

Table 6.4 (1) Water Balance Study : Huong River Basin (2) Future Demand - 2010 ; Without Dam (Maintenance Flow = 31 m3/sec)

	Huong Main River System (until Be Luong confluence)																												Bo River System (until Be Luong confluence)												Main River System (Be Luong Confluence to River Mouth)								Balance in Whole Basin							
	Reservoir				Canal				River				Canal				River				Canal				River				Canal				River				Canal				River															
	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff	Inflow	Storage	Outflow	Runoff								
1977	Jan	21.1	348.0	91.1	9.0	0.0	9.0	5.1	105.1	0.0	1.5	2.7	2.9	0.0	100.9	5.8	0.0	5.8	2.5	2.8	-	-	-	5.0	5.0	D	-	2.0	2.2	D	-	(3.7)	97.2	8.4	8.4	111.0	22.2	83.0	105.2	88.8	33.1	-	-	5.7	2.1	-	-									
1978	Jan	24.2	278.0	58.1	11.8	0.0	11.8	5.8	75.7	1.5	1.5	1.0	1.1	1.9	76.8	4.8	0.0	4.8	1.0	1.1	0.6	1.9	1.9	0.6	0.8	0.9	0.8	3.1	79.7	3.2	3.2	85.9	9.4	75.0	84.4	76.5	28.6	-	-	1.5	0.6	-	-													
1979	Jan	26.4	244.2	50.9	18.6	0.0	18.6	6.4	76.8	5.2	1.6	1.5	1.6	6.7	84.7	5.1	0.0	5.1	1.4	1.6	2.0	2.8	2.8	2.0	1.1	1.2	2.5	6.1	99.3	13.2	83.0	96.2	86.1	32.2	-	-	3.1	1.2	-	-																
1980	Jan	11.9	219.7	111.5	6.4	0.0	6.4	2.9	120.8	0.0	1.9	5.2	5.8	0.0	113.6	4.0	0.0	4.0	11.0	5.0	5.6	-	-	-	9.9	9.9	D	-	4.0	4.4	D	-	(7.9)	105.8	16.6	16.6	131.8	42.7	80.4	123.1	89.1	33.3	-	-	8.8	3.3	-	-								

T-25

Table 6.4 (3) Water Balance Study : Huong River Basin (2) Future Demand - 2010 ; Without Dam (Maintenance Flow = 31 m3/sec)

Year	Month	Huong Main River System (Unit: Be Luong confluence)															Bo River System (Unit: Be Luong confluence)															Main River System (Be Luong Confluence to River Mouth)														
		Reservoir					Canal					Reservoir					Canal					Water Resources					Water Requirement					Balance in Whole Basin														
		Inflow		Outflow		Storage	Inflow		Outflow		Storage	Inflow		Outflow		Storage	Inflow		Outflow		Storage	Total		Total		Total		Total		Total		Total		Total												
		(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)	(M3)												
1989	Jan	130.7	348.0	130.7	98.5	0.0	98.5	31.5	260.8	9.2	1.5	0.1	0.1	11.8	280.2	114.5	0.0	114.5	0.1	0.1	3.4	0.2	0.2	3.4	0.1	0.1	4.4	125.3	406.9	0.4	0.4	409.0	2.5	83.0	85.5	406.5	151.8	-	-	323.5	120.8	-	-			

Table 6.4 (4) Water Balance Study : Huong River Basin (2) Future Demand - 2010 ; Without Dam (Maintenance Flow = 31 m3/sec)

Huong Main River System (Unit: Be Luong Confluence)															Bo River System (Unit: Be Luong Confluence)															Main River System (Be Luong Confluence to River Mouth)															
Year	Month	Reservoir			Reservoir			Reservoir			Reservoir			Reservoir			Reservoir			Water			Water			Water			Water																
		Inflow	Storage	Outflow	Inflow	Storage	Outflow	Inflow	Storage	Outflow	Inflow	Storage	Outflow	Inflow	Storage	Outflow	Inflow	Storage	Outflow	Total	Water	Marine	Total	Surplus	Deficit	Total	Surplus	Deficit	Total	Surplus	Deficit														
			173			70			0			0			90						30.0			0			0			0															
			Inflow			Storage			Outflow			Inflow			Storage			Outflow			Inflow			Storage			Outflow			Inflow			Storage			Outflow									
			Runoff			Demand			Net drml			Gross			Runoff			Demand			Net drml			Gross			Runoff			Demand			Net drml			Gross									
			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)			(MM/MS)						
1995	Jan	105.4	348.0	105.4	86.3	0.0	86.3	25.4	217.1	0.0	1.5	2.8	3.1	0.0	212.8	135.0	0.0	135.0	2.7	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.5 (3) Water Balance Study : Huong River Basin (3) Future Demand - 2020 ; With Dam (Maintenance Flow = 31 m3/sec)

Table with 33 columns representing various water balance metrics and 130 rows representing monthly data from 1989 to 2020. Columns include Reservoir (Duong Hoa-Ta Trac) and Bo River System (Luong confluence) with sub-columns for Inflow, Runoff, Demand, and Supply. It also includes Water Requirement (Total, Agriculture, Industry, Maintenance) and Balance in Whole Basin (Surplus, Deficit) with sub-columns for Volume and Discharge.

Table 7.1 Possible Mitigation/Enhancement Measures for the Conceivable Impacts

	Conceivable impacts on environment	Possible mitigation/enhancement measures
Physical environment	<ul style="list-style-type: none"> · Humidity increase in both air and soil. · Lift up of groundwater level. 	<ul style="list-style-type: none"> · Reforestation/plantation in headwater areas and reservoir embankments
	<ul style="list-style-type: none"> · Mud flow and turbid flow from construction site. 	<ul style="list-style-type: none"> · Establishment of sedimentation basin just below the construction site.
	<ul style="list-style-type: none"> · Erosion at immediately below the Ta Trach dam or Thao Long barrage by scouring. 	<ul style="list-style-type: none"> · Due consideration of structural design.
	<ul style="list-style-type: none"> · Discharge of alkaline water while concrete placement works. 	<ul style="list-style-type: none"> · Establishment of alkaline water treatment facility.
	<ul style="list-style-type: none"> · Possibility of cold water intake for downstream irrigation and the damage to agricultural crops. 	<ul style="list-style-type: none"> · Establishment of several intake points, i.e. sluices, at the dam weir and the mixture of the water taken for discharging.
	<ul style="list-style-type: none"> · Water pollution in the reservoir. · Decomposition of submerged trees and plants. · Contamination by residual substances such as wastes, chemicals and/or fuels. 	<ul style="list-style-type: none"> · Clearance of existing plants, trees, houses and other residual substances on the reservoir bed before the submersion.
	<ul style="list-style-type: none"> · Possibility of eutrophication. 	<ul style="list-style-type: none"> · Clearance of existing substances mentioned above and reforestation in headwater areas.
	<ul style="list-style-type: none"> · Nutrient loss in downstream area in Huong river and Tam Giang – Cau Hai lagoon. 	<ul style="list-style-type: none"> · Proper regulation of flush water to release downstream deliberately at Ta Trach dam during rainy season.
Ecological Environment	<ul style="list-style-type: none"> · Loss of vegetation cover and accompanying habitat loss for terrestrial wild animals. 	<ul style="list-style-type: none"> · Reforestation/plantation in headwater area and reservoir embankments in order to recover and enhance the ecological functions, such as supplying hiding places, foods and breeding areas.
	<ul style="list-style-type: none"> · Impacts on aquatic organisms and aquaculture in Huong river and Tam Giang – Cau Hai lagoon. 	<ul style="list-style-type: none"> · The execution of the mitigation measure for nutrient loss mentioned above and establishment of bio-path at Ta Trach dam and at Tao Long barrage for the mitigation of impacts on migratory fish.
	<ul style="list-style-type: none"> · Threatening of the extinction of the precious and/or endemic species. 	<ul style="list-style-type: none"> · Implementation of on-site investigation for the identification of the precious and/or endemic animals/plants and consideration of practical method for their transplantation.
	<ul style="list-style-type: none"> · Impacts on Bach Ma National Park. 	<ul style="list-style-type: none"> · Reforestation/plantation in headwater area of Ta Trach river in Bach Ma National Park for limiting erosion and washing and the formation of habitat of wild animals.
Social Environment	<ul style="list-style-type: none"> · Impact of resettlement by Ta Trach Dam. 	<ul style="list-style-type: none"> · Due implementation of resettlement action plan in parallel with consultation with stakeholders.
	<ul style="list-style-type: none"> · Conflict between new comers and recipient communities of resettlers. 	<ul style="list-style-type: none"> · Preparation of communal society development program for stabilizing life conditions.
	<ul style="list-style-type: none"> · Deterioration of health and sanitary condition due to mobilization of workers during construction stage. 	<ul style="list-style-type: none"> · Provision of basic education and primary aid, and improvement of public medical services.
	<ul style="list-style-type: none"> · Impact of noise and dust during construction stage. 	<ul style="list-style-type: none"> · Due consideration to residential area on locating construction road and operating heavy equipment, restriction of work hours to daytimes, and water spraying on the road.

Table 7.2 Environmental Monitoring and Management Plan

	Area/Target		Locations	Monitoring parameters	Frequency	Methodology
Physical Environment	Water regime	Huong river basin	Existing hydrological station(s)	Rainfall, water level, run-off velocity and discharge.	Continuously.	Same as on going method.
	Water quality	Ta Trach reservoir	One station: representative point in the reservoir.	Physical, chemical and biological parameters in Surface Water Quality Standard of Vietnam (TCVN 5942, 1995).	Monthly (12 times a year)	Water sampling and laboratory tests.
		Huong river	Four stations: 1) Van Nien water supply factory. 2) Gia Vien water supply factory. 3) Down stream of sewage discharge from Hue city. 4) Sinh confluence.	Ditto	Monthly (12 times a year) for sampling station 1) and 2). Dry season and rainy season (2 times a year) for sampling station 3) and 4).	Ditto
		Tam Giang – Cau Hai lagoon	One station: representative point in the lagoon near Thuan An estuary.	Physical, chemical and biological parameters in Surface Water Quality Standard of Vietnam (TCVN 5942, 1995) and Coastal Water Quality Standard of Vietnam (TCVN 5945, 1995)	Monthly (12 times a year)	Ditto
	Erosion and sedimentation	Ta Trach reservoir	Surrounding areas of Ta Trach reservoir and inflow point of Ta Trach river into the reservoir	The magnitude of erosion, sedimentation and other risks of other earth related disaster.	Yearly, and when necessary, e.g. after flooding.	Ocular observation and on-site survey if necessary.
		Huong river including Ta Trach river	River banks	The magnitude of erosion along the river.	Ditto	Ditto
Tam Giang – Cau Hai lagoon		Tuan An estuary	The change of erosion/sedimentation caused by the existences of Ta Trah dam and Tao Long barrage.	Ditto	Ditto	
Ecological Environment	Flora	Terrestrial flora	Reservoir bed (area to be submerged) prior to the construction work. If the transplantation of precious species executed, the transplantation site.	Higher level plants and trees including precious species	Once at pre-construction period. If the transplantation of precious species executed, twice a year (dry season and rainy season) .	On-site identification and description on community and population and interview to local residents.
	Fauna	Terrestrial fauna	Reservoir bed (area to be submerged) prior to the construction work. If the transplantation of precious species executed, the transplantation site.	Mammals, birds, reptiles and amphibians	Ditto	On-site identification and description on breeding grounds and population and interview to local residents.
		Aquatic organisms	Ta Trach reservoir, Huong river and Tam Giang – Cau Hai lagoon	1) Composition and quantity of natural fishes including migratory fishes, phytoplankton, zooplankton and benthic organisms. 2) Composition, quantity, growth rate and production of raised fishes.	Once at pre-construction period and twice at operation period a year (dry season and rainy season).	On-site identification by net-catching and interview to local fisher forks and officials working at relevant organizations.
Social Environment	Resettlement	Effectiveness of action plan	Ta Trach dam, resettlement areas	Actual progress of and compliance with the plan. Socio-economic conditions and requirement of stakeholders.	Once at pre-construction stage, and continuously after construction work starts until achievement to self-sustenance.	Field observation, interview or inquiry, consultation with stakeholders.
	Health and sanitation	Construction workers, residents near reservoir	Ta Trach dam	Health condition of construction workers and sanitary condition of campsites during construction stage. Number of out-patients and morbidity trend after completion.	Twice a year during construction stage (dry season and rainy season). Once a year after completion.	Field observation, interview or inquiry, recording file review.
	Noise and dust	Dam construction	Residential areas near dam construction site	Nuisance status of noise and dust, Noise level and dust concentration if necessary.	Once a month during construction stage for qualitative confirmation, Field measurement when necessary.	Field observation, interview or inquiry, field measurement if necessary.

Table 8.1 Comparison of Alternative Plans (1/2)

	Capacity of Facilities			Technical Aspect				Environmental Aspect		Economic Aspect		Overall Evaluation	
	Storage capacity (mil. m ³)	Flood Control Capacity for Hue City (mil. m ³) (m ³ /s)		Water Utilization Plan (IR, WS, HY = 460 mil. m ³) */	Major Flood Control for Hue City (Requirement = 13,670 - 2,000 = 11,670 m ³ /s) 2/	10-yr. Probable Early Flood Control for Agriculture Lands (Requirement = less than 1,400 m ³ /s in D/S reaches) 2/	Bo River Flood Control (Requirement = 3,050 - 1,410 = 1,640 m ³ /s)	Indicators: 1) Impact on protected area 2) Impact on landscape of Hue 3) Impact on lagoon	Social Environment Indicators: 4) Impact of resettlement 5) Impact on important infrastructure such as national road and railway 6) Impact on regional economy regarding tourism	Construction Cost (Mil. US\$)	Economic Viability EIRR, % (B/C)		
		(mil. m ³)	(mil. m ³)										(m ³ /s)
I. With Dam													
I-A without Ta Trach Dam													
I-A.1	Huu Trach Dam (F.S.L = EL. 55.0)	182	182	4,720	Not Satisfied	Not Satisfied	Huonc: 1,904m ³ /s Bo : 1,005m ³ /s Total : 2,909m ³ /s Not Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-A.2	Huu Trach Dam (F.S.L = EL. 55.0) + Diversion Channel + Parapet Wall + Retarding Basin + Diversion Tunnel	182	182	4,720 5,000 400 350	Not Satisfied	Not Satisfied	Huonc: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-A.3	Huu Trach Dam (F.S.L = EL. 55.0) + Diversion Channel X 2 + Parapet Wall	182	182	4,720 8,000	Not Satisfied	Satisfied	- Ditto - Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-A.4	Huu Trach Dam (F.S.L = EL. 55.0) + Co Bi Dam (F.S.L = EL.40.0)	182 167	182 -	4,720 -	Satisfied	Not Satisfied	Huonc: 1,904m ³ /s Bo : 0m ³ /s Total : 1,904m ³ /s Not Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-A.5	Huu Trach Dam (F.S.L = EL. 55.0) + Co Bi Dam (F.S.L = EL.40.0) + Diversion Channel X 2 + Parapet Wall	182 167	182 -	4,720 8,000	Satisfied	Satisfied	Huonc: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	1) Slight (Phong Dien) by Co Bi 2) Medium by parapet wall 3) Slight - medium by 2 div. channels Acceptable	4) Unclear by Huu Trach & Co Bi but less than Ta Trach 5) Very large by 2 div. channels (20-40 thou. or more) 6) Large by 2 div. channels Medium by parapet wall Not Acceptable		(Screened out due to "Not Acceptable" from social environmental aspect)	
I-A.6	Co Bi Dam (F.S.L = EL. 40.0)	167	-	-	Not Satisfied	Not Satisfied	Huonc: 2,998m ³ /s Bo : 0m ³ /s Total : 2,998m ³ /s Not Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-A.7	Co Bi Dam (F.S.L = EL. 40.0) + Diversion Channel X 2 + Parapet Wall + Retarding Basin + Diversion Tunnel	167	-	- 8,000 400 350	Not Satisfied	Not Satisfied	Huonc: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-B With Max. Ta Trach Dam													
I-B.1	Max Ta Trach Dam (S.W.L = EL. 52.0)	460	392.6	8,070	Satisfied	Not Satisfied	Huonc: 1,094m ³ /s Bo : 1,005m ³ /s Total : 2,099m ³ /s Not Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)			16.6% (B/C=1.58)	
I-B.2	Max Ta Trach Dam (S.W.L = EL. 52.0) + Huu Trach Dam (F.S.L = EL.55.0)	460 182	392.6 105	8,070 3,600	Satisfied	Satisfied	Huonc: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	1) Slight (Bach Ma) by Ta Trach 2) None 3) Unclear on negative/positive direction by Ta Trach and Huu Trach Acceptable	4) Medium by Ta Trach (4-5 thou. population) 5) Unclear by Huu Trach & Co Bi but less than Ta Trach 6) None Acceptable	100.6 30.0 130.6	16.5% (B/C=1.55)	- Essential technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability is highest. Recommendable
I-B.3	Max Ta Trach Dam (S.W.L = EL. 52.0) + Min. Huu Trach Dam (F.S.L = EL.50.0)	460 105	392.6 105	8,070 3,600	Satisfied	Satisfied	- Ditto - Satisfied	Not Satisfied	-Ditto- Acceptable	-Ditto- Acceptable	100.6 22.0 122.6	16.4% (B/C=1.55)	- Essential technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability is slightly less than Case I-B.2. Not Better than Case I-B.2
I-B.4	Max Ta Trach Dam (S.W.L = EL. 52.0) + Co Bi Dam (F.S.L = EL.40.0)	460 167	392.6 -	8,070 -	Satisfied	Not Satisfied	Huonc: 1,094m ³ /s Bo : 0m ³ /s Total : 1,094m ³ /s Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-B.5	Max Ta Trach Dam (S.W.L = EL. 52.0) + Min. Co Bi Dam (F.S.L = EL.32.0)	460 45	392.6 -	8,070 -	Satisfied	Not Satisfied	- Ditto - Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-B.6	Max Ta Trach Dam (S.W.L = EL. 52.0) + Huu Trach Dam (F.S.L = EL.55.0) + Co Bi Dam (F.S.L = EL.40.0)	460 182 167	392.6 105 -	8,070 3,600 -	Satisfied	Satisfied	Huonc: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	1) Slight (Bach Ma & Phong Dien) by Ta Trach & Co Bi 2) None 3) Unclear on negative/positive direction by Ta Trach, Huu Trach & Co Bi Acceptable	4) Medium by Ta Trach (4-5 thou. population) 5) Unclear by Huu Trach & Co Bi but less than Ta Trach 6) None Acceptable	100.6 30.0 15.0 145.6	15.8% (B/C=1.46)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2. Not Better than Case I-B.2
I-B.7	Max Ta Trach Dam (S.W.L = EL. 52.0) + Huu Trach Dam (F.S.L = EL.55.0) + Min. Co Bi Dam (F.S.L = EL. 32.0)	460 182 45	392.6 105 -	8,070 3,600 -	Satisfied	Satisfied	- Ditto - Satisfied	Satisfied	-Ditto- Acceptable	-Ditto- Acceptable	100.6 30.0 10.0 140.6	16.0% (B/C=1.48)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2. Not Better than Case I-B.2
I-B.8	Max Ta Trach Dam (S.W.L = EL. 52.0) + Min. Huu Trach Dam (F.S.L = EL.50.0) + Co Bi Dam (F.S.L = EL.40.0)	460 105 167	392.6 105 -	8,070 3,600 -	Satisfied	Satisfied	- Ditto - Satisfied	Satisfied	-Ditto- Acceptable	-Ditto- Acceptable	100.6 22.0 15.0 137.6	15.8% (B/C=1.46)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2.
I-B.9	Max Ta Trach Dam (S.W.L = EL. 52.0) + Min. Huu Trach Dam (F.S.L = EL.50.0) + Min. Co Bi Dam (F.S.L = EL. 32.0)	460 105 45	392.6 105 -	8,070 3,600 -	Satisfied	Satisfied	- Ditto - Satisfied	Satisfied	-Ditto- Acceptable	-Ditto- Acceptable	100.6 22.0 10.0 132.6	16.0% (B/C=1.48)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2. Not Better than Case I-B.2
I-B.10	Max Ta Trach Dam (S.W.L = EL. 52.0) + Diversion Channel + Parapet Wall	460 - -	392.6 - -	8,070 3,000 2,000	Satisfied	Satisfied	Huonc: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	1) Slight (Bach Ma) by Ta Trach 2) Medium by parapet wall 3) Unclear on negative/positive direction by Ta Trach 3) Slight by div. channel Acceptable	4) Medium by Ta Trach (4-5 thou. population) 5) Large by div. channel (20 thou. population at least) 6) Large by div. channel Medium by parapet wall Not Acceptable	(Screened out due to "Not Acceptable" from social environmental aspect)		

Note: - 2/: Essential requirements from technical aspects * IR: Irrigation, WS: Water supply, HY: Hydropower, D/S: Downstream

Table 8.1 Comparison of Alternative Plans (2/2)

	Capacity of Facilities			Technical Aspect				Environmental Aspect		Economic Aspect		Overall Evaluation
	Storage capacity (mil, m ³)	Flood Control Capacity for Hue City		Water Utilization Plan (IR, WS, HY) = 460 (mil. m ³ /s) ^{2/}	Major Flood Control for Hue City (Requirement = 13,670 - 2,000 = 11,670 m ³ /s) ^{2/}	10-yr. Probable Early Flood Control for Agriculture Lands (Requirement = less than 1,400 m ³ /s in D/S reaches) ^{2/}	Bo River Flood Control (Requirement = 3,050 - 1,410 = 1,640 m ³ /s)	Indicators: 1) Impact on protected area 2) Impact on landscape of Hue 3) Impact on lagoon	Social Environment Indicators: 4) Impact of resettlement 5) Impact on important infrastructure such as national road and railway 6) Impact on regional economy regarding tourism	Construction Cost (Mil, US\$)	Economic Viability EIRR, % (B/C)	
		(mil, m ³)	(mil, m ³)									
I-B.11 Max Ta Trach Dam (S.W.L = EL. 52.0) + Diversion Channel + Parapet Wall + Co Bi Dam (F.S.L = EL.40.0)	460 - - 167	392.6 - - -	8,070 3,000 2,000 -	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	1) Slight (Bach Ma & Phong Dien) by Ta Trach & Co Bi 2) Medium by parapet wall 3) Unclear on negative/positive direction by Ta Trach & Co Bi 3) Slight by div. channel Acceptable	4) Medium by Ta Trach (4-5 thou. population) 4) Unclear by Co Bi but less than Ta Trach 4) Large by div. channel (20 thou. population at least) 5) Large by div. channel 6) Medium by parapet wall Not Acceptable			(Screened out due to "Not Acceptable" from social environmental aspect)
I-B.12 Max Ta Trach Dam (S.W.L = EL. 52.0) + Diversion Channel + Parapet Wall + Min. Co Bi Dam (F.S.L = EL 32.0)	460 - - 45	392.6 - - -	8,070 3,000 2,000 -	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	-Ditto- Acceptable	-Ditto- Not Acceptable			(Screened out due to "Not Acceptable" from social environmental aspect)
I-C With Min. Ta Trach Dam												
I-C.1 Min. Ta Trach Dam (S.W.L = EL. 50.0)	460	312	6,951	Satisfied	Not Satisfied	Huong: 1,094m ³ /s Bo : 1,005m ³ /s Total : 2,099m ³ /s Not Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.2 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Huu Trach Dam (F.S.L = EL.55.0)	460 182	312 182	6,951 4,720	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	1) Slight (Bach Ma) by Ta Trach 2) None 3) Unclear on negative/positive direction by Ta Trach & Huu Trach Acceptable	4) Medium by Ta Trach (4-5 thou. population or less) 4) Unclear by Huu Trach but less than Ta Trach 5) None Acceptable	97.0 30.0 127.0	16.4% (B/C=1.55)	- Essential technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability is slightly less than case I-B.2. Not Better than Case I-B.2
I-C.3 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Min. Huu Trach Dam (F.S.L = EL.50.0)	460 105	312 105	6,951 3,600	Satisfied	Not Satisfied	- Ditto - Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.4 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Co Bi Dam (F.S.L = EL.40.0)	460 167	312 -	6,951 -	Satisfied	Not Satisfied	Huong: 1,094m ³ /s Bo : 0m ³ /s Total : 1,094m ³ /s Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.5 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Min. Co Bi Dam (F.S.L = EL.32.0)	460 45	312 -	6,951 -	Satisfied	Not Satisfied	- Ditto - Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.6 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Huu Trach Dam (F.S.L = EL.55.0) + Co Bi Dam (F.S.L = EL.40.0)	460 182 167	312 182 -	6,951 4,720 -	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	1) Slight (Bach Ma & Phong Dien) by Ta Trach & Co Bi 2) None 3) Unclear on negative/positive direction by Ta Trach, Huu Trach & Co Bi Acceptable	4) Medium by Ta Trach (4-5 thou. population or less) 4) Unclear by Huu Trach & Co Bi but less than Ta Trach 5) None Acceptable	97.0 30.0 15.0 142.0	15.7% (B/C=1.45)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2. Not Better than Case I-B.2
I-C.7 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Huu Trach Dam (F.S.L = EL.55.0) + Min. Co Bi Dam (F.S.L = EL 32.0)	460 182 45	312 182 -	6,951 4,720 -	Satisfied	Satisfied	- Ditto - Satisfied	Satisfied	Acceptable -Ditto- Acceptable	Acceptable -Ditto- Acceptable	97.0 30.0 10.0 137.0	15.9% (B/C=1.48)	- All technical requirements are satisfied. - Acceptable from environmental aspects. - Economic viability becomes less than Case I-B.2. Not Better than Case I-B.2
I-C.8 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Min. Huu Trach Dam (F.S.L = EL. 50.0) + Co Bi Dam (F.S.L = EL.40.0)	460 105 167	312 105 -	6,951 3,600 -	Satisfied	Not Satisfied	- Ditto - Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.9 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Min. Huu Trach Dam (F.S.L = EL.50.0) + Min. Co Bi Dam (F.S.L = EL.32.0)	460 105 45	312 105 -	6,951 3,600 -	Satisfied	Not Satisfied	- Ditto - Satisfied	Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
I-C.10 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Diversion Channel + Parapet Wall	460 - -	312 - -	6,951 3,000 2,000	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	1) Slight (Bach Ma) by Ta Trach 2) Medium by parapet wall 3) Unclear on negative/positive direction by Ta Trach 3) Slight by div. channel Acceptable	4) Medium by Ta Trach (4-5 thou. population or less) 4) Large by div. channel (20 thou. population at least) 5) Large by div. channel 6) Medium by parapet wall Not Acceptable			(Screened out due to "Not Acceptable" from social environmental aspect)
I-C.11 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Diversion Channel + Parapet Wall + Co Bi Dam (F.S.L = EL.40.0)	460 - - 167	312 - - -	6,951 3,000 2,000 -	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 0m ³ /s Total : 0m ³ /s Satisfied	Satisfied	1) Slight (Bach Ma & Phong Dien) by Ta Trach & Co Bi 2) Medium by parapet wall 3) Unclear on negative/positive direction by Ta Trach & Co Bi 3) Slight by div. channel Acceptable	4) Medium by Ta Trach (4-5 thou. population or less) 4) Unclear by Co Bi but less than Ta Trach 4) Large by div. channel (20 thou. population at least) 5) Large by div. channel 6) Medium by parapet wall Not Acceptable			(Screened out due to "Not Acceptable" from social environmental aspect)
I-C.12 Min. Ta Trach Dam (S.W.L = EL. 50.0) + Diversion Channel + Parapet Wall + Min. Co Bi Dam (F.S.L = EL 32.0)	460 - - 45	312 - - -	6,951 3,000 2,000 -	Satisfied	Satisfied	- Ditto - Satisfied	Satisfied	-Ditto- Acceptable	-Ditto- Not Acceptable			(Screened out due to "Not Acceptable" from social environmental aspect)
II. Without Dam												
II-1 Diversion Channel x 2 + Parapet Wall + Retarding Basin + Diversion Tunnel	- - - -	- - - -	6,000 2,000 400 350	Not Satisfied	Not Satisfied	Huong: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	(Screened out due to "Not Satisfied" for essential technical requirements)				
II-2 Diversion Channel x 3 + Parapet Wall + Retarding Basin + Diversion Tunnel + Freshwater Production Facilities (219 MCM/annum in average)	- - - - -	- - - - -	9,000 2,000 400 350 -	Satisfied	Satisfied	Huong: 0m ³ /s Bo : 1,005m ³ /s Total : 1,005m ³ /s Satisfied	Not Satisfied	1) None 2) Medium by parapet wall 3) Medium by 3 div. channels Acceptable	4) Very large by 3 div. channels (60 thou. population at least) 5) Large by 3 div. channels 6) Medium by parapet wall Not Acceptable	52.0 x 3 1.3 13.0 68.9 239.2 US\$438 mil/yr (Freshwater production cost)	(B/C=0.1)	- Essential technical requirements are satisfied. - Not acceptable from environmental aspects. - Economic viability is extremely low. Not Justifiable Economically

Note: - 2/ : Essential requirements from technical aspects - IR: Irrigation, WS: Water supply, HY: Hydropower, D/S: Downstream

Table 8.2 Agricultural Development Direction in Thua Thien Hue Province (1/2)

Sector	Development Direction	Target in 2010(Annual Production)	Approach
Food Crops (Paddy)	Food security	Annual production of 25,000 ton, equivalent to 200 kg per capita. Expansion of area under 2 crops of paddy per annum through development and improvement of 26,000 ha paddy field.	<ul style="list-style-type: none"> - Development of infrastructure (expansion and rehabilitation of irrigation and drainage, protection from early flood, farm road network, post harvest facilities), - Improvement of farming practice (new variety, pest control, crop management, etc.) - Rural community development to improve living standard of farmers and rural population,
(Other Food Crop)		Expansion of cropped area of maize, cassava and potato in hilly area, 5 districts of 1) Phong Dien, 2) Huong Thy, 3) Huong Tra, 4) Nam Dong and 5) A Luoi.	<ul style="list-style-type: none"> - Expansion of irrigation area for dry season crop in flat to gently sloped area, - Improved farming practice (new variety, pest management, etc.) - Rural community development (- do -)
Annual Industrial Crops	Export	Groundnut: annual production of 5,000 ha Tobacco: 1,500 ha to 1,800 ha	- do -
Perennial Crop (Rubber)	Export and vegetation cover on slopes	Rubber: annual production of 3,300 ton in the form of rubber latex 5,500 ha in hilly area of districts 1) Nam Dong, 2) Phong Dien (Phong Son and Hoa My).	<ul style="list-style-type: none"> - Conversion of low productive annual crop land into perennial crop land, particularly steep slopes, - Development of infrastructure (nursery production, access road, collection center, post harvest, storage, marketing, transport)
(Horticulture)	Domestic consumption, tourist demand, vegetation cover on slopes	5,000 ha of spice and semi-tropical fruits (pepper, orange, lemon, persimmon, banana, etc.)	<ul style="list-style-type: none"> - Conversion of land (- do -) - Development of infrastructure for production and marketing,

Table 8.2 Agricultural Development Direction in Thua Thien Hue Province (2/2)

Sector	Development Direction	Target in 2010(Annual Production)	Approach
Livestock	Domestic consumption (watershed management) and forest products	280,000 heads of pigs, 35,000 heads of cattle, 35,000 heads of buffalo, increase of chicken eggs,	<ul style="list-style-type: none"> - Technical improvement (artificial insemination, rearing practice, etc.), - Development and improvement of infrastructure (improvement of grass land, rearing and grazing facilities, veterinary services, livestock health care, marketing, transportation)
Forest	Vegetation cover on slopes	Total forest area of 305,000 ha, of which 190,000 ha in natural forest and 115,000 ha in plantation	<ul style="list-style-type: none"> - Natural forest: acceleration of natural re-generation, protection from disease/ insect/ fire, reduction of crop cultivation on steep slopes, introduction of agro-forestry, - Plantation: development of nursery facilities, technical training for forest farmers, - Forest community development for watershed management (- do -),
Fishery			
(Marine Catch)	Domestic consumption and export	Annual production of 17,600 ton	<ul style="list-style-type: none"> - Improvement and development of infrastructure (fishery port, cold store, wholesale market, processing, transport) - Technical and managerial training of fishermen and organizing fishermen's group, - Fishermen's community development (- do-),
(Aqua culture)	Export and increase of farm income	Annual production of 4,800 ton in 4,500 ha for brackish water and 2,100 ha of fresh water.	<ul style="list-style-type: none"> - Careful expansion of aqua-culture in lagoon and mangrove area. - Development of basic infrastructure (supply of seed flies and nurseries, applied research, extension of technology, marketing and processing) - Technical training of aqua culture farmers, organizing farmers group, - Aqua culture farmers' community development (- do-),

Source: 2010 target stated in the Agriculture of Vietnam, 61 Provinces and Cities, National Institute of Agriculture Planning and Projection, 2001, with modification by the JICA Study Team, February 2002.

Table 8.3 Water Resource Related Agricultural Development Project in the Huong River Basin (1/2)

Project	Status	Location	Feature and Component	Remarks
1. Projects related to Ta Trach Reservoir				
1.1 Irrigation Rehabilitation and Drainage Improvement in downstream area of Ta Track Reservoir	Feasibility study completed in August 2000.	About 40,000 ha in gross extending over down-stream area of Ta Trach Reservoir. Net irrigation area of 25,900 ha on the low flood plains of the Bo and Huong Rivers.	- Rehabilitation of irrigation facilities, - Improvement of drainage, - Protection of flood, tidal wave and salt water intrusion.	- Increasing of cropping intensity (present 178% to future 200%). - 9,053 ha to be irrigated by the Bo River, and 16,847 ha by the Huong River
1.2 Thao Long Barrage	Construction on going.	Barrage located in the mouth of the Huong River	- Construction of dam, gates, shipping lock and a bridge - 15 gates with one way flap	- To prevent salt water intrusion - To store fresh water in the river channel
1.3 Settlement of Household from the proposed Ta Trach Reservoir	Preliminary settlement plan completed in June 1999. To be implemented by the province	Two communes (340 households) in Duong Hoa and Nam Dong communes of Nam Dong District.	- Establishment of infrastructure for rural community for settlers - Introduction of industrial crops along with food crops for income generation of settlers	- Industrial crops of sugarcane, pineapple, coffee and rubber. - Social support to be attached for organizing community - Agro-processing industries to be established (sugarcane mill under operation).
1.4 Watershed Management and Forest Community Development	Preliminary study	Upstream area of the river basin	- 45,000 ha for natural re-generation and - 70,000 ha of forest plantation	- Agro-forestry for income generation of local habitants - Forest community development to be applied for local population.

Table 8.3 Water Resource Related Agricultural Development Project in the Huong River Basin (2/2)

Project	Status	Location	Feature and Component	Remarks
1.2 Truoi Reservoir	Construction on going, and to be completed in 2002.	Truoi River in the south-eastern part of the province.	<ul style="list-style-type: none"> - Total irrigation area of 1,100 ha on right bank and 6,900 ha on left bank - Left bank including the area irrigated by the Huong River. 	<ul style="list-style-type: none"> - Diversion of water from to the Nong River. - Existing intake in the Nong River to be utilized.
2. Co Bi Irrigation Project	Preliminary study	Co Bi hamlet in the middle reach of the Bo River	<ul style="list-style-type: none"> - Intake for irrigation purpose 	<ul style="list-style-type: none"> - Irrigation area to be identified
3. Small Scale Irrigation Development	under consideration	Small area sporadically located in small spots	<ul style="list-style-type: none"> - Expansion of irrigation area in paddy field, upland crop field, and tree crops 	<ul style="list-style-type: none"> - Water source and irrigation area to be identified - Components for rural community development to be accompanied.
4. Fishery Development in the Existing Reservoirs	under consideration	Water surface of existing reservoirs	<ul style="list-style-type: none"> - Fish catch in the reservoir with release of fish fries 	<ul style="list-style-type: none"> - Intensive culture to be avoided for water quality deterioration - Rural community development to be attached
5. Shrimp and Fish Culture Development in Brackish Water Area	under consideration	Cultivated land along the coastal line, particularly land affected by salt water	<ul style="list-style-type: none"> - Conversion of low productive crop land to aqua culture ponds 	<ul style="list-style-type: none"> - Increase of productivity of land - Excessive expansion of aqua culture to be prevented in lagoon area - Rural community development to be attached with social support

Table 8.4: Sub-Areas with Command Area, Main Intake and Main Outlet

HUONG RIVER IRRIGATION SCHEME							
25,900 ha total							
Huong River North Network (Huong North)				Huong River South Network (Huong South)			
12,559 ha				13,341 ha			
Name of sub-scheme	Irrig.-area (ha)	Main irrig. intake	Main drainage outlet	Name of sub-scheme	Irrig.-area (ha)	Main irrig. intake	Main drainage outlet
		Bo River				Huong River	
Phong Son	185	left bank	Bo River	Thui Bieu	168		Huong River
Lai Bang	615	right bank	Bo River				
Co Bi	540	left bank	Bo River				
Bo Auen	304	left bank	Bo River				
Loi Thanh	60	right bank	Bo River	B14	42	left bank	Cau Long Outlet
Phong Hien	300	left bank	Bo River	Thuy Van	564	right side sub-branch	Cau Long Outlet
Vinh Phu	944	left bank	Bo River	B1	435	right side sub-branch	Cau Long Outlet
Phu Thanh	250	right bank	Bo River	B60	60	left bank	Cau Long Outlet
		<i>Bo River right bank branch to south</i>					
Phu O	357	end of branch	Bo River	B7	La Y	130	left bank
La Chu	308	right side of branch	Bo River	B6	La Y	590	left bank
Dong Xuan	404	right bank	Bo River	B5	La Y	154	right bank
Tan Thanh	510	left bank	Bo River	Phu Dong	La Y	200	left bank
		<i>Bo River right side branch to south</i>		B4	La Y	233	end of branch
Trieu Son Tai	415	left side of branch	Bo River				Cau Long Outlet
Trieu Son Trung	750	end of branch	Bo River				
		<i>branch to An Xuan and Ha Do outlets</i>		Phu Thuong		564	left bank
Bac Vong	126	left bank	An Xuan outlet	My An		338	left bank
Niem Pho	750	left bank	An Xuan outlet	Su Lo		868	left bank
Phu Long B	150	left bank	An Xuan outlet	B3		480	left bank
Phu Long A	505	right bank	An Xuan outlet	Thuy Thanh		425	left bank
An Xuan	117	left bank	An Xuan outlet	Phu Ho		100	left bank
		<i>sub-branch to Ha Do</i>		B8		420	left bank
An Gia I	150	left bank	Ha Do Outlet				
Phuoc Ly	334	right bank	Ha Do Outlet	Thuy Dong		2,087	right bank
An Gia II	271	right bank	Ha Do Outlet	Phu Luong		770	left bank
Cu Lac	1,398	end of sub-branch	small outlets to lagoon				
		<i>sub-branch to Quan Cua</i>		Phu Da	Truoi	540	left bank
Thanh Ha	150	right bank	Quan Cua Outlet	B10	Truoi	147	left bank
Phong An	124	right bank	Quan Cua Outlet	N5	Truoi	555	right bank
Trieu Thanh	255	right bank	Quan Cua Outlet	B11	Truoi	340	left bank
An Lai	263	left bank	Quan Cua Outlet	N6	Truoi	1,472	left side of branch
Kim Doi	348	right bank	Quan Cua Outlet	N11	Truoi	357	left side of branch
		Nham Bieu Intake (Huong River)					
Huong Long	450	right side sub-branch	Huong (or Bo River)				
Bo Pho	419	right side of branch	Huong (or Bo River)	B12	Truoi	812	left bank
An Luu	807	end of branch	Huong (or Bo River)	B16	Truoi	490	left bank

Table 8.5: Overall Irrigation and Drainage Requirements

Irrigation and Drainage requirements

Irrigation requirements		1.80 l/s.ha				Runoff	
Rainfall		150 mm				low lands uplands hills	
1-day rainfall =		175 mm				cultivatednon-cultivated	
2-day= 25+150 or 150+25=		200 mm				% %	
3-day= 25+150+25=							
Outside inflow		80 km ² =		8,000 ha, Nong River catchment		100 100	
(upland)		60 km ² =		6,000 ha, total catchment		5 5	
				other small rivers		25 25	
1-day		2-days		3-days		5 10	
low lands uplands		low lands uplands		low lands uplands		-----	
150 150		175 175		200 200		65 60	
98 90		114 105		130 120		% discharge via drainage system	
975 900		1,138 1,050		1,300 1,200		rainfall [mm]	
						runoff [mm]	
						volume [m ³ /ha]	

HUONG RIVER IRRIGATION SCHEME											
25,900 ha total											
Huong River North Network			Huong River South Network				Total				
12,559			13,341				25,900		ha irrigation/ drainage		
0			14,000				14,000		ha outside inflow		
Irrigation requirements:											
22.61			24.01				46.62		m3/s		
Drainage requirements			Volumes to be drained								
1 day (1-24 hour) rainfall			2 days (24-48 hours) rainfall			3 days (48-72 hours) rainfall					
north	south	total	north	south	total	north	south	total			
12,245	13,007	25,253	14,286	15,175	29,461	16,327	17,343	33,670	volume (1000 m3)		
0	12,600	12,600	0	14,700	14,700	0	16,800	16,800	volume (1000 m3)		
Required drainage capacity											
86,400			129,600							sec	
drainage in 1 day (24 hrs)			drainage in 1.5 days (36 hrs)								
north	south	total	north	south	total	north	south	total			
142	151	292	110	117	227	63	67	130	low land drainage Q (m3/s)		
0	146	146	0	113	113	0	65	65	upland inflow Q (m3/s)		
142	296	438	110	231	341	63	132	195	total Q (m3/s)		
172,800			216,000							259,200	
Drainage in 2 days (48 hrs)			Drainage in 2.5 days (60 hrs)			Drainage in 3 days (72 hrs)			sec		
north	south	total	north	south	total	north	south	total			
83	88	170	76	80	156	63	67	130	drainage Q (m3/s)		
0	85	85	0	78	78	0	65	65	inflow Q (m3/s)		
83	173	256	76	158	234	63	132	195	total Q (m3/s)		

Table 8.6: Sub-Area with Irrigation Water Demand and Pump Capacities

HUONG RIVER IRRIGATION SCHEME												
25,900 ha total												
Huog River North Network (Huog North)						Huog River South Network (Huog South)						
12,559 ha						13,341 ha						
Name of sub-scheme	Irrig.-area (ha)	Design irrigation (l/s/ha)	m ³ /s	Min.pump capacity*)		Name of sub-scheme	Irrig.-area (ha)	Design irrigation (l/s/ha)	m ³ /s	Min.pump capacity*)		
				m ³ /s	(m ³ /hr)					m ³ /s	(m ³ /hr)	
Phong Son	185	1.41	0.26	0.39	1,409	Thui Bieu	direct	168	1.41	0.24	0.36	1,279
Lai Bang	615	1.41	0.87	1.30	4,683							
Co Bi	540	1.41	0.76	1.14	4,112	B14	PCam	42	1.41	0.06	0.09	320
Bo Auen	304	1.41	0.43	0.64	2,315	Thuy Van	PCam	564	1.41	0.80	1.19	4,294
Loi Thanh	60	1.41	0.08	0.13	457	B1	PCam	435	1.41	0.61	0.92	3,312
Phong Hien	300	1.41	0.42	0.63	2,284	B60	PCam	60	1.41	0.08	0.13	457
Vinh Phu	944	1.48	1.40	2.10	7,544	B7	La Y	130	1.41	0.18	0.27	990
Phu Thanh	250	1.41	0.35	0.53	1,904	B6	La Y	590	1.41	0.83	1.25	4,492
						B5	La Y	154	1.41	0.22	0.33	1,173
Phu O	357	1.41	0.50	0.76	2,718	Phu Dong	La Y	200	1.41	0.28	0.42	1,523
La Chu	308	1.41	0.43	0.65	2,345	B4	La Y	233	1.41	0.33	0.49	1,774
Dong Xuan	404	1.41	0.57	0.85	3,076							
Tan Thanh	510	1.41	0.72	1.08	3,883	Phu Thuong	PCam	564	1.41	0.80	1.19	4,294
						My An	PCam	338	1.41	0.48	0.71	2,574
Trieu Son Tai	415	1.41	0.59	0.88	3,160	Su Lo	PCam	868	1.48	1.28	1.93	6,937
Trieu Son Trung	750	1.48	1.11	1.67	5,994	B3	PCam	480	1.41	0.68	1.02	3,655
						Thuy Thanh	PCam	425	1.41	0.60	0.90	3,236
Bac Vong	126	1.41	0.18	0.27	959	Phu Ho	PCam	100	1.41	0.14	0.21	761
Niem Pho	750	1.48	1.11	1.67	5,994	B8	PCam	420	1.41	0.59	0.89	3,198
Phu Long B	150	1.41	0.21	0.32	1,142							
Phu Long A	505	1.41	0.71	1.07	3,845	Thuy Dong	PCam	2,087	1.48	3.09	sub-scheme	
An Xuan	117	1.41	0.16	0.25	891							
						Phu Luong	PCam	770	1.48	1.14	1.71	6,154
An Gia I	150	1.41	0.21	0.32	1,142	Phu Da	Truoi	540	1.41	0.76	1.14	4,112
Phuoc Ly	334	1.41	0.47	0.71	2,543	B10	Truoi	147	1.41	0.21	0.31	1,119
An Gia II	271	1.41	0.38	0.57	2,063	N5	Truoi	555	1.41	0.78	1.17	4,226
Cu Lac	1,398	1.48	2.07	3.10	11,173	B11	Truoi	340	1.41	0.48	0.72	2,589
						N6	Truoi	1,472	1.48	2.18	3.27	11,764
Thanh Ha	150	1.41	0.21	0.32	1,142	N11	Truoi	357	1.41	0.50	0.76	2,718
Phong An	124	1.41	0.17	0.26	944							
Trieu Thanh	255	1.41	0.36	0.54	1,942	B12	Truoi	812	1.48	1.20	1.80	6,490
An Lai	263	1.41	0.37	0.56	2,002	B16	Truoi	490	1.41	0.69	1.04	3,731
Kim Doi	348	1.41	0.49	0.74	2,650							
Huong Long	NBieu	450	1.41	0.63	0.95	3,426						
Bo Pho	NBieu	419	1.41	0.59	0.89	3,190						
An Luu	NBieu	807	1.48	1.19	1.79	6,450						
Note: peak demand		1.41	l/s.ha for areas < 600 ha									
		1.48	l/s.ha for areas > 600 ha									
sub-total direct	10,883	ha	15.61	m³/s		sub-total direct	168	ha	0.24	m³/s		
sub-total NhamBieu	1,676		2.42			sub-total Phu Cam	7,153		10.35			
sub-total	12,559	ha	18.03	m³/s		sub-total La Y	1,307		1.84			
total Huog North	12,559	ha	18.03	m³/s		sub-total Truoi	4,713	ha	6.81			
total Huog South						13,341	ha	19.23				
Proposed pump capacities (example)	250	500	1,000	1,500	2,000	2,500	(m ³ /hr)					
	0.07	0.14	0.28	0.42	0.56	0.69	m ³ /s					
Required irrigation capacity	0.05-0.1	0.1-0.2	0.2-0.4	0.4-0.6	0.6-0.9	0.9-1.2	m ³ /s					
Proposed pumps	2@ 250	2@ 500	2@1000	2@1500	2@2000	2@2500	no@m ³ /hr					
Total pump capacity	0.14	0.28	0.56	0.83	1.11	1.39	m ³ /s					
<alternative>			4@ 500	3@1000	3@1500	3@2000						
<alternative>			0.56	0.83	1.25	1.67						
					4@1000	4@1500						
					1.11	1.67						
*) Irrigation pumps may run during peaks 20 out of 24 hours >> more realistic will be 04:00-20:00, i.e. 16 hrs per day												
>> minimum pump capacity 24/16*100= 1.50 x design irrigation capacity												

Table 8.7: Drainage Discharge Requirements (Dry Season) for Main Outlets

Irrigation and Drainage Requirements

Irrigation requirements:		1.80 l/s.ha				Runoff	
Rainfall	1-day rainfall =	150 mm				low lands	uplands hills
	2-day= 25+150 or 150+25=	175 mm				cultivated	non-cultivated
	3-day= 25+150+25=	200 mm				%	%
Outside inflow:	80 km2 =	8,000 ha, Nong River catchment		100	100		
(upland)	60 km2 =	6,000 ha, total catchment		5	5	intercepted by vegetation	
		other small rivers		25	25	storage on fields, canals, drains	
						infiltration in soil	
1-day	2-days	3-days		5	10	storage in reservoirs, depressions	
low lands	uplands	low lands	uplands	low lands	uplands		
150	150	175	175	200	200	mm rainfall	
98	90	114	105	130	120	mm runoff	
975	900	1,138	1,050	1,300	1,200	vol. [m3/ha]	
				65	60	% discharge via drainage system	

HUONG RIVER IRRIGATION SCHEME

25,900 ha total

HUONG RIVER IRRIGATION SCHEME																
Huong River North Network (Huong North)								Huong River South Network (Huong South)								
12,559 ha								13,341 ha								
Main outlet	Huong R.	Bo River	Lagoon direct	Ha Do outlet	An Xuan outlet	Quan Cua outlet	North total	Huong R.	2no's DP	Lagoon	Cau Long	Vung Cau Hai DP	Cong Cuan outlet	South total		
Contributing sub-areas (ha)	807	615	cont'd	1,398	150	126	348	168	130	868	564	490	2,087	cont'd	ha	
	419	185	357		271	750	255		154		60		425	812	ha	
	450	540	308		334	150	124		590		42		100	147	ha	
		304	404			505	263		200		564		420	340	ha	
		60	510			117			233		435		770	555	ha	
		300	750			150					338		540	1,472	ha	
		944	415								480			357	ha	
Total area (ha) per outlet	1,676	250	5,942	1,398	755	1,798	990	12,559	168	1,307	868	2,483	490	8,025	13,341	ha
Peak volume:																
1-day rain	1,634		5,793	1,363	736	1,753	965	12,245	164	1,274	846	2,421	478	7,824	13,007	x1000 m ³
2-day rain	1,906		6,759	1,590	859	2,045	1,126	14,286	191	1,487	987	2,824	557	9,128	15,175	x1000 m ³
3-day rain	2,179		7,725	1,817	982	2,337	1,287	16,327	218	1,699	1,128	3,228	637	10,433	17,343	x1000 m ³
outside inflow:																
1-day inflow		0	0	0	0	0	0	0	0	0	0	0	0	12,600	12,600	x1000 m ³
2-day inflow		0	0	0	0	0	0	0	0	0	0	0	0	14,700	14,700	x1000 m ³
3-day inflow		0	0	0	0	0	0	0	0	0	0	0	0	16,800	16,800	x1000 m ³
Discharge:																
in 1-day	19	67	16	9	20	11	142	2	15	10	28	6	236	296	m ³ /s	
in 1.5-days	15	52	12	7	16	9	110	1	11	8	22	4	184	231	m ³ /s	
in 2-days	11	39	9	5	12	7	83	1	9	6	16	3	138	173	m ³ /s	
in 2.5-days	10	36	8	5	11	6	76	1	8	5	15	3	126	158	m ³ /s	
in 3-days	8	30	7	4	9	5	63	1	7	4	12	2	105	132	m ³ /s	
	*)	*)	*)	**)	**)	**)		*)	**)	*)						

*) different outlets

**) reduction by local outlets

Table 9.1 Summary of Laboratory Test Results on Earth Materials of the Proposed Borrow Areas

Borehole No.	Layer	Gs	BD kN/m ³	DD kN/m ³	MC %	Gradation				Atterberg Limit			Remolding condition				Parameters after remolding				Remarks
						Clay	Silt	Sand	Gravel	LL	PL	LI	BDR	MBDR	Wr	Wop	c	φ	Mv	K	
						%	%	%	%	%	%	%	kN/m ³	kN/m ³	%	%	kN/m ²	degree	10 ⁻⁴ m ² /kN	10 ⁻⁵ cm/s	
VD-I	2b	2.67	18.30	15.50	18.45	21	27	49	3	34.5	17.5	17.0	17.0	17.8	16.0	15.5	24.0	16.0	0.9	0.1	
	3b	2.74	17.40	14.10	23.10					38.3	20.0	18.3	18.5	16.8	15.0	19.2	20.0	18.0	1.5	5.0	
VD-II	2b	2.71	18.70	15.20	23.86					40.6	23.5	17.1	16.5	16.3	19.0	21.6	25.0	15.0	1.6	1.0	
	3b	2.77	18.90	15.70	21.05					40.2	25.3	14.9	18.5	17.1	15.0	19.3	20.0	18.0	1.7	5.0	
VD-III	2b	2.70								41.0	24.7	16.3	16.0		21.0		25.0	15.0	2.0	0.1	
VD-IV	2b	2.69	16.60	13.70	20.70					31.8	19.6	12.2	16.5		17.0		20.0	18.0	1.6	1.0	
VD-V	2b	2.69								27.5	16.3	11.2	17.0		17.0		20.0	16.0	2.2	1.0	
VD-VI	2b	2.79	17.50	14.60	20.00					37.7	20.0	17.7	16.3	16.7	18.0	19.0	30.0	15.0	1.2	0.1	
	3b	2.69	18.50	15.50	19.00					30.0	16.0	14.0	17.4	19.0	17.0	11.0	30.0	20.0	0.8	0.1	
VD-VII	3b	2.79	18.90	15.30	24.08					42.2	27.2	15.0	18.5	16.3	15.0	22.3	20.0	20.0	1.6	5.0	
VDP-II	3b	2.69								28.5	14.5	14.0	17.4		15.0		20.0	18.0	1.5	1.0	

Note: GS=Specific gravity, BD=Bulk density, DD=Dry density, MC=Moisture Content, LL=Liquid Limit, PL=Plastic Limit, PI=Plasticity Index, BDR=Bulk density after remolded, MBDR=Maximum bulk density after remolded, Wr=Water content after remolded, Wop=Optimum water content, c=Cohesive soil, φ=internal friction angle, Mv=Coefficient of volume compressibility, K=Permeability coefficient.

1kgf/m³=10N/m³, 1kgf/cm²=100kN/m², 1cm²/kg=0.01m²/kN.

Table 9.2: Rehabilitation and Additional Works

HUONG RIVER IRRIGATION SCHEME 25,900 ha			Huong North: 12,569 ha Huong South: 13,341 ha	
Item	Rehab./new quantity	Rehabilitation and/or new civil works	Remarks	
(1) Rivers				
Improvement Bo River *)	0 km	dredging/ bank protection/ etc.	depends on recommendations of flood control study	
Improvement Huong River *)	0 km	dredging/ bank protection/ etc.		
(2) Dams and Reservoirs				
<i>main dams & barrage</i>				
Thao Long Barrage *)	0 no	barrage w. bridge under construction	responsibility of Huong River Enterprises	
Ta Trach Dam *)	0 no	dam & other works planned		
Truoi Dam *)	0 no	construction nearly completed		
<i>small dams</i>				
Phu Bai Dam *)	0 no	rehabilitation (nearly) completed		
Khe Nuoc Dam	0 no	dam & other works planned		
Chau Son Dam	0 no	none; assumed in good condition		
minor dams	0 no	none; assumed in good condition		
(3) Main canal/ drain network				
main canals/ drains	(excluding Huong and Bo rivers) 50 km	re-shaping/ dredging		responsibility of Huong River Enterprises
(4) Main inlets and outlets				
<i>main inlets on Huong River</i>				
Nham Bieu, with supporting pumping station *)	0 no	none; constructed 1996	responsibility of Huong River Enterprises 4@2.50; vert.gates and 2 pumps	
Phu Cam *)	0 no	none; old, but good condition	6@4.00; flap gates	
Dap Da *)	0 no	none; dam with road	22@2.50; doors 2@2.50; lift gates	
La Y spillway, combined with inlet sluice *)	0 no	none; recently rehabilitated		
<i>main outlets on lagoon</i>				
<i>North Huong Area</i>				
Quan Cua	0 no	rehabilitation completed	2@2.20; vert.gates	
An Xuan	0 no	rehabilitation completed	2@2.50; vert.gates	
Ha Do *)	0 no	bad condition; demolish	2@2.2+1@2.5;vert.gates	
<new Cau Long;to be planned>	1 no	new/replace; increase capacity		
<i>South Huong Area</i>				
Cong Quan *)	0 no	none; good condition; capacity too small	12@2.20; doors	
<additional Cong Quan;planned>	1 no	new; additional to Cong Quan		
Cau Long *)	0 no	bad condition; demolish	6@3.00; lift+flap gates	
<new Cau Long;to be planned>	1 no	new/replace; increase capacity		
<i>Small outlets</i>				
small outlets	25 no	new/ replace	1 opening w. vert.gate	
<i>flood regulators on Bo River</i>				
regulators	2 no	new; to be designed		
(5) Pumping stations				
pump houses	10 no	major maintenance/ reconstruct	responsibility of - - - -	
pumps & engines	80 no	replace/ additional		
(6) Embankments and roads 1)				
dikes along Huong River	0 km	earthwork and protection	responsibility of - - - - flood control study	
dikes along Bo River	0 km	earthwork and protection		
dikes along main canals/ drains	200 km	re-shape	flood control study	
lagoon dikes	30 km	re-shape & slope/ crest protection		
(7) Secondary system				
secondary canals (d/s of pumping station)	500 km	re-shaping and lining	responsibility of - - - -	
secondary drains	200 km	re-shaping		
(8) Tertiary system; on-farm works 2)				
structures in canals/ drains/ etc. }	25,900 ha		responsibility of communes, etc.	
tertiary canals/ drains/ dikes }				
on-farm works }				
(9) Fishponds 3)				
supply canals, discharge drains	0 km	construct/ re-shape	respons. of private organisations	
inlet/ outlet structures	0 no	construct/ re-shape		
ponds	0 ha	(re)-excavation		
NOTES:			*) works inspected during field trips	
1) rehab. length is total of both sides				
2) rehabilitation tertiary system: av.cost/ha , based on av.no/km density per ha				
3) fishponds are constructed, operated, maintained, etc. by private organisations				

Table 9.3: Capacities of Irrigation Pumping Stations

Pumping Station	Constr. year	Irrigation capacity		pract/ /theor (%)	Pumping Station	Constr. year	Irrigation capacity		pract/ /theor (%)
		Theoretical (ha)	Practical (ha)				Theoretical (ha)	Practical (ha)	
Hue Suburb					Huong Thuy District				
1 An Hoa	1986	400	200	50	1 Thuy Bang	1978	50	10	20
2 Huong Long	1984	300	170	57	2 Thuy Van 1	1982	240	125	52
3 Tho Xuan	1993	78	40	51	3 Thuy Van 2	1990	150	125	83
4 An Dong	1992	163	160	98	4 Thuy Thanh	??	??	150	--
5 An Tay	1992	73	70	96	5 Thuy Thanh	1984	300	300	100
6 Xuan Phu	1992	75	70	93	6 Thuy Duong	1985	300	200	67
7 Bai Dau	1993	39	10	26	7 Thuy Chau 1	1984	??	??	--
8 Vi Da	1985	50	50	100	8 Thuy Chau 2	1992	73	50	68
9 Thuy Bieu	1978	50	50	100	9 Thuy Chau 1	1992	50	30	60
Phu Vang District					10 Thuy Tan	1994	50	30	60
1 Phu Ho	1983	??	??	--	11 Thuy Phu 2	1992	50	??	--
2 Su Lo	1988	250	180	72	12 Thuy Luong	1984	??	??	--
3 Phu Da 1	1987	150	100	67	13 Tan Khai	??	??	??	--
4 Phu My 1	1980	300	200	67	Phu Loc District				
5 Phu My 2	1991	150	80	53	1 Loc An 1	1992	??	??	--
6 Phu Thuong	1977	250	137	55	total area 3,911 2,647 68 (except Thuy Thanh 1 & Thuy Phu 2)				
7 Phu Duong	1977	100	100	100					
8 Phu Luong 3	1984	??	??	--	1986 = older than 10 years (21 no's; 62%)				
9 Vinh Thao 3	1993	??	??	--	1992 = 10 years (7 no's; 21%)				
10 Vong Tri	1993	150	110	73	1994 = younger than 10 years (6 no's; 18%)				
11 Phu Mau 1	1993	120	50	42					

Source: Agricultural Service '94

Table10.1 Average Annual Workable Days (Earthwork), Huong River (1/2)

Data period: 1991- 2000

Daily Rainfall (mm)	Number of Rainy Days according to Rainfall Depth												Total	Suspended Day due to	Actual Waiting
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Less than 3mm	24.1	22.7	27.5	24.4	20.2	20.5	23.3	22.7	16.4	13.2	15.1	15.6	245.7	0.0	0.0
3.1 - 5.0mm	1.7	1.3	1.0	1.7	1.9	1.2	1.1	1.2	1.7	1.9	1.4	1.7	17.8	0.0	0.0
5.1 - 10.0mm	1.7	1.5	1.0	1.0	2.7	2.4	1.7	2.4	2.9	2.7	2.8	3.2	26.0	1.0	26.0
10.1-20.0mm	2.1	1.9	1.1	1.3	2.6	2.7	2.6	2.4	3.3	3.1	2.8	2.5	28.4	1.0	28.4
20.1 - 50.0mm	1.2	0.6	0.3	1.1	3.1	2.6	2.1	1.7	3.4	3.5	3.8	5.8	29.2	1.5	43.8
50.1 - 100.0mm	0.2	0.0	0.1	0.5	0.4	0.5	0.2	0.4	1.2	2.9	1.9	1.2	9.5	2.5	23.8
100.1 - 240.0mm	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.9	2.6	1.5	0.9	6.2	3.5	21.7
More than 240mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.1	0.7	0.1	2.2	4.5	9.9
Total	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0	-	153.6

Station : Nam Dong

Suspended Day	6.1	4.3	2.8	5.2	11.3	10.6	8.0	9.2	18.4	32.4	24.5	21.0	153.6
Sunday	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	4.0	4.0	5.0	4.0	52.0
Holiday	1.0	3.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	8.0
Working day	19.9	16.7	23.2	19.8	14.7	14.4	19.1	16.9	6.7	-5.4(0)	0.6	5.0	151.5

Annual workable days : 151 days/year 12.6 days/month
 Rainy season September-Dec : 3.1 days/month
 Dry season : 18.1 days/month

Table10.2 Average Annual Workable Days (Concrete Work), Huong River (2/2)

Data period: 1991- 2000

Daily Rainfall (mm)	Number of Rainy Days according to Rainfall Depth												Total	Suspended Day due to	Actual Waiting
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Less than 3mm	24.1	22.7	27.5	24.4	20.2	20.5	23.3	22.7	16.4	13.2	15.1	15.6	245.7	0.0	0.0
3.1 - 5.0mm	1.7	1.3	1.0	1.7	1.9	1.2	1.1	1.2	1.7	1.9	1.4	1.7	17.8	0.0	0.0
5.1 - 10.0mm	1.7	1.5	1.0	1.0	2.7	2.4	1.7	2.4	2.9	2.7	2.8	3.2	26.0	0.0	0.0
10.1-20.0mm	2.1	1.9	1.1	1.3	2.6	2.7	2.6	2.4	3.3	3.1	2.8	2.5	28.4	0.5	14.2
20.1 - 50.0mm	1.2	0.6	0.3	1.1	3.1	2.6	2.1	1.7	3.4	3.5	3.8	5.8	29.2	1.0	29.2
50.1 - 100.0mm	0.2	0.0	0.1	0.5	0.4	0.5	0.2	0.4	1.2	2.9	1.9	1.2	9.5	2.0	19.0
100.1 - 240.0mm	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.9	2.6	1.5	0.9	6.2	2.0	12.4
More than 240mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.1	0.7	0.1	2.2	2.0	4.4
Total	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0	-	79.2

Station : Nam Dong

Suspended Day	2.7	1.6	1.1	2.8	5.4	5.2	3.8	4.1	9.7	18.3	13.4	11.5	79.2
Sunday	4.0	4.0	5.0	4.0	4.0	5.0	4.0	5.0	4.0	4.0	5.0	4.0	52.0
Holiday	1.0	3.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	8.0
Working day	23.4	19.5	25.0	22.3	20.6	19.9	23.2	21.9	15.4	8.8	11.6	14.6	225.8

Annual workable days : 226 days/year 18.8 days/month
 Rainy season September-Dec : 12.6 days/month
 Dry season : 22.4 days/month

Table 10.3 Disbursement Schedule for Maximum Ta Trach Reservoir Project (S.W.L = EL.52.0)

Unit: Million VND, Million US\$

Description	Total	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Direct Construction Cost																				
(1) General Items and Equipment	282,687					56,537	56,537				67,845	50,884	50,884							
(2) Main Dam	358,223						30,091	59,823	59,823	59,823	59,823	59,823	29,016							
(3) Spillway	271,242						27,124	54,248	54,248	54,248	27,124	27,124	27,124							
(4) Outlet Works	197,995						24,749	49,499	49,499	49,499	24,749									
(5) Saddle Dams	34,334					5,837	5,837			5,837	11,330	5,493								
(6) Hydropower	150,556											75,278	75,278							
Sub-total	1,295,037	0	0	0	0	62,374	144,338	163,570	163,570	169,407	190,872	218,603	182,302							
Equivalent to US\$	85.9																			
2. Indirect Construction Cost																				
(1) Resettlement Cost	162,243	40,561	40,561	40,561	40,561															
(2) Engineering Cost & Administration Cost	68,374			4,102	7,521	7,521	7,521	7,521	7,521	7,521	7,521	7,521	4,102							
(3) Price Escalation (4.9 % / Year)	758,329	1,987	4,072	6,892	10,140	18,887	50,487	68,051	79,769	95,202	121,704	156,592	144,545							
(4) Physical Contingency (10 %)	228,398	4,255	4,463	5,156	5,822	8,878	20,235	23,914	25,086	27,213	32,010	38,272	33,095							
Sub-total	1,217,344	46,803	49,096	56,711	64,044	35,286	78,242	99,486	112,376	129,936	161,235	202,385	181,743							
Equivalent to US\$	80.8																			
Total	2,512,381	46,803	49,096	56,711	64,044	97,660	222,581	263,057	275,947	299,343	352,106	420,987	364,045							
Equivalent to US\$	166.7																			
3. VAT(5 %)	105,043	0	0	237	455	4,439	10,117	11,957	12,543	13,607	16,005	19,136	16,547							
Equivalent to US\$	7.0																			
Total	2,617,424	46,803	49,096	56,948	64,499	102,099	232,698	275,014	288,490	312,950	368,111	440,123	380,592							
Equivalent to US\$	173.7	3.11	3.26	3.78	4.28	6.78	15.44	18.25	19.15	20.77	24.43	29.21	25.26							

Table 10.4 Disbursement Schedule for Maximum Huu Trach Reservoir Project (FSL: EL. 55.0)

Unit: Million VND, Million US\$

Description	Total	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Direct Construction Cost																				
(1) General Items and Equipment	67,649												13,530	13,530		16,236	12,177	12,177		
(2) Main Dam	93,941													11,743	23,485	23,485	23,485	11,743		
(3) Spillway	64,910													8,114	16,228	16,228	16,228	8,114		
(4) Outlet Works	47,382													11,846	23,691	11,846				
Sub-total	273,882												13,530	45,232	63,404	67,794	51,890	32,033		
Equivalent to US\$	18.2												0.9	3.0	4.2	4.5	3.4	2.1		
2. Indirect Construction Cost																				
(1) Resettlement Cost	40,000								10,000	10,000	10,000	10,000								
(2) Engineering Cost & Administration Cost	27,615										3,452	3,452	3,452	3,452	3,452	3,452	3,452	3,452		
(3) Price Escalation (4.9 % / Year)	329,467								4,662	5,381	8,252	9,316	13,168	41,986	63,760	74,767	63,634	44,541		
(4) Physical Contingency (10 %)	67,096								1,466	1,538	2,170	2,277	3,015	9,067	13,062	14,601	11,898	8,003		
Sub-total	464,179								16,129	16,919	23,874	25,044	19,635	54,505	80,273	92,821	78,984	55,995		
Equivalent to US\$	30.8								1.1	1.1	1.6	1.7	1.3	3.6	5.3	6.2	5.2	3.7		
Total	738,061								16,129	16,919	23,874	25,044	33,165	99,737	143,677	160,615	130,873	88,028		
Equivalent to US\$	49.0								1.1	1.1	1.6	1.7	2.2	6.6	9.5	10.7	8.7	5.8		
3. VAT(5 %)	30,393								0	0	278	292	1,507	4,533	6,531	7,301	5,949	4,001		
Equivalent to US\$	2.0								0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.5	0.4	0.3		
Total	768,454								16,129	16,919	24,153	25,336	34,672	104,270	150,208	167,915	136,822	92,029		
Equivalent to US\$	51.0								1.1	1.1	1.6	1.7	2.3	6.9	10.0	11.1	9.1	6.1		

Table 10.5 Disbursement Schedule of Irrigation and Drainage Facilities for Huong River Basin

Unit: Million VND, Million US\$

Description	Total	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Direct Construction Cost																				
(1) General Items	75,027					37,514	37,514													
(2) Improvement of Main Canal / Drain Network	27,245						1,362	2,588	2,588	2,588	2,588	2,588	2,588	2,588	2,588	2,588				
(3) Construction and Rehabilitation of Main Inlet and Outlet																				
(i) Rehabilitation of Main Outlet	180						9	17	17	17	17	17	17	17	17	17				
(ii) Newly Construction, Main	60,447						3,022	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742	5,742				
(iii) Replace of Small Outlet	2,997						150	285	285	285	285	285	285	285	285	285				
Sub-total	63,624						3,181	6,044	6,044	6,044	6,044	6,044	6,044	6,044	6,044	6,044				
(4) Pumping Stations																				
(i) Pump House	2,197						110	209	209	209	209	209	209	209	209	209				
(ii) Replace and Additional of Pumps & Engines	169,939						8,497	16,144	16,144	16,144	16,144	16,144	16,144	16,144	16,144	16,144				
Sub-total	172,136						8,607	16,353	16,353	16,353	16,353	16,353	16,353	16,353	16,353	16,353				
(5) Embankments and Road																				
(i) Dikes along Main Canals / Drains	43,592						2,180	4,141	4,141	4,141	4,141	4,141	4,141	4,141	4,141	4,141				
(ii) Lagoon Dikes	13,078						654	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242	1,242				
Sub-total	56,669						2,833	5,384	5,384	5,384	5,384	5,384	5,384	5,384	5,384	5,384				
(6) Secondary System																				
(i) Secondary Canals	136,224						6,811	12,941	12,941	12,941	12,941	12,941	12,941	12,941	12,941	12,941				
(ii) Secondary Drains	27,245						1,362	2,588	2,588	2,588	2,588	2,588	2,588	2,588	2,588	2,588				
Sub-total	163,469						8,173	15,530	15,530	15,530	15,530	15,530	15,530	15,530	15,530	15,530				
(7) Tertiary System / On-farm Works	192,102						9,605	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250				
Total of 1	750,272						37,514	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276				
Equivalent to US\$	49.8						2.5	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7				
2. Indirect Construction Cost																				
(1) Resettlement Cost	0			0	0	0	0	0	0	0	0	0	0	0	0	0				
(2) Engineering Cost	75,027			2,851	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,552	5,552				
(3) Administration Cost	22,508			855	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666	1,666				
(4) Price Escalation (4.9 % / Year)	607,527			572	1,522	1,950	14,871	31,221	36,596	42,236	48,152	54,357	60,867	67,696	74,859	82,373				
(5) Physical Contingency (10 %)	145,533			428	874	917	5,960	10,971	11,509	12,073	12,665	13,285	13,936	14,619	15,335	16,087				
Total of 2	850,596			4,706	9,614	10,085	28,049	49,410	55,323	61,526	68,034	74,860	82,021	89,532	97,412	105,677				
Equivalent to US\$	56.5			0.3	0.6	0.7	1.9	3.3	3.7	4.1	4.5	5.0	5.4	5.9	6.5	7.0				
Total of 1 & 2	1,600,868			4,706	9,614	10,085	65,563	120,685	126,599	132,802	139,310	146,136	153,296	160,808	168,688	176,953				
Equivalent to US\$	106.2			0.3	0.6	0.7	4.4	8.0	8.4	8.8	9.2	9.7	10.2	10.7	11.2	11.7				
3. VAT (5 %)	72,767			214	437	458	2,980	5,486	5,754	6,036	6,332	6,643	6,968	7,309	7,668	8,043				
Equivalent to US\$	4.8			0.0	0.0	0.0	0.2	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5				
Total of 1 to 3	1,673,635			4,920	10,051	10,543	68,543	126,171	132,353	138,839	145,642	152,778	160,264	168,117	176,355	184,997				
Equivalent to US\$	111.1			0.3	0.7	0.7	4.5	8.4	8.8	9.2	9.7	10.1	10.6	11.2	11.7	12.3				

Note:

- (1) Cost data sources; Feasibility study interim report, December 1999 and other on-going project
- (2) Price level; As of Year 2001
- (3) Exchange rate; US\$ 1.0 = VND 15,068 = ¥123.39

Table 10.6 Disbursement Schedule of Domestic and Industrial Water Supply for Huong River Basin

Unit: Million VND, Million VND

Description	Total	Year																		
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Direct Construction Cost																				
(1) General Items	34,656					34,656														
(2) Phase 2 of Quang Te 2 Water Treatment Plant	203,418						101,709	101,709												
(3) Additional Pipeline	81,367					8,950	8,950	8,950	8,950	8,950	8,950	8,950	9,764							
(4) 45,000 House Connection	101,709					6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	6,713	7,730
(5) Booster Station and Ancillaries	27,122								27,122											
(6) Small Projects	150,680										49,724				49,724			51,231		
Sub-total of 1	598,953					50,320	117,372	117,372	42,786	15,663	65,388	15,663	15,663	16,477	56,437	6,713	6,713	57,944	6,713	7,730
Equivalent to US\$	39.8					3.3	7.8	7.8	2.8	1.0	4.3	1.0	1.0	1.1	3.7	0.4	0.4	3.8	0.4	0.5
2. Indirect Construction Cost																				
(1) Resettlement Cost	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2) Engineering Cost	34,656			3,466	6,238	6,238	6,238	6,238	6,238											
(3) Administration Cost	17,969			1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,060	1,006
(4) Price Escalation (4.9 % / Year)	391,177			698	1,539	15,569	41,447	49,587	23,351	8,999	40,762	11,581	12,968	15,125	54,835	8,157	8,938	74,061	10,615	12,944
(5) Physical Contingency (10 %)	104,275			522	884	7,319	16,612	17,426	7,343	2,572	10,721	2,830	2,969	3,266	11,233	1,593	1,671	13,307	1,839	2,168
Sub-total of 2	548,077			5,747	9,721	30,186	65,358	74,311	37,993	12,631	52,543	15,472	16,997	19,451	67,128	10,810	11,669	88,428	13,514	16,118
Equivalent to US\$	36.4			0.4	0.6	2.0	4.3	4.9	2.5	0.8	3.5	1.0	1.1	1.3	4.5	0.7	0.8	5.9	0.9	1.1
Total of 1 & 2	1,147,030			5,747	9,721	80,506	182,730	191,684	80,778	28,294	117,931	31,135	32,660	35,928	123,566	17,523	18,382	146,372	20,227	23,848
Equivalent to US\$	76.1			0.4	0.6	5.3	12.1	12.7	5.4	1.9	7.8	2.1	2.2	2.4	8.2	1.2	1.2	9.7	1.3	1.6
3. VAT (5 %)	52,138			261	442	3,659	8,306	8,713	3,672	1,286	5,360	1,415	1,485	1,633	5,617	797	836	6,653	919	1,084
Equivalent to US\$	3.5			0.0	0.0	0.2	0.6	0.6	0.2	0.1	0.4	0.1	0.1	0.1	0.4	0.1	0.1	0.4	0.1	0.1
Total of 1 to 3	1,199,168			6,008	10,163	84,165	191,036	200,396	84,450	29,580	123,291	32,550	34,145	37,561	129,182	18,320	19,217	153,025	21,147	24,932
Equivalent to US\$	79.6			0.4	0.7	5.6	12.7	13.3	5.6	2.0	8.2	2.2	2.3	2.5	8.6	1.2	1.3	10.2	1.4	1.7

Note:

(1) Price level; As of Year 2001

(2) Exchange rate; US\$ 1.0 = VND 15,068 = ¥ 123.39

Table 10.7 Summary of Disbursement Schedule for Huong River Basin

Unit: Million VND, Million US\$

Description	Total	Year																			
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
I-A. Ta Trach Reservoir Project																					
(1) Direct Construction Cost	1,295,037					62,374	144,338	163,570	163,570	169,407	190,872	218,603	182,302								
(2) Indirect Construction Cost	1,217,344	46,803	49,096	56,711	64,044	35,286	78,242	99,486	112,376	129,936	161,235	202,385	181,743								
Sub-total	2,512,381	46,803	49,096	56,711	64,044	97,660	222,581	263,057	275,947	299,343	352,106	420,987	364,045								
Equivalent to US\$	166.7	3.1	3.3	3.8	4.3	6.5	14.8	17.5	18.3	19.9	23.4	27.9	24.2								
(3) VAT	105,043			237	455	4,439	10,117	11,957	12,543	13,607	16,005	19,136	16,547								
Equivalent to US\$	7.0			0.0	0.0	0.3	0.7	0.8	0.8	0.9	1.1	1.3	1.1								
Total	2,617,424	46,803	49,096	56,948	64,499	102,099	232,698	275,014	288,490	312,950	368,111	440,123	380,592								
Equivalent to US\$	173.7	3.1	3.3	3.8	4.3	6.8	15.4	18.3	19.1	20.8	24.4	29.2	25.3								
I-B. Huu Trach Reservoir Project																					
(1) Direct Construction Cost	273,882											13,530	45,232	63,404	67,794	51,890	32,033				
(2) Indirect Construction Cost	464,179								16,129	16,919	23,874	25,044	19,635	54,505	80,273	92,821	78,984	55,995			
Sub-total	738,061								16,129	16,919	23,874	25,044	33,165	99,737	143,677	160,615	130,873	88,028			
Equivalent to US\$	49.0								1.1	1.1	1.6	1.7	2.2								
(3) VAT	30,393										278	292	1,507	4,533	6,531	7,301	5,949	4,001			
Equivalent to US\$	2.0											0.1									
Total	768,454								16,129	16,919	24,153	25,336	34,672	104,270	150,208	167,915	136,822	92,029			
Equivalent to US\$	51.0								1.1	1.1	1.6	1.7	2.3								
2. Irrigation and Drainage Facilities																					
(1) Direct Construction Cost	750,272						37,514	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276	71,276			
(2) Indirect Construction Cost	850,596			4,706	9,614	10,085	28,049	49,410	55,323	61,526	68,034	74,860	82,021	89,532	97,412	105,677	114,348				
Sub-total	1,600,868			4,706	9,614	10,085	65,563	120,685	126,599	132,802	139,310	146,136	153,296	160,808	168,688	176,953	185,624				
Equivalent to US\$	106.2			0.3	0.6	0.7	4.4	8.0	8.4	8.8	9.2	9.7	10.2	10.7	11.2	11.7	12.3				
(3) VAT	72,767			214	437	458	2,980	5,486	5,754	6,036	6,332	6,643	6,968	7,309	7,668	8,043	8,437				
Equivalent to US\$	4.8			0.0	0.0	0.0	0.2	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6				
Total	1,673,635			4,920	10,051	10,543	68,543	126,171	132,353	138,839	145,642	152,778	160,264	168,117	176,355	184,997	194,061				
Equivalent to US\$	111.1			0.3	0.7	0.7	4.5	8.4	8.8	9.2	9.7	10.1	10.6	11.2	11.7	12.3	12.9				
3. Domestic and Industrial water Supply																					
(1) Direct Construction Cost	598,953					50,320	117,372	117,372	42,786	15,663	65,388	15,663	15,663	16,477	56,437	6,713	6,713	57,944	6,713	7,730	
(2) Indirect Construction Cost	548,077			5,747	9,721	30,186	65,358	74,311	37,993	12,631	52,543	15,472	16,997	19,451	67,128	10,810	11,669	88,428	13,514	16,118	
Sub-total	1,147,030			5,747	9,721	80,506	182,730	191,684	80,778	28,294	117,931	31,135	32,660	35,928	123,566	17,523	18,382	146,372	20,227	23,848	
Equivalent to US\$	76.0			0.0	1.0	5.0	12.0	13.0	5.0	2.0	8.0	2.0	2.0	2.0	8.0	1.0	1.0	10.0	1.0	2.0	
(3) VAT	52,138			261	442	3,659	8,306	8,713	3,672	1,286	5,360	1,415	1,485	1,633	5,617	797	836	6,653	919	1,084	
Equivalent to US\$	3.0			0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	1,199,168			6,008	10,163	84,165	191,036	200,396	84,450	29,580	123,291	32,550	34,145	37,561	129,182	18,320	19,217	153,025	21,147	24,932	
Equivalent to US\$	80.0			0.0	1.0	6.0	13.0	13.0	6.0	2.0	8.0	2.0	2.0	2.0	9.0	1.0	1.0	10.0	1.0	2.0	
Total																					
(1) Direct Construction Cost	2,918,144	0	0	0	0	112,694	299,224	352,218	277,632	256,346	327,536	305,542	282,771	132,985	191,117	145,783	129,879	89,977	6,713	7,730	
(2) Indirect Construction Cost	3,080,196	46,803	49,096	67,164	83,379	75,557	171,649	223,207	221,821	221,012	305,686	317,761	300,396	163,488	244,813	209,308	205,001	144,423	13,514	16,118	
Sub-total of 1 to 3	5,998,340	46,803	49,096	67,164	83,379	188,251	470,874	575,426	499,452	477,358	633,222	623,303	583,166	296,473	435,931	355,091	334,879	234,400	20,227	23,848	
Equivalent to US\$	398.1	3.1	3.3	4.5	5.5	12.5	31.2	38.2	33.1	31.7	42.0	41.4	38.7	19.7	28.9	23.6	22.2	15.6	1.3	1.6	
(3) VAT of 1 to 3	260,341			712	1,334	8,556	21,403	26,156	21,969	20,929	27,975	27,486	26,508	13,475	19,816	16,141	15,222	10,654	919	1,084	
Equivalent to US\$	17.3			0.0	0.1	0.6	1.4	1.7	1.5	1.4	1.9	1.8	1.8	0.9	1.3	1.1	1.0	0.7	0.1	0.1	
Total of 1 to 3	6,258,681	46,803	49,096	67,876	84,713	196,807	492,277	601,581	521,421	498,288	661,197	650,787	609,674	309,948	455,745	371,232	350,100	245,054	21,147	24,932	
Equivalent to US\$	415.4	3.1	3.3	4.5	5.6	13.1	32.7	39.9	34.6	33.1	43.9	43.2	40.5	20.6	30.2	24.6	23.2	16.3	1.4	1.7	

