Tables

Table H.2.1 Water Quality Analysis of Tondano Lake (March 2000) (1/2)

Parameter	Unit	Water Sampling Location									
		1	2	3	4	5	6	7	8	9	10
Temperature	°C	26,0	26,0	26,0	26,0	26,0	25,0	25,5	25,0	25,0	25,0
Turbidity	NTu	3,29	3,44	2,66	2,82	4,72	3,64	2,69	4,11	2,82	4,45
SS	Mg/l	2,8	3,6	5,3	1,1	2,7	3,8	6,3	3,7	2,9	3,6
PH	-	6,37	6,98	7,20	7,28	7,21	7,23	7,26	7,28	7,24	7,18
DO	mg/l	6,1	5,7	5,9	5,8	6,2	5,7	5,8	5,6	6,4	5,6
BOD	mg/l	6,2	11,6	16,5	5,2	4,7	19,2	9,6	16,3	17,2	18,4
COD	mg/l	16,7	18,3	21,2	14,1	13,5	23,6	15,8	18,3	19,3	22,1
Total N	mg/l	2,97	2,92	1,97	1,56	3,81	3,22	2,22	2,98	2,66	3,77
total P	mg/l	0,66	1,99	2,93	2,97	3,11	3,73	3,68	3,11	2,33	2,84

Parameter	Unit	Water Sampling Location									
		11	12	13	14	15	16	17	18	19	20
Temperature	°C	25,0	27,0	27,0	27,0	26,5	27,0	26,0	26,5	27,0	27,0
Turbidity	NTu	3,47	2,45	3,00	2,60	2,76	2,20	2,00	2,54	2,54	2,60
SS	Mg/l	3,5	4,2	7,3	4,2	7,1	2,8	4,4	3,6	4,3	3,3
PH	-	7,18	7,35	7,36	7,33	7,31	7,48	7,50	7,49	7,56	7,61
DO	mg/l	5,8	6,0	5,3	5,6	5,7	5,2	5,1	5,2	5,9	6,0
BOD	mg/l	4,9	6,7	8,9	15,4	8,3	9,6	10,7	9,4	10,2	19,2
COD	mg/l	13,2	14,5	153	17,1	14,2	15,4	17,5	14,6	18,7	21,2
total N	mg/l	1,76	1,99	3,11	3,26	3,58	1,22	1,11	1,77	1,66	2,22
total P	mg/l	2,10	1,76	2,77	1,99	1,78	2,44	1,22	1,11	1,44	1,56

Parameter	Unit	Water Sampling Location									
		21	22	23	24	25	26	27	28	29	30
Temperature	°C	27,0	27,0	27,0	27,0	26,5	26,5	26,0	25,8	25,5	25,8
Turbidity	NTu	2,00	2,98	2,50	2,40	3,00	2,39	2,54	4,00	2,63	2,38
SS	Mg/l	4,5	2,6	2,1	1,8	2,1	1,7	3,1	3,3	2,8	2,3
PH	-	7,72	7,69	7,73	7,71	7,78	7,72	7,65	7,22	7,44	7,61
DO	mg/l	6,2	5,6	5,1	5,3	6,5	6,3	5,8	6,1	5,7	5,3
BOD	mg/l	6,6	8,7	19,7	20,2	14,9	7,9	8,9	8,2	8,4	8,2
COD	mg/l	16,3	15,6	25,1	27,3	22,7	15,8	18,7	20,1	27,1	188
Total N	mg/l	2,43	2,78	2,99	2,72	1,99	2,23	3,54	3,11	2,72	2,67
Total P	mg/l	1,77	1,46	3,99	2,79	2,88	2,65	2,96	2,13	3,33	3,12

Table H.2.1 Water Quality Analysis of Tondano Lake (March 2000) (2/2)

Parameter	Unit	Water Sampling Location									
		31	32	33	34	35	36	37	38	39	40
Temperature	°C	25,7	25,7	25,9	25,8	25,7	26,0	25,7	25,6	25,7	25,6
Turbidity	NTu	3,00	2,30	2,64	2,77	3,00	2,10	2,60	2,54	2,00	2,20
SS	Mg/l	3,6	3,6	2,8	2,51	2,6	4,2	2,6	3,1	4,7	8,2
PH	-	7,64	7,70	7,63	7,53	7,55	7,55	7,63	7,54	7,59	7,53
DO	mg/l	5,8	6,3	5,8	6,4	6,1	6,3	6,7	6,3	6,4	6,1
BOD	mg/l	7,9	7,5	13,8	8,1	9,2	14,6	13,7	12,6	14,2	12,9
COD	mg/l	17,3	16,1	26,7	21,6	18,3	26,5	24,2	22,6	25,1	21,2
total N	mg/l	2,33	1,26	1,41	1,66	1,97	2,12	2,01	2,51	3,23	2,16
total P	mg/l	2,99	2,87	2,66	2,72	3,13	3,66	3,26	1,87	3,11	2,79

Parameter	Unit	Water Sampling Location									
		41	42	43	44	45	46	47	48	49	50
Temperature	°C	27,0	26,0	26,0	27,0	27,0	26,0	26,0	26,0	26,0	25,0
Turbidity	NTu	2,80	2,69	2,57	3,00	3,10	3,72	3,00	2,70	2,60	4,00
SS	mg/l	4,5	4,1	4,3	4,4	6,7	6,6	5,8	3,3	3,8	5,2
pH	-	7,30	7,42	7,14	7,44	7,57	7,06	7,63	7,38	7,22	7,12
DO	mg/l	6,1	5,7	6,5	6,1	5,8	6,2	6,4	6,3	6,5	6,2
BOD	mg/l	7,9	9,6	8,8	7,2	13,6	13,9	19,2	20,1	21,6	22,1
COD	mg/l	18,1	19,2	19,1	16,6	21,2	23,3	26,2	25,7	28,5	36,6
total N	mg/l	2,03	3,09	3,54	1,66	3,02	3,22	3,11	3,58	2,94	3,35
total P	mg/l	1,69	2,89	1,66	2,72	1,84	1,66	1,62	1,96	3,11	2,99

Note : The weather condition was raining during sampling

NTu = Nephelometric Turbidity Unit

Table H.2.2 Watershed Conservation Plan

Zones	Land use	Slope gradient	Recommended management measures
Protection Zone	Forest	> 40%	Reforestation, prevention of deforestation, community forest
Waterfront Buffer Sub-zone	Farmlands, forest, wetland	n.a.*	Green belt, agroforestry, control of fishery in the lake, riverbed and bank protection works, check dams
Mountain Buffer Sub-zone	Estate	25-40%	Expansion of private forest, agroforestry (tree dominant type, multistory tree garden), erosion control measures (terracing, contour dikes, diversion ditches, etc.), road improvement, erosion control farming
		15-25%	Expansion of private forest, agroforestry (tree dominant type, multistory tree garden), erosion control measures (diversion ditches, contour dikes, infiltration trenches, etc.), road improvement, erosion control farming
	Upland farming	25-40%	Expansion of private forest, agroforestry (tree dominant type, multistory tree garden), erosion control measures (terracing, contour dikes, diversion ditches, etc.), road improvement, erosion control farming
		15-25%	Expansion of private forest, agroforestry (tree dominant type, multistory tree garden), erosion control measures (diversion ditches, contour dikes, infiltration trenches, etc.), road improvement, erosion control farming
		8-15%	Expansion of private forest, agroforestry (non-dominant crop type, multistory tree garden, multi-purpose trees, hedgerow cropping w/ leguminous trees), erosion control farming, erosion control measures (infiltration trenches, contour dikes, drains, etc.), road improvement
Farming Zone	Estate	8-15%	Agroforestry (non-dominant crop type, multistory tree garden, multi-purpose trees, hedgerow cropping w/ leguminous trees), erosion control farming, erosion control measures (infiltration trenches, contour dikes, drains, etc.), road improvement
		<8%	Agroforestry (non-dominant crop type, herbaceous crop dominant type,), erosion control farming (contour cropping, etc.) erosion control measures (drains, etc.), road improvement
	Upland farming	<8%	Agroforestry (non-dominant crop type, herbaceous crop dominant type,), erosion control farming (contour cropping, etc.) erosion control measures (drains, etc.), road improvement

Table H.2.3 Soil Loss Estimate after Erosion Control Works by Universal Soil Loss Equation (1/2)

Sub-Basin ID	Area	Computed Soil Loss		Rainfall and Runoff Factor	Soil Erodibility Factor	Topographic Factor	Cover and Management Factor	Support Practice Factor
		A		R	K	LS	C	P
	(km^2)	(ton/ha/year)	(mm/year)	(MJ×mm/ha×hr×year)	(ton×hr/MJ×mm)	(-)	(-)	(-)
1	15.2	9.41	0.78	1,546	0.12	6.444	0.108	0.611
2	7.1	8.31	0.69	1,546	0.12	5.269	0.115	0.341
3	16.9	3.24	0.27	1,337	0.14	1.531	0.040	0.119
4	6.2	4.40	0.37	1,546	0.14	0.830	0.188	0.160
5	5.6	6.57	0.55	1,546	0.14	0.985	0.193	0.194
6	7.7	4.82	0.40	1,505	0.22	0.655	0.183	0.135
7	12.6	6.36	0.53	1,521	0.16	1.104	0.150	0.172
8	8.6	4.84	0.40	1,519	0.14	0.796	0.240	0.166
9	18.0	3.95	0.33	979	0.22	0.997	0.143	0.130
11	7.7	5.54	0.46	829	0.22	1.803	0.082	0.207
12	13.1	8.28	0.69	806	0.23	1.887	0.128	0.263
13	10.9	7.18	0.60	806	0.23	1.740	0.131	0.242
14	7.7	10.36	0.86	806	0.23	1.417	0.197	0.228
15	8.8	5.38	0.45	910	0.19	0.747	0.164	0.220
16	15.8	9.65	0.80	991	0.19	1.775	0.142	0.244
21	4.5	7.99	0.67	1,014	0.20	6.183	0.036	0.435
22	5.3	10.18	0.85	1,014	0.17	4.438	0.034	0.361
23	7.9	11.02	0.92	1,019	0.20	4.279	0.043	0.335
24	7.3	12.02	1.00	1,110	0.17	4.079	0.071	0.360
25	12.0	13.51	1.13	1,110	0.18	4.079	0.042	0.397
31	11.1	9.09	0.76	1,110	0.19	1.794	0.129	0.262
32	7.3	7.95	0.66	1,110	0.16	2.217	0.272	0.298
33	10.7	12.30	1.02	1,110	0.19	3.069	0.085	0.299
34	7.5	7.76	0.65	1,110	0.18	2.108	0.098	0.303
35	7.9	11.99	1.00	1,110	0.14	5.872	0.199	0.518
36	8.8	15.25	1.27	1,110	0.20	4.416	0.097	0.391
37	4.7	14.58	1.21	1,110	0.21	4.205	0.043	0.426
38	10.7	18.23	1.52	1,287	0.22	5.325	0.071	0.447

Table H.2.3 Soil Loss Estimate after Erosion Control Works by Universal Soil Loss Equation (2/2)

Sub-Basin ID	Area	Computed Soil Loss		Rainfall and Runoff Factor	Soil Erodibility Factor	Topographic Factor	Cover and Management Factor	Support Practice Factor
		A		R	K	LS	C	P
	(km^2)	(ton/ha/year)	(mm/year)	(MJ×mm/ha×hr×year)	(ton×hr/MJ×mm)	(-)	(-)	(-)
39	10.1	22.38	1.87	1,143	0.23	6.227	0.083	0.523
40	11.1	17.93	1.49	1,240	0.23	6.002	0.058	0.617
41	6.2	18.08	1.51	1,631	0.23	3.269	0.041	0.375
42	13.7	16.72	1.39	1,636	0.23	2.973	0.040	0.401
43	10.7	9.84	0.82	1,888	0.23	1.516	0.037	0.405
44	7.9	7.15	0.60	1,923	0.23	1.053	0.041	0.401
45	10.3	15.35	1.28	1,923	0.23	1.328	0.131	0.293
46	3.6	10.77	0.90	1,923	0.23	0.831	0.182	0.164
51	10.7	11.37	0.95	1,239	0.14	6.290	0.064	0.598
52	9.2	23.80	1.98	1,923	0.23	3.323	0.052	0.392
53	7.7	22.61	1.88	1,787	0.23	3.284	0.059	0.383
54	5.8	13.86	1.15	1,912	0.23	2.081	0.042	0.396
55	9.0	13.67	1.14	1,333	0.16	3.608	0.072	0.373
56	11.3	16.48	1.37	1,444	0.22	3.194	0.049	0.395
57	9.0	13.36	1.11	1,631	0.23	2.371	0.041	0.402
58	7.1	19.82	1.65	1,631	0.23	3.526	0.037	0.405
59	7.1	11.08	0.92	1,905	0.23	1.680	0.037	0.405
60	5.1	22.25	1.85	1,923	0.23	2.096	0.092	0.360
61	3.9	36.74	3.06	1,923	0.23	2.240	0.162	0.286
62	10.9	19.49	1.62	1,923	0.23	1.923	0.109	0.311
71	10.3	19.55	1.63	1,620	0.23	3.894	0.078	0.477
72	15.4	17.75	1.48	1,631	0.23	2.825	0.082	0.356
73	12.2	9.22	0.77	1,631	0.23	7.153	0.044	0.645
74	10.9	10.97	0.91	1,631	0.23	4.378	0.045	0.576
75	7.5	10.38	0.87	1,631	0.23	1.442	0.116	0.323
76	12.6	8.23	0.69	1,631	0.23	4.805	0.036	0.584
TOTAL	506.6	11.94	1.00					
AVERAGE	9.4			1,411	0.20	3.025	0.097	0.354

Table H.3.1 List of Slope Failure on Hillside in the Intensive Area

No.	Location					Heigth (m)	Length (m)	Area (ha)	Estimated Depth (m)	Estimated Volume (m^3)	Possibility of Slope Failure Expansion	Possibility of Natural Rehabilitation	Applied Zoning
	North Latitude	East Longitude	Village	Sub District	Sub-watershed No.								
Mt. Maimberg	01°06'43"	124°47'26"	Noongan	Langowan	-	100	30	0.300	1.0	3,000	Middle	Low	P Zone
Kaayuran Atas	01°07'17"	124°49'51"	Kaayuran Atas	Langowan	24	30	10	0.030	0.5	150	Low	High	P Zone
Mt. Kamintong	01°13'25"	124°55'48"	Tandengan	Eris	18	20	25	0.050	1.0	500	Low	High	B1 Zone
Touliang Oki	01°14'56"	124°56'55"	Touliang Oki	Eris	-	20	30	0.060	1.0	600	Low	Low	B1 Zone
Makalonsouw	01°17'17"	124°57'02"	Makalonsouw	Toulimambot	14	25	10	0.025	1.0	250	Low	High	B1 Zone

Table H.3.2 List of Slope Failure along the Road in the Intensive Area

No.	Location					Heigth (m)	Length (m)	Area (ha)	Estimated Depth (m)	Estimated Volume (m^3)	Possibility of Slope Failure	Possibility of Natural Rehabilitatio	Applied Zoning
	North Latitude	East Longitude	Village	Sub District	Sub-watershed								
Paleloan	01°14'42"	124°53'34"	Paleloan	Tondano		4.5	10	0.005	2.0	90	High	Low	B2 Zone
Eris-1	01°12'53"	124°55'19"	Eris	Eris		4.0	5	0.002	0.7	10	Low	Middle	B1 Zone
Eris-2	01°12'52"	124°55'27"	Eris	Eris		8.0	8	0.006	1.5	60	Low	High	B1 Zone
Eris-3	01°12'55"	124°55'31"	Eris	Eris		4.0	15	0.006	0.5	30	Middle	Low	B1 Zone

Table H.3.3 Characteristics of the Sub-watersheds

Sub-watershed No.	Name of the River in the Downstream	Area (ha)	Average Slope (%)	Area more than 45% slope (ha)	Highest Point (m-MSL)	Lowest Point (m-MSL)	Elevation Difference (m)	Length of Whole Valley (m)	Valley Density (m/ha)	Coefficient of River Regime -
1	Toubeke	291	16	0	924	690	234	1,900	7	0.81
2	Toubeke	213	24	12	1,192	700	492	1,950	9	0.56
3	Toubeke	121	32	12	1,192	705	487	2,090	17	0.28
4	Toubeke	187	18	4	1,192	695	497	3,550	19	0.15
5	Tounsaru	100	20	4	913	690	223	1,530	15	0.43
6	Leleko	373	19	4	1,192	686	506	3,760	10	0.26
7	Mawalelong	158	20	0	1,111	728	383	1,340	8	0.88
8	Panasen	149	24	0	1,140	745	395	1,260	8	0.94
9	Panasen	147	14	0	1,003	793	210	2,030	14	0.36
10	Panasen	120	20	4	1,230	793	438	3,080	26	0.13
11	Panasen	379	21	24	1,548	815	733	12,560	33	0.13
12	Saluwangko	301	33	76	1,609	890	719	4,010	13	0.19
13	Saluwangko	201	29	16	1,592	860	732	3,640	18	0.15
14	Saluwangko	505	43	216	1,609	890	719	33,670	67	0.22
15	Kaweng 1	102	36	20	1,019	703	316	1,140	11	0.78
16	Watumea-Telap	61	46	32	995	705	290	550	9	2.03
17	Eris	100	35	32	1,068	700	368	3,010	30	1.21
18	-	43	48	24	1,068	700	368	620	15	1.11
19	Tandengan 2	30	33	8	1,000	700	300	630	21	0.76
20	Tandengan 1	62	36	16	975	695	280	730	12	1.17
21	Tandengan 1	44	36	8	968	698	271	570	13	1.35
22	Ranomerut 2	67	39	20	990	695	295	830	12	0.97
23	Kaarisan Touligang Oki	52	26	0	970	695	275	730	14	0.98
24	Touliang Oki	138	31	0	1,005	698	308	1,150	8	1.04
25	Tounipus	129	32	16	1,005	695	310	1,180	9	0.92
26	Serawat	48	35	12	970	698	273	660	14	1.10
27	Tounsukun	160	35	32	1060	698	363	1,230	8	1.06
28	Tounsukun	86	33	24	1,125	693	433	1,600	19	0.34
29	Tounsukun	76	38	20	1,137	728	409	970	13	0.81
30	Tounsukun	198	38	64	1,160	715	445	4,190	21	2.50

Sorce : 1:10,000 Topographic Map

Table H.3.4 Characteristics of the Main Torrent of Sub-watershed

Sub-watershed No.	Name of the River in the Downstream	Length (m)	Highest Point of Major Torrent (m)	Lowest Point of Major Torrent (m)	Elevational Difference (m)	Mean Gradient (%)
1	Toubeke	1,900	810	690	120	6.3
2	Toubeke	1,950	900	700	200	10.3
3	Toubeke	2,090	1,050	705	345	16.5
4	Toubeke	3,550	1,015	695	320	9.0
5	Tounsaru	1,530	850	690	160	10.5
6	Leleko	3,760	970	686	284	7.6
7	Mawalelong	1,340	890	728	163	12.1
8	Panasen	1,260	1,010	745	265	21.0
9	Panasen	2,030	980	793	188	9.2
10	Panasen	3,080	1,005	793	213	6.9
11	Panasen	5,460	1,535	815	720	13.2
12	Saluwangko	4,010	1,530	890	640	16.0
13	Saluwangko	3,640	1,480	860	620	17.0
14	Saluwangko	4,770	1,405	890	515	10.8
15	Kaweng 1	1,140	785	703	83	7.2
16	Watumea-Telap	550	955	705	250	45.5
17	Eris	910	900	700	200	22.0
18	-	620	1,015	700	315	50.8
19	Tandengan 2	630	955	700	255	40.5
20	Tandengan 1	730	895	695	200	27.4
21	Tandengan 1	570	860	698	163	28.5
22	Ranomerut 2	830	955	695	260	31.3
23	Kaarisan Touligang Oki	730	960	695	265	36.3
24	Touliang Oki	1,150	920	698	223	19.3
25	Tounipus	1,180	910	695	215	18.2
26	Serawat	660	845	698	148	22.3
27	Tounsukun	1,230	1,035	698	338	27.4
28	Tounsukun	1,600	1,050	693	358	22.3
29	Tounsukun	970	925	728	198	20.4
30	Tounsukun	890	1,025	715	310	34.8

Sorce : 1:10,000 Topographic Map

Table H.3.5 List of Existing Check Dam

No.	Name of the Dam	Location							Year of Construction	Government Agency	Catchment Area (ha)	Dam Dimension				
		North Latitude	East Longitude	Town	Sub District	Sub-watershed No.	Zone	Area				Type	No. of the Dam (nos.)	Crest Length (m)	Dam Height (m)	Crest Width (m)
CD - 1	Tataaran II	01°16'45"	124°52'02"	Tataaran II	Tondano	2	B1	West	1983/1984	BRLKT	133	Earth Fill Dam	1	25.0	4.0	4.0
CD - 2	Tataaran II	01°16'39"	124°52'05"	Tataaran II	Tondano	2	B1	West	1984/1985	BRLKT	32	Earth Fill Dam	1	45.0	6.5	10.0
CD - 3	Tataaran I	01°16'06"	124°52'48"	Tataaran I	Tondano	-	B2	West	1983/1984	BRLKT	81	Earth Fill Dam	1	45.0	Unknown	4.0
CD - 4	Roong	01°15'57"	124°53'32"	Tounsaru	Tondano	5	B2	West	1982/1983	BRLKT	100	Earth Fill Dam	1	40.0	4.5	3.5
CD - 5	Leleko	01°15'01"	124°51'56"	Leleko	Remboken	6	B2	West	1984/1985	BRLKT	68	Earth Fill Dam	1	45.0	5.0	2.5
CD - 6	Kasuratan	01°15'07"	124°50'11"	Kasuratan	Remboken	-	B3	West	1991/1992	BRLKT	22	Earth Fill Dam	1	30.0	2.0	3.5
CD - 7	Pulutan	01°13'11"	124°50'09"	Pulutan	Remboken	-	B2	West	1995/1996	District Forest Survice	13	Earth Fill Dam	1	44.0	6.0	3.5
CD - 8	Touure	01°08'50"	124°47'15"	Touure	Tompaso	10	B2	South	1991/1992	BRLKT	59.2	Earth Fill Dam	1	-	-	-
CD - 9	Tumaratas	01°09'12"	124°48'14"	Tumaratas	Langowan	11	F	South	1993/1994	District Forest Survice	379	Earth Fill Dam	1	45.0	8.0	4.0
CD - 10	Tounelet	01°07'57"	124°50'21"	Tounelet	Langowan	-	B2	South	1997/1998	District Forest Survice	19	Earth Fill Dam	1	40.0	4.5	3.5
CD - 11	Tountimomor	01°11'04"	124°52'26"	Tountimomor	Kakas	-	-	-	1997/1998	District Forest Survice	6,770	Gabion Box Check Dam	2	7.0	Unknown	-
CD - 12	Telap	01°12'44"	124°54'48"	Telap	Eris	16	B1	East	1994/1995	District Forest Survice	42	Dam Penahan	4	4.0	0.0	-
CD - 13	Eris	01°13'30"	124°55'06"	Eris	Eris	17	B1	East	1984/1985	BRLKT	100	Earth Fill Dam	1	75.0	2.5	4.0
CD - 14	Tandengan	01°13'51"	124°55'47"	Tandengan	Eris	19	B1	East	1984/1985	BRLKT	30	Earth Fill Dam	1	40.0	4.0	4.0
CD - 15	Ranomerut	01°14'41"	124°56'01"	Ranomerut	Eris	-	B2	East	1983/1984	BRLKT	13	Earth Fill Dam	1	35.0	3.0	6.0
CD - 16	Touliang Oki	01°15'07"	124°56'36"	Touliang Oki	Eris	24	B2	East	1997/1998	Provincial Irrigation Office	104	Wet Masonry Gravity Dar	1	80.0	5.0	3.0
CD - 17	Touliang Oki	01°15'25"	124°56'13"	Touliang Oki	Eris	-	B2	East	1983/1984	BRLKT	21	Earth Fill Dam	1	50.0	3.5	4.0

Table H.3.6 Status of Existing Check Dam

No.	Name of the Dam	Condition of Sediment Control			Condition of Water Supply				Condition of Dam Body
		Statas of Sediment Control	Deposition Gradient (%)	Average Sediment Yield (ton/ha/year)	Intention for Water Supply	Purpose of Water Supply	Present Land Use of Downstream	Condition of Downstream Irrigation System	
CD - 1	Tataaran II	Functioning	N/A	N/A	Yes	Irrigation	Arable Upland	Not functioning	
CD - 2	Tataaran II	Functioning	N/A	N/A	Yes	Irrigation	Arable Upland	Not functioning	
CD - 3	Tataaran I	Abandaned	N/A	N/A	Yes	Irrigation	University Campus / Arable Upland	Abandaned	
CD - 4	Roong	Functioning	0.5	2,800	Yes	Irrigation	Grassland	Not Functioning	
CD - 5	Leleko	Functioning	1.8	3,000	Yes	Irrigation	Arable Upland	Not functioning	A part of dam body has damaged.
CD - 6	Kasuratan	Functioning	N/A	N/A	No	None	-	-	A part of spillway has damaged.
CD - 7	Pulutan	Functioning	3.0	1,000	No	None	-	-	
CD - 8	Touure	Not Functioning	N/A	N/A	No	None	-	-	Dam body has collapsed.
CD - 9	Tumaratas	Functioning	N/A	N/A	Yes	Irrigation	Paddy Field	Good	
CD - 10	Tounelet	Functioning	N/A	N/A	Yes	Irrigation	Paddy Field	Unknown	
CD - 11	Tountimomor	Functioning	N/A	N/A	No	None	-	-	
CD - 12	Telap	Functioning	N/A	N/A	No	None	-	-	
CD - 13	Eris	Functioning	N/A	N/A	Yes	Inland Fishery	Fish Pond	-	
CD - 14	Tandengan	Functioning	N/A	N/A	Yes	Irrigation	Paddy Field	Not functioning	
CD - 15	Ranomerut	Functioning	N/A	N/A	Yes	Irrigation	Paddy	Bad	
CD - 16	Touliang Oki	Functioning	N/A	N/A	No	None	-	-	
CD - 17	Touliang Oki	Functioning	N/A	N/A	Yes	Irrigation	Paddy	Good	

Table H.3.7 Result of Sediment Yield Estimate

Item	Unit	Sub-watershed No.																													TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Area	ha	300	228	128	192	104	368	168	156	156	124	368	312	216	548	108	60	112	44	28	72	44	68	48	140	128	48	160	88	76	208	4,800
Erosion																																
Soil Erosion																																
'See Soil Barance Study'																																
Slope Failure on Hillside																																
Area Steeper than 30°	ha	0	0	0	0	0	0	0	0	0	0	8	12	4	128	4	8	4	12	4	0	0	8	0	0	0	0	0	0	4	8	204
Slope Failure Probability	%	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Area of Potential Critical Land	m^2	0	0	0	0	0	0	0	0	0	0	160	240	80	2,560	120	240	120	360	120	0	0	240	0	0	0	0	0	0	120	240	4,600
Assumed Failure Depth	m	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Amount	m^3	0	0	0	0	0	0	0	0	0	0	160	240	80	2,560	120	240	120	360	120	0	0	240	0	0	0	0	0	0	120	240	4,600
Landslide																																
Amount	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,000	0	0	30,000	0	0	0	60,000
Sediment Delivery Ratio	-	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.2	0.65	0.8	0.5	0.65	0.5	0.65	0.2	0.2	0.65	0.2	0.5	0.5	0.2	
Sedement Yield																																
by Soil Erosion	m^3	0	0	0	0	0	0	0	0	0	0	0	0	509	0	0	372	0	92	17	1,268	59	783	0	425	662	280	0	143	0	300	4,911
by Slope Failure on Hillside	m^3	0	0	0	0	0	0	0	0	0	0	32	48	16	512	24	120	24	234	96	0	0	120	0	0	0	0	0	0	60	48	1,334
by Landslide	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,000	0	0	6,000	0	0	0	12,000
Existing Check Dam			Yes			Yes	Yes					Yes						Yes		Yes					Yes			Yes				
Sediment Yield	m^3												**48**	**525**	**512**	**24**	**492**		**326**		**1,268**	**59**	**903**			**662**	**280**		**143**	**60**	**348**	**5,651**

New Check Dam is Required.

* Direct Countermeasure to the Erosion Site is Recommended.

Table H.3.8 List of Labor Cost for Construction Works of Monitoring System Development

Unit:Rp.

Item	Unit	F.C.	L.C.	Total
Foreman	m·day	0	32,500	32,500
Supervisor	m·day	0	22,500	22,500
Skilled Labor	m·day	0	30,000	30,000
Common Labor	m·day	0	20,000	20,000
Carpenter	m·day	0	27,500	27,500

Table H.3.9 List of Material Cost for Construction Works of Monitoring System Development

Unit:Rp.

Item	Unit	F.C.	L.C.	Total
Portland Cement	kg	471	52	523
Cobble	m3	41,525	33,975	75,500
Pebble	m3	14,625	7,875	22,500
Fine Aggregate	m3	55,900	30,100	86,000
Bench Mark	no.	120,000	80,000	200,000
Sand	m3	73,100	12,900	86,000
PVC Pipe 4"	m	48,900	0	48,900
Wire for Rainfall Gauge	unit	67,500	0	67,500
Brick	no.	309	166	475

Table H.3.10 List of Equipment Cost for Construction Works of Monitoring System Development

Unit:Rp.

Item	Unit	F.C.	L.C.	Total
Cement mixer	unit/hr	83,838	4,412	88,250
Miscellaneous	L.S.	400	100	500
Hand Compactor	no.	32,850	3,650	36,500

Note: F.C.=Foreign Currency, L.C.=Local Currency

Table H.3.11 List of Construction Unit Price for Monitoring System Development

Unit:Rp.

Work Item	Unit	F.C.	L.C.	Total
1 Earth Works				
1.1 Excavation (manpower), common soil	m3	400	15,663	16,063
1.2 Backfilling (manpower)	m3	3,285	10,390	13,675
2 Stone Works				
2.1 Wet Masonry	m3	166,921	156,021	322,942
3 Survey Works				
3.1 Bench Mark Construction	no.	120,000	107,150	227,150
4 Building Works				
4.1 Brick Works	m3	280,174	234,967	515,141
4.2 Plastering (all surface)	m2	6,037	15,129	21,166
4.3 Rainfall Gauge Installation	unit	67,500	40,000	107,500

Note: L.C.=Local Currency, F.C.=Foreign Currency

Table H.3.12 Breakdown of Direct Construction Cost of Monitoring System Development

Unit:Rp.

Work Item	Unit	Quantity	Total Cost		
			F.C.	L.C.	Total
1 Erosion and Sedimentation Monitoring					
1.1 Building and Measuring Well (3 locations)					
- Brick Works	m3	18	5,043,132	4,229,406	9,272,538
- Plastering (all surface)	m2	192	1,159,104	2,904,768	4,063,872
1.2 Measuring Flume (3 locations)					
- Excavation (manpower), common soil	m3	300	120,000	4,698,900	4,818,900
- Backfilling (manpower)	m3	60	197,100	623,400	820,500
- Wet Masonry	m3	189	31,548,069	29,487,969	61,036,038
1.3 Rainfall Gauge Installation (3 locations)					
- Rainfall Gauge Installation	unit	3	202,500	120,000	322,500
1.4 Bench Mark Construction (18 locations)					
- Bench Mark Construction	no.	18	2,160,000	1,928,700	4,088,700
Sub-Total 1.1 - 1.4			**40,429,905**	**43,993,143**	**84,423,048**
2 Water Balance Monitoring					
2.1 Rainfall Measurement (21 locations)					
- Rainfall Gauge Installation	unit	21	1,417,500	840,000	2,257,500
2.2 Flow Rate Measurement (12 new stations)					
Building and Measuring Well					
- Brick Works	m3	72	20,172,528	16,917,624	37,090,152
- Plastering (all surface)	m2	768	4,636,416	11,619,072	16,255,488
Measuring Flume					
- Excavation (manpower), common soil	m3	1,200	480,000	18,795,600	19,275,600
- Backfilling (manpower)	m3	240	788,400	2,493,600	3,282,000
- Wet Masonry	m3	756	126,192,276	117,951,876	244,144,152
Sub-Total 2.1 - 2.2			**153,687,120**	**168,617,772**	**322,304,892**
GRAND TOTAL			**194,117,025**	**212,610,915**	**406,727,940**

Table H.3.13 List of Monitoring Apparatus Cost

Unit:Rp.

No. Item	Unit	Quantity	F.C.	L.C.	Total
1 Rainfall gauge	no.	24	161,424,000	0	161,424,000
2 Balance	no.	1	15,826,000	0	15,826,000
3 Drier	no.	1	15,826,000	0	15,826,000
4 Motorboat	no.	1	133,730,000	0	133,730,000
5 Soil sampler for bottom materials	no.	1	23,739,000	0	23,739,000
6 DO meter	no.	1	9,891,000	0	9,891,000
7 pH meter	no.	1	6,884,000	0	6,884,000
8 EC meter	no.	1	6,568,000	0	6,568,000
9 Secchii disc for water clearness	no.	1	2,374,000	0	2,374,000
10 Water sampler	no.	1	15,826,000	0	15,826,000
11 Water level gauge (12 new gauges and 2 replacement)	no.	14	88,620,000	0	88,620,000
12 Current meter	no.	1	34,817,000	0	34,817,000
TOTAL			**515,525,000**	**0**	**515,525,000**

Note: F.C.=Foreign Currency, L.C.=Local Currency

Table H.3.14 Engineering Services Cost of Monitoring System Development (Engineering Items)

Unit:Rp.

No.	Item	Unit	Quantity	F.C.	L.C.	Total Cost
1	Erosion and Sedimentation Monitoring					
1.1	Monitoring of Erosion (weekly)					
	Specialist for Monitoring	m-day	975.0	0	405,600,000	405,600,000
	Helper for Monitoring	m-day	8892.0	0	177,840,000	177,840,000
1.2	Monitoring of Sediment Delivery Ratio (weekly)					
	Specialist for Monitoring	m-day	520.0	0	216,320,000	216,320,000
	Helper for Monitoring	m-day	3900.0	0	78,000,000	78,000,000
1.3	Monitoring of Sedimentation (in 6th year)					
	Bathymetry Survey	km2	46.0	83,229,410	35,252,054	118,481,464
SUB-TOTAL 1.1 - 1.2				**83,229,410**	**913,012,054**	**996,241,464**
2	Water Quality Monitoring					
2.1	Monitoring of Water Quality (4 times/year)					
	Specialist for Monitoring	m-day	48.0	0	19,968,000	19,968,000
	Helper for Monitoring	m-day	320.0	0	6,400,000	6,400,000
2.2	Sediment Sampling & Analysis (in 6th year)	set	1.0	49,700,700	16,566,900	66,267,600
SUB-TOTAL 2.1				**49,700,700**	**42,934,900**	**92,635,600**
3	Water Balance Monitoring					
3.1	Hydrological Analysis for 1 Month Data (monthly)					
	Specialist for Monitoring	m-day	54.0	0	22,464,000	22,464,000
SUB-TOTAL 3.1				**0**	**22,464,000**	**22,464,000**
GRAND TOTAL				**132,930,110**	**978,410,954**	**1,111,341,064**

Table H.3.15 Administration Cost of Monitoring System Development (Engineering Items)

Unit:Rp.

No.	Item	Unit	Quantity	F.C.	L.C.	Total Cost
1	Erosion and Sedimentation Monitoring					
1.1	Monitoring of Erosion (weekly)					
	Assistant for Monitoring	m-day	7098.0	0	124,215,000	124,215,000
1.2	Monitoring of Sediment Delivery Ratio (weekly)					
	Assistant for Monitoring	m-day	2496.0	0	43,680,000	43,680,000
SUB-TOTAL 1.1 - 1.2				**0**	**167,895,000**	**167,895,000**
2	Water Quality Monitoring					
2.1	Monitoring of Water Quality (4 times/year)					
	Assistant for Monitoring	m-day	226.0	0	3,955,000	3,955,000
SUB-TOTAL 2.1				**0**	**3,955,000**	**3,955,000**
3	Water Balance Monitoring					
3.1	Rain Gauge & Water Gauge Data Collection for 35 sites (weekly)					
	Assistant for Monitoring	m-day	3224.0	0	56,420,000	56,420,000
3.2	Hydrological Analysis for 1 Month Data (monthly)					
	Assistant for Monitoring	m-day	852.0	0	14,910,000	14,910,000
SUB-TOTAL 3.1 - 3.2				**0**	**71,330,000**	**71,330,000**
GRAND TOTAL				**0**	**243,180,000**	**243,180,000**

Table H.3.16 Capital Cost of Monitoring System Development (Engineering Items)

Unit: Rp. Million

No.	Work Description	F.C.	L.C.	Total	Remarks
1	Direct Construction Cost				
1.1	Erosion and Sedimentation Monitoring	40	44	84	
1.2	Water Quality Monitoring	0	0	0	
1.3	Water Balance Monitoring	154	169	322	
1.4	Information System Development	0	0	0	
Sub-Total 1.1 - 1.4		194	213	407	
2	Indirect Construction Cost	39	43	81	20% of Direct Construction Cost
3	Monitoring Apparatus Cost	516	0	516	
4	Engineering Services Cost	133	978	1,111	
5	Administration Cost	0	243	243	
6	O&M Cost of Montioring Appratus (12% of original price per year)	103	516	619	
GRAND TOTAL		**985**	**1,992**	**2,977**	

Note: Price contingency is not included in here.

Table H.3.17 Annual Disbursement Schedule of Monitoring System Development (Engineering Items)

Unit: Rp. Million

Components	Total		Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
1 Civil Works	233	255	233	255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 Purchase of Monitoring Apparatus	516	0	516	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 Engineering Survices	133	978	0	93	0	93	0	93	0	93	0	93	133	144	0	93	0	93	0	93	0	93
4 Administration Cost	0	243	0	24	0	24	0	24	0	24	0	24	0	24	0	24	0	24	0	24	0	24
5 O&M of Monitoring Appratus	103	516	10	52	10	52	10	52	10	52	10	52	10	52	10	52	10	52	10	52	10	52
TOTAL	985	1,992	759	424	10	169	10	169	10	169	10	169	143	220	10	169	10	169	10	169	10	169

Note: F.C.=Foreign Currency, L.C.=Local Currency

Table H.3.18 Annual Administration Cost of Monitoring System (Engineering Items) in Project Running Period

Unit:Rp.

No.	Item	Unit	Quantity	F.C.	L.C.	Total Cost
1	Water Quality Monitoring					
1.1	Monitoring of Water Quality (4 times/year)					
	Assistant for Monitoring	m-day	22.6	0	395,500	395,500
	SUB-TOTAL 1.1			**0**	**395,500**	**395,500**
2	Water Balance Monitoring					
2.1	Rain Gauge & Water Gauge Data Collection for 35 sites (weekly)					
	Assistant for Monitoring	m-day	322.4	0	5,642,000	5,642,000
2.2	Hydrological Analysis for 1 Month Data (monthly)					
	Assistant for Monitoring	m-day	85.2	0	1,491,000	1,491,000
	SUB-TOTAL 2.1 - 2.2			**0**	**7,133,000**	**7,133,000**
GRAND TOTAL				**0**	**7,528,500**	**7,528,500**

Table H.3.19 Engineering Monitoring Survey Cost in Project Running Period

Unit:Rp.

No.	Item	Frequency	Unit	Quantity	F.C.	L.C.	Total Cost
1	Erosion and Sedimentation Monitoring						
1.1	Monitoring of Sedimentation						
	Bathymetry	once in five years	km2	46.0	83,229,410	35,252,054	118,481,464
2	Water Quality Monitoring						
2.1	Sediment Sampling & Analysis	once in five years	set	1.0	49,700,700	16,566,900	66,267,600
GRAND TOTAL					**132,930,110**	**51,818,954**	**184,749,064**

Table H.3.20 Annual Operation and Maintenance Cost of Monitoring Apparatus

Unit:Rp.

No.	Item	% of original price	Unit	Quantity	F.C.	L.C.	Total
1	Operation of Monitoring Appratus	2.0%	L.S.	1	10,310,500	0	10,310,500
2	Maintenance Cost of Monitoring Apparatus	10.0%	L.S.	1	0	51,552,500	51,552,500

Table H.3.21 Replacement Cost of Monitoring System

Unit:Rp.

No.	Item	Useful Years	Unit	Quantity	F.C.	L.C.	Total Cost
1	Rainfall gauge	10	no.	21	161,424,000	0	161,424,000
2	Drier	5	no.	1	15,826,000	0	15,826,000
3	Motorboat	20	no.	1	133,730,000	0	133,730,000
4	Soil sampler for bottom materials	15	no.	1	23,739,000	0	23,739,000
5	DO meter	5	no.	1	9,891,000	0	9,891,000
6	pH meter	5	no.	1	6,884,000	0	6,884,000
7	EC meter	5	no.	1	6,568,000	0	6,568,000
8	Secchii disc for water clearness	5	no.	1	2,374,000	0	2,374,000
9	Water sampler	15	no.	1	15,826,000	0	15,826,000
10	Water level gauge (12 new gauges and 2 replacement)	10	no.	14	88,620,000	0	88,620,000
11	Current meter	10	no.	1	34,817,000	0	34,817,000
12	Computer with Monitor	10	no.	1	47,000,000	0	47,000,000
13	CD-ROM writer	10	no.	1	3,170,000	0	3,170,000
14	Color Printer for Documents	10	no.	1	6,315,000	0	6,315,000
15	Color Plotter for Map	10	no.	1	71,059,000	0	71,059,000
16	GIS Software	10	no.	1	27,000,000	0	27,000,000
TOTAL					**654,243,000**	**0**	**654,243,000**

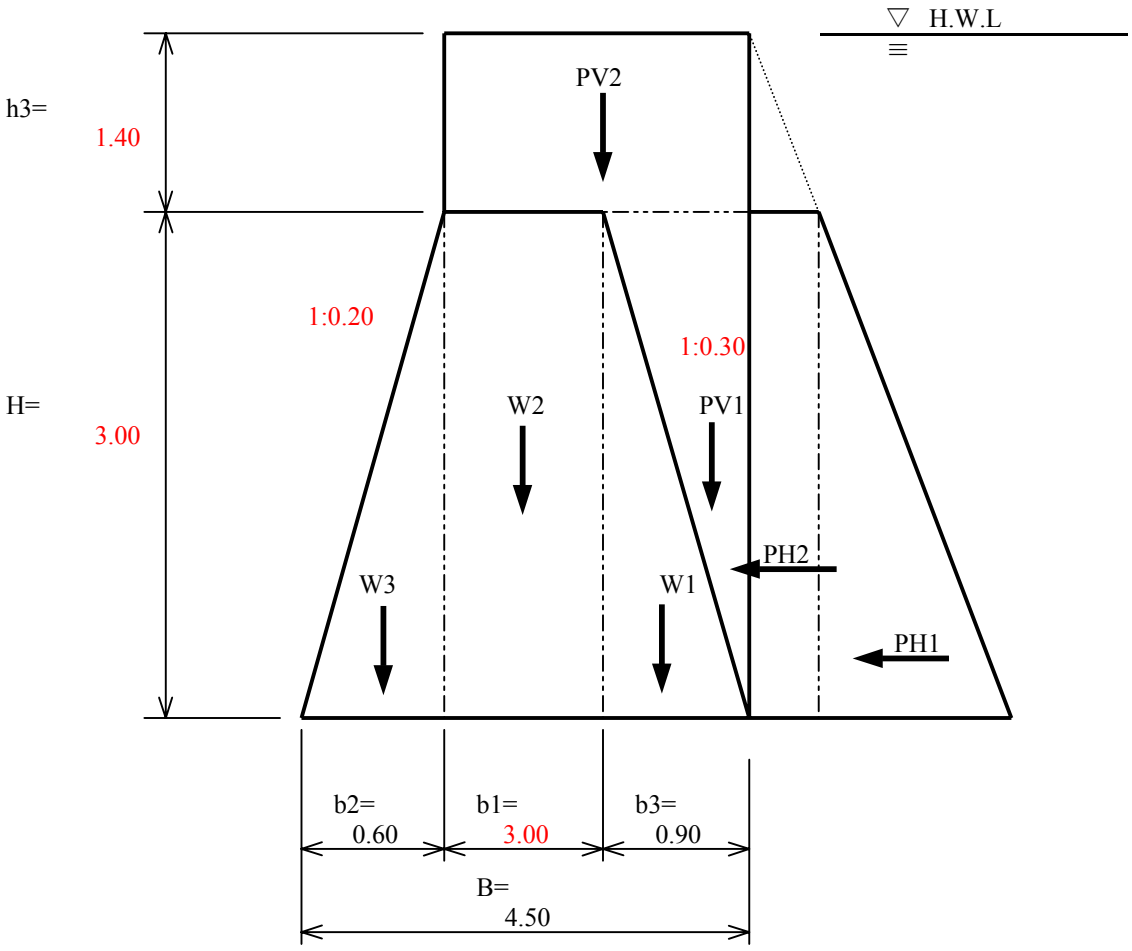
Note: L.S.=Lump Sum, F.C.=Foreign Currency, L.C.=Local Currency

Table H.3.22 Design Flood Dischrge for New Check Dam

Item			Value for Proposed Check Dams			
			Tataaran	Tandengan	Ranomerut	Tounipus
	Return Period	(year)	100	100	100	100
	Design Probable Rainfall	(mm/day)	130.0	130.0	130.0	130.0
Q_p	Peak runoff with clear water	(m^3/sec)	13.66	5.48	5.93	9.96
r_e	Average effective rainfall in flood concentration time	(mm/hr)	26.3	31.84	31.84	27.80
A	Catchment area	(km^2)	1.87	0.62	0.67	1.29
f_p	Coefficient of Peak runoff	(-)	0.85	0.85	0.85	0.85
r	Average measured rainfall in flood concentration time	(mm/hr)	30.9	37.5	37.5	32.7
t_p	Flood concentration time	(min)	107.89	78.89	78.89	97.72
C	Coefficient of Land use	(-)	290.0	290.0	290.0	290.0
α	Ratio of suspended solid	(-)	0.20	0.20	0.20	0.20
Q	Design discharge	(m^3/sec)	16.39	6.58	7.12	11.95

Table H.3.23 Assumption for the Stability Analysis of Proposed Check Dam at Tataaran (Flood Time)

1) Dimension



Unit Weight of Wet Masonry	:	23.0	kN/m^3
Unit Weight of Flowing Water	:	11.8	kN/m^3
Type of Foundation	:	Sand & Gravel	
Allowable Compressive Stress of Wet Maronry	:	3,920	kN/m^2
Allowable Tensile Stress of Wet Masonry	:	0	kN/m^2
Allowable Bearing Capacity of the Foundation	:	392	kN/m^2
Safety Factor for the Sliding	:	1.2	
Coefficient of Friction	:	0.6	

Table H.3.24 Calculation of Working Force on the Unit Section of the Proposed Check Dam at Tataaran (Flood Time)

Design Load	Symbol	Calculation	Vertical Force (V)	Horizontal Force (H)	Distance between Upstream End of Dam Bed and Line of Action (L)	Moment M=V·L+H·L
Dead Load	W					
	W1	$\frac{1}{2} \times 23.0 \times 0.30 \times 3.00^2$	31.09		$\frac{2}{3} \times 0.30 \times 3.00 = 0.60$	18.65
	W2	$23.0 \times 3.00 \times 3.00$	207.27		$0.30 \times 3.00 + \frac{1}{2} \times 3.00 = 2.40$	497.45
	W3	$\frac{1}{2} \times 23.03 \times 0.20 \times 3.00^2$	20.73		$0.30 \times 3.00 + 3.00 + \frac{1}{3} \times 0.20 \times 3.00 = 4.10$	84.99
Hydrostatic Pressure	P					
	PV1	$\frac{1}{2} \times 11.8 \times 0.30 \times 3.00^2$	15.88		$\frac{1}{3} \times 0.30 \times 3.00 = 0.30$	4.76
	PV2	$11.8 \times 1.40 \times (0.30 \times 3.00 + 3.00)$	64.21		$\frac{1}{2} \times (0.30 \times 3.00 + 3.00) = 1.95$	125.21
	PH1	$\frac{1}{2} \times 11.8 \times 3.00^2$		52.92	$\frac{1}{3} \times 3.00 = 1.00$	52.92
	PH2	$11.8 \times 1.40 \times 3.00$		49.39	$\frac{1}{2} \times 3.00 = 1.50$	74.09
Total			kN/m 339.18	kN/m 102.31		kN·m/m 858.07

Table H.3.25 Stability Analysis of Proposed Check Dam at Tataaran (Flood Time)

1) Stability for Overturn

$$X = \frac{\Sigma M}{\Sigma V} = \frac{858.07}{339.18} = 2.530 \quad m$$

$$0 \leqq X \leqq B$$

$$0.00 \leqq 2.530 \leqq 4.50 \quad \textbf{OK}$$

$$e = X - \frac{B}{2} = 2.530 - \frac{4.50}{2} = 0.280 \quad m$$

$$|e| \leqq \frac{B}{6} = \frac{4.50}{6} = 0.750 \geqq 0.280 \quad \textbf{OK}$$

X : Length from the Intersection Point of the Action Line of the Load Resultant and Dam Bed to Upstream End of Dam Bed (m)
ΣM : Moment of Load for the Unit Width of the Section which has the Support Point at Upstream End of the Dam Bed (kN･m/m)
ΣV : Total Vertical Force for the Unit Width of the Section (kN/m)
B : Dam Bed Width (m)
e : Distance between Center Line of the Dam Body and the Point of Action of Resultant (m)

2) Stability for Dam Body Desruction

$$P1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6 \cdot e}{B}\right)$$

$$= \frac{339.18}{4.50} \cdot \left(1 + \frac{6 \cdot 0.280}{4.50}\right) = 103.50 \quad kN/m^2$$

$$P2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6 \cdot e}{B}\right)$$

$$= \frac{339.18}{4.50} \cdot \left(1 - \frac{6 \cdot 0.280}{4.50}\right) = 47.25 \quad kN/m^2$$

Allowable Stresses					
Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	≧	103.50	kN/m^2 **OK**
Allowable Tensile Stress of Wet Masonry	0	kN/m^2	<	47.25	kN/m^2 **OK**

3) Stability for Foundation Desruction

Allowable Bearing Force of the Foundation	392	kN/m^2	≧	103.50	kN/m^2 **OK**

4) Stability for Sliding

$$n \leqq Fs = \frac{V}{\Sigma H} \qquad V = f \cdot \Sigma V$$

$$= \frac{203.508}{102.31} \qquad = 0.6 \cdot 339.18$$

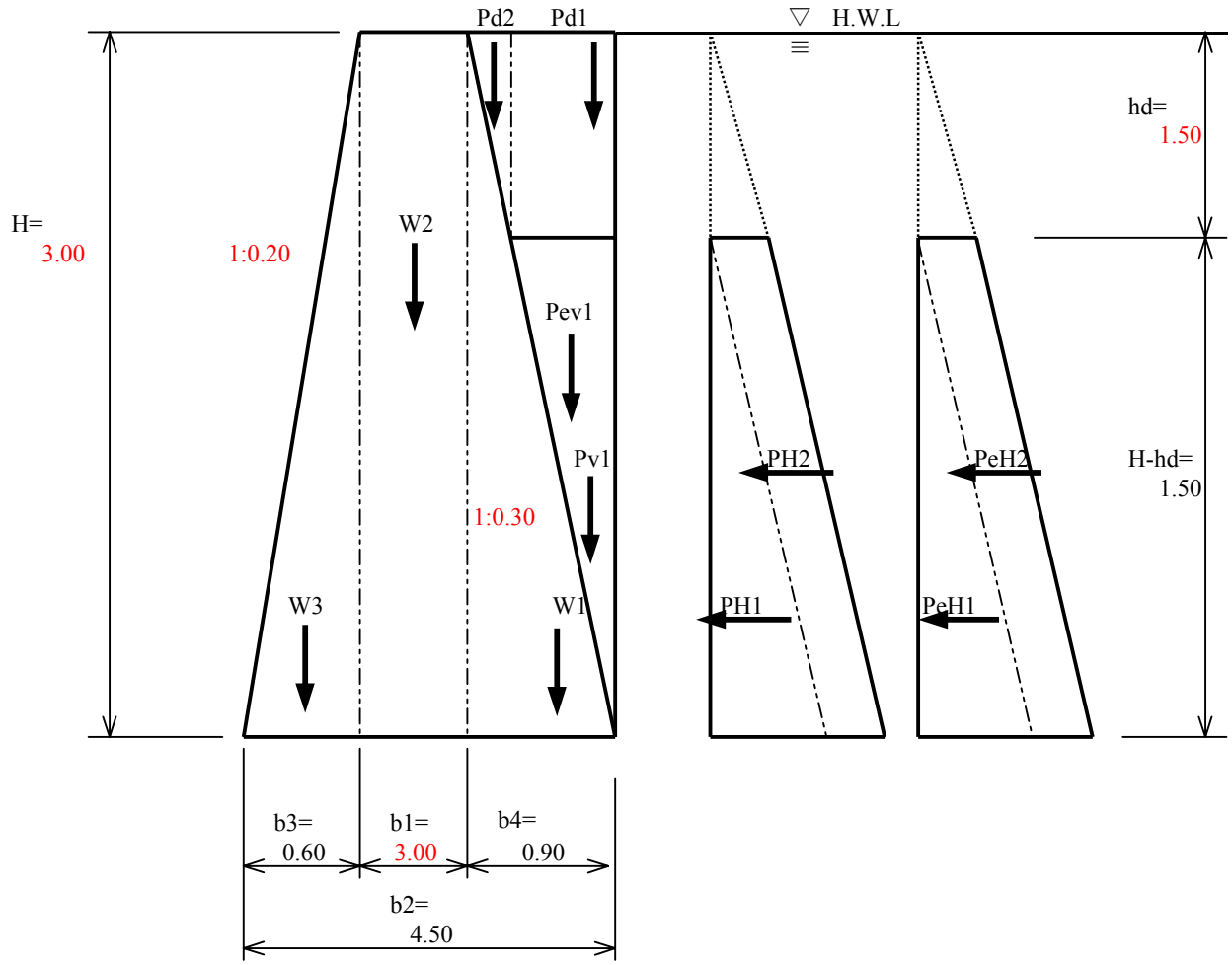
$$= 1.989 \qquad = 203.508 \quad kN/m^3$$

$$1.989 \geqq 1.2 \quad \textbf{OK}$$

n : Safety Factor
f : Coefficient of Friction

Table H.3.26 Assumption for the Stability Analysis of Proposed Check Dam at Tataaran (Debris Flow Time)

1) Dimension



	Type of Foundation	Sand and Gravel		
σ	: Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	
σ	: Allowable Tensile Stress of Wet Masonry	0	kN/m^2	
	Allowable Bearing Capacity of the Foundation	392	kN/m^2	
n	: Safety Factor for the Sliding	1.2		
f	: Coefficient of Friction	0.6		
ρ d	: Unit Weight of Debris Flow	16.7	kN/m^3	
ρ f	: Unit Weight of Gravel in the Debris Flow	6.9	kN/m^3	ρ d − W o
W s 1	: Submerged Unit Weight of Sediment	9.6	kN/m^3	
W c	: Unit Weight of Wet Masonry	23.0	kN/m^3	
W o	: Unit Weight of Clear Water	9.8	kN/m^3	
W o'	: Unit Weight of Mud Water	11.8	kN/m^3	
C e	: Coefficient of Earth Pressure	0.33		
U	: Velocity of Debris Flow	3.26	m/s	
α	: Coefficient	1.0		
g	: Acceleration of Gravity	9.8	m/s^2	

Table H.3.27 Calculation of Working Force on the Unit Section of the Proposed Check Dam at Tataaran (Debris Flow Time)

Design Load	Symbol	Calculation	Vertical Force (V)	Horizontal Force (H)	Distance between Upstream End of Dam Bed and Line of Action (L)	Moment M=V·L+H·L
Dead Load	W					
	W1	$\frac{1}{2} \times 23.0 \times 0.30 \times 3.00^2$	31.05		$\frac{2}{3} \times 0.30 \times 3.00 = 0.60$	18.63
	W2	$23.0 \times 3.00 \times 3.00$	207.00		$0.30 \times 3.00 + \frac{1}{2} \times 3.00 = 2.40$	496.80
	W3	$\frac{1}{2} \times 23.0 \times 0.20 \times 3.00^2$	20.70		$0.30 \times 3.00 + 3.00 + \frac{1}{3} \times 0.20 \times 3.00 = 4.10$	84.87
Hydrostatic Pressure	P					
	PV1	$\frac{1}{2} \times 9.8 \times 0.30 \times (3.00 - 1.50)^2$	3.31		$\frac{1}{3} \times 0.30 \times (3.00 - 1.50) = 0.15$	0.50
	PH1	$\frac{1}{2} \times 11.8 \times (3.00 - 1.50)^2$		13.28	$\frac{1}{3} \times (3.00 - 1.50) = 0.50$	6.64
	PH2	$1.50 \times 11.8 \times (3.00 - 1.50)$		26.55	$\frac{1}{2} \times (3.00 - 1.50) = 0.75$	19.91
Earth Pressure	Pe					
	PeV1	$\frac{1}{2} \times 9.6 \times 0.30 \times (3.00 - 1.50)^2$	3.24		$\frac{1}{3} \times 0.30 \times (3.00 - 1.50) = 0.15$	0.49
	PeH1	$\frac{1}{2} \times 0.33 \times 9.60 \times (3.00 - 1.50)^2$		3.56	$\frac{1}{3} \times (3.00 - 1.50) = 0.50$	1.78
	PeH2	$0.33 \times 6.9 \times 1.50 \times (3.00 - 1.50)$		5.12	$\frac{1}{2} \times (3.00 - 1.50) = 0.75$	3.84
Weight of Debris Flow	Pd					
	Pd1	$16.7 \times 1.50 \times 0.30 \times (3.00 - 1.50)$	11.27		$\frac{1}{2} \times 0.30 \times (3.00 - 1.50) = 0.23$	2.59
	Pd2	$\frac{1}{2} \times 16.7 \times 0.30 \times 1.50^2$	5.64		$0.30 \times (3.00 - 1.50) + \frac{1}{3} \times 0.30 \times 1.50 = 0.60$	3.38
Hydrodynamic Force of Debris Flow	F					
	F	$1.0 \times \frac{16.7}{9.8} \times 1.50 \times 3.26^2$		27.17	$(3.00 - 1.50) + \frac{1.50}{2} = 2.25$	61.13
Total			282.21	75.68		700.56

Table H.3.28 Stability Analysis of Proposed Check Dam at Tataaran (Debris Flow Time)

1) Stability for Overturn

$$X = \frac{\Sigma M}{\Sigma V} = \frac{700.56}{282.21} = 2.482 \quad m$$

$$0 \leqq X \leqq B$$

$$0.00 \leqq 2.482 \leqq 4.50 \quad OK$$

$$e = X - \frac{B}{2} = 2.482 - \frac{4.50}{2} = 0.232 \quad m$$

$$|e| \leqq \frac{B}{6} = \frac{4.50}{6} = 0.750 \geqq 0.232 \quad \textbf{OK}$$

X : Length from the Intersection Point of the Action Line of the Load Resultant and Dam Bed to Upstream End of Dam Bed (m)
ΣM : Moment of Load for the Unit Width of the Section which has the Support Point at Upstream End of the Dam Bed (kN･m/m)
ΣV : Total Vertical Force for the Unit Width of the Section (kN/m)
B : Dam Bed Width (m)
e : Distance between Center Line of the Dam Body and the Point of Action of Resultant (m)

2) Stability for Dam Body Desruction

$$P1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6 \cdot e}{B}\right)$$

$$= \frac{282.21}{4.50} \cdot \left(1 + \frac{6 \cdot 0.232}{4.50}\right) = 82.11 \quad kN/m^2$$

$$P2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6 \cdot e}{B}\right)$$

$$= \frac{282.21}{4.50} \cdot \left(1 - \frac{6 \cdot 0.232}{4.50}\right) = 43.31 \quad kN/m^2$$

Allowable Stresses

Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	≧	82.11	kN/m^2	**OK**
Allowable Tensile Stress of Wet Masonry	0	kN/m^2	<	43.31	kN/m^2	**OK**

3) Stability for Foundation Desruction

Allowable Bearing Force of the Foundation	392	kN/m^2	≧	82.11	kN/m^2	**OK**

4) Stability for Sliding

$$n \leqq Fs = \frac{V}{\Sigma H} \qquad V = f \cdot \Sigma V$$

$$= \frac{169.326}{75.68} \qquad = 0.6 \cdot 282.21$$

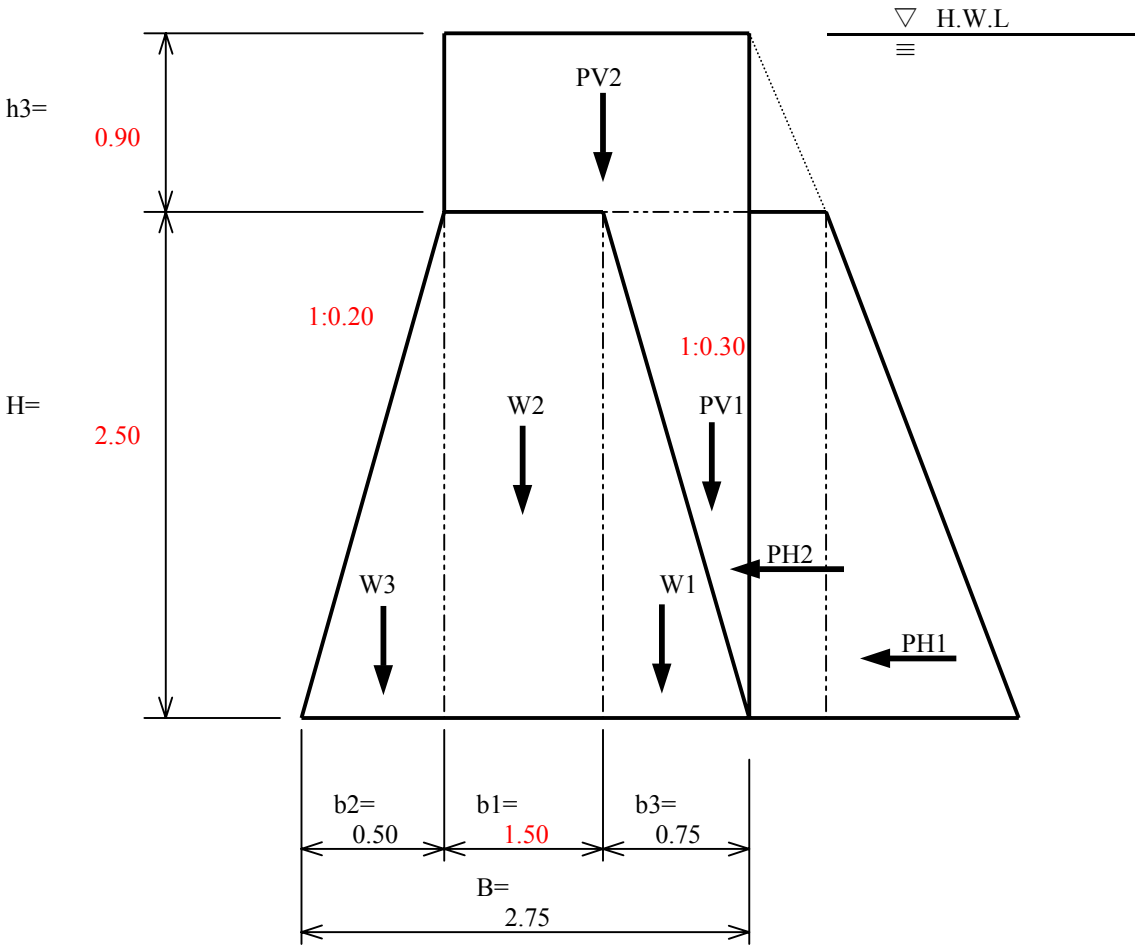
$$= 2.237 \qquad = 169.326 \quad kN/m^3$$

$$2.237 \geqq 1.2 \quad \textbf{OK}$$

n : Safety Factor
f : Coefficient of Friction

Table H.3.29 Assumption for the Stability Analysis of Proposed Check Dam at Tandengan (Flood Time)

1) Dimension



Unit Weight of Wet Masonry	:	23.0	kN/m^3
Unit Weight of Flowing Water	:	11.8	kN/m^3
Type of Foundation	:	Sand & Gravel	
Allowable Compressive Stress of Wet Maronry	:	3,920	kN/m^2
Allowable Tensile Stress of Wet Masonry	:	0	kN/m^2
Allowable Bearing Capacity of the Foundation	:	392	kN/m^2
Safety Factor for the Sliding	:	1.2	
Coefficient of Friction	:	0.6	

Table H.3.30 Calculation of Working Force on the Unit Section of the Proposed Check Dam at Tandengan (Flood Time)

Design Load	Symbol	Calculation	Vertical Force (V)	Horizontal Force (H)	Distance between Upstream End of Dam Bed and Line of Action (L)	Moment M=V·L+H·L
Dead Load	W					
	W1	$\frac{1}{2} \times 23.0 \times 0.30 \times 2.50^2$	21.59		$\frac{2}{3} \times 0.30 \times 2.50 = 0.50$	10.80
	W2	$23.0 \times 1.50 \times 2.50$	86.36		$0.30 \times 2.50 + \frac{1}{2} \times 1.50 = 1.50$	129.54
	W3	$\frac{1}{2} \times 23.03 \times 0.20 \times 2.50^2$	14.39		$0.30 \times 2.50 + 1.50 + \frac{1}{3} \times 0.20 \times 2.50 = 2.42$	34.82
Hydrostatic Pressure	P					
	PV1	$\frac{1}{2} \times 11.8 \times 0.30 \times 2.50^2$	11.03		$\frac{1}{3} \times 0.30 \times 2.50 = 0.25$	2.76
	PV2	$11.8 \times 0.90 \times (0.30 \times 2.50 + 1.50)$	23.81		$\frac{1}{2} \times (0.30 \times 2.50 + 1.50) = 1.13$	26.91
	PH1	$\frac{1}{2} \times 11.8 \times 2.50^2$		36.75	$\frac{1}{3} \times 2.50 = 0.83$	30.50
	PH2	$11.8 \times 0.90 \times 2.50$		26.46	$\frac{1}{2} \times 2.50 = 1.25$	33.08
Total			kN/m 157.18	kN/m 63.21		kN·m/m 268.41

Table H.3.31 Stability Analysis of Proposed Check Dam at Tandengan (Flood Time)

1) Stability for Overturn

$$X = \frac{\Sigma M}{\Sigma V} = \frac{268.41}{157.18} = 1.708 \quad m$$

$$0 \leqq X \leqq B$$

$$0.00 \leqq 1.708 \leqq 2.75 \quad \textbf{OK}$$

$$e = X - \frac{B}{2} = 1.708 - \frac{2.75}{2} = 0.333 \quad m$$

$$|e| \leqq \frac{B}{6} = \frac{2.75}{6} = 0.458 \geqq 0.333 \quad \textbf{OK}$$

X : Length from the Intersection Point of the Action Line of the Load Resultant and Dam Bed to Upstream End of Dam Bed (m)
ΣM : Moment of Load for the Unit Width of the Section which has the Support Point at Upstream End of the Dam Bed (kN･m/m)
ΣV : Total Vertical Force for the Unit Width of the Section (kN/m)
B : Dam Bed Width (m)
e : Distance between Center Line of the Dam Body and the Point of Action of Resultant (m)

2) Stability for Dam Body Desruction

$$P1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6 \cdot e}{B}\right)$$

$$= \frac{157.18}{2.75} \cdot \left(1 + \frac{6 \cdot 0.333}{2.75}\right) = 98.64 \quad kN/m^2$$

$$P2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6 \cdot e}{B}\right)$$

$$= \frac{157.18}{2.75} \cdot \left(1 - \frac{6 \cdot 0.333}{2.75}\right) = 15.67 \quad kN/m^2$$

Allowable Stresses						
Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	≧	98.64	kN/m^2	**OK**
Allowable Tensile Stress of Wet Masonry	0	kN/m^2	<	15.67	kN/m^2	**OK**

3) Stability for Foundation Desruction

Allowable Bearing Force of the Foundation	392	kN/m^2	≧	98.64	kN/m^2	**OK**

4) Stability for Sliding

$$n \leqq Fs = \frac{V}{\Sigma H} \qquad V = f \cdot \Sigma V$$

$$= \frac{94.308}{63.21} \qquad = 0.6 \cdot 157.18$$

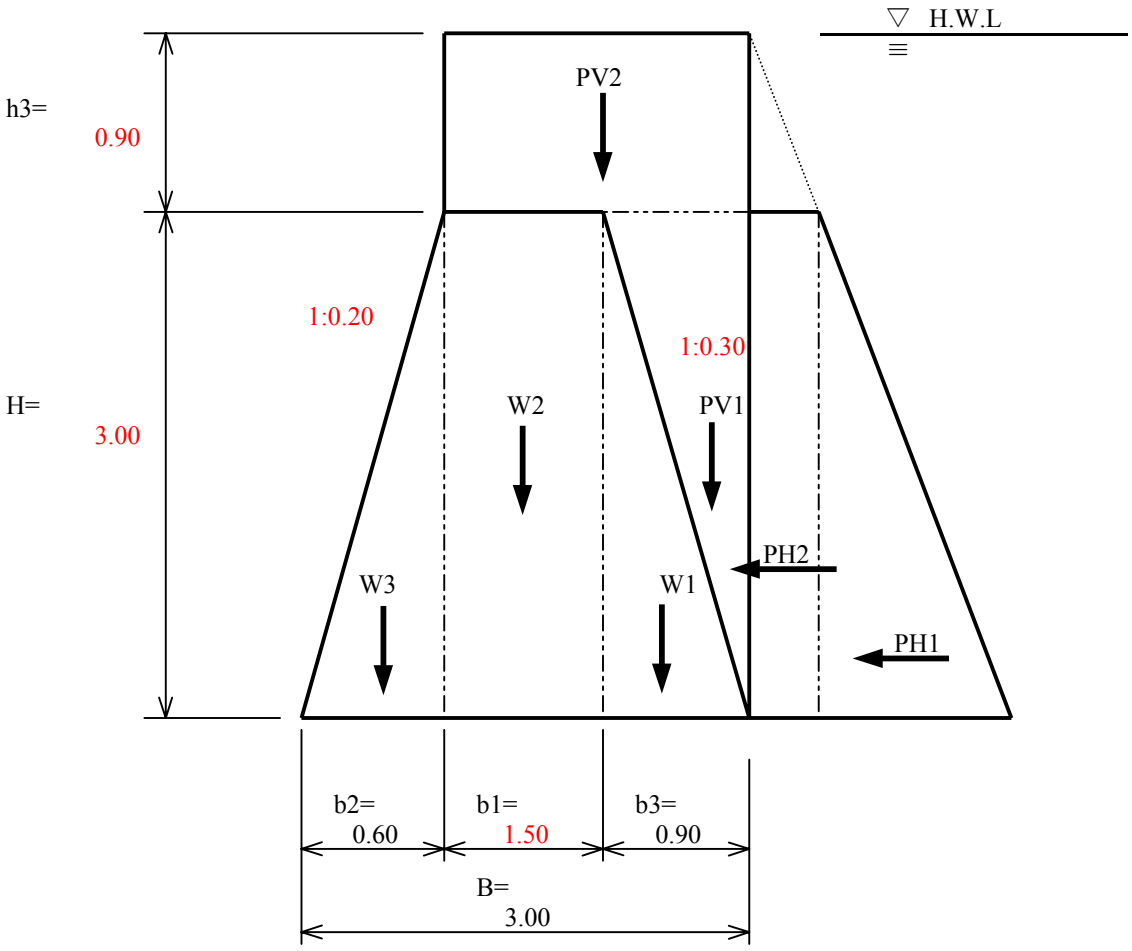
$$= 1.492 \qquad = 94.308 \quad kN/m^3$$

$$1.492 \geqq 1.2 \quad \textbf{OK}$$

n : Safety Factor
f : Coefficient of Friction

Table H.3.32 Assumption for the Stability Analysis of Proposed Check Dam at Ranomerut (Flood Time)

1) Dimension



Unit Weight of Wet Masonry	:	23.0	kN/m^3
Unit Weight of Flowing Water	:	11.8	kN/m^3
Type of Foundation	:	Sand & Gravel	
Allowable Compressive Stress of Wet Maronry	:	3,920	kN/m^2
Allowable Tensile Stress of Wet Masonry	:	0	kN/m^2
Allowable Bearing Capacity of the Foundation	:	392	kN/m^2
Safety Factor for the Sliding	:	1.2	
Coefficient of Friction	:	0.6	

Table H.3.33 Calculation of Working Force on the Unit Section of the Proposed Check Dam at Ranomerut (Flood Time)

Design Load	Symbol	Calculation	Vertical Force (V)	Horizontal Force (H)	Distance between Upstream End of Dam Bed and Line of Action (L)	Moment M=V·L+H·L
Dead Load	W					
	W1	$\frac{1}{2} \times 23.0 \times 0.30 \times 3.00^2$	31.09		$\frac{2}{3} \times 0.30 \times 3.00 = 0.60$	18.65
	W2	$23.0 \times 1.50 \times 3.00$	103.64		$0.30 \times 3.00 + \frac{1}{2} \times 1.50 = 1.65$	171.01
	W3	$\frac{1}{2} \times 23.03 \times 0.20 \times 3.00^2$	20.73		$0.30 \times 3.00 + 1.50 + \frac{1}{3} \times 0.20 \times 3.00 = 2.60$	53.90
Hydrostatic Pressure	P					
	PV1	$\frac{1}{2} \times 11.8 \times 0.30 \times 3.00^2$	15.88		$\frac{1}{3} \times 0.30 \times 3.00 = 0.30$	4.76
	PV2	$11.8 \times 0.90 \times (0.30 \times 3.00 + 1.50)$	25.40		$\frac{1}{2} \times (0.30 \times 3.00 + 1.50) = 1.20$	30.48
	PH1	$\frac{1}{2} \times 11.8 \times 3.00^2$		52.92	$\frac{1}{3} \times 3.00 = 1.00$	52.92
	PH2	$11.8 \times 0.90 \times 3.00$		31.75	$\frac{1}{2} \times 3.00 = 1.50$	47.63
Total			kN/m 196.74	kN/m 84.67		kN·m/m 379.35

Table H.3.34 Stability Analysis of Proposed Check Dam at Ranomerut (Flood Time)

1) Stability for Overturn

$$X = \frac{\Sigma M}{\Sigma V} = \frac{379.35}{196.74} = 1.928 \quad m$$

$$0 \leqq X \leqq B$$

$$0.00 \leqq 1.928 \leqq 3.00 \quad \textbf{OK}$$

$$e = X - \frac{B}{2} = 1.928 - \frac{3.00}{2} = 0.428 \quad m$$

$$|e| \leqq \frac{B}{6} = \frac{3.00}{6} = 0.500 \geqq 0.428 \quad \textbf{OK}$$

X : Length from the Intersection Point of the Action Line of the Load Resultant and Dam Bed to Upstream End of Dam Bed (m)
ΣM : Moment of Load for the Unit Width of the Section which has the Support Point at Upstream End of the Dam Bed (kN･m/m)
ΣV : Total Vertical Force for the Unit Width of the Section (kN/m)
B : Dam Bed Width (m)
e : Distance between Center Line of the Dam Body and the Point of Action of Resultant (m)

2) Stability for Dam Body Desruction

$$P1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6 \cdot e}{B}\right)$$

$$= \frac{196.74}{3.00} \cdot \left(1 + \frac{6 \cdot 0.428}{3.00}\right) = 121.74 \quad kN/m^2$$

$$P2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6 \cdot e}{B}\right)$$

$$= \frac{196.74}{3.00} \cdot \left(1 - \frac{6 \cdot 0.428}{3.00}\right) = 9.42 \quad kN/m^2$$

	Allowable Stresses				
Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	≧	121.74	kN/m^2 **OK**
Allowable Tensile Stress of Wet Masonry	0	kN/m^2	<	9.42	kN/m^2 **OK**

3) Stability for Foundation Desruction

Allowable Bearing Force of the Foundation	392	kN/m^2	≧	121.74	kN/m^2 **OK**

4) Stability for Sliding

$$n \leqq Fs = \frac{V}{\Sigma H} \qquad V = f \cdot \Sigma V$$

$$= \frac{118.044}{84.67} \qquad = 0.6 \cdot 196.74$$

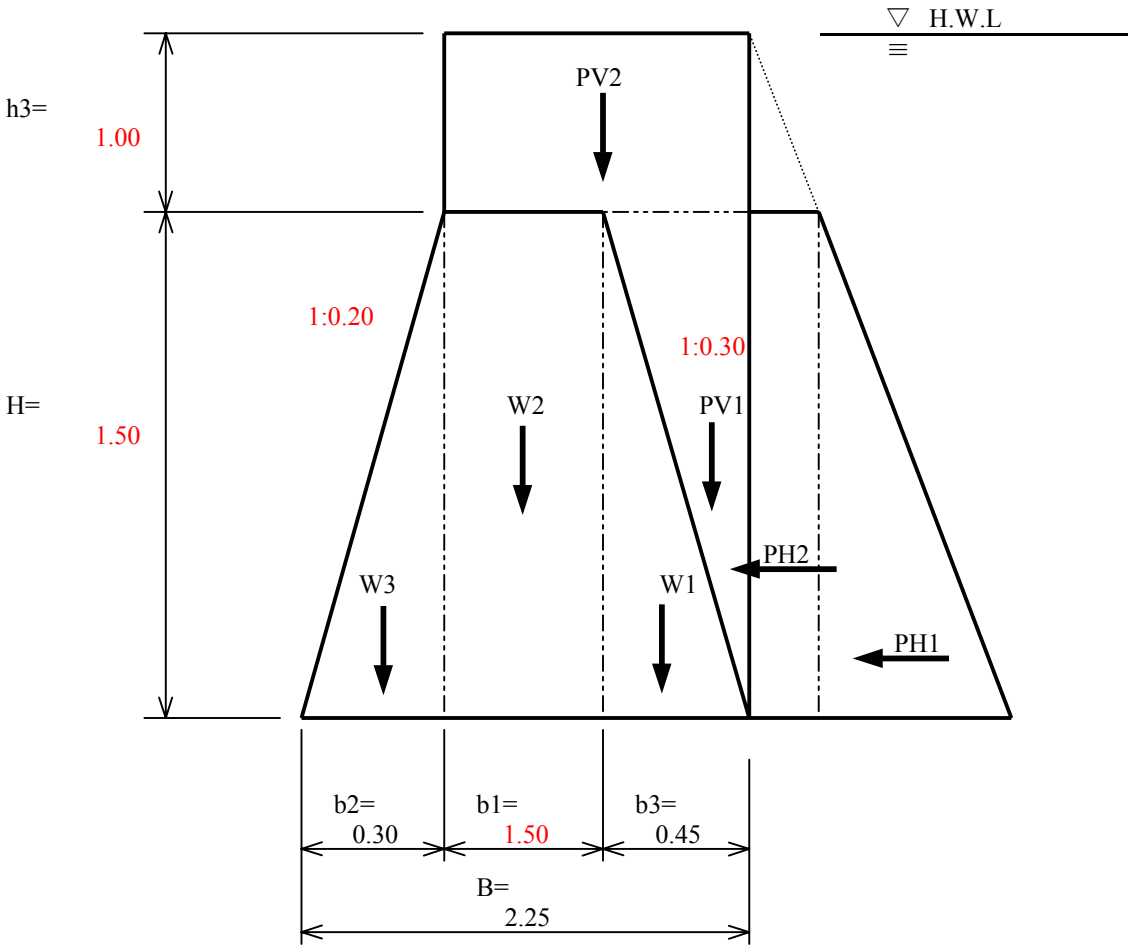
$$= 1.394 \qquad = 118.044 \quad kN/m^3$$

$$1.394 \geqq 1.2 \quad \textbf{OK}$$

n : Safety Factor
f : Coefficient of Friction

Table H.3.35 Assumption for the Stability Analysis of Proposed Check Dam at Tounipus (Flood Time)

1) Dimension



Unit Weight of Wet Masonry	:	23.0	kN/m^3
Unit Weight of Flowing Water	:	11.8	kN/m^3
Type of Foundation	:	Sand & Gravel	
Allowable Compressive Stress of Wet Maronry	:	3,920	kN/m^2
Allowable Tensile Stress of Wet Masonry	:	0	kN/m^2
Allowable Bearing Capacity of the Foundation	:	392	kN/m^2
Safety Factor for the Sliding	:	1.2	
Coefficient of Friction	:	0.6	

Table H.3.36 Calculation of Working Force on the Unit Section of the Proposed Check Dam at Tounipus (Flood Time)

Design Load	Symbol	Calculation	Vertical Force (V)	Horizontal Force (H)	Distance between Upstream End of Dam Bed and Line of Action (L)	Moment M=V·L+H·L
Dead Load	W					
	W1	$\frac{1}{2} \times 23.0 \times 0.30 \times 1.50^2$	7.77		$\frac{2}{3} \times 0.30 \times 1.50 = 0.30$	2.33
	W2	$23.0 \times 1.50 \times 1.50$	51.82		$0.30 \times 1.50 + \frac{1}{2} \times 1.50 = 1.20$	62.18
	W3	$\frac{1}{2} \times 23.03 \times 0.20 \times 1.50^2$	5.18		$0.30 \times 1.50 + 1.50 + \frac{1}{3} \times 0.20 \times 1.50 = 2.05$	10.62
Hydrostatic Pressure	P					
	PV1	$\frac{1}{2} \times 11.8 \times 0.30 \times 1.50^2$	3.97		$\frac{1}{3} \times 0.30 \times 1.50 = 0.15$	0.60
	PV2	$11.8 \times 1.00 \times (0.30 \times 1.50 + 1.50)$	22.93		$\frac{1}{2} \times (0.30 \times 1.50 + 1.50) = 0.98$	22.47
	PH1	$\frac{1}{2} \times 11.8 \times 1.50^2$		13.23	$\frac{1}{3} \times 1.50 = 0.50$	6.62
	PH2	$11.8 \times 1.00 \times 1.50$		17.64	$\frac{1}{2} \times 1.50 = 0.75$	13.23
Total			kN/m 91.67	kN/m 30.87		kN·m/m 118.05

Table H.3.37 Stability Analysis of Proposed Check Dam at Tounipus (Flood Time)

1) Stability for Overturn

$$X = \frac{\Sigma M}{\Sigma V} = \frac{118.05}{91.67} = 1.288 \quad m$$

$$0 \leqq X \leqq B$$

$$0.00 \leqq 1.288 \leqq 2.25 \quad \textbf{OK}$$

$$e = X - \frac{B}{2} = 1.288 - \frac{2.25}{2} = 0.163 \quad m$$

$$|e| \leqq \frac{B}{6} = \frac{2.25}{6} = 0.375 \geqq 0.163 \quad \textbf{OK}$$

X : Length from the Intersection Point of the Action Line of the Load Resultant and Dam Bed to Upstream End of Dam Bed (m)
ΣM : Moment of Load for the Unit Width of the Section which has the Support Point at Upstream End of the Dam Bed (kN･m/m)
ΣV : Total Vertical Force for the Unit Width of the Section (kN/m)
B : Dam Bed Width (m)
e : Distance between Center Line of the Dam Body and the Point of Action of Resultant (m)

2) Stability for Dam Body Desruction

$$P1 = \frac{\Sigma V}{B} \cdot \left(1 + \frac{6 \cdot e}{B}\right)$$

$$= \frac{91.67}{2.25} \cdot \left(1 + \frac{6 \cdot 0.163}{2.25}\right) = 58.43 \quad kN/m^2$$

$$P2 = \frac{\Sigma V}{B} \cdot \left(1 - \frac{6 \cdot e}{B}\right)$$

$$= \frac{91.67}{2.25} \cdot \left(1 - \frac{6 \cdot 0.163}{2.25}\right) = 23.06 \quad kN/m^2$$

Allowable Stresses						
Allowable Compressive Stress of Wet Maronry	3,920	kN/m^2	≧	58.43	kN/m^2	**OK**
Allowable Tensile Stress of Wet Masonry	0	kN/m^2	<	23.06	kN/m^2	**OK**

3) Stability for Foundation Desruction

Allowable Bearing Force of the Foundation	392	kN/m^2	≧	58.43	kN/m^2	**OK**

4) Stability for Sliding

$$n \leqq Fs = \frac{V}{\Sigma H} \qquad V = f \cdot \Sigma V$$

$$= \frac{55.002}{30.87} \qquad = 0.6 \cdot 91.67$$

$$= 1.782 \qquad = 55.002 \quad kN/m^3$$

$$1.782 \geqq 1.2 \quad \textbf{OK}$$

n : Safety Factor
f : Coefficient of Friction

Table H.3.38 Estimate of Workable Days

Unit:days

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Monthly Day	31	28	31	30	31	30	31	31	30	31	30	31	365
Frequency of Rainfall													
0mm - 10mm	26	24	25	25	23	25	28	28	27	24	22	26	303
10mm - 30mm	4	3	4	4	6	4	3	2	2	5	6	4	47
30mm - 50mm	1	1	1	1	1	1	0	0	1	1	1	1	10
more than 50mm	0	0	1	0	1	0	0	1	0	1	1	0	5
Time Length to be Suspended	3	3	5	3	6	3	2	3	2	6	6	3	45
Holidays	7	4	5	8	5	6	5	5	4	6	4	8	67
Total Days to be Suspended	10	7	10	11	11	9	7	8	6	12	10	11	112
Workable Days	21	21	21	19	20	21	24	23	24	19	20	20	253

Table H.3.39 List of Labor Cost

Unit:Rp.

Item	Unit	F.C.	L.C.	Total
Foreman	m·day	0	32,500	32,500
Supervisor	m·day	0	22,500	22,500
Semi-skilled labor	m·day	0	25,000	25,000
Skilled Labor	m·day	0	30,000	30,000
Common Labor	m·day	0	20,000	20,000
Steel Fixer	m·day	0	25,000	25,000
Carpenter	m·day	0	27,500	27,500

Table H.3.40 List of Material Cost

Unit:Rp.

Item	Unit	F.C.	L.C.	Total
Portland Cement	kg	471	52	523
Cobble	m3	41,525	33,975	75,500
Pebble	m3	14,625	7,875	22,500
Fine Aggregate	m3	55,900	30,100	86,000
Coarse Aggregate	m3	47,175	8,325	55,500
Tree	no.	0	300	300
Bench Mark	no.	120,000	80,000	200,000
Sand	m3	73,100	12,900	86,000
Wooden Frame	m3	408,000	72,000	480,000
PVC Pipe 4"	m	48,900	0	48,900
Wire for Rainfall Gauge	unit	67,500	0	67,500
Nail	kg	13,500	0	13,500
Reinforcing Bar	kg	12,800	0	12,800
Hoop Tie	kg	8,800	0	8,800
Palm Fiber, t=10cm	m2	0	29,250	29,250
Plastic Tape	kg	5,000	0	5,000
Wooden Pile	no.	0	1,000	1,000
Brick	no.	309	166	475
Bamboo (big)	no.	0	6,000	6,000
Bamboo (small)	no.	0	4,000	4,000
Palm Roof	m3	0	1,250	1,250
Sod	m2	0	48,750	48,750
Galvanized Iron Wire 2mm	kg	9,475	0	9,475
Galvanized Iron Wire 4mm	kg	9,475	0	9,475
Manufactured Gabion, (W=1.0m, L=2.0m, H=0.5m)	no.	365,000	0	365,000

Note: L.C.=Local Currency, F.C.=Foreign Currency

Table H.3.41 List of Equipment Cost

Unit:Rp.

No.	Item	Unit	F.C.	L.C.	Total
1	Cement mixer	unit/hr	83,838	4,413	88,250
2	Miscellaneous	L.S.	400	100	500
3	Concrete Vibrator	unit/hr	67,450	3,550	71,000
4	Concrete Bucket	no.	7,363	388	7,750
5	Concrete Mixer	no.	56,525	2,975	59,500
6	Hand Compactor	no.	32,850	3,650	36,500
7	Hammer	no.	43,200	4,800	48,000
8	Saw	no.	40,613	4,513	45,125
9	Bar Cutter	unit/hr	48,000	0	48,000
10	Bar Bender	unit/hr	36,500	0	36,500
11	Hoe	no.	79,425	8,825	88,250
12	Shovel	no.	53,550	5,950	59,500
13	Handcart	no.	726,300	80,700	807,000
14	Chopping Knife	no.	22,500	2,500	25,000
15	Cutting Knife	no.	27,675	3,075	30,750
16	Scaffolding	L.S.	4,500	500	5,000

Table H.3.42 List of Construction Unit Price

Unit:Rp.

Work Items	Unit	F.C.	L.C.	Total
1 Earth Works				
1.1 Clearing	m2	0	1,268	1,268
1.2 Excavation (manpower), common soil	m3	400	15,663	16,063
1.3 Excavation (manpower), weatherd rock	m3	400	31,225	31,625
1.4 Backfilling (manpower)	m3	3,285	10,390	13,675
1.5 Embankment (manpower)	m3	3,285	24,315	27,600
1.6 Sod Facing	m2	42,630	88,010	130,640
1.7 Grading (manpower), common soil	m3	400	11,225	11,625
2 Concrete Works				
2.1 Plain Concrete	m3	276,705	200,865	477,570
2.2 Concrete for Reinforced Concrete 175kg/cm2	m3	276,705	157,065	433,770
2.3 Form Works for Reinforced Concrete 175kg/cm2 including Demolition	m3	22,558	29,623	52,181
2.4 Reinforcing Bar Arrangement for Concrete 175kg/cm2	m3	1,438,100	353,000	1,791,100
2.5 Reinforced Concrete 175kg/cm2	m3	1,731,448	399,338	2,130,786
3 Stone Works				
3.1 Wet Masonry	m3	166,921	156,021	322,942
3.2 Plastering (all surface)	m2	6,037	15,129	21,166
3.3 Plastering (without masonry stone surface)	m2	4,019	11,816	15,835
3.4 Gabion Box (manpower)	m3	227,213	77,748	304,961
3.5 Manufactured Gabion Box 1.0 x 2.0 x 0.5 m	m3	392,101	36,230	428,331
3.6 Palm Fiber Filter, t=10cm	m2	28,508	32,577	61,085
3.7 Riprap	m3	41,525	41,575	83,100
4 Hillside Works				
4.1 Bamboo Terrace	10m	0	52,145	52,145
5 Building Works				
5.1 Brick Works	m3	280,174	234,967	515,141
5.2 Plastering (all surface)	m2	6,037	15,129	21,166
5.3 Rainfall Gauge Installation	unit	67,500	40,000	107,500
6 Other Works				
6.1 Re-vegetation	nos.	0	888	888

Note: L.C.=Local Currency, F.C.=Foreign Currency

Table H.3.43 Breakdown of Direct Construction Cost

Unit: Rp.

Work Item	Unit	Design Quantity	Quantity	Total Cost		
				F.C.	L.C.	Total
1 Check Dam						
1.1 Rehabilitation Works						
1.1.1 Check Dam Leleko						
- Embankment (manpower)	m3	30	30	98,550	729,450	828,000
- Sod Facing	m2	600	600	25,578,000	52,806,000	78,384,000
1.1.2 Check Dam Kasuratan						
- Riprap	m3	10	10	415,250	415,750	831,000
1.1.3 Check Dam Tontimomor						
- Gabion Box (manpower)	m3	20	20	4,544,260	1,554,960	6,099,220
1.2 Proposed Check Dam Construction						
1.2.1 Wet Masonry Check Dam (4 locations)						
- Clearing	m2	17,450	17,450	0	22,126,600	22,126,600
- Excavation (manpower), common soil	m3	8,264	8,264	3,305,520	129,435,899	132,741,419
- Excavation (manpower), weatherd rock	m3	918	918	367,280	28,670,795	29,038,075
- Backfilling (manpower)	m3	7,520	7,520	24,703,693	78,134,359	102,838,051
- Manufactured Gabion Box 1.0 x 2.0 x 0.5 m	m3	1,740	1,740	682,255,740	63,040,200	745,295,940
- Palm Fiber Filter, t=10cm	m2	6,480	6,480	184,731,840	211,098,960	395,830,800
- Wet masonry	m3	4,940	4,940	824,589,740	770,743,740	1,595,333,480
- Plastering (without masonry stone surface)	m2	1,980	1,980	7,957,620	23,395,680	31,353,300
- Reinforced Concrete 175kg/cm2	m3	8	8	13,851,584	3,194,704	17,046,288
- Plain Concrete	m3	19	19	5,257,395	3,816,435	9,073,830
- Re-vegetation	nos.	200	200	0	177,600	177,600
Sub-Total of 1				**1,777,656,472**	**1,389,341,132**	**3,166,997,604**
2 Groundsill						
2.1 The River Panasen (6 locations)						
- Manufactured Gabion Box 1.0 x 2.0 x 0.5 m	m3	1,260	1,260	494,047,260	45,649,800	539,697,060
- Excavation (manpower), common soil	m3	3,000	3,000	1,200,000	46,989,000	48,189,000
- Backfilling (manpower)	m3	1,200	1,200	3,942,000	12,468,000	16,410,000
- Palm Fiber Filter, t=10cm	m2	1,890	1,890	53,880,120	61,570,530	115,450,650
Sub-Total of 2				**553,069,380**	**166,677,330**	**719,746,710**
3 River Revetment Works						
3.1 The River Panasen						
- Manufactured Gabion Box 1.0 x 2.0 x 0.5 m	m3	3,150	3,150	1,235,118,150	114,124,500	1,349,242,650
- Excavation (manpower), common soil	m3	8,550	8,550	3,420,000	133,918,650	137,338,650
- Backfilling (manpower)	m3	5,589	5,589	18,359,865	58,069,710	76,429,575
- Palm Fiber Filter, t=10cm	m2	7,200	7,200	**205,257,600**	**234,554,400**	**439,812,000**
Sub-Total of 3				**1,462,155,615**	**540,667,260**	**2,002,822,875**
4 Hillside Works						
4.1 Hillside Slope Failure HSF-1						
- Bamboo Terrace	10m	15	15	0	782,175	782,175
- Grading (manpower), common soil	m3	150	150	60,000	1,683,750	1,743,750
- Gabion Box (manpower)	m3	120	120	27,265,560	9,329,760	36,595,320
- Backfilling (manpower)	m3	250	250	821,250	2,597,500	3,418,750
Sub-Total of 4				**28,146,810**	**14,393,185**	**42,539,995**
5 Slope Protection Works for Road						
5.1 Slope Protection Works at Paleloan						
- Gabion Box (manpower)	m3	26	26	5,907,538	2,021,448	7,928,986
- Backfilling (manpower)	m3	20	20	65,700	207,800	273,500
5.2 Slope Protection Works at Eris(3)						
- Grading (manpower), common soil	m3	180	180	72,000	2,020,500	2,092,500
- Clearing	m2	195	195	0	247,260	247,260
- Sod Facing	m2	180	180	7,673,400	15,841,800	23,515,200
Sub-Total of 5				**13,718,638**	**20,338,808**	**34,057,446**
GRAND TOTAL				**3,834,746,915**	**2,131,417,715**	**5,966,164,630**

Table H.3.44 List of Maintenance Equipment Cost

Unit:Rp.

No.	Item	Unit	Quantity	F.C.	L.C.	Total
1	**Vehicle and Equipment**					
1.1	Pick-up Truck	no.	2	360,000,000	0	360,000,000
GRAND TOTAL				360,000,000	0	**360,000,000**

Table H.3.45 Engineering Services Cost

Unit:Rp.

No.	Item	Unit	Quantity	F.C.	L.C.	Total Cost
1	Detailed Design Stage					
1.1	Remuneration	M/M	18.0	0	8,200,000	147,600,000
1.2	Direct Cost, Equipment Cost, Additional Survey & Investigation (50% of above)	L.S.	1.0	0	73,800,000	73,800,000
SUB-TOTAL 1.1 - 1.2						**221,400,000**
2	Supervision Stage					
2.1	Remuneration	M/M	18.0	0	8,200,000	147,600,000
2.2	Direct Cost & Equipment Cost (30% of above)	L.S.	1.0	0	44,280,000	44,280,000
SUB-TOTAL 2.1 - 2.2						**191,880,000**
GRAND TOTAL						**413,280,000**

Table H.3.46 Capital Cost of Erosion Control Facility Development

Unit: Rp. Million

No.	Work Description	F.C.	L.C.	Total	Remarks
1	Direct Construction Cost				
1.1	Check Dam	1,778	1,389	3,167	
1.2	River Bed Protection Works	553	167	720	
1.3	River Bank Protection Works	1,462	541	2,003	
1.4	Slope Protection Works for Hillside	28	14	43	
1.5	Slope Protection Works for Road	14	20	34	
Sub-Total 1.1 - 1.5		3,835	2,131	5,966	
2	Indirect Construction Cost	767	426	1,193	20% of Direct Construction Cost
3	Maintenance Equipment Cost	360	0	360	
4	Land Acquisition	0	9	9	
5	Engineering Services Cost	0	413	413	
TOTAL without Physical Contingency		**4,962**	**2,980**	**7,942**	
6	Physical Contingency	383	213	597	10% of Direct Construction Cost
TOTAL with Physical Contingency		**5,345**	**3,193**	**8,539**	

Table H.3.47 Annual Disbursement Schedule of Erosion Control Facility Development

Unit: Rp. Million

Items	Year 1	Year 2	Year 3-10	Total
1 Direct Constrcution				
1.1 Check Dam	1,056	2,111	-	3,167
1.2 River Bed Protection Works	720	0	-	720
1.3 River Bank Protection Works	0	2,003	-	2,003
1.4 Slope Protection Works for Hillside	43	0	-	43
1.5 Slope Protection Works for Road	34	0	-	34
2 Indirect Construction	370	823	-	1,193
3 Maintenance Equipment	360	0	-	360
4 Land Acquisition	9	0	-	9
5 Engineering Services	276	138	-	413
Total	2,867	5,075	0	7,942

Table H.3.48 Annual Maintenance Cost

Unit:Rp.

No.	Item	Unit	Quantity	Total Cost
1	**Annual Maintenance Cost**	L.S.	1	30
GRAND TOTAL				**30**

(0.5% of Direct Construction Cost)

Table H.3.49 Replacement Cost

Unit:Rp.

No.	Item	Usefule Years	Unit	Quantity	Total Cost
1	**Vehicle and Equipment**				
1.1	Pick-up Truck	10	no.	2	360,000,000
GRAND TOTAL					**360,000,000**

Note: F.C.=Foreign Currency, L.C.=Local Currency, M/M=Man Month, L.S.=Lump Sum