# Chapter 2 Contents of the Project

facilities, rural roads and rural electrification are expected to be realized in the project area. The Grant Aid Project is to rehabilitate irrigation facilities and rural roads and undertake rural electrification.

Inputs and Activities Plan

Japan's side:

1. Rehabilitation of irrigation facility
   (1) Rehabilitation of Ho Thanh reservoir irrigation system
      1) Countermeasure for reservoir leakage
      2) Rehabilitation of main canal No.2 : 2.4 km long
   (2) Rehabilitation of Nam Trung pump irrigation system
      1) Rehabilitation of pumping station
      2) Rehabilitation of main canal : 3.6 km long
2. Improvement of rural roads
   (1) Improvement of Route 15A : 15.7 km long (asphalt pavement, 4 bridges, countermeasures for erosion at 3 sites) and partial improvement in 4.4 km long (raising up road surface at 3 sections, 1 box culvert,)
   (2) Improvement of Nam Kim-Nam Phuc-Nam Cuong road : 6.1 km long (asphalt pavement 4.3 km long, concrete pavement 2.6 km long, 1 bridge and 4 box culverts)
3. Construction related to the rural electrification
   (1) Construction of substations with transformers, installation of transmission and distribution lines (for three areas of Ru Bui, Am Gia and Dong Trai)
4. Detailed design and Implementation Supervision

Vietnamese side:

1. To secure the land necessary for the project implementation
2. Construction of a part of the projects under VN's responsibility
3. Operation and Maintenance for constructed facilities

Note: The construction of rural drainage facility is excluded from the components of the project because GOV has already started this construction as an urgent measure for the flood that occurred in September 2002.

Organizations related to the operation and maintenance include Departments of Nghe An Province, maintenance companies, People's Committee of Nam Dan District and cooperatives of communes. Operation, maintenance and management are proceeded basically under the existing system.

### 2-2-1-6 Policy related to Facilities' Grade

- To keep facility grade to an appropriate level where maintenance applies.
- To regard grades of existing facilities and of adopted plans as important.
- To adopt the road class set by GOV.
- To consider the "visibility of Japanese Aid".

### 2-2-1-7 Policy related to Method of Construction, Procurement and Terms of Construction

- To adopt construction methods taking into account the availability of local engineers and local technical standards.
- To adopt construction methods that can improve local techniques.
- The procurement method of materials and labors is to be a package contract by competitive bid.
- Construction materials should be procured whenever possible in the proximity of the project area and/or in VN.
- To divide the term of construction work into 3 periods, considering the term of Detailed Design by the consultant, bidding, construction, natural and socio-economic conditions of the project area.

**Table 2-2-1-7.1 Division of Construction Term**

| | The first term | The second term | The third term |
|---|---|---|---|
| Detailed Design／Construction Supervision | ○ | ○ | ○ |
| Construction・Procurement | | | |
| Rehabilitation of Ho Thanh Reservoir Irrigation System | ○ | | |
| Rehabilitation of Nam Trung Pump Irrigation System | | ○ | ○ |
| Improvement of NR15A | ○ | ○ | ○ |
| Improvement of KPC Road | ○ | ○ | ○ |
| Construction of Rural Electrification Facility | ○ | | |

# 2. Contents of the Project

## 2-1 Basic Concept of the Project

### 2-1-1 Overall Goal and Project Purpose

Socialist Republic of Viet Nam (VN) has accomplished a rapid economic growth since the establishment of the policy "Doi Moi" in 1986. However the economic differential among regions has expanded due to different conditions of infrastructure development and existing resources. In this context, poverty reduction and narrowing income gaps among regions are the main policy objectives in the 6$^{th}$ five-year plan.

In the government development plan entitled "Government Direction on Agriculture and Rural Development (December 1998) ", the Ministry of Agriculture and Rural Development placed agricultural and rural development as essential foundations for socio-economic development and national stability. The main issues are poverty eradication, reduction of differential between regions and improvement of rural infrastructure.

In the North Central Coast of VN, where the project area is located, economic development has been intrinsically tied up with agricultural development, however the improvements of agriculture and rural infrastructure have lagged behind. In Nam Dan District, Nghe An Province due to harsh natural condition such as "Laos Wind", typhoon and flood combined with such problems as the lack of irrigation facilities and agricultural infrastructure, the living standard of local villagers remains very low.

In order to improve the living conditions of the inhabitants, the Government of VN (GOV) formulated "Master Plan of Model Rural Development Project in Nam Dan District, Nghe An Province" through the technical cooperation from the Government of Japan (GOJ). "The Project for Improvement of Rural Living Condition in Nam Dan District in Nghe An Province", is a part of the above Master Plan expected to be implemented under the Japanese Grant Aid Scheme. It's overall goal is to improve the living conditions of the inhabitants in Nam Nam area of Nam Dan District by means of implementing the rehabilitation of irrigation facilities and improvement of rural roads, and by extension of rural electrification.

### 2-1-2 Basic Concept of the Project

In the Basic Design Study, "Inputs" and "Activity" as stated below are to be implemented in order to attain the above-mentioned project purpose. Hence, as the "Outputs" the improvement of irrigation

## 2-2 Basic Design of the Requested Japanese Assistance

### 2-2-1 Design Policy

#### 2-2-1-1 Basic Policy

**(1) Basic Policy**

The basic policies of the basic design are as follows.

① The components of the project are to be limited to those related to improving the rural living conditions and the agricultural products are to be only for local consumption.

② The scope of the Project about irrigation facilities is just for rehabilitation of existing ones and the extension of irrigation area are excluded from the scope of the Project. Improvement of existing irrigation facilities is to be implemented for the sole purpose of retrieving the original ones.

③ For the Ho Thanh reservoir system, in addition to the improvement of canals, countermeasure against the leaking from the reservoir is to be considered from a technical viewpoint and economic effectiveness.

④ National Road 15A (NR15A) is to be improved to ensure a year-round traffic.

⑤ Pavement of Nam Kim-Nam Phun-Nam Cuong Road (KPC Road) is to be designed taking into account the recurrent inundation of the road by flood.

⑥ Erosion control facility is to be included in the component of rural road as protection/gully erosion control facility for NR15A.

⑦ The needs and priority in the project area are to be respected in the basic design.

⑧ The rural electrification for three areas selected in the site survey, in accordance with the basic plan prepared by Nam Dan District and approved by Nghe An Province, is to be considered as a high cost efficiency and having significant positive effects to the inhabitants.

⑨ The scale and contents of the facilities are to be appropriate for the organizational and budgetary conditions of the responsible agencies for operation and maintenance.

⑩ Appropriate technology for the local engineers and/or local people is to be applied and the local productions and materials, which can be procured in the project site, are to be considered in the basic design of the facilities which are to be easy to maintain.

⑪ The construction of drainage facilities is excluded from the components of the project as GOV has already started this work as an urgent countermeasure for the flood in September 2002.

### (2) Examination of the Requested Sub-components

Basic policies of each component are shouwn in Table 2-2-1-1.1.

**Table 2-2-1-1.1 Components of the Project and Basic Policies**

| Components／Sub-components | Remarks and Basic Policies |
|---|---|
| ① Irrigation Facilities | |
| Improvement of Ho Thanh Reservoir Irrigation system<br>1. Leakage measure<br>2. No.2 canal : 2.4km | * Anti-leakage measure is given high priority by GOV and needed implementation from technical viewpoint, cost-effectiveness, negative effect in case of not implemented and visibility of Japanese aid.<br>* Although improvement of No.2 canal is given medium priority by GOV, this is a main facility of the irrigation system.<br>* Benefited area & household; No.2 canal for 40ha/120HH, Anti-leakage measure for 70ha/210HH |
| Improvement of Nam Trung Pump Irrigation system<br>1. Pumping station<br>2. Main canal : 4.9km | * Given high priority by GOV and major component in the project<br>* Existing pumping station including three pumps need reconstruction due to serious damages, however the scale is not to be enlarged.<br>* Irrigated area is not to be expanded.<br>* Improvement of downstream section of main canal needs consideration on self-effort implementation.<br>* Benefited area & household; 470ha/1,410HH |
| ② Rural Road | |
| Improvement of NR15A<br>1. Road : 20.1km (6.5m road width, Asphalt pavement)<br>2. Four bridges, One box culvert | * One of the major components of the project.<br>* This component is beneficial to all local people.<br>* NR15A is to be class V.<br>* Converts to year-round traffic and/or all-weather road.<br>*Pavement for the most southern section of NR15A needs consideration of self-effort implementation due to the limited budget.<br>* Benefited household; 8,200 HH |
| Improvement of KPC Road<br>1. Road : 6.9km (6.5m road width, pavement)<br>2. One bridge, Four Box culverts | * It becomes the most important road for three communes in low-flat area.<br>* The road is to allow inundation in case of flood.<br>* Raising the road is not to be implemented because of influence on drainage condition.<br>* Inundated section needs to be considered for concrete pavement from viewpoint of damage by flood, annual maintenance, high priority by GOV, negative effect in case of not implemented and an impressive assistance.<br>* Benefited household; 3,470 HH. |
| ③ Rural Electrification | |
| Extension of rural electrification<br>1. Three transformer stations (areas of Am Gia、Dong Trai、Ru Bui)<br>2. Distribution networks | * These three areas are selected among 4 based on the necessity and urgency.<br>* Needs to consider ongoing settlement for poverty program.<br>* The aims are to increase in electrification rate and reduce electricity cost.<br>* Cost-effectiveness<br>* Benefited household; 1,700 HH |
| ④Environmental Conservation | |
| 1. Construction of erosion control facility on three sites. | * Included in the improvement of rural road.<br>* Necessary as a protection facility for NR 15A. |

Note: The construction of rural drainage facilities is excluded from the components of the project because GOV has already started the construction as an emergent countermeasure for the flood that occurred in September 2002.

Although all the sub-components above are confirmed as necessary to achieve the project purpose, the total scale of the project has to be within the amount of the budgetary allocation of Grant Aid Scheme. Therefore, in order to assist the selection of sub-components to be implemented in the project, five cases are considered. Several items are considered, such as the background of the request, results of the discussions with GOV and the site survey and the scale of each component. The Basic Points on the selections are described below and Table 2-1-2 shows combinations of sub-components by the cases.

**Basic Points on Selection Case**

① In view of the project purpose "to improve living condition of inhabitants in Nam Dan District", at least three components are to be implemented. And balances between communes and components are to be taken into account.

② To give a priority for cases which have higher necessity and relevance.

③ To respect actual needs of the inhabitants and GOV's priority.

④ To consider that sub-components or a part of them to be implemented by VN side are planned to be divided in years depending on the local budgetary condition.

**Table 2-2-1-1.2 Five Cases of Sub-component Combination**

| Components | | Sub-components / Alternatives | Case1 | Case2 | Case3 | Case4 |
|---|---|---|---|---|---|---|
| Irrigation Facility | 1-1 (a) | Improvement of Nam Trung pumping stations and main canal of 4.9km | ○ | ○ | | |
| | 1-1 (b) | Improvement of Nam Trung pumping stations and upper part of the main canal of 3.6km | | | ○ | ○ |
| | 1-2 | Leakage measure of Ho Thanh resovoir | ○ | ○ | ○ | ○ |
| | 1-3 | Improvement of Ho Thanh No.2 canal, 2.4km | ○ | ○ | | |
| Rural Road | 2-1(a) | Improvement of asphalt pavement of the whole of NR15A, 20.1km | ○ | | | |
| | 2-1(b) | Improvement of 15.7km from beginning of NR 15A*1 | | ○ | ○ | ○ |
| | 2-2(a) | Improvement of district road of asphalt pavement in villages and concrete pavement in the inundated section | ○ | ○ | ○ | |
| | 2-2(b) | Improvement of district road of asphalt pavement in villages and gravel pavement in the inundated section | | | | ○ |
| Rural Electrification | 3-1 | Electrification in Am Gia area | ○ | ○ | ○ | ○ |
| | 3-2 | Electrification in Dong Trai area | ○ | ○ | | |
| | 3-3 | Electrification in Ru Bui area | ○ | ○ | | |

Note) *1: In the rear portion of 4.4km of NR15A, four inundated sections are to be raised to ensure year-round traffic.
○: selected as a sub-components

**Explanation and Evaluation of Each Case**

Case 1: Includes all sub-components confirmed in the discussions with GOV including countermeasure for leakage of Ho Thanh reservoir in Ho Thanh reservoir irrigation system.

Case 2: Includes the same sub-components as Case 1, excluding the asphalt pavement of NR15A (20.1km) and including improvement of 15.7km from beginning of NR 15A that is inundated portion during a flood in order to ensure for year -round traffic. Since the project cost for the road sector accounts for 3/4 of the entire cost in case 1, when some reduction of the entire cost is required, reduction in the improvement of NR15A is to be considered. In this case, asphalt pavement of NR15A will be from the beginning point of NR15A (on the right bank of Nam Dan Bridge) to the intersection with Nam Kim-Nam Phuc-Nam Cuong road including construction of Vuc Nang Bridge. Four inundated parts in the rest of 4.4 km, between the bridge and a boundary of Ha Thin Province, are to be raised to ensure for year-round traffic.

Case 3:Includes the same sub-components as Case 2 excluding a 1.3 km of the main canal improvement of Nam Trung pumping irrigation system, improvement of No.2 canal of Ho Thanh reservoir irrigation system and the rural electrification in two areas. The concept of the alternative plan is that canals that seem comparatively small scale and easy construction for GOV shall be improved by its effort. This plan also includes the rural electrification of the first priority.

Case 4: Includes all sub-components in Case 4, but the concrete pavement is changed into a gravel pavement in the inundated section of Nam Kim-Nam Phuc-Nam Cuong road. As pertial improvement only of a part of Nam Kim-Nam Phuc-Nam Cuong road would not have much effect, improving this road on its entire length is required. Even though frequent maintenance would be required, gravel pavement is preferred over the asphalt pavement and the macadam pavement that can be easily damaged by flood.

**Sub-Components Proposed by Study Team**

Aforementioned alternative cases are plans considering combination of sub-components based on Case 1 as a full scale one. The Study Team recommends Case 2 to be adopted as appropriate from the results of examining the cost-benefit efficiency of each case and considerations as below.

① Regarding the reasons in Case 2 on exclusion of improvement 4.4km of asphalt pavement of NA15A in Case 1.

- Beneficiaries of NR15A are the whole population in the project area (five communes). As adopting Case 2, only the inhabitants of Nam Kim commune will be excluded from road benefit directly. However other four communes' residents can get the benefit of the road. Therefore exclusion of asphalt pavement for 4.4km will present relatively low negative impact.

- Since the inhabitants of Nam Kim commune can use NR15A throughout the year regardless of flood, they get better access to Nam Dan and Bin city using the improved road of 15 km length. As a result, the living conditions of the inhabitants will be improved.
- To scale-down the road sector seems appropriate from the viewpoint of the balance among the subcomponents.
- Priority by inhabitants in the excluded section of NR15A is relatively low.
- The implementation of improvement work seems easy by self-reliant effort in divided manners.

② Regarding to the excluded terminal section of 1.3km length from the improvement of Nam Trung irrigation system.

- On the excluded section of 1.3km, a management road beside the canal has been already repaired. The scale of the canal is comparatively small for GOV to rehabilitate it by self-reliant effort depending upon the allocation of local budget.
- From the restoration of pumping discharge occasioned by the improvement of Nam Trung pump stations and the improvement of conveyance losses from the concrete lining for the upstream portion, the supply of irrigation water to the excluded area will be improved.

③ Regarding to other cases

- In Case 3, the scale of improvement of Ho Thanh No.2 canal and Nam Trung main canal is comparatively small for GOV to implement it by self-reliant effort by the allocation of local budget. However, No.2 canal has been remarkably damaged by a flood in September 2002 and needs an emergent improvement. Furthermore, as the improvement this canal holds a high priority, excluding it from the project would be inappropriate.
- Furthermore in Case 3 the rural electrification is to be implemented only in one area. In the excluded areas, implementation of rural electrifications is conjectured to be widely delayed. In addition to the sub-components excluded in improvement of NR15A, Nam Kim commune will not receive much benefit from the project. From this viewpoint, this case is not proper to the proposed to be.
- Case 4 does not meet the strong demand of concrete pavement in the inundated section of Nam Kim – Nam Phuc – Nam Cuong road. Therefore, this case is not also adequate plan to meet people's desire.

### 2-2-1-2 Policy related to Natural Conditions

The study area is a low-flat area with mountains on the west side, Lam River on the north and east side and La River on the south. The eastern part of the area is surrounded with dikes. Annual rainfall is 1,700mm with 60% of the rainfall occurring from August to October. In addition, Lam River and La River reach their peak discharge at the same time, the water level inside the dikes increase, resulting in the inundating of about 85% of Trung, Nam Phuc and Nam Cuong communes along with most of the

farmland and roads located in low elevations. In case of a large-scale flood, the residential areas are inundated because the water levels of the rivers exceed the dike' crest. For designing facilities, design water level and flood discharge are to be based on hydrology data of 10 year-return periods. Patterns of rainfall and high water level of Lam River are shown in below table.

**Table 2-2-1-2.1 Rainfall and Lam River H.W.L. Data in the Study Area**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall*1 | 30 | 36 | 37 | 65 | 143 | 142 | 107 | 219 | 323 | 448 | 127 | 41 | 1,717 |
| H.W.L. of Lam River*2 | 164 | 143 | 135 | 134 | 181 | 226 | 248 | 318 | 371 | 374 | 266 | 196 | — |

*1：Source: Nam Dan observatory 1982～2001（Unit：mm）
*2：Source:Nam Dan observatory（Unit：El.cm）

Policy related to flood condition are to improve NR15A to secure year-round traffic on all-weathered road and to keep the existing height of KPC road surface in order to avoid negative affects to drainage conditions in the low-flat area inundated during rainy season.

Major constructions are not to be undertaken from August to October due to flood, and working schedule is to be set from June to August considering "Laos Wind" and harvesting season.

During the constructions of box culverts and bridges on road improvement, temporary bridges and detours are to be provided. When construction work is done below water level, dry work with dewatering is to be implemented.

### 2-2-1-3 Policy related to Socio-economic Conditions

In order to activate local economy condition and to promote participatory awareness of local inhabitants, they will be employed for the construction works as unskilled workers. However, as 90% of the local inhabitants are farmers, it seems difficult to hire them during a harvest season. Almost all construction works are to be stopped temporary during Teto (the New Year holidays by the lunar calendar) which is one of the most important occasions in Viet Nam.

Half-way construction method is to be adopted in order to keep traffic available on NR15A which is the only main road in the area. On the other hand, KPC road is to be closed to all vehicles during construction except sections going through the villages.

### 2-2-1-4 Policy related to Construction Condition

Design of irrigation facility, rural road and bridge is to be based on "Proceedings of Viet Nam

Construction Standards" and Japanese construction standards. Design of rural electrification is to be based on a plan prepared by Nam Dan district.

The construction works for the improvement of irrigation facilities and the improvement of rural roads are carried out under the consultant's supervision and approved by the Project Management Board (PMB). Implementation of rural electrification is to be proceeded according to the official regulatory procedure under the consultant's supervision.

Other considerations on design and construction are below.

- To utilize local materials available in the area considering economic condition and maintenance.
- To procure aggregate and materials for sub-base course from an existing quarry located between Bin and Nam Dan on Route 46.
- Delivery routes of construction materials are Route 46 to Nam Dan district and NR15A via Nam Dan Bridge from Nam Dan to the construction sites. The weight limit of Nam Dan Bridge is only 16.9 ton per vehicle. Therefore, for the delivery of heavy machineries, ferries and temporary Jetty are to be provided.

### 2-2-1-5 Policy related to Management Capacity of Executive Agencies

The responsible agency of the project is the Ministry of Agriculture and Rural Development (MARD). When the project implementation is commenced, Project Management Board (PMB) is to to be set up as a project administrator. PMB receives guidance from MARD.

According to the decentralization policy, the head of Agriculture and Rural Development Service of the Province People's Committee or the Chairman of the committee are to be the head or sub-head of PMB. Vice Directors of Plannning/Investment Department and Transportation Department will be other members of PMB.

The implementation organization taking a practical role on the sites is Nam Dan District People's Committee. The head office has 65 staff members including 38 university graduaters (including 28 engineers). As the head office has many experience of domestic projects, it is judged as well a experienced and able an implementation organization.

A Steerring Committee, a technical and financial-examinating organization, is to be set up with representaives of MARD, Province People's Committee, Ministry of Planing and Investment (MPI), Ministry of Finance, Nam Dan District People's Committee and Embassy of Japan. Representative of Province People's Committee is to be the Chairman of the Steerring Committee.

## 2-2-2 Basic Plan

### 2-2-2-1 Irrigation Facility

#### (1) Nam Trung Pumping Irrigation System

1) Basic Policy

The Project area, including Nam Nam area, especially the three communes of Nam Trung, Nam Phuc and Nam Cuong, depends on paddy farming that is constrained by flood in the rainy season and drought in the dry season. The Nam Trung pumping irrigation system is one of the most important infrastructure in the Project area. However, the inhabitants have experienced low living standards under the current harsh natural conditions compounded by obsolete irrigation facilities. Therefore, the improvement of the irrigation system is needed in the Project area.

Pumping station: The improvement of this system will be limited to restoring its original form and function of the pumping stations for the existing farms. Two pumping stations are presently operating. A second old pumping station uses the spare pump of the existing station. However, only the existing pumping station is planned for rehabilitation. They would irrigate a proposed irrigation area of 470 ha. The existing pumping station is to be completely rehabilitated because of the considerable depreciation of the facilities and pump house.

**Table 2-2-2-1.1 Summary of Existing Pumping Facilities**

| | | |
|---|---|---|
| Existing pumping stations: 3 pumps<br>Construction in 1973 | Capacity* | Discharge 1,000 $m^3$/hr/no, 33 kw, 3,300 rpm |
| | Electricity | 110KV-10KV-0.4KV、transformer 320KVA |
| | Irrigation area | 470ha (Actual irrigation area 340 ha) |
| Old pumping station：1borrowed pump<br>Construction in 1964 | Capacity* | Discharge 1,000 $m^3$/hr/no, 33 kw, 3,300 rpm |
| | Electricity | 110KV-10KV-0.4KV、transformer 320KVA |

* Existing capacity reduced to approximately 80% of design capacity

Nam Trung Pumping Station

Pumps in Nam Trung Pumping Station

**Table 2-2-2-1.2 Facilities Planned for Improvement**

| Section | Existing Facilities | Amount |
|---|---|---|
| Main canal (upstream) | 1.85 km from the starting point, stone masonry canal, brick canal | L=1.85km |
| Main canal (downstream) | The end from 1.85km, unlined canal | L=3.03km |
| Diversion | Concrete pipe: φ200-300 | 28 sites |

Main Canal: A section of 1.85 km long from the starting point will be improved with lining, however the existing conditions of the canal are remarkably deteriorated in spite of the relatively short period of 2 to 3 years after the construction.

Furthermore, the existing canal has no definite slope, width and height of sidewall. Moreover, the sections in more than 70% of the canal cannot accommodate the proposed discharge. Therefore, an improvement limited to only the damaged sections is insufficient, and requires the rehabilitation and improvement of all sections of the canal to accommodate the design discharge.
The downstream section (from 1.85 km point to the end point) of the existing main canal is unlined. The main objectives of improvement of this section are to decrease the loss of conveyance efficiency for the effectiveness of the irrigation water. The maintenance road and farm work road along the canal will also be improved.

Canal type: The basic canal type will have a rectangular shape section lined with concrete material including the unlined section downstream to ensure appropriate discharge capacity and sufficient durability, and the method of construction will take into account the existing construction conditions. With these improvement works, the maintenance road along the canal will be improved as a road for water management and farm work. Also, from the view point of improving water management, small gates will be established at the existing 28 diversion works sites, and regulating gates will be established in the main canal side of the major diversion points.

2) Basic Plan and Basic Design

(a) Water Requirement and Design Discharge

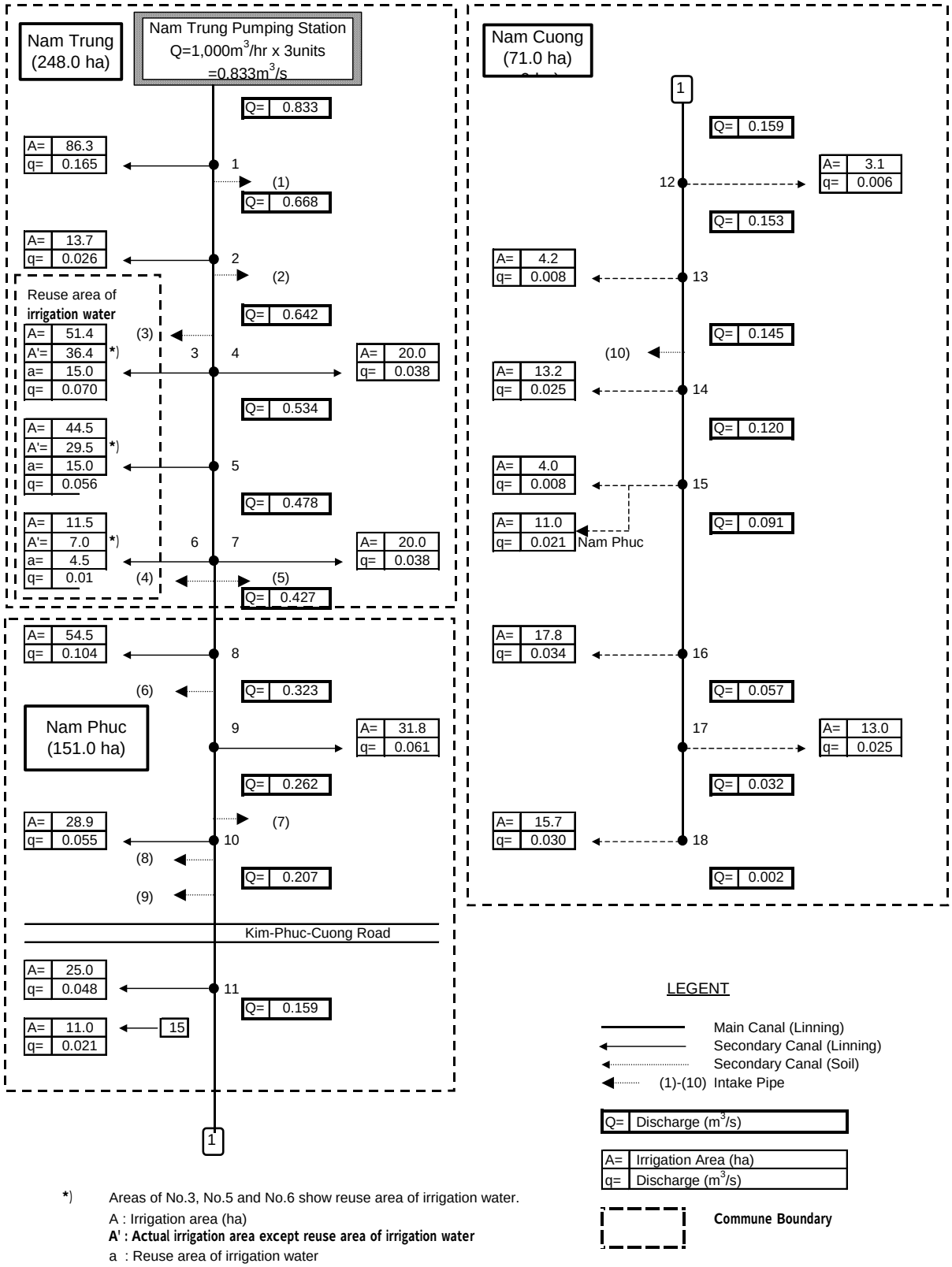
i)Irrigation Area

Design irrigation area is 470 ha covering three communes; 248 ha in Nam Trung commune, 151 ha in Nam Phuc commune and 71 ha in Nam Cuong commune.

ii)Water requirement and Design Discharge

Design discharge of diversion works and canal is calculated with unit water requirement (q= 1.9 litter/s/ha), which is adopted in the Feasibility Study.

Irrigation water plan and design discharge of each section of Nam Trung canal is shown in Figure 2-2-2-1.1.




*) Areas of No.3, No.5 and No.6 show reuse area of irrigation water.
A : Irrigation area (ha)
**A' : Actual irrigation area except reuse area of irrigation water**
a : Reuse area of irrigation water

**Figure 2-2-2-1.1 Nam Trung Pumping Station Irrigation Network Plan**

(b) Rehabilitation plan for Nam Trung Pump Station

i)Outline of the Rehabilitation Plan

The principle of the rehabilitation plan is to recover the functions of the existing facilities related with Nam Trung pump. The plan of each facility is shown as below.

- Location of the pump station: The pump station is to be reconstructed on the same site as the existing one due to the following advantages. The site is nearer to the river's major flow; there is little or no risk of sedimentation; any additional connection to the main canal would not be required.
- Pump facilities: The design pump discharge is to be 1,000 $m^3$ /hour/unit same to the existing pump. And the Namber of pump is three units same to the present Namber.
- Pump house: The existing pump house has suffered several damages from floods. Therefore, the new design would raise the level of the house to prevent flood damages.
- Suction pipe: The new suction pipe will be of the same type as the present one. Setting will also be similar to the present one; the pipe will be directly set in contact with the river.
- Outlet box: The dimension of the existing outlet box is oversized. It is to be designed with proper dimensions and structure.

ii)Basic Design of Pump Facility

Based on the above design policies, the pump facility will be planned as follows.

(i) Decision of Pump Station Site

The location of the new pump station is set at the same site of the present one for the following reasons.

① The existing intake site is located near the major flow route of the river, where sedimentation has been rarely recorded. A structure protecting against sedimentation is constructed in the river and there has been no trouble of sedimentation for 30 years since construction.

② The station is to be connected to the irrigation canal following the same route of the present one. In other words, the present location of the station should not be changed otherwise it would require additional extension works on the canal construction for connecting the pump.

(ii) Design Discharge and Intake Water Level

① Design discharge is same as existing pump as follows.

$$\Sigma Q = 1{,}000 m^3/hr/unit \times 3 units = 3{,}000 m^3/hr$$
$$= 16.67 m^3/min/unit \times 3 units = 50.00 m^3/min$$

② Design intake water level is based on a 10 years return period drought. LWL = 0.47m

**Table 2-2-2-1.3 Intake Water Level Estimated for Given Drought Return Periods**

| Nam Trung Pumping Station | 1/100 | 1/50 | 1/30 | 1/10 | 1/5 |
|---|---|---|---|---|---|
| Water Level | 0.33 | 0.36 | 0.39 | 0.47 | 0.53 |

(iii) Method of Water Intake and Water Outlet

① The method of water intake would be a direct intake similar to the present method. A flexible pipe will be inserted into the intake pipe at the joining point with the house wall to protect it against damages caused by vibrations.

② The water outlet system will also be similar to the present system with a discharge box. However, the new box will be designed to appropriate size, as the existing box is too large. A Flap valve will be installed at the end of the outlet pipe in the box to stabilize the flow toward the irrigation canal.

③ The diameter of the pipe will be decided based on the proper velocity in the pipe. Usually, in case of small pipes, the velocity is around 1 to 2 m/s. Therefore φ450mm pipe is selected to accommodate 1.75 m/s velocity.

(iv) Pump Head

Total head of the pump is estimated as below.

H = Actual Head (h) + Various head losses (⊿h)

Here,

- Actual head: High Water Level at Discharge Box（$HWL_{out}$）- Low Water Level at Suction（$LWL_{in}$）
- High Water Level at Discharge Box（$HWL_{out}$）: Beginning Water level at the irrigation canal + Head loss of the levee crossing work. → $HWL_{out}$ ＝6.10m
  Note) refer to “(ix) Levee crossing work”
- Low Water Level in Suction（$LWL_{in}$）: from aforementioned, $LWL_{in}$＝0.47m
- Various head losses （⊿h）: Total losses of flow in, flow out, pipe head losses and others → ⊿h＝0.955m

Therefore,

H = Actual head (h) + Various head losses (⊿h)

＝ （6.10 － 0.47） ＋ 0.955

＝ 6.585m

⇒ <u>6.6m</u>

(v) Type, Quantity and Diameter of Pump

Three Horizontal volute pumps of φ350mm are placed in the existing pump station. However, the suitable type, quantity and diameter of the replacement pumps were considered as below.

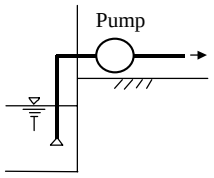
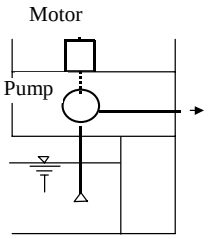
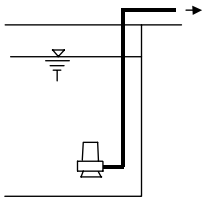
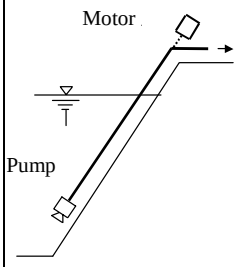
① As the applicable pump type, the following four pumps are examined.

a) Horizontal volute (axial) pump
b) Vertical axial pump
d) Submersible motor pump
e) Incline pump

The characteristics of the four types of pumps are shown below. From the viewpoint of reliability and

facility of O/M, the “Horizontal volute (axial) pump” is selected as the proper pump, which is the same type as the existing one.

**Table 2-2-2-1.4 Pump Style**

| Pump Style | Horizontal volute (axial) pump | Vertical axial pump | Submersible motor pump | Incline pump |
|---|---|---|---|---|
| Type |  |  |  |  |
| Structural Characteristics | Good for pump performance | Pump area can be small | Pump is simple and operation is easy | Operation is easy but trouble occur very often and easily |
| Safety, reliability | High | High, but placement is difficult | Medium | Low |
| Pump efficiency | Around 80% | Around 78% | Around 75% | Around 78% |
| Operation | Relatively easy | Relatively easy | Easy | Easy |
| Maintenance | Easy | Placement is difficult | Relatively easy | Difficult to put on and to take off, and trouble occurred very often and easy |
| Pump Space | Area: Large,<br>Height: Low | Area: Small,<br>Height: High | Area: Small,<br>Height: Need high for pull up | Area: Large,<br>Height: Need high for pull up |
| Procurement of Vietnam made | Possible | Possible | Impossible<br>(All imported) | Impossible<br>(All imported) |
| Pump Price | 1.0 | 1.2 | 1.0 | 1.0 |
| Total assessment | Superior (adoption) | Disadvantage in price and so on. | Life span is short and maintenance difficult | Reliability is low due to trouble occurring very often. |

②The Namber of pumps is decided as three, same to the present conditions. From the operating situation of the existing pumps, all three pumps are used during puddling time, and one or two are used during other management periods. Therefore, three pumps are suitable from the viewpoint of operation and maintenance.

③A φ350mm pump diameter is suitable based on the “relation between standard diameter and pump discharge” as shown in the following table.

**Table 2-2-2-1.5 Relation between Standard Diameter and Pump Discharge**

| Standard diameter (mm) | Discharge ($m^3$/min) | Standard diameter (mm) | Discharge ($m^3$/min) |
|---|---|---|---|
| 250 | 5 ～ 8 | 400 | 18 ～ 23 |
| 300 | 8 ～ 12 | 450 | 23 ～ 28 |
| 350 | 12 ～ 18 | 500 | 28 ～ 36 |

Sources: Ministry of Agriculture, Forestry and Fisheries / Farmland improvement project planning design criteria “Pump station”

(vi) Motor Output

Motor output is estimated in following formula.

$$P = \frac{(K \times \gamma \times Q \times H)}{n/100} \times (1+\alpha)$$

Here,

P：Motor output（kw）
K： Invariable Namber (K=0.163 in case of kw)
γ： Specific gravity of pumped up liquid ( γ =1.00 in case of water)
n： Pump efficiency (%) → 74% in case of volute pump of φ350mm
Q： Discharge（$m^3$／min） = 16.67 $m^3$/min
H： Total Head（m） = 6.6m
α： Afford ( α =0.1 in case of water)

From aforementioned,

$$P = \frac{(0.163 \times 1.0 \times 16.67 \times 6.6\text{m})}{1.0 \times 1.0 \times 0.74} \times (1+0.1)$$

= 26.66kw

⇒ <u>33kw（rated output）</u>

(vii) Pump House

①The pump facilities, especially motor and electrical equipment, must be protected against flood damages. The setting elevation of the pump is usually around “LWL + 3 meters”. Therefore, the elevation of the pump axis center is decided as below.

・Elevation of suction pipe axis center （$EL_P$）

= Low Water Level（LWL）+ Height of LWL to Pump

= 0.47m + 3.0m = 3.47m

⇒ <u>EL.3.50m</u>

The motor will be installed at the same level as the pump for direct connection. However, the lower part of the station will be built with waterproof reinforced concrete to avoid any damages by floods.

Furthermore, since the electrical equipment, such as control panel, must be protected from floods and high humidity, it must be installed at a higher elevation than the past highest flood water level. Also, since the pump station will be again constructed at the same location near the levee, the elevation of the electrical equipment is decided as below.

・Elevation of Upper floor = (the past highest flood water level) + (wave height)

＝ 7.72m ＋ 0.4m ＝ 8.12m

⇒ EL.8.15m

Therefore, the pump station will adopt a two-floor type with pumps and motors installed in the down floor and electrical equipment installed in the upper floor.

The pump house will also be built in reinforced concrete, as a crane facility will be installed in the house.

The height of the house is decided in consideration that a 2-ton truck can come in and out of it. The height (Hu) will be decided as below.

・ Height of house (Hu)

= (lift up height of Crane) + (height of crane facility) + (height of beam)

= (height of the bed of a truck + height of Panel + minimum lift up height of crane) + (height of crane equipment) + (height of beam)

= (1.00m ＋ 2.20m ＋ 0.25m）＋（1.20m）＋（0.40m）

＝ 5.05m

Therefore, the ceiling elevation in the pump house (Els) will be decided as below

・ Ceiling elevation in the pump house (Els)

= floor elevation + height of house

＝ EL8.15m ＋ 5.05m

＝ EL13.20m

②Distribution Plan

Based on the abovementioned design dimensions, the distribution plan of the pump station is as below.

・ Length of pump station (Direction of water flow)

Length of the pump station parallel to the water flow direction: Length A

Length A = (suction length) + (pump and motor length) + (space for O/M)

= 1.20m ＋ （1.07m ＋ 0.88m）＋ 1.85m

= 5.00m

・Length of the pump station perpendicular to the water flow direction: Length B

Length B = (corridor space) + (total pump length) + (space for O/M)

$= \quad 1.40\text{m} + (1.75\text{m} \times 2) + 4.1\text{m}$

$= \quad \underline{9.00\text{m}}$

The space for O/M is decided considering the moving area of the crane, needed repairing space and so on.

(viii) Accessory of Pump

As the accessories of the pump, the following equipments will be supplied.

①Electrical Equipment

A 400-volt power distribution line will be used for the new pump station similarly to the existing one. The following new electrical equipments will be installed in the house.

- Switch Board × 1 unit (Incoming and control panel of 400 Volt electric line)
- Local control panel × 3 units (On-off switch board for each pump)

②Valve

At the suction side in front of the pump, a sluice valve will be installed to stop water during maintenance of the pump. Furthermore, a flexible flange will be installed to accommodate the expansion and contraction of the pipe.

At the end of the outlet pipe, a flap valve will be installed to stabilize the water flow to the canal.

③Vacuum Pump

The suction pipe must be filled with water prior to starting the pump. The following two methods of filling water to the suction pipe will be considered.

- Method A: pour water into the suction pipe from an outside water tank
- Method B: pump water up from the river into the suction pipe using a vacuum pump

Method A would require a small pump with a water tank of around 7 m3. The water tank would not be necessary for method B, which is more popular in Viet Nam. Method B will therefore be adopted in this plan.

④Crane, etc.

A Crane will be installed in order to move the pump equipments and electrical facilities in the pump house. The crane will be a two-way movement type with the capacity of hanging 1-ton charge considering the weight of each equipment. Furthermore, one $\phi$ 50 mm diameter submergible motor pump will be provided to drain water out of the pump floor.

(ix) Levee Crossing Work

A Culvert of $\phi$1200 mm diameter and a 14.6m length iron pipe are to be installed under the levee to connect the discharge box of the pump to the irrigation canal. This culvert will replace the old one which has been used for over 30 years.

This culvert connects to the irrigation canal. A concrete box culvert is adopted from hydraulic and structural viewpoints. The inside height of the section is 1.00 meter in consideration of O/M.

The elevation (Eli) of the culvert invert at the beginning side will be decided as below.

ELi = (invert elevation of irrigation canal at beginning point) + (culvert length × canal bed slope)

= EL5.26m + （14.6m × 1/1500）

= EL5.27m

The High water level, HWLo, in the Discharge box will be adopted as the pump's design discharge water level. This water level will be decided as below.

ELi = (elevation of culvert invert at beginning side) + (water depth) + (head losses between discharge box and irrigation canal)

Note: Head losses are estimated on transformation of sections.

= EL5.27m + 0.781m + 0.043m

= EL6.094m

→ EL6.10

From the results of the estimation above, the high water level in the discharge box (HWLo) is EL6.10m.

(x) List of Pump Facilities and Equipments

From the abovementioned estimation, the list of pump facilities and equipments to be renewed is shown as follows.

**Table 2-2-2-1.6 List of Pump Facilities and Equipments for Renewal**

| Facility/Equipment | Specification | Quantity |
|---|---|---|
| 1. Pump | φ350mm、1,000m3/hr<br>Horizontal volute mixed flow type | 3 units |
| 2. Motor | 33kw<br>Water proof open basket type | 3 units |
| 3. Pipe materials | Suction and Discharge pipes, flexible joint, flap gate, etc | 1 L.S. |
| 4. Sluice valve | φ350mm、manual operated type | 3 units |
| 5. Vacuum pump | φ40mm for Priming | 2 units |
| 6. Pump for draining | φ50mm,Submerged motor pump | 1 unit |
| 7. Crane | 1 ton of hang up capacity, manual type | 1 unit |
| 8. Electrical panel | Incoming and switch board | 1 L.S. |
| 9. Local switch board | | 3 units |
| 10. Electrical wire | | 1 L.S. |

iii)General Layout of Pump Facilities

General layouts of designed pump facilities are shown in Figure 2-2-2-1.2.

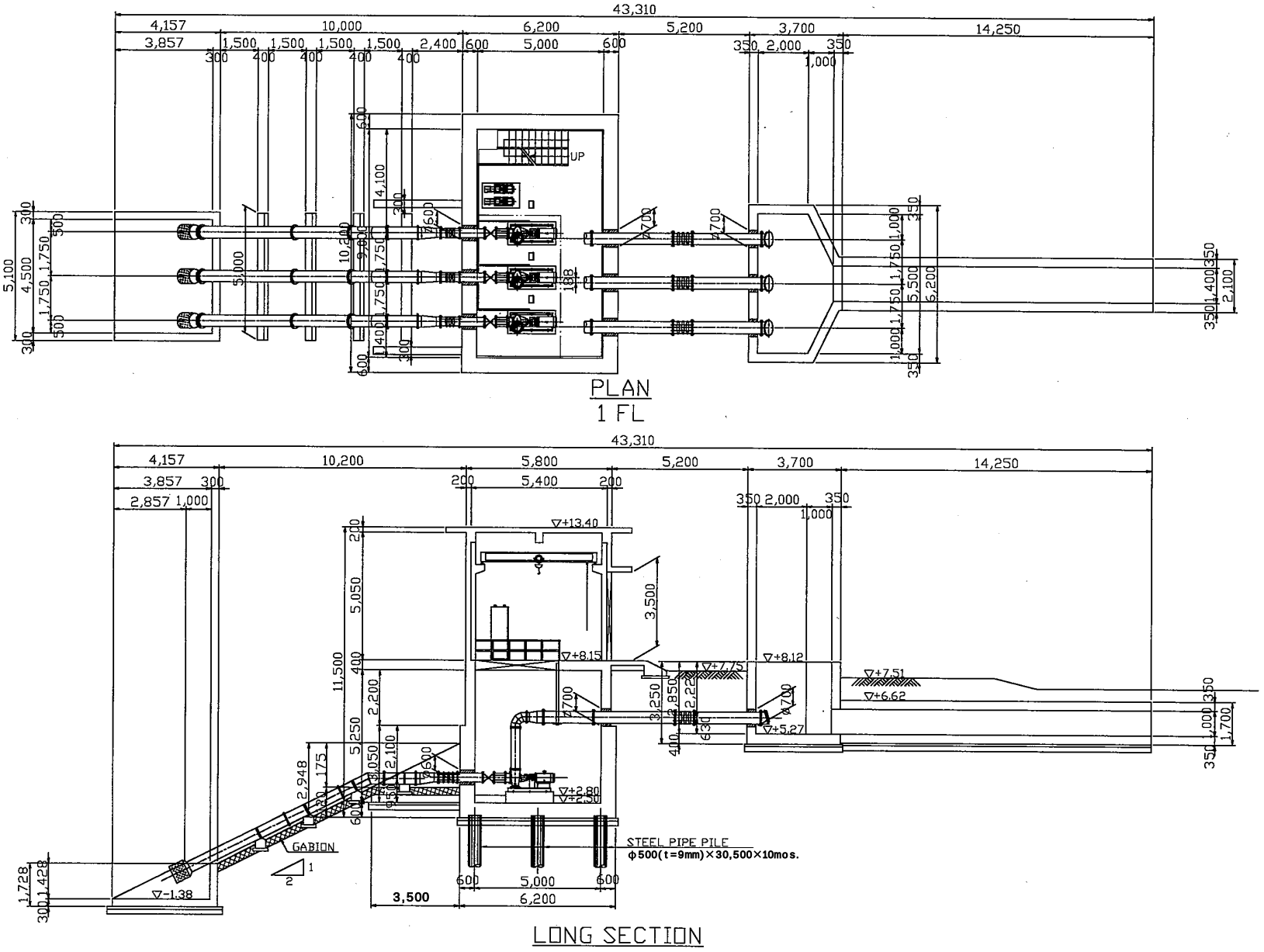



**Figure 2-2-2-1.2 General layouts of designed pump facilities**

(c) Rehabilitation of Irrigation Canal

i)Basic Design of the Canal

(i) Canal Type

The canal structure type is selected from the following comparative study.

**Table 2-2-2-1.7 Comparison of Characteristics for Canal Structure Type**

| Type | Structure | Operation /Maintenance | Construction | Cost | Evaluation |
|---|---|---|---|---|---|
| Reinforced Concrete Canal | Cast-in place Reinforced Concrete. Thickness of the concrete section is thinner than plain concrete due to reinforced bar included. ○ | Easy Repair job is bit troublesome due to inner reinforced bar. △ | Assembling of reinforced bar takes a lot of time. Construction progress: 4.9m/day △ | 122US$/m (1.01)※ | |
| Plain Concrete Canal | Cast-in site Plain Concrete. Thickness of concrete is relatively thin . ○ | O/M and Repair jobs are easy. ○ | Construction is easy. Construction progress: 6.1m/day ○ | 118US$/m (1.00)※ | ○ |
| Masonry Canal | Cast-in site masonry and concrete works. Strength may be insufficient in case of work done unconscientiously. △ | O/M and Repair jobs are easy. Canal strength is weaker than concrete canal. ○ | Popular canal type in Viet Nam. Construction is relatively easy. Construction progress: 1.1m/day × | 127US$/m (1.08)※ | |

※ Namber in bracket shows the ratio compared with 1.0 of Plain Concrete Canal.

※ Comparative section adopts B1.30m×H0.80m.

※ ○: excellent, △：good, ×: no good

From the above comparison, Plain Concrete Canal is adopted as the planned canal type.

(ii) Decision of Canal Section

The longitudinal section of the canal is studied based on the following principles.

① To set the design height of the canal invert at the present level which enables all existing division works to secure the required water level to the secondary canals.

② To consider the balance between excavation and filling.

The rough longitudinal section of the canal is as below.

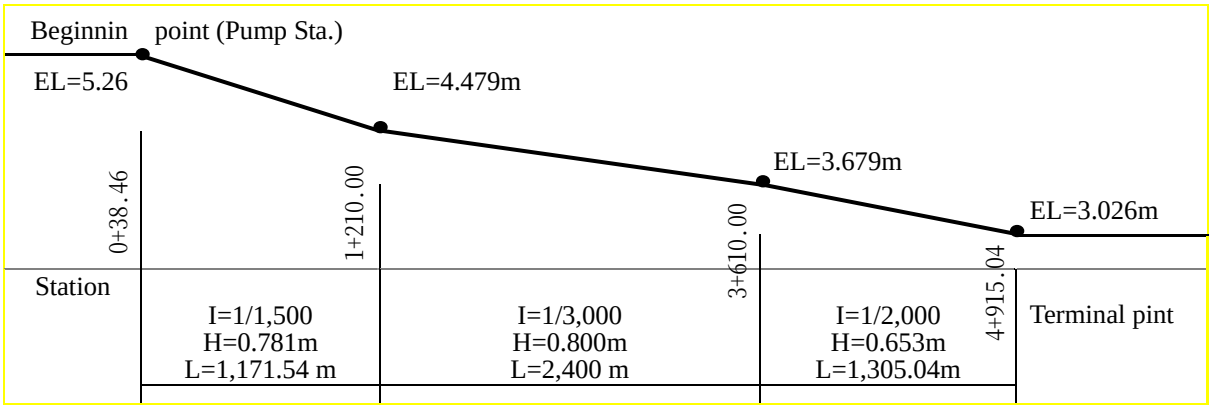
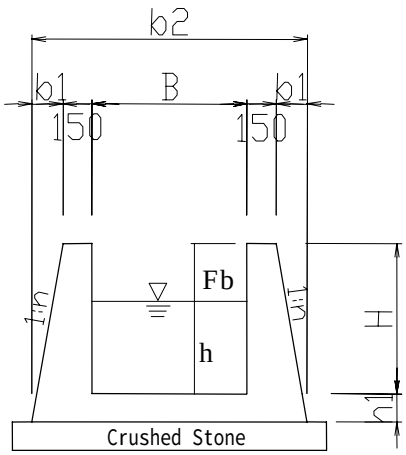



**Figure 2-2-2-1.3 Planned Long Section of Nam Trung Canal**

The hydraulic dimensions of the canal are estimated using the Manning formula, one of the mean velocity formula based on design discharge and invert slope of each section. The structural dimensions of the canal section are decided based on a structural study using typical drawing books published by related agencies of both countries and structural examinations.

**Table 2-2-2-1.8 Typical Cross Section of Nam Trung Canal** (m)

| Illustrated Section | No | B | b1 | b2 | H | h1 | n | h | Fb | Length |
|---|---|---|---|---|---|---|---|---|---|---|
|  | ① | 1.40 | 0.17 | 2.04 | 0.85 | 0.25 | 0.2 | 0.70 | 0.15 | 121.3 |
| | ② | 1.30 | 0.16 | 1.92 | 0.80 | 0.25 | 0.2 | 0.62～0.70 | 0.10～0.18 | 1712.3 |
| | ③ | 1.20 | 0.07 | 1.64 | 0.75 | 0.20 | 0.1 | 0.64 | 0.16 | 496.8 |
| | ④ | 1.10 | 0.07 | 1.54 | 0.70 | 0.20 | 0.1 | 0.57 | 0.13 | 273.0 |
| | ⑤ | 1.00 | - | 1.30 | 0.65 | 0.20 | - | 0.53 | 0.17 | 425.6 |
| | ⑥ | 0.90 | - | 1.20 | 0.60 | 0.20 | - | 0.50 | 0.10 | 542.6 |
| | ⑦ | 0.80 | - | 1.10 | 0.50 | 0.15 | - | 0.38 | 0.12 | 525.0 |
| | ⑧ | 0.70 | - | 1.00 | 0.50 | 0.15 | - | 0.37 | 0.13 | 309.0 |
| | ⑨ | 0.65 | - | 0.95 | 0.45 | 0.15 | - | 0.32 | 0.13 | 177.0 |
| | ⑩ | 0.50 | - | 0.80 | 0.40 | 0.15 | - | 0.30 | 0.10 | 294.1 |



◎ Design conditions

① Load: 0.3t／$m^2$ of a large group of people load or T-10 (10 ton Truck) load

② Concrete strength: 18N/$mm^2$ in case of plain concrete

(iii) Shift of the Canal Centerline

Since the right bank's O/M road and the existing earth lined canal are narrow in width, vehicle traffic is much restricted in some parts of the road. Therefore, the canal center will be shifted toward the left bank side in the plan so as to secure 1.0m width foot path on that bank and a sufficient road width for motor vehicles on the right bank.

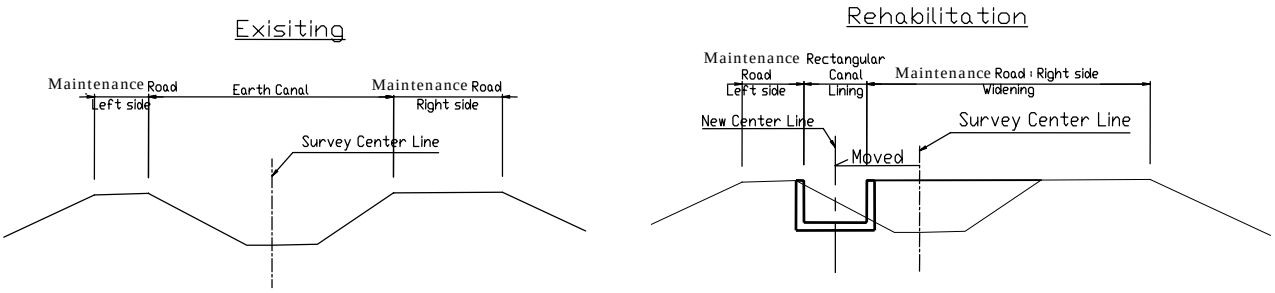



**Figure 2-2-2-1.4 Alteration of the Maintenance Roads on both Banks in the Earth-lining Period**

ii) Basic Design of Related Facilities

The following related facilities are furnished in the canal section. These facilities will be replaced when constructing the canal. The design policies are as follows.

**Table 2-2-2-1.9 Design Conception of Related Facilities**

| Facility | Quantity | | Design Conception |
|---|---|---|---|
| | Existing | Plan | |
| 1) Division work | 28 | 28 | Simplified gate will be installed at branch canal side |
| 2) Check gate work | | 4 | Gates for O/M will be installed at main division works. |
| 3) Crossing road work | 16 | 16 | The style of the works will be decided from the comparison of the culvert and bridge types. |
| 4) Gate-way (Traffic slab bridge for crossing the canal) | 26 | 26 | Simplified bridge type will be selected same as existing type using concrete slab. |
| 5) Washing place works | 6 | 7 | Steps type will be selected as washing place works same as the existing. |

(i) Division Work

Division works are constructed at 23 locations in the canal section. In this plan, the repair works of these facilities will be standardized following two types based on the condition of the branch canals.

① Division Works with Branch Canal: 18 Locations

This type distributes water from the main canal to the branch canal using φ20-50mm pipe. In the plan, the division works use the same pipes as the existing works. A simplified slide gate will be installed at the branch canal side of the division works for water management purposes. Outflow works with 3 meter-length canals will be constructed at the branch canal side.

The water level in the main canal is sufficiently high for the elevation of any command field. However, four check-gates will be installed at the border of the irrigation blocks in the canal from the operation and maintenance viewpoint. A division work is shown as below.

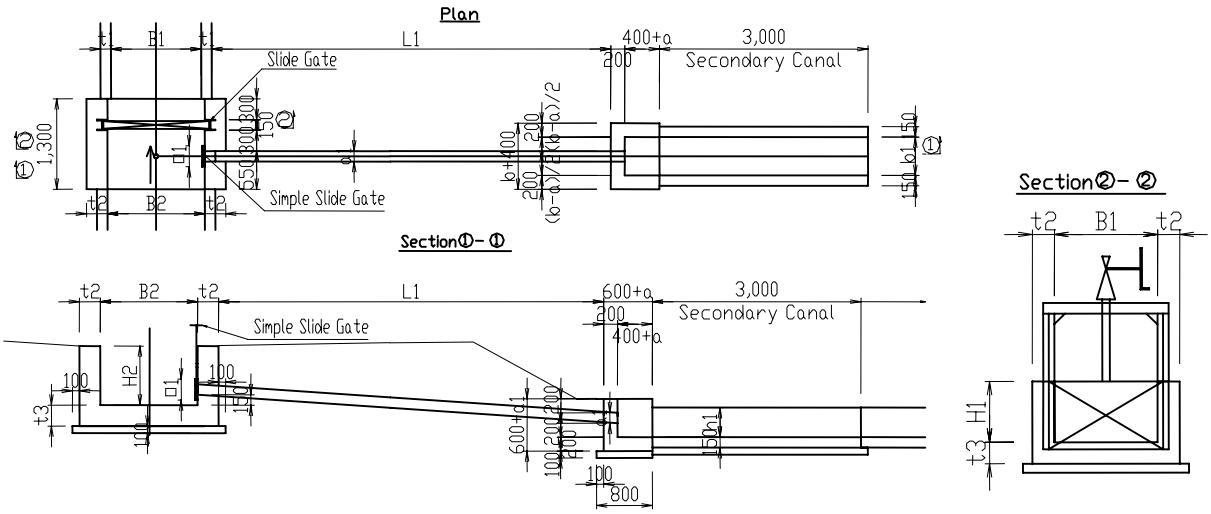



**Figure 2-2-2-1.5 Division Work with Secondary Canal**

② Division Works without Secondary Canal: 10 Locations

The structure of ten division works without branch canal is selected for the direct distribution system using ϕ20-50mm pipe from the main canal to deliver water directly to 1-2 ha rice field.

(ii)Crossing Road Work

Three types of road crossing work are compared considering a maximum canal width of 1.30m. From the comparison, the slab bridge type is selected from the viewpoints of structure, hydraulics, construction and cost.

**Table 2-2-2-1.10 Comparison of Crossing Road Works**

| Type | Structure characteristics | Hydraulic characteristics | Construction characteristics | Economical characteristics | Evaluation |
|---|---|---|---|---|---|
| ① Pipe culvert | A pipe covered with reinforced concrete and attached wings linking road with both sides of the culvert will be arranged due to big difference of the surface elevations between road and culvert. △ | Head losses are occurred at entrance of the culvert due to alteration of the sections. △ | Crane for construction will be needed depend on the site conditions △ | 468US$/m (Under gravel pavement road) | |
| ② Box culvert | A Reinforced concrete structure linking the road with both sides of the culvert will be arranged due to big difference of the surface elevations between road and culvert. △ | No hydraulic influence in case of the planned culvert section is same as canal. ○ | Constructed in the site and support work needs. △ | 267US$/m (Under gravel pavement road) | |
| ③ Slab bridge | A Simplified structure of laid concrete slab straddling on both walls of the open canal. However, the canal under this bridge must be made in reinforced concrete. ○ | No hydraulic problem ○ | Constructed in the site. Crane for installation will be needed. ○ | 220US$/m (Under concrete pavement road) | ○ |

Exceptionally, a box culvert will be used instead of the slab bridge at the 10m-length section located 3.30km from the beginning point. However, a footpath bridge made of a concrete slab will be used instead of the culvert when the canal width is less than 2 m. The slab is also used as a bridge to cross the canal to enter houses. This is explained in details in the next paragraph.

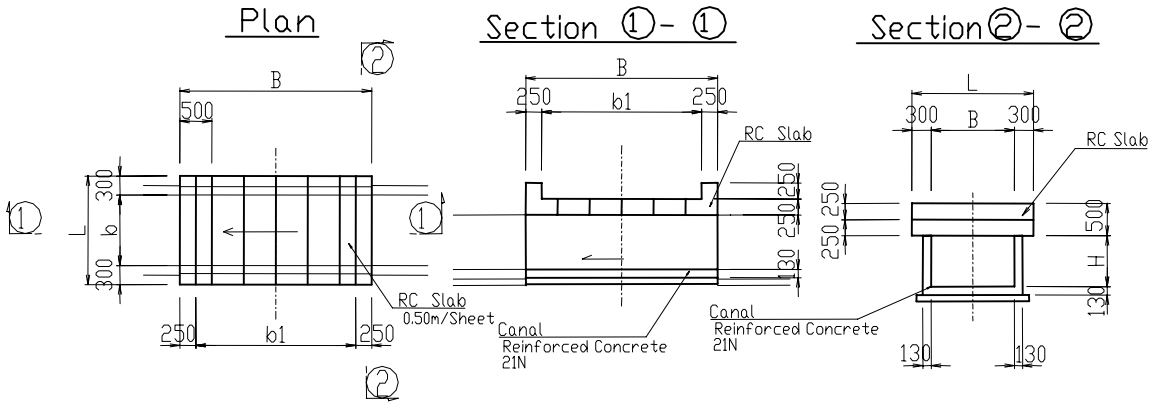



**Figure 2-2-2-1.6 Structure of RC Slab Bridge**

◎ Dimensions for structural examination
① Load: T-10, loading in the direction of long section
② Concrete strength: 21N/mm$^2$ of reinforced concrete

(iii) Slab Bridge for the Entrance to House

A Concrete slab acting as a bridge crosses the canal at the entrance to shops and private houses in the upstream canal area.

The slab has a length of 0.50m, a width of 0.60m added to the canal width and a thickness of 0.15m. The structure is shown as below. In the plan, the necessary Namber of slabs will be laid to meet their present width.

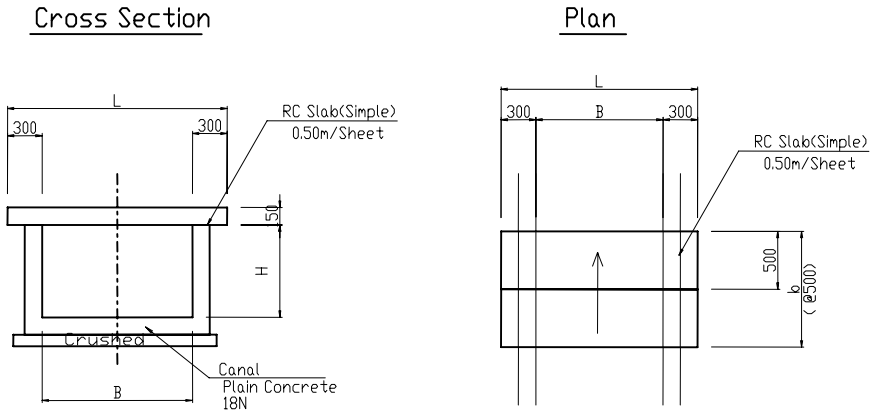



**Figure 2-2-2-1.7 Crossing Slab Bridge for the Entrance to House**

◎ Dimensions for structural examination
① Load: T-2, loading in the direction of long section
② Concrete strength: 21N/mm$^2$ of reinforced concrete

(iv) Washing Place Work

This canal water is also used for washing clothes, cattle and agricultural equipments.

In the plan, washing place works are to be constructed at six locations upstream and one location downstream. The installation sites are as follows.

① Near where they exist presently

② Near road crossing works

③ Near villages

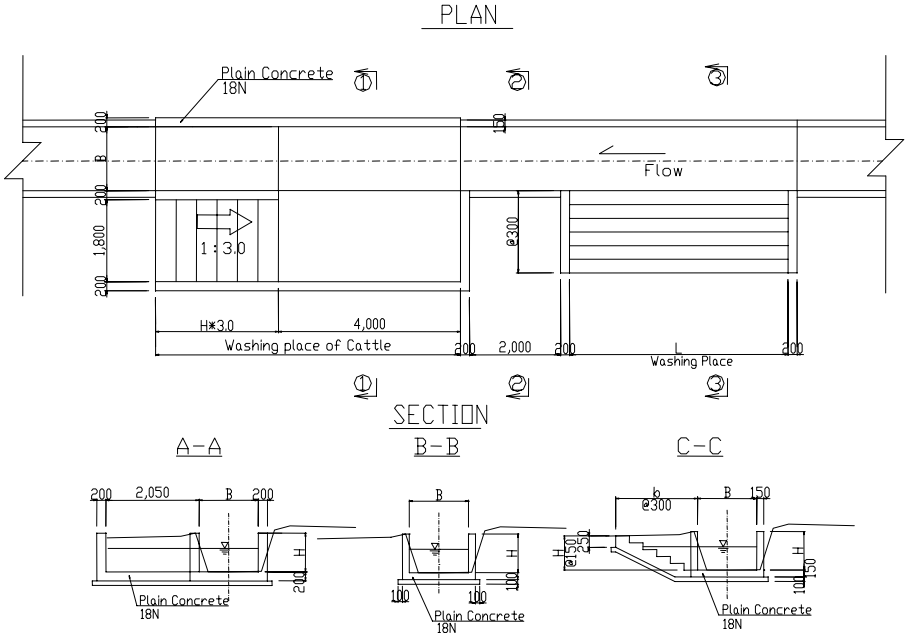



**Figure 2-2-2-1.8 Washing Place Work**

**(2) Ho Thanh Reservoir Irrigation System**

1) Basic Policy

The Ho Thanh reservoir irrigation system was constructed approximately 30 years ago. Depreciation is at a very advanced stage, with leakages observed at two sites of the dam body. The effective capacity of the reservoir has decreased by 20 to 30% due to sedimentation at its upstream side. The lack of other alternative water resources in the project area makes the reservoir the most important facility in the area. The recovery of its function is therefore urgently needed. The Master Plan has given a high priority in the rehabilitation of the system.

**Table 2-2-2-1.11 Summary of Ho Thanh Reservoir**

| | |
|---|---|
| 1) Reservoir | Effective capacity 900,000 $m^3$, Existing estimated effective capacity 650,000 $m^3$ |
| 2) Dam body | Homogeneous type dam, Height of dam 12.0 m, Crest length 163.0 m, Crest width, 4.0 m, Slope (Upstream 1:3, Downstream 1:3&1:2.5), Dam crest elevation EL.22.00 m, Full water level EL.20.00 m |
| 3) Intake facility | Concrete pipe φ600 mm, Height of pipe EL.12.00 m, Maxim intake depth 8.00 m |
| 4) Spillway | Inflow type, EL.20.00 m, Width in inflow point 20.0 m, Width in downstream 12.6 m |

Countermeasure work for leakage of reservoir: A leakage exists at the toe of the slope located on the downstream side of the dam body close to the right bank. As the result of the leakage, a part of the said toe has collapsed. This leakage occurred immediately after the completion of the dam and has not been corrected since. It has reduced the discharge from the dam, whose safety has to be secured by repairing the toe of the slope.

Another leakage exists at the bottom of the intake facility, and the scale of this leakage cannot be disregarded. As this leakage occurred with the depreciation of the intake facility, some countermeasures will be planned for the overall improvement of the facility.

Improvement of No.2 Canal: For the effective use of water, No.2 canal, which is operating under a reduced capacity, will be improved by lining parts of the canal where conveyance is reduced.

2) Basic Plan and Basic Design

(a) Countermeasure for Leakage

As a countermeasure for leakage, the rehabilitation of the whole intake facility and toe of the slope on the reservoir is to be undertaken.

i)Rehabilitation of Intake Facility

This work includes removal of the whole existing intake facility and building of a new facility similar to the existing one. The facility will consist of a steel-slide gate as an intake gate, reinforced concrete as an intake tower for a gate-operation, 600mm-diameter concrete pipe as a bottom pipe to lead water, a plain-concrete division tank as a tank after the bottom pipe.

The bottom pipe is to be rolled up in concrete. To prevent leakage, a wall to stop flow is to be built at three points. Though 30 years passed since the construction of the reservoir, the foundation under the bottom pipe seems to have remained stable, without need for any treatment.

The division tank is to be rebuilt where No.1 and No.2 canals start. In order to manage water supply properly, a simple gate is to be set.

For the rehabilitation work, excavation and filling-back, which is comparatively a low-cost method is to be considered.

The general section of the dam, excavation and bottom pipe of Ho Thanh reservoir are illustrated below.

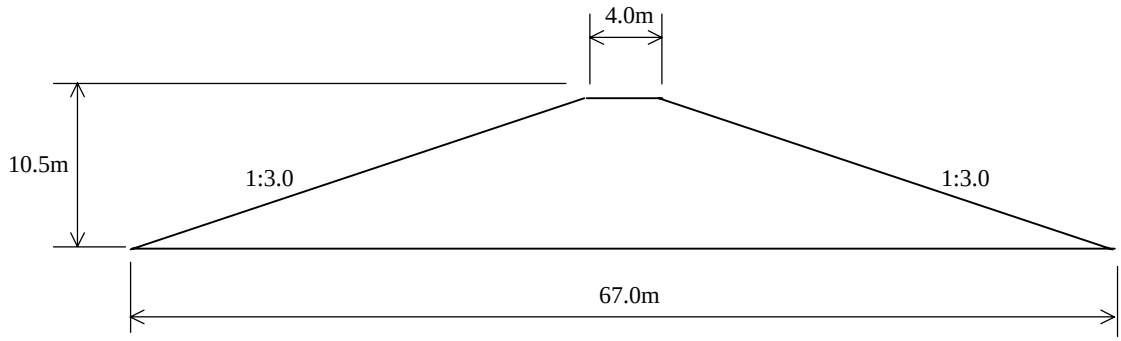



**Figure 2-2-2-1.9 General Section of Ho Thanh Reservoir's Dam**

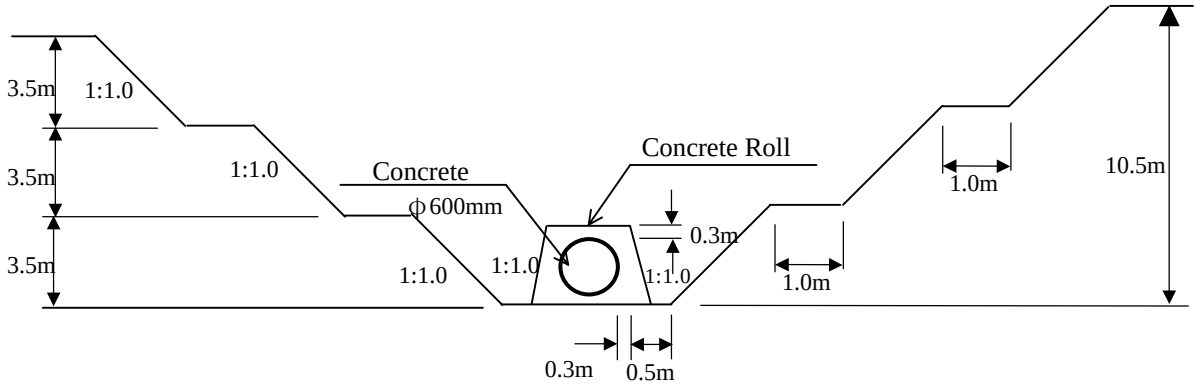



**Figure 2-2-2-1.10 General Section of Excavation**

ii)Countermeasure for Leakage

It is observed that water is leaking through the dam on the right bank side of the reservoir. To stop the leakage, which has remained for the last few decades without serious damage to the bank, could generate a new path of leaking. The aim of the countermeasure would be not to stop the leakage but to protect embankment from explained leakage.

Firstly to remove deteriorated soil around the leaking and grade, secondary to fill back with high-permeable soil with a function of a filter and compact it well, thirdly to set stone riprap on the slope. This operation prevents soil from flowing from the leakage and enlarging the crack in the dam. In order to drain leaked water safely, 300mm-diameter concrete pipe is to be set as an under drain crossing under a road.

Picture of the counter measure for leakage is shown below.

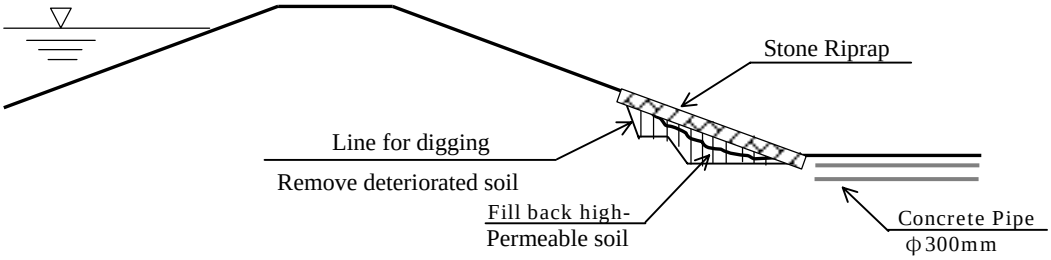



**Figure 2-2-2-1.11 Counter Measure for Leakage**

**Table 2-2-2-1.12 Structure of the Countermeasure for Leakage of Ho Thanh Reservoir**

| Structure | | | Dimension | Nos. | Remarks |
|---|---|---|---|---|---|
| Intake facility | Intake tower | RC | — | 1 | |
| | Intake gate | Slide gate | — | 1 | |
| | Bottom pipe | Concrete pipe with concrete roll | φ600mm | 80m※1 | |
| Division facility | Division tank | Plain concrete | —※1 | 1 | |
| | Division work | Simple gate | — | 2 | |
| Rehabilitation for leaking part of dam | Toe of slope | High-permeable soil | — | $220m^3$ | (5.0 + 11.2)/2 × 13.0×2.0 (m) |
| | | Stone piprap | — | $110m^2$ | (5.0 + 11.2)/2 × 13.0 (m) |
| | Under drain | Concrete pipe | φ300mm | 3.2m | |

※1：Survey needs on Detailed Design for definite measre.

(b) Rehabilitation of Ho Thanh No.2 Main Canal

i)Calculation of Water Requirement

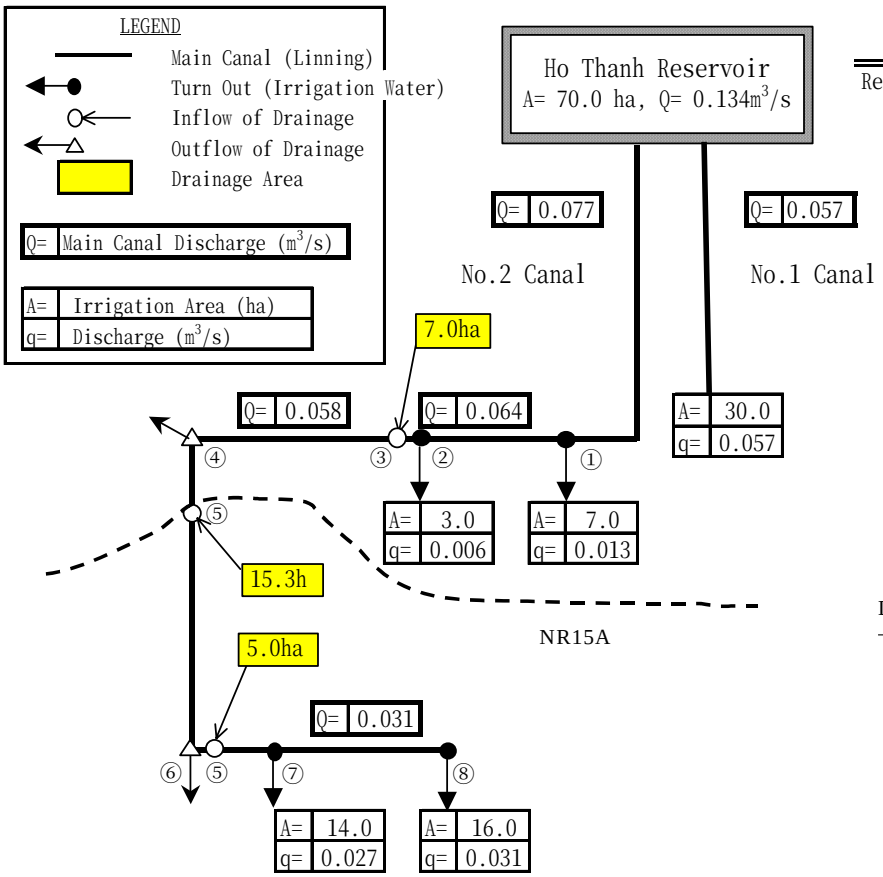
The area to be irrigated by Ho Thanh No.1 and No.2 canals is 40ha. In order to calculate the water requirement, a unit water requirement of 1.9 liter/second/hectare (L/s/ha) is considered. Figure 2-2-1.12 shows the irrigation system in Ho Thanh area.

ii) Basic Design of Ho Thanh Canal

(i)Design Discharge

This canal starts from the Ho Thanh reservoir as the water resource. It has the functions of not only supplying water but also acting as a drainage canal. Therefore, calculating the design discharge requires considering both function, namely a water requirement discharge and a drainage discharge.

The water requirement and drainage discharges in Ho Thanh area are shown in Figure 2-2-2-1.12.




| | Cumulative Distance | Distance | Require-ment | Drainage |
|---|---|---|---|---|
| Reservoir | 0m | | | |
| | | 630m | **0.077** | — |
| ① | 630m | | | |
| | | 380m | **0.064** | — |
| ② | 1010m | | | |
| | | 320m | **0.058** | — |
| ③ | 1330m | | | |
| | | 460m | 0.058 | **0.644** |
| ④ | 1790m | | | |
| | | 120m | **0.058** | — |
| ⑤ | 1910m | | | |
| | | 172m | 0.058 | **0.676** |
| ⑥ | 2082m | | | |
| | | 48m | 0.058 | **0.271** |
| ⑦ | 2130m | | | |
| | | 280m | 0.031 | **0.271** |
| ⑧ | 2410m | | ($m^3/s$) | ($m^3/s$) |

Drainage discharge is calculated for a 10 year –return period rainfall.

**Figure 2-2-2-1.12 Ho Thanh Reservoir Irrigation System and Design Discharge**

Design discharge is equal to drainage discharge during the rainy season, when the canal is only used for drainage, and it is equal to water requirement discharge during the dry season, when no drainage occurs.

(ii)Canal Type

According to the Basic policy, the existing canals (earth type) are repaired using a plain concrete lining material in the same style as the Nam Trung Canal.

A maintenance road is constructed along the right side of the canal for operation and maintenance purposes.

(iii)Decision of Canal Section

In order to decide the dimensions of the canal section, the discharge in each section, which is calculated as previously mentioned, and the canal slope are used.

The longitudinal section of the canal is studied based on the following principles.

(1) The formation height of the canal invert sets the existing level as a rule because all the existing division works secure the required water level for the secondary canals.

(2) The volume of soil cutting should meet that of soil banking for the sake of balance.

(3) A drop structure is set at a point near the End Point, because the existing canal slope between location 1,300m and location 2,070m from the Beginning Point is steep.

The rough longitudinal section of the canal is shown as below;

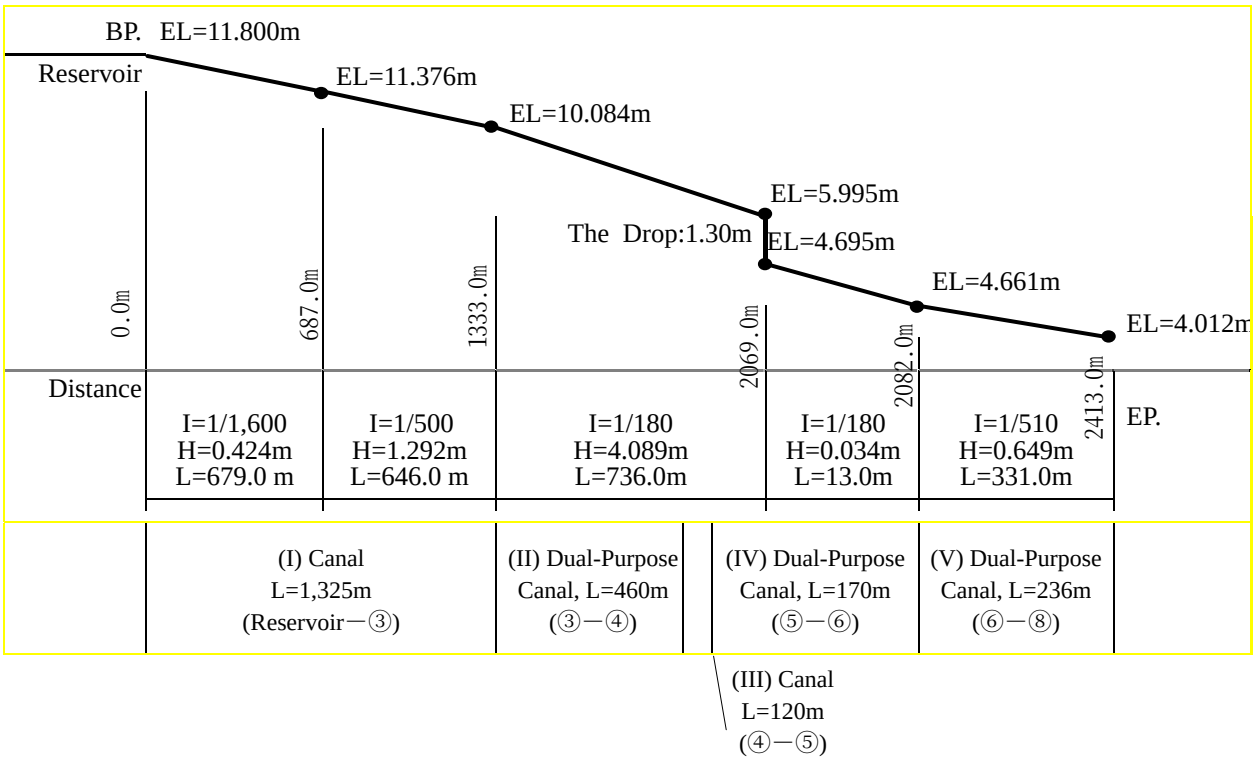



**Figure 2-2-2-1.13 Ho Thanh Canal Profile**

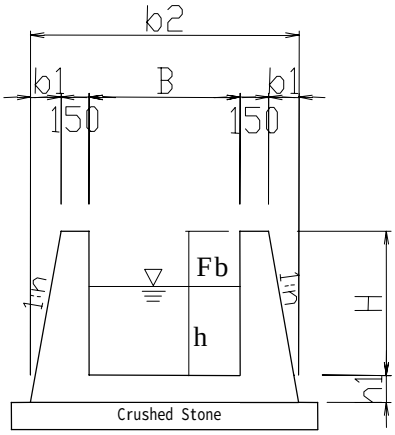
A Canal exhibiting functions of not only water supply but also drainage at some sections is considered a dual-purpose canal, and drainage discharge is much larger than water requirement discharge.
A dual-purpose canal has a double section. Reference drawing is shown in Table 2-2-2-1.13.

When discharge does not concern drainage discharge, water flows in only one part of the flume (lower part of canal), but when drainage discharge is concerned, water flows through all sections (including parts of the upper canal).

Section (IV) in Figure 2-2-2-1.13 is to be taken as a rectangular shape section, because the maintenance road running along the canal downstream needs to be enlarged as it is near a market and should accommodate a large traffic. The canal at this section is closed with a RC-slab in order to be used by the traffic.
The hydraulic dimensions of each canal section are computed using Manning's formula based on design discharge and canal slope. Details are shown in Table 2-2-2-1.13.

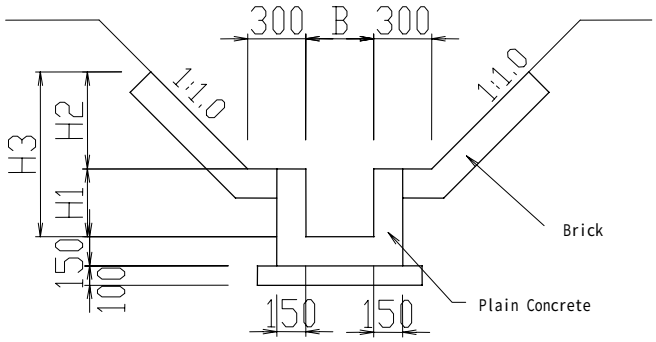
**Table 2-2-2-1.13 Typical Section of Ho Thanh Canal** (m)

Rectangular Canal




| No | Section | B | b1 | b2 | H | h1 | n | h | Fb | Distance |
|---|---|---|---|---|---|---|---|---|---|---|
| a | 0－① | 0.60 | - | 0.90 | 0.40 | 0.15 | - | 0.28 | 0.12 | 622.5 |
| b | ①－③ | 0.55 | - | 0.85 | 0.40 | 0.15 | - | 0.24～0.27 | 0.13～0.17 | 702.5 |
| d | ④－⑤ | 0.35 | - | 0.65 | 0.35 | 0.15 | - | 0.17 | 0.18 | 114.0 |
| e | ⑤－⑥ | 0.85 | 0.16 | 1.47 | 0.75 | 0.15 | 0.2 | 0.44 | 0.31 | 170.0 |

Dual-purpose Canal




| No | Section | B | H1 | H2 | H3 | h | Fb | Distance | |
|---|---|---|---|---|---|---|---|---|---|
| c | ③－④ | 0.35 | 0.35 | 0.50 | 0.85 | 0.61 | 0.24 | 465.00 | |
| f | ⑥－⑦ | 0.40 | 0.35 | 0.35 | 0.70 | 0.53 | 0.17 | 53.00 | |
| g | ⑦－⑧ | 0.35 | 0.35 | 0.35 | 0.70 | 0.53 | 0.17 | 304.00 | |

◎Dimensions for structural examination

① load: 0.3t/m$^2$ or T-10 (loading point 50cm from the side wall) ; the heavier load of the two will be adopted.

② Sources: Ministry of Agriculture, Forestry and Fisheries / Farmland improvement project planning design criteria “Canal Works”

(iv)Aqueduct

In Section (I), there is an aqueduct at location 200m from the BP. The aqueduct is 15m long and is set at the said point in order not to restrain the water flow below it from the Ho Thanh Canal spillway

The existing aqueduct is made of a steel pipe(φ600) with two piers set at every 5m. This aqueduct is to be replaced by a new “flume type” aqueduct which is more economical and easier to maintain and operate than the existing “metal pipe type”.

A RC slab laid on top of the wall will close the planned “flume type” aqueduct.

Table 2-2-2-1.14 shows the comparison between a “flume type” and a “metal pipe type” aqueduct, and a reference drawing is shown in Figure 2-2-2-1.14.

**Table 2-2-2-1.14 Comparison of Style of Aquaduct**

| Style of Structure | Flume style | Metal pipe style |
|---|---|---|
| Distance | 15.0m(7.5*2) | 15.0m (5.0m*3) |
| Material | Reinforced concrete | Metal pipe |
| Dimension of section | B600×H500 | φ500mm |
| Relative facilities | Abutment 1, Pier 1 | Abutment 1, Pier 2 |
| Estimate costs | $ 1,170 | $ 2,530 |
| Ease of O/M | Easy (because of open canal) | A little difficult (because of closed pipe) |
| Evaluation | ○ | △ |

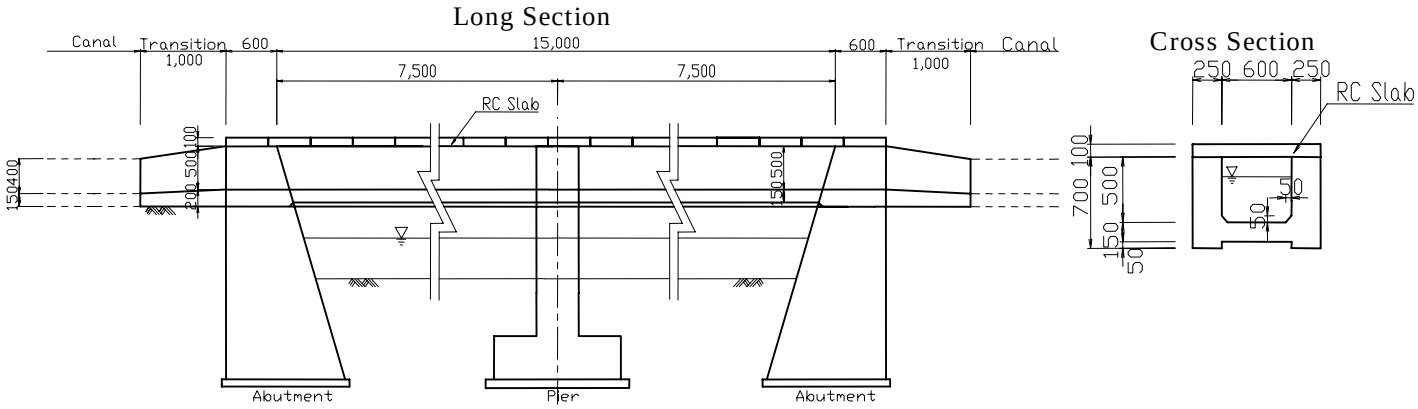



**Figure 2-2-2-1.14 Detail of Aquaduct**

(v)Shift of The Canal Centerline

The survey centerline turns left at station MC.62 and passes in front of 4 private houses from location 400m in the plan. At this section, the centerline is shifted and is to cross the road at station MC.62, as shown in Figure 2-2-2-1.15, because there are few merits as follows;

① After the shift, 4 gateways are no more needed on the canal path.

② The crossing road at MC.64+29.0 will be shorter after the shift as it will cross the canal diagonally.

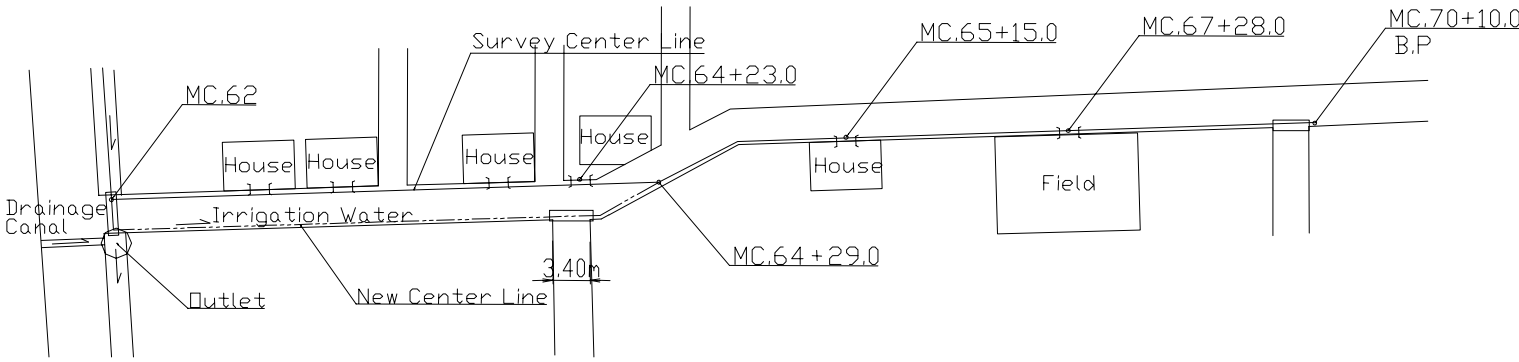



**Figure 2-2-2-1.15 Shift of Canal Centerline**

iii)Basic Design of related facilities

The related facilities and their design principles are as follows;

**Table 2-2-2-1.15 Design Conception of Related Facilities with Canal**

| Facilities | Quantity | | Design principles |
|---|---|---|---|
| | Existing | Plan | |
| 1) Division work | 2 | 4 | Simplified slide gate is installed |
| 2) Aquaduct | 1 | 1 | Comparing flume style with metal pipe style (reference to previous section) |
| 3) Crossing road | 8 | 10 | RC-Slab is adopted (the same of Nam Trunh Canal) |
| 4) Gateway | 36 | 32 | Simplified RC-Slab is adopted（the same of Nam Trunh Canal |
| 5) Drop | | 1 | Step style is adopted |

(i)Division Work

Ho Thanh canal area needs 4 division works, two are to be repaired and the others two are to be newly set up. A Division works is separated into two types (the upstream type and the downstream type) according to the allocated functions.

① The upstream type: This type supplies water using a 300mm pipe from the main canal to the paddy fields after crossing the maintenance road between the division works and the paddy fields.

② The downstream type: This type supplies water directly to the paddy fields. A simplified slide gate is installed at the paddy field side of the division works.

Details of the drawing are as follows;

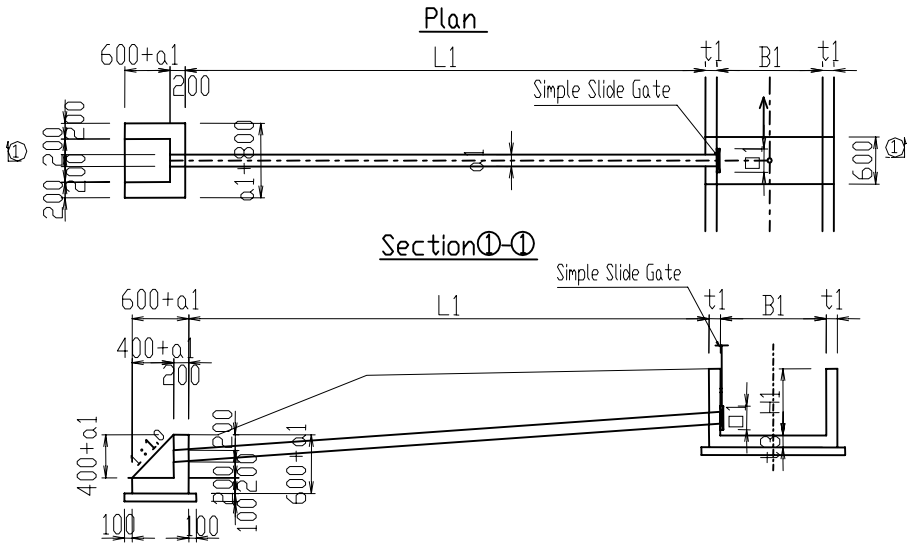



**Figure 2-2-2-1.16 Division Work Type I**

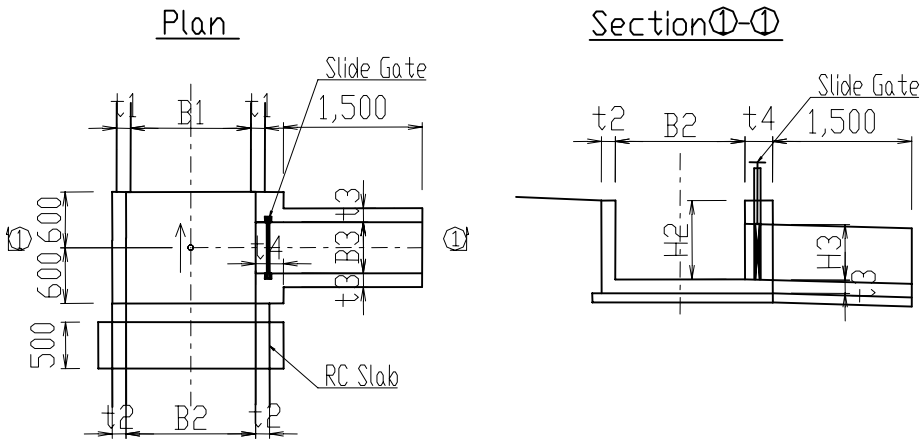



**Figure 2-2-2-1.17 Division Work Type II**

※ At the forth division works located at the end of the canal a stop log is installed.

(ii)Plan of Drop Structure

A Drop structure is placed at a point located 2,069m from the BP, which has a head drop of 1.30m. The type of drop structure is decided as below.

In case of the Ho Thanh Canal, a “Water Cushion type” and a “Step type” are observed. This time, a Step style is to be adopted because it has a few merits as follows.

① It is smaller than the water cushion type

② Earth and sand would not accumulate in it

③ It is safer, when a person or water buffalo etc. falls in it, as the head is much lower than the water cushion type.

Details of the structure are as follows;

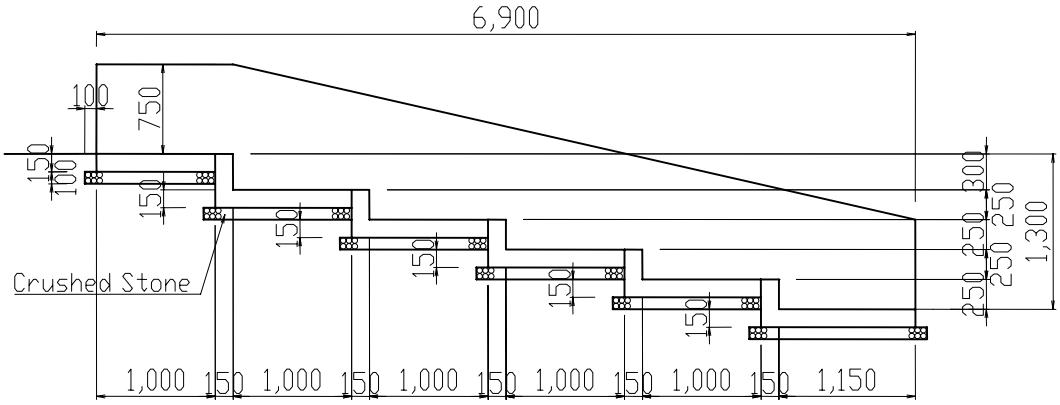



**Figure 2-2-2-1.18 Drop Structure**

(iii)Plan of Crossing Road

The crossing roads are to be made of RC-Slab in the same style as the Nam Trung canal except for 2 specific locations.

At one specific location, a simplified RC-Slab is to be used as gateway because the canal width is 2.00m or less there, and cars will not pass through the structure. At the other location where NR15A crosses the canal, a Box culvert is to be used because the elevation of NR15A is high and earth covering there is large.

(iv)Gateway (Slab Bridge at the Entrance of Houses)

Along the canal, there are many private houses and shops, which requires the setting of 32 gateways for crossing the canal. For these gateways, a simplified RC-Slab is to be used in the same style as the Nam Trung canal.

### 2-2-2-2 Rural Road

#### (1) Basic Concept of Design

##### 1) National Road 15A (NR15A)

NR15A is the only one route that connects Nam Nam area with the central area of Nan Dan district as well as Ha Tinh Province. Therefore, the improvement of this road is the most important and necessary component for improvement of living environment in Nam Nam district.
In addition, NR15A plays an important role as one of the main trunk road network in Ngha An Province that connects NR7, NR46 and NR48 with each other in the north-south direction for traffic distribution as well as runs towards Laos through NR8 in Ha Tinh.
However, the current NR15A does not perform the role expected effectively due to poor road condition of an unpaved road (Figure 2-2-2-2.1).

With the progress of improvement of NR15A such as the improvement of this project road (Nam Dan - Ha Tinh Province) and improvement of section between Do Luong and Nam Dan that have been carried out by Viet Nam side, socio-economic activities will be encouraged by smooth transportation and decentralization of traffics in main national roads in inland area. Therefore, the improvement of NR15A is expected to contribute economic growth not only in Nam Nam area, but also in Nam Dan district and all other area of Nghe An Province.

The project road on NR15A is the section from Nam Dan to the boundary between Ha Tinh Province, however this section can not secure transportation all through the year because of various problems mentioned above. Limited access to market, school, hospital and other urban facilities discourages the opportunities of employment and economic activities of the rural inhabitants. Existing road is unpaved with 5 to 7 m width, and is under poor conditions by outflow of soil in rainy day and rough road surface for traveling by vehicles. The improvement to the level to be able to access to the center of Nam Dan district and Ha Tinh Province through a year is necessary conditions.
Problems and its countermeasures of NR15A is shown as follows:

**Table 2-2-2-2.1 Problems and its Countermeasures of NR15A**

| No | Problems to be solved | Countermeasures |
|---|---|---|
| 1 | Blocking the road due to flood | Road elevation is to be increased to design water level (improvement to an all-weather standard) ※1 |
| 2 | Blocking the road by piling up soils due to gully erosion in flood | Countermeasures to avoid piling up soils and provision of drainage channel downstream. |
| 3 | Bad condition for traveling due to uneven road surface | Road surface is to be paved. |

※1:Regarding the road elevation in 4.65km long section from Nam Dan Bridge shown in Figure 2-2-2-2.1, it shall not be raised to avoid adverse effects to Nam Dan Bridge and its upstream area.


**Figure 2-2-2-2.1 Section that Road Elevation not to be Raised (Request from Executing Agency)**

At present, following two routes on NR15A are serviced as bus routes. A new bus service will be provided under state control with the improvement of NR15A.

a) Nam Dan District – Thanh Chuong (New Economic Zone): under state control (under management of DOT)

b) Nam Dan District- Nam Kim: Private

### 2) Nam Kim－Nam Phuc－Nam Cuong Road (KPC Road)

KPC Road is crossing in the east-west direction in Nam Nam area that is in low-lying area of right bank of the Lam River. It plays a very important role as a communication road and an access road to NR15A for Nam Nam area, an agricultural road for farmers as well as an access road to the central area of Nam Dan district, Vinh City and Ha Tinh Province together with NR15A.

Nam Nam area except for residential area is inundated 50cm deep over the road surface every year by rainfall, for dikes encompass its area to avoid damage by flooding from the Lam River. Moreover, in times of large-scale flood, Nam Nam area plays an important role as a reservoir to protect Vinh City by means of allowing flooding water to flow into it over the dikes. In the 1978, 1888 and 1996 floods, water depth was approximately 3 meters in the whole of this area.

Concerning the current road conditions, road width is narrow with 2 - 3 meters together with seriously eroded slope as well as severely uneven road surface with traveling low speed of 5 km/h.

KPC Road running in the east-west direction divides Nam Nam area into north and south parts. It dams water flow from north to south that raises water level in its area. Hence, raising road elevation and alteration of opening area in the locations of bridge and culvert shall be avoided so as not to affect adverse effects to agricultural cultivation and drainage conditions in both north and south area.

Problems to be solved and their countermeasures for KPC Road are shown below.

**Table 2-2-2-2.2 Problems and its Countermeasures of KPC**

| No | Problems to be solved | Countermeasures |
|---|---|---|
| 1 | Road improvement not to affect adverse effects to agricultural cultivation. | Road elevation not to be raised. (Inundation of road is allowed.) |
| 2 | Bad condition for traveling due to uneven road surface | Road surface is to be paved. |

### 3) Pavement Structure

Three types of pavement structures used in Vietnam, namely surface treatment pavement, asphalt concrete pavement and concrete pavement were compared in consideration of water effect to pavement structure, as 7 locations along NR15A and KPC Road are inundated during the rainy season.

Pavement structure is designed in general based on the number of axial load of large-scale vehicles, as it is damaged due to their repetitions. In case the pavement is inundated, its damage is more serious because load capacities of sub-grade, sub-base and base course become small due to pore water pressure.

**Table 2-2-2-2.3 Comparison of Pavement Structure**

| Pavement Type | Surface treatment pavement | Asphalt concrete pavement | Concrete pavement |
|---|---|---|---|
| Outlines | * Existing ground<br>* Crushed stone (1 or 2 layer)<br>* Asphalt emulsion | * Existing ground<br>* Sub-base<br>* Base-course<br>* Asphalt Concrete | * Existing ground<br>* Sub-base<br>* Base-course<br>* Concrete with wire mesh |
| Durability to water | * Load capacities of sub-grade, sub-base and base course are small due to its thinness and less compaction.<br>* This type is susceptible to damage such as uneven road surface in case of inundation. | * Asphalt concrete pavement is susceptible to damage on account of its flexibility due to axial loads with pore water pressure. | * Concrete pavement is not damaged on account of the rigidity of concrete plate.<br>* Sub-grade, sub-base and base course are not damaged due to dispersed axial loads. |
| Construction Cost | 1.00 | 1.25 | 2.34 |

In addition to the above, the operation and maintenance costs on each pavement structure are compared for 20-year design period, that is the maximum design period among three options, based on the following premises:

**Table 2-2-2-2.4 Frequency of Maintenance Works and its Items**

| | | Surface treatment pavement | Asphalt concrete pavement | Concrete pavement |
|---|---|---|---|---|
| Un-inundated section | Maintenance Work | Once per 4 years (Crushed stone 15cm + Prime Coat) | Once per 5 years (Resurfacing) | — |
| | Repair Work | Once per 10 years (Reconstruction) | Once per 20 years (Reconstruction) | Once per 20 years (Reconstruction) |
| Inundated section | Maintenance Work | Once per 2 years (Crushed stone 15cm + Prime Coat) | Once per 5 years (Resurfacing) | — |
| | Repair Work | Once per 10 years (Reconstruction) | Once per 10 years (Reconstruction) | Once per 20 years (Reconstruction) |

The comparison of operation and maintenance cost for each pavement structure is shown in Table 2-2-2-2.5.

**Table 2-2-2-2.5 Comparison of Maintenance Cost**

| | Surface treatment pavement | Asphalt concrete pavement | Concrete pavement |
|---|---|---|---|
| Un-inundated section | 1.00 | 0.66 | 0.35 |
| Inundated section | 1.00 | 0.75 | 0.22 |

According to the Tables 2-2-2-2.4 and 2-2-2-2.5, comparison of total cost for construction and maintenance work was made shown in Table 2-2-2-2.6.

**Table 2-2-2-2.6 Comparison of Total Cost for Construction and Maintenance Works**

| | Surface treatment pavement | Asphalt concrete pavement | Concrete pavement |
|---|---|---|---|
| Un-inundated section | 1.00 | 0.89 | 1.12 |
| Inundated section | 1.00 | 0.89 | 0.81 |

Based on the economic analysis taking into account the total cost of construction and maintenance works, the following pavement structure types are to be adopted.

**Table 2-2-2-2.7 Proposed Pavement Structure**

| | Inundated/ Un-inundated | Pavement Structure to be adopted |
|---|---|---|
| NR15A | Un-inundated | Asphalt Concrete |
| Nam Kim-Nam Phuc -Nam Cuong Road | Inundated | Concrete |
| | Un-inundated | Asphalt Concrete |

**4) Drainage Plan**

(a) National Road 15A (NR15A)

NR15A is designed under the assumption that inundation will be prevented. Inundation of NR15A occurs in the low land area from Nam Dan Bridge to approximately 9.5 km point and inundation is mainly resulted by flood of Lam River that flows along this road. Therefore, water level of 10 years return period of Lam river is adopted as design water level on road plan. Design water level in the main points of NR15A is as follow:

**Table 2-2-2-2.8 Design Water Level on Main Points on NR15A**

| Points | Nam Dan Station | Mung Bridge | Hao Hao Bridge | 9.5 km Point |
|---|---|---|---|---|
| Design Water Level (EL.m) | 8.33 | 7.54 | 7.38 | 7.22 |

(b) KPC Road

Proposed elevation of KPC road is same to existing elevation and inundation is permitted. The section of inundation is paved with concrete and the section of no inundation adopts asphalt pavement. The section of inundation is calculated with 3 days continuous rainfall in normal year.

**Table 2-2-2-2.9 Design 3-day Continuous Rainfall (Normal Year)**

| Date | 12 Sep. 1996 | 13 Sep. 1996 | 14 Sep. 1996 |
|---|---|---|---|
| Daily Rainfall (mm) | 21 | 173 | 68 |

Inundation water level is as follows:

**Table 2-2-2-2.10 Conditions of Inundation on each Section**

| Section of Road | West End – Nam Don Canal | Nam Don Canal – Nam Trung Canal | Nam Trung Canal – Nam Nam Dike |
|---|---|---|---|
| Inundation Level (EL .m) | No inundation | 3.30 m | 3.50 m |

(C) Bridges and Structures

i) Design Water Level

Design water level of bridges of NR15A is decided with the discharge of 10 years return period. The opening of bridges of KPC is designed with the same area to the opening of existing bridges. However, the existing opening of Ven bridge has a pipe culvert only of diameter 1,000 mm and the scale of opening is extremely small compared to others. Therefore, the opening of Ven bridge is designed with the discharge of normal year.

Also, Vuc Mau bridge exist in the down stream of the spillway of existing reservoir and the width of Vuc Mau bridge is same to the width of this spillway from safety point of view. Design flood discharge of 200 years return period as discharge from spillway is 41.36 m3/s as discharge. However, Vuc Mau bridge has sufficient discharge capacity.

Design water level of NR15A and KPC is as follows:

**Table 2-2-2-2.11 Design Water Level on NR15A**

| Bridge Name | Discharge ($m^3/s$) | Design Water Speed (m/s) | Design Water Level (El .m) | Remarks |
|---|---|---|---|---|
| Mung | 130.3 | 0.92 | 7.54 | Affected by Lam River |
| Hao Hao | 52.7 | 1.45 | 7.38 | Affected by Lam River |
| Vuc Mau | 41.4 | (Not less than 3.00) | - | Spillway |
| Vuc Nang | 36.5 | 1.15 | 6.50 | |
| Cong Vinh | 12.4 | 1.47 | 5.40 | |

**Table 2-2-2-2.12 Design Water Level on KPC Road**

| Bridge Name | Discharge ($m^3/s$) | Design Water Speed (m/s) | Design Water Level (El .m) | Remarks |
|---|---|---|---|---|
| Ven | 9.1 | 1.66 | 4.30 | |

**5) Protection of Slope and Riverbed**

The wet masonry structure (revetment) is planned to protect slope against erosion caused by the disturbance of river flow. Length of revetment work is 10 m upstream and 15 m downstream. Slope

of revetment is planned with 1: 1.0.

Also, riprap in each bridge is proposed to prevent scour of riverbed by disturbance of river. Length of riprap is 10 m upstream and 15 m downstream. The type of riprap is gabion box work with thickness of 0.5 m.

### 6) Crossing Structure

There are many crossing structures on 2 project roads for irrigation and drainage such as RC pipe culverts and stone masonry culverts.

Some of them are short of discharge capacity and need extension accompanied by the widening of road. Some others are seriously damaged with scaling of mortar, stones and bricks exposed, honeycombs and aggregates exposed for RC structures due to poor construction and flooding water flow.

Problems to be solved and their countermeasures for crossing structures are shown below.

**Table 2-2-2-2.13 Problems and Countermeasure of Crossing Structure**

| No | Problems to be solved | Countermeasures |
|---|---|---|
| 1 | Shortage of flow area | Reconstruction as RC structure |
| 2 | Need extension accompanied by widening of road | Extension same as the existing structure |
| 3 | Need improvement due to serious damage | Newly construction as RC structure |

## (2) Basic Design

### 1) Road

(a) Specifications to be used

* Vietnamese specifications TCVN4054 : 1998
* Vietnamese specifications TCVN4054 : 1985
* Road Geometric Standard (Japan Road Association)
* Guidelines of Pavement Design and Construction (Japan Road Association)

(b) Geometric Standard

Road geometry is shown in Table2-2-2-2.14 based on the road classification and design speed as the results of the discussions with the executing agency.

* NR15A: Road Classification V, Design Speed 20km/h
* KPC Road: Road Classification VI, Design Speed 15km/h

**Table 2-2-2-2.14 Road Geometry**

| Items | Unit | Project Roads | |
|---|---|---|---|
| Road Classification | - | V<br>NR15A | VI<br>KPC Road |
| **Design Speed** | km/h | 20 | 15 |
| **Cross Sectional Component** | | | |
| - number of lane | lane | 1 | 1 |
| - width of 1 lane | m | 3.50 | 3.50 |
| - width of central strip | m | - | - |
| - width of shoulder | m | 1.50 | 1.25 |
| - width of shoulder with treatment | m | 1.00 | - |
| - maximum superelevation | % | 6 | 6 |
| **Horizontal Alignment** | | | |
| - minimum radius (superelevation 6%) | m | 15 | 15 |
| - minimum radius (without superelevation) | m | 100 | 100 |
| **Vertical Alignment** | | | |
| - maximum vertical slope | % | 9 | 9 |
| - minimum vertical slope | | | |
| 凸 | m | 200 | 200 |
| 凹 | m | 100 | 100 |
| - minimum stopping sight distance (static object) | m | 20 | 20 |
| - minimum stopping sight distance (opposing car) | m | 40 | 40 |
| - minimum passing sight distance | m | 100 | 100 |
| **Clearance (Height)** | m | 4.50 | 4.50 |

Source: Vietnamese Specifications TCVN4054 (1985, 1998)

(c) Typical Cross Section

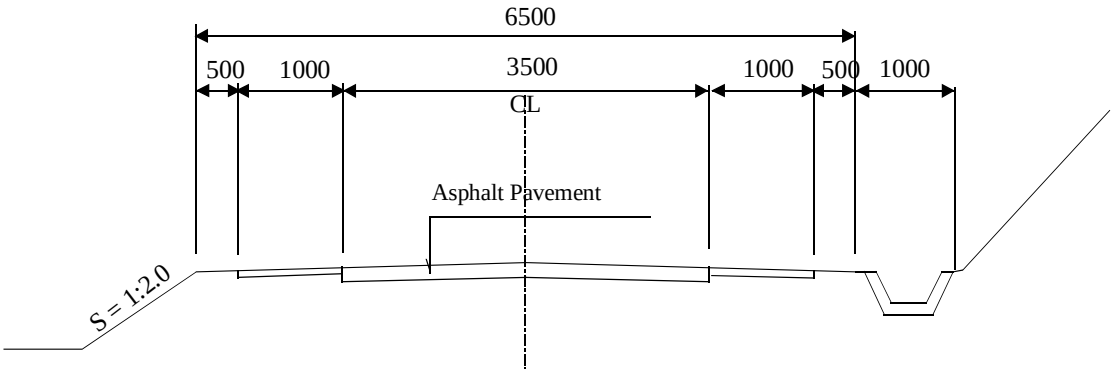



**Figure 2-2-2-2.2 Road Classification V (NR15A) on Embankment Section**

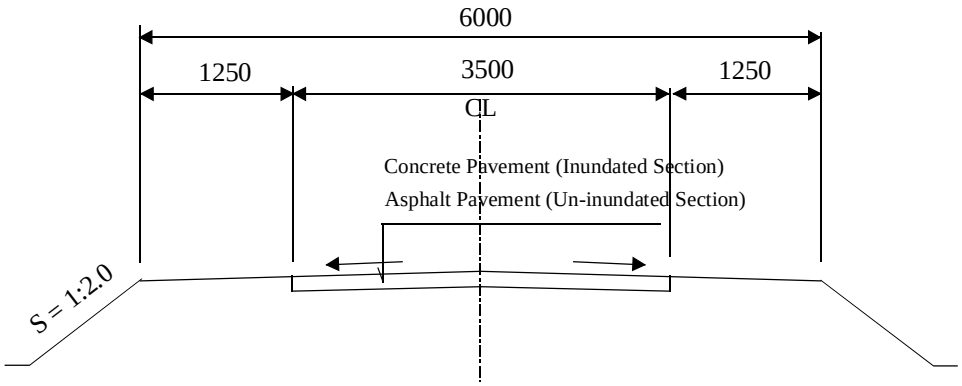



**Figure 2-2-2-2.3 Road Classification VI (KPC Road) on Embankment Section**

(d) Road Alignment

The following considerations were made for road alignment.

i) Horizontal Alignment

* Existing road alignment shall be basically used.
* Improvement of geometry shall be made if the current geometry does not satisfy with the specifications.
* Relocation of houses and electrical poles accompanied with the widening of road shall be minimized.
* Nam Kim－Nam Phuc－Nam Cuong Road shall be widened to both sides in inundated section so that carriageway on the existing road to avoid damage to concrete pavement due to consolidation settlement.

ii) Vertical Alignment

① NR15A

Road elevation shall be basically 50cm above the design flood level (10-year frequency) to avoid damage to the pavement structure. The road elevation in the 4.65km long section from Nam Dan Bridge shall not be raised to avoid adverse effects to the Nam Dan Bridge and its upstream area.

② KPC Road

Design road elevation is basically the same as the existing road elevation.

**2) Pavement Structure**

(a) Standard Specification to be used

Guidelines of Pavement Design and Construction (Japan Road Association)

(b) Design conditions

Design CBR

Sub-grade is the existing road for sections that do not require embankment construction, and is constructed using soils from borrow pits for sections that require embankment construction due to the increase of road elevation or change of alignment.

The value of CBR for sub-grade is 6% based on the geo-technical investigation carried out in this project and data from another project in Vietnam.

In addition to the above, CBR values for sub-base and base course are 30% and 80% respectively.

* CBR for subgrade: 6%
* CBR for subbase: 30%
* CBR for base course: 80%

Design Period

The design periods of asphalt concrete pavement and concrete pavement are 10 years and 20 years respectively, based on the specifications.

(c) Design Methodology

The thickness of the pavement structure is calculated from the traffic volume for pavement design and CBR value of sub-grade. This traffic volume is defined as the average traffic volume of

large-sized vehicles for design period.

In this project, the traffic volume survey was conducted in 2002, and the opening year of the project roads is predicted to be 2005 in consideration of the detailed design period and construction period.

In conclusion, the traffic volume for pavement design is calculated as follows:

i) Asphalt Concrete Pavement

The traffic volume in 2010, that corresponds to that in the middle of the 10 years design shall be used for pavement design. The equation to be used is as follows:

$V = V0 * (1 + i)^8$

Where, V: Traffic volume for pavement design

V0: Daily traffic volume from traffic volume survey

i: Rate of increase of traffic volume

ii) Concrete Pavement

The traffic volume in 2015, that corresponds to that in the middle of the 20 years design shall be used for pavement design. The equation to be used is as follows:

$V = V0 * (1 + i)^{13}$

Where, V: Traffic volume for pavement design

V0: Daily traffic volume from traffic volume survey

i: Rate of increase of traffic volume

On the basis of the traffic volume for pavement design calculated above and CBR value of sub-grade, the equivalent asphalt concrete thickness requirement, and concrete pavement composition are taken from the Tables below.

**Table 2-2-2-2.15 Classification of Traffic Volume**

| Traffic volume for pavement design (vehicles / day, direction) | Classification |
|---|---|
| 3,000 <= T | D |
| 1000 <= T < 3,000 | C |
| 250 <= T < 1,000 | B |
| 100 <= T < 250 | A |
| T < 100 | L |

Source: Guidelines of Pavement Design and Construction (Japan Road Association)

**Table 2-2-2-2.16 Equivalent Thickness Requirement of Asphalt Concrete Pavement Ta** (cm)

| Design CBR | Classification of traffic volume | | | | |
|---|---|---|---|---|---|
| | L | A | B | C | D |
| (2) | (17) | (21) | (29) | (39) | (51) |
| 3 | 15 | 19 | 26 | 35 | 45 |
| 4 | 14 | 18 | 24 | 32 | 41 |
| 6 | 12 | 16 | 21 | 28 | 37 |
| 8 | 11 | 14 | 19 | 26 | 34 |
| 12 | 11 | 13 | 17 | 23 | 30 |
| 20 | 11 | 13 | 17 | 20 | 26 |

Source: Guidelines of Pavement Design and Construction (Japan Road Association)

**Table 2-2-2-2.17 Concrete Pavement Structure**

| Traffic volume for pavement design (vehicles / day, direction) | Design requirement | | | Space of expansion joint | Tie bar, Dowel bar |
|---|---|---|---|---|---|
| | Design flexure concrete strength | Thickness | Wire mesh | | |
| T < 100 | 4.4 MPa (3.9 MPa) | 15 cm (20cm) | To be used. | 8m with wire mesh | To be used. |
| 100 <= T < 250 | 4.4 MPa (3.9 MPa) | 20 cm (25cm) | 3 kg/m$^2$ | 5m without wire mesh | |
| 250 <= T < 1,000 | 4.4 MPa | 25 cm | | | |
| 1000 <= T < 3,000 | 4.4 MPa | 28 cm | | 10m | |
| 3,000 <= T | 4.4 MPa | 30 cm | | | |

Source: Guidelines of Pavement Design and Construction (Japan Road Association)

**Table 2-2-2-2.18 Sub-base Thickness for Concrete Pavement**

| Traffic volume for pavement design (vehicles / day, direction) | Design CBR value of sub-grade | Mechanically stabilized stone (cm) | Crushed stone (cm) |
|---|---|---|---|
| T < 250 | (2) | 25 (20) | 40 (30) |
| | 3 | 20 (15) | 25 (20) |
| | 4 | 25 (15) | 0 |
| | 6 | 20 (15) | 0 |
| | 8 | 15 (15) | 0 |
| | Not less than 12 | 15 (15) | 0 |

Source: Guidelines of Pavement Design and Construction (Japan Road Association)
Note: 1) ( ) in mechanically stabilized stone column is for cement stabilized sub-grade
2) ( ) in crushed stone column is for cement stabilized sub-base
3) In case CBR value for sub-grade (existing ground) is 2 or less, construction of sub-grade shall be considered.
4) Thickness of sub-grade for design CBR is 1.0m.

As for asphalt concrete pavement, the following equation shall be satisfied.

Ta <= Ta'

Where Ta: equivalent asphalt concrete thickness requirement from Table 2-2-2-2.19.

Ta' = a1 * T1 + a2 * T2 + a3 * T3

Where a1, a2, a3: Conversion coefficient

T1, T2, T3: Thickness of each layer (cm)

**Table 2-2-2-2.19 Conversion Coefficient for Equivalent Asphalt Concrete Thickness**

| Pavement component | Material to be used | Requirement | Coefficient |
|---|---|---|---|
| Surface & Binder course | Hot asphalt mix for surface and binder course | | 1.00 |
| Base course | Mechanically stabilized stone | Modified CBR value not less than 80 | 0.35 |
| Sub-base | Crushed stone | Modified CBR value not less than 30 | 0.25 |

Source: Guidelines of Pavement Design and Construction (Japan Road Association)

iii) Pavement Structure

Design results of pavement structure are as follows. Details of calculation are in Appendix.

①NR15A

Asphalt concrete: 5 cm

Base course: 10cm

Sub-base: 30cm

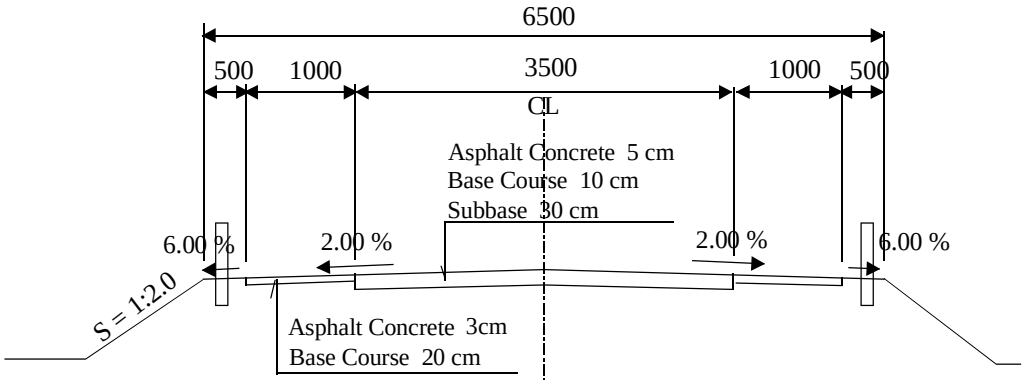



**Figure 2-2-2-2.4 Pavement Structure of NR15A**

②KPC Road

Asphalt concrete: 5 cm

Base course: 10cm

Sub-base: 15cm

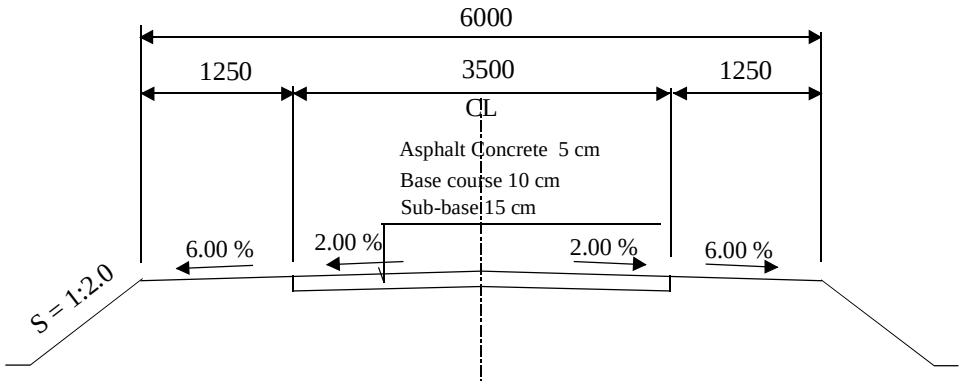



**Figure 2-2-2-2.5 Asphalt Concrete Pavement Structure of KPC Road (Un-inundated Section)**

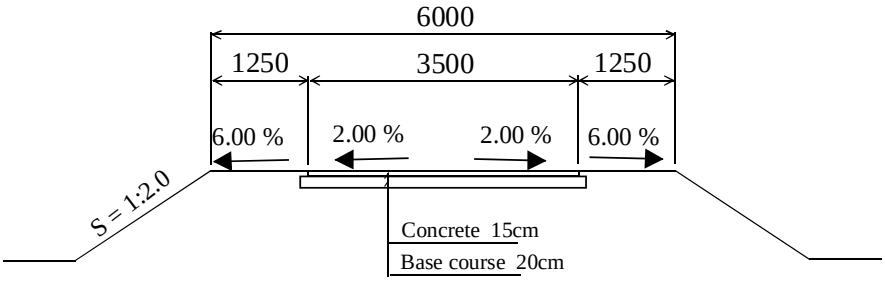



**Figure 2-2-2-2.6 Concrete Pavement Structure (Inundated Section)**

**3) Structure**

(a) Specifications to be used

* Vietnamese specifications No 2057QD/Kt4 : 1979
* Road Geometric Standard (Japan Road Association)
* Specifications for Highway Bridges (Japan Road Association)
* Specifications for River facilities (Japan River Association)

(b) Road Width on Structure

Based on the Vietnamese specifications and discussions with the Department of Road in Nghe An Province, road width on structure is as shown in Figure 2-2-2-2.7. Values in parenthesis are for structures with length of not more than 6m.

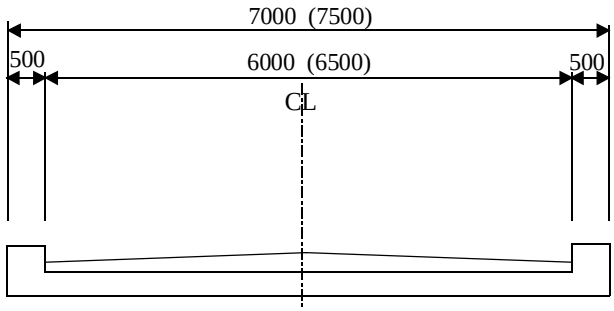



**Figure 2-2-2-2.7 Road Width on Structure**

(c) Design Methodology

Allowable stress method is used for structure design with the verification of ultimate load capacity by Vietnamese specifications.

(d) Loadings

i) Dead Load

**Table 2-2-2-2.20 Unit Weight of Material**

| Material | Unit Weight (ton/$m^3$) | Material | Unit Weight (ton/$m^3$) |
|---|---|---|---|
| Steel | 7.85 | Reinforced Concrete<br>Prestressed Concrete | 2.50 |
| Cast Iron | 7.20 | Plain Concrete | 2.40 |
| Lead | 11.40 | Asphalt Pavement | 2.30 |
| Aluminum | 2.70 | Timber | 0.80 |

ii) Live Loading

Live loadings to be used for both NR15A and KPC Road are as follows based on the results of the discussions with the executing agency.

**Table 2-2-2-2.21 Live Loading**

| | Design Live Loading | Classification |
|---|---|---|
| NR15A | H13, X60 | V |
| Nam Kim - Nam Phuc - Nam Cuong Road | H13, X60 | VI |

Source: Specification for Bridge and Culvert Design to Ultimate Limit State

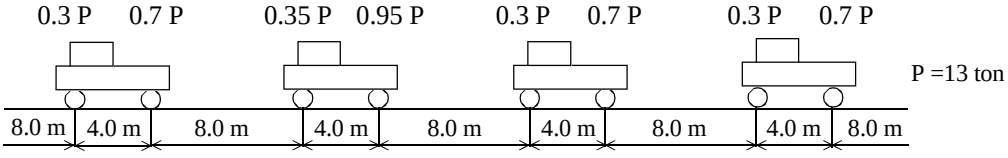



**Figure 2-2-2-2.8 H13 Live Loading (Truck Load)**

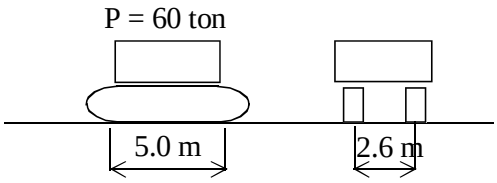



**Figure 2-2-2-2.9 X60 Live Loading (Crawler Load)**

iii) Seismic Force

According to the Vietnamese specifications, horizontal seismic force is calculated by the following equation. Seismic intensity is "7" from the Seismic Intensity Map in Vietnam in Figure 2-2-2-2.10.

$$Sik = K1 * K2 * Smk = K1 * K2 * AC * W = K * W \quad (K = K1 * K2 * AC)$$

Where,

Sik: Design seismic horizontal force

K1: Coefficient by importance of structure

- Class 1: K1=1.00 (No settlement and crack is permitted.)
- Class 2: K1=0.25 (Small deformation, deflection and crack are permitted. Structure is open to traffic in safety but with inconvenience. )
- Class 3: K1=0.12 No effect to people, while structure shall be closed to traffic with large deformation, deflection and crack.

K2: Coefficient by structural analysis K2 = 1.00

Smk: Specific design seismic horizontal force Smk = W * AC

W: Dead load

AC: Acceleration coefficient

**Table 2-2-2-2.22 Relationship between Seismic Intensity and Acceleration Coefficient**

| Seismic Intensity (SI) | 6 | 7 | 8 | 9 |
|---|---|---|---|---|
| Acceleration Coefficient (AC) | 0.04 | 0.07 | 0.17 | 0.25 |

In conclusion, design seismic horizontal coefficient K is calculated as follows.

$$K = K1 * K2 * AC = 0.63 * 1.00 * 0.07 = 0.05$$

The coefficient by importance of structure shall be between Class 1 and 2, for structures in this project shall be based on the followings:

* Small cracks are permitted.
* Structure shall be open to traffic without any inconvenience.
* Safety to traffic and people shall be assured.

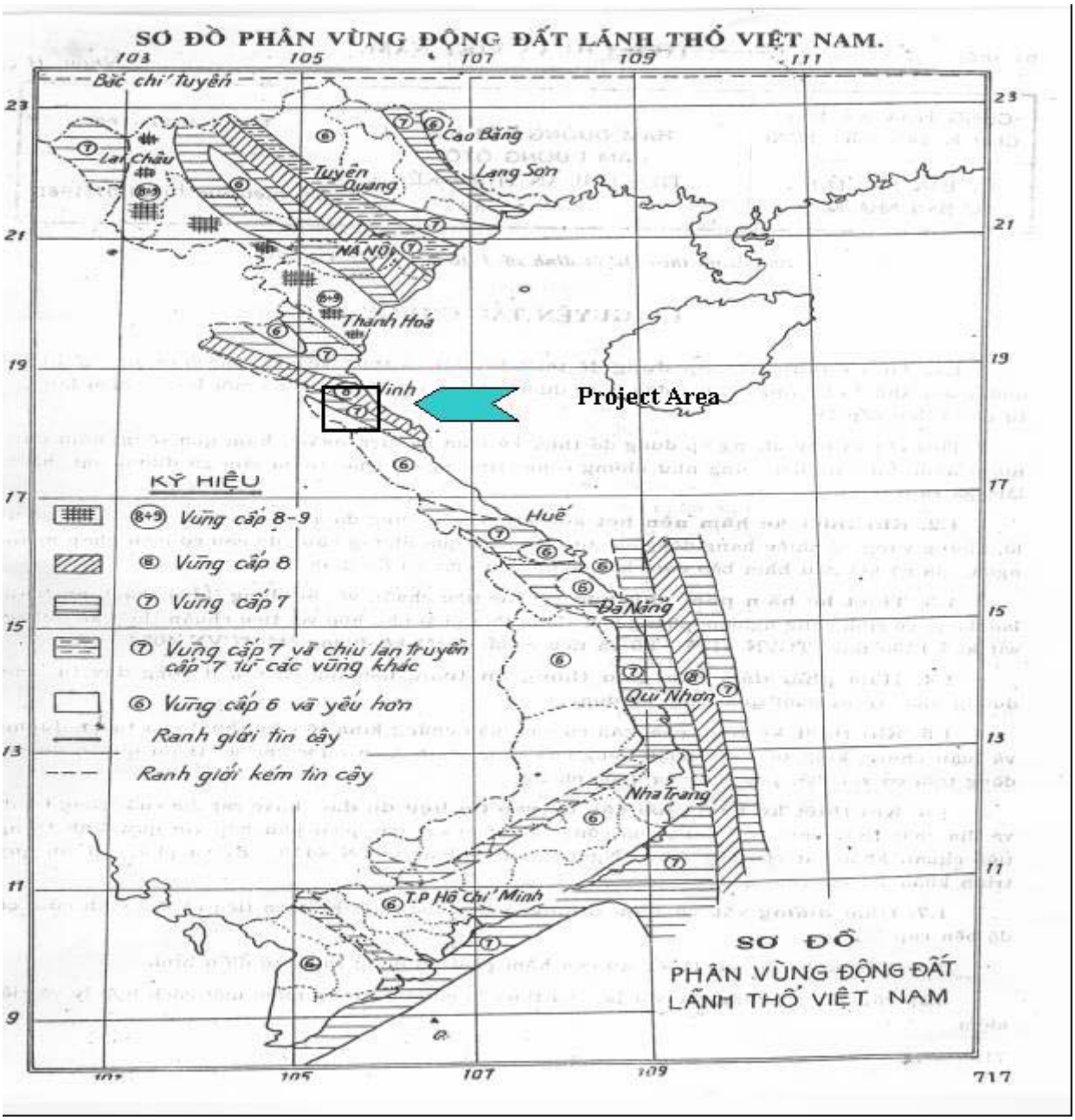



**Figure 2-2-2-2.10 Seismic Intensity Map in Vietnam**

iv) Others

The following loads are used if required.

* Wind Load
* Creep of Concrete
* Shrinkage of Concrete
* Earth Pressure
* Hydrostatic Pressure
* Buoyancy
* Settlement

(e) Strength of Materials

**Table 2-2-2-2.23 Design Specific Strength of Concrete**

| Materials | Design specific strength ($kN/mm^2$) |
|---|---|
| Post-tensioning PC girder | 35 |
| Slab | 30 |
| Abutment, Pier | 21 |
| RC pile | 30 |
| Lean concrete | 15 |

Source: Vietnamese specifications

**Table 2-2-2-2.24 Yield Strength of Reinforcement**

| Materials | Yield strength ($N/mm^2$) |
|---|---|
| Round bar (A-I) | 190 |
| Deformed bar (A-II) | 240 |
| Deformed bar (A-III) | 300 |

Source: Vietnamese specifications

**Table 2-2-2-2.25 Yield Strength of Prestressing Steel**

| Materials | Yield strength ($N/mm^2$) |
|---|---|
| SWPR7B | 1600 |

Source: Japanese standard

**4) Design of Structures**

(a) Design Concept

The followings are taken into account for designing the structures.

i) Dimensions of Structures

The structures provide the necessary opening space for the floodwater from the Lam River and for drainage. The design of structures shall therefore be made in consideration of the following points in addition to the hydrological analysis results and geological conditions.

* The existing opening space shall be provided at least to avoid adverse effects to the current hydrological conditions.
* The obstruction ratio to water flow shall be not more than 6%.
* The clearance under bridge girders and upper slab of culverts on NR15A shall be at least 50cm under design flood condition to prevent adverse effects to road and structures due to clogging of debris. For structures on KPC Road, it shall not be provided.

ii) Type of Structure

The selection of structure type shall be made in consideration of the easiness of operation and maintenance works in Vietnam in addition to the necessary opening space, easiness of construction, local technical difficulty, local construction experience, construction programming considering periods of dry and rainy season, availability of equipment and materials. Geological and geo-technical survey results shall also be taken into account.

Structures shall be of concrete based on construction experience, availability of materials and easiness of operation and maintenance works.

iii) Stimulation of Economy and Encouragement of Technology Transfer

Wherever possible, the construction system and method shall be planned to stimulate local economic activities, to encourage technology transfer, and to make use of local technology and labor.

(b) Necessary Opening Space

The following opening spaces are required at each structure location.

**Table 2-2-2-2.26 Required Opening Width (NR15A)**

| NR15A | Mung | Hao Hao | Vuc Mau | Vuc Nang | Cong Vinh |
|---|---|---|---|---|---|
| Required width(m) | 34.00 | 36.00 | 24.00 | 18.00 | 3.60 |
| Discharge ($m^3$/s) | 130.3 | 52.7 | 41.4 | 36.5 | 12.4 |

**Table 2-2-2-2.27 Required Opening Width (KPC Road)**

| KPC Road | Ven | Xuan My | Nam Dong | Trao | Coi |
|---|---|---|---|---|---|
| Required width (m) | 3.20 | 15.00 | 3.10 | 5.40 | 4.00 |
| Discharge ($m^3$/s) | 9.1 | Existing opening width is to be provided | | | |

(c) Selection of Structure Type

Structure type is generally selected based on the opening width and span arrangement. The standard structure type in Vietnam shown in Table 2-2-2-2.28 is used taking into account of economy, easiness construction and especially easiness of operation and maintenance works with the following modifications.

* Culverts including wing walls shall be of reinforced concrete. Current stone masonry structure is vulnerable to erosion, washing backfill soil away due to its lack of integration.
* Pre-tension prestressed concrete beam is not used in this project due to the difficulty in transportation related to the geological features.
* Abutment and pier shall be of reinforced concrete.

**Table 2-2-2-2.28 Structure Type to be applied by Span Length in This Project**

| Span Length (m) | Structure Type | Remarks |
|---|---|---|
| L <= 2.0 | Pipe culvert | Culvert itself and wing walls shall be of RC structure. |
| 2.0 < L<= 6.0 | Box culvert | Culvert itself and wing walls shall be of RC structure |
| 6.0 < L<= 20.0 | RC girder | Abutment and pier shall be of RC structure. |
| 20 < L | PC girder (post-tension) | Abutment and pier shall be of RC structure. |

In conclusion, Table 2-2-2-2.29 shows the structure type to be used at each structure location.

**Table 2-2-2-2.29 Bridge and Culvert to be adopted**

| | NR15A | KPC Road |
|---|---|---|
| Bridge | Mung, Hao Hao, Vuc Mau, Vuc Nang | Xuan My |
| Culvert | Cong Vinh | Ven, Nam Don, Trao, Coi |

(d) Selection of Bridge Type

Bridge is selected in case the opening width exceeds 6 meters. Results of superstructure, substructure and foundation type are shown below.

i) Superstructure Type

First of all, the possibility of installation of piers shall be studied in terms of obstruction ratio to water flow. The followings show the results for all 5-bridge locations.

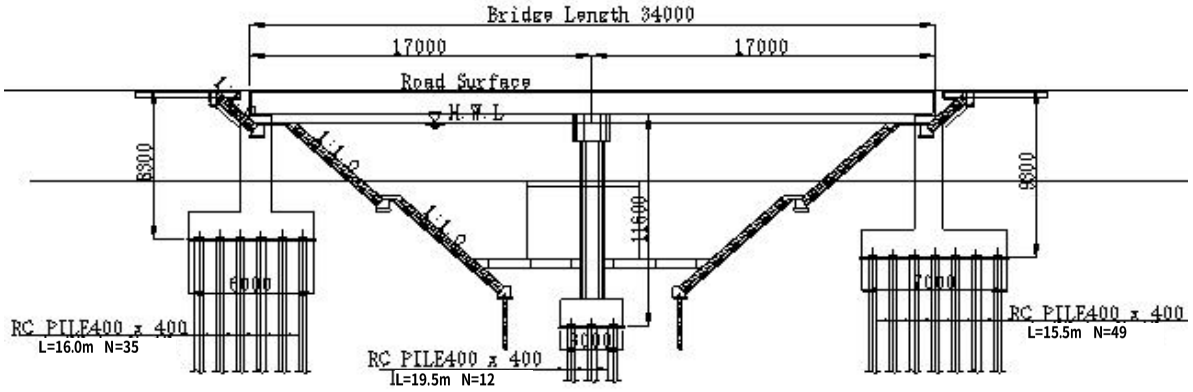
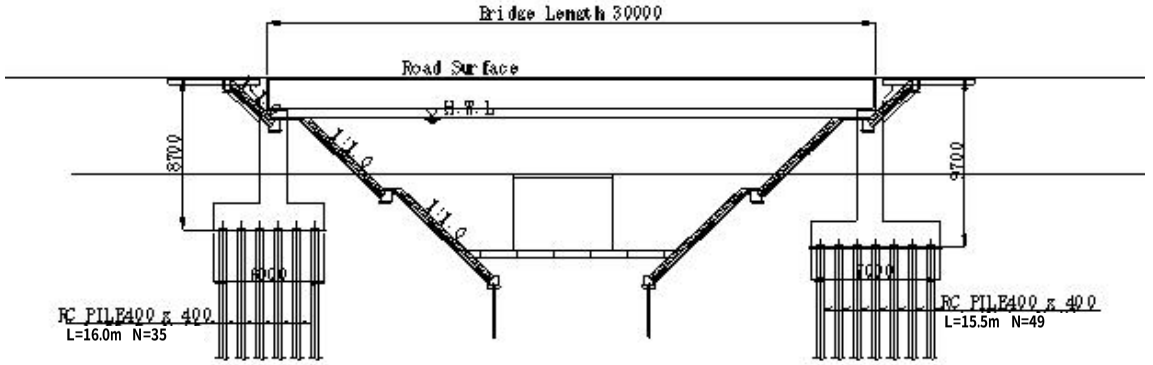
**Table 2-2-2-2.30 Possibility of Pier Installation of the 5 Bridges**

| Bridge Name | Bridge Length (m) | Possibility of Pier Installation |
|---|---|---|
| Mung | 34.00 | Obstruction ratio to river flow is not more than 6% for 2@17.00= 34.00m. Possible. |
| Hao Hao | 36.00 | Obstruction ratio to river flow is not more than 6% for 2@18.00= 36.00m. Possible. |
| Vuc Mau | 24.00 | Obstruction ratio to river flow is almost 10% for 2@12.00= 24.00m. Impossible. |
| Vuc Nang | 18.00 | Impossible. |
| Xuan My | 15.00 | Impossible. |

Installation of piers is possible at Mung and Hao Hao bridge locations.

For Mung Bridge, two options of superstructure type were compared as shown in Table 2-2-2-2.31. As a result, RC-girder bridge is more economical than PC-girder bridge as far as the obstruction ratio to water flow does not exceed 6%.

Table 2-2-2-2.31 Comparison of Superstructure Type

| | Side View of Each Alternative | Characteristics | | Evaluation |
|---|---|---|---|---|
| Type-1 |  | Economy | 1.00<br>Economical | Appropriate |
| | | Ease of Construction | Smaller crane is necessary for girder erection due to lighter girder weight than that of PC girder. Good experience in Vietnam. | |
| | | Construction Period | Longer | |
| | | Others | The bridge length is 4 m longer than that of PC girder bridge to reduce obstructions to water flow. | |
| Type-2 |  | Economy | 1.03<br>Not economical | |
| | | Ease of Construction | Bigger crane is necessary for girder erection due to heavier girder weight than that of RC girder. Many practices in Vietnam. | |
| | | Construction Period | Shorter | |
| | | Others | Girder height is bigger than that of RC girder. It makes road elevation higher and causes bigger area and higher cost for land acquisition. | |

Summary of superstructure type at each bridge is shown in Table 2-2-2-2.32.

**Table 2-2-2-2.32 Superstructure Type**

| Bridge Name | Bridge Length (m) | Span Arrangement (m) | Superstructure Type |
|---|---|---|---|
| Mung | 34.00 | 2@17.00 | 2 Span Simple RC T-girder |
| Hao Hao | 36.00 | 2@18.00 | 2 Span Simple RC T-girder |
| Vuc Mau | 24.00 | 24.00 | 1 Span Simple PC T-girder |
| Vuc Nang | 18.00 | 18.00 | 1 Span Simple RC T-girder |
| Xuan My | 15.00 | 15.00 | 1 Span Simple RC T-girder |

ii) Substructure Type

The following substructure types for abutment and pier were selected as shown in Table 2-2-2-2.33 respectively in terms of economy and durability against scour.

Pile caps or footing shall be installed under the ground to avoid scour.

**Table 2-2-2-2.33 Substructure Type**

| Substructure | Type | Comment | Adoption |
|---|---|---|---|
| Abutment | RC Gravity (H < 5m) | Used for reasons of economy | ○ |
| | RC Reversed-T (H >= 5m) | Used for reasons of economy | ○ |
| | Pile bent | This type is risky against increased speed of river flow. | △ |
| Pier | RC wall | Obstructions to river flow are minimized. Good against scour. | ○ |
| | Pile bent | This type accelerates scour around structures. | △ |

iii) Foundation Type

The foundation types are spread foundation, reinforced concrete driven pile (□400*400) manufactured at site, steel pile and cast-in-place concrete pile depending on the depth of bearing layer.

The length of one reinforced concrete driven pile and steel driven pile is 12 meters in Vietnam in terms of availability of pile driving machine.

| Foundation Type | | Depth to Bearing layer | | | | Remarks |
|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | |
| Spread foundation | | ═ | | | | |
| Pile | Reinforced concrete driven pile | ═ | ═ | ═ | | not more than 24m |
| | Steel driven pile | ═ | ═ | ═ | ═▶ | |
| | Cast-in-place concrete pile | ═ | ═ | ═ | ═▶ | |

Bearing layer and its depth for bridge foundation is summarized in Table 2-2-2-2.34 at each geological survey location with the proposed foundation type.

At Mung bridge location, approximately 15m thick sand layer with SPT blow count of 20 is intervened up to the bearing layer. It is supposed to be difficult to drive RC pile with closed end in such a thick stiff sand layer. Therefore, the following two options are adopted whichever is economical.

Option 1: Pile ends are embedded in this sand layer taking account of pile group effect for axial compressive force.

Option 2: Pile ends are embedded in good bearing layer with wider space between adjacent piles to alleviate the difficulty of pile driving.

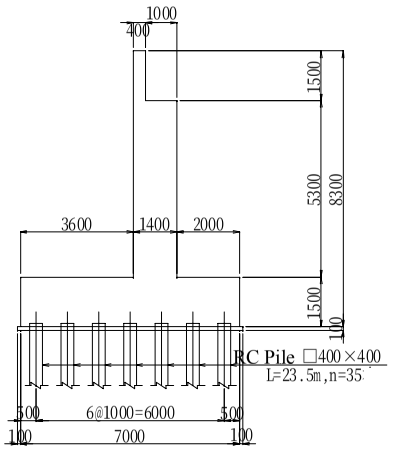
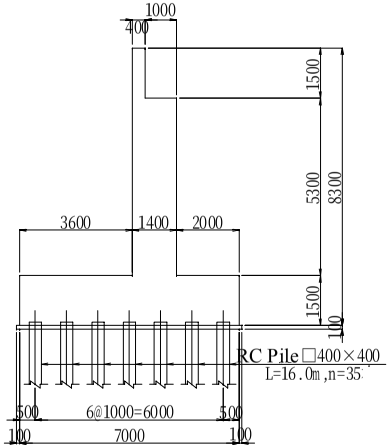
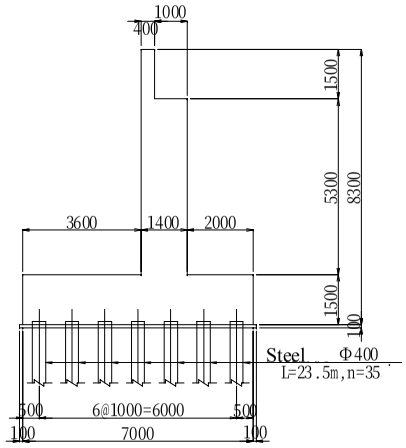
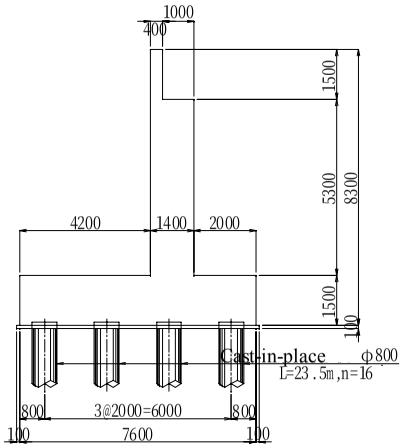
**Table 2-2-2-2.34 Bearing Layer and Foundation Type to be used at Each Survey Location**

| Bridge Name | | Bearing layer | Depth | Foundation Type |
|---|---|---|---|---|
| NR15A | Mung | Peat Bed<br>Silty clay on top of ground (SPT blowcounts of 5 – 6) | Approximately 27 m deep | Pile Foundation |
| | Hao Hao | Sandstone, Peat Bed<br>Silty clay on top of ground(SPT blowcounts of 20) &silty clay on top of ground(SPT blowcounts of 4) | Approximately 10 – 12 m deep | Pile Foundation |
| | Vuc Mau | Silty Rock, Peat Bed | Approximately 1 m deep | Spread Foundation |
| | Vuc Nang | Sandstone intervened by peat bed<br>Silty clay on top of ground | Approximately 1.5 - 5 m deep | Spread Foundation |
| KPC Road | Ven | Silty clay<br>Sandy silt on top of ground | Approximately 2 m deep | Spread Foundation |
| | Trao | Sand with gravel<br>Clay on top of ground (SPT blowcounts of 5 - 10) | Approximately 40 m deep | Pile Foundation |

Four alternatives of pile foundation were compared as shown in Table 2-2-2-2.35. In conclusion, reinforced concrete driven pile with pile end embedded in good bearing layer is the most appropriate with the exception that steel driven pile is suitable in case of pile exceeding 24 meters.

As for Mung bridge, pile ends at both abutments were embedded in a stiff sand layer with SPT blow count of 20 in consideration of pile group effect, and center-to-center space between adjacent piles at pier was wider than usual.

**Table 2-2-2-2.35 Comparison of Pile Foundation Type**

| | Type-1: RC Driven Pile □400×400 | Type-2: RC Driven Pile □400×400 (Considering Pile Group Effect) | Type-3: Steel Driven Pile φ400 | Type-4: Cast-in-placed Concrete Pile: φ800 |
|---|---|---|---|---|
| Pile Arrangement of Each Alternative |  |  |  |  |
| Economy | ◎ 1.00 Economical | ◎ 0.79 Economical | ○ 1.46 Not Economical | △ 2.00 Not Economical |
| Ease of Construction | ○ Piles are manufactured at site. Good experience in Vietnam. Easier to construct. Better performance is expected. | ○ Piles are manufactured at site. Good experience in Vietnam. Easier to construct. Better performance is expected. | ○ Transportation of steel piles is necessary. Good experience in Vietnam. Easier to construct. Better performance is expected. | △ This requires large-scale facilities such as water tank. It will cause less performance for foundation. |
| Period | △ Longer due to many piles | △ Longer due to many piles | △ Longer due to many piles | ○ Shorter due to less piles |
| Others | Driving machine can be procured in Vietnam. | Driving machine can be procured in Vietnam. | Availability of steel piles (imported) in Vietnam is uncertain. Steel piles must be imported as the case may be. | Access to the site is very bad due to narrow width of road. Transportation of pile machine is difficult. |
| Evaluation | Appropriate<br>In case pile length does not exceed 24 m. | Appropriate<br>For both Abutments at Mung Bridge | Appropriate<br>In case pile length exceeds 24 m. | Inappropriate |

**5) Soft Ground Treatment**

According to the geo-technical survey, Mung and Trao lie in soft ground area. The construction of road with high embankment will probably cause uneven road surface by consolidation settlement and collapse by circular sliding.

The analyses for consolidation settlement and circular sliding were carried out for both locations. The results are summarized in Table 2-2-2-2.36. Details are described in Appendix.

**Table 2-2-2-2.36 Safety Factor against Circular Sliding and Consolidation Settlement**

| Location | Embankment Height HE (m) | Safety Factor against circular sliding Fs | Consolidation Settlement (cm) | Necessary time to 90% settlement |
|---|---|---|---|---|
| Mung | 6.00 | 1.304 > 1.2 (OK) | 54.4 | 16.8 years |
| Trao | 2.60 | 1.377 > 1.2 (OK) | 29.4 | 22.8 years |

Considerable consolidation settlement is expected for both locations, while circular sliding is not. The followings are the considerations for each location.

(a) Mung (NR15A)

Mung has a bridge which is supported by piles to avoid settlement. If no countermeasure is provided against an approximately expected 55cm settlement of the embankment, a large difference in elevation between the abutment and the embankment will result and cause bad ride quality and road inundation even though the proposed road elevation is 50cm higher than design flood level.
Therefore, the countermeasure, consists of accelerating settlement during the construction period to minimize the said difference in elevation in the future, which is judged necessary to minimize maintenance works and cost after completion.

(b) Nam Kim-Nam Phuc-Nam Cuong Road (KPC Road)

Trao has a box culvert where weight is lighter than the embankment material. In general, a spread foundation alone is enough for box culvert for settlement to occur together with the embankment so as to minimize the difference in elevation between the structure and the embankment and subsequently the maintenance cost. Therefore, no countermeasure is necessary.

Alternatives to countermeasures against considerable consolidation settlement are generally sand drain, plastic board drain (PBD), sand compaction and piling. Comparison of 4 alternatives was conducted as shown in Table 2-2-2-2.37.

**Table 2-2-2-2.37 Comparison of Soft Ground Treatment**

| | Alternatives | | | |
|---|---|---|---|---|
| | Sand Drain | PBD | Sand Compaction | Piling |
| Diameter (mm) | 400 | 65 | 700 | 400×400 |
| Increase of strength kg/cm$^2$ | C = 0.3 ⇒ 1.0 | C = 0.3 ⇒ 0.5 | C = 0.3 ⇒ 3.0 | ― |
| Effective Depth | 30m | 15m | 35m | 30m |
| Minimum Intervals | 1.2m | 0.9m | 1.2m | 1.0m |
| Construction Speed | 300m/day | 2,500m/day | 150m/day | 120m/day |
| Cost | 1.0 | 0.2 | 2.4 | 11.0 |
| Others | A lot of experience | A lot of experience in Vietnam | | |

In conclusion, PBD is judged appropriate in terms of economy, construction experience and large increase of ground strength.

For the Mung bridge, the following countermeasure shall be taken to avoid considerable difference in elevation after completion and to minimize the maintenance works and cost.

* A1 Abutment: PBD @ 1.00m * Depth 10 m
* A2 Abutment: PBD @ 1.00m * Depth 5 m

**Table 2-2-2-2.38 Effect by the Plastic Board Drain**

| Bridge | Embankment Height HE (m) | Speed of Construction (cm/day) | Intervals of PBD (m) | Construction Period (Month) | Residual Settlement *1 (cm) |
|---|---|---|---|---|---|
| Mung | 6.00 | 10 | 1.00 | 6 | 11.5 |

Note) *1: After the completion of embankment work

**6) Protection of Slope and River Bed**

Slope protection around structures is judged essential from the current situation, as the slope is susceptible to erosion due to increased speed of water flow. The possible alternatives are stone masonry structure (riprap) and wire cylinders.

Wire cylinders require frequent maintenance works to improve protection effect as wires are subjected to damage and corrosive, while the wet masonry is a permanent structure that can prepare the washing away of backfill material.

Wet masonry shall be used basically for slope protection on account of low maintenance cost and good appearance while wire cylinders can be used on soft ground area with future potential settlement, for wet masonry is susceptible to damage due to the settlement of the ground. Wire cylinders shall be used

with protection mat to prevent the washing away of backfill soil.

Regular inspection shall be made especially for wire cylinders. When damage is observed on the steel wires such as corrosion and cuts, these shall be replaced immediately.

Table 2-2-2-2.39 and Table 2-2-2-2.40 show the types of slope protection for each structure.

**Table 2-2-2-2.39 Types of Slope Protection (NR15A)**

| NR15A | Mung | Hao Hao | Vuc Mau | Vuc Nang | Cong Vinh |
|---|---|---|---|---|---|
| Structure Type | Wet masonry | | | | |

**Table 2-2-2-2.40 Type of Slope Protection (KPC Road)**

| KPC Road | Ven | Xuan My | Nam Dong | Trao | Coi |
|---|---|---|---|---|---|
| Structure Type | Wet masonry | | — | Wire cylinder | |

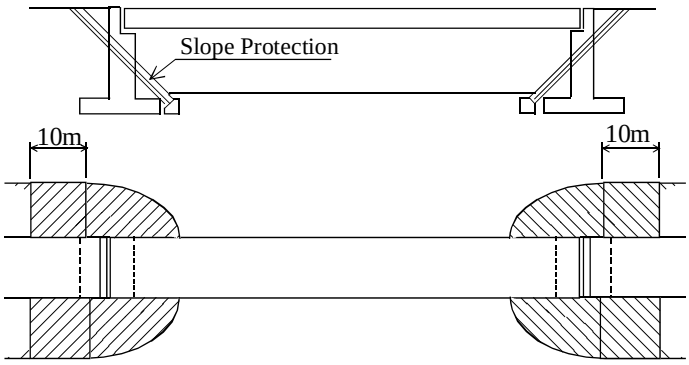



**Figure 2-2-2-2.11 Slope Protection around Structure**

Gabion boxes shall be installed 50 cm thick around structures to prevent scouring and to protect the toe of riprap structure. Protection mat shall be installed under the gabion boxes to prevent the washing away of foundation soil. When damage is observed on the steel wire such as corrosion and cuts, these shall be replaced immediately.

### 7) Countermeasures for Gully Erosion

Serious gully erosion in mountainous side hinders year-round traffic at three locations on NR15A due to the piling up of soil during the rainy season. In addition, erosion is observed in the river side due to water and soil flow. The following countermeasures shall therefore be taken not only in mountainous side but also in river side.

**Table 2-2-2-2.41 Countermeasure for Gully Erosion (NR15A)**

| Location | Countermeasure | Remarks |
|---|---|---|
| Upstream | Install gabion boxes to avoid piling up soils on the road surface. | To provide year-round traffic |
| Downstream | Install concrete drainage ditch to avoid erosion downstream due to water flow. | |

The availability of land in riverside to install drainage ditch was confirmed by the executing agency and the JICA study Team.

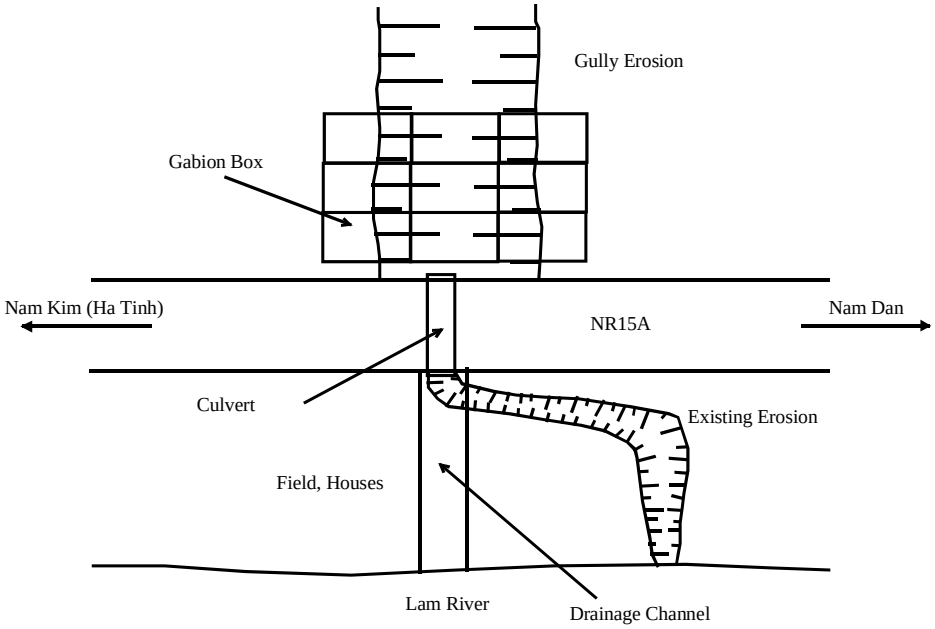



**Figure 2-2-2-2.12 Plane of Gully Erosion Countermeasure**

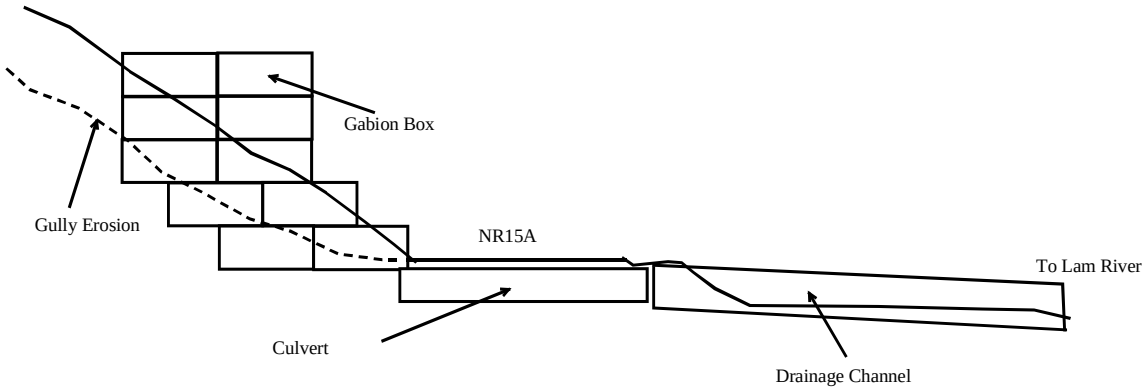



**Figure 2-2-2-2.13 Cross Section of Gully Erosion Countermeasure**

### 2-2-2-3 Rural Electrification

#### (1) Design Conception

From the field study, “low electrification ratio” and “high electricity charge” are confirmed to be the problems to be urgently solved for three non-electrified areas.

These problems, the basic concept of the electrification plan and its expected effectiveness are discussed below.

1) Problems

(a) Low Electrification Ratio

Electrification ratio in the Nam Dan district reaches 95.8 % for a total number of households of 33,500. The electrification progress in the district is higher than that in the entire Nghe An Province which stands at 89.0%. Electrification ratio in the selected three areas is between 87 to 93%, which is the same as the entire province average. After completion of the provincial settlement program (2001 – 2005) currently underway, the electrification ratio is forecasted to drop between 47 to 64 %. The main purpose of the settlement plan is to distribute land to new settlers. Electrification is not included in such plan due to limited budget. Actually, the local electricity agency does not have any concrete plan for the electrification of the settlement areas. Therefore, a new settler will get his new land but will not get electricity for a while. Electricity is necessary for daily life and is expected to be supplied to the non-electrified existing areas and settlement areas.

(b) High Electric Charge

Proposed beneficiaries who use electricity at present in the command areas pay a high-priced electricity charge of 1,100VND/KWh, which is twice compared with the average 500 VND/KWh of the entire country. This charge is fairly high compared with the average charge (750 VND/KWh) of the total province. The reasons associated to this are poor voltage transmission caused by too long transmission lines and poor distribution efficiency caused by low quality wires. These negative situations result in higher electricity charge.

The low voltages of electricity are caused by the shortage of substations and the low quality wires. Since the supply capacity of electric power source is enough, it is possible to reduce the losses using proper arrangement of substations and appropriate quality wires. Therefore, the arrangement of new extension lines for non-electrified areas and new substations can reduce cost and lead to proper electricity charge.

2) Arrangement Concepts

(a) Subject Areas and Households

The proposed transmission and distribution lines are destined to the subject areas which include the non-electrified existing areas and new settlement areas in two communes. The outline of the plan is as follows.

- Subject areas: Three areas (Ru Bui、Am Gia、Dong Trai)
- Subject households: 95 household (352 persons) in the non-electrified existing areas and 613 household (2,086 persons) in the settlement areas

The subject areas are included in the program of "SOCIO-ECONOMIC DEVELOPMENT IN THIN NHAN NEW ECONOMIC ZONE, NAM DAN DISTRICT, NGHE AN PROVINCE 2001-2005". Existing settlers are included in the beneficiaries of the electrification plan. The electrification ratio has fallen to 69.1% as of the end of 2001. Furthermore, the ratio is expected to drop to 58.5% as of the end of 2005.

**Table 2-2-2-3.1 Beneficiary Households/Persons/Electrify Ratio in Subjected Areas**

| Proposal Area | Commune | Village | Existing Household | | Existing Residence | | Settlement Plan | | | | Electrification Rate | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Electrify Household | No-electrify Household | Electrify Residence | No-electrify Residence | 2001 | | 2002-2005 | | Existing (2001) | Plan |
| | | | | | | | Household | Population | Household | Population | % | % |
| Bu Bui | Khanh So | Xom 11 | 42 | 6 | 134 | 21 | 12 | 37 | 18 | 60 | | |
| | | Xom 13 | 126 | 4 | 400 | 56 | 36 | 196 | 15 | 48 | | |
| | | Xom 14 | 65 | 5 | 210 | 18 | 15 | 48 | 25 | 80 | | |
| | | Xom 15 | 92 | 8 | 264 | 25 | 28 | 104 | 13 | 20 | | |
| | | *Sub-total* | *325* | *23* | *1,008* | *120* | *91* | *385* | *71* | *208* | ***74.0*** | ***63.7*** |
| Am Gia | Khanh So | Xom 14 | 90 | 2 | 282 | 7 | 32 | 128 | 5 | 20 | | |
| | | Xom 15 | 80 | 4 | 238 | 12 | 18 | 85 | 4 | 20 | | |
| | | Xom 16 | 140 | 8 | 560 | 27 | 62 | 188 | 6 | 30 | | |
| | | Khe Sau | 60 | 12 | 176 | 40 | 15 | 45 | 10 | 45 | | |
| | | *Sub-total* | *370* | *26* | *1,256* | *86* | *127* | *446* | *25* | *115* | ***70.1*** | ***67.5*** |
| DongbTrai | Nam Kim | Ho Truong | 40 | 12 | 76 | 48 | 32 | 96 | 70 | 240 | | |
| | | Khe Khe | 42 | 22 | 81 | 72 | 25 | 73 | 56 | 170 | | |
| | | Thung Huye | 100 | 6 | 361 | - | 40 | 125 | 25 | 80 | | |
| | | Dong Dai | 120 | 6 | 383 | 26 | 36 | 108 | 15 | 40 | | |
| | | *Sub-total* | *302* | *46* | *901* | *146* | *133* | *402* | *166* | *530* | ***62.8*** | ***46.7*** |
| | | | | | | | | | | | | |
| **Total** | | | **997** | **95** | **3,165** | **352** | **351** | **1,233** | **262** | **853** | **69.1** | **58.5** |

**Existing Household in total:1,092** **Settlement Household:613**

(b) Outline of the Electrification Plan

The new arrangements adopted in the plan include the following three categories based on the meetings with the local electricity agency.

- Extension of 22kv middle voltage power transmission lines, L = 4.9 km
- New construction of substations （Transformer capacity: 180kvA, 3 places）
- Extension of 0.4kv distribution lines, L = 11.8 km

The location of the above-mentioned extension lines is shown in "Chapter 4 Annex 4.3 Rural Electrification". However, the expenditures related to the laying the distribution lines and their connection to each residence should be borne by the beneficiaries themselves.

(c) Efficiency

After the above-mentioned electrification plan is completed, the proposed areas will get stable electricity supply for a subsequent comfortable living.

Furthermore, the present high electricity charge of 1,100 VND/kwh will drop to 700～800 VND/kwh, which is the same as the provincial level.

(d) Applied Criteria, etc

Design and construction standards follow those of the local electricity agency. The main criteria and standard are as below.

- The transformer is set outdoor in case the capacity is less than 250kvA
- The transformer includes two terminals furnished with 10kv and 22kv at the primary coil side. The reason is the replacement of the 10kv line with the 22kv line.
- Poles must be of height 10 to 12 m with class C grade .
- 22kv middle voltage transmission lines must be AC50 wires coated with aluminum.
- 0.4kv distribution lines PVC coated wires in the dangerous sections of short circuit.
- The new substation site will be chosen within 500m of the length of the low voltage line.
- In case the length of the line is greater than 500m, a breaker will be installed on the line.
- Zinc plated steel material must be used for supporting beams of insulators
- Insulators must accommodate 22kv
- For security purposes, the management reserved land under the electric lines must secure the following widths.
  - In case of less than 35kv line: 9.0m
  - In case of less than 10kv line: 4.5m
  - In case of less than 0.4kv line: 1.0m

According to the explanation given by the local government staff, the procedure of the electrification plan is as explained below. Furthermore, land acquisition formality has to be commenced simultaneously with the said procedure.

① The study is conducted by the Nam Dan District PC
② An application form is submitted by the Nam Dan District PC to the Nghe An Provincial electricity agency
③ The Nghe An Provincial electricity agency studies the form for approval, following which the Nam Dan District PC makes a contract with the agency.
④ An approved local agent carries out the necessary land survey and detailed design
⑤ Construction work is conducted under the supervision of the said agent
⑥ There will be a transfer of jurisdiction on the completed facilities after approval for the construction work by the local agent. Transmission lines and substations of the entire

works are transferred to the local agency, and distribution lines are transferred to the commune PC.

Existing Substation: T2NK1 M2

Rural Electrification Beneficiary Area

**(2) Basic Plan**

The rural electrification plan for the three non-electrified areas is shown below.

The main facilities consist of the power transmission lines, distribution lines and substations. This plan meets the design and construction criteria of the electricity agency of the local government based on the discussions with the persons concerned.

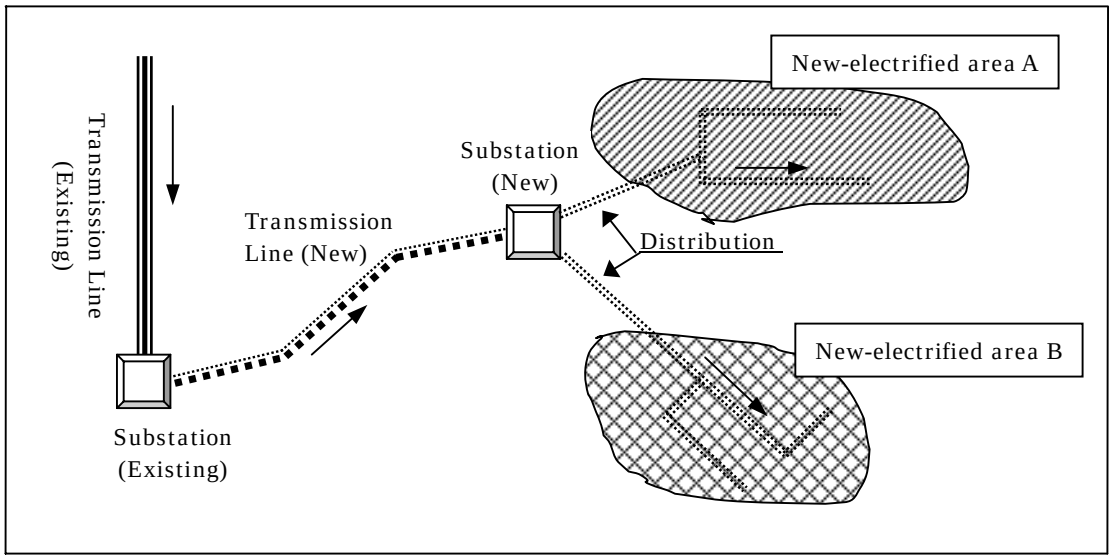



**Figure 2-2-2-3.1 Illustration of Rural Electrification**

1) Design Conditions

**Table 2-2-2-3.2 Beneficially Households and Population**

| Command Area | Non-electrified households and population | | Settlement households and population | | Total households and population | |
|---|---|---|---|---|---|---|
| | Households (house) | Population (person) | Households (house) | Population (person) | Households (house) | Population (person) |
| Ru Bui | 23 | 120 | 162 | 593 | 185 | 713 |
| Am Gia | 26 | 86 | 152 | 561 | 178 | 647 |
| Dong Trai | 46 | 146 | 299 | 932 | 345 | 1,078 |
| Total | 95 | 352 | 613 | 2,086 | 708 | 2,438 |

Note: Intended settlers are people from same communes.

2) Study of Power Transmission Line and its Voltage

The new power transmission line which supply the source of electric power to the new beneficially areas are new extension line from existing substation to new existing one.

Based on the meeting with local electricity agency, the turnout point and length of the line to the new substations are shown as below.

| Command Area | Existing substation (Turnout point) | | New substation (Terminal point) | | Transmission voltage |
|---|---|---|---|---|---|
| | Line | Point | Length | Point | |
| Ru Bui | Station No.2 At Nam Kim 2 | Pole No.17 | 0.8 km | Ru Bui substation | 10kv |
| Am Gia | Ru Bui substation | — | 2.4 km | Am Gia substation | do |
| Dong Trai | Station No.2 Nam Kim | — | 1.7 km | Dong Trai substation | do |
| Total | | | 5.1 km | (Threesubstations) | |

3) Study of Substation

(a) Selection of Transformer

Three newly founded substations have transformer facilities from power transmission line to distribution line in each command area. However, the agency is proceeded the replacement plan of the power line from 10 kv to 22 kv. Therefore, this new transformer will be selected two terminals furnished of 10 kv and 22 kv type.

The new transformers in three stations will be selected the capacity of 180 kvA type from the scale of households in the command areas.

The style of transformer placement will be selected “direct placement in outdoors” type based on the criteria of the agency.

**Table 2-2-2-3.3 Selection Criteria of Transformer**

| Capacity of transformer | Style of placement | Remarks |
|---|---|---|
| More than 350 kvA | Indoor placement | |
| 250 ～ 350 kvA | Indoor placement | |
| Less than 250 kvA | Outside placement (on the concrete basement) | Applicable |

(b) Other Facilities

Transformer of outdoors type is installed on the concrete basin. Breaker and panel (switch board) will be furnished with transformer.

General layout of the substation is shown below.

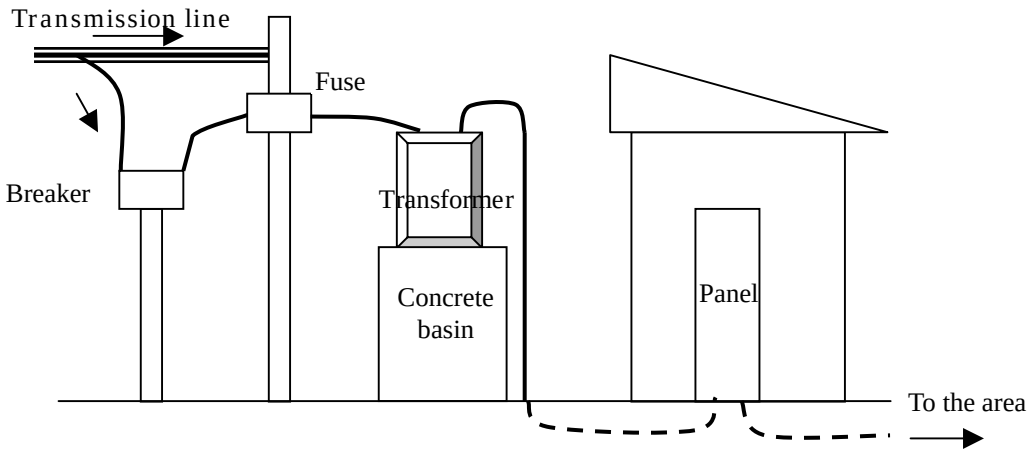



**Figure 2-2-2-3.2 General Layout of Facilities in Substation**

The panel (switch board) is installed inside a small shed. All of the facilities in substation is enclosed with fence into management area of 15m×10m =150m2 which managed by the agency.

4) Study of Distribution Line

New distribution lines will be laid between new substation and main residential areas in the target area. The route and length of each distribution lines are shown in below.

| Command Area | Distribution Line | Length (m) | Household of Beneficiaries (house) |
|---|---|---|---|
| Ru Bui | Route No.1 | 500 | 330 |
| | No.2 | 1,000 | 110 |
| | No.3 | 1,200 | ― |
| Am Gia | Route No.1 | 1,300 | 90 |
| | No.2 | 1,500 | 80 |
| | No.3 | 1,600 | 140 |
| | No.4 | 1,200 | 60 |
| Dong Trai | Route No.1 | 500 | 226(including No.3) |
| | No.2 | 500 | 220(including No.4) |
| | No.3 | 1,200 | ― |
| | No.4 | 1,300 | ― |
| Total | | 11.800 | |

5) Laying Plan of Transmission Line

New extended transmission line is laid from the branch off point such as existing substation to new substation in the new command area. The relay poles which suspend the wire are installed every regular intervals.

Main facility plans are as below.

(a) Pole

Relay poles of transmission line select the grade C type of centrifugal electric pole in accordance with the agency's criteria. The pole adopts the length of between 10 to 12 meters, and the poles are installed every 80 to 100 meter interval according to the land condition. The quantity of the poles are estimated 64 pieces that composes of 11 pieces in Ru Bui, 31 pieces in Am Gia and 22 pieces in Dong Trai.

(b) Wire

Wiring material for transmission line (10 kv) selects AC50 that wire coated with Aluminum in accordance with the agency's criteria. The total length of transmission line is 5.1 km that compose of 0.8km in Ru Bui, 2.4km in Am Gia and 1.7km in Dong Trai.

(c) Other Equipment

Insulator, supporting beam and metal fittings will be selected for the purpose of the wire fixing at pole.

The insulator selects for 22kv. Material of beam adopts zinc-plated steel.

(d) Management Reserved Area under the Line

As the management reserved area under the transmission line based on a government regulation, the management body secures following width.

- In case of less than 35 kv line: Width of 9 meters
- In case of less than 10 kv line: Width of 4.5 meters

6) Wiring Work Plan of Distribution Line

New extended distribution line is laid from the new substation to new household area. The relay poles which suspend the wire are installed every regular intervals.

Main facilities plan are as below.

(a) Pole

Relay poles of distribution line select the grade C type of centrifugal electric pole in accordance with the agency's criteria. The pole adopts the length of 10 meters, and the installation interval is between 80 and 100 meters according to the land condition. The quantity of the poles are estimated 156 pieces that composes of 36 pieces in Ru Bui, 73 pieces in Am Gia and 47 pieces in Dong Trai.

(b) Wire

Wiring material for distribution line (0.4 kv) selects PVC covered wire in dangerous sections of short circuit in order to mitigate power failure and power losses. In other sections non-covered wire is selected. The total length of distribution line is 11.8 km that compose of 2.7 km in Ru Bui, 5.6 km in Am Gia and 3.5km in Dong Trai. In other section a

(c) Other Equipment

Insulator, supporting beam and metal fittings will be selected for the purpose of the wire fixing at pole.

The insulator selects for low voltage type. Material of beam adopts zinc-plated steel.

(d) Management Reserved Area under the Line

As the management reserved area under the distribution line based on a government regulation, each management body secures following width.

In case of less than 0.4 kv line: Width of 1 meter

7) Operation and Maintenance Plan

Regarding the operation and maintenance (O/M) after completion of the new electrification facilities, transmission lines and substation will be taken charge by local electricity agency, while their distribution line will be managed by Commune PC.

Since some electrical engineers are assigned in the each commune, they carry usual O/M works.

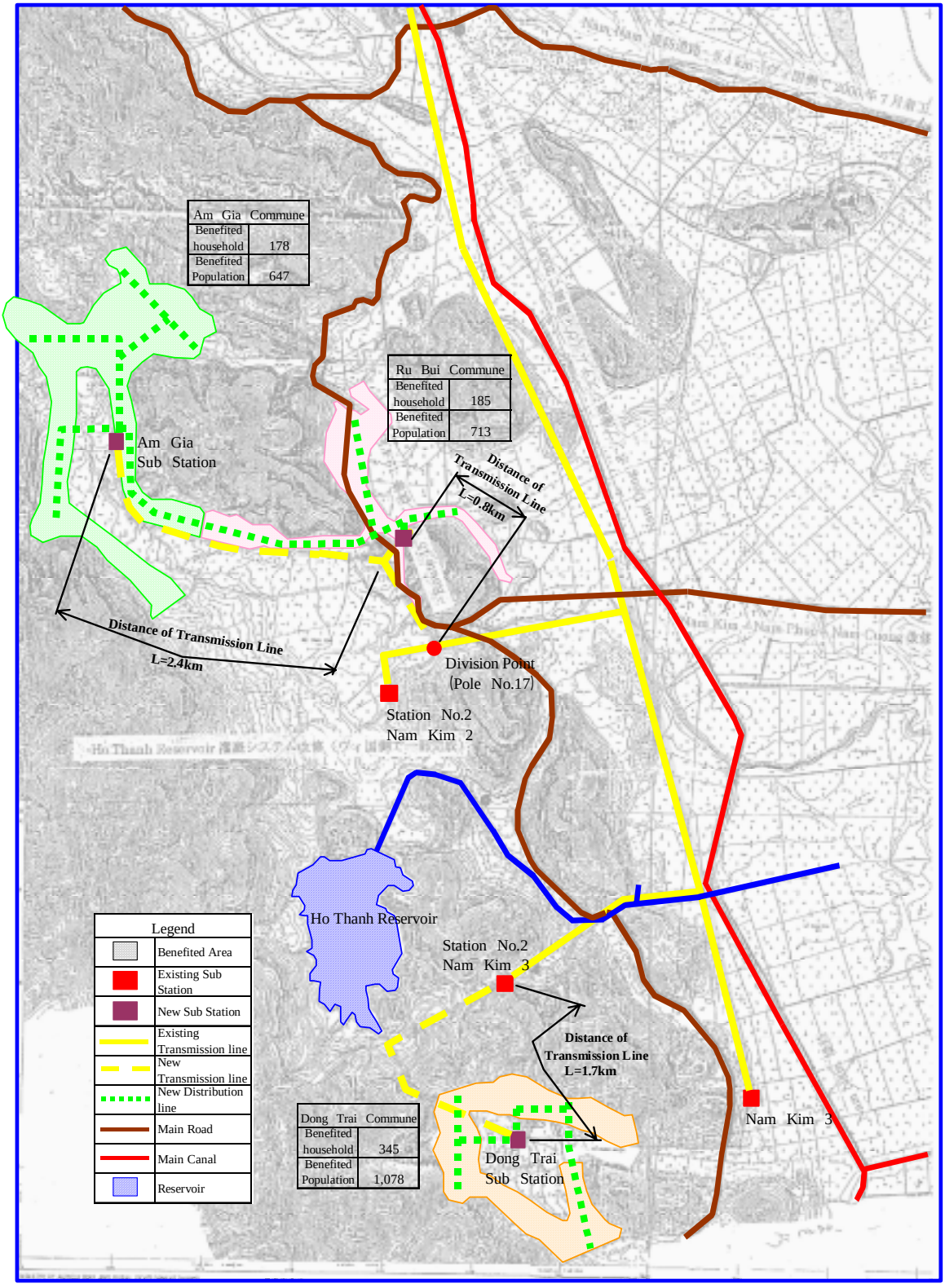



**Figure 2-2-2-3.3 General Layout of Electrification Plan**

### 2-2-3 Basic Design Drawing

General Plan is attached to next page. The other basic drawings are attached to Appendix: Basic Design Drawing, in the end of report.

## 2-2-4 Implementation Plan

### 2-2-4-1 Implementation Policy

#### (1) Basic Policy of Construction

The facilities planed for construction are below.

**Table 2-2-4-1.1 Summary of Construction Plan**

| | Components | Construction |
|---|---|---|
| 1 | Rehabilitation of Nam Trung Pump Irrigation System | Rehabilitation of one Pumping Station (Pump Q=1,000m3/hour×3 pumps) |
| | | Rehabilitation of Main Canal (L=3.6km, Q≦0.833m3/s) |
| 2 | Rehabilitation of Ho Thanh Reservoir Irrigation System | Ho Thanh Reservoir Countermeasure for Leakage |
| | | Rehabilitation of Canal (L=2.4km, Q≦0.644m3/s) |
| 3 | Improvement of National Road 15A (NR15A) | Asphalt Pavement (L=15.7km,W=6.5km), Raising (4 Sections 1.2km long) |
| | | Four Bridges, One Box Culvert |
| 4 | Improvement of Nam Kim- Nam Phuc-Nam Cuong Road (KPC Road) | Concrete Pavement (L=2.6km,W=6.0m)、Asphalt pavement (L=4.3km,W=6.0m) |
| | | One Bridge, Four Box Culverts |
| 5 | Construction of Rural Electrification Facility | Three Sub Stations、10Kv line (L=4.9km) Distribution Networks in Three Areas (0.4KV x 11.8km) |

Equipments to be procured include pumping equipments for Nam Trung irrigation system and transformers etc. for electrification, which are packaged with the facilities. The cost of the equipments is only 1.5% of the total project cost. Therefore a contractor is to be procured in bid of a bulk contract, where the main contractor is treated as a constructor.

Local contractors are to apply as subcontractors for the implementation of the construction work under the main contractor.

Considering the natural and socio-economic conditions, the construction work is divided into three terms based on terms including a term for design, a term for bidding and a term for construction. Each term is to be implemented a year-implementation project.

#### (2) Use of Local Contractor

The prime contractor, a Japanese construction company, will employ local firms as sub-contractors. In this Project, several sub-contractors will be employed as the sites are scattered and there are many kinds of construction works, namely irrigation canal, pumping station, road, bridge, rural electrification etc. Conditions that are needed to select the proper sub-contractors having enough

experience for these construction works shall be described in the specifications.

The farmers in the project area shall be employed as labors at the construction stage in order to improve their sense of participation in the Project.

**(3) Scheme of Operation**

The implementation period will be divided into 3 phases, and each phase will be completed in less than one year following the Japan's Grant Aid Scheme of a single fiscal year execution. The implementation plan should consider to lower work efficiency in the Tet holiday (the lunar New Year in Vietnam) of February and the rainy season from August to October.

Five working groups will be put based on their specialties, one in charge of the irrigation, three in charge of road and one in charge of rural electrification sector. As the work volume on the road sector is larger than the other sectors and the critical period will occur in the road construction of NR15A, the latter will be divided into two sections. In addition to KPC Road section, the construction work in the road sector will be executed simultaneously at the three sections.

**(4) Dispatch of Japanese Engineers**

Four Japanese engineers will be permanently stationed in accordance with the specialties, one civil engineer will be in charge of total management as the construction manager, one office manager will be in charge of administration and accountant, two engineers will be in charge of irrigation / pump station and road / bridge construction. Pavement, electrical, mechanical and architectural engineers will be dispatched as short-term engineers based on the construction schedule. Local engineers will be arranged to support each Japanese engineer.

**(5) Approval System**

In case of implementation of this project as Japan's grant aid, GOV's signers for documents are below.

Consultant contract : Director General of Inetrnatioal Cooperation Department of MARD
Approval of bid documents : The chairperson of the project management board
Construction contract : Director General of Inetrnatioal Cooperation Department of MARD
Surty on the completion : Head of PMB

**2-2-4-2 Implementation Condition**

Important notices concerned with the implementation of the construction work are shown below.

Weather condition

In the rainy season from August to October, 60% of total annual rainfall occurs and the heavy floods will adversely affect work efficiency.

Heat wave caused by Laos Wind blowing from July to August adversely also affects work efficiency.

Access road to the Project area

There are two access roads to the Project area. Route 46 as north route leads to the Project area from Vinh City trough Nam Dan Bridge. The South route is crossing the La river to the Project area from Ha Tinh Province located on the south of Nghe An Province via route 8A. However, on both routes, heavy-duty truck over 17t cannot pass because of the load limitation of the bridges.

Irrigation

In Nam Trung Pump Irrigation Area, it is necessary to supply irrigation water even during construction period.

Execution period

In the Tet holiday (lunar New Year in Viet Nam) of February and harvest season of May, it is difficult to keep the employing farmers as laborers.

### 2-2-4-3 Scope of Work

As for the share of the works of the Project between Vietnam and Japan, the main work which includes the construction of the pump house, canal, road, bridge, etc., is to be borne by Japan, while that of the works concerned with necessary land ensuring and clearing should be borne by Vietnam. In the rural electrification work, the service wire from the distributing board to each house should be installed by the beneficiaries. The share of construction by the Japanese side is mentioned below.

- Power transmission line from an existing substation to a new substation.
- New substations.
- Power distribution line network from a new substation to a distribution board.

### 2-2-4-4 Consultant Supervision

The detailed design and supervisory work will be conducted by a Japanese consulting firm in accordance with the consultant contract to be signed with MARD following the signing of the Exchange of Notes (E/N). This consultant contract will be prepared in accordance with the E/N and will come into effect after its verification by the Government of Japan. The consultant contract consists of detailed design work and supervisory work.

#### (1) Detailed Design Work

In the field survey of the detailed design work, appropriateness and rationality about the results of the basic design study will be confirmed in order to make a final decision on design conditions. Moreover, the concepts of structural design will be explained to make operation and maintenance easy for further users. The following supplementary works will be additionally carried out.

- Geological Survey related with the Ho Thanh reservoir countermeasure for leakage and the Bridge works
- Topographic Survey related with the Ho Thanh reservoir countermeasure for leakage and the Rural electrification works

Furthermore, the boundary between inside and outside of the construction site, and the area to be expropriated will be confirmed on site in company with the persons concerned for the purpose of smooth implementation of the construction work.

After one-month site survey, the consultant will complete the detailed design with the preparation of bid documents and visit Vietnam to get the approval of the Head of Project Management Board (PMB) on the bidding documents. After six months of consultant contract, the bidding will be carried out in Japan.

**(2) Supervisory Work**

Supervisory work shall be carried out in accordance with the above-mentioned implementation concept, and the use of local consultants as assistant consultant engineers is taken into account.
One resident engineer will be continuously stationed to supervise the construction works. Pavement, mechanical and architectural engineers will be dispatched as spot supervisors in accordance with the construction schedule. Under the Japanese resident engineer, two local assistant engineers shall be in charge of irrigation and road section respectively. The Project manager will conduct the overall supervision work at the beginning and end of the construction period.

An agricultural civil engineer having experience in the implementation of rural development projects should be appointed as the resident engineer (for supervision) considering that the improvement work consists of the various rural infrastructures, such as irrigation canal, pump station, reservoir, road, bridge and rural electrification.

**2-2-4-5 Quality Control Plan**

As the Quality Control in the supervisory work, a physical and chemical test will be conducted to grasp the quality of the construction materials, and the results of these tests will be recorded onto the control charts and tables for an accurate management of material's quality.

The control items of the main construction works are shown as follows,

① Concrete Work

- Material : cement test, sieve analysis test, specific gravity test, absorption of coarse aggregate test and etc.
- Construction : alkari-aggregate reaction test, slump test, air contents test, test for

compressive strength at age of 28 days and etc.

② Road Work

- Material：test for moisture-density relation of soil, CBR test, specific gravity test and etc.
- Construction：field water content, in-site CBR test, plate loading test, proof rolling test and etc.

③ Canal Work

- Material：test for moisture-density relation of soil, specific gravity test and etc.
- Construction：in-site density test, test for water contents and etc.

④ Asphalt Pavement Work

- Material：penetration test, ductility test, sieve analysis test and etc.
- Construction：thermometry, in-site density and etc.

Frequency and standard values are summarized in table 2-2-4-5.1 below.

**Table 2-2-4-5.1 Quality Control of Materials and Construction**

| Items | Frequency | Standard Value |
|---|---|---|
| Concrete Work | | |
| Cement test | Manufacture′s certification | Physical and chemical properties |
| Sieve analysis test | Once/600m$^3$ concrete & each borrow pit | Design value |
| Specific gravity test | – ditto – | – ditto – |
| Test for abrasion of coarse aggregate | Once at the beginning of construction<br>Once/each borrow pit | ≦35% (Asphalt concrete)<br>< 40%(other concrete) |
| Alkali-aggregate reaction | Twice/day (morning and afternoon) | ≧0.3mg/m3 |
| Slump test | – ditto – | 2.5cm: ±1.0cm, 5.0～6.5cm: ±1.5cm<br>8.0～18cm: ±2.5cm, 21cm: ±1.5cm |
| Air contents test | – ditto – | ±1.5% |
| Compressive strength (28days) | < 50m$^3$/day: once/50m$^3$<br>≧50m$^3$/ day: twice/day ( morning, afternoon) for reinforced concrete, once/day for other concrete | In case of field mixture concrete;<br>Average for 3 test piece made at some time should not be below 80% of standard value in 1/20 probability. |
| Road Work | | |
| Test for moisture-density relation of soil | Once/each borrow pit | Design value |
| CBR test of soil | – ditto – | – ditto – |
| Field water content test | ≧5,000m3: once/1,000m3 (3 points per cross section)<br>＜5,000m3: once/200m (ditto) | Design value |
| In-site CBR test | As specification | – ditto – |
| Plate loading test | – ditto – | – ditto – |
| Proof rolling | Whole length of the road | No subsidence |
| Field density test | Once/200m (3 points per cross section) | As road: ≧93% of maximum dry density<br>Co road: ≧95% of maximum dry density |
| Canal Work | | |
| In-site density | Once/200m (3 points per cross section) | A, B: ≧90% of maximum dry density<br>C, D, E: ≧85% of maximum dry density |
| Asphalt Pavement Work | | |
| Penetration test | Manufacture′s certification | |
| Ductility test | – ditto – | |
| Thermometry test | Once/each dump truck | 110℃ or ±20 ℃ for designed temperature |
| In-site density | Once/500m$^3$ | Surface & basement: 94% of design value<br>Bituminous stabilization: 93% of design value |

For Pump Installation Work and Rural Electrification Work, workmanship will be observed, and test run will be carried to confirm the performance of pump and transmission installed.

### 2-2-4-6 Procurement Plan

#### (1) Manpower

According to the Vietnamese Law, the Japanese contractor cannot employ directly local farmers as workers for the construction work of the Project. Therefore, the Consultant will instruct the Japanese Contractor that local farmers be hired as the workers by the Vietnamese sub-contractor in order to improve the farmer's motivation of participation in this Project and promote the good influence of economical growth in this Project area.

The results of the Basic design survey confirmed that the Vietnamese engineers, such as civil engineer, surveyor, assistant engineer for supervision etc., have enough competencies. Consequently, these will be employed as engineers.

#### (2) Construction Machinery and Material

Common materials such as cement, aggregates, lumber, reinforcing bars, etc. are all available at the Vietnamese markets. Other materials and equipments are pump, RC pile, steel pipe pile and transformer, and shall be procured at Vietnamese markets in principle.

This type of work does not require the use of special machinery. Therefore, all the machinery can be procured from the local company and would not require bringing anything from Japan.

#### (3) Transportation Plan

Construction materials and heavy equipments will be procured and transported to the Project site as follows,

**Table 2-2-4-6.1 Transportation Plan of Main Procurement Items in Vietnam**

| No. | Item | Procurement place | Transportation Plan |
|---|---|---|---|
| 1 | Filling soil | Borrow pit | Carry to each sites by dump truck from the borrow pits in the Project site. |
| 2 | Road metal | Quarry site | Carry to temporary yard by dump truck from the quarry site near the Project site. |
| 3 | Heavy-duty equipments | Hanoi and other city | Carry by trailer via Route 1 & Route 46 and cross Lam river by ferryboat to Nam Dan. |
| 4 | RC & SP Pile | Ditto | Carry by truck via Route 1 & Route 46 to Nam Dan. |
| 5 | Pump | Ditto | Ditto |

### 2-2-4-7 Implementation Schedule

#### (1) Detailed Design Period

After the signature of the Exchange Note (E/N), the schedule until the contract signing for the construction work is as follows,

| | Phase 1 | Phase2, 3 |
|---|---|---|
| ・Contract for Consultant | 1.0 month | 1.0 month |
| ・Detailed Design (Field Work) | 1.0 month | ― |
| ・Preparation of Bid Document | 2.0 months | 1.0 months |
| ・Approval of Bid Document | 0.5 month | 0.5 month |
| ・Bidding & Contractor's Contract | 2.5 months | 2.5months |

#### (2) Construction Period

According to the divide three phases of this Project, each construction work will be completed within a year.

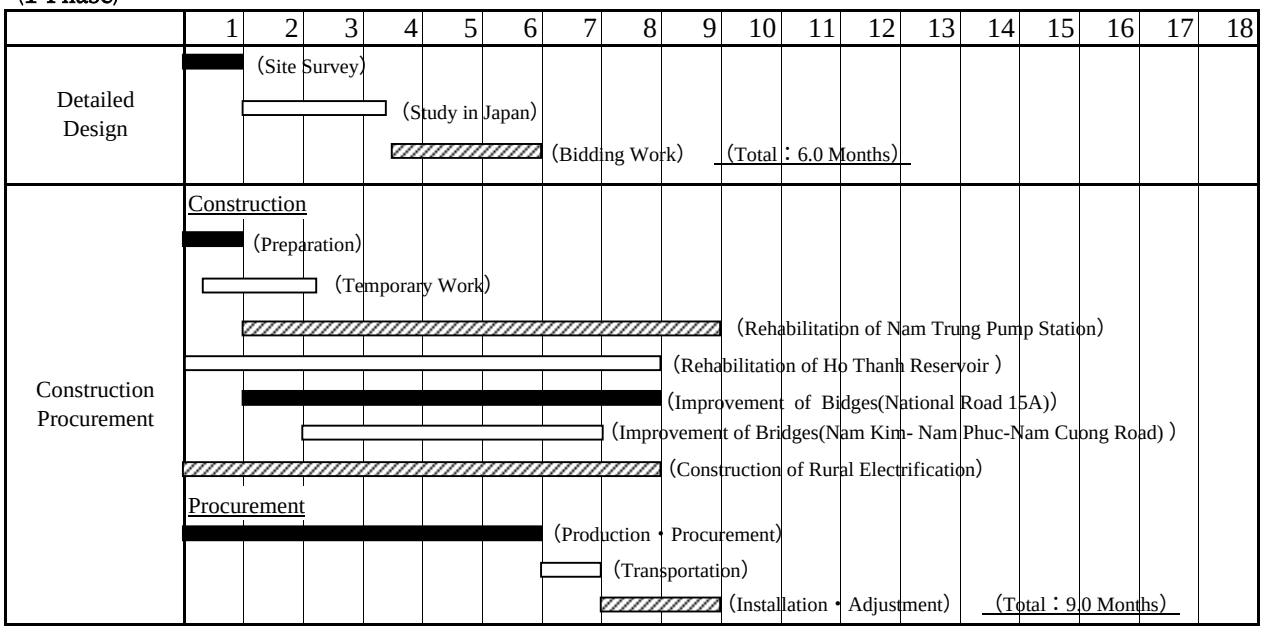
The necessary construction period of each item is as follows,

| | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|
| ・Preparation | 1 month | ― | ― |
| ・Temporary Work | 1 month | ― | ― |
| ・Nam Trung Irrigation System (Canal) | ― | 10 months | 10 months |
| ・Nam Trung Irrigation System (Pump Station) | 8 months | ― | ― |
| ・Ho Thanh Reservoir Irrigation System | 8 months | ― | ― |
| ・NR15A | ― | 9 months | 8 months |
| ・KPC Road | ― | 9 months | 7 months |
| ・NR15A Bridges | 7 months | ― | ― |
| ・KPC Road Bridge | 5 months | ― | ― |
| ・Rural Electrification | 8 months | ― | ― |

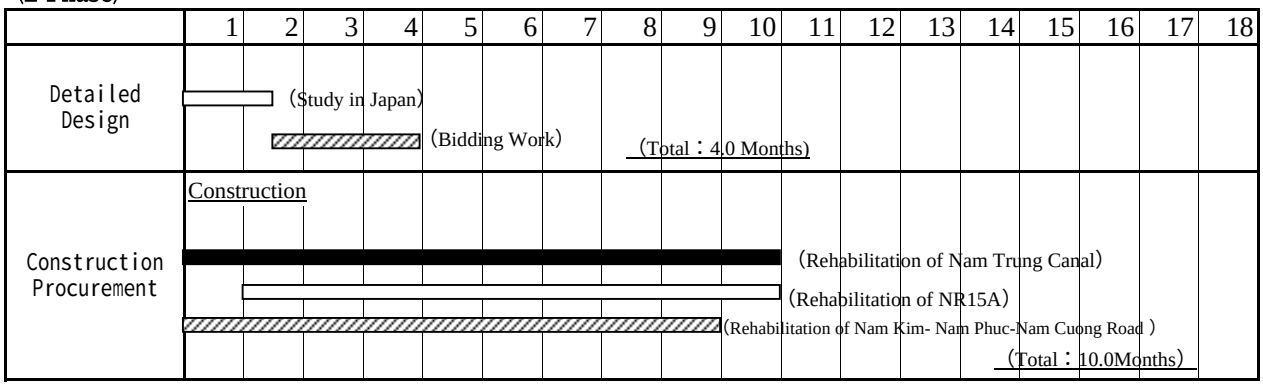
※No working periods include 1 month between phase 1 and phase2, and 2 months between phase 2 and phase 3.

The total construction period of this Project is estimated as about 32 months (38 months including period of detailed design) from the beginning until the completion of the work. The construction schedule is shown in Figure 2-2-4-7.1.

(1 Phase)




(2 Phase)




(3 Phase)

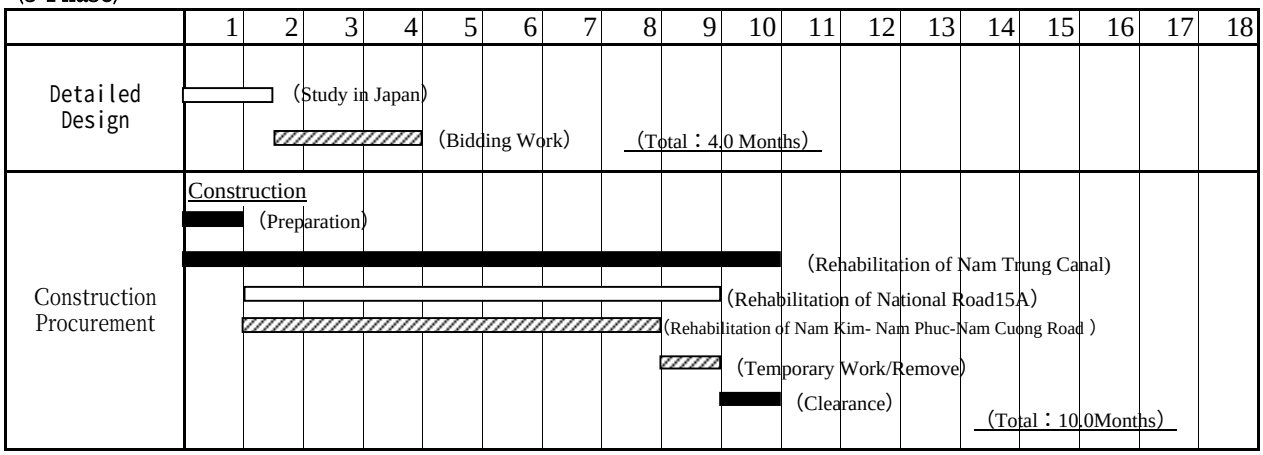



**Figure 2-2-4-7.1 The Construction Schedule**

## 2-3 Obligations of Recipient Country

### 2-3-1 Obligations of Vietnamese Side

The obligations of Vietnamese side in the Project are as follows;

- To secure the land necessary for irrigation facilities, roads, bridges, electrification facilities, temporary office and storage yards and to clear, level and reclaim the land prior to commencement of the construction.
- To secure electricity to the Project site (pumping station).
- To secure the necessary budget and personnel for operation and maintenance of the equipment and facilities of the Project.
- To secure the official appraisal and approval required for the implementation of the Project by the Government of Viet Nam by March 2003.
- To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in Viet Nam with respect to the supply of the products and services under the Verified Contracts.
- To accord Japanese nationals, whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into Viet Nam and stay therein for the performance of their work.
- To maintain and use facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.
- To open an account in the name of the Government of Viet Nam in a bank in Japan (hereinafter referred to as "the Bank") in order to be executed the Grant Aid by the Government of Japan.
- To bear an advising commission of an Authorization to Pay and payment commissions to the Bank.
- To notify the inhabitants of the project implementation prior to commencement of the construction.

## 2-3-2 Cost Estimation Borne by The Government of Vietnam

Cost born by the Government of Vietnam for the project implementation is estimated as follows:

**Table 2-3-2.1 Cost Estimation Borne by The Government of Vietnam**

unit：million VND

| Item | Phase 1 | Phase 2 | Phase 3 | Total |
|---|---|---|---|---|
| Land Acquisition | 811 | 770 | 1,216 | 2,797 |
| Land Compensation | 21 | 43 | 42 | 106 |
| Land clearance | 33 | 69 | 62 | 164 |
| Replacement of Existing Pumps | 2 | 0 | 0 | 2 |
| Banking Commission | 59 | 59 | 39 | 157 |
| Total | 926 | 941 | 1,359 | 3,226 |

## 2-4 Project Operation Plan

The components of this project include the rehabilitation of facilities, which are presently operated and maintained by the given organizations. Each of these organizations for operation and maintenance (O/M) is running almost satisfactorily without any serious trouble. Therefore, the to-be rehabilitated facilities in this project will be managed under the existing O/M systems. The organizations for O/M of the concerned rehabilitated facilities are shown below.

**Table 2-4.1 The Organizations for Operation and Maintenance**

| Sector | Facility | Operation and Maintenance organization |
|---|---|---|
| Irrigation Facility | Nam Trung Pump Stations | Nam Trung cooperative association |
| | Nam Trung Main Canal | Commune cooperative association |
| | Ho Thanh Reservoir | Irrigation Corporation of Nam Dan District |
| | Ho Thanh No.2 Main Canal | Irrigation Corporation of Nam Dan District （No.1 Canal is by Nam Kim Cooperative） |
| Rural Road | NR15A | Management and Maintenance of Road and Navigation Company belonging to the Department of Transportation of Nghe An Province |
| | KPC Road | People's Committee of Nam Dan District (Industry, Construction and Transportation Service) |
| Rural Electrification | Medium and High voltage lines, Distribution Networks and Sub Stations | Electric Power Corporation of Nghe An Province (Branch office of Nam Dan District) |
| | 0.4KV Distribution Lines (further from Sub station) | Commune People's Committee （ entrusted to Agricultural Cooperative） |

### 2-4-1 Operation and Maintenance of Nam Trung Pumping Irrigation System

In Nam Trung Pumping Irrigation System, there are two different O/M systems; one for the pump station and another for the canal.

The pumping station was operated and maintained by Nghe An South Irrigation Corporation until 1988, when the O/M of the station was transferred to Nam Trung Cooperative, which remains in charge up to now. However, the O/M of the canal is entrusted to communes' cooperatives which have dispatched 3 pump operators and 14 water managers (Figure 2-4.3).

O/M works consist of water management such as distribution of required water, water conveyance, rotated irrigation etc., maintenance of facilities and collection of water fee. Water distribution is decided for every planting season, water conveyance and rotated irrigation are done everyday during the irrigation season, inspection of facilities is done before and after irrigation season, facilities are repaired principally in the dry season after irrigation and water fee is collected every planting season. Collected water fee in this system is 19,500VND/500$m^2$/season.

With the intended rehabilitation work, the function of the facility is expected to be fully recovered and

the present irrigated area is expected to be restored to the original-design irrigated area. The present water management system is to be reorganized accordingly based on a mutual consent between beneficiaries and related cooperatives.

### 2-4-2 Operation and Maintenance of Ho Thanh Reservoir Irrigation System

In the Ho Thanh Reservoir Irrigation System, the reservoir and No.2 canal are operated and maintained by Nam Dan Agricultural Irrigation Company in Ngeh An South Irrigation Corporation. No.1 canal is operated and maintained by Nam Kim Corporative No.2.One gate operator is employed for the reservoir intake facility. Collected water fee in this area is in kind and amounts to 300kg paddy/ha/season.

With the intended rehabilitation work, the function of the facility is expected to be fully recovered and the present irrigated area is expected to be restored to the original-design irrigated area. The present water management system is to be reorganized accordingly based on a mutual consent between beneficiaries and related cooperatives similarly to the Nam Trung pumping irrigation system.

### 2-4-3 Maintenance of National Route 15A

The management and Maintenance of Road and Navigation Company belonging to the Department of Transportation (DOT) of Nghe An Province, is in charge of the maintenance of NR15A after the improvement work. This company manages provincial and national roads located in 7 districts such as Nam Dan, Quyung Luu, Yen Thanh, Nghi Loc, Tan Ky, Hung Nghi and Do luong. It has 317 staffs of which 265 are engineers. 31 of these engineers have more than 5 years experience and, 35 have 3 years experience.

The maintenance work, aiming to keep the condition of the road network appropriate includes the four items, such as patrol, usual maintenance, regular maintenance and improvement. Patrol is done once a month, usual maintenance for partial repair of road pavement and filling-up is done before and after the rainy season, regular maintenance is done every 5 years to repair asphalt pavement by overlay. Improvement is done depending on the scale of damage.
The organization chart of DOT, Nghe An Province, is shown in Figure2-4-5.1.

### 2-4-4 Maintenance of Nam Kim-Nam Phuc-Nam Coug Road

Nam Kim-Nam Phuc-Nam Coug Road (KPC Road) is maintained by the Industry, Construction and Transportation Division of Nam Dan District People’s Committee. The division has 6 engineers:

One electrical engineer

Two transport (Road & Bridge) engineers
Two civil engineers
One mechanical engineer

A temporary worker has practiced the maintenance work under the supervision of one transport engineer. In 2003, a Road Operation and Maintenance Management Section in charge of maintenance was established under the Industry, Construction and Transportation Division. The new section needs to be well organized to ensure a proper KPC Road maintenance.

The budget of the Industry, Construction and Transportation Division is partially financed through local inhabitants contribution given either in cash or in kind. Contribution in kind involves unpaid labor consisting of 10days-road construction work where the required age range would be 18 - 45 years for men and 18 - 25 years old for women.

KPC Road will remain subjected to inundation after the improvement work. In order to prevent road pavement damage, it is desirable to prohibit four-wheeled vehicles' traffic until the flood level falls below the height of road surface.

### 2-4-5 Maintenance of Rural Electrification Facility

In the maintenance of rural electrification facilities after the construction, Nghe An Province Power Corporation will be in charge of medium voltage lines (10KV) and the sub stations, and the Commune People's Committee will be in charge of distribution network (0.4KV). (Figure 2-4-5.1, Figure 2-4-5.3).

A work group, consisting of 13 staffs of the Nam Hun Branch of the Power Corporation will implement the maintenance work. The commune cooperative will implement the maintenance work under the Industry Construction and Transportation Division of Nam Dan District. Each commune cooperatives will set up a maintenance group of 4-6 operators to maintain the distribution facilities and collect electricity fee (Figure2-4-5.4). The cost for the maintenance work by the commune cooperatives is provided from the electricity fee paid by the electric power users in the communes.

An electric technician is placed in the Industry, Construction and Transportation Division, to manage the electrification plan and electric services provided by cooperatives. In 2003, Low-tension Line Electricity Management section is to be established. This would require improving the technical skill of electricity-construction engineers in each commune and placing several of electric them, for a proper prevention and effective conservation of the facilities constructed in this project.

## 2-4-6 Operation and Maintenance Cost

Annual Cost estimate of operation and maintenance of facilities are shown below.

**Table 2-4-6.1 Annual Cost of Operation and Maintenance**

unit：million VND

| Section | Facility | Operation/ Maintenance |
|---|---|---|
| Irrigation Facility | Nam Trung Pump Station | 183 |
| | Nam Trung Main Canal | 42 |
| | Ho Thanh Reservoir and No.2 Main Canal | 30 |
| Rural Road | NR15A | 480 |
| | KPC Road | 60 |
| Rural Electrification | Medium/High Voltage Line, Distribution network, Sub Station | 20 |
| | 0.4KVDistribution network (Further from substation) | 50 |

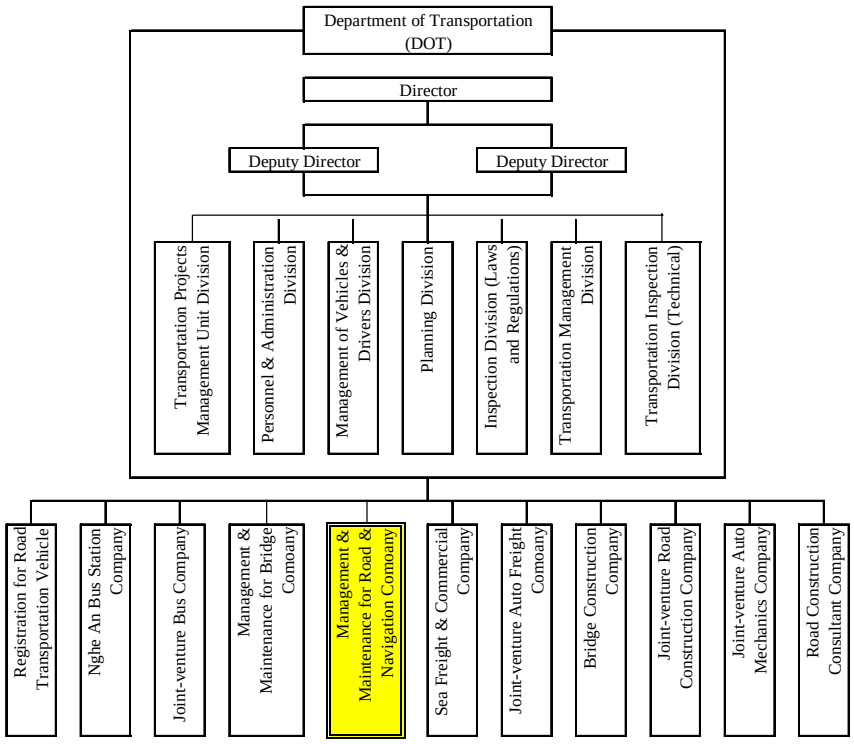



**Figure 2-4-6.1 The Structure of The Department of Transportation of Nghe An Province**

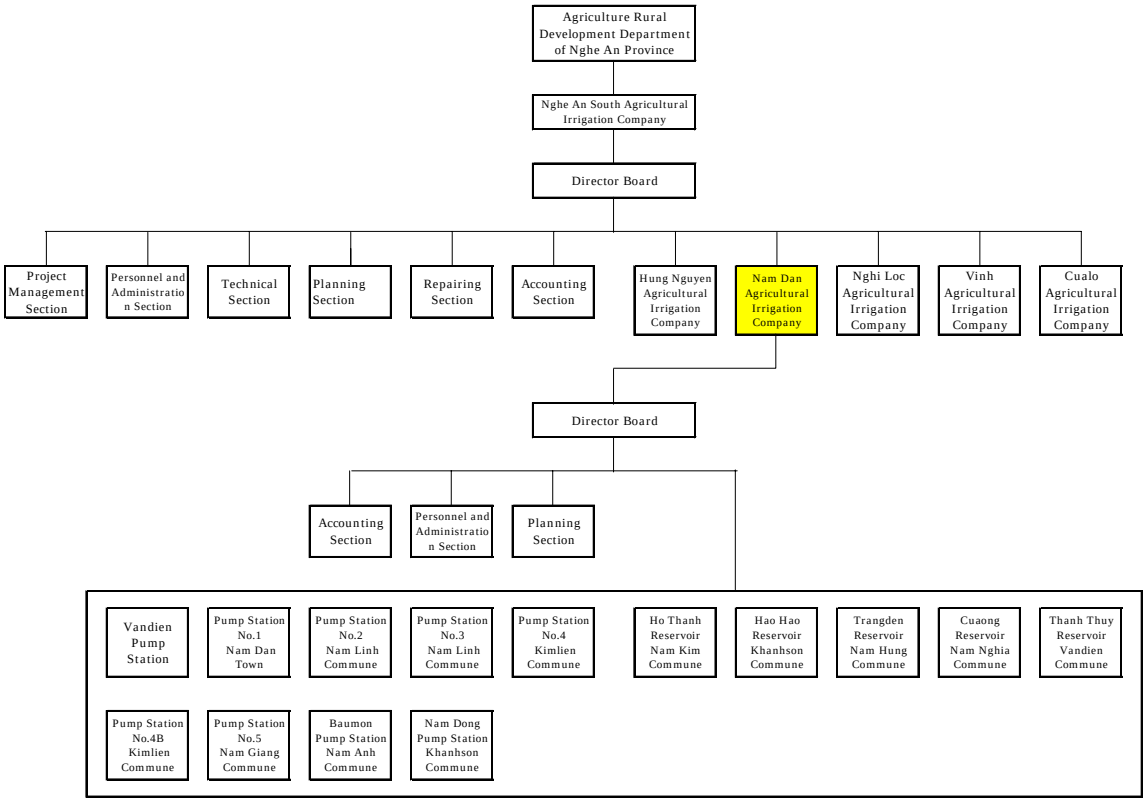



**Figure 2-4-6.2 The Structure of The Irrigation Corporation of Nghe An Province**

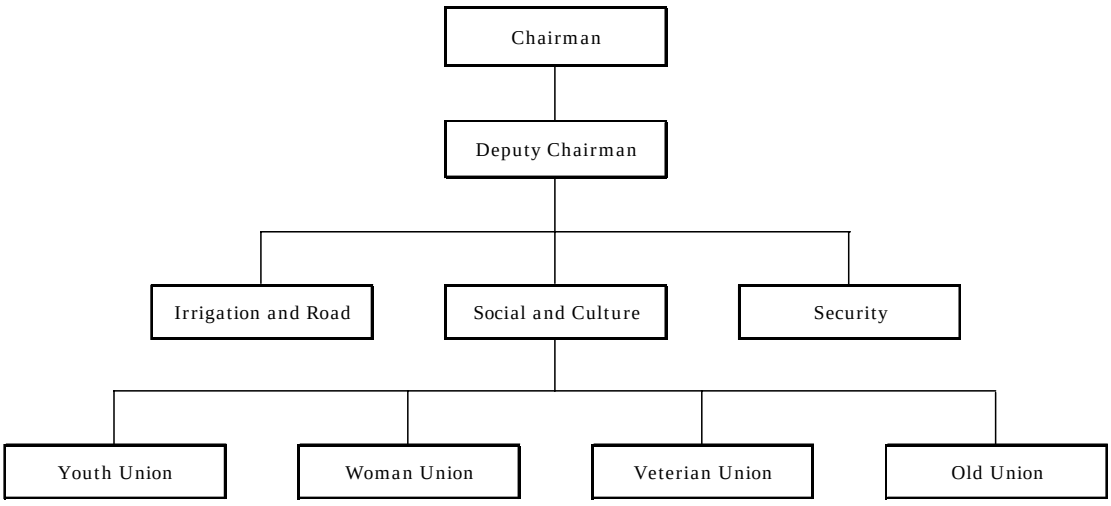



**Figure 2-4-6.3 The Structure of Commune People's Committee**

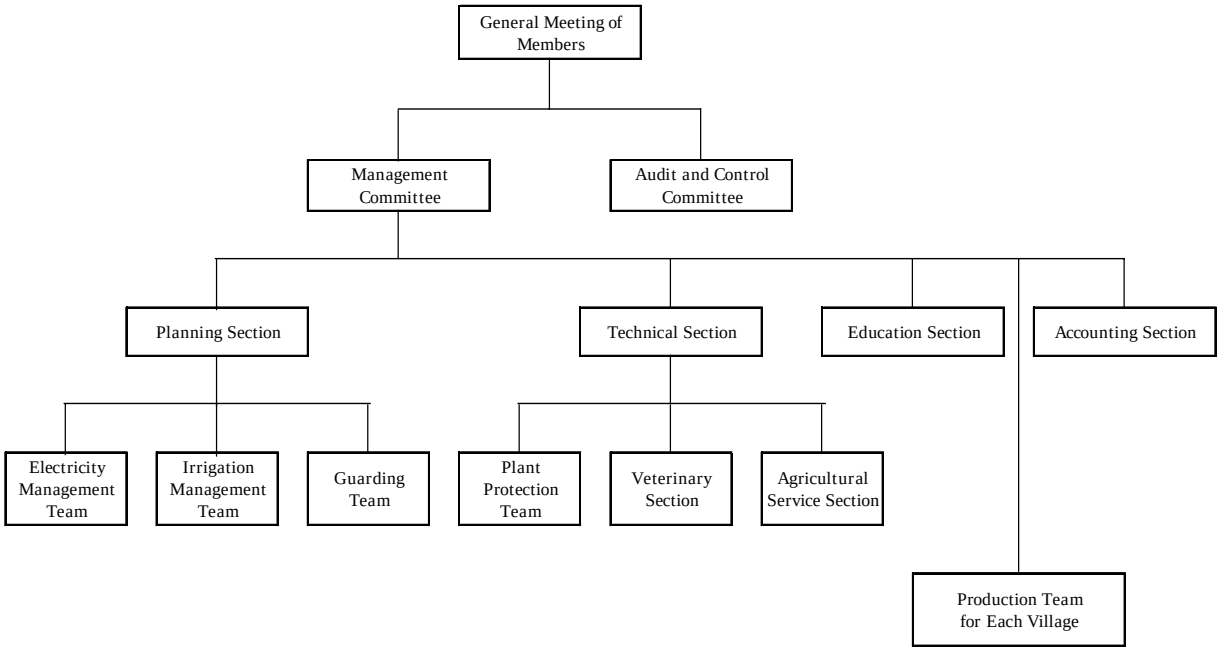



**Figure 2-4-6.4 The Structure of Commune Cooperative**