Part II : Feasibility Study

12. PROJECT AREA

At the Steering Committee meeting held on July 19, 2006, the Master Plan for sustainable countermeasures for sedimentation issues in the Wonogiri reservoir was approved. Priority projects covering the urgent countermeasures proposed in the Master Plan was also approved, subject to a feasibility study in Phase II of the Study. The urgent countermeasure (the Project) comprises three projects; i) construction of sediment storage reservoir with new gates, ii) watershed conservation works in the Keduang River basin, and iii) procurement of dredger for periodic maintenance.

The Feasibility Study was commenced in July 2006 as Phase II of the Study. Total duration of the feasibility study was scheduled to be 8 months ending in February 2007. During the feasibility study, the field investigations; i) topographic survey for the sediment storage reservoir site, ii) geological investigation and laboratory tests, iii) land use survey in Keduang River basin, and iv) environmental impact assessment (EIA) of the Project, were carried out, entrusted to the local contractors and university.

The project area covers; i) the Wonogiri dam and reservoir (reservoir area of 90 km^2), ii) Keduang River basin (catchment area of 421 km^2), and iii) downstream reaches of the Bengawan Solo River from the Wonogiri dam to the confluence with the Madiun River.

13. PRESENT CONDITIONS OF THE PROJECT AREA FOR FEASIBILITY STUDY

13.1 Socio-Economic Condition

(1) General

The Keduang watershed is about 42,000 ha (the so called project area) from which 82 villages having about 36,900 ha were selected as the target villages for the Keduang Watershed Conservation Project as explained later. In this Section, the present socio-economic conditions are presented for 82 villages (the so called project proposed area).

(2) Population

The project proposed area is located within Wonogiri District, Central Java Province. It has 9 kecamatans, 82 villages and 517 Dusuns (hamlet). The total population was 306,522 in 2004. An annual population growth rate was 1.26% from 2003 to 2004. The population density was as high as 817/km^2 in 2004, which indicates a higher rate than that of Indonesian overall and Central Java.

It is recognized that there is a lot of migration out of the project proposed area and about 30% of the total out migration in Kabupaten Wonogiri. The people are migrating to find work in major cities, such as Jakarta, Surabaya, Surakarta, etc.

(3) Economic Profile

The agricultural sector in the project proposed area was estimated to contribute 52 % of GRDP in 2004 and about 44.59% of Kabupaten Wonogiri, followed by transportation/communication sector, services sector, manufacturing sector, etc. Based on the village profile, it was estimated that the agricultural sector absorbed about 49% of the total employment in the project proposed area in 2004.

The average of GRDP per capita in project proposed area was estimated to be 2.36 million Rp/year/person, or Rp 6,500 (or 0.7$) /day/person, which is a little below the average in Kabupaten Wonogiri (Rp. 2.6 million).

The productive labor force, which is supposed to be comprised of people over 20 years old, is estimated at about 183,000 persons or about 61.8% of the total population in project proposed area.

(4) Social Profile

About 98 % of the population in the project proposed area is Moslem, followed by Christians Catholics/Protestant (1.4%); Buddhism (0.4%); and Hind (0.0%). All of population is Javanese.

55 % of the population in the project proposed area has received an elementary education. About 15% of the population has graduated from Junior High School and remaining 11 % from tertiary education (Senior High School and University).

Health facilities are insufficient in the project proposed area. Every clinic has to provide services to 50,200 peoples, public health centre to 43,000 peoples and supporting public health center (SPHC) to 7,926 peoples. The numbers of medical care staff are also insufficient in the project area, as indicated by the ratio of the number of staff per 100 local peoples: 3.7 doctors, 2.63 health advisors, 1.59 nurses and 0.93 traditional nurses. The total number of public health service post (POSYANDU) is about 440 in the project area, playing an important role in provision of various health advice/services such as maintaining health of mother and child (during pregnancy until under 5 years old).

The local government (Kabupaten Wonogiri) uses a classification of the state of family welfare to specify poverty. Based on the classification, over 50% of people in the project proposed area is assessed as being in a poverty class.

People in the project area are not isolated. The rural road system is well developed. Public transportation is available in the area. Even, transportation necessary for agricultural produces is available, making it easy to reach markets in kabupaten capital or other cities. People in the project proposed area utilize water from spring (40%), shallow (16%), PDAM (5%) pump well (5%), hydrant (2%) for drinking water. Most of people (40.7%) in the project area have piped water. But shallow wells (70.2%) are the most commom source of water.

13.2 Soils and Topography

The soils distributed in the project area comprise Mediteran (44%), Latosol (34%), and Litosol (23%). Topographically, the project area is steep. 53% of the project area is classified into steepness with over 8% in gradient. The lands in the project area are deeply dissected by many tributaries, in which one of the reasons why the slope of land is often very steep.

13.3 Land Use

In the present feasibility study, the land use map prepared under the master plan study has been updated through a detailed ground truth survey. The land use features in the area are shown in comparison with the same in the Wonogiri watershed as follows: The proportion of settlement areas and paddy field in the Keduang watershed are larger than that in the Wonogiri watershed, while the upland in the Keduang watershed is smaller than the Wonogiri watershed. The proportion of other land use is almost same.

Table 27 Present Land Use in the Keduang Watershed and Wonogiri Watershed

Land Use Category	Keduang		Wonogiri	
	Area (ha)	Proportion(%)	Area (ha)	Proportion(%)
(1) Paddy Field	13,042	31	30,495	25
(2) Upland Field	8,491	20	39,761	32
(3) Home Settlement	11,064	26	26,764	22
-Upland field in settlement area	*(7,250)*	*(17)*	*(19,475)*	*(16)*
-Housing yard and garden	*(3,814)*	*(9)*	*(7,289)*	*(6)*
(4) Orchard/Plantation	3,707	9	12,867	10
(5) Dense forest	213	-	281	-
(6) State Forest*	5,027	12	12,779	10
-Dense forest	*(201)*	*(-)*	*(385)*	*(-)*
-Other land use (areas covered with young trees reforested and upland crops in State forest)	*(4,826)*	*(12)*	*(12,394)*	*(10)*
(7) Others (lakes, roads, rivers and other use)	337	1	1,384	1
Total	**41,883****	**100**	**124,331**	**100**

Note; *: Include lands under forest & upland field conditions, **: Difference of areas between M/P and F/S may occur owing to calculation error of GIS Source: JICA Study Team

The upland fields in the Keduang are mostly bench-terraced (about 70%) with different protection measures and maintenances and intensively used for seasonal crops. Most bench-terraced uplands have been deteriorated in the system of the lip and slope of terrace and collected drainage for soil erosion control. To a limited extent, there are upland fields with ridged-terraced and the remaining are uplands without terrace construction. Major crops are maize, cassava and beans, and cropping index is dependent on seasonal rainfall distribution. Upland fields are the most serious soil erosion sources in the project area.

Lands under home settlement include housing yards, home gardens and surrounding areas under upland field conditions. The home gardens are used intensively for agricultural purposes and provide an important source of farm income and are commonly planted with a variety of crops. Upland fields accommodated in this land category are used for seasonal crops production with limited soil conservation measures. Upland fields in home settlement are one of the main sources of soil erosion in the area and proper soil conservation measures are essential for the mitigation of the sedimentation problems in the Wonogiri Reservoir.

13.4 Estimate of Soil Loss from the Surface of the Keduang Watershed

Annual average soil loss form the Keduang watershed is estimated using the Universal Soil Loss Equation (USLE). Annual average soil loss form the Keduang watershed is calculated at 4.79 million tons/year.

13.5 Site Geology on the Proposed Sediment Storage Reservoir

(1) New Gates and Spillway

Geological investigation and laboratory testing for the proposed sediment storage reservoir was carried out from September to December, 2006. The base rock at the location of the new gates is moderately hard tuff breccia (CL class). The proposed construction site of the new spillway is underlain by lapilli tuff, volcanic breccia, sandy tuff and tuff breccia in descendant order and a relative soft sandy tuff layer is intercalated by tuff breccia as shown in Figure 29. Very stiff layers (SPTN Value>50), which is suitable for the foundation of spillway channel, will be encountered at a depth of 2.5-8 m.

(2) Closure Dike

At the closure dike site, very soft sediments in the reservoir (SPTN value <1) cover

near-horizontal strata of tuff breccia and volcanic breccia, which formed meandering and narrow valleys of Keduang River before construction of the dam as shown in Figure 30. Sediment deposits, reaching 21 m in thickness at the middle of the reservoir, consist mainly of clay. Relatively thin sand strata are sometimes intercalated in some portions of the sediments, which are expected to have been river traces. Tuff breccia underlying soft reservoir sediments is suitable for the foundation of closure dike except for surface zone.

(3) Overflow Dike

The proposed construction site of the overflow dike is underlain by near-horizontal strata of volcanic breccia, tuff breccia, tuff, and sandy tuff in descendant order. After removal of the surface residual soil including plant detritus etc, embankment dike and small structures of 2-3 m in height can be founded on the base rock.

14. STUDY ON OPERATION OF SEDIMENT STORAGE RESERVOIR

14.1 Flood Routing of Sediment Storage Reservoir

Flood routing simulation on the sediment storage reservoir was carried out to verify the flood control function against several design floods by means of joint operation of both two reservoirs. In view of safety reservoir operation against extreme flood events, it would be fairly desirable to have little difference of reservoir water levels between the sediment storage reservoir and Wonogiri main reservoir.

As the result of the flood routine simulation, it is determined that:

- Length of overflow dike is 250 m in view of cost effectiveness,
- Design discharge of new spillway structure and gates is 1,140 m^3/sec at the spillway design discharge of 5,100 m^3/s and 1,270 m^3/s at Probable Maximum Flood (PMF) of 9,600m^3/s.

Flood routine simulation against the PMF shows that both maximum water levels at the sediment storage reservoir and the main reservoir are below the Extra Flood Water Level 139.1 m. Thus the Wonogiri reservoir is judged to be safe against PMF because the original freeboard against overtopping the dam is secured.

14.2 Turbidity Analysis for Downstream Reaches from Wonogiri Dam

While the sediment sluicing/flushing system is in operation, plenty of highly turbid water will be released to downstream reaches for a certain duration. Turbidity analysis for downstream reaches was carried out aimed at examination of suitable operations to minimize the impacts to the downstream reaches. The turbidity analysis result in case of wet year (1998/1999) is shown in Figure 28. As a result, it is predicted that:

i) In the river stretch between the Wonogiri dam and the Colo weir, peak of SS concentration would be almost the same as those observed at the beginning of wet season in the current condition. The frequency of occurrence of higher SS concentration would increase.

ii) In the river stretch between Jurug (52 km downstream of the dam) and Tangen (97 km downstream of the dam), peak of SS concentration would be influenced by the sediment releasing operation when the inflow from tributaries is small. In such condition, peak SS concentration will increase.

iii) Evaluation in terms of the Stress Index (SI) shows that the maximum SI value by sediment release would be slightly smaller than the estimated monthly maximum in 1990-2004 at two stations above. It is evaluated that the sediment release would cause

no serious impacts to the downstream river environments.

15. FEASIBILITY DESIGN OF SEDIMENT STORAGE RESERVOIR

15.1 Design Condition and Criteria

The sediment storage reservoir was a recommended countermeasure in master plan study. Merits of this countermeasure are to; i) refrain from gathering sediment and garbage at and around the intake of Wonogiri reservoir, ii) make it possible to conduct sediment flushing/sluicing without lowering the water level of the main reservoir, resulting in few effects on the water use of storage capacity of the Wonogiri reservoir. Further, iii) as most of the facilities can be accommodated within the PBS premise, impact on the environment and social consideration will be small.

The sediment storage reservoir consists of the new spillway, closure dike and overflow dike. Facilities layout plans of are shown in Figures 32 to 35. Design condition and criteria is shown in Table 28. Required structures and quantities are shown in Table 29.

Table 28 Design Condition and Criteria

Structure	Item	Condition and Criteria
(1)New Spillway	Type	Front overflow weir
	Elevation of Inlet	EL.127.0 m (Design deposits level)
	Design discharge	Q=1,270 m^3/s (at PMF)
	Water level	EL.139.1 m
(2) Closure Dike	Crest elevation	EL.138.3 m（Surcharge water level）
	Elevation of foundation	EL.127.0 m（Design sediment deposits level）
	Width of crest	W=10.0 m
(3) Overflow Dike	Crest height	Crest Height EL.136.0m
	Design discharge	Q=550 m^3/s (at SHFD) Sediment storage reservoir: EL. 138.1 m Main reservoir: EL. 137.8 m.

Source: JICA Study Team

Table 29 Main Composition and Quantity of Sediment Storage System

Composition	Item	Quantity
(1) New Spillway	Type	Front overflow weir
	Gate	Radial gate 170t, B7.5m×h12.6m×2nos
	Length	708.79 m
	- Training Channel	162.55 m
	- Chute Channel	452.24 m
	- Energy dissipater	94.00 m
	Width of Spillway	15.00 m
	Concrete Volume	93,320 m^3
	Excavation	389,240 m^3
	Backfill	134,970 m^3
(2) Closure Dike	Type	Earth fill dike with W-wall
	Length of Dike	658 m
	Height of Dike	11.3m
	Embankment volume	167,800 m^3
	Steel sheet pile	4,450 t
(3) Overflow Dike	Type	Dike with Concrete fixed Weir
	Length of the Weir	250 m
	Height of Weir	2.0 m
	Excavation	29,750 m^3
	Concrete	11,000 m^3
	Earth filling	61,600 m^2

Source: JICA Study Team

15.2 New Gate and Spillway

The new spillway has functions of sediment flushing/sluicing and flood control. The new spillway with a length of 715 m will be constructed on the right abutment of Wonogiri dam. The slope of spillway chute channel is as gentle as 1/108 due to topography. A front overflow weir type is adopted for the inlet where the elevation is set at EL. 127.0 m, as the sediment deposit level is set at EL. 127.0 m. Two radial gates (B7.5 m x 2 nos. = 15.0 m) will be installed on the inlet. A ski jump type energy dissipater is adopted at the plunge pool of the spillway. Design discharge at PMF is 1,270 m^3/sec.

15.3 Closure Dike

The closure dike will be constructed to separate the Keduang River from main reservoir at DFWL (EL. 138.3 m). The earth-fill cofferdam type is adopted for the closure to secure spoil bank of excavated materials for spillway construction. The length of the dike is 660 m. The top elevation of the dike is set at EL. 138.3 m (SWL). The width of closure dike is 10 m. The closure dike is reinforced by double-wall sheet piles to ensure safety against scouring of the dike.

15.4 Overflow Dike

The overflow dike will be constructed to divert the water from the sediment storage reservoir to the Wonogiri main reservoir for water storage during the wet season. The crest elevation is set at NHWL 136.0 m with a length of 250 m. The concrete fixed weir type is adopted because it is maintenance free.

16. FEASIBILITY DESIGN OF WATERSHED CONSERVATION IN KEDUANG CATCHMENT

16.1 Basic Concepts and Approach

The Keduang Watershed Conservation Project is formulated in principle based on the same approaches and basic concepts applied to the Master Plan Study.

The approaches and basic concepts were made from considering the three aspects that are summarized by the following: Firstly water/soil conservation will be carried out by formation/upgrading of terraces and their related structures with vegetative measures. Secondly soil conservation based agricultural measures consisting of improved soil/agricultural technology and agro-forestry development will be introduced. Thirdly there will be the socio-institution aspects comprising the introduction of the community based development, creation of an implementation committee to guarantee the transparency of all the project activities, and consideration of the proper incentive to the beneficiaries.

16.2 Formulation of Watershed Conservation Plan

(1) Demarcation of Target Area for Watershed Conservation Plan

In the Feasibility Study, land use map prepared under the Master Plan Study has been updated through the detail ground truth survey. Based on the new map, the target areas for the Keduang watershed conservation project have been screened and selected by the same methodology applied to the Master Plan Study. The total target areas of 11,120 ha are demarcated as shown in Table 27, covering 82 villages in total.

(2) Proposed Watershed Conservation Plan

The proposed Keduang watershed conservation plan is formulated in principle based on

the methodology applied to the Master Plan Study. The proposed basic watershed conservation measures consist of three components.

First proposed component is implementation of soil conservation measures consisting of i) the bench terrace improvement and construction works, ii) improvement of waterway and drop structures, iii) improvement of side ditch in the settlement area, iv) stabilization for lip and terrace riser by vegetative measures, and v) hedge row at fringe of housing yard.

Second proposed component is introduction of improved farming technology and agro-forestry development by introducing perennial estate and fruit and trees.

Third proposed one is the support program for promoting water conservation project consisting of i) support programs for community development such as village action plan for soil conservation, establishment of an implementation committee, guidance for the village grant fund and education program, ii) support program for soil and water conservation measures such as farmer and farmer groups empowerment package program, package program for operation and implementation of conservation measures, and field staff empowerment program, and iii) support programs for land management and agricultural promotion measures such as the technology development program, demonstration program , pilot demonstration field of tree crops/trees and farmer and farmer group training program, farming support programs, palawija seed production program and strengthening of logistic support for extension activities.

(3) Project Works

The project works for the Keduang watershed conservation project are shown in the Table 28 below. The project works will be performed by introduction of farmer's participation system. Works such as cutting/filling, excavation, masonry and vegetation planting will be shared by the Government and beneficiary farmers in the project. All the materials necessary for the project such as farm inputs and construction materials are will be purchased by the Government.

Table 31 Project Works

item	(unit)	Total Project Work	item	(unit)	Total Project Work
		(1,000)			(1,000)
1. Land preparation			**2. Side diches (for housing yard)**		
1) Terracing			1) Side ditch		
(1) Cutting and filling	m^3	4,673	(1) Stone material	m^3	20
2) Waterway and drop			(2) Excavation work	m^3	29
(1) stone material	m^3	44	(3) Masonry work	m^3	18
(2) Excavation work	m^3	62	2) Headgerow		
(3) Masonry work	m^3	40	(1) Shrub, for hedger row	nr.	4,467
3) Lip and rizer, planting			(2) planting work, hedge row	m2	558
(1) Seedling, grass for lip	nr.	83,858	**3. Agro-forestry and annual crops**		
(2) Seedling, shrub for lip	nr.	5,032	1) Agro-forestry and annual crops	Ls	
(3) Seedling, grass, for rizer	nr.	115,938	**4. Support program**		
(4) Planting work, for lip	m	25,258	1) Support programs	Ls	
(5) Planting work, for rizer	m2	23,188			

Source: JICA Study Team

(4) Reduction of Annual Soil Loss

Soil loss in the "without project condition" and "with project condition" are calculated by using by the same methodology of USLE applied in the Master Plan Study.

The annual average soil loss produced in the entire Keduang watershed is estimated as

shown in the following table.

Table 32 Reduction of Annual Average Soil Loss in Keduang Watershed

Land Categories	Annual Average Soil Loss (1,000 ton)		Reduction of Annual Average Soil Loss (1,000 tons)
	Present condition	After implementation	
(1)Paddy field	11	11	0
(2)Settlement area			
(i) Home settlement area	957	849	108
(ii) Settlement area under upland field condition	1,698	803	895
(3)Upland field	1,465	751	714
(4)Orchard and Plantation	363	363	0
(5)Forest	11	11	0
(6)State forest land			
(i) forest land	5	5	0
(ii) Other land use (areas covered with young trees reforested and upland crops in State forest)	264	176*	88
(7)Others (lakes, roads, rivers and other use)	4	4	0
Total	**4,778**	**2,973**	**1,805**

Note: In this feasibility study, a detailed land use survey was carried out for the Keduang River basin. The accuracy of current land use has been increased compared to that in the master plan stage. Therefore, the estimated average soil loss in this table is different from that in Table 21 which was estimated in the master plan stage.
Remarks; *:This annual average soil loss is estimated under the land use condition in state forest area that 90% of the other land use in the state forest land will be reforested and the remaining 10% is assumed to be lost during the growing period due to pest/diseases and other risks.
Source: JICA Study Team

The annual average soil loss is estimated at 4,778 thousand tons in the without project condition and 2,973 thousand tons in the with project condition. It may be concluded from the above table that 38% of the present total annual average soil loss is trapped or reduced after implementation of the project.

17. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The result of the EIA indicated that there will be several environmental impacts evaluated as negative and significant. They are; i) impacts on air quality, noise and vibration exceeding environmental standard level due to construction works, especially excavation for spillway, and ii) impacts on local traffic and transportation due to transportation of excavated materials. These impacts will occur only during construction works and therefore the period of impact is limited. The area of impact is limited to only near villages. Accordingly, these impacts are judged not to cause serious problem but can be mitigated by proper socialization and appropriate compensation.

However, the following impacts have not been completely clarified; i) impacts on fish species downstream of the Bengawan Solo River due to the change of water quality during the releasing of sediment, and ii) impacts on the downstream river environment due to garbage release from the sediment storage reservoir. Regarding these impact, it is necessary to carry out monitoring of the river environment during the release of sediment, focusing on water quality and sanitary condition of the Bengawan Solo River, so that the optimal operation of the sediment storage reservoir can be established for minimizing the environmental impacts. In conclusion, it can be assumed that with appropriate management and monitoring activities, the Project is valid from the environmental point

of view. Table 30 below summarizes the evaluation result of environmental impacts.

Table 33 Evaluation Result of Environmental Impact of the Project

Environmental Components \ Project Activity		Project Stage									
		Pre-Construction		Construction						Operation & Maintenance	
		Socialization of the Project	Procurement of land required for project facilities	Mobilization and Establishment of base camp	Site clearance for project facilities	Construction work, especially excavation for work	Transportation of excavated materials	Recruitment as construction worker	Watershed management in Keduang river basin	Sluicing of sediment deposits from the reservoir	Periodic maintenance dredging
Physical Components	Groundwater					-TP					
	Air Quality					-P	-P				-TP
	Noise and Vibration					-P	-P				
	Water Quality and River Discharge									-TP	
Biological Components	Terrestrial Flora and Fauna				-TP				+TP		
	Aquatic Organisms									-TP	
	Protected Species										
Socio-economic Components	Land Acquisition and Resettlement										
	People's Unrest	-TP			-TP					-TP	
	Income and Livelihood Change				-TP			+P		-TP	
	Economic Activities of Downstream Areas*									-TP	
	Local Traffic and Transportation			-TP			-P				
	Public Health			-TP		-TP	-TP			-TP	

Note) -P: Negative and significant, -TP: Negative but not significant, +P: Positive and significant, +TP: Positive but not significant

*: This items include: 1) sand mining, 2) inland navigation, 3) water use by PDAM and irrigation, and 5) fishery,

Source: JICA Study Team

18. COST ESTIMATE

The total cost of the Project is estimated as US$ 76.3 million excluding tax. Implementation of the Project will require a total period of 4.5 years from the commencement of the detailed engineering for structural measures. The construction works will require 2.5 years for the sediment storage reservoir, one year for procurement of dredger and 4 years for watershed conservation.

Table 34 Summary of Project Cost

Item	Cost (US$ thousand)
1. Construction Cost	
a. Sediment storage reservoir	40,318
b. Watershed conservation in Keduang River basin	11,017
c. Procurement of a dredger	3,579
2. Consulting Services	5,491
3. Land Acquisition	69
4. Government Administration	691
5. Contingencies	15,112
Total	**76,277**

Source: JICA Study Team

Table 35 Overall Implementation Schedule of the Project

Major Work Item	Year						
	2007	2008	2009	2010	2011	2012	2013
1 Financial Arrangement							
2 Sediment Storage Reservoir							
Detailed Design							
PQ and Tender							
Construction							
3 Watershed Conservation in Keduan Catchment							
Socialization and Planning							
Implementation							
Supporting Program							
4 Procurement of Dredger							
Design							
Manufacturing							
Installation							

Source: JICA Study Team

19. PROJECT EVALUATION

The economic viability of the Project is evaluated in terms of the economic internal rate of return (EIRR). The project benefit is defined as the difference of the profit between the future "with project" and "without project" conditions. The project benefits consist of irrigation, hydro-power and watershed benefits. It is assumed that water intake to provide for irrigation and hydro-power can not function by the year of 2022 in the "without project condition". The benefit from the watershed conservation project is defined as incremental production of agricultural crops from land improvement and from fruit tree planting in the bench terrace area. The EIRR of the project is 16.9%. The evaluation of the Project shows that it will be economically feasible.

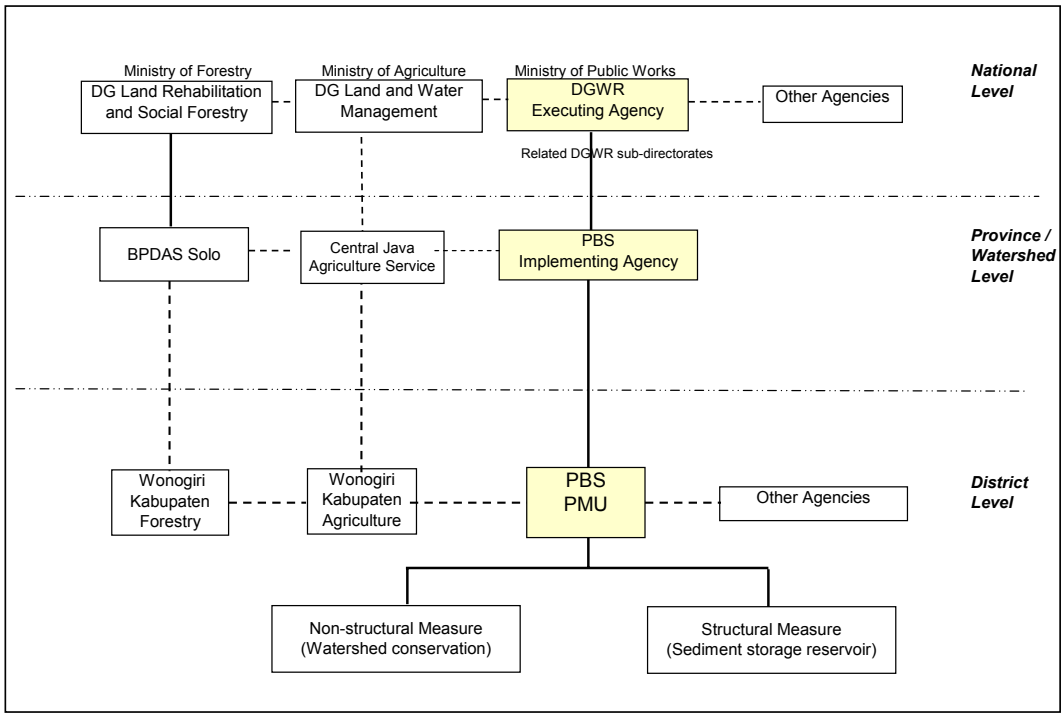
20. PROJECT IMPLEMENTATION

20.1 Executing and Implementation Agencies

The executing agency at national level for implementing the Project will be the Directorate General of Water Resources (DGWR) of the Ministry of Public Works (MPW). At the site level, the Bengawan Solo River Basin Development Project (PBS) will act as an implementing agency.

20.2 Project Management Organization

The DGWR as the executing agency would be assisted by related agencies. This would be done in accordance with the Memorandum of Understanding (MOU). At the outset, the MOU should be signed by Directorate General level agencies from the Ministries of Forestry and Agriculture and DGWR agreeing to overall project management by DGWR/PBS on terms specified in the MOU. This agreement would then be made known to Central Java Province and Kabupaten Wonogiri forestry, agriculture and public works services. The diagram as shown in Figure 36 below outlines the proposed project management organization down to district level to implement the Project.



Source: JICA Study Team

Figure 36 Project Management Organization

The DGWR would establish a Project Management Unit (PMU) at the district level. The PMU will be under the direct control of PBS as the implementing agency and would be responsible for the day-to-day supervision and coordination of the two constituent projects; construction of sediment storage reservoir and watershed conservation works.

20.3 Organization Set-up for Watershed Conservation Activities at Field and Village Levels

Communities at village level should take a responsible role for the watershed conservation activities. As practitioners, the communities are essential from the planning stage and through the collaborative activities of all stakeholders. The implementation arrangement at field and village levels should be initiated with an "Implementation Committee" to be established at village level. The implementation committee is responsible for; i) supervision of all the conservation works and activities in village, ii) coordination with PMU and agencies concerned, and iii) operation of the village grant fund. The member of the implementation committee should be selected with transparency at the beginning of the implementation under the guidance and support of PMU.

As shown in Figure 37, formation and empowerment of beneficiaries or practitioner groups, Kelompok Konservasi Tanah dan Air (K2TA; Soil and Water Conservation Farmer Group) will also be established at the field level. Such formation and introduction empowerment guidance is to be put in place about a year prior to the implementation of conservation works. The K2TA is responsible for; i) terracing, ii) agro-forestry development, iii) monitoring and evaluation, and iv) supporting program for community development.

21. OPERATION AND MAINTENANCE PLAN

21.1 Organizational Reform for Balai Besar Wilayah Sungai

The Ministry of Public Works (MPW) decided to consolidate several water resources management implementing organizations, including river basin development projects, flood control and coastal protection projects and Jasa Tirta Public Corporations (PJTs), into one water resources managing institution for each major river basin. Such institutions were named as Balai Besar Wilayah Sungai (River Basin Office). Similar institutions for smaller less developed river basins would be known as Balai Wilayah Sungai. The organization and management of Balai Besar Wilayah Sungai is set out in MPW Regulation No.12/PRT/M/2006.

Figure 38 shows the organizational structure of Balai Besar Wilayah Sungai. As shown, TIUs at national and provincial levels can provide assistance to provincial and kabupaten water resources services, if requested. In addition, provincial and kabupaten water resources services can undertake tasks (if they agree) for national and provincial governments respectively, for which they would be compensated financially.

In the Bengawan Solo River basin, the current organization structure of PBS was changed and the Balai Besar Wilayah Sungai Bengawan Solo was established in January 2007. The organization structure of Balai Besar Wilayah Sungai Bengawan Solo is shown in Figure 39.

21.2 Operation Works of Sediment Storage Reservoir

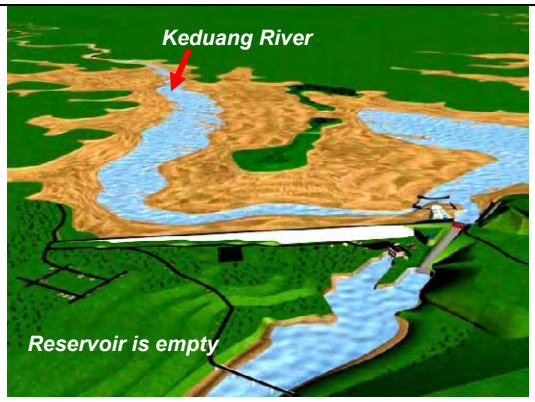
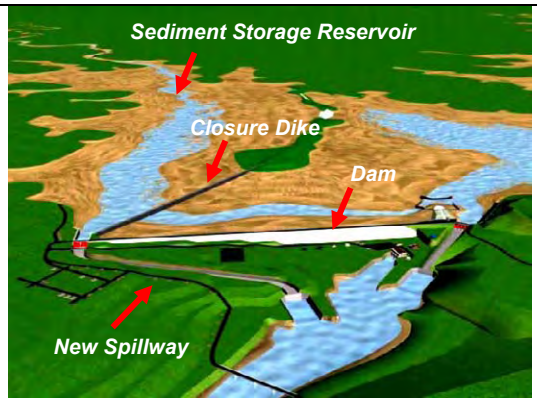
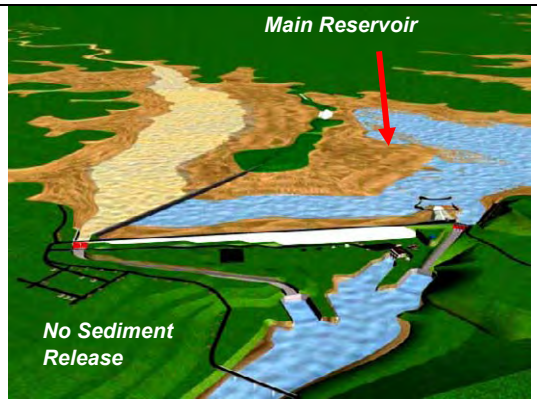
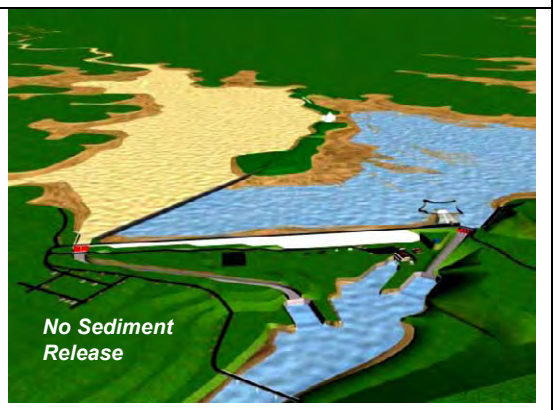
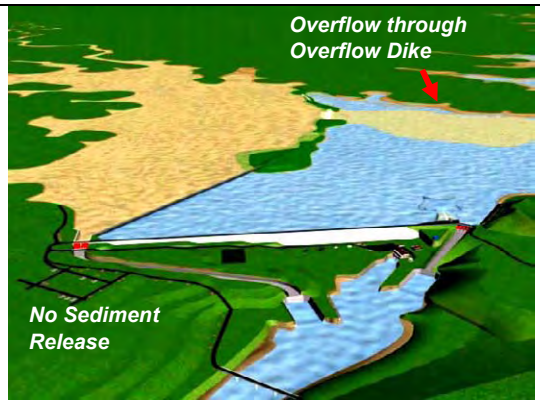
The Wonogiri reservoir will be divided into two reservoirs by the closure dike; a sediment reservoir and the Wonogiri main reservoir. The storage capacity of the sediment storage reservoir is small at around 11 million m^3 at the CWL 135.3 m. Both reservoirs are to be operated independently. The current reservoir operation rule of the Wonogiri dam is unchanged and thus will be applied to the operation of Wonogiri main reservoir as summarized below:

Table 36 Reservoir Operation Rule

Definition	Wonogiri main Reservoir	Sediment Storage Reservoir
1. Period (Article 3) Flood Non-flood Recovery	 December 01 to April 15 May 01 to November 30 April 16 to April 30	 December 01 to April 15 May 01 to November 30 April 16 to April 30
2. Flood discharge (Article 2)	Inflow discharge exceeding 400 m^3/s	Inflow discharge exceeding 400 m^3/s
3. Water Level in Flood Period (Article 13)	Maintain CWL 135.3 m, Flood control capacity (El. 135.3 m – El. 138.3 m)	Maintain CWL 135.3 m, Flood control capacity (El. 135.3 m – El. 138.3 m)
4. Water Level in Non-Flood Period (Article 13)	Draw down of El. 127.0 m – El. 136.0 m, water use capacity for irrigation and hydropower	Draw down of El. 127.0 m – El. 136.0 m, water use capacity to the main reservoir thru the connecting conduit

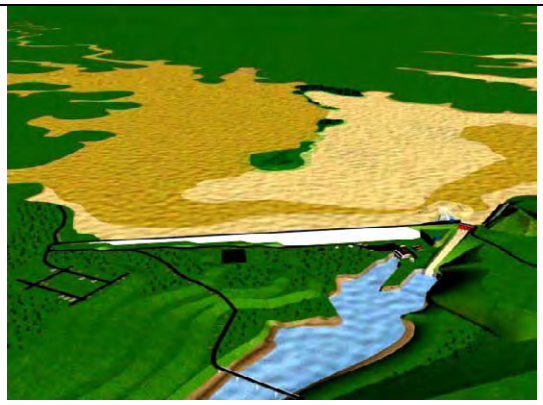
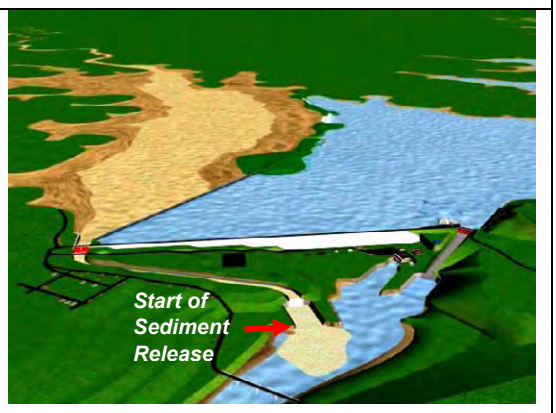
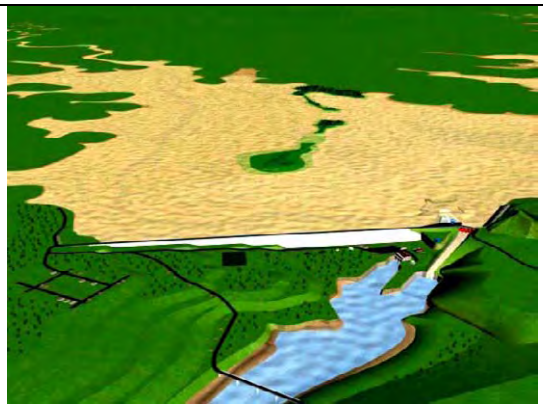
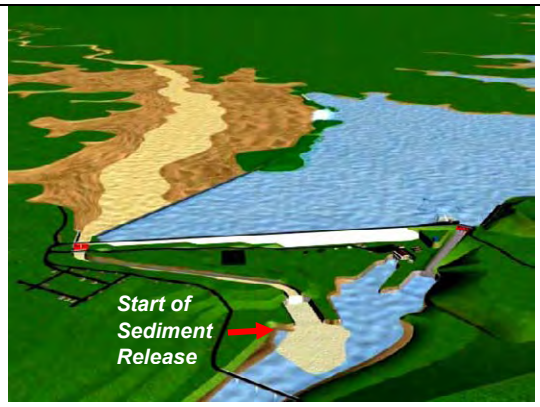
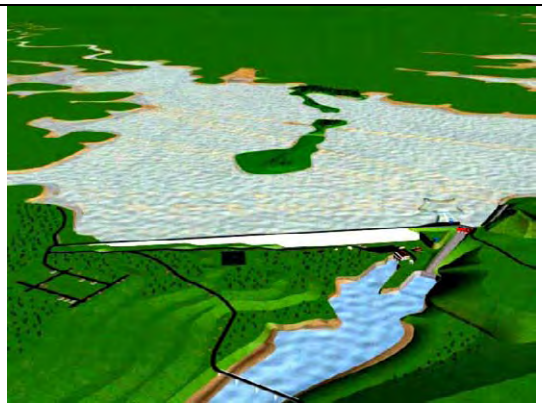
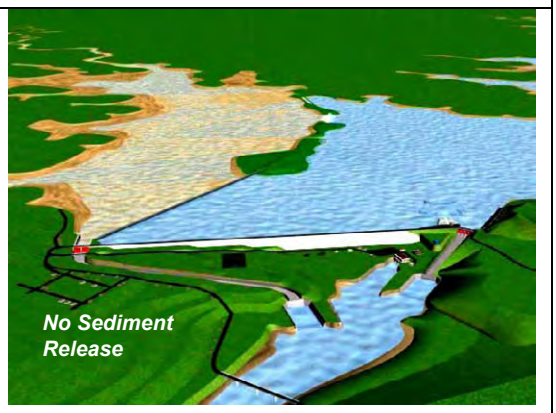
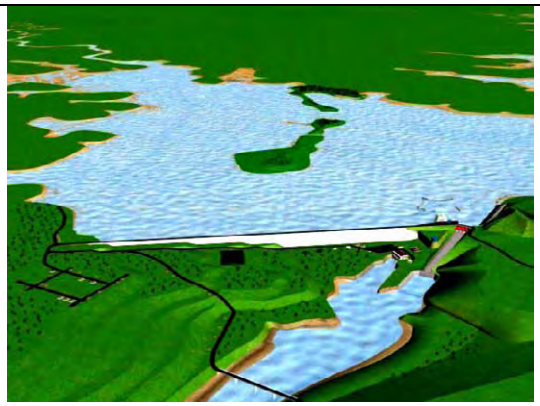
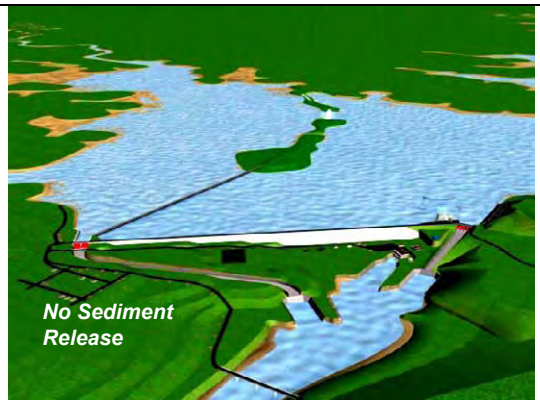
Note: Article Number is from Manual for Operation and Maintenance, February 1984
Source: JICA Study Team

Figure 37 below illustrates typical operation of the sediment storage reservoir and Wonogiri main reservoir compared to the current operation of Wonogiri reservoir.

Month	Present Operation of Wonogiri Reservoir	Operation of Sediment Storage reservoir
Oct. *End of Dry Season*		
Nov. *Beginning of Wet Season*		
Dec.		
Jan.		

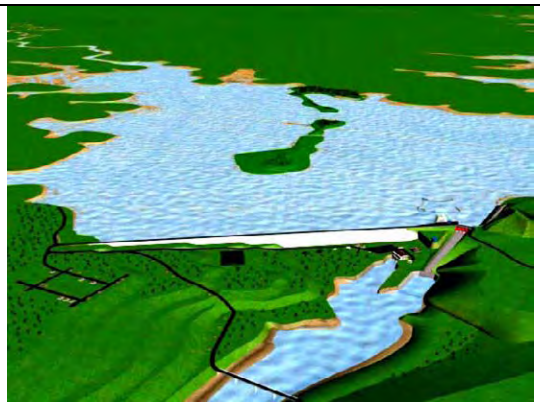
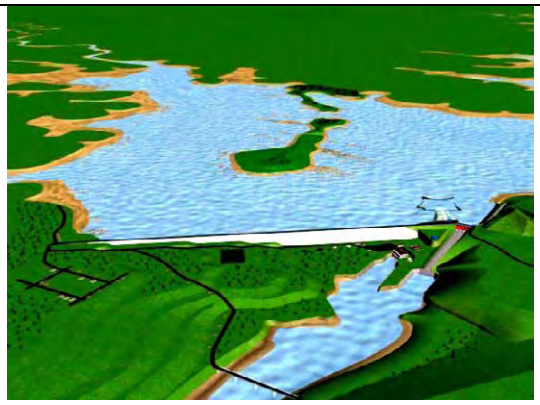
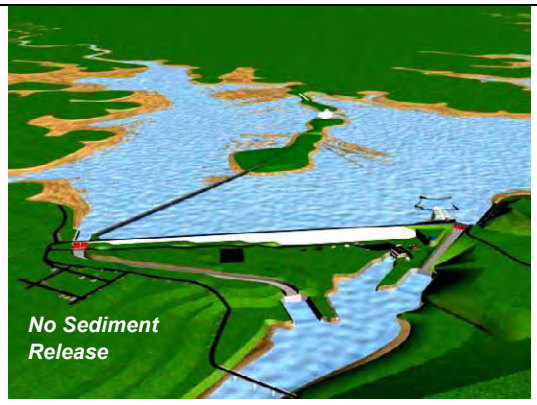
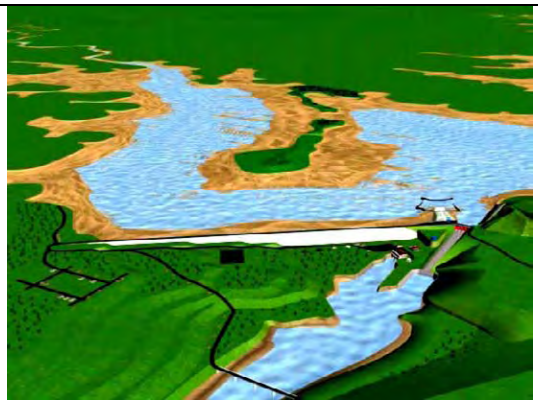
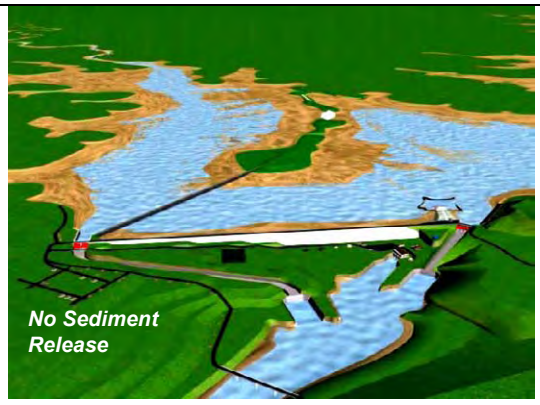
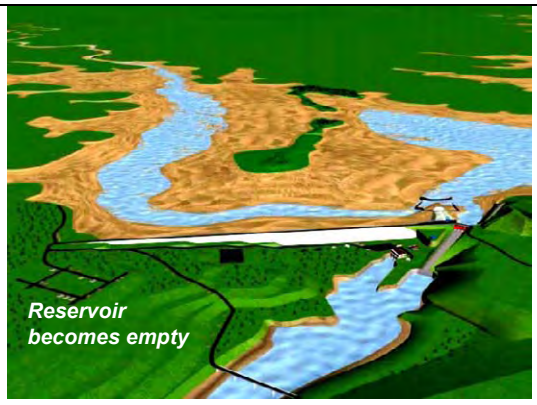
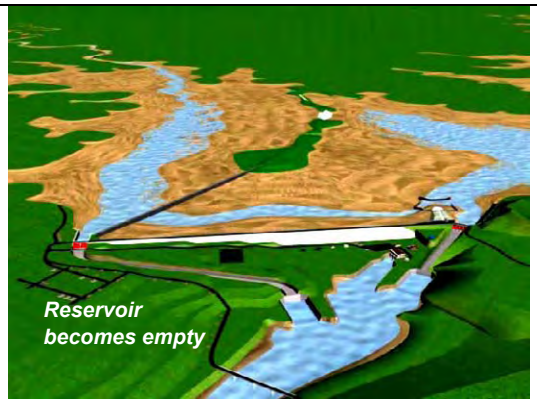
Source: JICA Study Team

Figure 40 Illustration of Monthly Operation of Current Wonogiri Reservoir and Sediment Storage Reservoir (1/3)

Month	Present Operation of Wonogiri Reservoir	Operation of Sediment Storage reservoir
Feb.		
Mar.		
Apr. *End of Wet Season*		
May. *Beginning of Dry Season*		

Source: JICA Study Team

Figure 40 Illustration of Monthly Operation of Current Wonogiri Reservoir and Sediment Storage Reservoir (2/3)

Month	Present Operation of Wonogiri Reservoir	Operation of Sediment Storage reservoir
Jun.		
Jul.		
Aug.		
Sep. End of Dry Season		

Source: JICA Study Team

Figure 40 Illustration of Monthly Operation of Current Wonogiri Reservoir and Sediment Storage Reservoir (3/3)

22. INSTITUTIONAL STRENGTHENING FOR WATERSHED MANAGEMENT

The inequity of benefits between upstream and downstream of the Wonogiri dam has long been a source of dissatisfaction for the upstream communities and has been discussed many times in workshops and other forums. But to date, nothing has been implemented. A procedure has been suggested to transfer funds from downstream beneficiaries to farmers upstream. The scheme would distribute collected money to upstream villages and rely on village or sub village level agencies to distribute equitably to watershed conservation works and, if appropriate, individual farmers, although this is less likely. The money should be used as far as possible on formally planned soil conservation measures which are currently unfunded.

Preliminary study on the scheme requirement and possible sequence of actions was carried out with several suggestions on possible agencies for actions. It would involve up to 250,000 farmers as well as government agencies in forestry, agriculture and finance in up to seven kabupatens in Central Java, and in Central Java Province itself, and NGOs. Therefore implementation will require a significant amount of further design work, costing and consultation. It is recommended that further investigation should be undertaken by those with a thorough knowledge of upstream and downstream farmers and community organizations.

A pilot implementation of a Wonogiri Watershed Conservation Coordination Committee (WC3) is recommended. This comes from an increasing need for improved coordination of; i) watershed management in upstream catchments like that of Wonogiri dam, and ii) watershed management in the framework of water resources management in river basins generally. This problem is being addressed nationally by the GN-KPA movement. The purpose of WC3 would be to coordinate the planning, implementation, monitoring and evaluation of all watershed management in the Wonogiri watershed. This would be done using the responsible local government agencies and assisted by stakeholders representing the main interests in the area or who can provide technical advice and support.

It is recommended that Dinas Agriculture and Sub-Dinas Forestry in Kebpaten Wonogiri should be strengthened by increasing available funds, staff and equipment, and by putting more emphasis on field staff training. Central Government should supply them with sufficient funds to allow adequate capacity building.

23. TECHNOLOGY TRANSFER

Technology transfer is one of the main objectives of this Study. Technology transfer has been conducted by means of on-the-job training, joint meetings and workshop/seminar during the course of the Study. Joint meetings with counterpart personnel were started in November 2004 during the first field works in Indonesia. In total meetings were held 19 times during the first and the second field works.

The GIS training seminars for Wonogiri GIS database developed by the Study Team were conducted twice during the periods from November 28, 2005 to December 2, 2005 and December 11-14, 2006. Workshops have been held four times for incorporating the various demands and needs of communities and stakeholders into the planning process and for empowering the stakeholders.

24. CONCLUSIONS AND RECOMMENDATIONS

24.1 Conclusions

It may be concluded from both the Master Plan Study and Feasibility Study that:

i) The Wonogiri multipurpose dam completed in 1981 is the sole large reservoir on the Bengawan Solo River. The Wonogiri dam has contributed much to social welfare in the basin and has greatly benefited the country in terms of both regional and national economic developments.

ii) The Wonogiri reservoir has been suffering from sediment deposits and garbage at the intake that provides water for power generation and irrigation water supply. The Keduang River that enters the reservoir just upstream of the dam is the primary cause of the current sediment-related problems. The sediment and garbage from the Keduang River have deposited massive quantities of sediment in the forebay adjacent to the dam. The reservoir sedimentation survey in 2006 showed sediment deposition depth of approximately 20 m in maximum in the forebay. It was predicted that in the near future the forebay area would be completely filled with sediment deposits due to continuing sediment inflow from the Keduang River. Establishment of sustainable sediment management system in the reservoir has become crucial.

iii) The main source of the sediment was identified as the soil erosion from the cultivated upland fields and settlement areas within the Wonogiri dam watershed. The volume of annual soil erosion is estimated at around 93% of the annual sediment inflow into the reservoir (annual average 3.2 million m^3 in 1993-2004). Such high soil erosion rate might be caused as a consequence of the poor land management and agricultural development that local farmers had to adopt, due to poverty and the large farming population, in the topographically critical areas on steeper mountain slopes. Out of sub-watersheds, the Keduang watershed produces the highest soil loss.

iv) Urgent countermeasures (the Project) were proposed in the Master Plan. The Project aims at securing the proper function of the intake with provision of combination of structural and non-structural measures to cope with the sediment inflow into the reservoir from the Keduang River. The watershed conservation in the Keduang sub-watershed as the non-structural measure will mitigate sediment yield, thereby reducing the sediment inflow from its watershed. The sediment storage reservoir as the structural measure will release the sediment inflow from the Keduang River to the downstream reach through the new spillway; thereby the sedimentation at the intake will be drastically decreased.

v) Most of the sediment and garbage inflow from the Keduang River will be completely retained in the sediment storage reservoir. The existing intake will become completely relieved from the current sediment-related issues. The retained sediment and garbage in the sediment storage reservoir will be easily released from the new spillway.

vi) Implementation of the watershed conservation will be carried out by means of community-based management, encouraging the local farmers to increase farm income and thereby to improve the quality of life by improving their current land use practices. This comprehensive approach for the watershed conservation will much contribute to poverty alleviation providing stabilization of the farmers' economic situation.

vii) The Project is technically sound and economically feasible, showing high economic

viability with an EIRR 16.4%. The Project will make sustainable operation of the Wonogiri reservoir possible and contribute to stabilization of the livelihood of people in the local communities as well as improvement of social welfare from the national economic points of view.

24.2 Recommendations

Recommendations from both the Master Plan Study and Feasibility Study are summarized below:

i) The Wonogiri dam is one of the lifelines of the national infrastructures. The economic value of the Wonogiri dam for water storage is undoubtedly very high. As stipulated in the Scope of Works, it was agreed between DGWR and JICA that the goals of the Study is to implement the proposed countermeasures to secure the long-term ability of the Wonogiri reservoir. Because of the urgent needs to cope with the sediment inflow, the Project should be implemented as early as possible to keep the intake functioning properly.

ii) In the highly populated Java Island, the reservoir is a precious water source that would be very difficult to replace when once it is completely filled with sediments. From a realistic view points, it would be difficult to develop a new reservoir. It is strongly recommended that technical approaches and solutions provided under the Study should be applied to solve similar sedimentation problems in the existing reservoirs in Indonesia.

25. STEERING COMMITTEE MEETING ON MAY 30, 2007

The Steering Committee Meeting was held in Jakarta on May 30, 2007 to discuss the content of the Draft Final Report as well as the comment at the JICA Advisory Committee Meeting held at the JICA headquarters in Tokyo on May 24, 2007.

The Advisory Committee organized by JICA provides technical guidance and advices to the JICA Study at milestone stages of the Study. The Advisory Committee advised to confirm the intension of the Government of Indonesia to implement the watershed conservation project for the Keduang River basin as the urgent plan. This was due to the consideration that as the reduced portion of the sediment inflow from the Keduang River basin by the watershed conservation works could be released to the downstream reach through the new spillway in the sediment storage reservoir, watershed conservation works for another river basin might be given the higher priority in view of effectiveness of investment.

As a result of discussion at the Steering Committee Meeting, the Government of Indonesia decided to implement the watershed conservation project for the Keduang River basin as the urgent plan based on the following reasons:

i) For the implementation of the watershed conservation project as proposed by JICA Study, coordination and integration with the ongoing community-based programs in the Wonogiri dam catchment, mainly Keduang River basin, under GNKPA (i.e. coordination programs among Ministry of Public Works, Ministry of Forestry and Ministry of Agriculture in accordance with the MOU) would be very important.

ii) Flood control is the main function of the Wonogiri reservoir. In view of mitigation of flood and sediment inflow, watershed conservation and management for the Keduang River basin would be ranked as top priority.

iii) The sediment storage reservoir would become check dam or sand pocket in future without proper operation. If the sediment storage reservoir is filled with sediment deposits, almost all of the sediment inflow from the Keduang River would overflow into the main Wonogiri reservoir. To avoid this critical situation, proper operation of sediment storage reservoir and watershed conservation in the Keduang River basin would be very important.

Tables

Table 8 Evaluation Results of Alternatives for Sediment Deposits and Garbage at Intake

Alternative	Construction Cost	Technical Applicability	Environmental and Social Impacts
1) Modification of intake	$3,160,000	Not sustainable solution because sedimentation will continue year by year over the inlet elevation at the intake.	Irrigation water supply and power generation shall be suspended due to temporary stoppage of the intake during construction.
2) Relocation of intake	$8,800,000	Sedimentation will occur at the new intake, although sedimentation rate is small compare to that at the existing intake. Periodic dredging at the new intake would be required in the future.	Irrigation water supply and power generation shall be suspended due to the connection work with the existing intake. Large disposal area will be necessary. Magnitude of impact will be larger due to
3) Garbage trapping structure at intake	$3,670,000	Blocking of the intake will be solved by periodical garbage removal. Sediment deposits at the intake shall be solved by other structural measures.	Water supply shall be suspended due to temporary stoppage of the intake during construction.
4) Garbage trapping structure in the Keduang River	$1,370,000	Periodical removal of the trapped garbage will be required. Sediment inflow flow Keduang River continues to enter into the reservoir without being trapped.	Positive impact will occur. Degradation of water quality in the reservoir will be mitigated owing to trapping of garbage from the Keduang River.
5) Dredging by hydro-suction method	$2,875,000	There are operational constraints depending on the reservoir water level because of necessity of water head difference.	Possible negative impact on water quality of downstream Bengawan Solo River due to release of dredged sediment.
6) Hydraulic dredging	$4,456,700	Most common measures for removing sediment deposits in reservoir. Huge spoil bank areas are required.	Relatively less impact because of lots of worldwide experiences provided with spoil bank areas.

Source: JICA Study Team

Table 10 Comparison of Alternatives for Sediment Inflow from Keduang River

Alternative	Construction Cost, Unit Cost and Released Sediment	Technical Applicability	Environmental and Social Impacts
1) Keduang River sediment bypass	$82,940,000 $10.7/m^3 476,000 m^3/year	Technically applicable. But due to small discharge capacity of bypass tunnel (50 m^3/sec) flood inflow from the Keduang River with high sediment concentration cannot be fully diverted. Considerable volume of sediment flow as well as garbage from the Keduang River enters the Wonogiri reservoir. Modification of intake or periodic dredging at the intake will be indispensable in view of sustainable operation of the reservoir. Huge construction cost will be required.	Serious negative impacts with larger magnitude will occur. Huge disposal areas of excavated materials (around 270,000 m^3) spawned by tunneling are necessary. It might be very difficult to secure spoil bank areas near the dam area. Impacts during construction works include topographic and geologic changes, waste of excavated materials, drawdown of groundwater level and inconvenience of well water use, air quality, noise ,unrest of local people, some conflicts/opposition from local people, etc.
2) Sediment sluicing by new gates	$35,630,000 $4.7/m^3 509,000 m^3/year	Technically applicable. Sluicing operation will be applicable at the beginning of wet season only when the water level is the lowest. If the gates are fully opened, considerable amount of garbage would be released to the downstream reach. However, release flow from the gates shall be controlled not to exceed 400 m^3/s according to the current reservoir operation rule. There is a risk that the reservoir water level can not reach NHWL at the end of wet season when much water is used for sluicing. More than half of the sediment inflow from the Keduang River will be deposited in the reservoir. Periodic maintenance dredging at the intake is necessary.	Highly turbid water from the Keduang River will be released. The released turbid water might cause negative impacts on aquatic organisms, especially fish. At the worse, high concentration of SS might cause a respiratory impediment of fishes. Huge disposal areas of excavated materials (around 800,000 m^3) are necessary. It might be very difficult to secure spoil bank areas near the dam area. Impacts during construction works include topographic and geologic changes, waste of excavated materials, air quality and noise, etc.
3) Sediment storage reservoir with new gates in the reservoir	$47,090,000 $3.8/m^3 1,280,000 m^3/year	Technically applicable. Sediment sluicing (sediment routing) and flushing contemplates to effectively utilize the water power (sediment transport capacity) of a natural river with less running cost. As the sediment storage reservoir can be operated independently from the Wonogiri main reservoir, the current operation rule can be applied for sediment releasing operation. After the reservoir water level reaches NHWL, sediment releasing operation will be started without using the stored water in the main reservoir.	Highly turbid water from the Keduang River will be released through the new gates. The released turbid water might cause negative impacts on aquatic organisms, especially fish. At the worse, high concentration of SS might cause a respiratory impediment of fishes. Huge disposal areas of excavated materials (around 800,000 m^3) are necessary. It might be very difficult to secure spoil bank areas near the dam area. Impacts during construction works include topographic and geologic changes, waste of excavated materials, air quality and noise, etc.

Note: Released sediment volume is estimated from the reservoir sedimentation simulation analysis applying the inflow of hydrological wet year 1998/99. Unit cost for sediment releasing is estimated based on the construction cost and required O&M cost for 50 years.

Source: JICA Study Team

Table 11 Evaluation Results of Alternatives for Sediment Inflow from Other Tributaries

Alternative	Construction Cost	Technical Applicability	Environmental and Social Impacts
1) Sediment storage dam for sediment removal	$225,460,000	Technically applicable but not sustainable solution in view of practicability. Around 83 units of storage dam would be necessary for trapping the annual sediment deposition volume of 2.0 million m^3 from other tributaries. Continuous sediment removal works for 2.0 million m^3 will be necessary every year. It would not be practical and applicable.	Huge disposal areas are necessary for periodic sediment removal works. It would be impossible to secure annually spoil bank areas for spoiling 2.0 million m^3 of sediments near the reservoir.
2) Hydraulic dredging in reservoir	$44,567,000	Technically applicable but not sustainable solution in view of practicability.10 dredgers would be necessary to dispose the annual sediment deposition volume of 2.0 million m^3. Huge running cost and spoil bank areas are required. It will not be practical and applicable.	Huge disposal areas are necessary for dredging works. It would be impossible to secure annually spoil bank areas for disposing 2.0 million m^3 of dredged sediments near the reservoir.
3) Dry excavation in reservoir	$287,990,000	In view of sustainable and economical measure, dry excavation deems not applicable. So many equipments such as bulldozers, crawler loaders and dump trucks would be necessary to excavate the annual sediment deposition volume of 2.0 million m^3. Huge running cost and spoil bank areas are required.	Huge disposal areas are necessary for periodic sediment removal works. It would be impossible to secure annually spoil bank areas for spoiling 2.0 million m^3 of sediments near the reservoir. Possible impacts on air quality, noise and transportation during the excavation works.
4) Managing of sediment within the reservoir by water releasing from the intake	$0	By use of the maximum intake discharge (70 m^3/s) for power generation, previously deposited sediments are moved toward the dead zone of the reservoir, thereby maintaining or increasing the effective capacity of the reservoir. However, reliability of this method will be considered to be low, because of likely blocking of the intake due to garbage.	Significant amount of water must be released through power generation, and there is a risk that the reservoir water level can not reach NHWL. This might cause water deficit for irrigation in downstream area and impacts on paddy fields in case of inappropriate water release. It might spawn people's unrest or conflict.
5) Dam heightening	No Estimation	This method is to raise the dam crest to secure the effective storage capacity. Dam heightening would be the option to adopt in the future when the storage capacity of the reservoir decreased substantially. The Steering Committee on August 22, 2005 concluded dam heightening not recommendable.	This measure might cause social controversy because it would require large area of land acquisition and possibly resettlement. Not only the social controversy, but also a large scale of civil work would be needed, which may cause serious negative impacts on the local residents.

Source: JICA Study Team

Table14 Coding of Land Units in Subject Areas

Terrace Type & Condition	Slope Class (%)				
	0-8	8-15	15-25	25-40	>40
Upland Field					
- Good Quality BT *	US1T1	US2T1	US3T1	US4T1	US5T1
- Medium Quality BT	US1T2	US2T2	US3T2	US4T2	US5T2
- Fair/Bad Quality BT	US1T3	US2T3	US3T3	US4T3	US5T3
- Traditional Terrace	US1T4	US2T4	US3T4	US4T4	US5T4
- Composite **	US1T5	US2T5	US3T5	US4T5	US5T5
Settlement area under Upland Field					
- Complex (composite and traditional terrace)	PS1T6	PS2T6	PS3T6	PS4T6	PS5T6
Housing Yard	HS1	HS2	HS3	HS4	HS5

*: BT = bench terrace
**: Association of ridge and non-terrace
Source: JICA Study Team

Table 15 Subject Area Classified by Coding of Land Units (ha) in the Wonogiri Dam Watershed

	Slope Class (%)					Total	(%)
	0-8	8-15	5-25	25-40	>40		
Upland Field							
-Good quality BT*	475	213	147	83	68	980	1
-Medium quality BT	482	418	334	243	319	1,800	3
-Fair/Bad quality BT	4,644	2,508	2,539	2,904	5,263	17,860	27
-Traditional terrace	701	654	935	1,119	1,633	5,040	8
-Composite**	1,351	1,629	2,482	3,366	5,249	14,080	21
Uplands in settlement area (complex of traditional terrace and composite)	9,526	4,152	2,660	1,617	1,520	19,470	29
Settlement area (housing yard)	2,480	1,620	1,259	933	997	7,290	11
Total (ha)	**19,660**	**11,190**	**10,350**	**10,270**	**15,050**	**66,520**	
(%)	**30**	**17**	**15**	**15**	**23**		**100**

Note: Subject area does not include the State Forest area
*: BT= bench terrace
**: Association of ridge and non-terrace
Source: JICA Study Team

Table16 Target Areas for Watershed Conservation by Sub-Basin

Unit: ha

Land use			Code of land	Keduang	Tirtomoyo	Temon	Upper Solo	Alang	Ngungga-han	Wuryan-toro	Remnant	Total (ha)	(%)
Upland Field	Bench terrace	good	US1T1	0	0	0	0	0	0	0	0	0	0
			US2T1	0	0	0	0	0	0	0	0	0	0
			US3T1	0	0	0	0	0	0	0	0	0	0
			US4T1	0	0	0	0	0	0	0	0	0	0
			US5T1	0	0	0	0	0	0	0	0	0	0
		medium	US1T2	0	0	0	0	0	0	0	0	0	0
			US2T2	23	30	0	0	0	0	86	0	139	0
			US3T2	20	10	0	0	1	16	121	23	191	1
			US4T2	19	17	0	25	19	7	41	22	150	0
			US5T2	12	32	0	18	20	11	28	17	138	0
		fair/poor	US1T3	1	0	0	0	0	0	0	0	1	0
			US2T3	736	217	245	89	378	3	169	11	1,848	5
			US3T3	868	339	166	190	160	13	97	29	1,862	5
			US4T3	807	440	110	211	62	6	38	19	1,693	5
			US5T3	1,322	710	110	262	53	25	22	11	2,515	7
	Traditional terrace		US1T4	7	0	0	0	2	0	0	0	9	0
			US2T4	147	46	7	204	3	49	14	58	528	2
			US3T4	101	100	16	397	7	96	36	99	852	2
			US4T4	58	112	15	439	19	81	15	72	811	2
			US5T4	128	102	4	408	0	120	67	71	900	3
	Composite (ridge and non terrace)		US1T5	51	99	47	61	0	15	12	27	312	1
			US2T5	74	209	96	350	316	176	31	40	1,292	4
			US3T5	92	456	144	664	471	251	50	46	2,174	6
			US4T5	79	694	157	779	449	196	44	53	2,451	7
			US5T5	201	1,128	162	826	337	150	68	84	2,956	9
Settlement area under upland field condition			PS1T5	1,471	341	48	233	103	38	414	47	2,695	8
			PS2T5	1,820	417	199	496	404	136	200	53	3,725	11
			PS3T5	1,071	379	115	457	199	141	80	43	2,485	7
			PS4T5	400	288	44	273	84	59	28	20	1,196	3
			PS5T5	364	195	12	163	46	44	18	8	850	2
Settlement area			HS1	0	1	0	0	0	0	0	0	1	0
			HS2	566	82	40	71	22	13	27	7	828	2
			HS3	363	131	26	96	30	25	14	7	692	2
			HS4	190	158	16	101	20	16	9	9	519	2
			HS5	269	157	6	85	23	15	9	5	569	2
Total (ha)				11,260	6,890	1,785	6,898	3,228	1,702	1,738	881	34,382	100
(%)				33	20	5	20	9	5	5	3	100	

Source: JICA Study Team

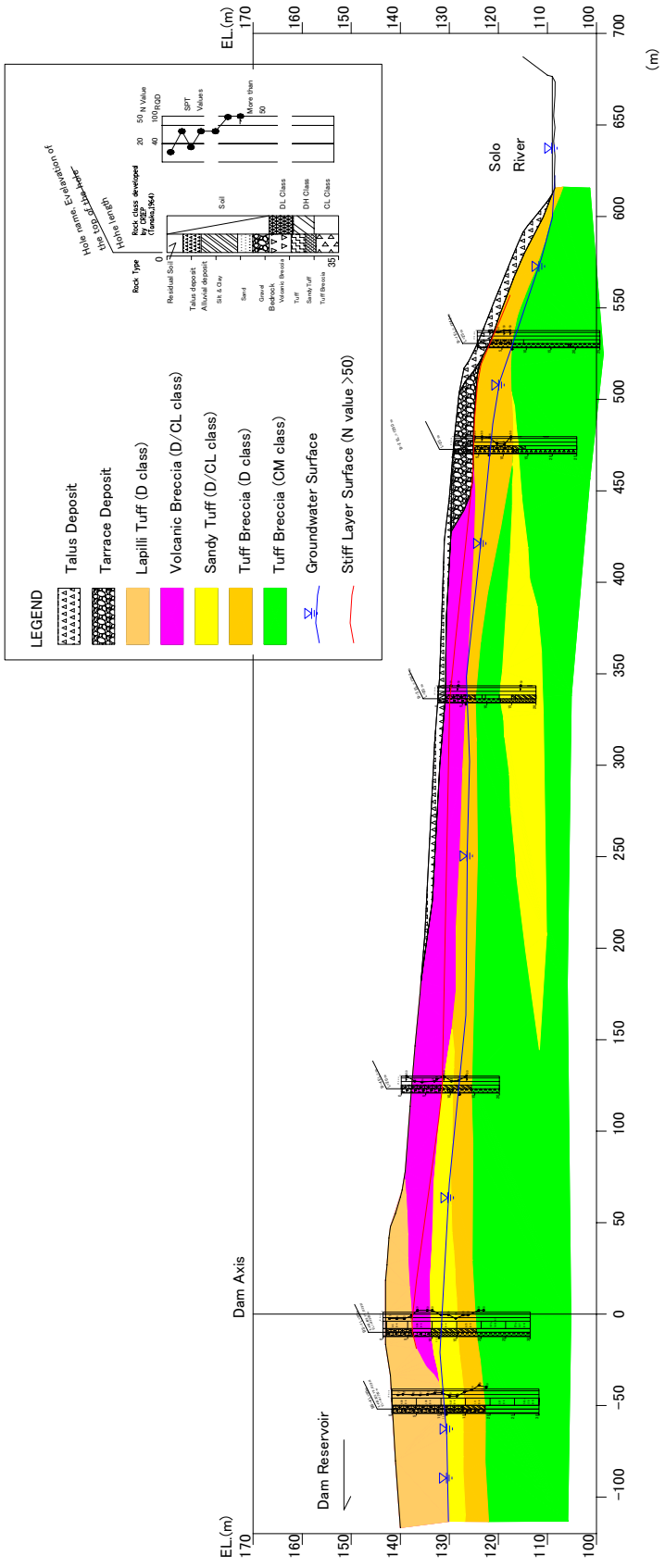
Table 30 Target Areas for Watershed Conservation in Keduang Watershed

Unit: ha

Land use			Code of land	Area (ha)	Land use	Code of land	Area (ha)
Upland Field	Bench terrace	good	US1T1	0	Uplands in settlement area (complex)	PS1T6	1,520
			US2T1	0		PS2T6	1,765
			US3T1	0		PS3T6	1,039
			US4T1	0		PS4T6	394
			US5T1	0		PS5T6	365
			sub-total	0	sub-total		5,083
		medium	US1T2	0	Settlemt area	HS1	0
			US2T2	6		HS2	569
			US3T2	8		HS3	372
			US4T2	7		HS4	185
			US5T2	3		HS5	270
			sub-total	24	sub-total		1,396
		fair/poor	US1T3	0			
			US2T3	984			
			US3T3	1,027			
			US4T3	870			
			US5T3	1,392			
			sub-total	4,273			
	Traditional terrace		US1T4	3			
			US2T4	40			
			US3T4	33			
			US4T4	26			
			US5T4	71			
			sub-total	173			
	Composite (ridge and non terrace)		US1T5	1			
			US2T5	9			
			US3T5	31			
			US4T5	44			
			US5T5	82			
			sub-total	167	Total		11,116

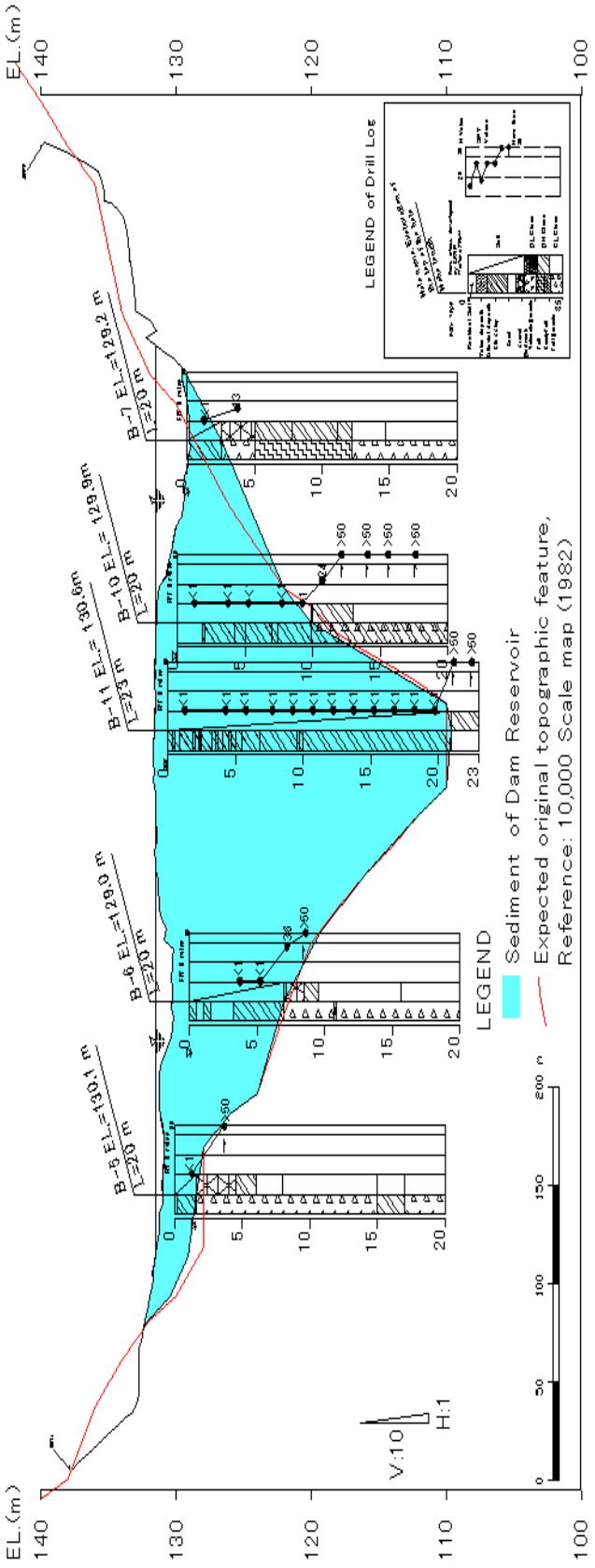
Source: JICA Study Team

Figures



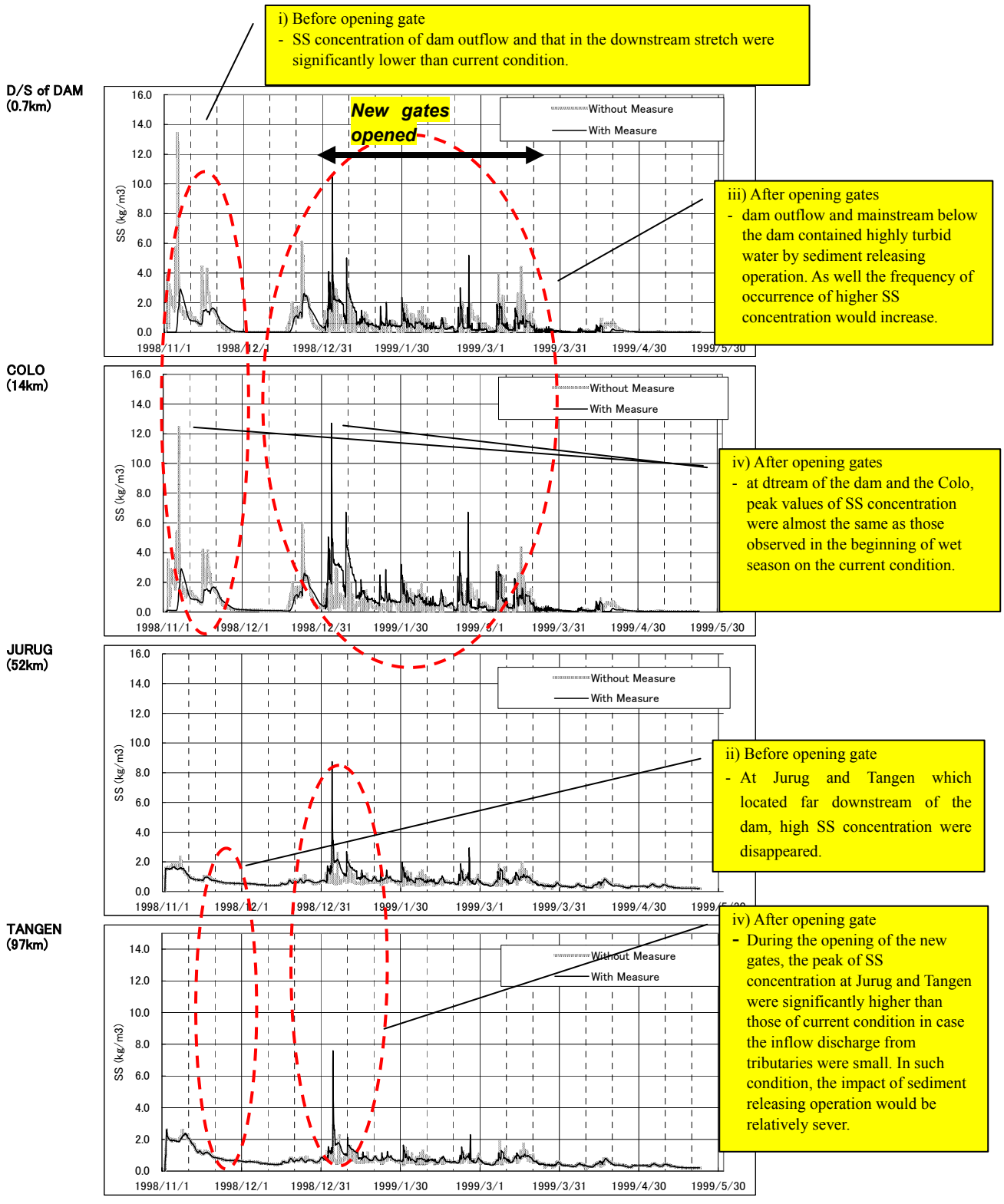
Source: JICA Study Team

Figure 29 Geological Profile of Proposed Spillway Alignment



Source: JICA Study Team

Figure 30 Geological Profile of Closure Dike



Note:" Without Measure" is the case in present condition assuming for dam operation to follows the existing rule. "With Measure" is the case after implementation of the measure (Sediment storage reservoir with new gates).

Source : JICA Study Team

Figure 31 Comparison of SS concentration in Upper Solo Mainstream between With and Without Measure in Wet Year (1998/1999)

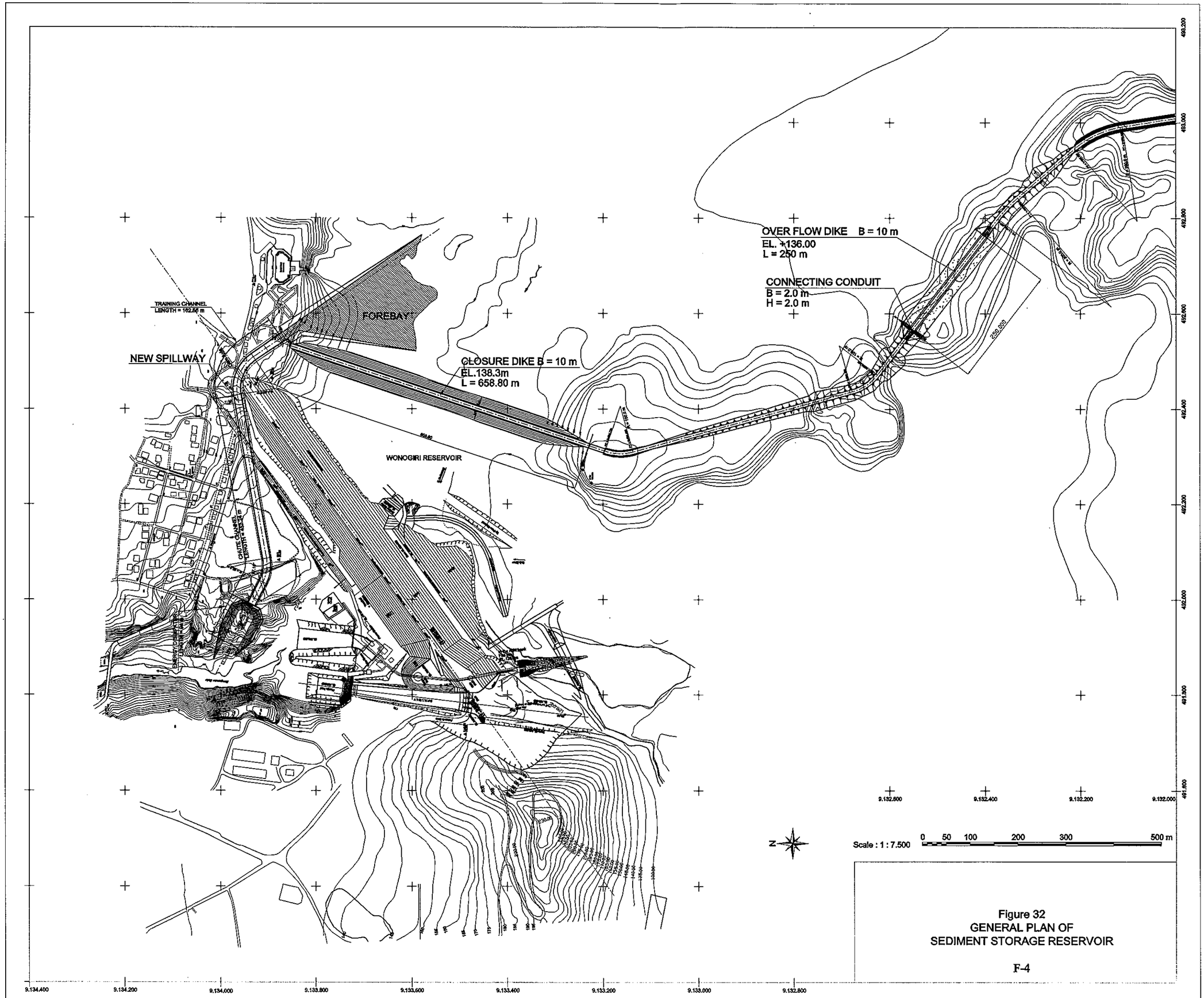


Figure 32
GENERAL PLAN OF
SEDIMENT STORAGE RESERVOIR

F-4

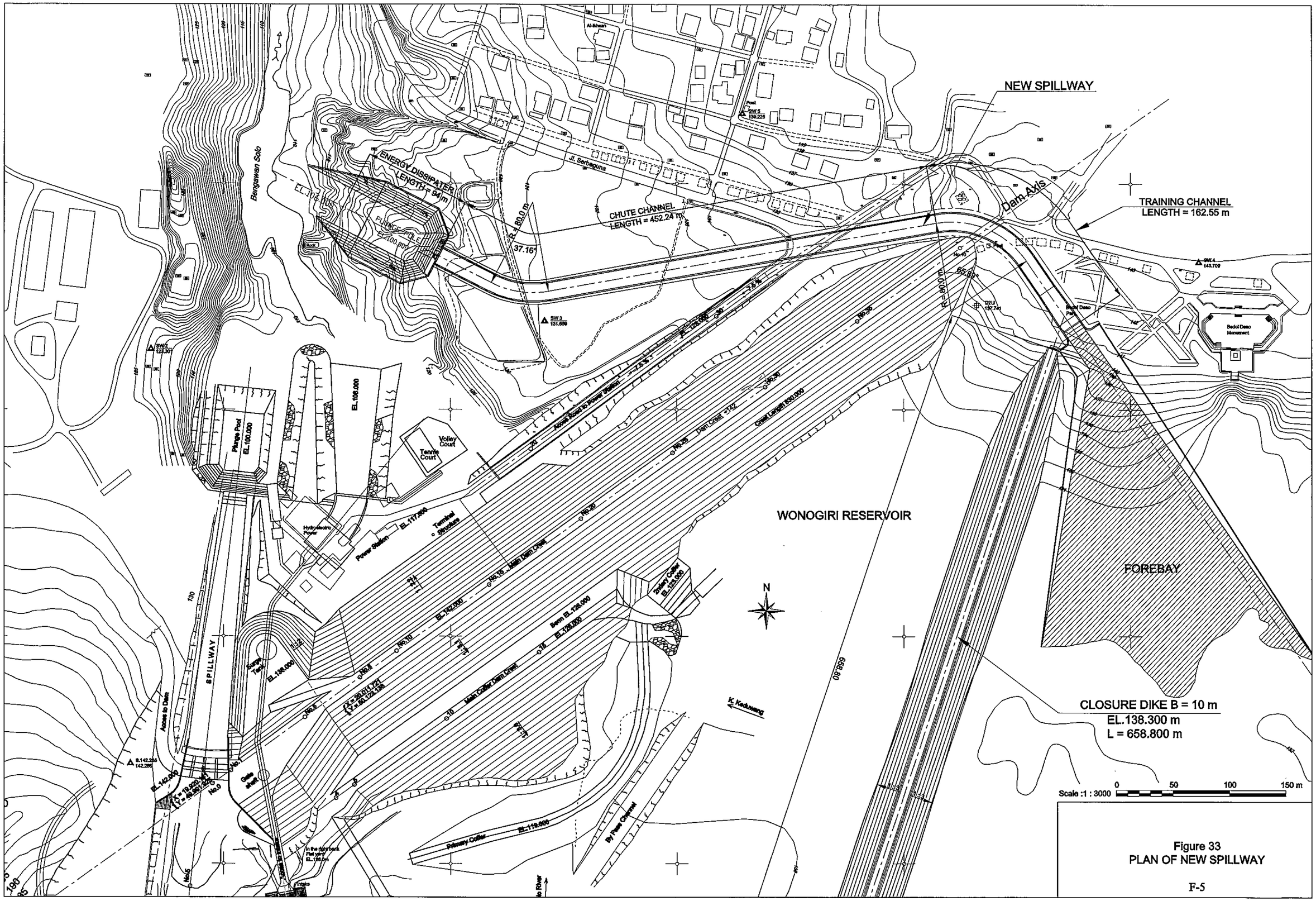
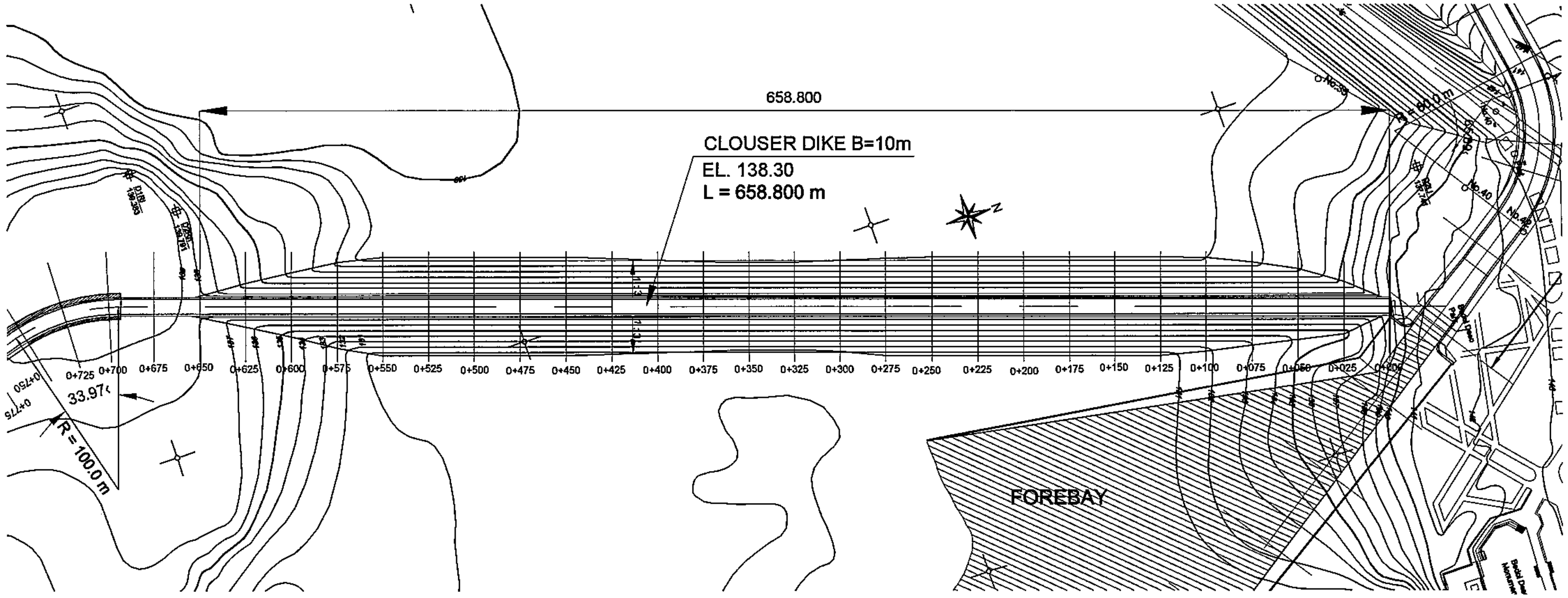


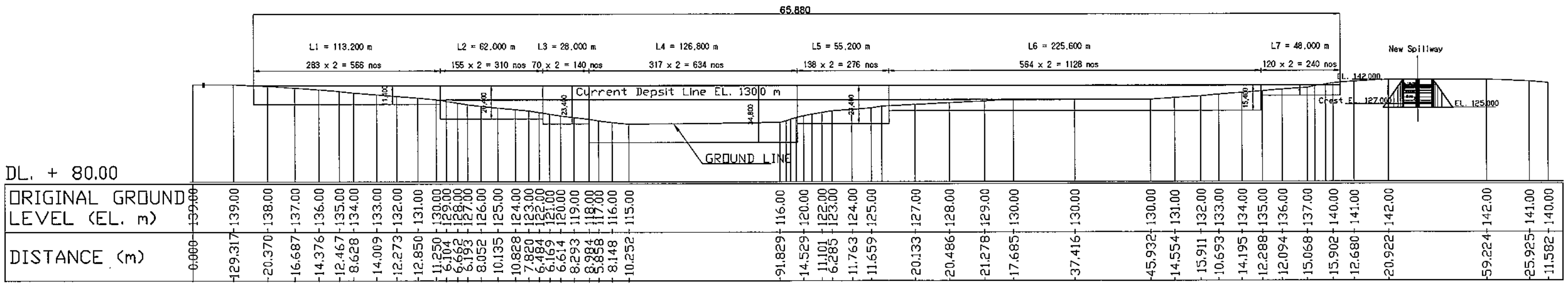
Figure 33
PLAN OF NEW SPILLWAY

F-5

PLAN OF CLOSURE DIKE

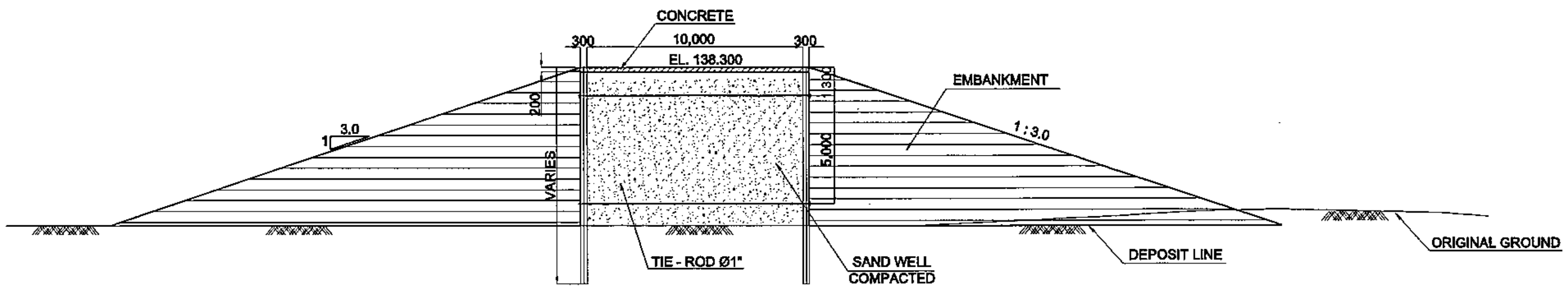
SCALE : 1 : 3000





LONGITUDINAL PROFILE OF CLOUSER DIKE

Scale : 1 : 2500



TYPICAL CROSS SECTION

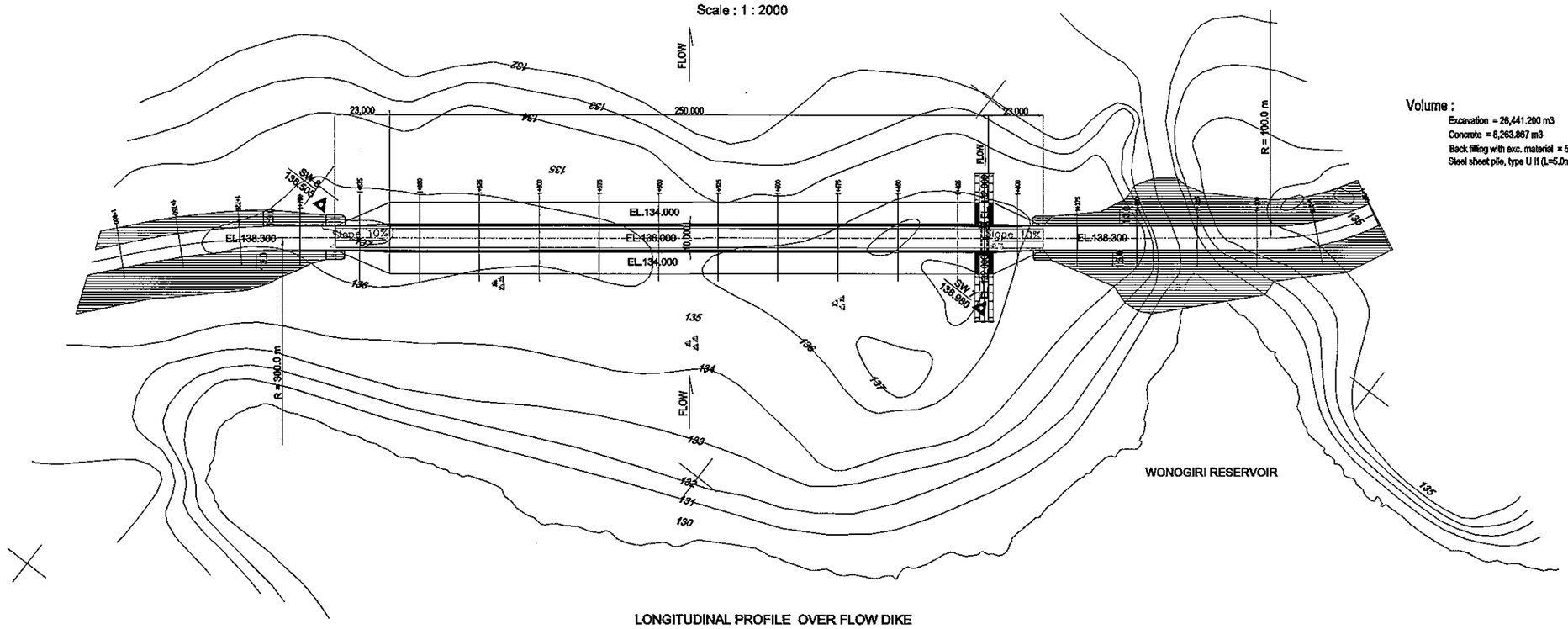
Scale : 1 : 300

Scale : 1 : 2500 0 10 20 40 60 80 100 m

Figure 34
PLAN AND STRUCTURE OF CLOSURE DIKE

PLAN OF OVERFLOW DIKE

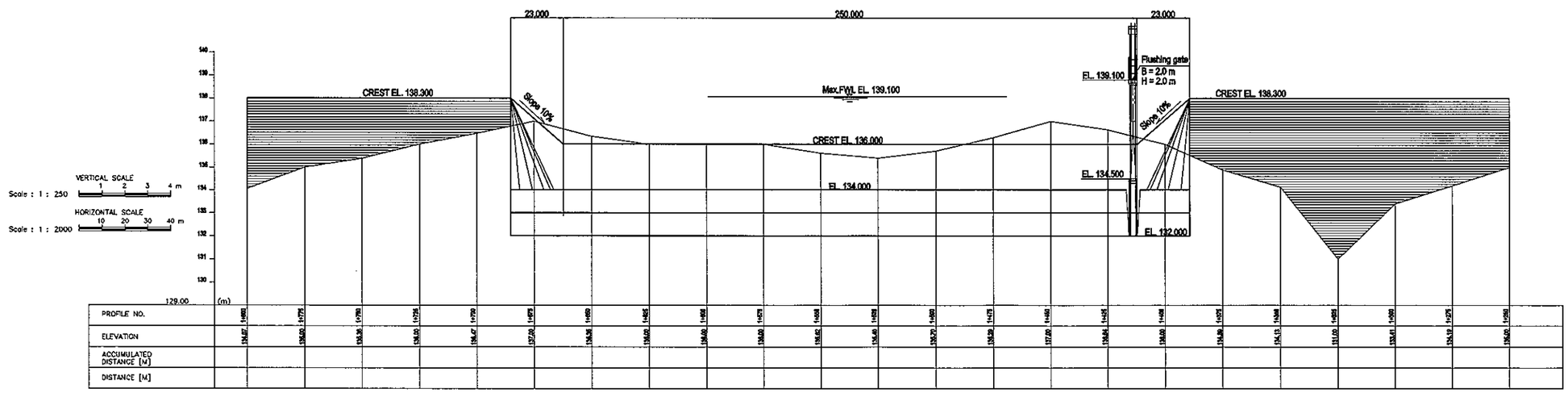
Scale : 1 : 2000

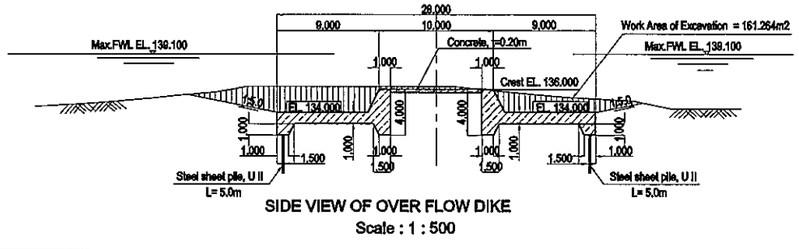


Volume :

Excavation = 26,441.200 m3
Concrete = 8,263.867 m3
Back filling with exc. material = 5,321.500 m3
Steel sheet pile, type U II (L=5.0m) = 562.0 m²

LONGITUDINAL PROFILE OVER FLOW DIKE





SIDE VIEW OF OVER FLOW DIKE

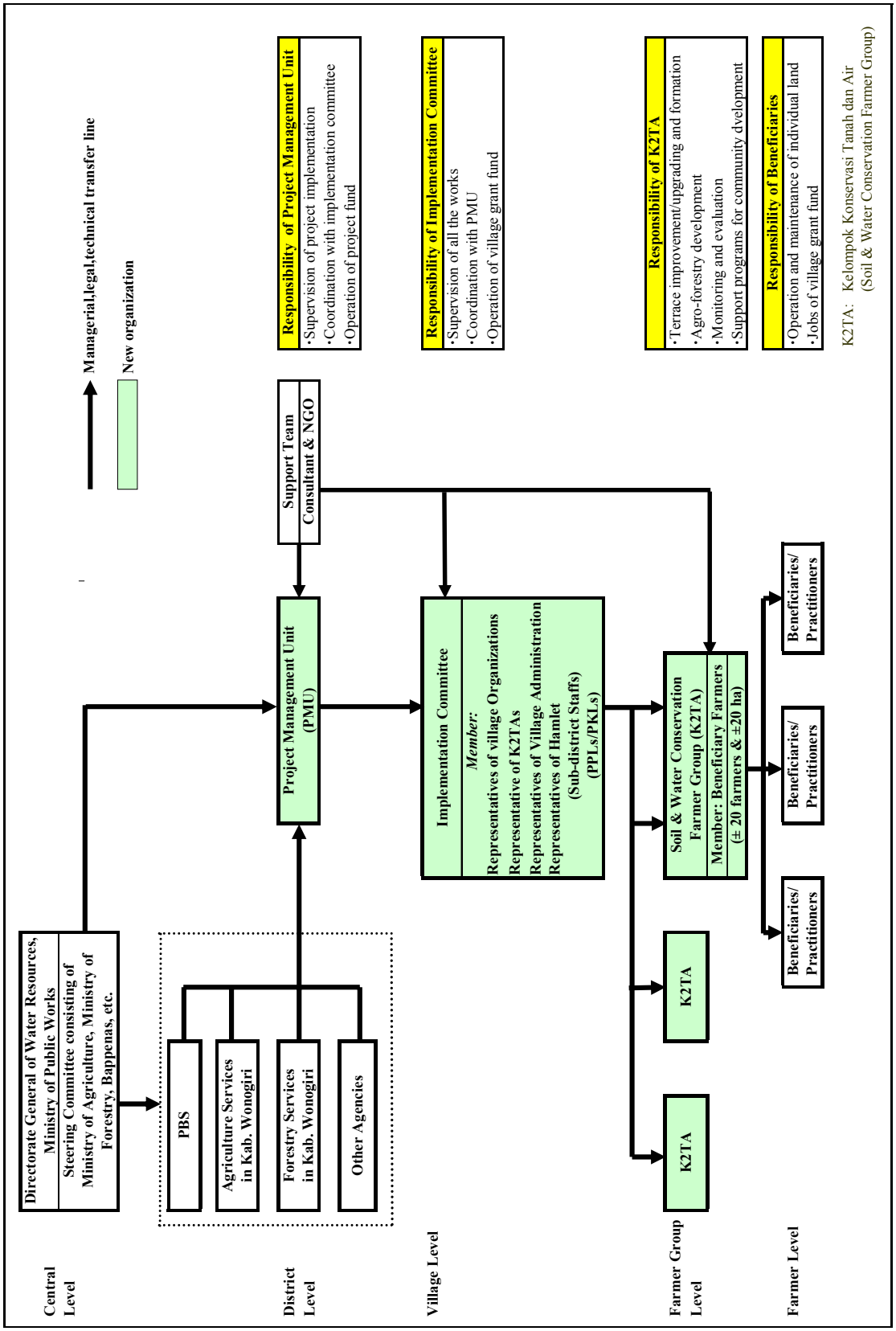
Scale : 1 : 500

SCALE : 1: 2000 — 0 20 40 60 80 100m

SCALE : 1:500 — 0 5 10 15 20 25m

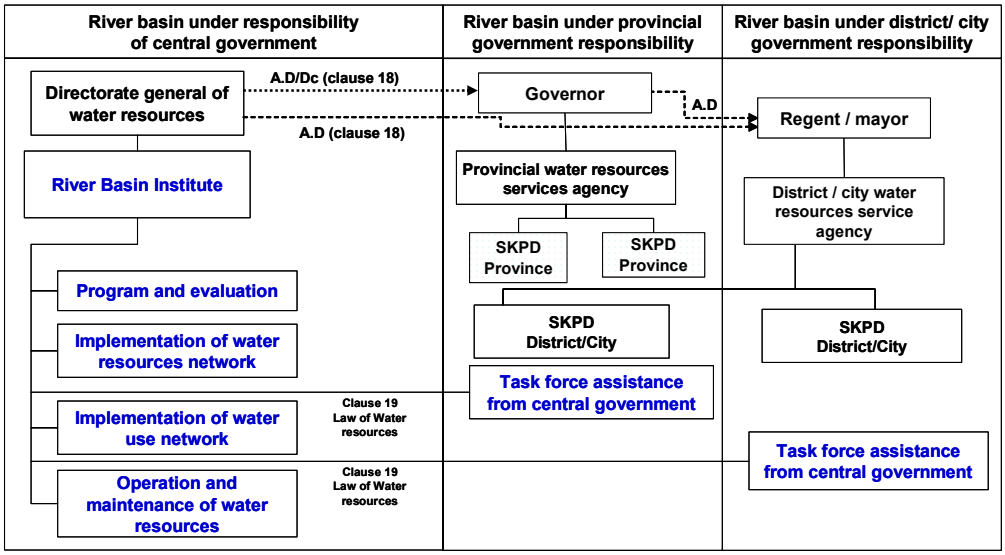
Figure 35
PLAN AND SECTION OF OVERFLOW DIKE

F-7



Source: JICA Study Team

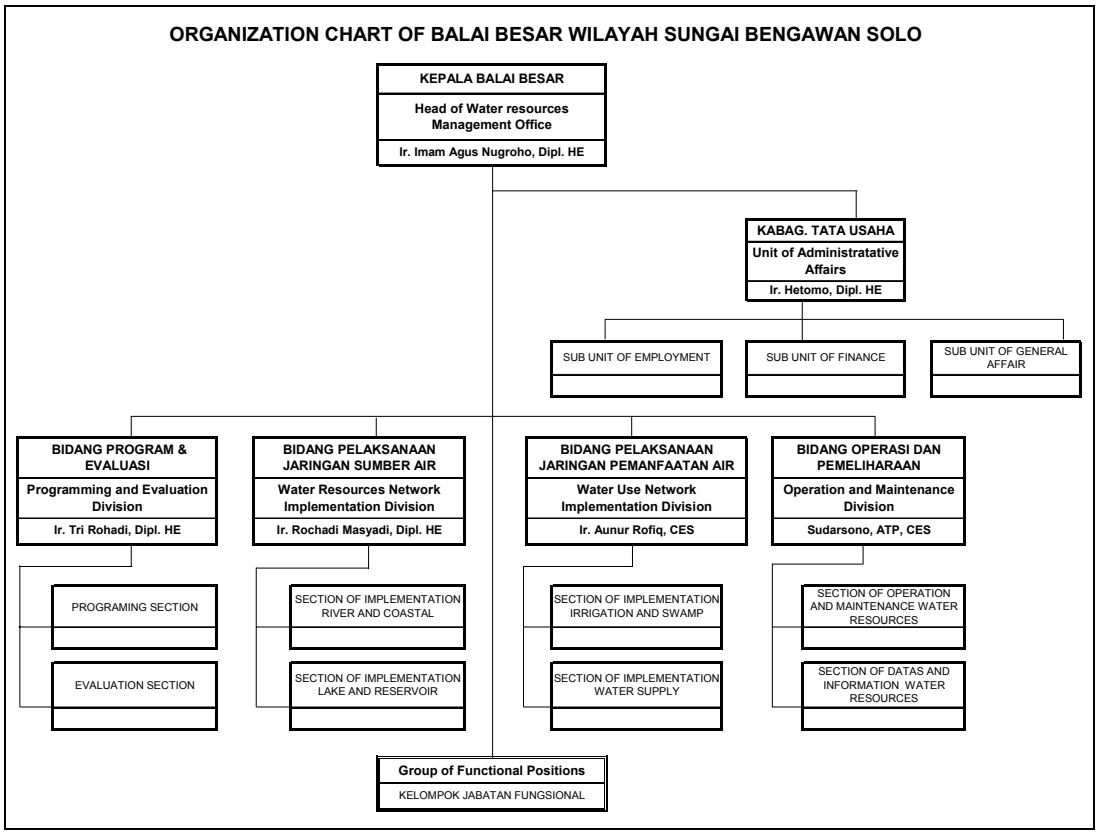
Figure 37 Organizational Set-up at Village and Filed Levels for Implementation of Watershed Conservation Works



Notes: The status of Technical Implementation Unit (UPT) in each central, provincial and kabupaten/kota (district/city) government is:
(1) Provincial Govt Working Unit (SKPD Prov.) is UPT under Provincial Water Resources Services with its working area in the related river basin. For example, the working area of SKPD Porong is in the Porong River basin
(2) Kabupaten/Kota Government Working Unit (SKPD Kab./Kot.) is UPT under Kabupaten/Kota Water Resources Services with its working area in the related river basin.
Abbreviations: A.D. = Assistance Task; Dc = deconcentration; Clauses are from the WR Law 7/2004

Source: DGWR

Figure 38 Balai Besar Wilayah Sungai in Government Structure on Water Resources Management



Source: Balai Besar Wilayah Sungai Bengawan Solo

Figure 39 Organization Structure of Balai Besar Wilayah Sungai Bengawan Solo