CHAPTER 4 SANITATION IMPROVEMENT PLAN

4.1 Issues on Environmental Sanitation in Rural Vietnam

The problems on environmental sanitation are presented by using the logical problem tree as shown in Figure 4.1.1. In the Problem Tree, the core problem is given as "Sustainability of environmental sanitation in rural areas is low". And the following seven issues are identified as the main issues.

(1) Sanitation Coverage in Rural Area is Much Lower than the National Target

Sanitation coverage in rural area of Vietnam is estimated to be 56%. (2006, "WHO/UNICEF Joint Monitoring Programme for Water and Sanitation") However, serious situation is presumed in the report "Rural Environmental Sanitation Survey in Vietnam, MOH, 2007". It reports only 22.5% of total households surveyed have latrines which meet hygienic standards. Considering the national target set by RWSS NTP II is 70% in 2010, it is so difficult to accomplish the target within the remaining time, since sanitation promotion requires long time to change peoples' awareness.

(2) Institution and Organization for Sanitation Promotion in Provincial Level is Weak

Activities for sanitation improvement at the provincial level don't seem active enough because of little awareness of RWSS NTP II which results in less budget allocation and personnel mobilization for sanitation promotion, and little cooperation among the related organizations.

(3) Personal Hygiene is Insufficient due to Lack of IEC

Personal hygiene of rural residence is reportedly insufficient from the survey results of MOH (2007). In order to raise personal hygiene, it is essential to provide IEC effectively and continuously. Although importance of IEC is recognized well in central level and many IEC materials have been produced, implementing framework to provide IEC systematically has not been established in local level.

(4) Lack of Funds to Build Sanitation Facility

According to survey by MOH (2007), lack of household finance is the foremost reason for rural residents who don't have toilet. The Government of Vietnam promotes a financial supporting policy through an unsecured loan by VBSP (Vietnam Bank for Social Policies) to build WSS facilities. Yet, several issues are pointed out; e.g. loan amount is not enough to cover construction cost and little involvement of MARD/N-CERWASS who provides technical guidance to the borrowers.

(5) Groundwater Pollution by Effluent from Septic Tank

In the Model Sanitation Program, water quality analysis was carried out for effluent (overflow) and sediment sludge of the existing septic tank toilets (septic tank sludge). From the result, it is turned out that the existing septic tanks have few effects to reduce pollution loads and a risk of groundwater pollution of shallow wells is progressing by the effluent of septic tanks, which is the most popular among rural residents.

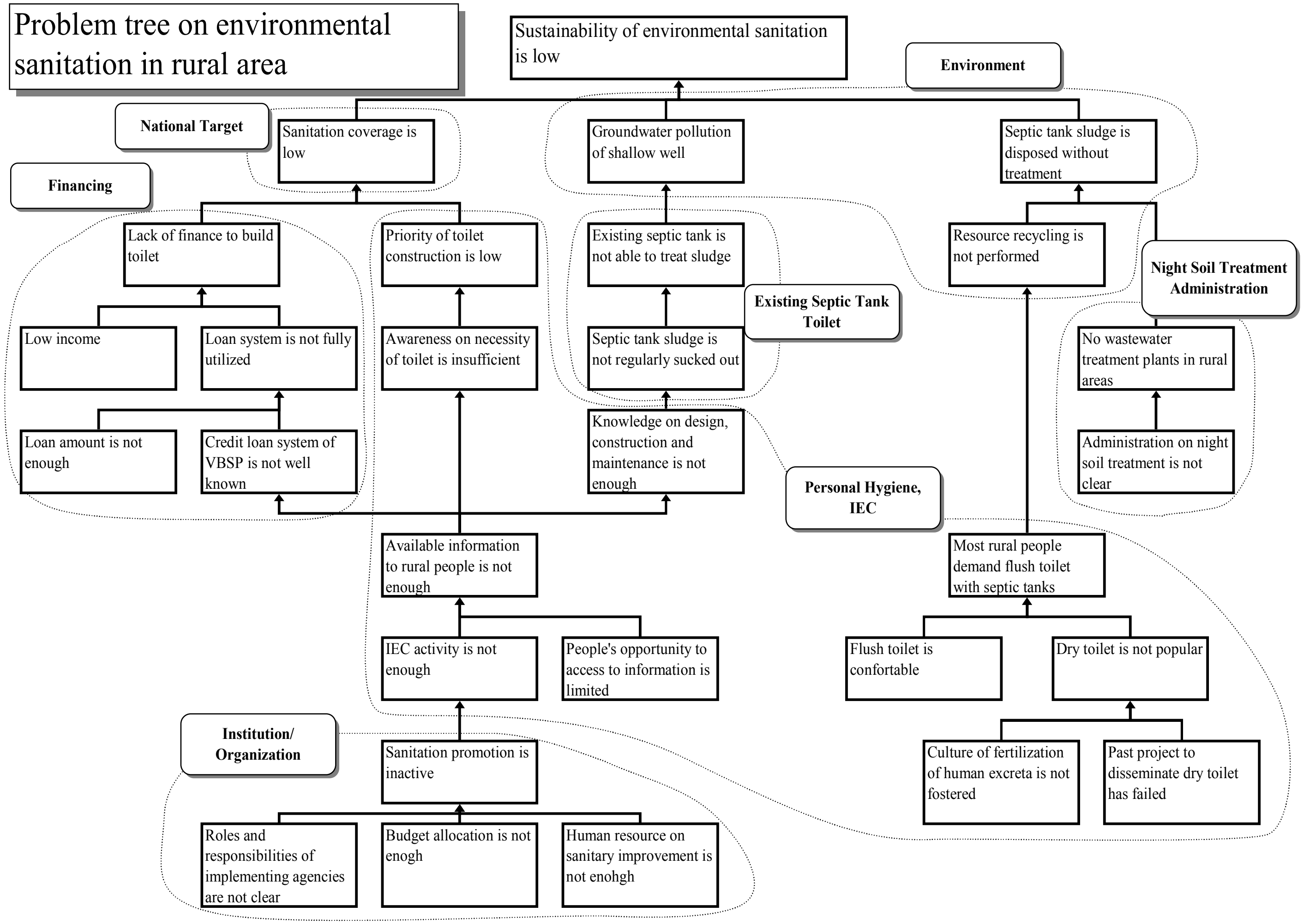


Figure 4.1.1 Problem Tree on Environmental Sanitation in Rural Area

(6) Administration for Night Soil Treatment

Night soil treatment in rural areas is supposed to be on-site system, which requires septic tank sludge collection and treatment. However, administrative structure for night soil treatment is not established in rural area, whereas it is clearly defined to be MOC for urban area.

(7) Environmental Issues Caused by Disposal of Untreated Septic Tank Sludge

Sediment sludge in septic tank (septic tank sludge) is sucked out by vacuum cars. The collected sludge is currently disposed in the mountainous fields without treatment which causes degradation of natural environment.

Since serious environmental problems are presumed with increase use of septic tank toilet in future, treatment facilities should be planned and developed.

4.2 Recommendable Approach toward Sustainable Improvement of Environmental Sanitation

(1) Establishment of Provincial Taskforce for Sanitation Promotion

In order to enhance implementation organization in provincial level, information sharing and consolidated policy formation is recommended by forming a cross-sectoral workgroup; e.g. “Provincial Taskforce for Sanitation Promotion” as shown in Table 4.2.1:

Table 4.2.1 Recommended Taskforce for Sanitation Promotion

Member	DARD(leading agency), P-CERWASS, DOH, DOET, DONRE, DPC, etc.
Main functions	(1) Policy formation: through discussion of priority subject and decision making (2) Needs identification and analysis: by surveying and monitoring knowledge, attitude and practice (KAP) related to sanitation (3) Cooperation with local authorities: by information sharing with DPC and CPC (4) Implementation of pilot project (5) Support to grass-roots activity

(2) Raising Personal Hygiene through Enhancement of IEC channels

It is identified that IEC is the key factor to approach sanitation promotion. Although a lot of IEC materials have been prepared by N-CERWASS as well as MOH, they are not fully utilized in promotion activities in local level.

The reasons of ineffective use in provincial level are presumed as listed below:

- Shortage of IEC staff in P-CERWASS, DOH and other organizations involved in IEC.
- Little knowledge and experience of IEC staff.
- Information is provided in instructive way with little dialogues and explanation.
- IEC materials are not necessarily attractive for all target groups.

・Inadequate budget allocation to IEC activities.

Since behavioural change takes long time, long term intervention through diversified communication channels should be taken into account in addition to short term and single activity. And IEC should be performed through every possible ways of communication, by improving delivery of information. For this purpose, the existing community-based local network, such as women's union, farmers' union, etc. shall be utilized. In this case, local motivators, who can influence and motivate people by using their grass-roots networks, should be developed.

As the actions to be taken by the implementing organizations, the following activities are recommended to improve IEC for raising personal hygiene in rural area.

- P-CERWASS fosters IEC specialists (through training by N-CERWASS)
- The IEC specialists provide IEC to local motivators (training in commune by using training package to be prepared by N-CERWASS)
- Involvement of related organizations to the IEC activity (Collaboration with DOH, health workers, schools, mass media, etc.)
- Supportive working conditions will be ensured to mobilize IEC participants
- Diversified IEC media/ methodology (Production of visual media, use of mass media, local campaign event, etc.)

(3) Dissemination of New Design of Urine-Feces Separation Toilet

It is pointed out that the existing pour flush latrine with septic tank, which is the most popular in the study area, may cause groundwater pollution since the septic tank has few effects to treat the excrement. On the other hand, DVCL toilet is not popularly accepted by the rural residents in southern provinces, although the JICA Study Team recommends it from the ecological point of view.

In the Model Sanitation Program, the Team introduced urine-feces separation type with chair type stool for both dry and septic tank toilet. They are designed in consideration of the above mentioned issues of the existing toilets. The design concept of the new urine-feces separation toilet is given as below.

・To be ecological by resource recycling of excreta as fertilizer and by mitigating groundwater pollution from septic tank effluent: Urine-feces separation type
・To be comfortable and friendly for any users, especially for aged and handicapped persons: Chair type stool
・To provide options to be chosen by customers: Dry and pour flush with septic tank types
・To be reasonable price: Locally manufactured (production cost of prototype: VND 700,000.- per stool)

The characteristics of the existing and the new designs of both dry and septic tank toilets are summarized in Table 4.2.2.

Table 4.2.2 Comparison between Existing and New Design Urine-Feces Separation Toilet

<< Dry Type>>

Item	Existing Design (DVCL)	New Design Toilet
Comfortable	Squat type is difficult for aged or handicapped users Little bad smell (if properly constructed and used)	Chair type stool is comfortable Little bad smell
Groundwater pollution	No	No
Resources recycling	Urine and feces are recycled	Urine and feces are recycled
Water supply	No need (except hand washing water)	No need (except hand washing water)
Economy	Approx. USD 400 #1)	Approx. USD 500 #2)
O&M	Wooden ash or lime should be used after defecation for disinfection. Water can not be used. Two feces chambers should be alternately used after every 6 months. Feces should be kept in dry condition for more than 6 months.	Wooden ash or lime should be used after defecation for disinfection. Water can not be used. (but small amount of mist water can be used for cleaning feces hole) Some containers for feces storage should be prepared for removable cartridge which is placed in the single feces chamber. Feces should be kept in dry condition for more than 6 months.
Other risk	Water intrusion into feces chamber in rainy season may not suitable	To date, the new type stool is not sold on the market

<< Pour Flush with Septic Tank Type>>

Item	Existing Design	New Design Toilet
Comfortable	Chair type stool is comfortable Little bad smell	Chair type stool is comfortable Little bad smell
Groundwater pollution	Effluent from septic tank may pollute groundwater	Pollution load is mitigated by separating urine. (Approx. 88%#3) of nitrogen is reduced)
Resources recycling	Urine and feces are not recycled	Urine is recycled as fertilizer
Water supply	Necessary	Necessary, but less water consumption
Economy	Approx. USD 400 – 600 #1)	Approx. USD 600 #2)
O&M	Septic tank sludge shall be sucked out by vacuum track	Septic tank sludge shall be sucked out by vacuum truck (but less frequent than the existing design) Urine tank shall be removed to spray in the field. (urine discharge pipe by using gravity flow can be optionally installed)
Other risk	Environmental degradation due to disposal of untreated sludge	To date, the new type stool is not sold on the market

(Note)
#1) Research by the Study Team, 2007
#2) Actual cost of the Model Sanitation Program (2007), including toilet stool cost of VND 700,000.
#3) "A Proposal of Advanced Sanitation System and Attempts to Improve Vietnamese Sanitation, Hidenori Harada, 2007"

In the Model Sanitation Program under the Study, the new model toilets have been introduced and effects are monitored. The design drawings and monitoring results are presented in ANNEX 1 “Activity Report on Model Sanitation Program”. As a result of monitoring, new design of urine-feces separation toilets is accepted and properly used by most users, even it is of dry or flush toilets. It seems that rural people in the Study Area possibly accept this model. Therefore, it is highly recommendable to disseminate this new design toilet from environmental point of view.

In disseminating the new design toilet, the following issues should be taken into account.

- Design approval by MOH: The new design is in progress for approval by MOH (as of November 2008). MOH basically agrees and enough hygienic and environmental effects should be verified with demonstration data. MOH has policy to increase types of the hygienic latrine standards to be diversified and applicable for different climate, culture, etc.
- Commercialization of the new design stool: Since it is newly introduced in Vietnam, the new stool is produced as a prototype and not on sale in market. Manufacturing and market system should be developed.
- Price of the stool: The prototype model was manufactured at the cost of VND 700,000.- per stool. It doesn’t include cost and profit margin of distributors. But the production cost could be reduced by mass production and distribution. Policy to provide preferential conditions for ecological benefits of the urine-feces separation type should also be considered, e.g. financial subsidy for people who buy the urine-feces type stool.
- Advertisement and public information: Since it is new model introduced in Vietnam, advertisement is important for dissemination. Technical guidance should be provided to rural people, including information about hygienic and ecological benefits, how to build, use and maintain toilet. In this connection, booklets and DVD video for teaching how to build toilet were produced and provided in the Model Sanitation Program.
- Long time to disseminate: It takes a long time to disseminate this model widely for rural people.

(4) Enhancement of Financial Support and Incentive Mechanism

The preferential loan offered by VBSP (Vietnam Bank for Social Policies) seems attractive for rural households to construct water supply and sanitation facilities. Some constraints are identified in the Study. For example, the loan system is not widely known by rural people, depending on involvement of commune having branch office. Technical standard and evaluation system is not established, which may fail in design failure, etc., due to little involvement of P-CERWASS. And loan amount is sometimes insufficient.

As the measures against these constraints, maximum utilization of VBSP loan is recommended, through promoting measures as described below:

- More advertisement and public information to rural people: More information about how to apply loans and actual case should be provided to public through aforementioned IEC activities. Information should be easy enough and accessible to any people.
- Increasing loan amount: Current loan amount of maximum VND 4 million is not enough to cover entire construction cost, while it is assumed that approx. VND 6-8 million is required in many

cases.

- Sufficient technical guidance: People should have sufficient information on appropriate technical options and necessary knowledge and skills for construction, how to use and maintenance, that would be provided by P-CERWASS.
- Incentive strategy: For example, premium financial support for urine-feces separation toilet, which contributes ecology as above mentioned, would give motivation.
- Cost reduction: Construction cost would be reduced by standardization of toilet design and/or package purchase of construction materials, which would be done by any group of beneficiaries. In this regard, local residential groups, such as Women's Union, would be potential motivator.
- Technical evaluation and monitoring: To ensure transparency and sustainability, technical evaluation and monitoring of constructed facility should be programmed in the financial mechanism.

(5) Environmental Administration and Night Soil Treatment

It is envisaged that MONRE would be the administration body responsible for night soil treatment and sludge disposal in rural area, although legal framework has not been formulated yet. As multi-sectoral organizations are currently involved in rural sanitation, it is recommended to establish single administrative organization which is responsible for dissemination of hygienic latrines as well as for collection and treatment of sediment sludge from septic tank in order to promote sanitation with conscious of environmental conservation. Provision of regulation is also recommended to collection, treatment and disposal of septic tank sludge.

In this regards, a case study is conducted for septic tank sludge treatment system in a rural province, which aims to examine technical solution, preliminary design and cost estimations. The result of the case study is presented in ANNEX 2 of the Main Report.

4.3 Probable Implementation Scheme

The approaches discussed in the previous section are rather challenging, since they require extensive efforts of all the related organizations of central and local levels. Therefore, it is recommended to implement with assistance from foreign donors. In addition to the currently supporting donors, such as UNICEF and TPBS, this section discusses about probable implementation scheme for further promotion.

(1) Grass-Roots Assistance

As sanitation promotion should be carried out continuously at local level, grass-roots assistance by NGOs is envisaged to be suitable to support public relations and technical instruction for toilet construction in commune level.

In this scheme, the target group is envisaged to be local residents who need hygienic latrines. They are to be assisted by NGOs for choosing appropriate technology, designing, construction and maintenance. Information on finding fund sources is also to be provided. Transmitted effect by the residents who construct toilets with the assistance should be considered in the program. Namely, they are expected to be local motivators to disseminate their experience through their grass-roots network in commune.

As an idea, the grant aid for grass-roots group funded by the Government of Japan would be applicable to follow-up the Model Sanitation Program commenced under the Study.

Outline of the program is provisionally presented as Table 4.2.1.

Table 4.3.1 Outline of Grass-Roots Assistance Program (Provisional)

Objectives:	- To provide information on appropriate technology for hygienic latrines and resources recycling to be chosen by the residents. - To assist designing, preparation of work plan, procurement and construction of toilets - To provide the new urine-feces toilet stool - To monitor behavioral effect and personal hygiene
Target group:	- CPC and Residents of target communes of the Model Sanitation Program under JICA Study
Counterpart:	- N-CERWASS, DOH, DARD, DOET, CPC
Period:	- One year

(2) Technical Cooperation for Capacity Development on Environmental Administration in Rural Area

To cope with the environmental issues pointed out in this report, such as groundwater pollution and septic tank sludge disposal, institutional and administrative capacity should be developed through technical cooperation by international donor agency, since institutional framework has not been formed yet in Vietnam.

In that case, a pilot project should be considered to construct a pilot plant for septic tank sludge treatment.

Table 4.3.2 Outline of Technical Cooperation Project (Provisional)

Objective:	- To formulate institutional framework on wastewater discharge and sludge disposal in rural area - To develop capacity of the administrative organization - To carry out a pilot project to examine effects of septic tank sludge treatment plant
Target group	- Related government organizations; MARD, MOH, MONRE, etc.
Period	- 3 years (including construction and operation of the pilot plant)

(Note) This outline is provisionally prepared, which isn't based on any commitment by donors and NGO's.

(3) Septic Tank Sludge Treatment Plant Project by CDM Scheme

In the "Case Study on Septic Tank Sludge Treatment" presented in ANNEX 2 of the Main Report, GHG reduction is expected by combustion of methane gas which is to be collected through septic tank sludge treatment.

This implies a possibility of project implementation by CDM (Clean Development Mechanism) which is an international arrangement to execute commitment for GHG reduction. Namely under CDM scheme, industrialized countries, including Japan, who commit reduction of GHG invest in project that reduce GHG emissions in development countries to get emission reduction credits provided by the project.

By implementation of the project, technologies and fund for project implementation can be introduced to Vietnam, as the host country. And groundwater pollution and environmental degradation would be mitigated through treatment plant operation. At the same time, for the investing countries are able to execute commitment to reduce GHG emission by the carbon credit. Thus, CDM is an incentive scheme for both of host and industrialized countries.

In order to implement CDM project, a lot of procedures for project approval by the authorized agency are required. Also the project effect must be monitored annually by the agency. In order to apply CDM to this case, technical issues identified in the case study should be cleared. And the project implementation organization should be established to prepare detailed project implementation plan, in order to get approval by both of government of Vietnam as well as the authorized operational entity registered by the Executive Board of CDM.

CHAPTER 5 FEASIBILITY STUDY

5.1 Preliminary Design of Water Supply System

5.1.1 Objective of the Project

In this part, Feasibility Study (FS) is carried out for the priority projects selected through the Master Plan study. Based on National Target plan (NRWSSS), the target year is year 2020. The target year of the FS is year 2000 considering view point of national target year, technical and economical aspects because the average growth rate of water demand in all target area from year 2006 to year 2020 is estimated as 18% only.

The aim of the study is to achieve improvement in living standards and promotion of sound socio-economic activities through the project by providing sufficient water to the people in the study area. The rate of population served in the area is considered to reach 100% by means of house connections by the year 2020.

5.1.2 Outline of the Project Area

(1) Project area

The project area includes 9 water supply systems located in 15 communes of 4 provinces. The relation between the system and commune and outline of the project area are summarized in Table 5.1.1.

Table 5.1.1 Outline for the FS Commune

Province	Commune		System		Population in 2020	Water demand in 2020(m3/d)	Raw water source	Intake-commune (km)
			No.	Pattern				
Phu Yen	An Dinh	P-2	FPS-2	Single	6,856	502	Dong Tron reservoir	5.5
	An My	P-4	FPS-3	Single	13,256	998	Groundwater	1
	Son Phuoc	P-5	FPG-4	Group	11,666	874	Ba river	4.5
	Ea Cha Rang	P-6						
	Suoi Bac	P-7						
	Son Thanh Don	P-8	FPS-5	Single	9,292	651	Groundwater	1.9
Khanh Hoa	Cam An Bac	K-1	FKS-6	Single	6,626	485	Groundwater	0.5
	Cam Hay Tay	K-3	FKS-8	Single	6,978	526	Groundwater +Cam Ranh reservoir	1 8
Ninh Thuan	Phuoc hai	N-5	FNG-10	Group	29,715	2,149	Cai river at Lam Com Weir	14.5
	Phuoc Dinh,	N-6						
Binh Thuan	Muong Man	B-1	FBS-11	Single	7,378	557	Com Hang reservoir	4.7
	Nghi Duc	B-3	FBG-13	Group	52,241	3,730	La Nga river	4.5
	, Me Pu,	B-5						
	Suong Nhon	B-6						
	Da Kai	B-7						
	15 communes		9 systems		144,008	10,472		46.1

5.1.3 Water Sources

Water sources of the selected nine facilities for 15 communes in total are planned as follows.

(1) Groundwater

Groundwater development plan of three facilities for three communes based on the results of this study including test well drilling survey is described as follows.

a. P-4 (An My)

Since they have to develop fissure water in fault zone, it is not easy to exploit sufficient groundwater. Therefore, it is assumed that the safety yields of two wells which will be newly developed are 50% of the test well and the total withdrawal volume (691× (1+0.5×2) = 1,382m^3/day) is expected to cover the design water capacity: 1,198m^3/day for the water supply facility plan in An My Commune.

b. P-8 (Son Thanh Don)

It is possible to develop another well whose safety yield is the same as the test well. The total volume of them becomes 864m^3/day (432×2=864m^3/day) and can cover the design water capacity: 781m^3/day.

c. K-1 (Cam An Bac)

K-1 is also possible to set another well having the same yield as the test well. The total safety yield is expected to be 720m^3/day (360×2=720m^3/day) which can cover the design water capacity: 582m^3/day.

(2) Combination of Groundwater and Surface Water

a. K-3 (Cam Hay Tay)

Approximately 40 % of the test well's safety yield in K-3 is regarded as an additional yield by another well. Total volume of groundwater by the wells is 403m^3/day (288× (1+0.4) =403m^3/day). Meanwhile, it is expected to add 250 m^3/day of surface water from Cam Ranh Reservoir where is located about four kilometer west of K-3. Therefore, such a combination of groundwater and surface water can cover the design water capacity: 650m^3/day.

As to water quality of above-mentioned groundwater sources, all of them except K-1 satisfy the drinking water standards. An appropriate facility is needed to remove total iron and manganese for K-1.

(3) Surface Water

According to the alternative water source survey which was conducted to look for other water sources for the communes having inadequate groundwater sources, it is possible to develop surface water for five water supply facilities in 11 communes as described below.

a. P-2 (An Dinh)

Surface water of Dong Tron Reservoir located about five kilometers south-southwest from P-2 is taken to the water supply facility to cover water demand of P-2 commune. The intake water volume is 700m^3/day.

b. P-5,6,7 (Son Phuoc, Ea Cha Rang, Suoi Bac)

The water source of the water supply facility for P-5, 6 and 7 comes from the Ba River about four to ten kilometers away from their communes. The intake water volume is 1,100m^3/day.

c. N-5, 6 (Phuoc Hai, Phuoc Dinh)

The intake facility of the water supply facility for N-5 and 6 communes is located about ten kilometers away from the river mouth of the Cai River. The intake water volume is designed to be 2,900m^3/day.

d. B-1 (Muong Man)

The water source of the water supply facility for B-1 commune is Cam Hang Reservoir about five kilometers away from there. The intake water volume is designed to be 800m^3/day.

e. B-3, 5, 6, 7 (Nghi Duc, Me Pu, Sung Nhon, Da)

The intake facility of the water supply facility for B-3, 5, 6 and 7 communes is located about four kilometers away from the center of B-6. The intake water volume designed to be 5,000m^3/day.

As to water quality of above-mentioned surface water sources, turbidity, ferric oxide and coli form of them dissatisfy the drinking water standards because they are not groundwater but surface water. Water treatment facilities should be set into the water supply systems.

5.1.4 Design Conditions

(1) Design Water Capacity

The design capacity of all the facilities in each water supply system considered for FS has been determined based on "Design water capacity" of Chapter 3 and the result is presented in Table 5.1.2.

Table 5.1.2 Design Water Capacity for FS

System	(1) Daily average (m^3/d)	(2) Daily Max. (m^3/d)	(3) Intake water flow (m^3/d) (3) = ((2) x 10%)	(4) Hourly max. (m^3/hr.)
FPS-2	502	600	700	50
FPS-3	998	1,200	1,200	100
FPG-4	874	1000	1,100	83
FPS-5	651	800	800	67
FKS-6	485	600	600	50
FKS-8	526 *GW :403 *SW:123	600	650 GW:400 SW:250	50
FNG-10	2,149	2,600	2,900	217
FBS-11	557	700	800	58
FBG-13	3,730	4,500	5,000	375
9	10,472	12,600	13,750	

Note: * GW: Groundwater, SW: Surface Water
Capacity used to design following facility.
Daily Max.: Transmission pipeline and reservoir tank
Intake water flow: intake facility and treatment plant
Hourly max.: distribution pipeline

(2) Design Conditions and Criteria

1) Design raw water quality

The system is designed based on drinking water quality standards of Vietnam. According to the water quality analysis test, the design raw water quality before treatment is defined by each water source as shown in Table 5.1.3.

Table 5.1.3 Design Water Quality of Raw Water

Water source	System	Parameters for treatment			
		Total Iron (mg/L)	Manganese (mg/L)	Turbidity (NTU unit)	
				Max.	Average
Groundwater (A)	FPS-3, FPS-5, FKS-8	less than 0.5	less than 0.5	less than 2	less than 2
Groundwater (B)	FKS-6	0.7	0.6	less than 2	less than 2
Surface water (River)	FNG-10, FBG-13	less than 0.5	less than 0.5	300	100
	FPG-4	1.37	Less than 0.5	300	100
Surface water (Irrigation reservoir)	FKS-8,FBS-11	less than 0.5	less than 0.5	100	50
	FPS-2	1.77	Less tan 0.5	100	50
Drinking water standard of Vietnam * (Treated water quality)		0.5	0.5	2	2

Note: *: Drinking water hygienic standards (Standard No. TCVN5502:2003 Domestic supply water quality requirements)

2) Intake facility

a. Intake structure for groundwater

According to the design criteria* of Vietnam issued by MOC, in case of groundwater source, the spare well is applied for each system based on the water supply project size and the number of wells needed. (Note *: Ministry of Construction TCXDVN33:2006 Distribution system and facilities Design Criteria Hanoi 3/2006)

The test wells constructed by the study are used for production well. The new wells are required to construct depending on the conditions of the water demand. The drilling depth of new wells is determined considering the result of existing boring data and the electrical sounding. The length of screen is determined based on the result of the existing boring data and considering the inflow velocity.

b. Intake structure for river water

The configuration of the intake is constructed open channel system. The stop-log and bar screen is designed in the channel. In order to protect corrosion by the flowing water, a part of upstream and downstream of the intake is protected by gabion mat or concrete wall and intake base is constructed by piling for protection against scouring. Intake pump

In case of intake from river, submersible motor pump is proposed as intake pump due to protection against flood. The use of submersible motor pump is also proposed for deep well.

3) Transmission main

The pipe materials between intake, treatment plant and distribution reservoir is PVC pipe. However, in cases when the pipelines are to be laid for long distance and has big diameter or require laying along the national road, the pipe materials are Ductile Cast Iron Pipe (DCI) in order to protect external pressure on these pipe. These pipelines are applied for system in case of FPG-4, FNG-10 and FBG-13. For the part of pipelines crossing railway or river, pipe materials are Steel pipe with concrete pipe as protection.

4) Distribution facility

a. Capacity of distribution reservoir

The capacity needs to have storage for 6 hours of daily maximum water. It also facilitates the water supply for certain duration in case of emergency such as occurrence of facilities failure or in case of suspension of intake facilities and water treatment facilities due to some unavoidable reasons. Therefore, it is better to have some allowance in the capacity. Taking this into consideration, the retention time or capacity of each reservoir is to have storage for 8 hours of daily maximum water in the design.

b. Distribution pipeline

In principle, distribution system from the reservoir to service area is recommended by gravity flow. However, when the gravity flow system is impossible due to geological conditions, it uses booster pump under the pressure control system. The residual pressure at distribution pipe end is designed as more then 5m.

c. Determination of pipe diameter

The diameter of the distribution pipe network is calculated by “Hazen Williams” formula.

5) Monitoring method for pump operation

The monitoring is proposed considering fixed-line phone or mobile phone in normal cases.

However, in case of the systems located far from each other or for systems having big capacity, such as FPG-4, FNG-10 and FBG-13, the monitoring is proposed through wireless system type GRP (Global Packet Radio).

6) Water treatment plant

a. Process

In order to remove turbidity including silt and Iron as ferric, the process consists of function such as coagulation, sedimentation and filtration. The fabrication of each tank is in the form of RC structure. The structure of system FKS-8 is fabricated steel plate due to its small capacity.

b. Operation method

The treatment plant in system of FPS-2, FKS-6, FKS-8 and FBS-11 with relatively small capacity is proposed to be operated by manually. However, the filter operation for big capacity systems is designed by automatic washing system on the filter console for easy operation and maintenance.

c. Flocculation

The detention time is from 20 to 40 minutes for appropriate formation of the flocks. The mixing method of coagulation chemical is baffling type without mechanical and electrical equipments.

d. Sedimentation

In case of sedimentation tank, the detention time is from 3 to 5 hrs, in order to secure sufficient volume of sedimentation. The type of sedimentation is horizontal-flow. The length of the tank is more than 3 times the width of tank.

e. Filter

The type is rapid sand filter. The filter speed is from 120 to 150m/day. The washing is considered to be carried out through surface and back wash system. The type of FKS-6 is slow sand filter and filter speed is 5m/day.

f. Clear water tank

The capacity of clear water tank is more than 2 hrs of design filtration flow to secure water consumed in treatment process, such as washing water.

g. Transmission pump

Clear water is pumped up to distribution reservoir. The design operating time of transmission pump is considered as 20 hrs.

h. Chemical dosing

The coagulation chemicals are powdered PAC (Poly-Aluminum-Chloride). These chemicals are generally used for existing water supply systems also. It is proposed to use PAC. Lime as 70% $Ca(OH)_2$ is recommended as the chemical for pH control.

Table 5.1.4 shows the chemical dosing rate.

Table 5.1.4 Chemical Dosing

Chemical	Max. (mg/L) as 100NTU of Turbidity (Irrigation reservoir)	Max. (mg/L) as 300NTU of Turbidity(River)
PAC	12	17
Lime	4.6mg/L	6.5mg/L

i. Disinfection facility

As a result of consideration for some disinfection system, chlorine gas system, which is popularly used for rural areas, is proposed. Based on the experience of existing water treatment in the project area and raw water quality analysis, the chlorine dosing rate can be estimated. The chlorine dosing rate is shown in Table 5.1.5

Table 5.1.5 Chlorine Dosing Rate

Disinfection: Chlorine gas	Ave. (mg/L)	Max. (mg/L)
	1.5	3.0

Accurate dosing rate shall be determined on considering result of Break-point test before detailed design stage.

j. Discharge waste water

If treatment plant capacity is 5,000m^3/d as maximum capacity in the project; the volume of waste water is estimated to be less than 150m^3/d. However, considering the view point of environment, the waste water shall be treated by simple sedimentation lagoon. The lagoon is excavation without timbering and capacity has reserve for more than 4 hours. The waste water is separated into solid and liquid in the lagoon. The supernatant water is discharged back to river.

5.1.5 Preliminary Design

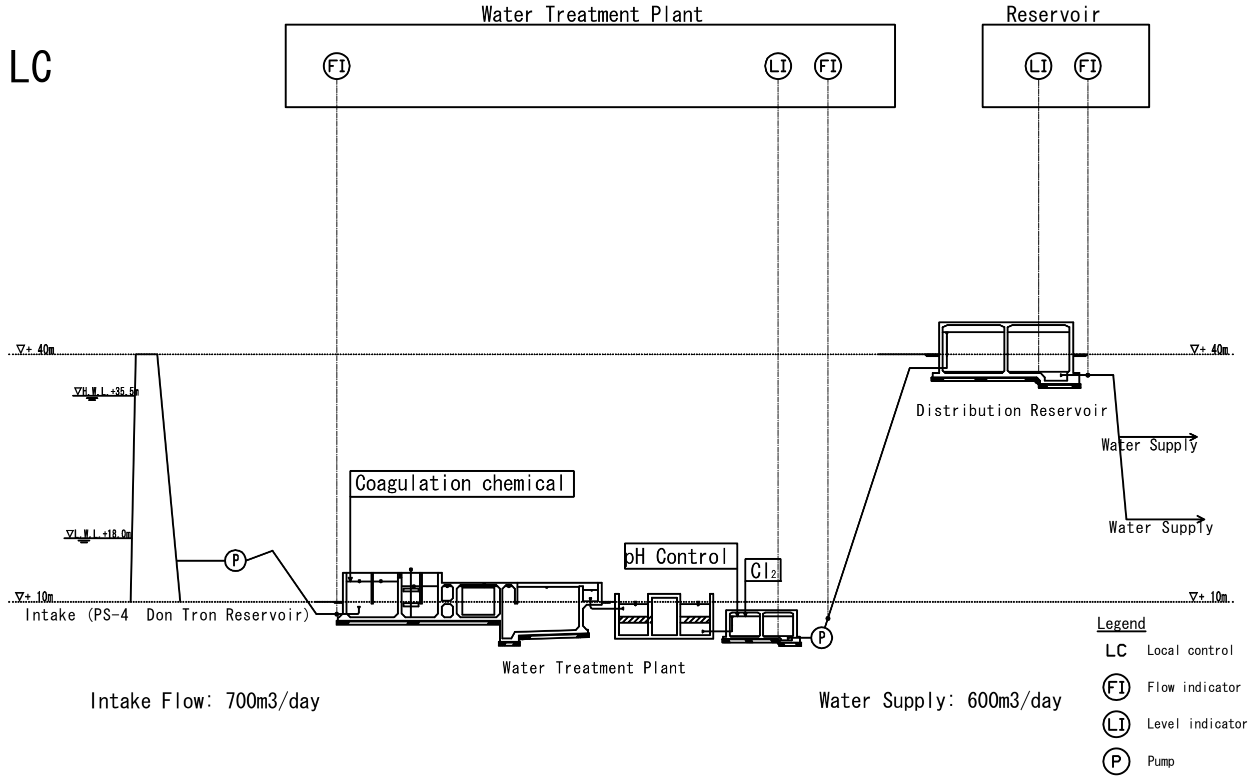
Based on the design conditions, the process flow chart and summarized facility plan are shown in Table 5.1.6 and Figure 5.1.1 to Figure 5.1.6.

Table 5.1.6 Summarized Facility Plan

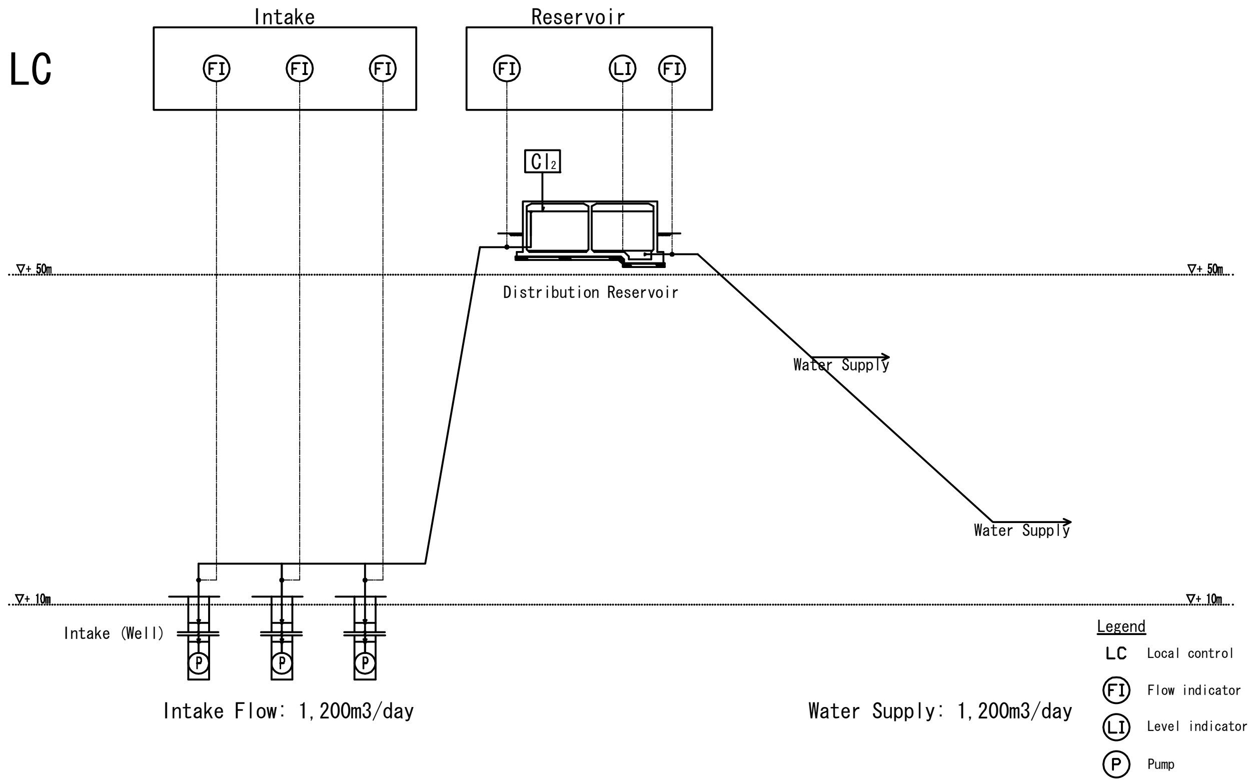
	FPS-2	FPS-3	FPG-4	FPS-5	FKS-6	FKS-8	FNG-10	FBS-11	FBG-13
1.Intake and pipeline									
Intake type	Reservoir	Well	Reservoir	Well	Well	Well and River	River	Reservoir	River
Intake pump	NA	4sets x SM*2 pumps	3 x SM	2 x SM	2 x SM	5 x SM	3 x SM	3 x SM	3 SM
Booster pump	CF pump*1	NA	NA	NA	NA	NA	NA	NA	NA
Pipe line (intake-reservoir, WTP-reservoir)	7.2km, PVC	1.3km, PVC	5.9km, PVC	2.5km, PVC	0.7km, PVC	11.7km, PVC	18.9km, DCI	6.1km, PVC	5.6km, DCI
2. Water treatment plant									
Pre-settling tank	NA	NA	NA	NA	NA	NA	NA	NA	2tanks (833m^3)
No. of flocculation	2 tanks (15.4m^3)	NA	2 (27.7m^3)	NA	NA	1(6.5m^3)	2 (60m^3)	2(18.7m^3)	2 (108m^3)
No. of sedimentation	2 tanks (105m3)	NA	2 (173m^3)	NA	NA	1 (12.6m^3)	2 (450m^3)	2 (122m^3)	2 (756m^3)
No. of filter	Rapid filter 2 tanks (5.8m^2)	NA	2 (120m^2)	NA	Slow filter 2 (120m^2)	2 (2.6m^2)	2 (24m^2)	2 (6.6m^2)	2 (120m^2)
No. of clear water tanks	2 tanks (60m^3)	NA	2（409m^3)	NA	Including in distribution	Including in distribution	Including in distribution	Including in distribution	2 (429m^3)
Chemical dosing	PAC, Lime, Chlorine	Chlorine	PAC, Lime, Chlorine	Chlorine	Chlorine	PAC, Lime, Chlorine	PAC, Lime, Chlorine	AC, Lime, Chlorine	PAC, Lime, Chlorine
3. distribution									
Pump	3setsx CF pump	NA	3 x CF	3 CF	NA	3 CF	4 CF	3 CF	3 CF
Tank	2 tanks (203m^3)	2 (405m^3)	2 (24m^3)	2 (270m^3)	2 (257m^3)	2 (254.4m^3)	2 (390m^3)	2 (315m^3)	2 (1152m^3)
Booster pump	NA	NA	NA	NA	NA	NA	3 CF	3 CF	3 CF
Pipeline	19.95km, PVC	12.7km, PVC	44km, PVC	15.4km PVC	8km, PVC	13.5km PVC	29km, PVC	7.4km, PVC	54km, PVC

Note: *1 CF pump: Centrifugal pump
*2 SM pump ：Submergible pump

FPS-2 (P-2)

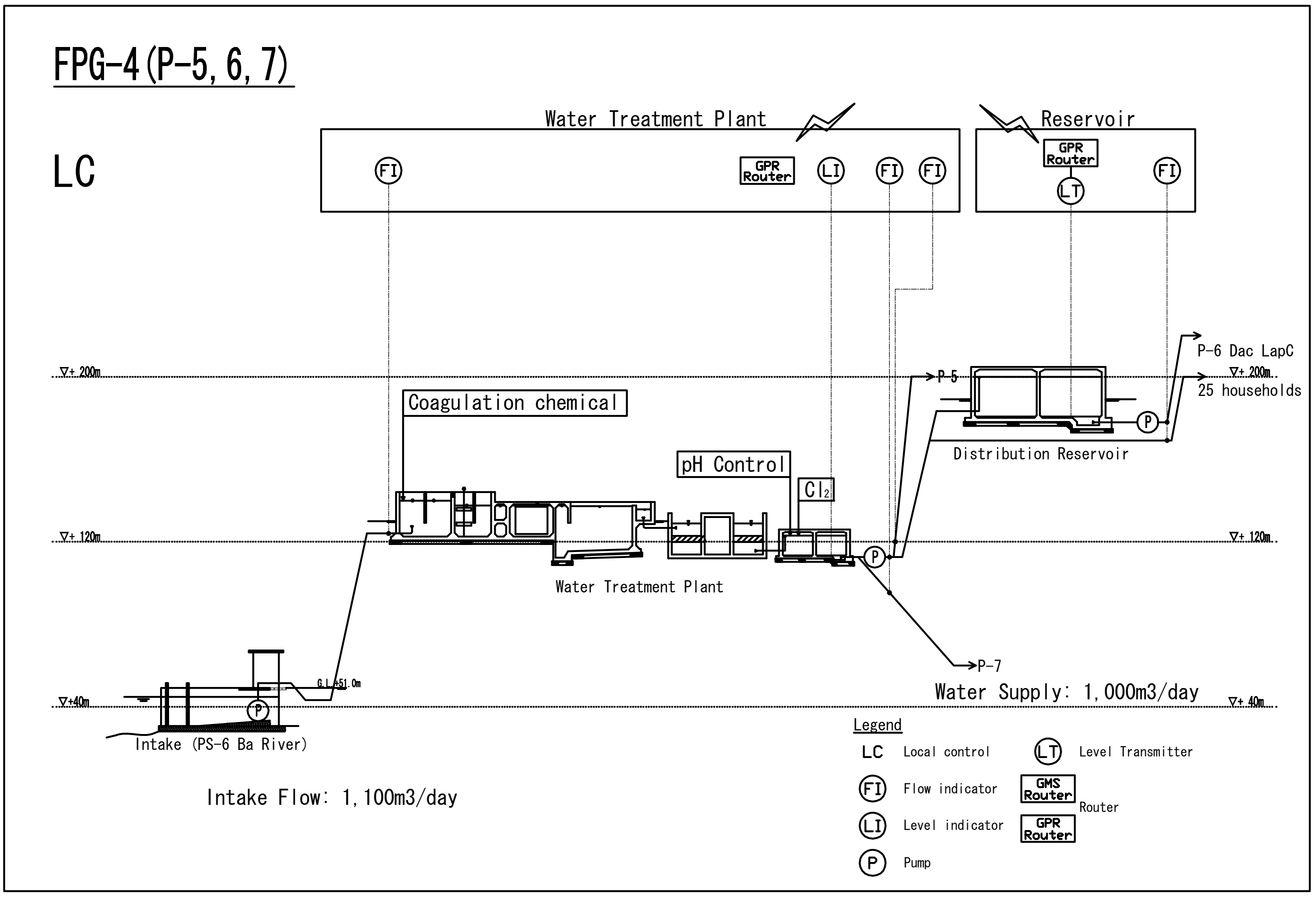


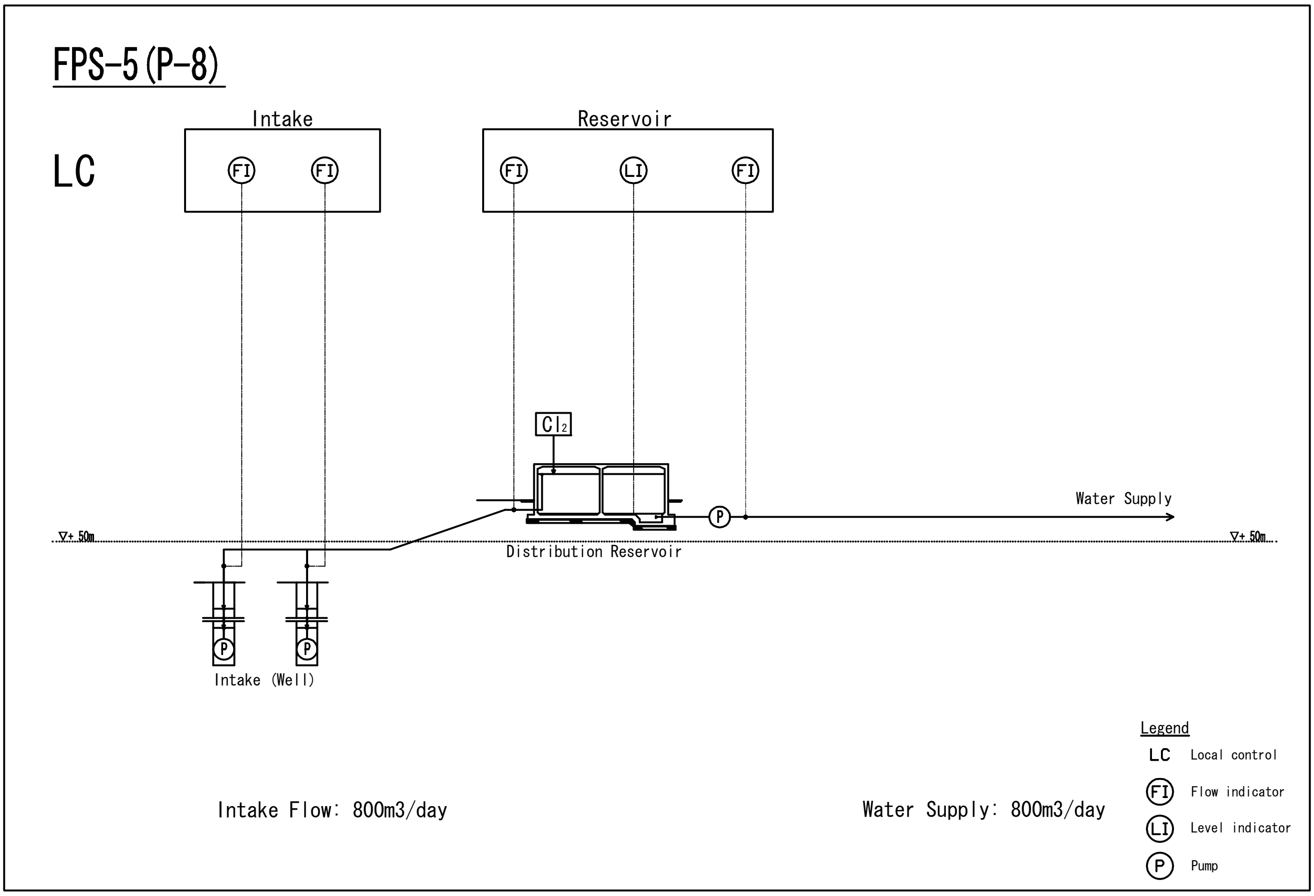
FPS-3 (P-4)



Preliminary

THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FPS-2, FPS-3)	Scale : Non	Figure. 5.1.1





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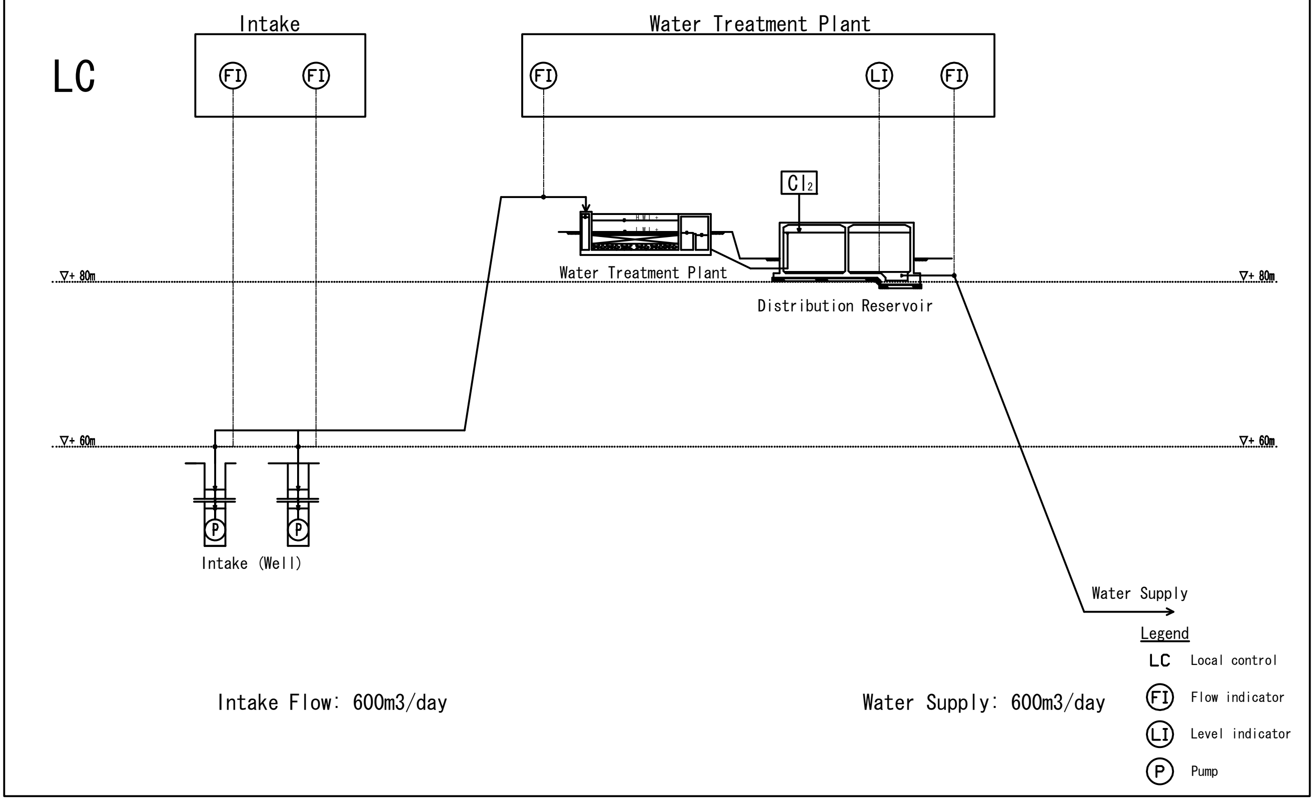
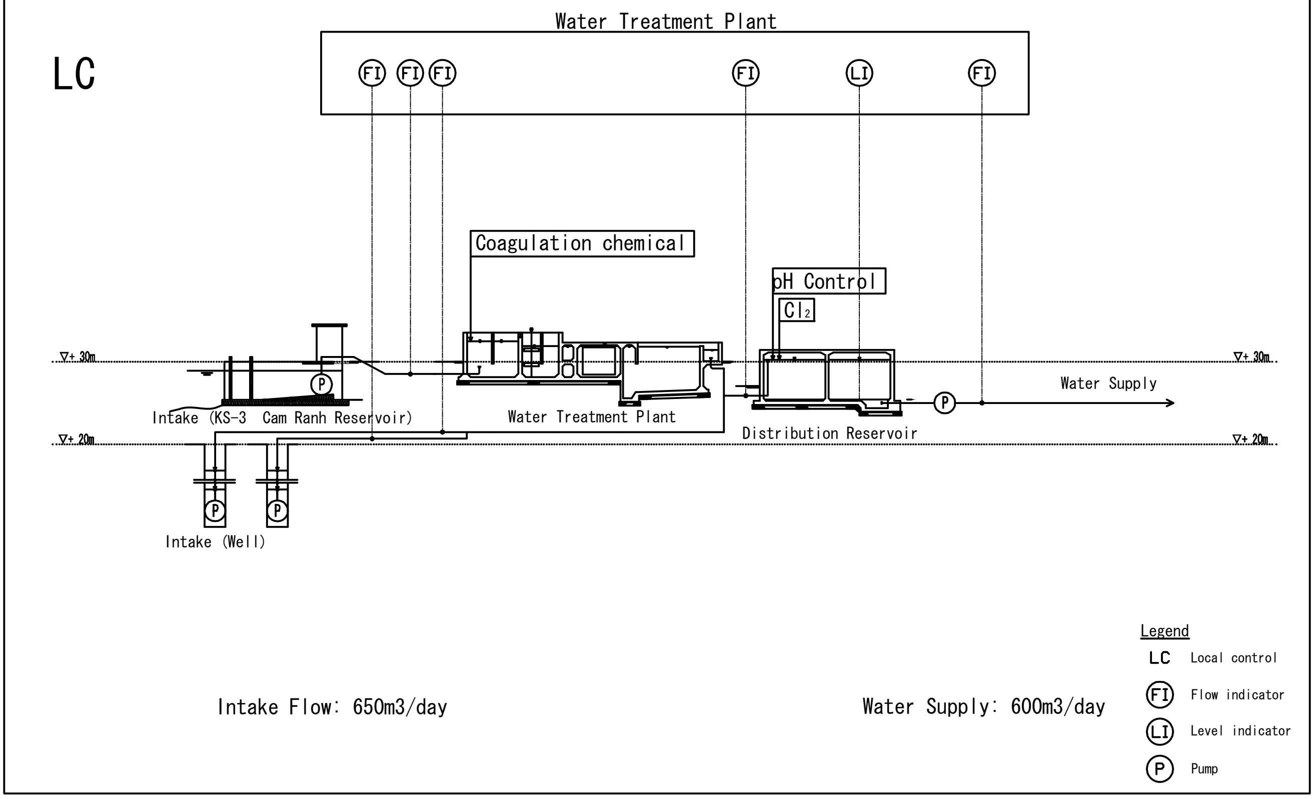
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FPG-4, FPS-5)	Scale : Non	Figure. 5.1.2

FKS-6 (K-1)



FKS-8 (K-3)



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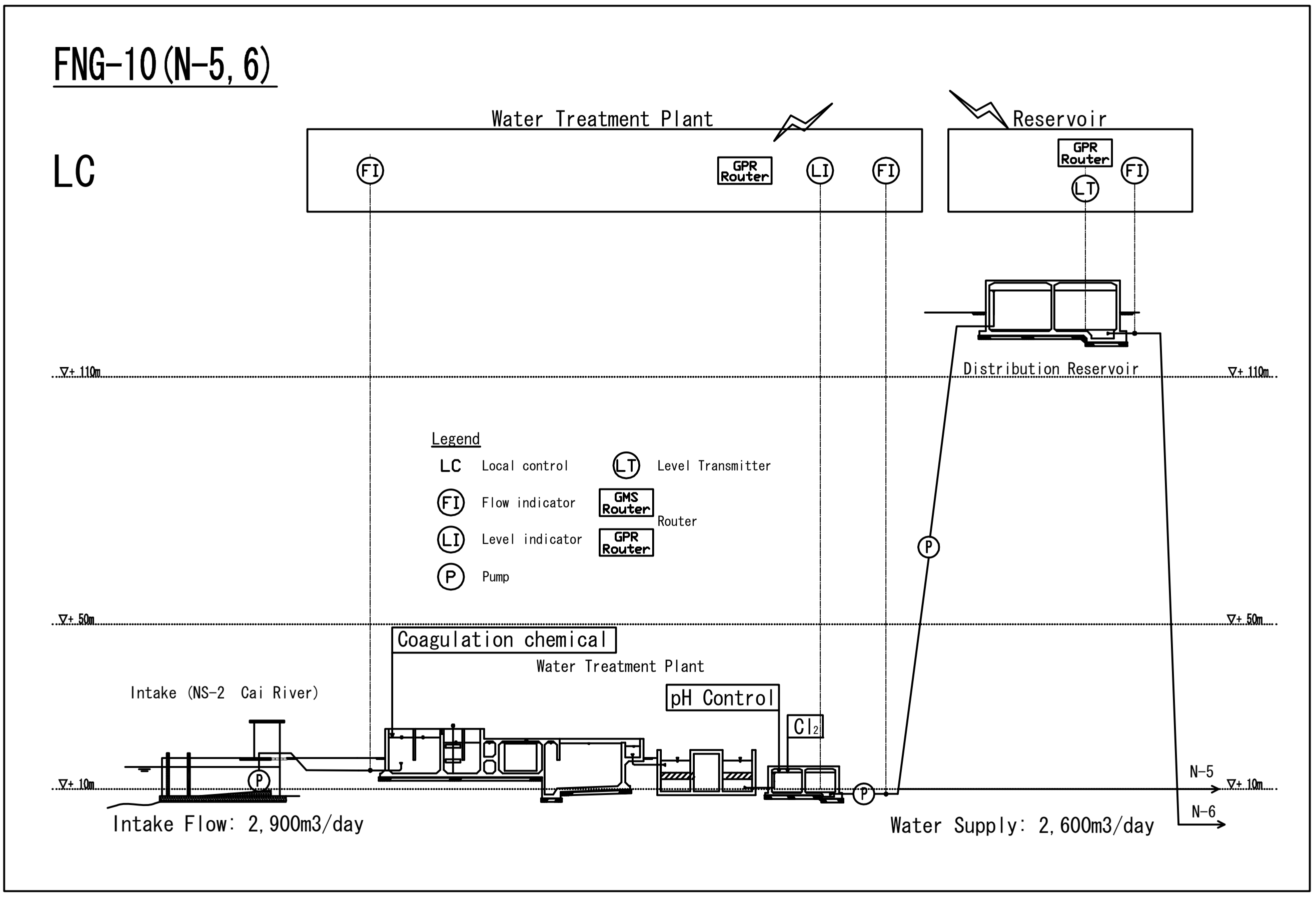
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FKS-6, FKS-8)	Scale : Non	Figure 5.1.3



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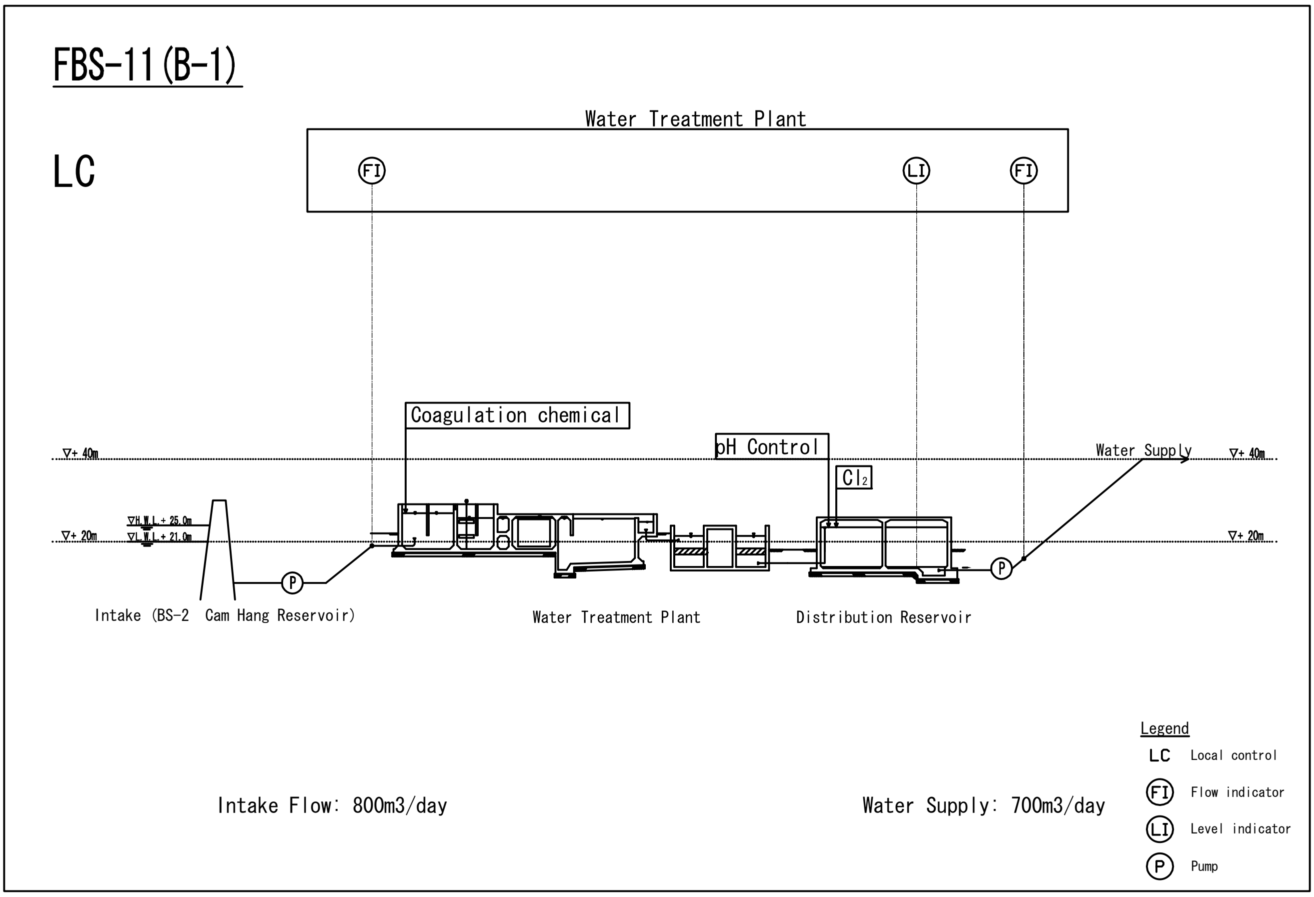
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FNG-10)	Scale : Non	Figure 5.1.4



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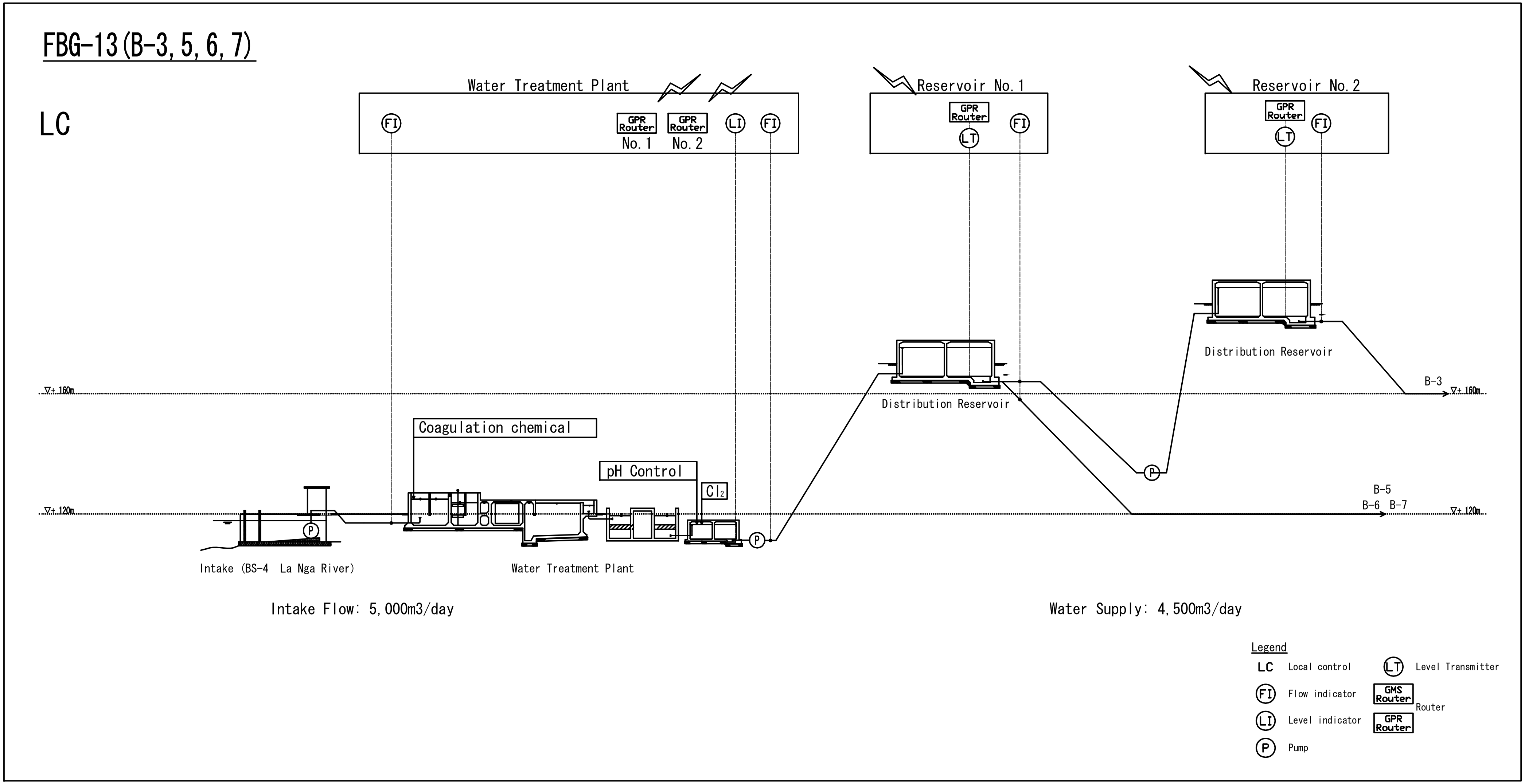
THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FBS-11)	Scale : Non	Figure 5.1.5



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THE STUDY ON GROUNDWATER DEVELOPMENT IN THE RURAL PROVINCES OF THE SOUTHERN COASTAL ZONE IN THE SOCIALIST REPUBLIC OF VIETNAM	Water Supply Process (FBG-13)	Scale : Non	Figure 5.1.6