	83	0	0	0	0	0	0	14	6	20	1	4	5
(Major repair)	7	54	61	25	54	79	20	2	22	0	0	0	0	3	3
Sub-total	153	206	359	345	179	524	68	3	71	32	12	44	18	17	35

N.B. Work volumes are only those answered in the questionnaire; some were not answered.

Table 3-20 WORK REQUIREMENT WANTED FOR IMPROVEMENT & REPAIR OF IRRI. & DRAINAGE SYSTEM IN THE DELTA BY STRUCTURE TYPE

Work Item	Unit	Gravity Irri. Area			Water Conserv. Area			Total		
		Req'ed	Exist.	(%)	Req'ed	Exist.	(%)	Req'ed	Exist.	(%)
1. Irrigation Canal	km	2,254	3,490	(65)	1,457	⇩	*	3,711	⇩	*
2. Drainage Canal	km	1,685	2,387	(71)	1,245	⇩	*	2,930	⇩	*
3. Communi. Canal	km	108	*	*	534	⇩	*	642	⇩	*
4. Natural Canal	km	467	*	*	3,213	⇩	*	3,680	⇩	*
Total	km	4,515	5,877	*	6,449	5,419*2	*	10,963	11,296	*
5. Flood Protec. Dike	km	1,015	*	*	376	*	*	1,391	*	*
6. Canal Dike	km	1,491	*	*	520	*	*	2,011	*	*
7. Road	km	281	*	*	25	*	*	306	*	*
8. Other Dike	km	212	*	*	0	*	*	212	*	*
Total	km	2,999	*	*	921	*	*	3,920	*	*
9. Reg. (Po-To-Ro)	plc	153	167	(92)	206	279	(74)	359	446	(80)
10. Reg. (To-Ro-Bo)	plc	345	1,028	(34)	179	198	(90)	524	1,126	(47)
11. Siphon/Flume/Culvert	plc	68	*	*	3	*	*	71	*	*
12. Pump Station	plc	32	*	*	12	*	*	44	*	*
13. Navigation Lock	plc	18	*	*	17	*	*	35	*	*

N.B. Work values are only those answered in the questionnaire to water masters; some did not answer.

*2 Calculated from 1:50,000 project maps; some natural streams are not counted into.

PHONLATHEP

Table 3-21 (1) WORK VOLUME AND ESTIMATED COST FOR REPAIR AND IMPROVEMENT WANTED BY FIELD STAFF (1/25)

(CANAL)	Irrigation Canal			Drainage Canal			Communi. Canal			Natural Canal			Remarks
	M฿	km	M฿	M฿	km	M฿	M฿	km	M฿	M฿	km	M฿	
Dredging	0.05		-	0.1	22.2	2.2	0.2	2.9	0.6	0.2		-	2/3 blocks
Widening	0.25		-	0.45		-	0.45		-	0.45		-	40,000/118,700=33%
Removal of St.	0.15		-	0.3		-	0.3		-	0.3		-	
Slope Protection	0.05		-	0.05		-	0.05		-	0.05		-	
New Construction	0.8	2.0	1.6	1.6		-	3.0		-	-		-	
Lining	1.0	27.7	27.7	-		-	-		-	-		-	
Major Repair	0.5		-	0.5		-	0.9		-	-		-	
Total			29.3			2.2			0.6			0	

(DIKE)	Flood Protec. Dike			Canal Dike			Road			Other Dike			
	M฿	km	M฿	M฿	km	M฿	M฿	km	M฿	M฿	km	M฿	
Heightening	0.25		-	0.25	3.7	0.9	0.6		-	0.15	70.3	10.5	
Widening	0.25		-	0.25		-	0.6		-	0.15	70.3	10.5	
Paving	0.3		-	0.3		-	1.0		-	0.3		-	
Slope Protection	0.05		-	0.05		-	0.05		-	0.05		-	
New Construction	1.3		-	-		-	3.0		-	0.7		-	
Major Repair	0.4		-	0.4		-	1.0		-	0.2		-	
Total			0			0.9			0			21.0	Grand Total 59.3

(OTHER STRUC.)	Regulator/Barrage			Regulator			Siphon/Culvert			Pumping Station			Navigation Lock		
	M฿	plc	M฿	M฿	plc	M฿	M฿	plc	M฿	M฿	plc	M฿	M฿	plc	M฿
Larger Gate	1.2			0.1			0.1			0.1					
Water Leak	0.05		-	-		-	-		-	-		-	-		-
Lower Sill	-		-	-		-	-		-	-		-	-		-
New Construction	2.0		-	0.15		-	0.15		-	2.6		-	4.0		-
Repair Gate/Hoist	1.1	1	1.1	0.1	23	2.3	0.1		-	0.6		-	0.6	1	0.6
Repair Other St.	0.5		-	0.05	15	0.8	0.05	3	0.2	0.3		-	0.3	1	0.3
Remove Sedi/Weeds	0.05		-	-		-	-		-	0.05		-	0.05		-
Major Repair	1.0		-	0.05		-	0.05		-	0.8		-	1.2		-
Total			1.1			3.1			0.2			0			0.9

Table 3-21 (2) WORK VOLUME AND ESTIMATED COST FOR REPAIR AND IMPROVEMENT WANTED BY FIELD STAFF (2/25)

THABOTE

(CANAL)	Irrigation Canal			Drainage Canal			Communi. Canal			Natural Canal			Remarks		
Dredging	0.05 M฿	km	- M฿	0.1 M฿	31.0 km	3.1 M฿	0.2 M฿	3.9 km	0.8 M฿	0.2 M฿	1.5 km	0.3 M฿	2/2 block		
Widening	0.25		-	0.45		-	0.45		-	0.45		-			
Removal of St.	0.15		-	0.3	0.2	0.1	0.3		-	0.3		-			
Slope Protection	0.05		-	0.05		-	0.05		-	0.05		-			
New Construction	0.8		-	1.6		-	3.0		-	-		-			
Lining	1.0	75.9	75.9	-		-	-		-	-		-			
Major Repair	0.5		-	0.5	13.5	6.8	0.9		-	-		-			
Total			75.9			10.0			0.8			0.3			
(DIKE)	Flood Protec. Dike			Canal Dike			Road			Other Dike					
Heightening	0.25 M฿	km	- M฿	0.25 M฿	10.0 km	2.5 M฿	0.6 M฿	km	- M฿	0.15 M฿	- km	- M฿			
Widening	0.25		-	0.25	3.1	0.8	0.6		-	0.15		-			
Paving	0.3		-	0.3		-	1.0		-	0.3		-			
Slope Protection	0.05		-	0.05		-	0.05		-	0.05		-			
New Construction	1.3		-	-		-	3.0		-	0.7		-			
Major Repair	0.4		-	0.4		-	1.0		-	0.2		-			
Total			0			3.3			0			0	Grand Total 94.4		
(OTHER STRUC.)	Regulator/Barrage			Regulator			Siphon/Culvert			Pumping Station			Navigation Lock		
Larger Gate	1.2 M฿	plc	- M฿	0.1 M฿	plc	- M฿	0.1 M฿	plc	- M฿	0.1 M฿	plc	- M฿	- M฿	plc	- M฿
Water Leak	0.05		-	-		-	-		-	-		-	-		-
Lower Sill	-		-	-		-	-		-	-		-	-		-
New Construction	2.0		-	0.15		-	0.15		-	2.6		-	4.0		-
Repair Gate/Hoist	1.1		-	0.1		-	0.1		-	0.6		-	0.6		-
Repair Other St.	0.5		-	0.05		-	0.05		-	0.3		-	0.3		-
Remove Sedi/Weeds	0.05		-	-		-	-		-	0.05		-	0.05		-
Major Repair	1.0	3	3.0	0.05	20	1	0.05	2	0.1	0.8		-	1.2		-
Total			3.0			1			0.1			0			0

SAMCHUK

Table 3-21 (3) WORK VOLUME AND ESTIMATED COST FOR REPAIR AND IMPROVEMENT WANTED BY FIELD STAFF (3/25)

(CANAL)	Irrigation Canal			Drainage Canal			Communi. Canal			Natural Canal			Remarks
Dredging	0.05 M฿	52.8 km	2.6 M฿	0.1 M฿	20.0 km	2.0 M฿	0.2 M฿	km	- M฿	0.2 M฿	km	- M฿	
Widening	0.25		-	0.45	3.0	1.4	0.45		-	0.45		-	
Removal of St.	0.15		-	0.3	0.8	0.2	0.3		-	0.3		-	
Slope Protection	0.05	0.8	0	0.05		-	0.05		-	0.05		-	
New Construction	0.8		-	1.6		-	3.0		-	-		-	
Lining	1.0	30.0	30.0	-		-	-		-	-		-	
Major Repair	0.5		-	0.5		-	0.9		-	-		-	
Total			32.6			3.6			0			0	

(DIKE)	Flood Protec. Dike			Canal Dike			Road			Other Dike			
Heightening	0.25 M฿	km	- M฿	0.25 M฿	4.4 km	1.1 M฿	0.6 M฿	km	- M฿	0.15 M฿	km	- M฿	
Widening	0.25		-	0.25	31.6	7.9	0.6		-	0.15		-	
Paving	0.3		-	0.3		-	1.0	30.0	30.0	0.3		-	
Slope Protection	0.05		-	0.05		-	0.05		-	0.05		-	
New Construction	1.3		-	-		-	3.0		-	0.7		-	
Major Repair	0.4		-	0.4		-	1.0		-	0.2		-	
Total			0			9.0			30.0			0	Grand Total 84.1

(OTHER STRUC.)	Regulator/Barrage			Regulator			Siphon/Culvert			FTO			Navigation Lock		
Larger Gate	1.2 M฿	2 plc	2.4 M฿	0.1 M฿	7 plc	0.7 M฿	0.1 M฿	1 plc	0.1 M฿	- M฿	plc	- M฿	- M฿	plc	- M฿
Water Leak	0.05	1	0.1	-		-	-		-	-		-	-		-
Lower Sill	-		-	-		-	-		-	-		-	-		-
New Construction	2.0	2	4.0	0.15	1	0.2	0.15		-	-		-	4.0		-
Repair Gate/Hoist	1.1		-	0.1	2	0.2	0.1		-	0.03	31	0.9	0.6		-
Repair Other St.	0.5		-	0.05		-	0.05		-	-		-	0.3		-
Remove Sedi/Weeds	0.05		-	-		-	-		-	-		-	0.05		-
Major Repair	1.0		-	0.05	5	0.3	0.05		-	-		-	1.2		-
Total			6.5			1.4			0.1			0.9			0

DON CHEDI

Table 3-21 (4) WORK VOLUME AND ESTIMATED COST FOR REPAIR AND IMPROVEMENT WANTED BY FIELD STAFF (4/25)

(CANAL)	Irrigation Canal			Drainage Canal			Communi. Canal			Natural Canal			Remarks
Dredging	0.05 MB	12.8 km	0.6 MB	0.1 MB	3.0 km	0.3 MB	0.2 MB	km	- MB	0.2 MB	7.5 km	1.5 MB	1/2 block
Widening	0.25		-	0.45	17.5	7.9	0.45		-	0.45		-	
Removal of St.	0.15		-	0.3	0.1	0.0	0.3		-	0.3		-	82,900 / 162,500 = 51%
Slope Protection	0.05	5.4	0.3	0.05		-	0.05		-	0.05		-	
New Construction	0.8	2.0	1.6	1.6		-	3.0		-	-		-	
Lining	1.0	26.0	26.0	-		-	-		-	-		-	
Major Repair	0.5		-	0.5		-	0.9		-	-		-	
Total			28.5			8.2			0			1.5	

(DIKE)	Flood Protec. Dike			Canal Dike			Road			Other Dike		
Heightening	0.25 MB	17.5 km	4.4 MB	0.25 MB	km	- MB	0.2 MB	km	- MB	0.15 MB	km	- MB
Widening	0.25	17.5	4.4	0.25		-	0.2		-	0.15		-
Paving	0.3	17.5	5.3	0.3	10.9	3.3	1.0		-	0.3		-
Slope Protection	0.05		-	0.05	14.6	0.7	0.05		-	0.05		-
New Construction	1.3		-	-		-	1.0	6.0	6.0	0.7		-
Major Repair	0.4		-	0.4		-	0.3		-	0.2		-
Total			14.1			4.0			6.0			0

Grand Total 65.8

(OTHER STRUC.)	Regulator/Barrage			Regulator			Siphon/Culvert			Pumping Station			Navigation Lock		
Larger Gate	1.2 MB	plc	- MB	0.1 MB	plc	- MB	0.1 MB	plc	MB	0.1 MB	plc	- MB	- MB	plc	- MB
Water Leak	0.05		-	-		-	-		-	-		-	-		-
Lower Sill	-		-	-		-	-		-	-		-	-		-
New Construction	2.0	1	2	0.15	10	1.5	0.15		-	2.6		-	4.0		-
Repair Gate/Hoist	1.1		-	0.1		-	0.1		-	0.6		-	0.6		-
Repair Other St.	0.5		-	0.05		-	0.05		-	0.3		-	0.3		-
Remove Sedi/Weeds	0.05		-	-		-	-		-	0.05		-	0.05		-
Major Repair	1.0		-	0.05		-	0.05		-	0.8		-	1.2		-
Total			2			1.5			0			0			0