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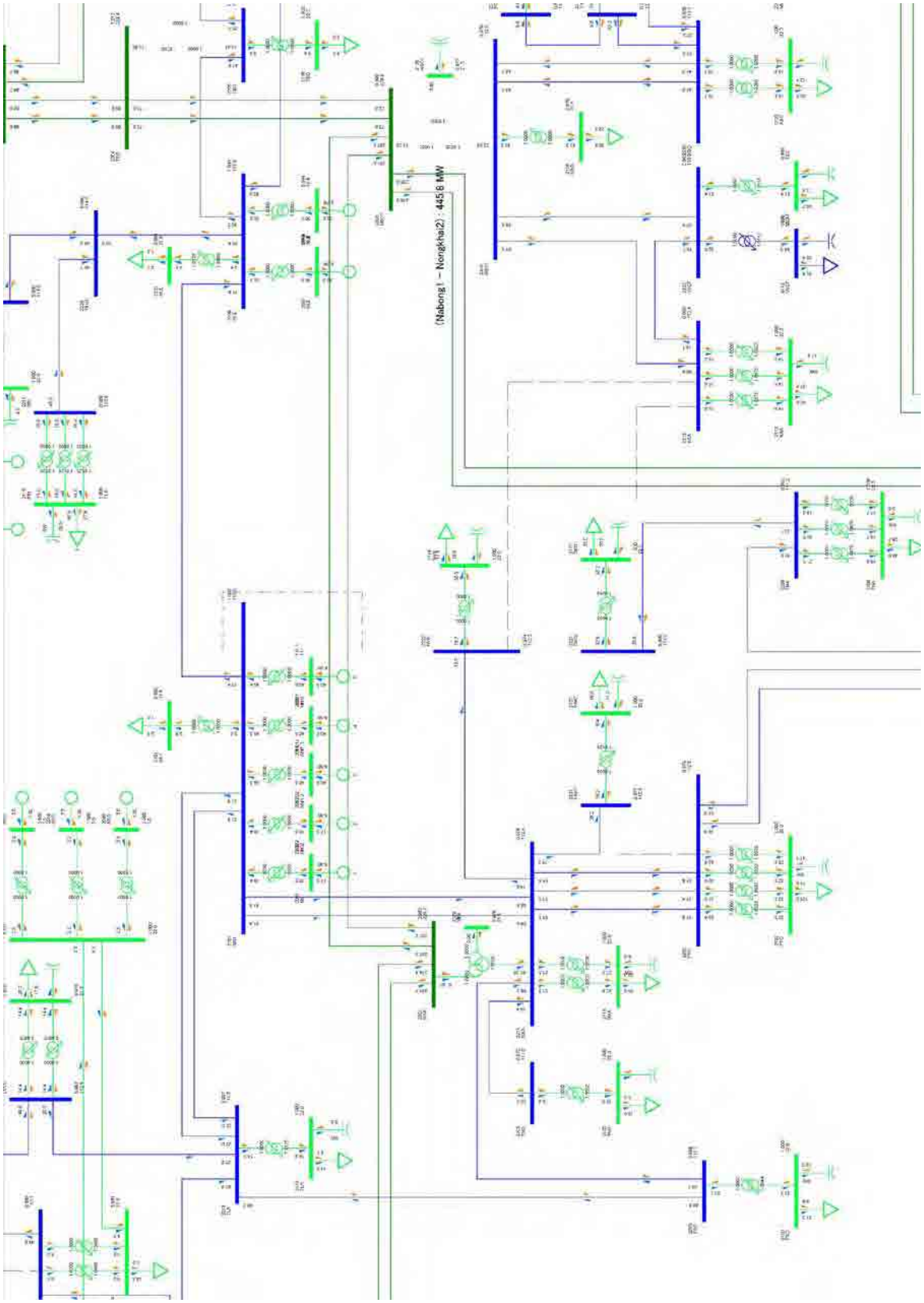
Appendix A

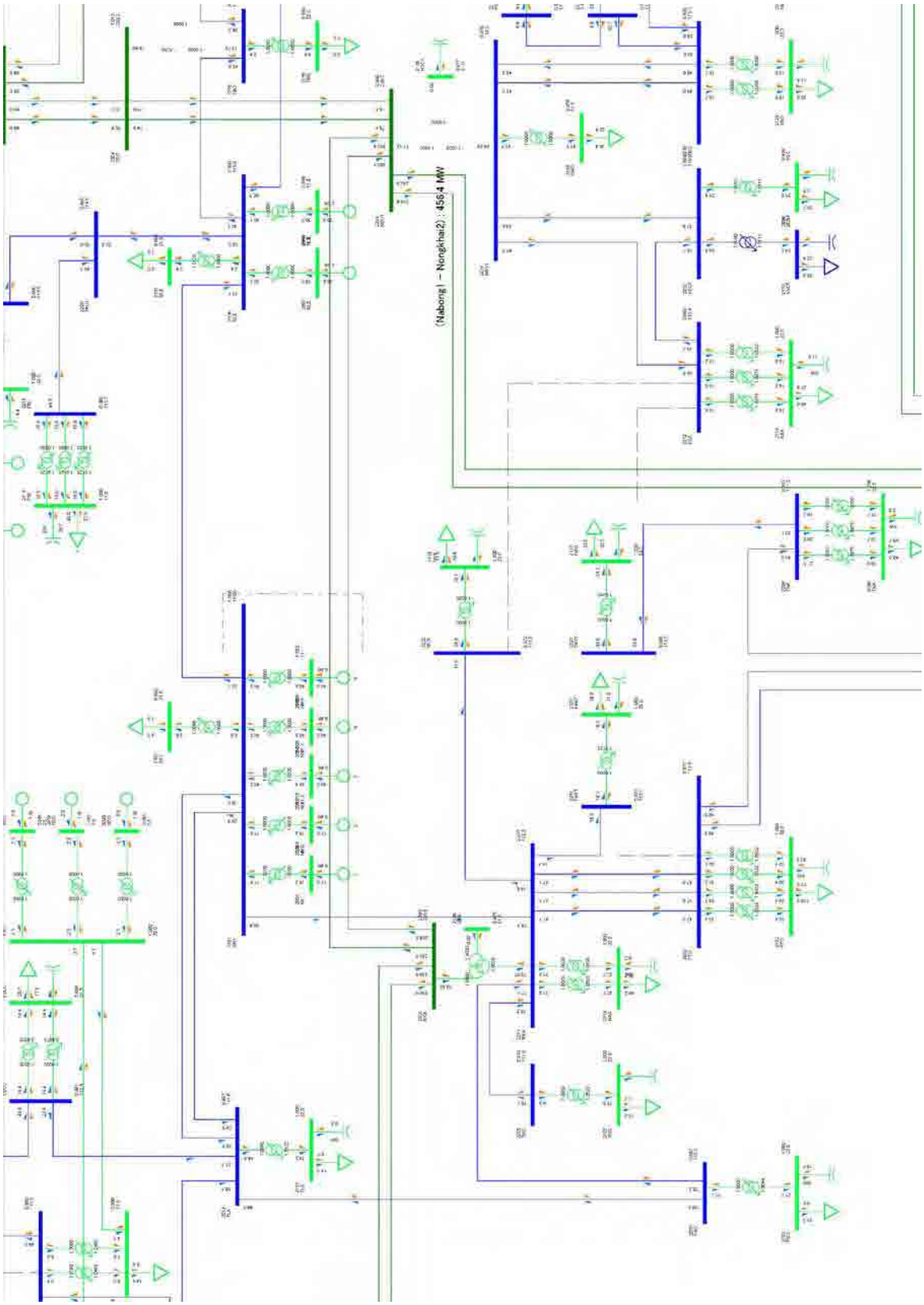
Result of Power Flow and Voltage Regulation Analysis

List of Drawings



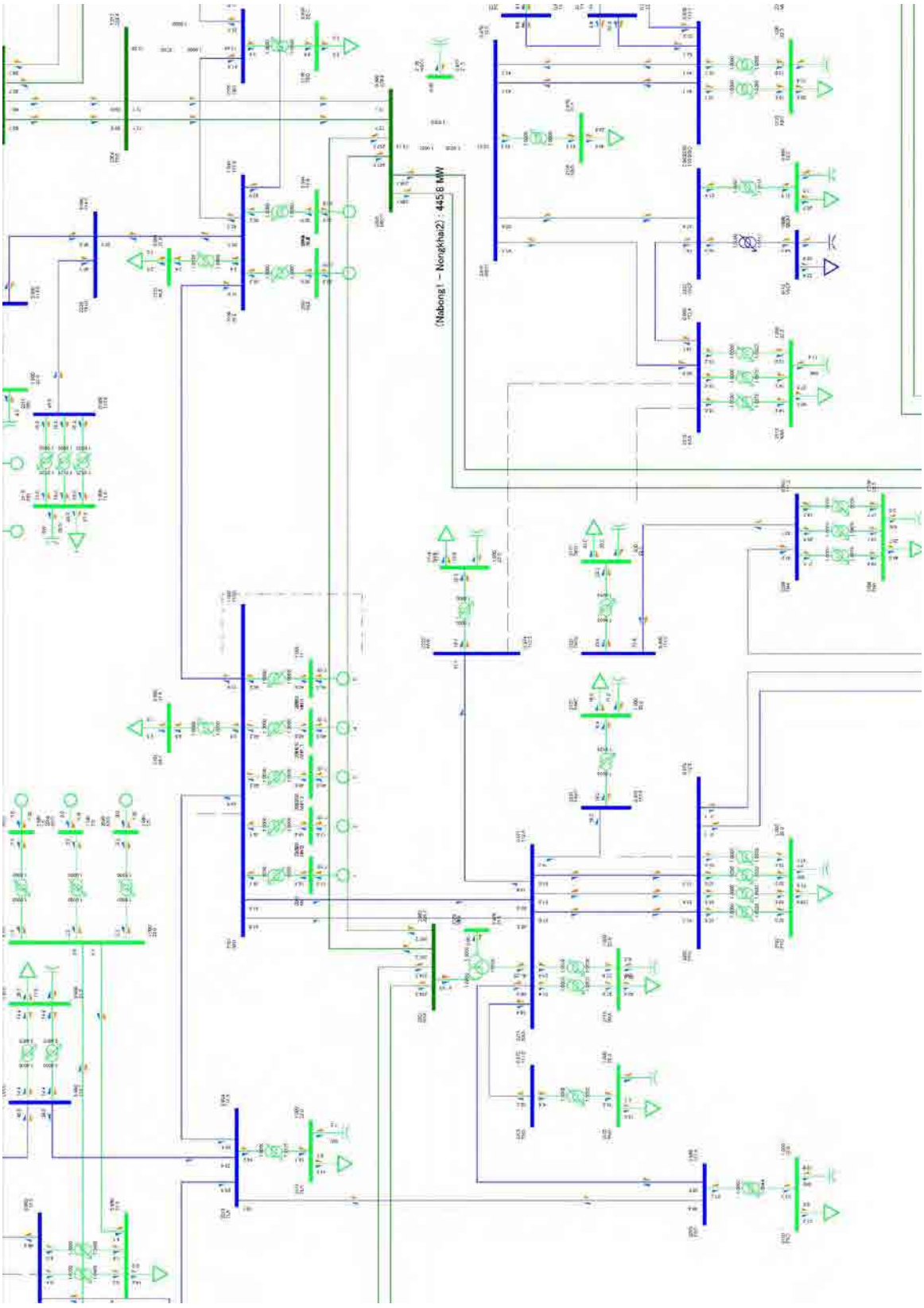
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-1 Result of Power Flow and Voltage Regulation Analysis (w/o Expansion, Normal Condition)



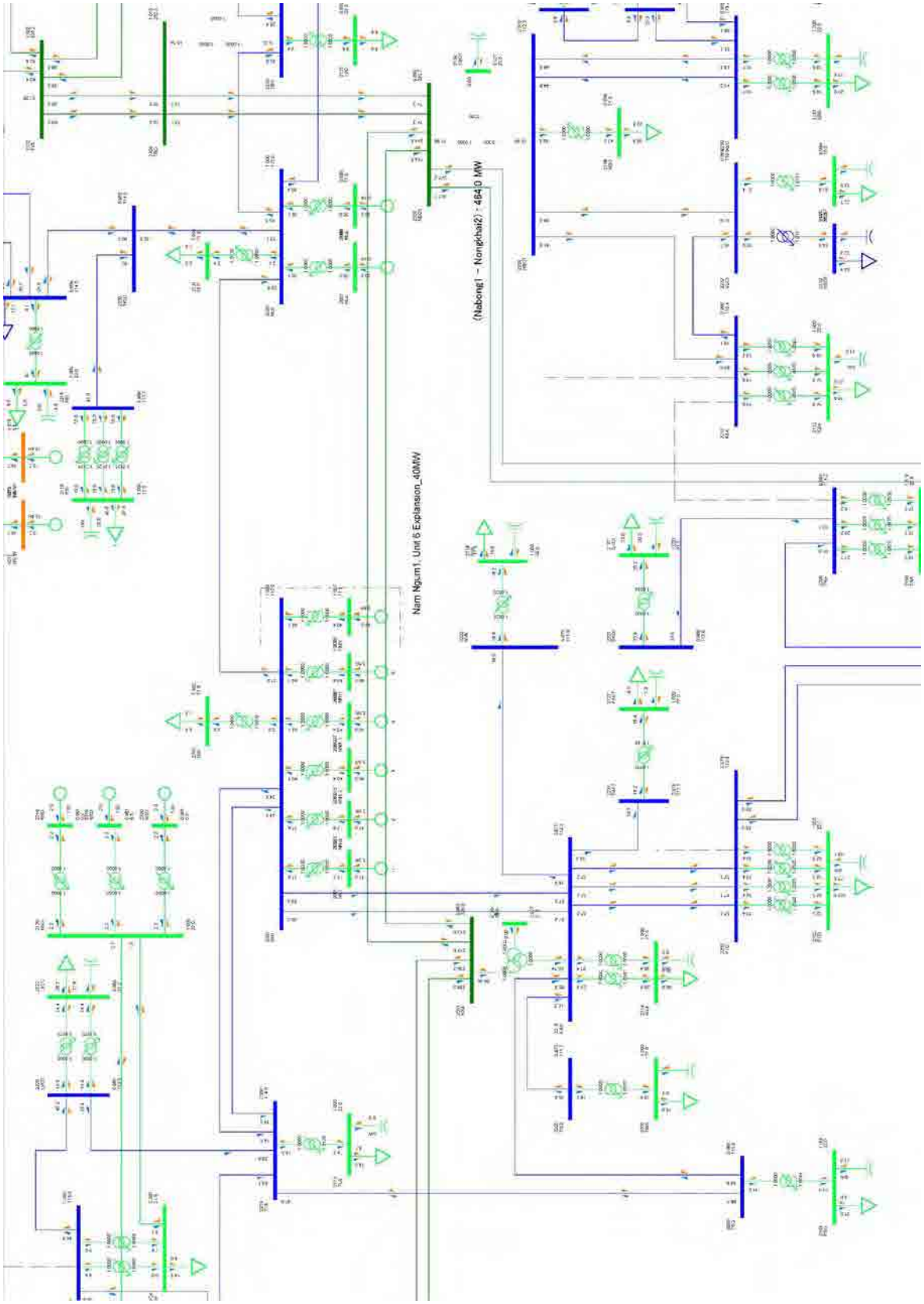
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-2 Result of Power Flow and Voltage Regulation Analysis (w/o Expansion, N-1 Contingency: NN1-NXA Fault)



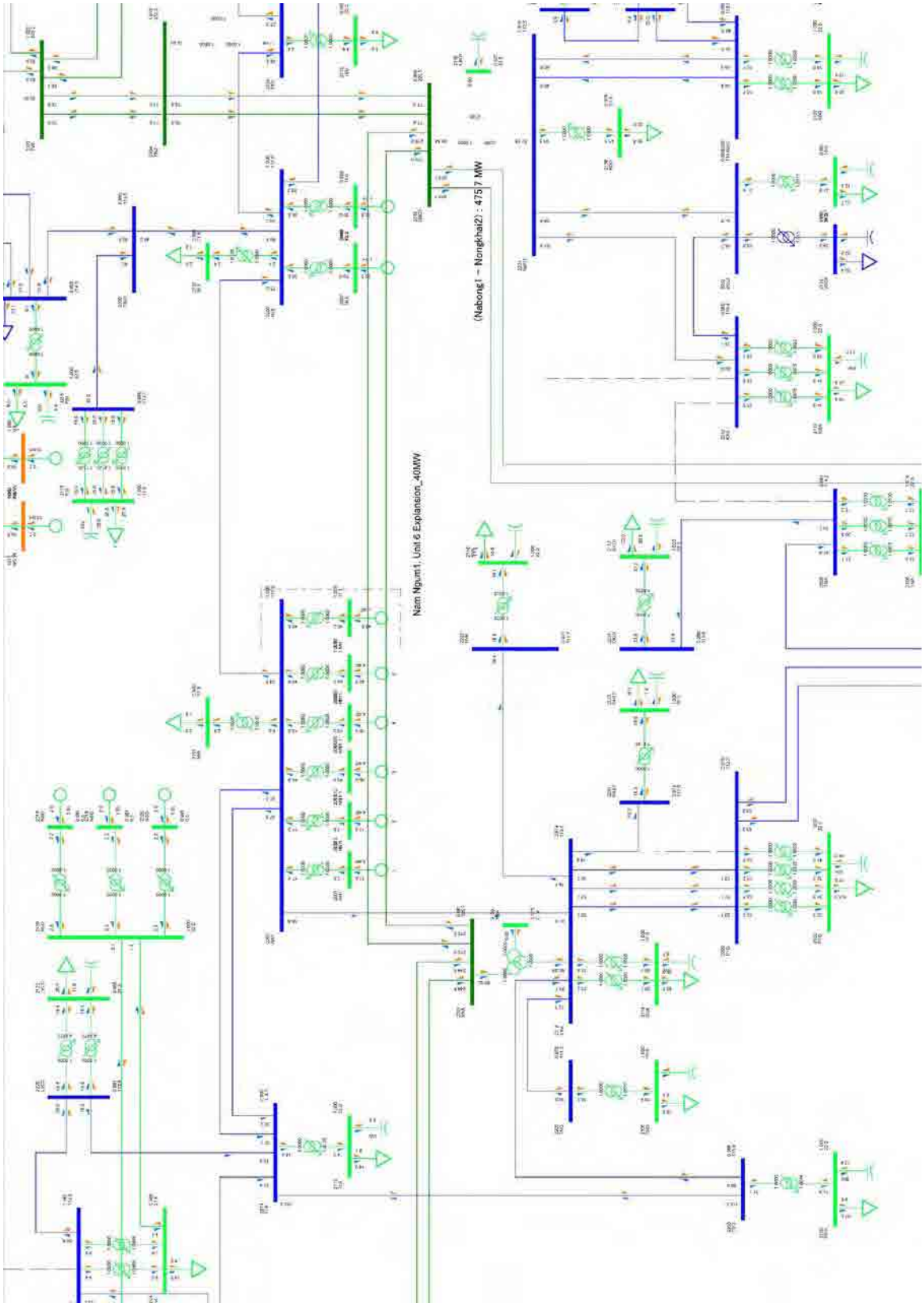
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-3 Result of Power Flow and Voltage Regulation Analysis (w/o Expansion, N-1 Contingency: NN1-TLA Fault)



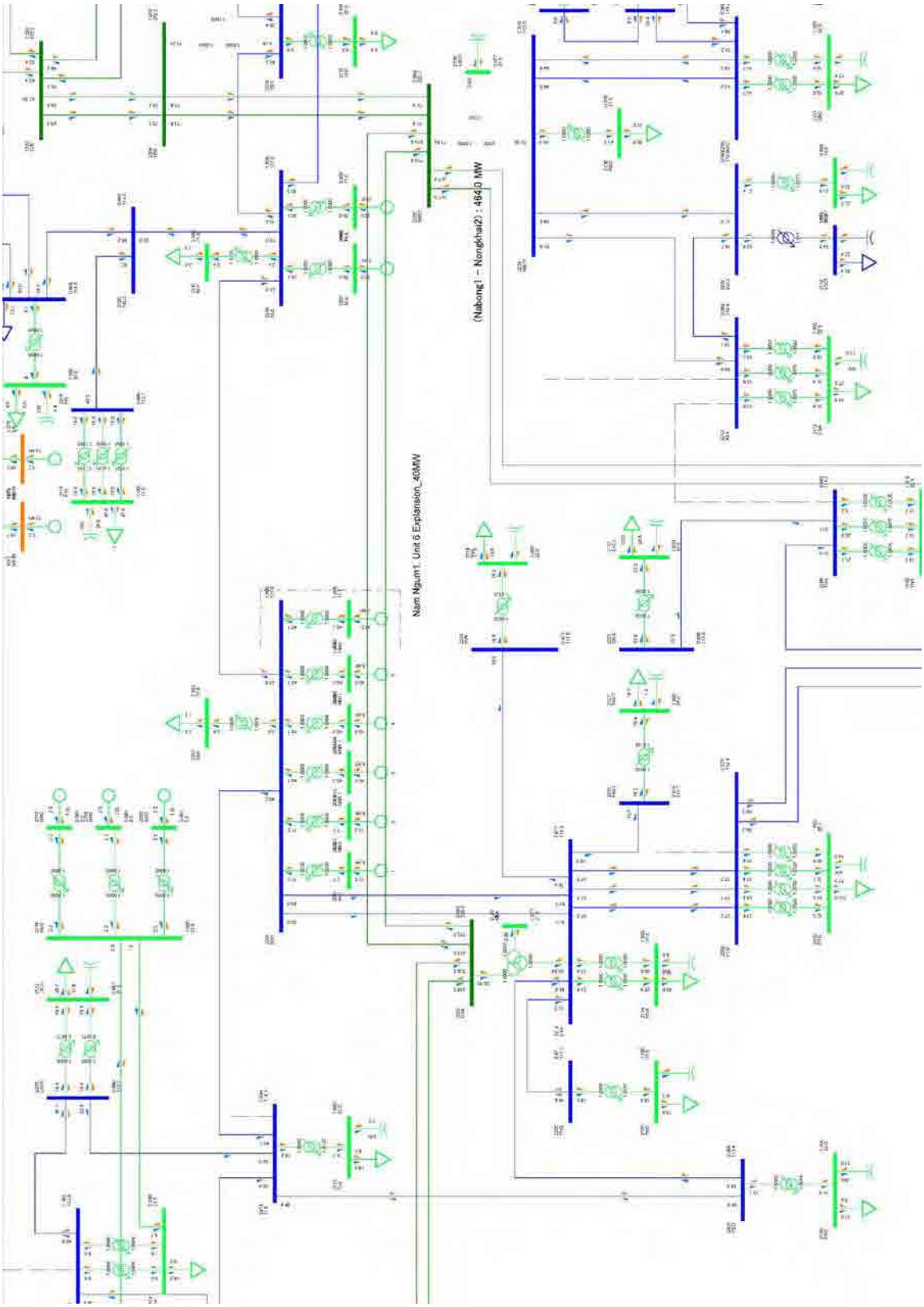
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-4 Result of Power Flow and Voltage Regulation Analysis (40MW Expansion, Normal Condition)



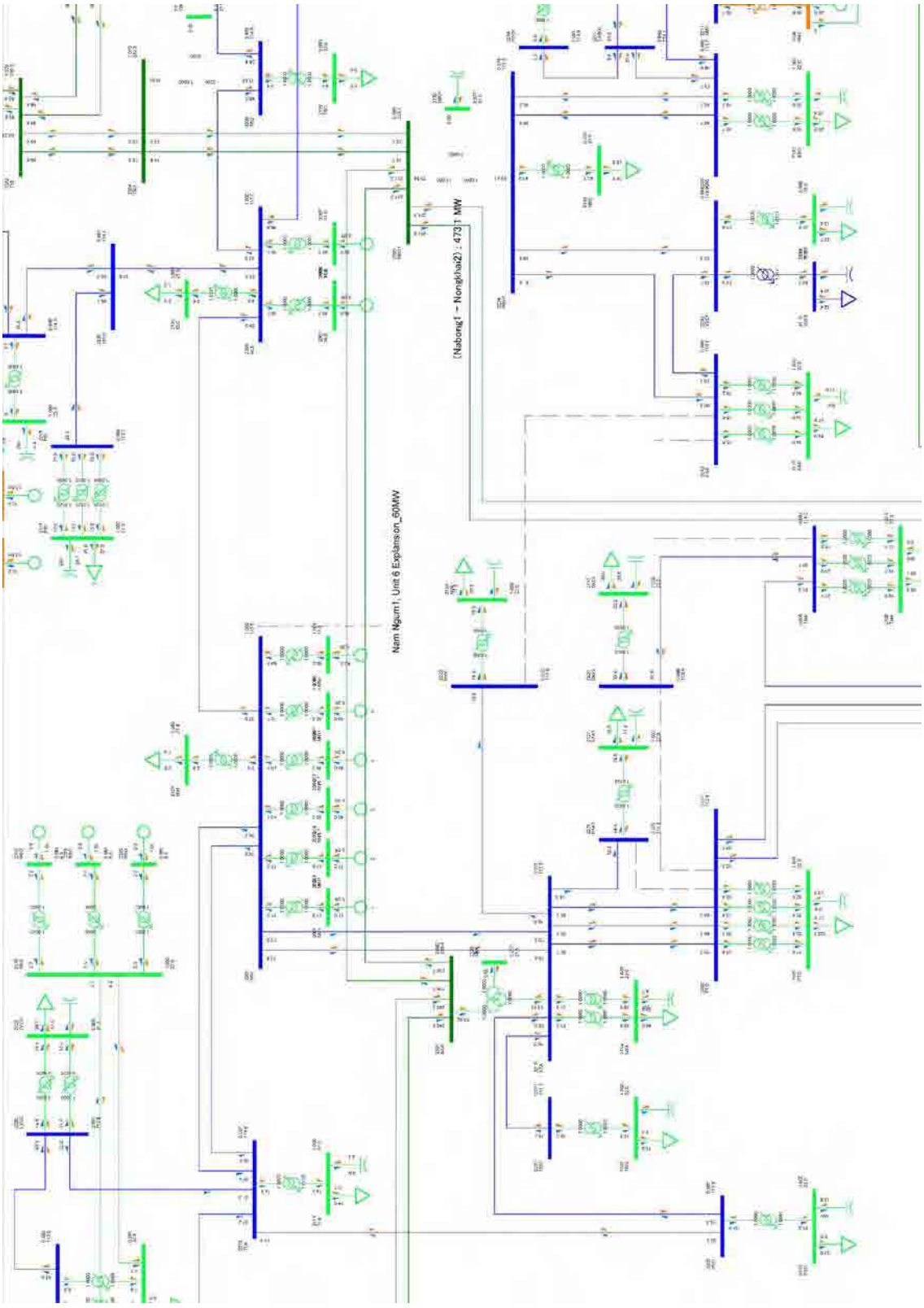
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-5 Result of Power Flow and Voltage Regulation Analysis (40MW Expansion, N-1 Contingency: NN1-NXA Fault)



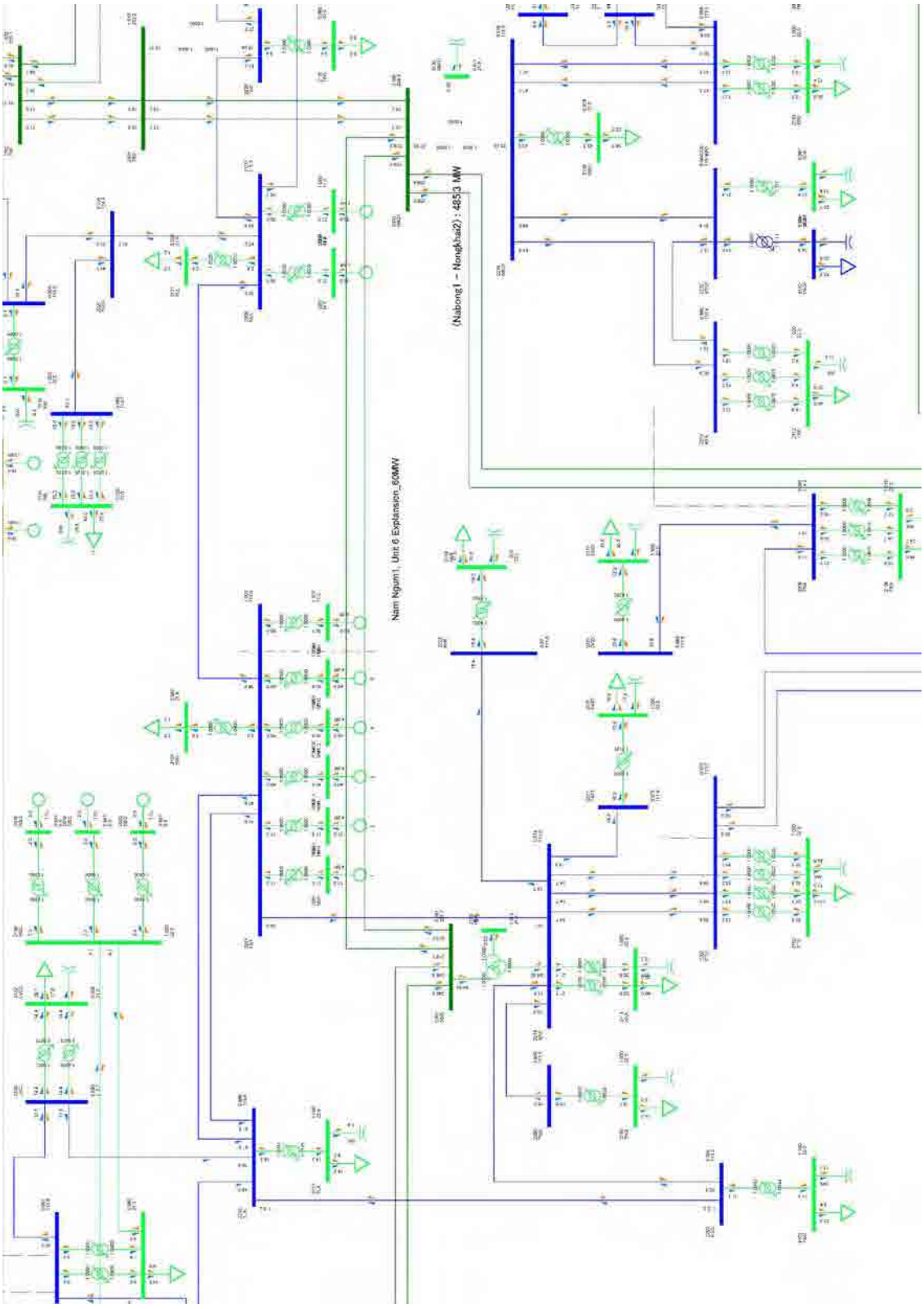
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-6 Result of Power Flow and Voltage Regulation Analysis (40MW Expansion Plan, N-1 Contingency: NN1-TLA Fault)



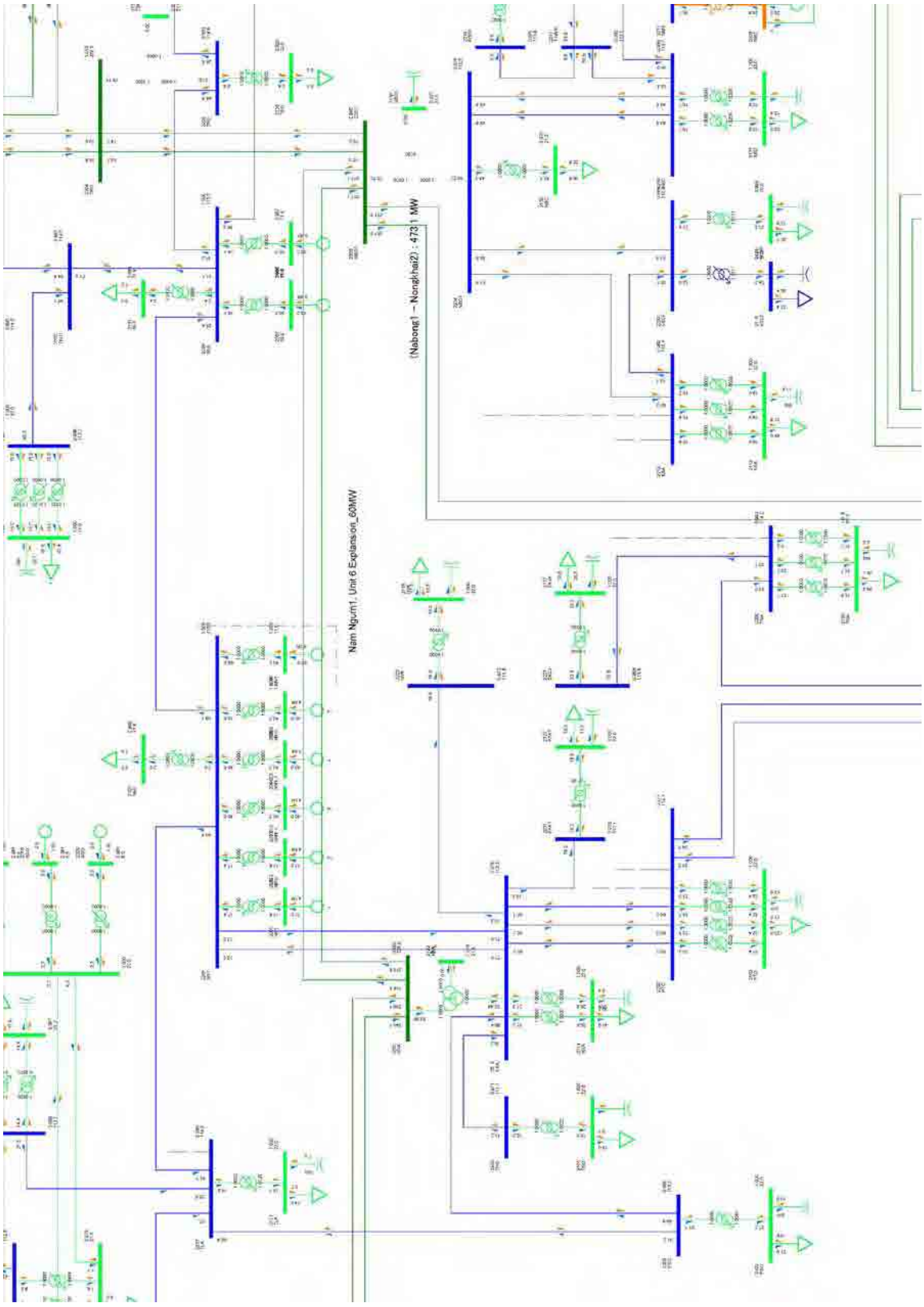
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-7 Result of Power Flow and Voltage Regulation Analysis (60MW Expansion, Normal Condition)



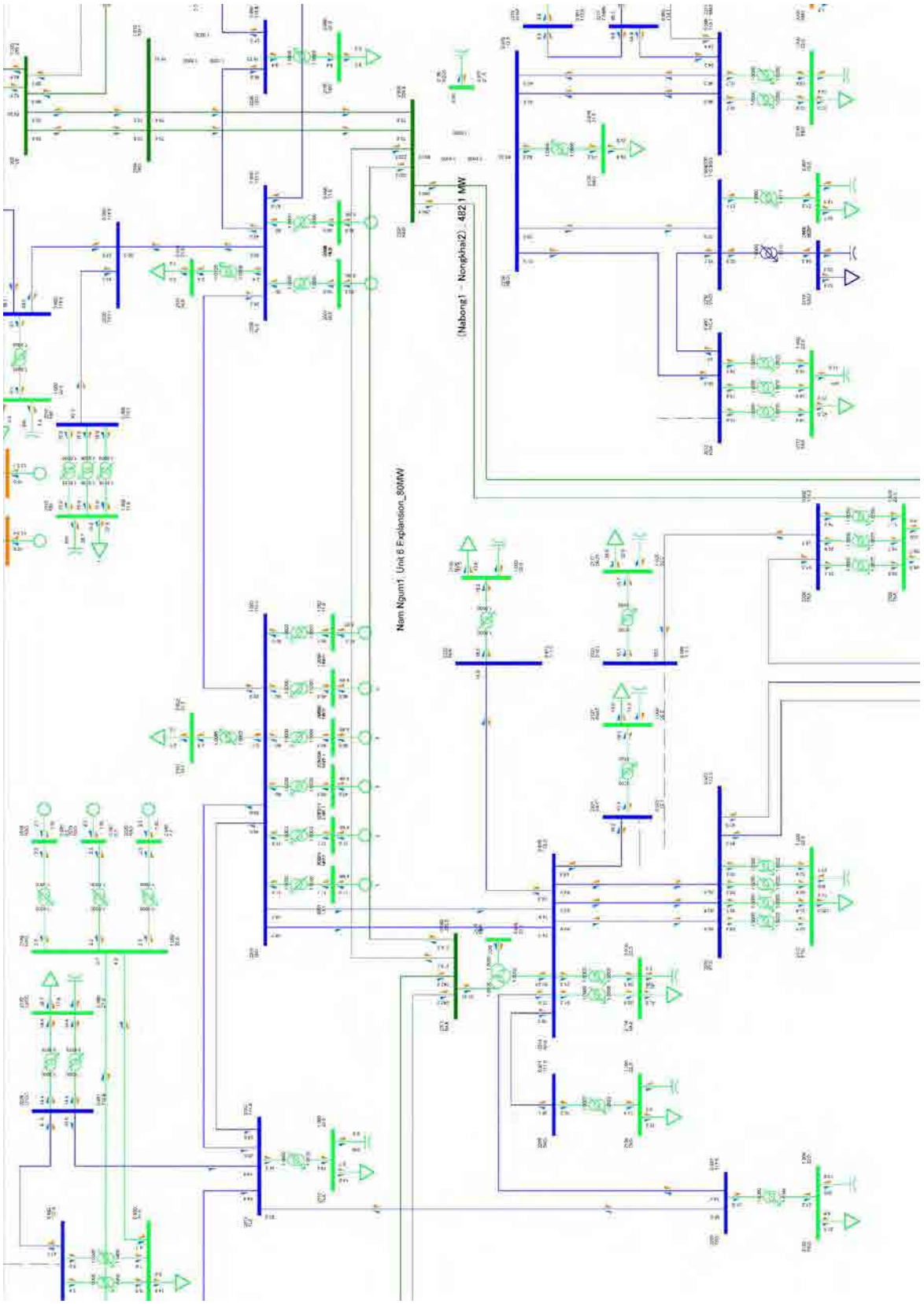
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-8 Result of Power Flow and Voltage Regulation Analysis (60MW Expansion, N-1 Contingency: NN1-NXA Fault)



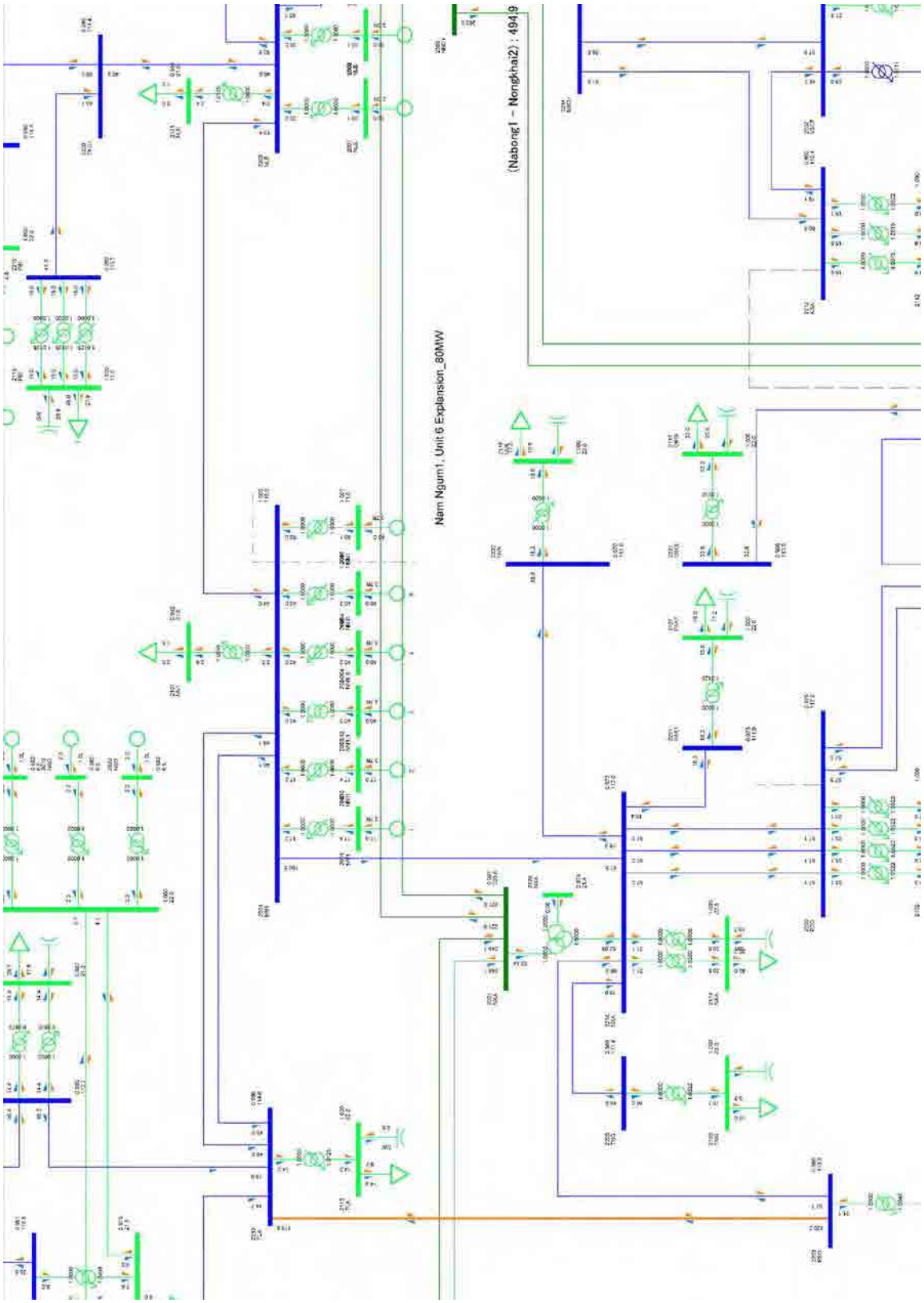
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-9 Result of Power Flow and Voltage Regulation Analysis (60MW Expansion, N-1 Contingency: NN1-TLA Fault)



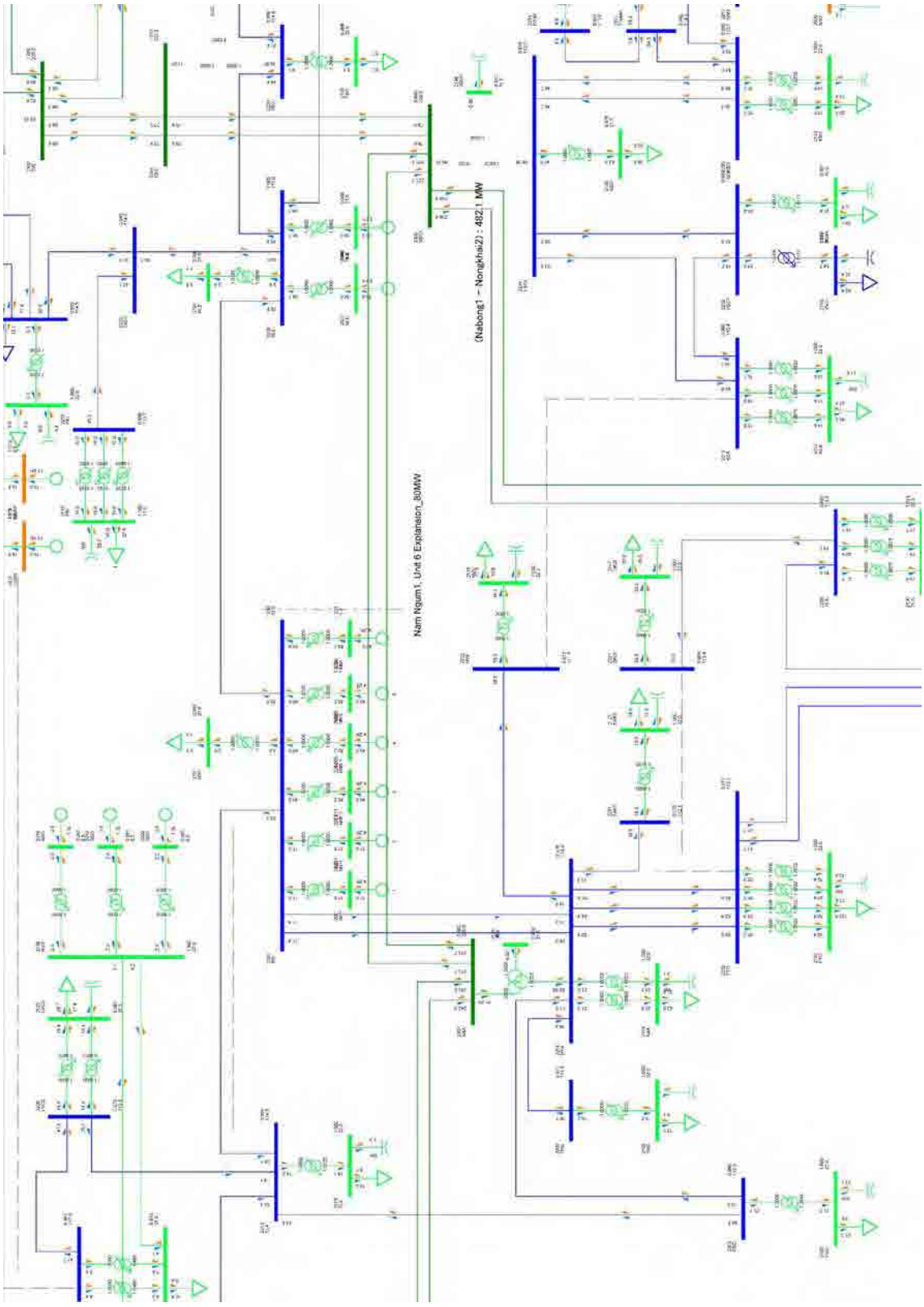
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-10 Result of Power Flow and Voltage Regulation Analysis (80MW Expansion, Normal Condition)



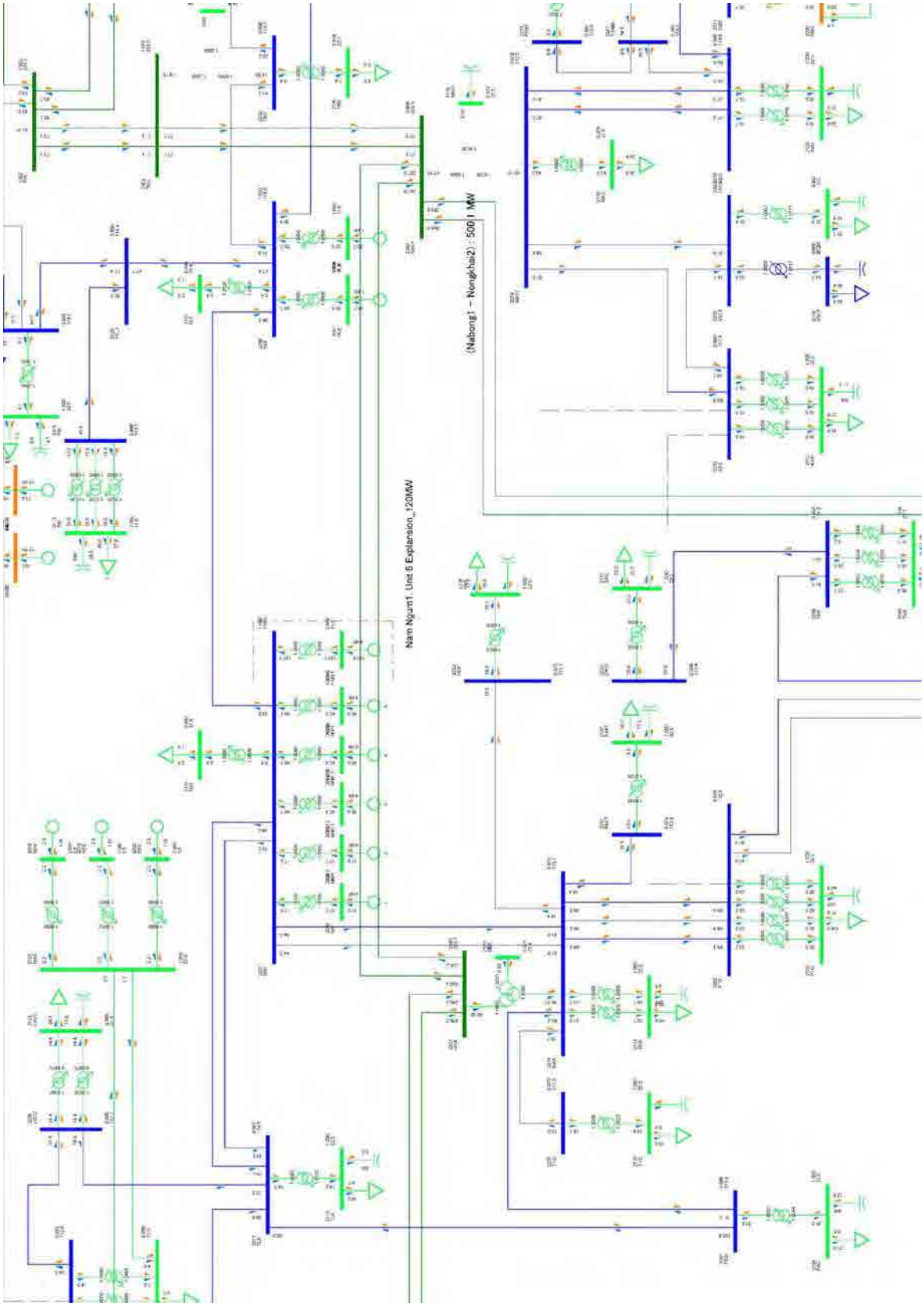
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-11 Result of Power Flow and Voltage Regulation Analysis (80MW Expansion, N-1 Contingency: NN1-NXA Fault)



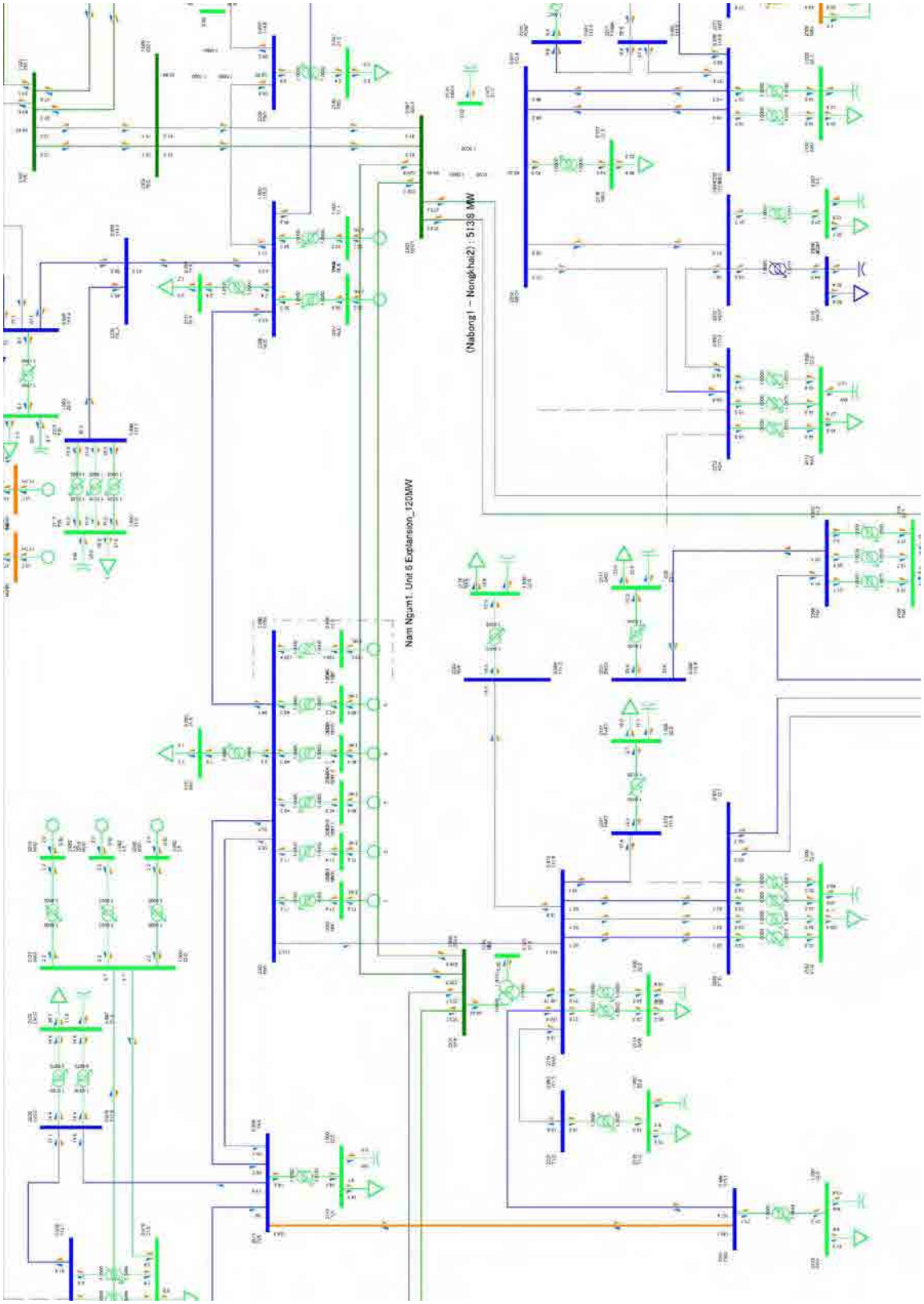
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-12 Result of Power Flow and Voltage Regulation Analysis (80MW Expansion, N-1 Contingency: NN1-TLA Fault)



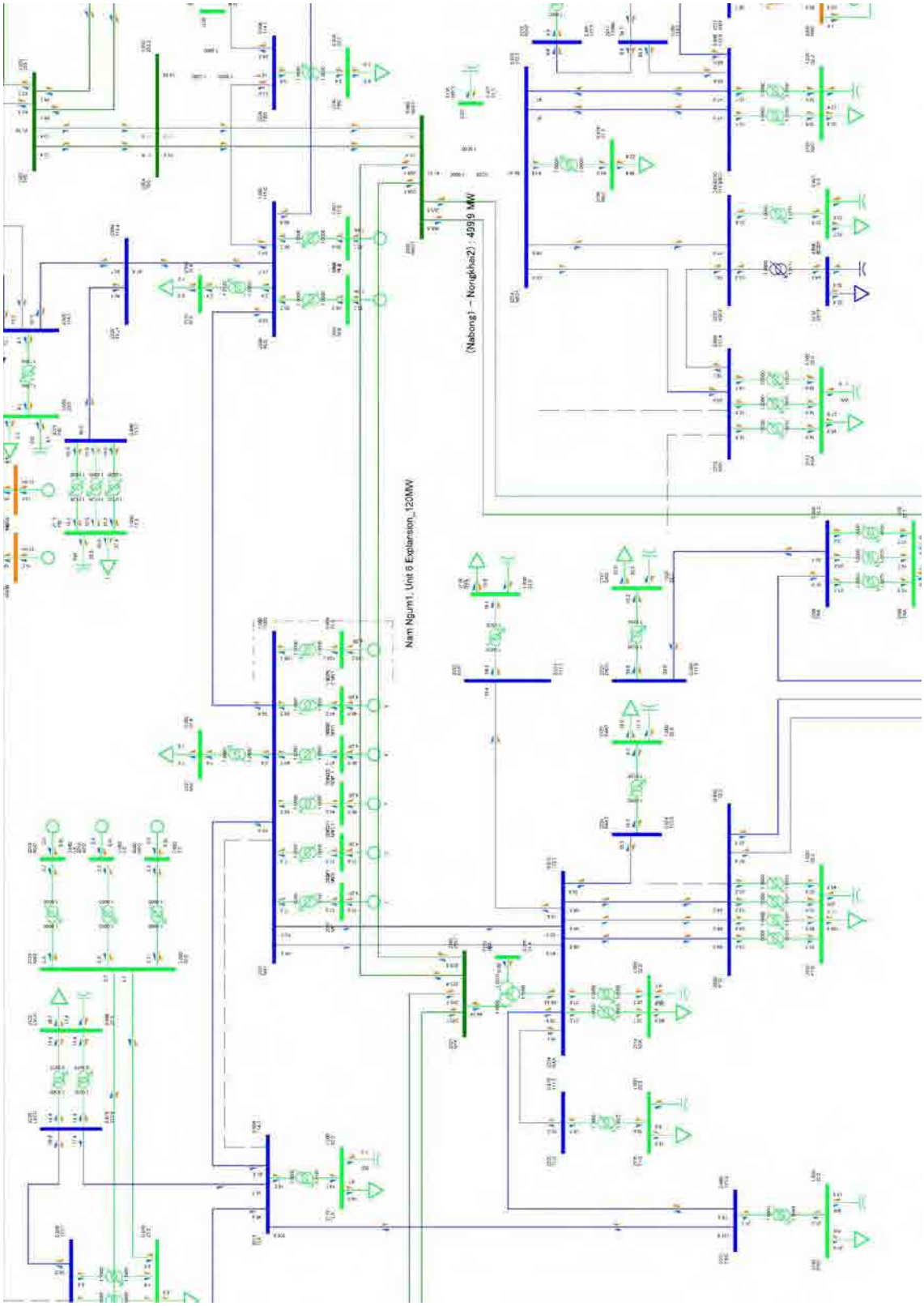
Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-13 Result of Power Flow and Voltage Regulation Analysis (120MW Expansion, Normal Condition)



Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-14 Result of Power Flow and Voltage Regulation Analysis (120MW Expansion, N-1 Contingency: NN1-NXA Fault)



Note: Unit of Load Flow of Transmission Lines: MVA, Bus voltage: PU

Figure A-15 Result of Power Flow and Voltage Regulation Analysis (120MW Expansion, N-1 Contingency: NN1-TLA Fault)

Appendix B

Result of Reservoir Operation

Table AP2-1 Monthly Average Inflow into Nam Ngum 1 Reservoir with NN2

Unit: cms

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1972	258	294	248	264	156	312	617	1,126	819	494	329	272	432
1973	276	259	262	272	262	346	701	789	1,151	529	308	264	452
1974	254	251	234	283	200	383	492	605	612	418	318	291	362
1975	287	192	84	65	174	495	612	944	991	540	306	279	414
1976	260	267	241	263	235	422	614	661	616	514	360	277	394
1977	271	269	317	319	154	190	595	596	584	371	312	304	357
1978	142	99	90	93	193	614	771	1,098	915	380	310	270	415
1979	286	287	261	272	319	430	534	701	555	366	311	264	382
1980	275	194	86	101	169	438	699	634	730	380	303	258	356
1981	272	272	271	267	216	518	867	1,026	973	782	301	278	503
1982	267	270	258	284	298	434	543	870	644	512	316	286	415
1983	274	277	256	274	317	288	600	695	612	428	313	289	385
1984	272	282	171	150	160	351	754	753	540	422	308	278	370
1985	277	277	257	271	241	410	538	680	570	383	336	286	377
1986	281	238	86	147	359	590	700	582	501	326	281	270	363
1987	274	186	84	103	110	236	354	639	543	405	337	313	299
1988	147	94	70	99	185	177	409	630	508	356	313	108	258
1989	91	91	76	81	183	551	562	612	516	394	318	296	314
1990	285	112	142	111	189	539	709	508	648	411	346	301	358
1991	279	278	262	160	136	377	578	637	535	390	328	290	354
1992	164	115	84	61	86	240	557	553	486	369	219	112	254
1993	109	103	64	37	181	481	784	795	625	381	316	294	347
1994	268	255	158	102	267	607	740	1,077	953	579	370	327	475
1995	268	263	265	268	248	426	588	955	875	326	282	271	420
1996	264	278	278	309	209	397	620	749	602	396	347	282	394
1997	269	266	274	210	187	442	525	566	746	399	293	284	372
1998	259	277	258	281	220	356	601	546	493	333	209	84	326
1999	70	39	67	103	390	648	608	595	595	407	315	281	343
2000	271	225	84	146	332	652	706	726	716	376	296	265	400
2001	258	259	296	252	299	570	713	799	666	417	312	273	426
2002	267	275	254	254	334	646	782	1,040	644	382	336	302	460
2003	272	275	248	259	186	336	541	609	555	369	300	149	342
2004	163	104	61	148	228	370	743	705	965	295	257	235	356
2005	243	251	227	238	174	492	804	1,265	889	479	273	253	466
2006	265	262	246	254	361	307	754	614	471	352	274	246	367
2007	243	240	85	91	151	276	403	544	572	574	292	249	310
2008	225	115	123	121	325	821	1,191	1,098	589	479	388	292	481
2009	282	269	310	229	259	444	738	596	478	397	295	277	381
2010	266	235	221	72	63	372	530	627	579	328	283	237	318
2011	80	90	173	372	513	701	807	951	965	582	445	286	497
Mean	238	217	188	192	232	442	650	755	676	426	311	262	382
Max	287	294	317	372	513	821	1,191	1,265	1,151	782	445	327	503
Min	70	39	61	37	63	177	354	508	471	295	209	84	254
STDV	63	75	87	91	90	146	148	199	177	94	40	54	60

Table AP2-2 Simulated Monthly Spill of NN1 (without 40MW Expansion)

Unit: MCM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1972	0	0	0	0	0	0	0	818	1,016	227	0	0	2,060
1973	0	0	0	0	0	0	0	576	1,843	316	0	0	2,736
1974	0	0	0	0	0	0	0	0	0	28	0	0	28
1975	0	0	0	0	0	0	0	0	1,257	344	0	0	1,601
1976	0	0	0	0	0	0	0	17	517	277	0	0	810
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	480	1,255	0	0	0	1,735
1979	0	0	0	0	0	0	0	464	368	0	0	0	832
1980	0	0	0	0	0	0	0	0	17	0	0	0	17
1981	0	0	0	0	0	0	428	1,580	1,397	955	0	0	4,359
1982	0	0	0	0	0	0	0	766	587	272	0	0	1,624
1983	0	0	0	0	0	0	0	105	508	59	0	0	672
1984	0	0	0	0	0	0	0	0	32	43	0	0	76
1985	0	0	0	0	0	0	0	0	399	0	0	0	399
1986	0	0	0	0	0	0	0	0	197	0	0	0	197
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	3	0	0	3
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	1,267	1,347	443	0	0	3,057
1995	0	0	0	0	0	0	0	868	1,155	0	0	0	2,023
1996	0	0	0	0	0	0	0	395	482	0	0	0	878
1997	0	0	0	0	0	0	0	0	218	0	0	0	218
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	371	761	0	0	0	1,132
2001	0	0	0	0	0	0	379	999	641	33	0	0	2,052
2002	0	0	0	0	0	0	824	1,614	586	0	0	0	3,023
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	575	0	0	0	575
2005	0	0	0	0	0	0	0	1,615	1,188	190	0	0	2,993
2006	0	0	0	0	0	0	0	155	165	0	0	0	320
2007	0	0	0	0	0	0	0	0	0	120	0	0	120
2008	0	0	0	0	0	0	848	1,766	452	189	0	0	3,255
2009	0	0	0	0	0	0	64	483	181	0	0	0	729
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	243	1,388	1,377	449	101	0	3,558
Mean	0	0	0	0	0	0	70	393	463	99	3	0	1,027
Max	0	0	0	0	0	0	848	1,766	1,843	955	101	0	4,359
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
STDV	0	0	0	0	0	0	202	567	527	192	16	0	1,249

Table AP2-3 Simulated Monthly Energy of NN1 (without 40MW Expansion)

Unit: GWh

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1972	90	77	85	83	117	108	117	117	113	115	91	77	1,189
1973	92	77	85	83	117	113	117	116	113	115	85	76	1,190
1974	88	77	86	83	117	108	117	112	98	107	88	82	1,163
1975	94	77	86	84	110	98	89	112	113	115	85	78	1,142
1976	90	77	85	83	117	111	117	116	112	115	99	78	1,201
1977	92	77	85	82	116	110	117	114	102	95	86	87	1,162
1978	87	78	87	82	106	77	102	116	113	109	85	77	1,120
1979	93	76	85	82	116	113	116	116	112	105	85	76	1,176
1980	90	77	86	85	112	98	93	109	98	109	85	76	1,119
1981	87	77	85	83	117	113	116	117	113	116	85	76	1,185
1982	91	77	85	83	117	113	117	116	112	115	87	81	1,193
1983	92	76	85	83	117	113	117	116	112	115	86	82	1,194
1984	92	76	85	84	116	103	115	117	112	115	85	78	1,179
1985	92	76	85	83	117	113	117	116	112	110	93	81	1,195
1986	93	77	86	84	116	108	117	116	111	94	85	76	1,163
1987	86	77	87	85	108	62	73	65	52	44	88	89	915
1988	88	78	87	82	106	59	50	64	46	29	82	74	846
1989	63	79	84	77	81	58	75	66	60	44	85	80	851
1990	93	77	87	85	112	100	109	109	90	82	95	85	1,125
1991	93	76	85	83	117	106	116	110	96	81	91	82	1,137
1992	84	78	87	83	105	58	66	64	46	29	82	72	854
1993	63	78	82	75	58	57	76	107	91	83	87	83	940
1994	91	77	86	84	116	107	117	117	113	116	102	94	1,219
1995	91	77	85	83	117	113	117	116	113	94	85	76	1,167
1996	86	77	85	82	117	113	117	116	112	113	95	80	1,192
1997	91	77	85	83	117	109	117	115	112	114	85	76	1,182
1998	89	77	85	83	117	112	117	117	105	76	84	74	1,135
1999	63	78	82	76	93	62	80	107	78	65	86	79	950
2000	92	77	86	84	116	107	117	116	113	108	85	76	1,176
2001	86	77	85	83	117	113	116	117	112	115	86	77	1,183
2002	91	77	85	83	117	112	116	117	112	109	93	86	1,198
2003	92	76	85	83	117	108	117	113	100	86	85	75	1,138
2004	66	78	87	82	107	61	80	109	112	85	84	75	1,026
2005	83	77	86	84	117	105	117	117	113	115	85	76	1,176
2006	87	77	86	83	117	112	117	116	111	101	85	76	1,168
2007	86	77	87	84	104	63	77	65	53	84	85	76	943
2008	87	78	87	84	105	105	117	117	112	115	107	83	1,196
2009	93	76	85	82	117	113	116	116	111	113	85	76	1,184
2010	89	77	86	84	114	98	79	103	75	52	84	75	1,015
2011	66	79	87	84	116	110	116	117	113	116	111	81	1,196
Mean	87	77	86	83	111	98	105	108	100	95	88	79	1,117
Max	94	79	87	85	117	113	117	117	113	116	111	94	1,219
Min	63	76	82	75	58	57	50	64	46	29	82	72	846
STDV	9	1	1	2	11	20	19	17	21	26	7	5	111

Table AP2-4 Simulated Water Level of NN1 (without 40MW Expansion)

Unit: EL.m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1972	211.9	211.5	211.3	210.9	209.6	207.9	208.1	211.1	212.0	212.0	212.0	212.0	210.9
1973	211.9	211.5	211.1	210.9	210.0	209.0	209.6	211.7	212.0	212.0	212.0	212.0	211.1
1974	211.8	211.3	210.8	210.4	209.4	208.2	208.1	209.0	210.7	212.0	212.0	212.0	210.5
1975	211.9	211.3	209.9	207.9	205.7	204.8	206.2	209.3	212.0	212.0	212.0	212.0	209.6
1976	211.9	211.4	211.0	210.6	209.6	208.7	209.3	211.0	212.0	212.0	212.0	212.0	211.0
1977	211.9	211.5	211.4	211.6	210.6	208.5	208.1	209.4	210.8	211.9	212.0	212.0	210.8
1978	211.4	209.8	208.0	206.1	204.0	204.1	206.6	210.5	212.0	212.0	212.0	212.0	209.0
1979	211.9	211.6	211.4	211.2	210.6	210.2	210.6	211.8	212.0	212.0	212.0	212.0	211.4
1980	211.9	211.2	209.9	208.0	205.9	204.7	206.2	208.3	210.7	212.0	212.0	211.9	209.4
1981	211.8	211.4	211.2	211.0	209.9	209.4	211.3	212.0	212.0	212.0	212.0	212.0	211.3
1982	211.9	211.5	211.2	210.9	210.3	209.8	210.2	211.8	212.0	212.0	212.0	212.0	211.3
1983	211.9	211.5	211.3	211.0	210.4	209.3	209.4	211.1	212.0	212.0	212.0	212.0	211.2
1984	211.9	211.5	210.9	209.7	207.9	206.3	207.2	209.7	211.6	212.0	212.0	212.0	210.2
1985	211.9	211.5	211.3	211.0	210.1	209.2	209.4	210.9	212.0	212.0	212.0	212.0	211.1
1986	211.9	211.4	210.3	208.6	207.5	207.7	209.4	211.2	212.0	212.0	211.9	211.7	210.5
1987	211.7	211.1	209.7	207.8	205.6	204.0	203.9	205.7	208.5	210.8	212.0	212.0	208.6
1988	211.4	209.8	207.9	205.9	203.8	202.2	202.4	204.8	207.6	209.9	210.9	210.2	207.2
1989	209.0	207.5	205.5	203.4	201.5	201.8	203.9	206.3	208.7	210.7	211.8	212.0	206.8
1990	211.9	210.9	209.5	207.9	205.9	205.2	206.8	208.2	209.8	211.6	212.0	212.0	209.3
1991	211.9	211.5	211.3	210.6	208.7	207.2	207.5	208.9	210.4	211.7	212.0	212.0	210.3
1992	211.6	210.2	208.5	206.3	203.7	202.0	202.8	205.2	207.6	209.8	210.5	209.5	207.3
1993	208.3	206.9	204.9	202.5	201.0	201.3	204.1	207.5	210.2	211.7	212.0	212.0	206.9
1994	211.9	211.4	210.6	209.2	207.5	207.4	209.3	211.8	212.0	212.0	212.0	212.0	210.6
1995	211.9	211.4	211.1	210.9	210.0	209.1	209.7	211.7	212.0	212.0	211.9	211.8	211.1
1996	211.7	211.3	211.2	211.1	210.3	209.2	209.7	211.6	212.0	212.0	212.0	212.0	211.2
1997	211.9	211.4	211.2	210.7	209.3	208.3	208.6	209.5	211.3	212.0	211.9	211.9	210.7
1998	211.9	211.4	211.2	210.9	210.0	208.8	209.0	210.2	211.0	211.8	211.6	210.4	210.7
1999	208.9	207.2	204.9	202.9	201.8	203.1	205.6	207.5	209.3	211.2	212.0	212.0	207.2
2000	211.9	211.3	210.1	208.4	207.2	207.5	209.5	211.6	212.0	212.0	211.9	211.9	210.4
2001	211.8	211.3	211.1	210.9	210.2	210.2	211.7	212.0	212.0	212.0	212.0	212.0	211.4
2002	211.9	211.5	211.2	210.8	210.2	210.7	212.0	212.0	212.0	212.0	212.0	212.0	211.5
2003	211.9	211.5	211.2	210.8	209.6	208.2	208.1	209.2	210.7	211.8	212.0	211.4	210.5
2004	210.6	209.5	207.6	205.7	204.0	203.3	205.4	208.3	211.3	212.0	211.8	211.4	208.4
2005	211.2	210.6	210.0	209.4	207.9	207.0	208.7	211.8	212.0	212.0	211.9	211.6	210.3
2006	211.5	211.0	210.6	210.2	209.6	208.8	209.5	211.6	212.0	212.0	211.8	211.6	210.9
2007	211.4	210.7	209.5	207.6	205.6	204.3	204.6	206.1	208.6	211.3	211.9	211.8	208.6
2008	211.5	210.2	208.7	207.0	205.8	206.8	210.9	212.0	212.0	212.0	212.0	212.0	210.1
2009	211.9	211.5	211.5	211.2	210.3	209.6	210.9	212.0	212.0	212.0	211.9	211.9	211.4
2010	211.9	211.3	210.7	209.4	206.8	204.9	205.5	207.2	209.2	210.9	211.5	211.3	209.2
2011	210.5	208.9	207.4	206.9	207.3	208.5	211.1	212.0	212.0	212.0	212.0	212.0	210.0
Mean	211.5	210.8	210.0	209.0	207.6	206.9	208.0	209.8	211.0	211.7	211.9	211.8	210.0
Max	211.9	211.6	211.5	211.6	210.6	210.7	212.0	212.0	212.0	212.0	212.0	212.0	211.5
Min	208.3	206.9	204.9	202.5	201.0	201.3	202.4	204.8	207.6	209.8	210.5	209.5	206.8
STDV	0.9	1.2	1.8	2.5	2.8	2.7	2.5	2.2	1.4	0.6	0.3	0.5	1.4

Table AP2-5 Simulated Monthly Spill of NN1 (with 40MW Expansion)

Unit: MCM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1972	0	0	0	0	0	0	0	419	652	0	0	0	1,070
1973	0	0	0	0	0	0	0	6	1,480	0	0	0	1,486
1974	0	0	0	0	0	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	0	0	0	997	0	0	0	997
1976	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	609	890	0	0	0	1,499
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	107	0	0	0	107
1981	0	0	0	0	0	0	78	1,202	1,032	580	0	0	2,891
1982	0	0	0	0	0	0	0	141	228	0	0	0	368
1983	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	920	982	75	0	0	1,977
1995	0	0	0	0	0	0	0	324	791	0	0	0	1,115
1996	0	0	0	0	0	0	0	0	42	0	0	0	42
1997	0	0	0	0	0	0	0	0	79	0	0	0	79
1998	0	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	94	399	0	0	0	493
2001	0	0	0	0	0	0	0	466	281	0	0	0	747
2002	0	0	0	0	0	0	139	1,236	227	0	0	0	1,602
2003	0	0	0	0	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	611	0	0	0	611
2005	0	0	0	0	0	0	0	1,233	824	0	0	0	2,057
2006	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0	0	28	0	0	28
2008	0	0	0	0	0	0	990	1,387	95	0	0	0	2,473
2009	0	0	0	0	0	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	127	1,011	1,012	81	0	0	2,231
Mean	0	0	0	0	0	0	33	226	268	19	0	0	547
Max	0	0	0	0	0	0	990	1,387	1,480	580	0	0	2,891
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
STDV	0	0	0	0	0	0	158	428	412	93	0	0	838

Table AP2-6 Simulated Monthly Energy of NN1 (with 40MW Expansion)

Unit: GWh

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1972	74	96	96	92	103	108	125	143	150	140	90	78	1,294
1973	79	95	95	92	104	110	129	155	149	150	85	78	1,319
1974	70	95	95	91	103	109	125	110	91	109	87	83	1,168
1975	82	95	93	86	56	91	124	133	149	152	85	79	1,224
1976	74	95	95	91	104	110	128	142	125	145	99	78	1,286
1977	77	95	96	93	105	108	124	110	91	86	85	87	1,158
1978	67	92	89	83	55	84	126	150	149	108	85	78	1,168
1979	81	96	96	92	105	121	130	153	115	103	85	78	1,255
1980	76	95	93	86	57	94	122	112	129	108	85	77	1,133
1981	71	96	96	92	104	112	145	154	149	155	85	78	1,336
1982	75	95	95	92	105	114	130	155	150	144	87	81	1,324
1983	78	96	96	92	105	111	128	144	124	121	86	82	1,262
1984	77	96	95	90	99	96	117	134	109	120	85	79	1,196
1985	79	96	96	92	104	110	128	133	113	108	92	82	1,232
1986	80	95	93	87	86	109	130	155	97	91	84	77	1,186
1987	69	95	93	86	56	66	81	67	82	64	92	88	938
1988	67	92	89	83	55	65	78	66	59	40	84	76	854
1989	64	87	85	78	52	63	81	68	90	69	87	84	909
1990	81	94	92	86	57	97	126	113	111	118	95	86	1,155
1991	80	96	96	91	101	106	121	108	90	76	90	83	1,137
1992	67	93	90	84	55	64	79	67	64	42	83	75	862
1993	63	87	84	77	51	61	80	109	103	108	87	84	992
1994	76	95	94	88	89	108	130	154	149	155	102	92	1,333
1995	76	95	95	92	104	110	129	153	150	93	84	77	1,259
1996	68	95	96	93	105	111	129	154	142	113	95	80	1,281
1997	76	95	96	92	103	108	126	111	115	114	85	77	1,198
1998	73	96	96	92	104	110	127	113	92	77	84	75	1,137
1999	63	86	82	76	52	67	106	92	91	98	86	80	979
2000	77	95	93	87	82	109	135	155	150	107	85	77	1,251
2001	68	95	96	92	105	130	146	155	150	120	85	78	1,319
2002	76	96	95	92	105	135	153	154	150	109	92	86	1,342
2003	77	96	95	92	103	108	125	110	91	80	85	77	1,138
2004	66	90	87	82	55	66	103	111	140	85	84	77	1,046
2005	67	94	93	89	100	106	127	154	149	137	84	77	1,278
2006	67	95	95	91	104	110	130	155	101	93	84	77	1,201
2007	67	94	92	86	56	73	81	67	84	111	85	77	974
2008	67	93	91	85	62	112	150	154	150	137	107	83	1,291
2009	80	95	96	92	105	111	138	155	115	109	85	77	1,258
2010	73	95	95	89	59	95	110	89	91	71	84	77	1,029
2011	66	90	88	85	87	125	150	154	149	155	123	81	1,354
Mean	73	94	93	88	85	100	121	127	119	108	88	80	1,176
Max	82	96	96	93	105	135	153	155	150	155	123	92	1,354
Min	63	86	82	76	51	61	78	66	59	40	83	75	854
STDV	6	3	4	5	23	20	20	31	28	30	8	4	140

Table AP2-7 Simulated Water Level of NN1 (with 40MW Expansion)

Unit: EL.m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1972	212.0	211.7	211.1	210.4	209.2	207.8	207.8	210.8	212.0	212.0	212.0	212.0	210.7
1973	212.0	211.6	210.9	210.3	209.5	208.7	209.3	211.1	212.0	212.0	212.0	212.0	210.9
1974	212.0	211.6	210.7	210.0	209.1	208.1	208.0	208.8	210.6	212.0	212.0	212.0	210.4
1975	212.0	211.3	209.6	207.5	206.2	206.6	207.5	210.0	212.0	212.0	212.0	212.0	209.9
1976	212.0	211.6	210.8	210.1	209.2	208.6	209.1	210.2	211.4	212.0	212.0	212.0	210.8
1977	212.0	211.6	211.2	211.0	210.0	208.1	207.6	208.8	210.5	211.8	212.0	212.0	210.5
1978	211.6	210.2	208.2	206.2	205.1	206.1	208.2	211.3	212.0	212.0	212.0	212.0	209.6
1979	212.0	211.7	211.1	210.5	210.0	209.7	209.6	210.4	211.4	212.0	212.0	212.0	211.0
1980	212.0	211.3	209.7	207.7	206.5	206.6	207.7	209.5	211.5	212.0	212.0	211.9	209.9
1981	211.9	211.6	211.0	210.4	209.5	209.1	210.9	212.0	212.0	212.0	212.0	212.0	211.2
1982	212.0	211.6	210.9	210.4	209.8	209.5	209.7	211.1	212.0	212.0	212.0	212.0	211.1
1983	212.0	211.7	211.0	210.4	209.9	209.0	208.9	210.2	211.4	212.0	212.0	212.0	210.9
1984	212.0	211.7	210.7	209.2	207.6	206.6	207.6	210.0	211.4	212.0	212.0	212.0	210.2
1985	212.0	211.7	211.0	210.4	209.5	208.9	209.0	210.1	211.4	212.0	212.0	212.0	210.8
1986	212.0	211.5	210.0	208.2	207.7	208.3	209.8	210.8	211.3	212.0	211.9	211.7	210.4
1987	211.9	211.3	209.6	207.6	206.2	205.6	205.5	207.2	209.6	211.2	212.0	212.0	209.1
1988	211.6	210.2	208.1	206.0	204.9	204.4	204.3	206.2	208.6	210.6	211.6	210.9	208.1
1989	209.6	208.0	205.9	203.8	202.6	203.5	205.6	208.0	210.1	211.3	212.0	212.0	207.7
1990	212.0	211.0	209.3	207.6	206.5	207.0	208.4	209.7	211.2	212.0	212.0	212.0	209.9
1991	212.0	211.7	211.0	210.0	208.3	207.0	207.3	208.6	210.2	211.5	212.0	212.0	210.1
1992	211.7	210.4	208.5	206.3	204.6	203.9	204.7	206.9	208.8	210.6	211.3	210.3	208.2
1993	209.1	207.6	205.4	203.1	201.7	202.4	205.1	208.5	211.1	212.0	212.0	212.0	207.5
1994	212.0	211.6	210.4	208.7	207.6	207.9	209.6	211.8	212.0	212.0	212.0	212.0	210.6
1995	212.0	211.6	210.9	210.3	209.5	208.9	209.3	211.2	212.0	212.0	211.9	211.8	211.0
1996	211.9	211.6	211.0	210.7	209.8	209.0	209.4	210.7	211.8	212.0	212.0	212.0	211.0
1997	212.0	211.6	211.0	210.2	208.9	208.1	208.3	209.1	211.2	212.0	211.9	211.9	210.5
1998	212.0	211.7	211.0	210.4	209.5	208.6	208.8	209.8	210.9	211.8	211.6	210.4	210.5
1999	208.9	207.0	204.7	202.6	202.4	204.5	206.9	208.4	210.5	211.9	212.0	212.0	207.6
2000	212.0	211.4	209.9	208.1	207.5	208.3	210.1	211.6	212.0	212.0	211.9	211.9	210.6
2001	211.9	211.6	211.0	210.5	209.8	209.9	210.8	211.9	212.0	212.0	212.0	212.0	211.3
2002	212.0	211.7	211.0	210.3	209.7	210.2	211.5	212.0	212.0	212.0	212.0	212.0	211.4
2003	212.0	211.7	210.9	210.2	209.1	207.9	207.8	208.8	210.4	211.7	212.0	211.4	210.3
2004	210.6	209.3	207.2	205.3	204.5	204.9	206.8	209.2	211.7	212.0	211.8	211.4	208.7
2005	211.3	210.9	210.0	209.1	207.8	207.2	208.8	211.7	212.0	212.0	211.9	211.6	210.4
2006	211.7	211.4	210.6	209.9	209.5	208.9	209.5	210.8	211.3	212.0	211.8	211.6	210.7
2007	211.5	211.1	209.5	207.5	206.2	205.9	206.0	207.5	209.6	211.6	211.9	211.8	209.2
2008	211.6	210.6	208.8	207.1	206.6	208.4	211.6	212.0	212.0	212.0	212.0	212.0	210.4
2009	212.0	211.6	211.1	210.6	209.6	209.2	210.3	211.3	211.5	212.0	211.9	211.9	211.1
2010	212.0	211.5	210.5	209.0	207.2	206.6	206.9	208.2	210.4	211.7	211.9	211.6	209.8
2011	210.8	209.1	207.4	206.9	207.9	209.5	211.3	212.0	212.0	212.0	212.0	212.0	210.3
Mean	211.6	211.0	209.8	208.6	207.7	207.5	208.4	209.9	211.2	211.8	211.9	211.8	210.1
Max	212.0	211.7	211.2	211.0	210.0	210.2	211.6	212.0	212.0	212.0	212.0	212.0	211.4
Min	208.9	207.0	204.7	202.6	201.7	202.4	204.3	206.2	208.6	210.6	211.3	210.3	207.5
STDV	0.8	1.2	1.7	2.2	2.3	1.9	1.9	1.6	0.9	0.3	0.1	0.4	1.1

Appendix C

Environment

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)Y (b) Y (c) Y (d) N	(a) Only Initial Environmental Examination (IEE) is required since it is the expansion of an existing project and it has small impacts on downstream. After carrying out the IEE, the IEE reports, comprise of IEE main report and Environmental and Social Management Plan (ESMP) were submitted to the Environmental and Social Impact Assessment Department (Dept. of ESIA) in Water Resources and Environmental Administration (WREA: now the task is taken by the Ministry of Natural Resources and Environment: MoNRE) in 2009. (b) It was approved by Dept. of ESIA in WREA on 13 April 2010. (c) The report was approved without conditions. (d) There is no other required environmental permits, however, the ESMP shall be reviewed and updated and then submit to MoNRE for obtaining approval six month before commencement of project.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Consultation meeting at village level was held in conducting initial social assessment survey for all 24 affected villages. Consultation meeting at district, provincial and national level was organized in July, 2009 and consensus on the implementation of the project was made. (b) Comments were incorporated in the IESE reports. (IESE report, page 79)
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) 12 alternatives were screened in the light of environmental and social considerations (IESE report, page 61).
2 Pollution Control	(1) Water Quality	(a) Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?	(a) - (b) - (c) - (d)Y (e)Y	(a) (b) (c) The project is an extension of hydropower plant thus the negative impact is not expected on reservoir site. (d) During construction turbidity might be become higher however, the impacts are considered to be small (Environmental and Social Management Plan: ESMP P.56). (e) The significant negative impacts is not expected in downstream areas. Mitigation measures shall be applied in case any degradation of the water quality detected in operation phase.(ESMP, page 67).
	(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Dispose of materials to approved area so as no to disturb scenery and not to contaminate water (ESMP, page 73).

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country' s laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Phou Khao Khouay NBCA is located southeast of NN1 reservoir which covers the catchment area of Nam Leuk Hydropower which is diverted and flow into NN1 reservoir. There will be no problem to NBCA or protected areas with regards to the expansion of the project (IESE page 47).
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? Are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that installation of structures, such as dams will block the movement of the migratory fish species (such as salmon, trout and eel those move between rivers and sea for spawning)? Are adequate measures taken to reduce the impacts on these species?	(a) N (b) N (c) N (d)N	(a) Not found. (b) Listed endangered species have not been found in downstream area of NN1. (c) Mitigation can be done by selecting off-peak output (IESE page 64). (d)Dam already exists, the expansion should not cause any problems regarding this issue.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?	(a) Y	(a) The range of water fluctuation would be increased, however, it will not make significant impact on the surface and groundwater flows (IESE page 75).
	(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? Are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?	(a)N (b)N	(a) There is no plan of constructing reservoir, but using existing reservoir thus no impact is expected. (b)Excavation, spill and wastage embankment give a little change to the geographical feature but the impact is not significant(ESMP, page 28).

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b)- (c)- (d)- (e)- (f)- (g)- (h)- (i)- (j)-	(a) (b) (c) (d) (e) (f) (g) (h) (i) (j) No resettlement or compensation is required.
	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(a)N (b)N (c)N (d)N (e)Y (f)N (g)N (h)N	(a) Water level fluctuation does not affect the downstream social activities (b)Any change of land use nor change of local resources is expected. (c) During construction phase, transportation of the construction materials disturbes the existing traffic systems, however, the impact is not significant. (d) Construction camps are to be installed enough away from local residents thus the immigration of workers will not directly affect to the living of local people. (e) Minimum maintenance flow has to secure to give no affect on irrigation and water pumping use at downstream in dry season.(ESMP, page 52). (f) No negative impact is expected. (g) Construction workers health problem and disease may happen during construction phase, however, it can be mitigated with appropriate provision for sanitation with septic facilities and untreated human waste not to enter any watercourse. (h) Minimum maintenance flow has to secure to give no affect on Irrigation and water pumping use at downstream in dry season. (ESMP, page 52).

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N	(a)No cultural heritage is reported in affected areas.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N	(a) New powerhouse and possible downstream bed rock excavation affects landscape at the dam site, however, the impact is not significant.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a)N (b)N	(a) Not necessary. Because all ethnic groups risiding within the project area have a long association with the local area and they have been absorbed into the mainstream Lao-speaking society. (b)No special rights for ethnic minorities exist.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)Y	(a) In comply with legislations of the Lao PDR, the protection of health, prevention of accidents are enforced by applying the ESMP. (b) Tangible safety considerations are incorporated in the ESMP. (c)Proper safety management during expansion works is to be provided at responsibility of contractor with CEMP implementation based on the ESMP. (d) Contactor shall take all necessary precautions against risk of loss of life or of injury to any person employed in the works. (ESMP, page 73).

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a)Y (b)Y (c)Y	(a) Appropriate mitigation measures are already considered(ESMP, page 65). (b) Mitigation measures such as provision of sedimentation pond or reducing excavation speed were addressed. in ESMP (page56) (c) Adequate measures are already considered to mitigate the impacts (ESMP, page 17).

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Accident Prevention Measures	(a) Is a warning system established to alert the inhabitants to water discharge from the dam?	(a)Y	(a) The alert system on water discharge from the dam has been established in 2012. As for the alert system for water increase due to the shift of operation pattern from off-peak to on-peak, it needs to study where to locate the warning signboards and to consider the necessity of setting up an automatic warning system in D/D.
5 Others	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)Y	(a) It's stated in Environmental and Social Monitoring Plan (ESMP, page 65). (b) Overall monitoring, ambient monitoring, validation monitoring, effectiveness monitoring, compliance monitoring (ESMP, page 66-69). (c) Monitoring by Environmental /Social Team (construction phase) and Corporate Social Responsibility Unit (operation phase) for compliance of ESMP and ECC. In addition, MoNRE and Livelihood Restoration Committee will be involved for monitoring supervision in both construction and operation phase. (d) Quarterly Reports & Final Environmental Monitoring Report(ESMP, page 77).
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects in the mountains including large areas of deforestation). (b) In the case of dams and reservoirs, such as irrigation, water supply, and industrial water purposes, where necessary, pertinent items described in the Agriculture and Water Supply checklists should also be checked. (c) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a)N (b)N (c)N	(a) Not necessary as it is the development of an expansion of existing project. (b) Not necessary (c) Not necessary
	Note on Using Environmental Checklist	(a) If necessary, the impacts to trans-boundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as trans-boundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a)N	(a) No trans-boundary issue will be occurred as the project site is located in Lao boundary.

Appendix C-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)

1) Regarding the term “Country’s Standards” mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Appendix C-2 Monitoring Form

1． Responses/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring item	Monitoring results during report period
Responses/Actions to Comments and Guidance from Government Authorities	

2． Mitigation Measures

- Air Quality（Emission Gas / Ambient Air Quality）

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Sprinkle water to control dust	Construction site	Daily	Construction	
Minimize travel distance	Construction site	Daily	Construction	
Regular checking of engine and exhaust of machinery and its recording and reporting	Construction site	Monthly	Construction	
Respiratory protection for worker at site	Construction site	Daily	Construction	

- Water Quality（Effluent/Wastewater/Ambient Water Quality）

Item	Unit	Measured value（Mean）	Measured value（Max.）	Country's standards	Remarks (measurement point, frequency)
pH	-			6-9.5	Entry point of the NN1 reservoir and at NN1 Dam, monthly
SS (Suspended Solid)	mg/l			40	Entry point of the NN1 reservoir and at NN1 Dam, monthly
BOD	mg/l			60	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly
DO	mg/l			6	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly
Ammonia Nitrogen	mg/l			0.2-4	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly
TDS	mg/l			1500	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly
Total Phosphorus	mg/l			1	Entry point of the NN1 reservoir and at NN1 Dam, monthly
Temperature	°c			<40	Entry point of the NN1 reservoir and at NN1 Dam, monthly
COD	ml/l			350	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly
Oil & Grease	mg/l			20	Entry point of the NN1 reservoir and at NN1 Dam and all worker's camp, monthly

- Waste

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Dispose of material to approved area so as not to disturb scenery and not to contaminate water	Construction site	Weekly	Construction	

- Soil contamination

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Capture insulation oils in barrel and use oil proof sheet to avoid any leakage	Construction site	Weekly	Construction	

Appendix C-2 Monitoring Form

- Noise / Vibration

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Instruction to driver to comply speed limit	Construction site	Weekly	Construction	
Check proper material loading and uploading	Construction site	Weekly	Construction	
Use silencer and muffler for equipment	Construction site	Weekly	Construction	

- Management of Abandoned Sites

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Site rehabilitation with topsoil recovery, reshaping, re-vegetation and remediation with site cleanup work	Construction site	-	At finishing stage of construction phase	

３． Natural Environment

- Ecosystem

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Provision of minimizing the disturbance under water	Construction site	Monthly	Construction	

- Topography and Geology

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Prevention with rock support and prompt concrete work in construction	Construction site	-	Before construction	

４． Social Environment

- Sanitation

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Provision of proper sanitation with septic facilities (prohibition of untreated human waste to enter any watercourse)	Construction site/Worker's camp	Weekly	Construction	

- Living / Livelihood

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Source workforce from qualified locals and orient workers on desirable working relationship with skill enhancement and employment program	-	-	Work commencement	

- Landscape

Monitoring item	Measurement point	Frequency	Implementation phase	Monitoring result during report period
Provision of explanation to villagers and tourist for the meaning of work	-	-	At finishing stage of construction phase	

-Hydrology/Social and Economic Environment/Public Safety

Appendix C-2 Monitoring Form

Monitoring item	Measurement point*	Frequency	Implementation phase	Monitoring result during report period
Daily monitoring downstream water level including the Nam Lik avoid zero or single 18 MW operation for off-peak hours to keep downstream water level	Thalat and Pakkagnoung Water level Gauges	Daily	Operation	
Precaution to downstream communities for rapid increase/decrease of river water level with sign board and public consultation. Keep present output increase rate and conduct gradual opening as possible	To be designated at D/D	Daily	Operation	

*to be finalized at D/D

- Water Quality

Item	Unit	Measured value (Mean)	Measured value (Max.)	Country's standards	Remarks (measurement point, frequency, implementation phase)*
pH	-			6-9.5	Entry point of the NN1 reservoir and at NN1 Dam, monthly, operation
SS (Suspended Solid)	mg/l			40	Entry point of the NN1 reservoir and at NN1 Dam, monthly, operation
BOD	mg/l			60	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp, monthly, operation
DO	mg/l			6	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp, monthly, operation
Ammonia Nitrogen	mg/l			0.2-4	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp monthly, operation
TDS	mg/l			1500	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp, monthly
Total Phosphorus	mg/l			1	Entry point of the NN1 reservoir and at NN1 Dam, monthly, operation
Temperature	°c			<40	Entry point of the NN1 reservoir and at NN1 Dam, monthly, operation
COD	ml/l			350	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp, monthly, operation
Oil & Grease	mg/l			20	Entry point of the NN1 reservoir and at NN1 Dam and former worker's camp monthly, operation

*to be finalized at D/D

Appendix C-3 Water Quality Standards in Lao PDR

4.1.5 Surface Water Quality Standards

No	Substances	Symbol	Unit	Standard Value	Method of Measurement
1	Colour, Odour and Taste	-	-	N	-
2	Temperature	t	°C	N'	Thermometer
3	Potential of Hydrogen	pH	-	5-9	Electronic pH Meter
4	Dissolved Oxygen	DO	mg/l	6	Azide Modification
5	COD	COD	ml/l	5	Potassium permanganate
6	BOD_5	BOD_5	mg/l	1,5	Azide Modification at 20 degree C, 5 days
7	Total Coliform Bacteria	Coliform Bacteria	MPN/100 ml	5000	Multiple Tube Fermentation
8	Faecal Coliform Bacteria	Faecal Coliform	MPN/ 100 ml	1000	
9	Nitrate-Nitrogen	NO_3-N	mg/l	<5.0	Cadmium Reduction
10	Ammonia-Nitrogen	NH_3-N	mg/l	0.2	Distillation Nesslerization
11	Phenols	C_6H_3-OH	mg/l	0.005	Distillation, 4-Amin anti-pyrenne
12	Copper	Cu	mg/l	0.1	Atomic Absorption Direct Aspiration
13	Nickel	Ni	mg/l	0.1	
14	Manganese	Mn	mg/l	1.0	
15	Zinc	Zn	mg/l	1.0	
16	Cadmium	Cd	mg/l	0.005	
17	Chromium, Hexavalent	Cr^{6+}	mg/l	0.05	
18	Lead	Pb	mg/l	0.05	
19	Mercury	Hg	mg/l	0.002	Atomic Absorption Cold Vapour
20	Arsenic	As	mg/l	0.01	Atomic Absorption Direct Aspiration
21	Cyanide	CN^-	mg/l	0.005	Pyridine-Barbituric
22	Alpha ¬Radioactive	α	Becquere l/l	0.1	Counting machine
23	Beta ¬ Radioactive	β	Becquere l/l	1.0	
24	Total Organochlorine	-	mg/l	0.05	Gas Chromatography
25	DDT	$C_{14}H_9Cl_5$	mg/l	1.0	
26	Alpha -BHC	αBHC	mg/l	0.02	
27	Dieldrin	$C_{12}H_8Cl_6O$	mg/l	0.1	
28	Aldrin	-	mg/l	0.1	
29	Heptachlor and Heptachlor Epoxide	-	mg/l	0.2	
30	Endrin	-	mg/l	None	

Source: Agreement on National Environmental Standards, WREA 2009

5.1 General Industrial Wastewater Discharge Standards

5.1.1 Standards for General Industries

No	Parameters	Symbols	Unit	Maximum Concentration
1	BOD_5	BOD_5	mg/l	40
2	Ammonia Nitrogen	NH_3-N	mg/l	4
3	Total Suspended Substances	TSS	mg/l	40
4	Potential of Hydrogen	pH	-	6-9.5
5	Total Dissolved Substances	TDS	mg/l	3,500
6	Phenols	C_6H_5OH	mg/l	0.3
7	Phosphorous	P	mg/l	1.0
8	Silver	Ag	mg/l	0.1
9	Zinc	Zn	mg/l	1.0
10	Sulphide	S	mg/l	1.0
11	Free Chlorine	Cl_2	mg/l	1.0
12	Chloride	Cl^-	mg/l	500
13	Iron	Fe	mg/l	2.0
14	Fluoride	F	mg/l	15
15	Cyanide	CN^-	mg/l	0.1
16	Copper	Cu	mg/l	0.5
17	Lead	Pb	mg/l	0.2
18	Oil and Grease	-	mg/l	5
19	Nickel	Ni	mg/l	0.2
20	Mercury	Hg	mg/l	0.005
21	Manganese	Mn	mg/l	1.0
22	Arsenic	As	mg/l	0.25
23	Barium	B	mg/l	1.0
24	Cadmium	Cd	mg/l	0.03
25	Chromium	Cr^{+6}	mg/l	0.1
26	Total Chromium	Total Cr	mg/l	0.5

Source: Agreement on National Environmental Standards, WREA 2009

Annex C4-1 Summary of the Public Consultation at Village Level

Source: IESA Report of NN1 Hydropower Station Expansion 2009

Public Consultation schedule

In accordance with the TOR for the IESE study for Nam Ngum 1 Expansion Project, the survey team from SD&XP Consultant Group was fielded. Subsequently, the testing survey with draft questionnaire was conducted with JICA survey team at Ban Thaxan village in Keo Oudom District Vientiane Province on 22 May 2009. Then the survey team was engaged and trained for 5 teachers from Pakcheng Secondary school to conduct the field interview, which was started from 28 May to 6 June 2009. Afterwards, the public consultation workshop was organized on 16 July 2009 with participation of line agencies, District authorities of Keooudom, Viengkham and Thoulakhom and 24 downstream village authorities.

Selection criteria's for the interview:

The interview survey was conducted for 100 persons in villages selected from inhabitant of Nam Ngum river bank, nearby Nam Ngum dam and its downstream within 50 km and within 1 km from river bank. Although upstream villages are not affected by the expansion project, some villages from upstream of the Nam Ngum River Basin were also interviewed for reference.

For village level interviewing, the survey team conducted with village authorities as on the list given in the TOR for 25 downstream villages. Some villages upstream of the NN1 dam were also interviewed for reference in formation.

Methodology and process to conduct field interview

The survey team conducted interview in totally 27 villages (24 villages downstream and 3 upstream villages) and 94 potentially affecting households out of targeted 24 villages and additional 6 households from upstream 3 villages as reference. The household selection for interview was based on the main occupation of the households that is related to river water usage: riverside gardening, boat transportation, fishing, water pumping, etc. which is related to the water level increase and decrease. Then the candidate households were proposed by village chief in each village.

According to the selection for the optimum 40 MW of the NN1 Hydropower station expansion, the adverse impact study was focusing on how many household likely to be affected, compare to present water level, if the water level increases 0.5 m or more at peak time and how many households would affected from the water level decreases about 0.5 m or more at off-peak time.

(1) Survey team formation:

- The survey team included 1 Socio-economic Specialist and 1 Environmental Specialist from SD&XP Consultant Group, 5 surveyors engaged teachers from Pakagnoung Secondary school

- The survey team members were then trained on the scope and purposes of the project with all needed handout, medias, graphs and presentation material.

(2) Consultation with villagers

- Selection of households for interview: the surveyor would firstly consult with village authority about the list of household practicing riverside gardening, boat transportation, water pumping, fish

caging, etc. that likely to be affected by operation of NN1 Hydropower expansion project. Particularly for the downstream villager who own the above occupations.

- Presentation venue: most of the villages conducted the interview at the temples or village chief's house.
- Presentation of project scope and objectives to the interviewees: before interview the surveyors were well present about project scope and objectives together with graph of water fluctuation when the system operates. In association with the presentation there were time for questions and answer to ensure full understanding of the participants.
- Interview survey: the interview involved 2 levels as the followings
  - (i) Village level interview: use village level questionnaire to interview village authority totally 24 available village downstream and some villages upstream (currently 24 downstream and 3 upstream villages)
  - (ii) Households level interview: use household level to interview 100 households that likely to be affected by NN1 Hydropower Expansion project (totally 94 downstream households and 5 upstream households
- Explanation that the goal of NN1 expansion project is to increase the national electricity output and export especially to develop socio-economic aspect of people in the project pilot villages.

Result of the field survey:

1. Economic and subsistence activities of the downstream people;
   The main income sources of the downstream people of NN1 are agriculture, fishery, boat transportation, etc. and the water level fluctuation of at the range of 0.5 m makes very little impact to them if compare to the current seasonal fluctuation.

2. Status of water use and hygienic condition;
   People are freely using natural river for several purposes such as fishing, boating, washing, irrigation, riverside garden watering, etc. For the sources of drinking water, most of the villagers use open well as well as tube wells.

3. Infrastructure/ public facilities in the downstream villages
   All downstream villages have easy access to good road structure, electricity, river transportation, etc. the same as easy access to public facilities like schools, dispensary and hospital in the District center of 3 target districts of Viengkham, Keo Oudom and Thoulakhom.

4. Condition of Natural resources use;
   Most of the downstream villages of NN1 dam own the land for rice and other cash crop production. None of the villages settle inside the protected areas or conservation area. Villagers are mainly engaged in agriculture and fisheries for their income earning.

5. Affecting water level increase for riverside gardening and affecting water level decrease for boat transportation, fish pond, gage fisheries and water pumping;
   The water level fluctuation is considered to affect during dry season for downstream households and it is confirmed by conducting field survey that there is almost no adverse impact to the economic status of downstream villagers by the fluctuation range at 0.5 m, while none of the riverside cultivators complaining that they will be affect at 0.5m of increase water.

6. Requirement for resettlement and compensation
   Since the result of village as well as household interview shown that the fluctuation of water level will not affect to the assets of the community. The maximum water level is expect to increase about 0.5 m at peak time, while villagers confirmed that the allowable level of water is 0.5 m cm and when the water level decrease to 0.6 m at off peak time it will affect to two families, who engaged in boat

transportation and fisheries as their allowable water level is 50 cm but they are all waive for project to go on.

7. Overall opinion of the downstream people to the project
All village authorities and household head interviewed are agreed with the Government's plan for NN1 Hydropower station expansion as it would be the main potential income sources for the country and all are opted to waive for any resettlement and compensation due to the water level will not at all affect their assets compare to natural disaster.

(3) Data computation and analysis
In order to be able to assess socio-economic and environmental condition in the project area a set of data analysis table were formed. All the data were computed, analyze and translate the result to the report text.

(4) Organize workshop for officially public consultation: on 16 July 2009 the project team organized a public consultation workshop at NN1 Hydropower camp. Attending this workshop are Mr. Vilath Sisouvong, Voce Governor of Vientiane province, Mr. Khammany Inthilath, the Director of EDL, Representative of WREA in Vientiane, the Board of director NN1, District Governors of 3 concern Districts, village chief of affected villages and concerned line agencies.

Annex C4-2 Minutes of the Public Consultation

Source: IESA Report of NN1 Hydropower Station Expansion 2009

Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity

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Minutes

of the consultative meeting on the Initial Environmental Examination of the Nam Ngum 1 Hydro Power Plant expansion project

The consultative meeting on the Nam Ngum 1 expansion project has been held at the meeting hall of the Nam Ngum 1 Hydro Power Station, Vientiane Province on 16 July 2009 from 13:30 to 17:00. Presence at the meeting were Mr. Vilath Sisouvong, head of Vientiane Provincial Cabinet, representative of Water Resource and Environment Agency, representative of the Department of Electricity, Ministry of Energy and Mine, representatives from villages concerned, representatives of NIPPON KOEI Co., Ltd of Japanese consultant for Nam Ngum 1 Expansion Study, SD & XP Consultants Group of local consultants for IESE study of Nam Ngum 1 Expansion Plan, and other participants from different divisions concerned from Electricite du Laos (list of participants attached). The meeting was co-chaired by Mr. Vilath Sisouvong, head of Vientiane Provincial Cabinet, Mr. Khammany Inthilath, member of the National Assembly for the 10th constituency of Vientiane Province and Director General of Electricite du Laos. Mr. Vilath delivered his opening remark by stressing the objective of the meeting as to discuss the Initial Environmental Examination Study with regard to the Nam Ngum 1 expansion project in order to make the participants more understood on the electricity development of the Electricite du Laos. He also raised the importance of the hydro power station and electricity development in Lao PDR aiming at implementing the government policy on national development in order to lift the country out of least developed country status. At the same time, Lao PDR will also make households across the country access to electricity at 70% by 2010 and at 90% by 2020, and to make Lao PDR a battery of ASEAN. Mr. Head of Vientiane Provincial Cabinet stressed the meeting should focus and participate actively on the consultation and officially opened the meeting.

After the opening, Mr. Khammany Inthilath, member of the National Assembly for the 10th Constituency of Vientiane Province, and Director General of the Electricite du Laos, who were also co-chaired of the meeting, had given their views on the general potential for the hydro power plant development, especially different projects in Vientiane Province which are important to the socio-economic

development in the Lao PDR. He also raised the importance of the Nam Ngum 1 expansion project and the link of the transmission network in Lao PDR which covers the northern, central and southern parts of the country. He also reminded the future plan of electricity projects should take into account and focus on both positive and negative impacts on environment as well as society that may arise from the future development project and should follow the laws and regulations of the Lao PDR as main reference for carrying out measures under socio-environment management. This project is one of the projects that will supply electricity to locality and export of electricity in order to reduce the import of electricity and to generate revenue for the Lao PDR. They thanked to the village, district and provincial authorities for giving attention to and participation in the meeting.

The SD&XP Consultants Group, who conducts a joint study with NIPPON KOEI under JICA funding, presented details on background, technique, and outcomes of the environmental and socio-economic impact study of the Nam Ngum 1 expansion project in order to make participants more understood and saw the outcome of the study in 3 main areas as follows:

- The study of the existing environment which could be affected from the project during its construction and operation.
- Recommendations of measures, action plan, prevention and impact mitigation during the construction and operation, such as: water level fluctuation and mitigation measure for construction of expansion works
- Recommendations of environment monitoring during the construction and operation.

After that, the meeting was open for comments and discussion from participants on the report made by the consulting company, which are summarized as follows:

1. Comments from the participants, such as: Mr. Khaokeo Somchanmavong, Head of Thoulakhom District and Ms. Chanhpheng Viphavanh, Head of Viengkham District: Both agreed with the presentation of the consulting company on the information regarding initial environmental and social impact and measures to address the issues. They gave further instruction to organizations concerned such as: concerned units of the province, district and authority at the village level must take responsibility to help educate people in order to make them whom is likely to be affected from the project understand more with the aim to achieving overall national interest, otherwise misunderstanding such as impact on flood, which is not related to the expansion project, may occur.
2. Mr. Souphon, representative of the Water Resource and Environment Agency commented and advised for the plan for environmental management that the consultant should give focus on:

    - the further attention be given to the long term impact that may arise from the development of the project

- the allocation of funding in detail that will be used in the work of environmental and social management as well as monitoring from each relevant sector that should be done sufficiently.
- the attention should be given to the stage of working with locality especially the participation of the people as well as community who may be affected from the expansion project.

3. Comments from other participants such as Mr. Khamphuoa Phengphanhak, Head of Provincial Water Resource and Environment Office, Mr. Khammy Viengvilay, Village Head of Ban Sengsavang and Mr. Sisamone Boudsalath, Village Head of Ban Boungphoa:
    - They asked the project as well as consultant to pay attention to measures carefully and clearly in order to make the project goes smoothly, without or reduce possible negative impacts to the locality either on environment or society and those measures must be included in the agreement in order to make the contractor implement them and make it easier to monitor.

The project as well as consultant agreed to take all the comments made above into consideration in order to improve its report on the Initial Environmental Impact study of the project to make it more complete and with regard to the above mentioned comments.

Mr. Phoumy Nitibandith, Deputy Head of Production Division, Director of Nam Ngum Hydro Electric Dam 1 made additional clarification on the questions, benefit and negative impact from the extension project of Nam Ngum 1 as follows:

<u>Benefits:</u>

- Produce electricity for social consumption in an effective manner.
- Having the biggest reservoir in the country that can store water for fishery of the people.
- Using the reservoir as convenient transport route for the people living nearby the reservoir area of the Nam Ngum 1.
- Serving as beautiful tourist attraction site for the local people as well as for the foreign tourist, which can generate additional income to the people of Vientiane province as well as for Lao PDR.
- Water from the production of electricity can be used for irrigation and that amount of water can sufficiently feed the agriculture in the Vientiane plain.
- Can reduce flood in the sub-area of the Nam Ngum 1 and provide water for dry season.
- Serving as a venue for building and training of human resource of the Lao PDR on the hydro electric dam management skill and other jobs related to the management of dam, station and transmission line for example.
- The project has very limited negative impact on socio-environment compared to other new hydro power plant development projects and other similar projects.

Negative impacts:

- Loss of some riverside gardening land along the sub-area of Nam Ngum 1 during dry season if no consideration is held.

Through consultation mentioned above, the meeting concluded that the Initial Environmental Examination impact study and the mitigation plan are suitable, complete and implementable. In general, participants of the meeting as well as those who made comments have agreed in consensus with the said study and supported the development of the project (Nam Ngum 1 extension project).

At the end of the meeting, Mr. Vilath Sisouvong, Head of Vientiane Provincial Cabinet and Mr. Khammy Inthilath, member of the National Assembly for the 10th constituency of Vientiane Province, co-chairs of the meeting had made additional guidance, namely: in general it is agreeable with the study, but it was requested that the consultant to provide answer to questions raised and provide clearer study in IESE. However, in order to make the project study right, suitable and implementable on the basis of the law and regulations of the Lao PDR, in case of any participants still have questions that could not be raise today, they can submit through the concerned authority of the village, district and province for further comments and clear answer. This is to improve the study report to make it more complete that in the next stage it will be submitted to the sector concerned: Electricity Department, Ministry of Energy and Mines and Water Resource and Environment Agency.

The meeting adjourned at 17:00 hours with consensus reached from all parties.

Vientiane Province, 16 July 2009

Chair of the Meeting	Recorder
pp. Signature for Chair of Meeting	Mr. Vongvilay

Mr. Somsanith SENGTHONG

Participant of Public Consultation Meeting on 16 July 2009

List of villages Head (Participant Representative) for NN1_IEE on 16 July 2009 at Thalat (NN1 meeting hall)

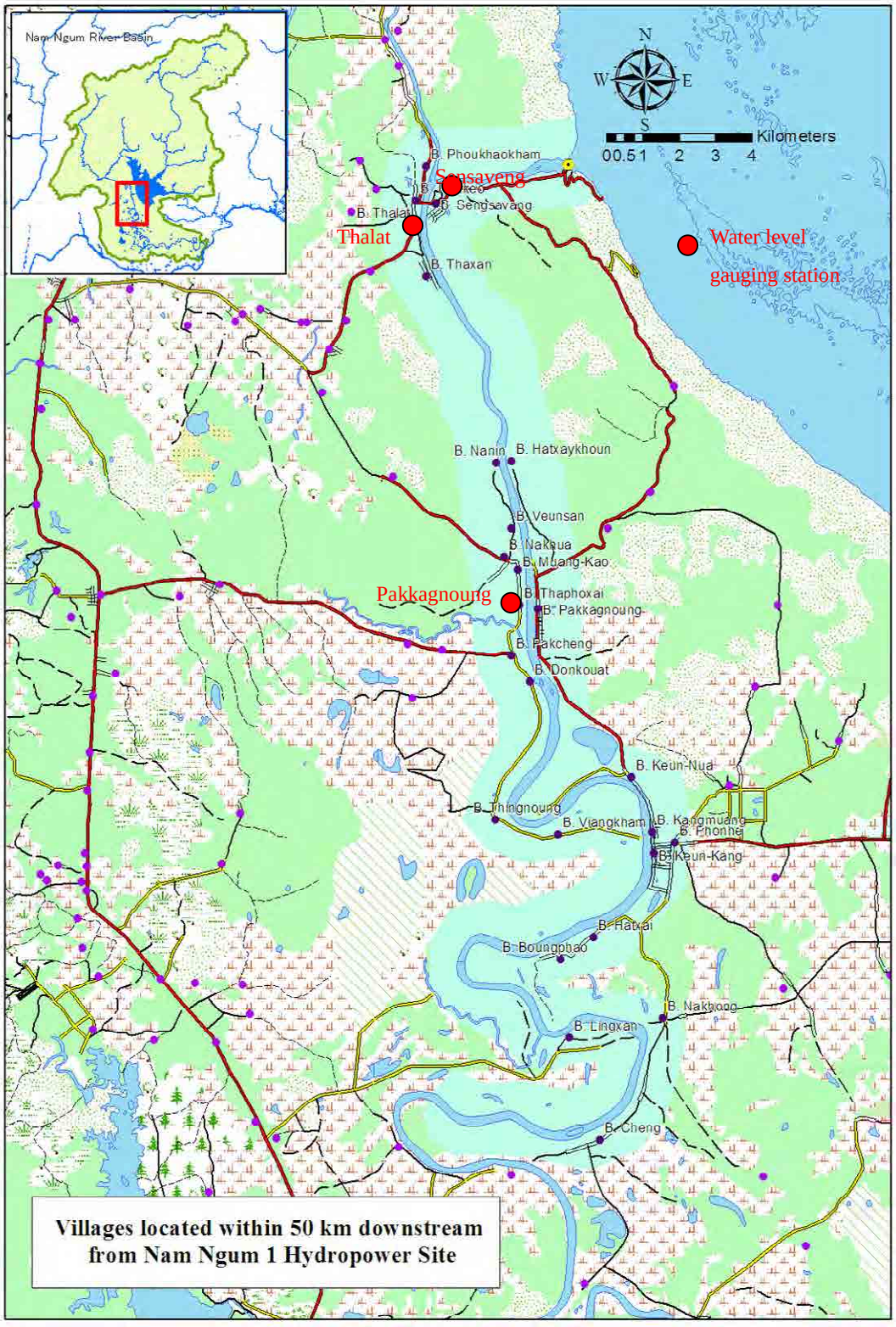
No	Nam and Surname	Village Names	Remark
	Keo Oudom District		**Not presented 2 villages of downstream villages.There are 22 villages of down stream villages which were particpated is equivalent to 91.6%. For Upsteam villages not presented because they are very far from meeting site, also they have obstacle of voyages. For 2 Villages have not information. May be They are busy with paddy rice production. Also the in vitation cards has been delivered by hand.**
1	Mr. Hong Thong	Thalat	
2	Mr.Leuxay Bouttavong	Thaxan	
3	Mr. BounPheng VongKhamphanh	Phoukhaokham	
4	Mr. Khammy Viengvilay	Seng Savang	
5	Mr. Bouathong	Thinhkeo	
Sub_Total:	**5**		
	Vieng Kham District		
1	Not presented	Hatsaykhoune	
2	Mr. Bouapha Oudomphone	Vieng Kham Village	
3	Mr. Khammao	Naninh	
4	Not Presented	Veunsanh	
5	Mr. Intong	Pakkhagnoung	
6	Mr. Ketkeo Ssysomchay	Thaphoxay	
7	Mr. Phone Xao phouvong	Nakheua	
8	Mr. Soukanh Xayyasne	Thingnoung	
9	Mr. Bounthiane Vongsay	Mouang Kao	
10	Mr. Phouvong Southammavong	Pakcheng	
11	Mr. Bouasavanh	Done Kuath	
Sub_Total:	**9**		
	Thoulakhom District		
1	Mr. Khankham	Nakhong	
2	Mr. Khamphanh Vong say	Keunkang	
3	Mr. Noumanh	Hatsay	
4	Mr.Kounthong Soydara	Keunneua	
5	Mr. Norkham Phetthongsy	Phone Hair	
6	Mr. Saythong	Cheng	
7	Mr. PhayKeo Luang Aphay	Lingsanh	
8	Mr. Sysamone Bouthsalath	Boungphao	
Sub_Total:	**8**		
Total:	**22 persons(villages Head)**		
	Home District		
1	NotPresented	San Patong	
2	NotPresented	Namone	
3	NotPresented	Phonesavanh	

List of participants (Central and Province Representative)
for NN1_IEE on 16 July 2009 at Thalat (NN1 meeting hall)

No	Nam and Surname	From
	SD &XP Consultants Group	
1	Mr. Chanthip Latsavanh(PM)	**SD&XP**
2	Mr. Bounheuang Phanthasith(TL)	**SD&XP**
3	Mr. Anousith Sramany(Hg)	**SD&XP**
4	Mr. Phanthong Maxisonsay(Socio)	**SD&XP**
5	Mr. Khamla (ADMIN)	**SD&XP**
Sub-Total	**5**	
	JICA /Nippon Koei Co., LTD	
1	Ms. Yuka Nakagawa	**JICA Survey Team/NK**
2	Mr. Takuji Katoaka	**JICA Survey Team/NK**
Sub-Total	**2**	
	Participnats of Central Level	
1	**Mr. Souphonh**	**WREA**
Sub-Total	**1**	
	DoE/EDL	
1	Mr. Khammany Inthirath	**EDL/General Director**
2	Mr. Lattana Pathoumvanh	
3	Mr. Thong Phet DuangNgeun	**EDL/Technical Electricity Director**
4	Mr. Vilaphorn. V	**EDL/ Env.section, Head**
5	Mr. Vongvilay	**EDL/Env.**
6	Mr. Kailath	**EDL/Production study System**
7	Mrs. Alivanh Mangkhaseum	**EDL/Production study System**
Sub-Total	**7**	
	Vientiane Province Level/NN1	
1	Mr.Vilat Sisouvong	**Head of Provincial Cabinet Office**
2	Mr. Khamphua Phengphanh Hak	**PWREO**
2	Mr. Thongsang Chanthavong	**Province Agriculture and Forestry Office(PAFO)**
3	Mr. Chandeng Keopaseuth	**Head of Energy and Mines of Vientiane Province**
4	Mr. Amkha Keoluang Khot	**Evr./ADMIN_ NN1 Hp**
5	Mr. Bouavanh Chanthaphet	**Dpty of NN1 Hp**
6	Mr. Phoumy	**General Director of NN1**
Sub-Total	**6**	
	Keo Oudom District	
1	Mrs. Siriphone Chanthamith	**DWREO**
2	Mr. Khamla Luang Bouddy	**District Energy and Mines**
3	Mr. Somchay	**District Office Cabinet**
4	Mr. Bouahong	**Land Titling of District**
Sub-Total	**3**	
	Vieng Kham District	
1	Mrs. Changpheng Viphavanh	**District Governor's**
2	Mr. BounGnong Keomala	**DWREO**
3	Mr. Kalaketh Southammavong	**District Energy and Mines**
4	Mr. Inpeng Vongchandy	**District Cabinet Office**
Sub_Total:	**4**	
	Thoulakhom District	
1	Mr.Khao Keo Somchanmavong	**District Governor's**
2	Mr. Phokham Luangphayvong	**District Energy and Mines**
3	Mr. Koumkham Xayyasane	**District Cabinet Office**
Sub-Total	**3**	
Total:	**31**	

A total of participants for meeting is 53 persons(22 villages head +31 of stafts + Districts/Povince

Appendix C-5 Location of Affected Villages



Source: IESA Report of NN1 Hydropower Station Expansion 2009

BASELINE DATA
Village Identification

District:

Village:

Location GPS Lat (WGS84)

Location GPS Long (WGS84)

Mark Location on Map

Date of Data Collection:

List the Names and Positions of Persons Collecting Data

Name:

Position:

Name:

Position:

Name:

Position:

Village Representation

No. Position First Name Surname Phone number

1.

2.

3.

4.

5.

6.

7.

1. Population, Demography and Settlement

What is the total population and women population in the Village?

…….

How many households reside in Village?

……HHs

Total agricultural area in the village including riverbank area

_____ ha

2. Economic Status of Village

2.1. How much an average income per capita per year?

……Kip

2.2. What is the main income source (%)? Percentage of hhs main income in each activity.

Agriculture

……%

Agriculture (Riverbank garden)

……..%

Small-scale trading (shops, stalls, retail)

……%

Government service

……%

Fishing Culture

……..%

Others

…… % ……..%

……....% ……..%

2.3 How many households that are designated as poor (vulnerable)?

Definition of vulnerable stipulated in Decree192;
- divorced or widowed female headed households with dependents and low income
- households with disabled or invalid persons,
- households with person falling under the generally accepted indicator for poverty as defined by the Ministry of Labor and Social Welfare or the landless,
- elderly and disable households with no means of support

……..HHs

3. Activities related to the Nam Ngum river

3.1. Categories of river water usage

Use for general purpose …….HHs

Use for drinking …….HHs

Use for commercial fishing …….HHs

Use for fish culture …….HHs

Use for transportation route …….HHs

Use for irrigation …….HHs

Use for riverbank garden ……..…HHs

4. Riverbank Gardening

4.1. Total area of the river bank garden in the village _____ha

4.2. Average income gain from river bank activities _____kips/ha/year

4.3. How many households practice riverbank gardening? …….. HHs

4.4. How many meters are secured for buffer zone?

……m from ……..

4.5. What is the status in the riverbank gardening area?

Belong to Government (but customary use recognized)
Permanent Land Use Certificate Issued
Temporary Land Use Certificate Issued
Tax Imposed

Detail Description (eg. how to measure the riverbank area etc.,)

……

……

…….

4.6. What kind of vegetable is planted in the riverbank garden?

……

……

…….

…….

4.7. Cost of Productivity land in this area?

_____

4.8. How much is the price of the river bank area? (if there is the price difference between the most expensive and average, please give both prices)

_____ (expensive) kip/ha

_____ (average) kip/ha

5. Electrification Status

5.1. What is the electrification rate in your village? …….%

5.2. What is the average electricity consumption per month? ……kWh

BASELINE DATA
Household Identification

District:

Village:

Location GPS Lat (WGS84)

Location GPS Long (WGS84)

Mark Location on Map

Date of Data Collection:

List the Names and Positions of Persons Collecting Data

Name:

Position:

Name:

Position:

Name:

Position:

Household's Representation

No. Position First Name Surname Phone Number

1.

2.

3.

1. Demography

How many members in your household?

……

2. Economic Status of Household

2.1. How much an average income per household per year?

…….Kip

2.2. What is the main income source (%)?

Agriculture

…….%

Agriculture (Riverbank garden)

……..%

Small-scale trading (shops, stalls)

……%

Government service

……%

Fishing Culture

……..%

Others

…… % ……%

……....% ……%

3. Riverbank Gardening

3.1. How many meters are secured for buffer zone?

……m

3.2. What is the status on the land where you practices riverbank gardening?

Belong to Government (but customary use recognized)

Permanent Land Use Certificate Issued

Temporary Land Use Certificate Issued

Tax Imposed

3.3. What is total riverbank area?

……..ha

(Length ((m)) x Width ((m))

……..m x …….. m

Location
Bottom (the nearest to the river) Latitude:…… Longitude:……..
Top (the farthest from the river) Latitude:…….. Longitude:……

3.4. What kind of vegetables grown in your riverbank garden?
Type / Frequency / Productivity (eg. red pepper / 3 times from September to March / 1kg per ha/ 100,000 kip)

……

……

……

……

……

3.5. How many % of income from the riverbank gardening will be in total household's income?

…….%

3.6. How many % of the riverbank garden will be affected if the water level increases in 80cm from the present level?

…….…….%

3.7. How many % of income from the affected riverbank garden will be in total household's income?

…….%

3.8. How much for the riverbank garden area?

…….kip/ha

Appendix C7-1 Village Population and Vulnerable Households

	Entity	Population		Household	Vulnerable Households
		Total	Female		
1	**National**	6,256,197	3,133,059	1,027,468	-
2	**Vientiane Province**	475,140	233,055	86,730	-
3	**Keo-Oudom District**	18,988	9,401	3,912	-
4	Thinkeo Village	1,168	568	218	0
5	Sengsavang Village	1,403	726	313	0
6	Thalat Village	1,056	568	207	0
7	Thatxan Village	932	486	165	0
8	**Viengkham District**	18,566	8794	3,780	-
9	Hatxaykhoun Village	247	119	64	0
10	Nanin Village	539	273	122	1
11	Veunsan Village	1,307	669	282	0
12	Muangkao Village	855	427	201	0
13	Thaphoxai Village	532	273	104	4
14	Pakkagnoung Village	2,397	1,208	530	5
15	Pakcheng Village	807	395	150	0
16	Donkouat Village	892	447	185	5
17	Thingnyoung Village	1,501	732	310	3
18	Viengkham Village	732	374	131	2
19	**Thoulakhom District**	-	-	-	-
20	Keun-Nua Village	1,784	920	342	0
21	Keun-Kang Village	1,999	979	368	2
22	Hatxai Village	1,071	582	213	30
23	Boungphao Village	1,587	837	340	1
24	Nakhong Village	842	426	166	-
25	Lingxan Village	1,615	801	297	2
26	Cheng Village	1774	825	368	0
Total No. Impacted Village		**25,040**	**12,635**	**5,076**	**55**

Source: Statistic Year Books, 2011
Social Economic Development Plan, 2010-11, Vientiane Province
Land Use Allocation Plan, Viengkham District, 2011
Social Economic Development Plan, 2010-14, Keo-Oudom District, Vientian Province
Village Hearings by ,JICA study team, 24-26 May2012 and 28-31 Aug 2012

Appendix C7-2 Average Income and Income Source

No.	Entity	Average Income	Main Income					Remark
			Agriculture	Fish Farming	Trading	Government Services	Others	
1	**National**	1,088	N/A	N/A	N/A	N/A	N/A	Information from Year 2010
2	**Keo-Oudom District**	595	N/A	N/A	N/A	N/A	N/A	Information from Year 2009
3	Thinkeo Village	N/A	0.10%	0	95%	4.90%	0	
4	Sengsavang Village	750	7.50%	2.50%	20%	70%	0	
5	Thalat Village	N/A	20%	0	75%	5%	0	
6	Thatxan Village	700	80%	0	8%	0%	12%	
7	**Viengkham District**	720	N/A	N/A	N/A	N/A	N/A	Information from Year 20011
8	Hatxaykhoun Village	1200	20%	0	0	0	80%	
9	Nanin Village	700	70%	0	0	5%	25%	
10	Veunsan Village	600	20%	0	0	50%	30%	
11	Muangkao Village	850	100%	0	0	0	0	others income source is a supplement, Average income is quite high in this village as most of the families are retired from government service.
12	Thaphoxai Village	1200	30%	0	8%	50%	12%	
13	Pakkagnoung Village	1200	60%	0	40%	0	0	
14	Pakcheng Village	1100	75%	0	15%	0	10%	
15	Donkouat Village	750	100%	0	0	0	0	
16	Thing young Village	800	90%	0	10%	0	0	
17	Viengkham Village	800	70%	0	10%	0	20%	
18	**Thoulakhom District**	N/A	N/A	N/A	N/A	N/A	N/A	
19	Keun-Nua Village	1,876	80%		15%	5%	0	
20	Keun-Kang Village	1,400	70%	1%	19%	10%	0	
21	Hatxai Village	850	80%	0	0	3%	17%	
22	Boungphao Village	900	70%	0	20%	0%	15%	
23	Nakhong Village	760	70%	0	20%	10%	0	
24	Lingxan Village	800	80%	0	20%	0%	0	
25	Cheng Village	700	90%	0.03%	3%	6.97%	0	
	Average	944	61.08%	0.18%	18.00%	10.47%	10.52%	

Note: Exchange rate is 1 = 8,000 kips

Appendix C7-3 Electrification Rate and Electricity Bill

No.	Village	District	Electrification Rate (%)	Average Elevtricity Consumption / Month
1	Thinkeo	Keoudom	100	-
2	Sengsavang	Keoudom	100	-
3	Thalat	Keoudom	100	-
4	Thatxan	Keoudom	100	50,000 kip/month
5	Hatxaykhoun	Viengkham	100	30,000 kip/month
6	Nanin	Viengkham	100	50,000 kip/month
7	Veunsan	Viengkham	100	50,000 kip/month
8	Muaungkao	Viengkham	100	-
9	Thaphoxai	Viengkham	100	95,000 kip/month
10	Pakkagnoung	Viengkham	100	100,000 kip/month
11	Pakcheng	Viengkham	100	60,000 kip/month
12	Donkouat	Viengkham	100	-
13	Thin-Nyoung	Viengkham	100	-
14	Viengkham	Viengkham	100	50,000 kip/month
15	Keun-Neua	Thoulakhom	96.5	100,000 kip/month
16	Keun-kang	Thoulakhom	100	-
17	Hatxai	Thoulakhom	100	-
18	Boungphao	Thoulakhom	100	50,000 kip/month
19	Nakhong	Thoulakhom	100	-
20	Lingxan	Thoulakhom	94.6	50,000 kip/month
21	Cheng	Thoulakhom	100	-

Appendix C7-4 River Related Activities in the Downstream of the Nam Ngum River

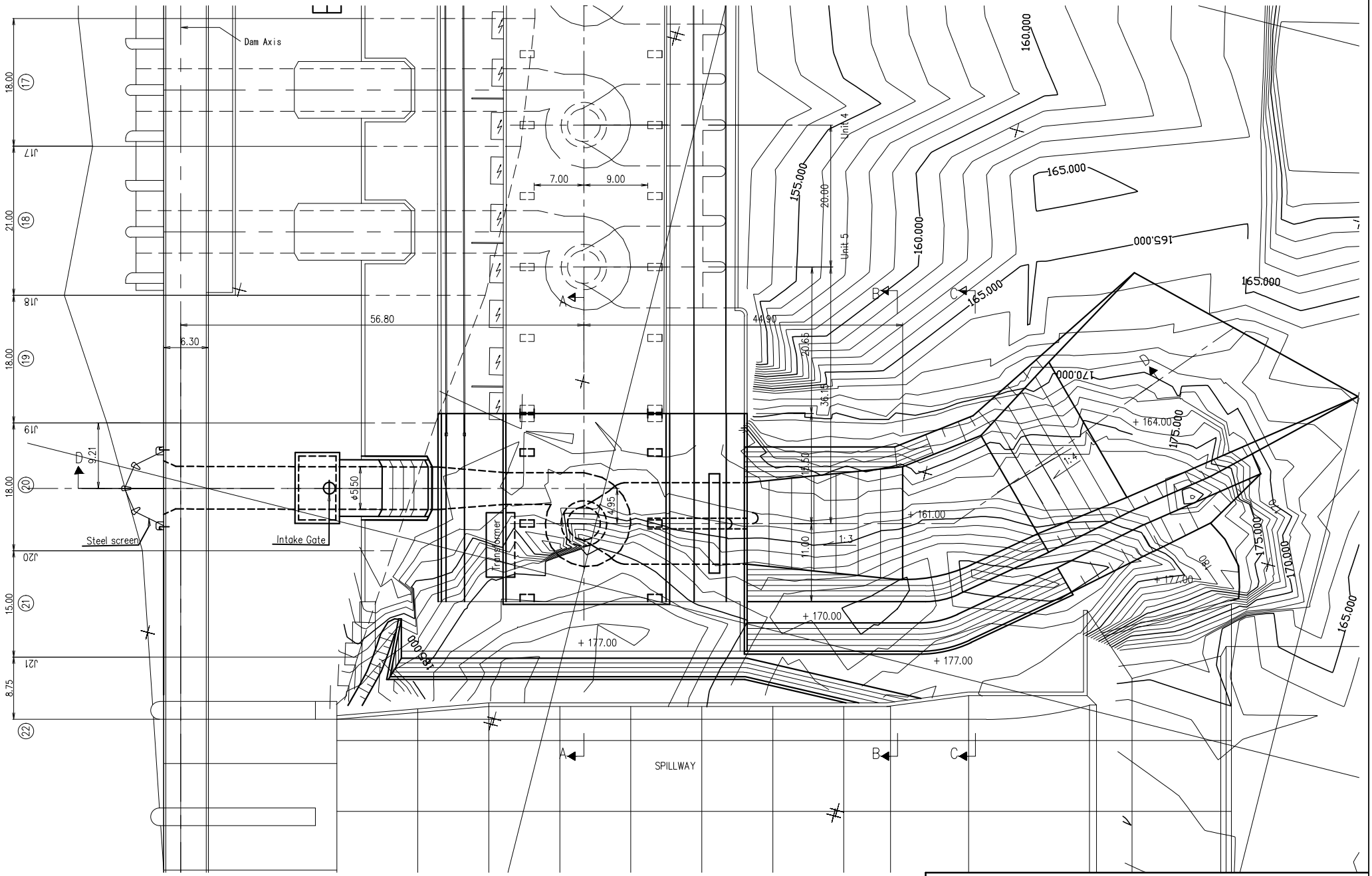
No.	Village	District	Households	Irrigation (HHs)	%	Riverbank Garden (HHs)	%	Navigation (HHs)	%	Fishery (HHs)	%	Fish Farming (HHs)	%
1	Thinkeo	Keoudom	218	0	0	1	0.5	0.0	0.0	6.0	2.8	0.0	0.0
2	Sengsavang	Keoudom	313	0	0	0	0.0	0.0	0.0	0.0	0.0	8.0	2.6
3	Thalat	Keoudom	207	21	10.1	30	14.5	0.0	0.0	10.0	4.8	0.0	0.0
4	Thatxan	Keoudom	165	0	0.0	50	30.3	0.0	0.0	0.0	0.0	0.0	0.0
5	Hatxaykhoun	Viengkham	64	0	0.0	25	39.1	0.0	0.0	0.0	0.0	0.0	0.0
6	Nanin	Viengkham	122		0.0	30	24.6	0.0	0.0	0.0	0.0	0.0	0.0
7	Veunsan	Viengkham	282		0.0	58	20.6	0.0	0.0	0.0	0.0	0.0	0.0
8	Muaungkao	Viengkham	201	0	0.0	0	0.0	0.0	0.0	15.0	7.5	0.0	0.0
9	Thaphoxai	Viengkham	104		0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Pakkagnoung	Viengkham	530	176	33.2	50	9.4	0.0	0.0	0.0	0.0	0.0	0.0
11	Pakcheng	Viengkham	150	75	50.0	3	2.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Donkouat	Viengkham	185	0	0.0	148	80.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Thin-Nyoung	Viengkham	310	114	36.8	0	0.0	0.0	0.0	10.0	3.2	0.0	0.0
14	Viengkham	Viengkham	131	104	79.4	3	2.3	0.0	0.0	0.0	0.0	0.0	0.0
15	Keun-Neua	Thoulakhom	342	60	17.5	25	7.3	0.0	0.0	0.0	0.0	0.0	0.0
16	Keun-kang	Thoulakhom	368	0	0.0	35	9.5	2.0	0.5	15.0	4.1	2.0	0.5
17	Hatxai	Thoulakhom	213	0	0.0	170	79.8	0.0	0.0	170.0	79.8	0.0	0.0
18	Boungphao	Thoulakhom	340	20	5.9	30	8.8	0.0	0.0	0.0	0.0	0.0	0.0
19	Nakhong	Thoulakhom	166	50	30.1	12	7.2	0.0	0.0	80.0	48.2	0.0	0.0
20	Lingxan	Thoulakhom	297	65	21.9	25	8.4	0.0	0.0	0.0	0.0	0.0	0.0
21	Cheng	Thoulakhom	368	235	63.9	150	40.8	0.0	0.0	5.0	1.4	1.0	0.3
	Total		5076	920	348.8	845	385.1	2.0	0.5	311.0	151.7	11.0	3.4

Appendix C7-5 Type of Vegetables from Riverbank Gardening

No.	Name	Village	District	Type of Vegetable	Frequency	Season	Productivity (kg/Rai/kip)	Total Area for Riverbank Gardening (m2)
1	Ms. Phoukhong	Thatxan	Keoudom	Cash crop	9	Oct toJun	N/A	3,200
				Pumpkin	3	Oct toJun	N/A	-
				Corn	3	Oct toJun	N/A	-
2	Ms. Onchan	Thatxan	Keoudom	Long bean	3	Oct toJun	N/A	250
				pumpkin	3	Oct toJun	N/A	-
				sweet potato	3	Oct toJun	N/A	-
3	Mr. ThongLor	Hatxaykhoun	Viengkham	cash crop	8	Oct toJun	300,000	1,600
4	Ms. Khambao	Hatxaykhoun	Viengkham	Cash crop	12	Jan to Dec	5,000,000	2,000
5	Mr.Souay	Nanin	Viengkham	cash crop & long bean	8	Oct toJun	2,000,000	200
6	Mr. Khamfong	Nanin	Viengkham	egg plant	3	Oct toJun	5,000,000	1,500
				corn	3	Oct toJun	-	-
				long bean	3	Oct toJun	-	-
				Morning glory	8	Oct toJun	-	-
7	Mr. Khambai	Veunsan	Viengkham	cucumber	3	Oct toJun	2,300,00	800
				corn	3	Oct toJun	-	-
				Long bean	3	Oct toJun	-	-
				cash crop	8	Oct toJun	-	-
8	Mr. Thongsai	Veunsan	Viengkham	Long bean	3	Oct toJun	4,000,000	1,800
				corn	3	Oct toJun	-	-
				chili	3	Oct toJun	-	800
				crash crop	8	Oct toJun	-	-
9	Ms. Chongkham	Pakkagnoung	Viengkham	corn	3	Oct toJun	3,000,000	1,600
				cash crop	8	Oct toJun	-	-
10	Mr. Leokham	Pakkagnoung	Viengkham	Corn	3	Oct toJun	900,000	300
11	Ms. Nouandee	Pakcheng	Viengkham	cash crop	5	Oct toJun	1,000,000	1,600
				chili	3	Oct toJun	-	-
				egg plant	3	Oct toJun	-	-
12	Mr. Inta	Pakcheng	Viengkham	cash crop	8	Oct toJun	1,000,000	850
				chili	3	Oct toJun	-	-
				egg plant	3	Oct toJun	-	-
13	Mr. Bounyonh	Keun-Nua	Thoulakhom	cash crop	8	Oct toJun	3,000,000	1,600
14	Ms. Hung	Keun-Nua	Thoulakhom	cash crop	8	Oct toJun	30,000,000	15,000
				vegetable shoot	12	Oct toJun	-	-
15	Mr. Khamphou	Hatxai	Thoulakhom	cash crop	8	Oct toJun	3,000,000	400
16	Mr. Saykham	Hatxai	Thoulakhom	chili	3	Oct toJun	8,000,000	1,600
				egg plant	3	Oct toJun	500,000	-
				papaya	3	Oct toJun	3,000,000	-
17	Mr. Khamfun	Boungphao	Thoulakhom	corn	2	Nov to May	3,200,000	1,600
18	Mr. Nouanthong	Boungphao	Thoulakhom	Corn	3	Nov to May	3 t/season	570
				egg plant	3	Nov to May	21 t/season	-
				chili	3	Nov to May	500 kg/season	-
19	Mr. Bouasavanh	Cheng	Thoulakhom	chili	6	Nov to May	288 kg/season	3,000
				egg plant	6	Nov to May	289 kg/season	-
20	Mr. Bounpheng	Cheng	Thoulakhom	chili	7	Nov to May	5,000,000	1,200
				egg plant	8	Nov to May	-	-

Appendix D

Alternative Plans



PLAN A1
(40 MW)

0 10 20 30M
SCALE

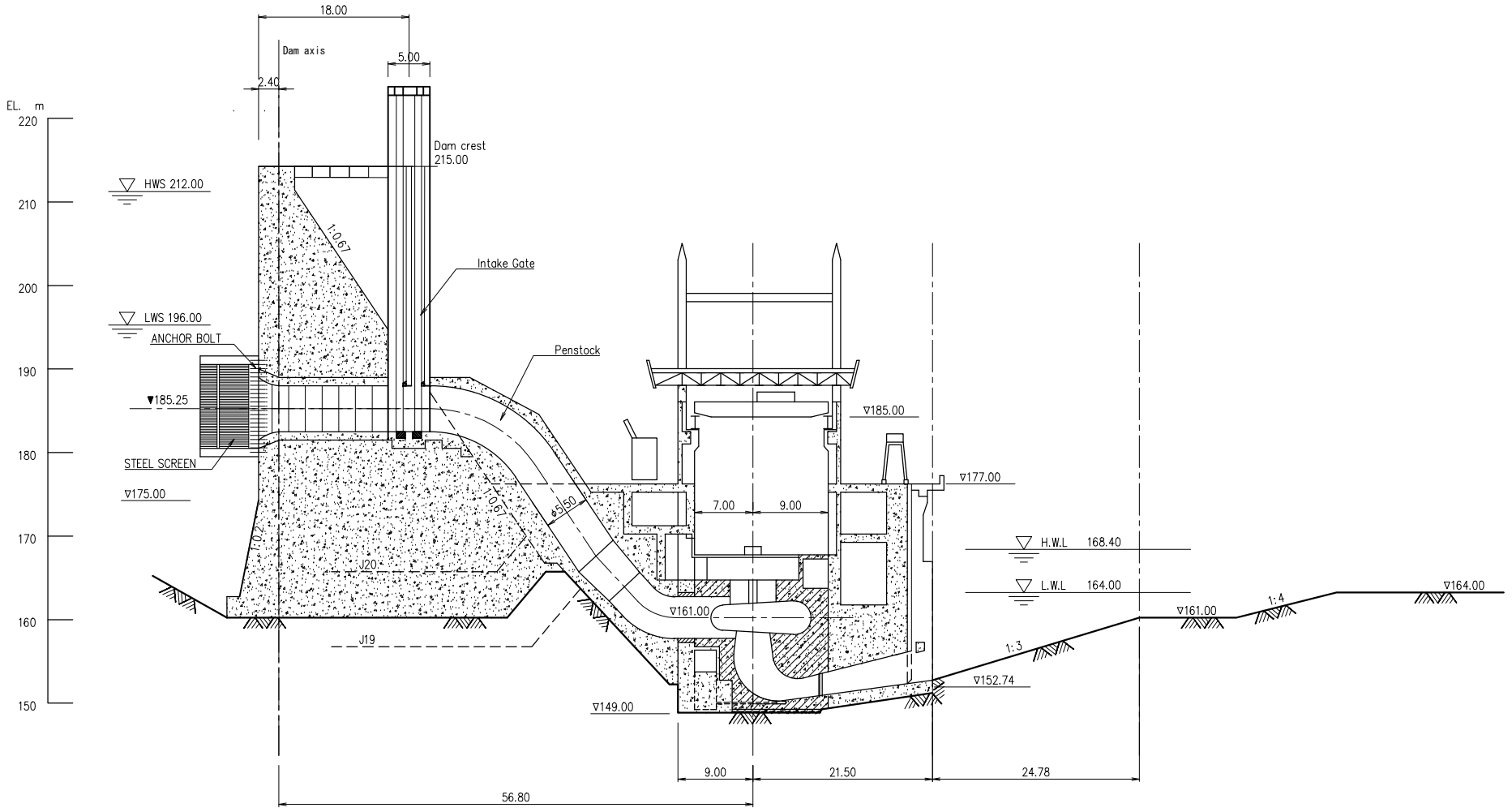
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION PHASE2 IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / J-POWER

Drawing Title: Alternative Plan A1 Plan

Drawing No: A1(1)

Date: August 2012



PROFILE (SECTION D-D)

0 10 20 30M

SCALE

PLAN A1
(40 MW)

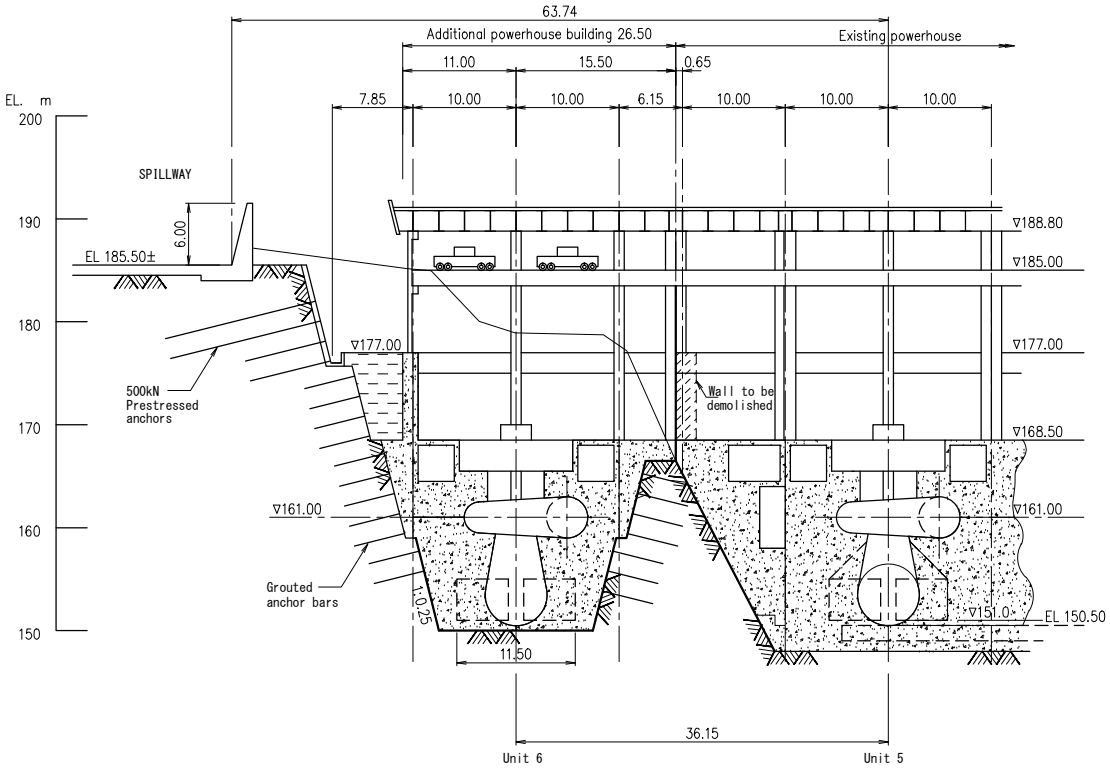
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER

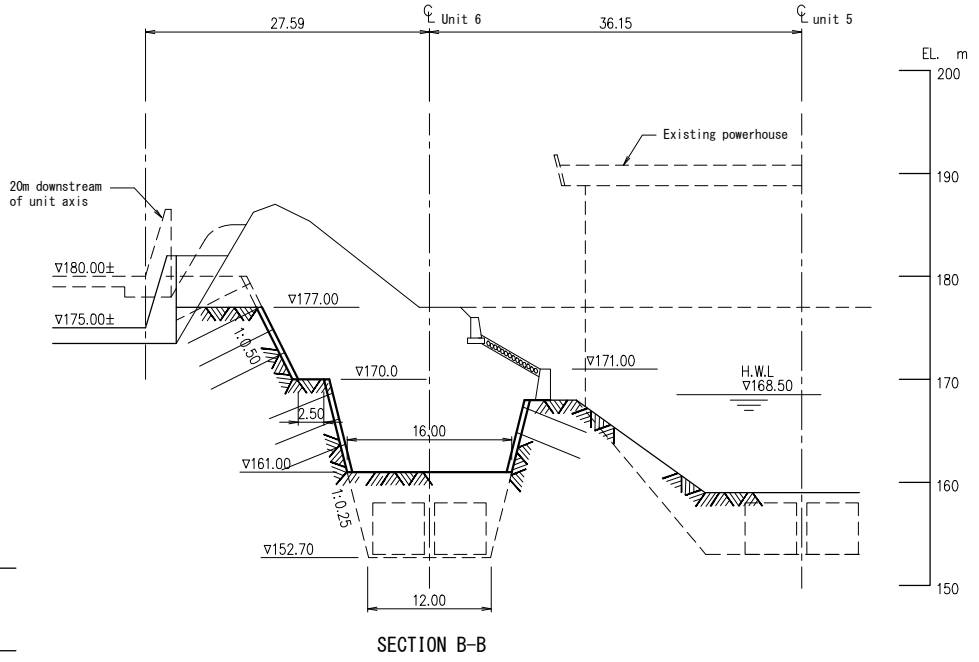
Drawing Title: Alternative Plan A1 Profile

Drawing No: A1(2)

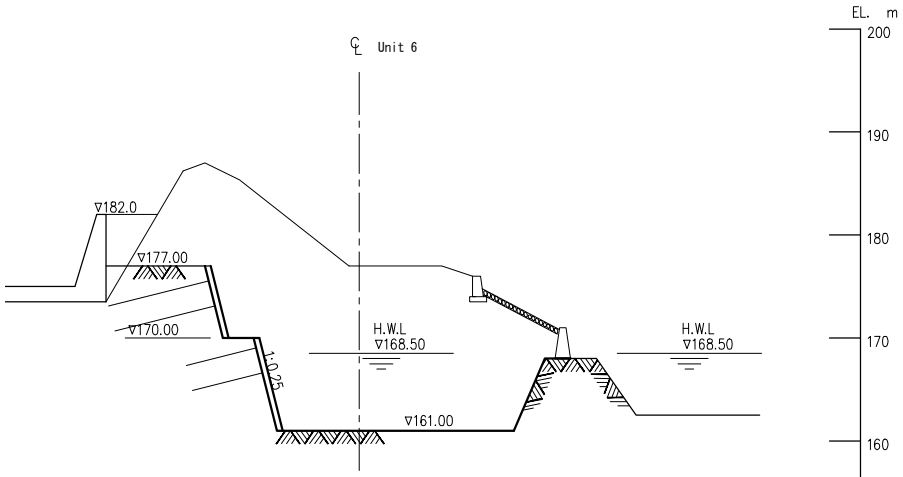
Date: August 2012



SECTION A-A



SECTION B-B

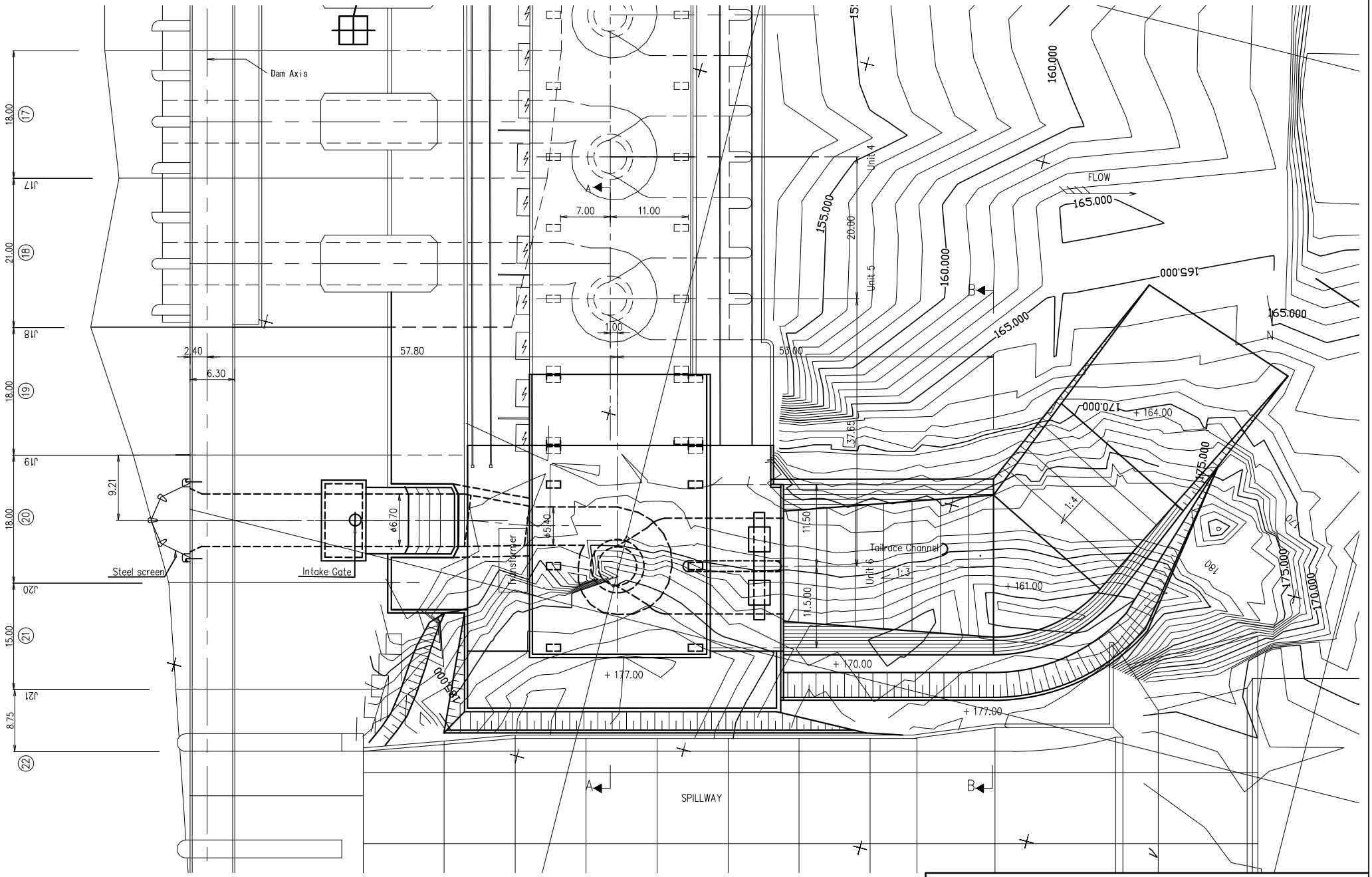


SECTION C-C

PLAN A1
(40 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	Alternative Plan A1 Sections	A1(3)
		Date: August 2012



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION PHASE2 IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER	Drawing Title: Alternative Plan A2 Plan	Drawing No: A2(1)
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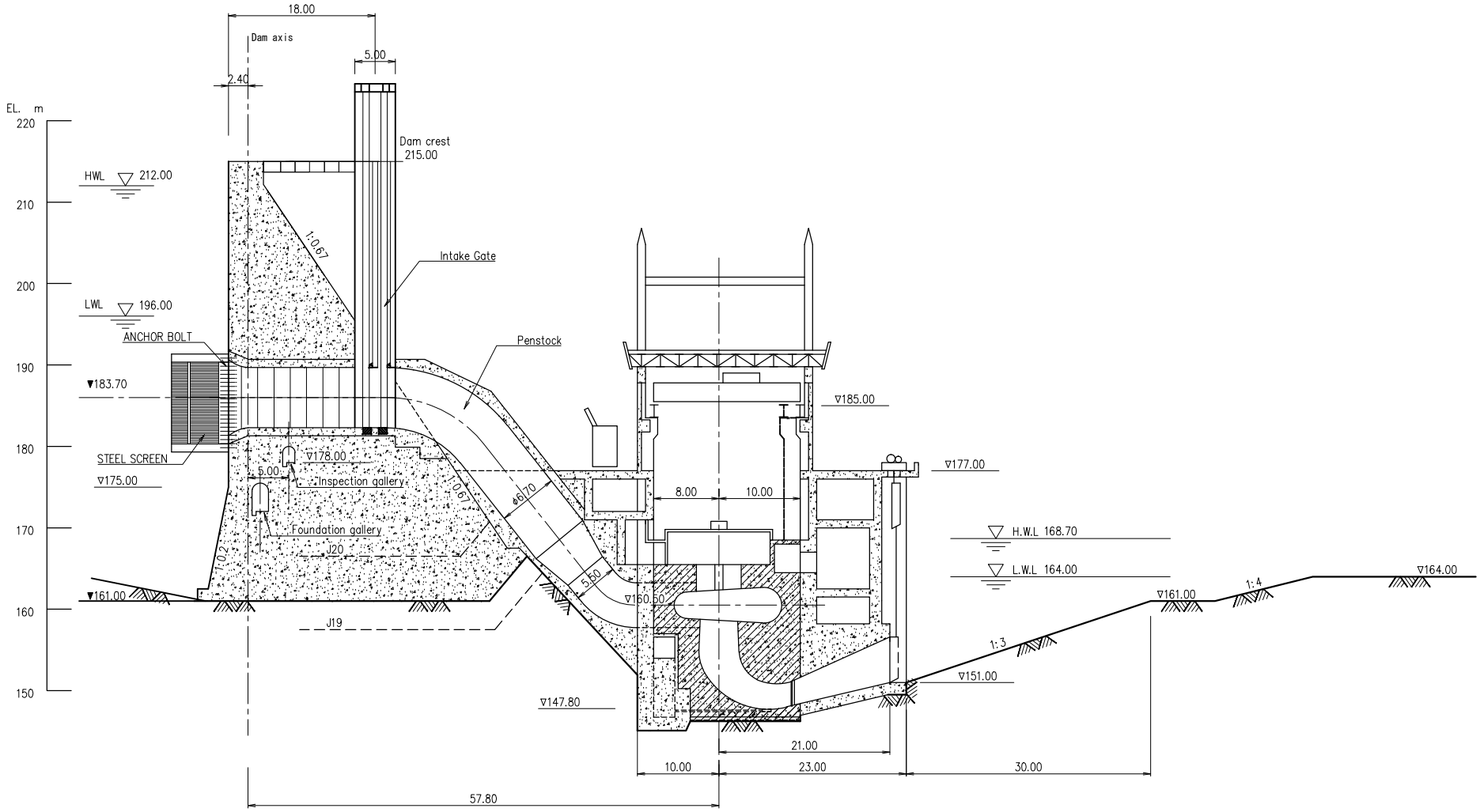


PROFILE

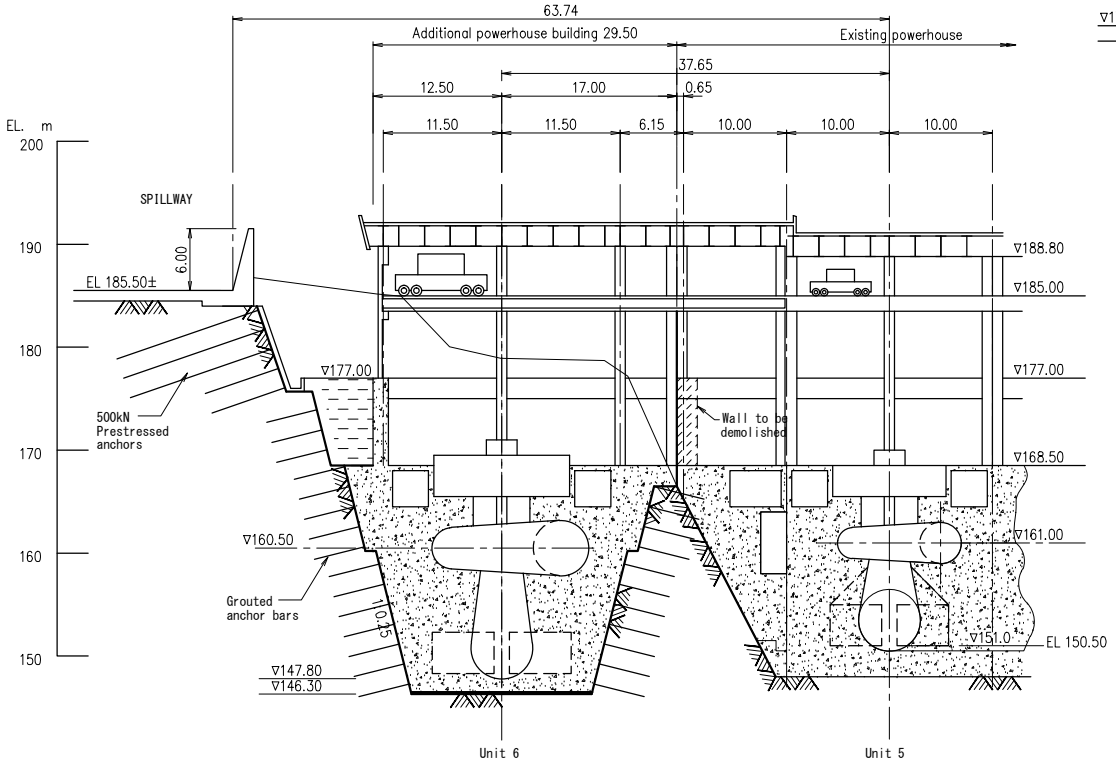
0 10 20 30M

SCALE

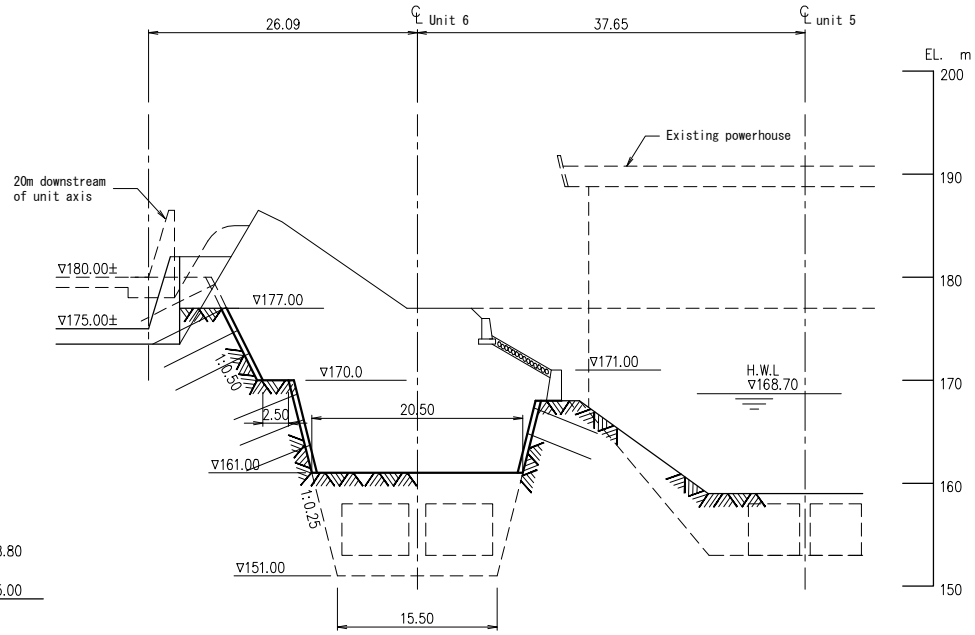
PLAN A2
(60 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

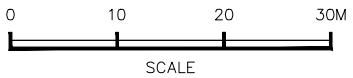
Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	Alternative Plan A2 Profile	A2(2)
		Date: August 2012



SECTION A-A



SECTION B-B



PLAN A2
(60 MW)

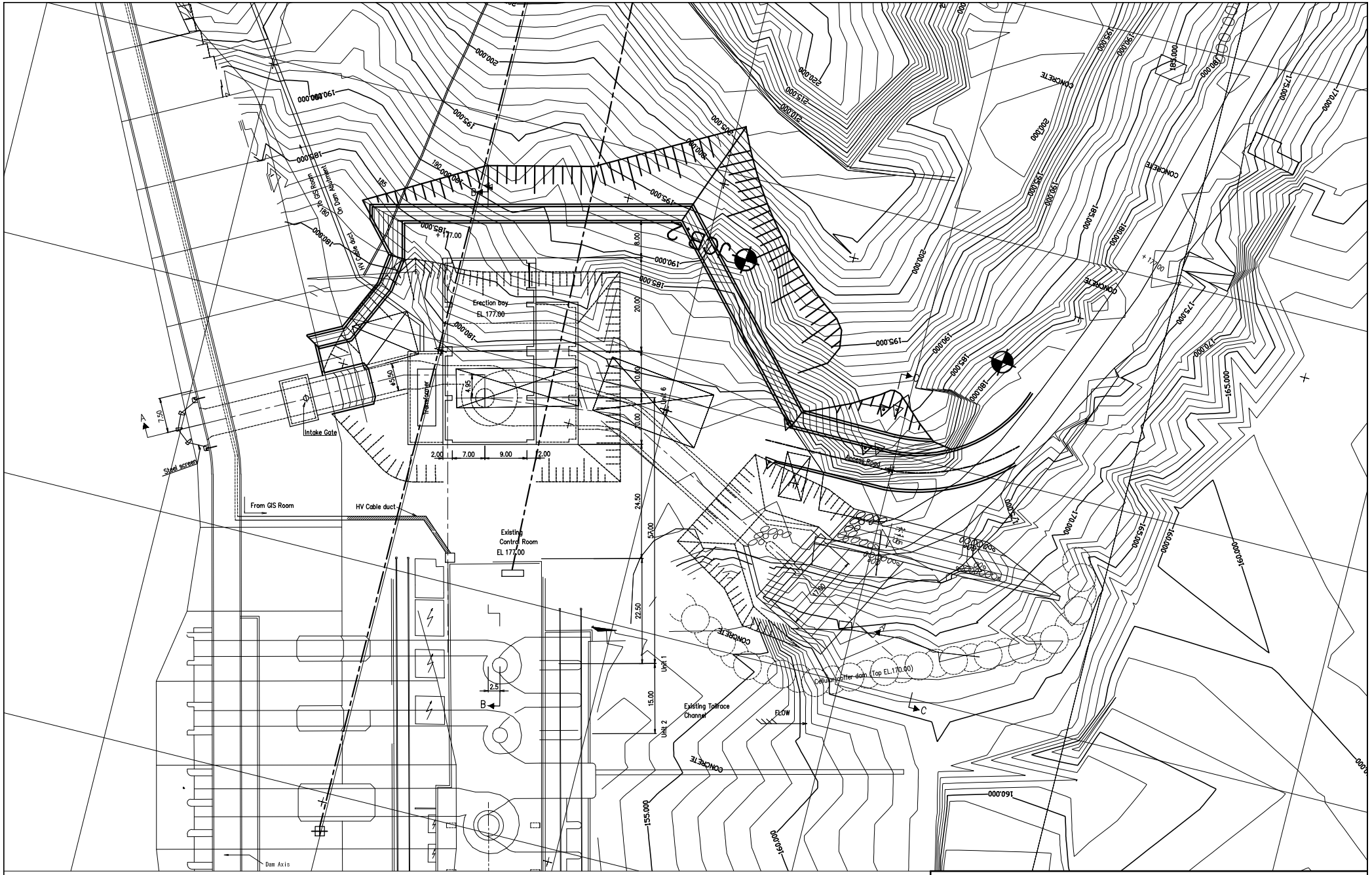
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / J-POWER

Drawing Title: Alternative Plan A2 Sections

Drawing No: A2(3)

Date: August 2012



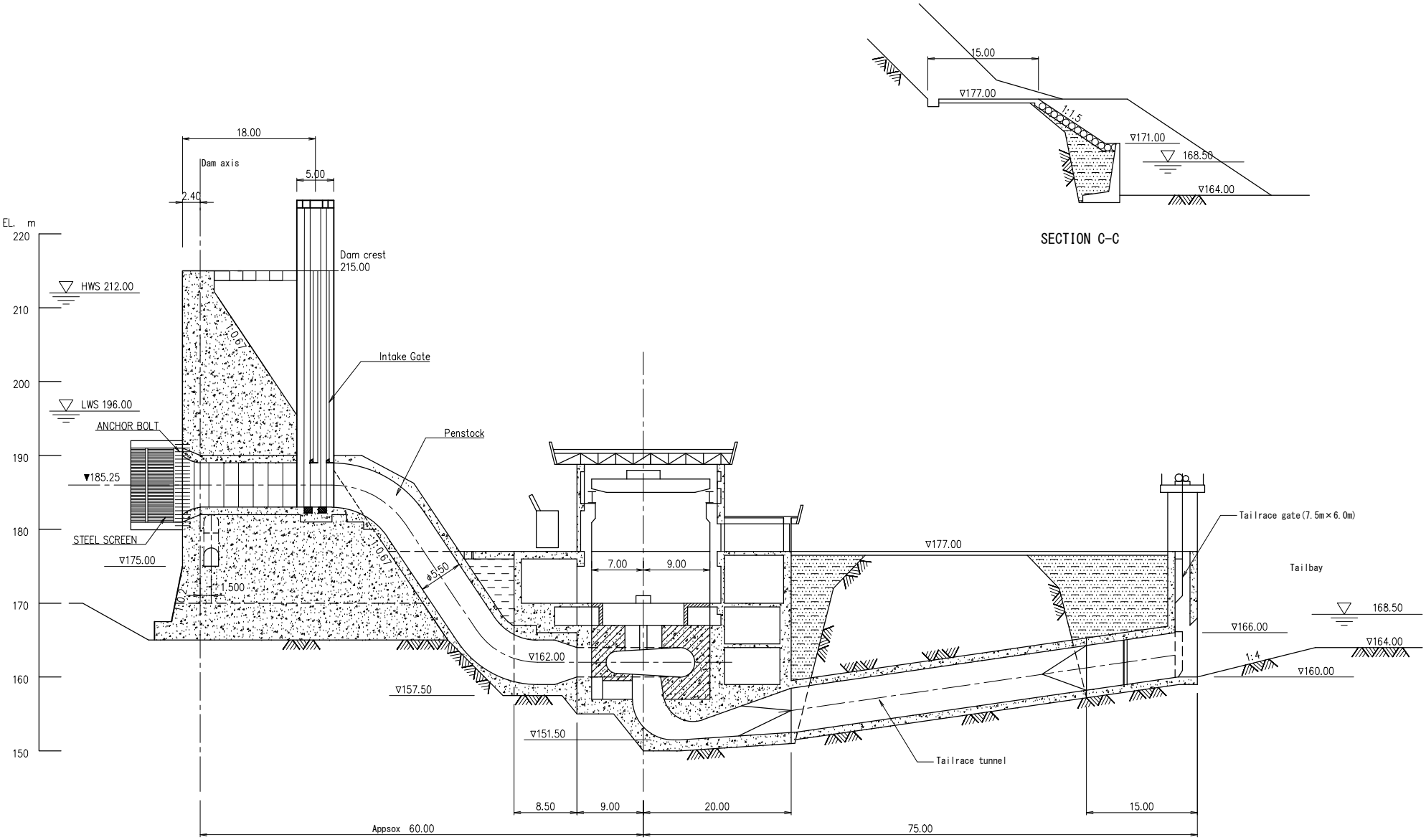
0 10 20 30M

SCALE

PLAN A4-1
(40 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	Alternative Plan A4-1 Plan	A4-1(1)
		Date: August 2012



PROFILE (SECTION A-A)

0 10 20 30M

SCALE

PLAN A4-1
(40 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER

Drawing Title: Alternative Plan A4-1 Profile

Drawing No: A4-1(2)

Date: August 2012

PLAN A4-4
(60 MW)

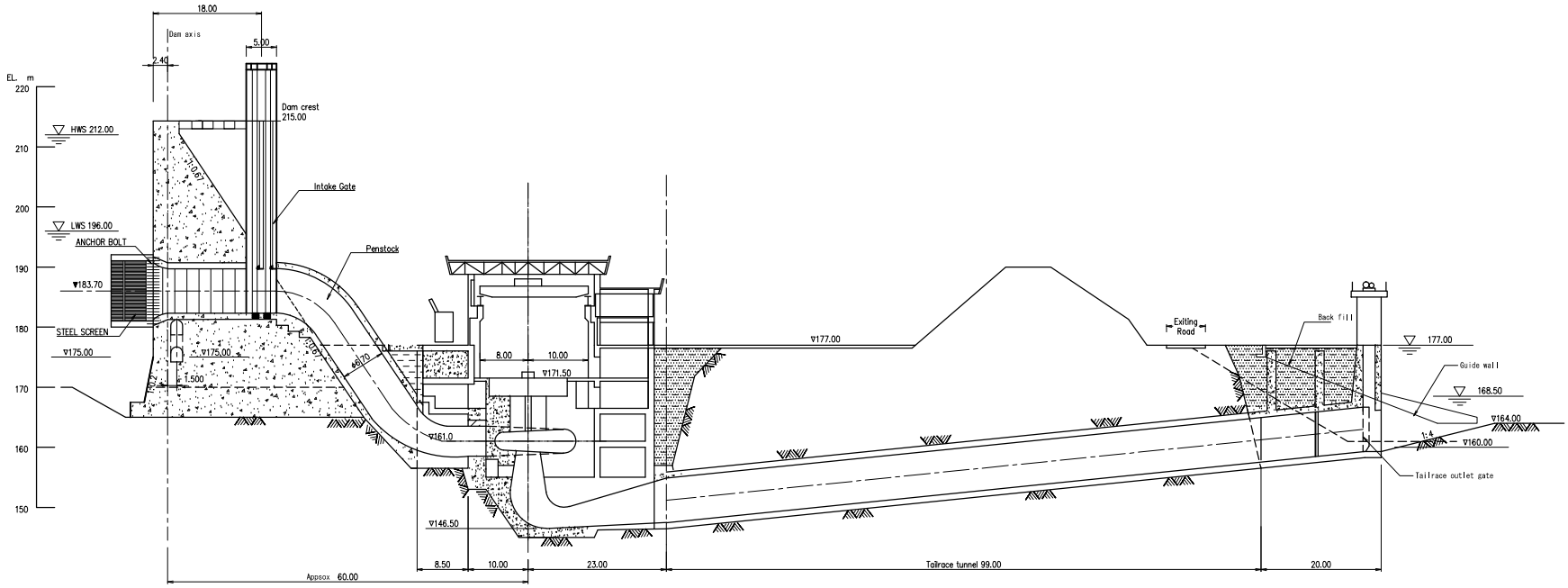
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI, J-POWER

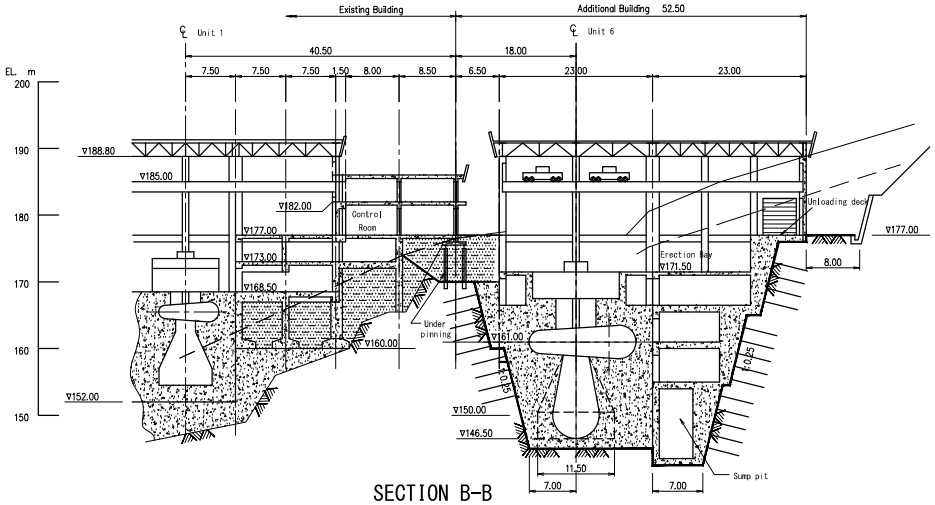
Drawing Title: Alternative Plan A4-4 Plan

Drawing No: A4-4(1)

Date: August 2012



PROFILE (SECTION A-A)



SECTION B-B

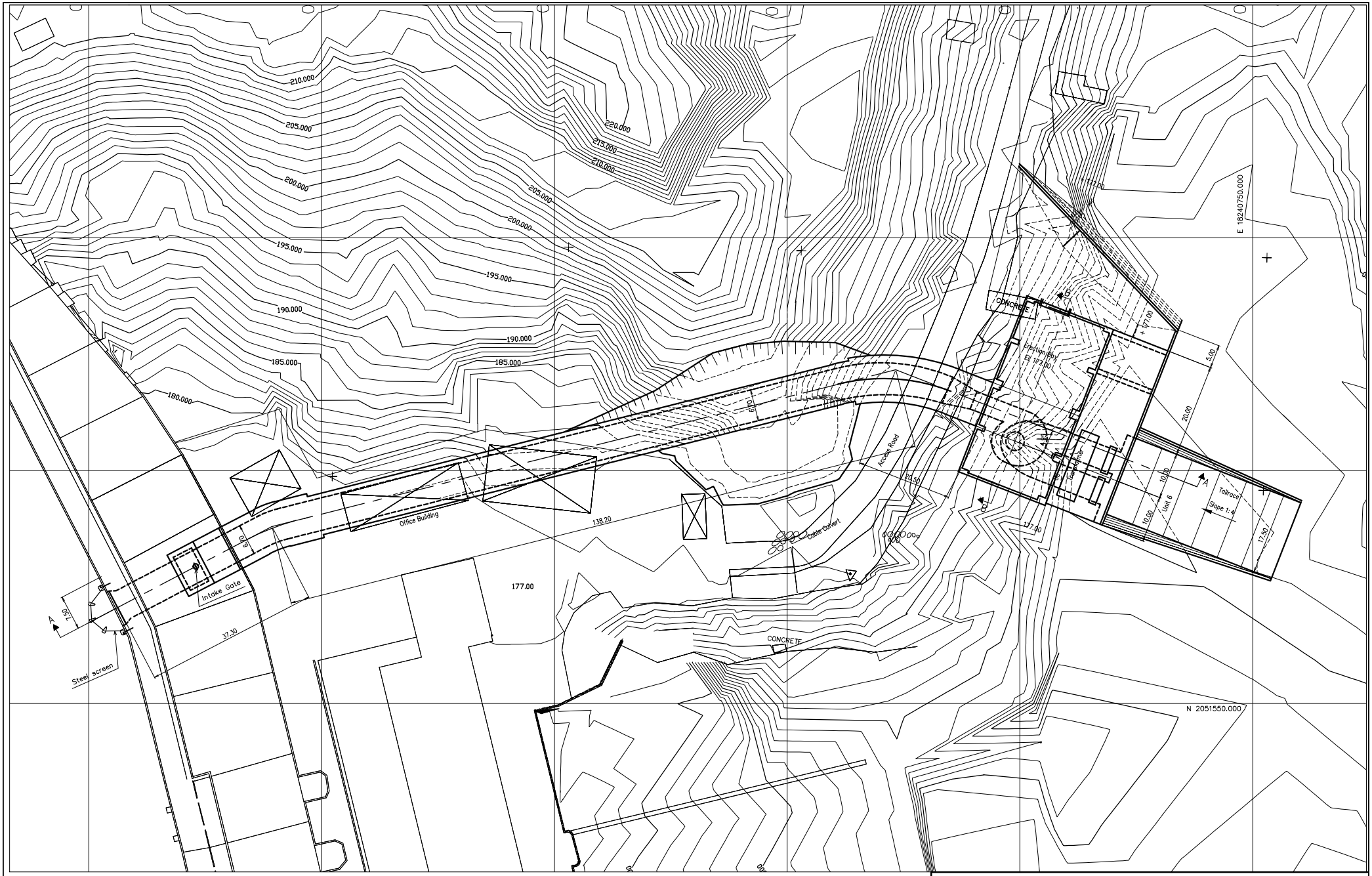
0 10 20 30M

SCALE

PLAN A4-4
(60 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	Alternative Plan A4 Sections	A4-4(2)
		Date: August 2012



PLAN B2'-2-1

(60 MW)

0 10 20 30M

SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY

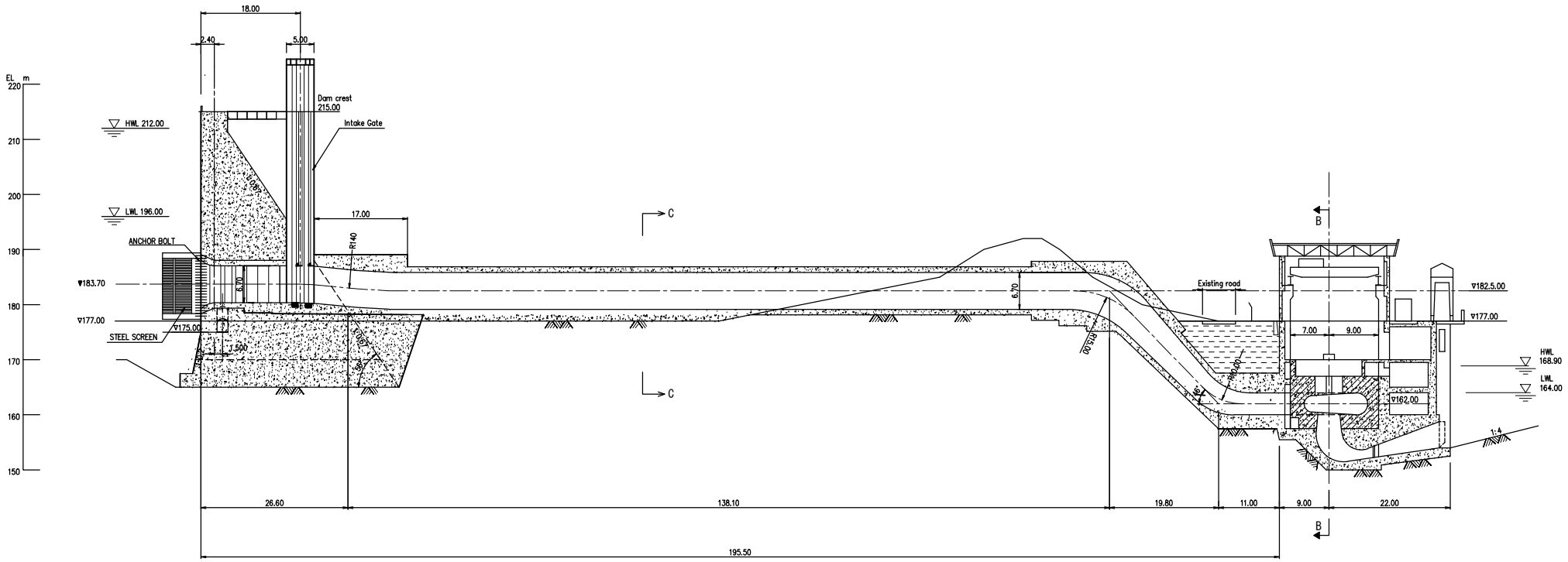
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI, J-POWER

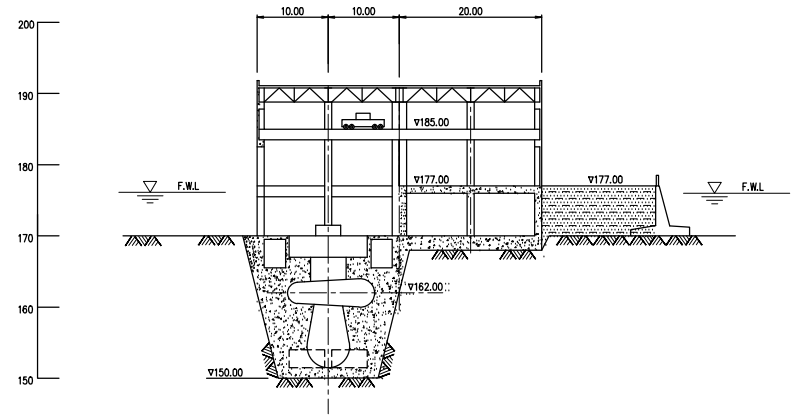
Drawing Title: Alternative Plan B2'-2-1 Plan

Drawing No: B2'-2-1(1)

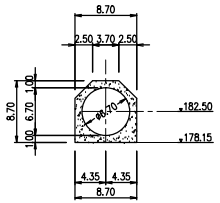
Date: August 2012



PROFILE (SECTION A-A)



SECTION B-B



TYPICAL SECTION C-C

0 10 20 30M

SCALE

PLAN B2'-2-1

(60 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Alternative Plan B2'-2-1 Profile (Section)	B2'-2-1(2)
		Date: August 2012

PLAN B2'–2

(120 MW)

0 10 20 30M

SCALE

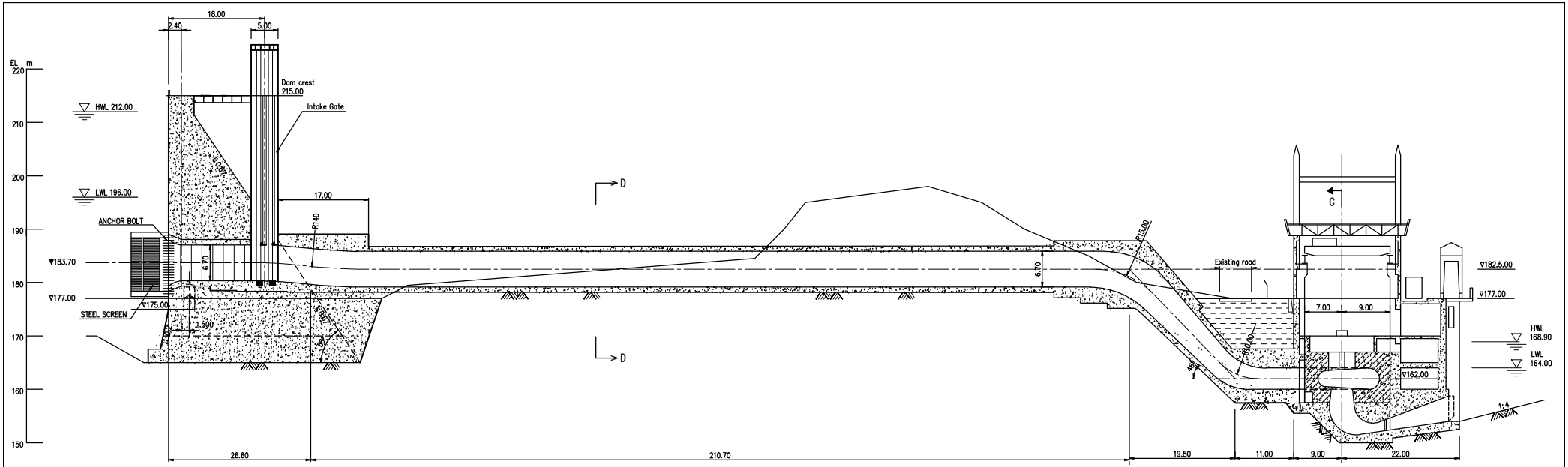
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI, J-POWER

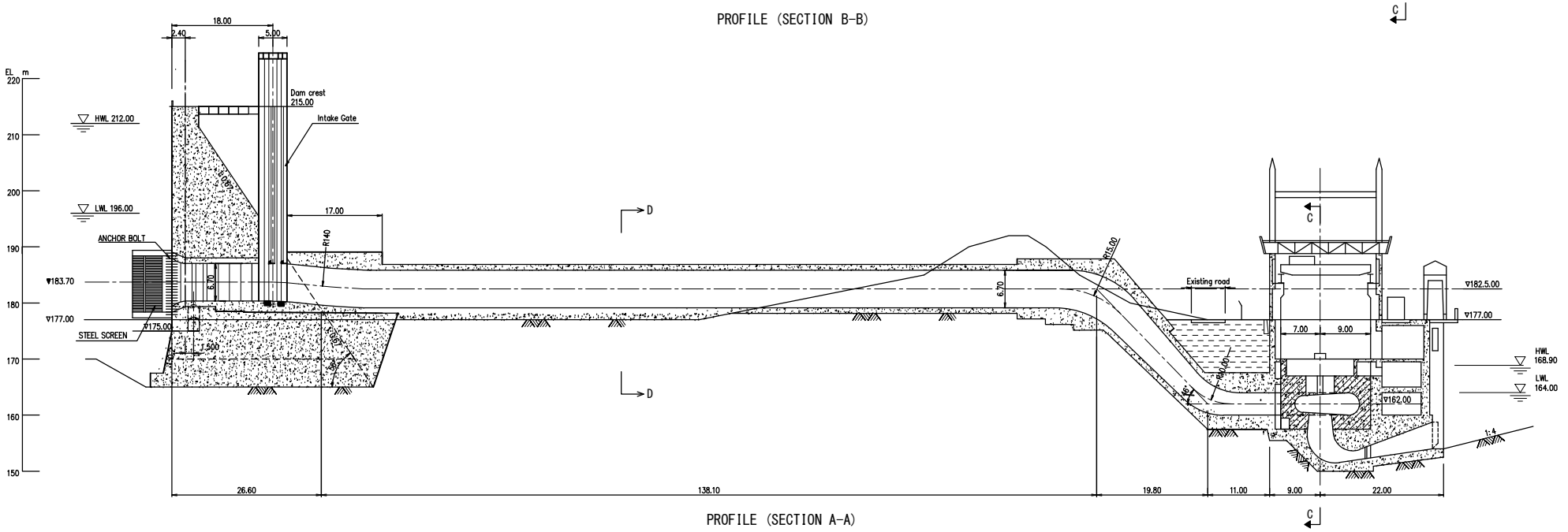
Drawing Title: Alternative Plan B2'-2 Plan

Drawing No: B2'-2(1)

Date: August 2012



PROFILE (SECTION B-B)



PROFILE (SECTION A-A)

0 10 20 30M

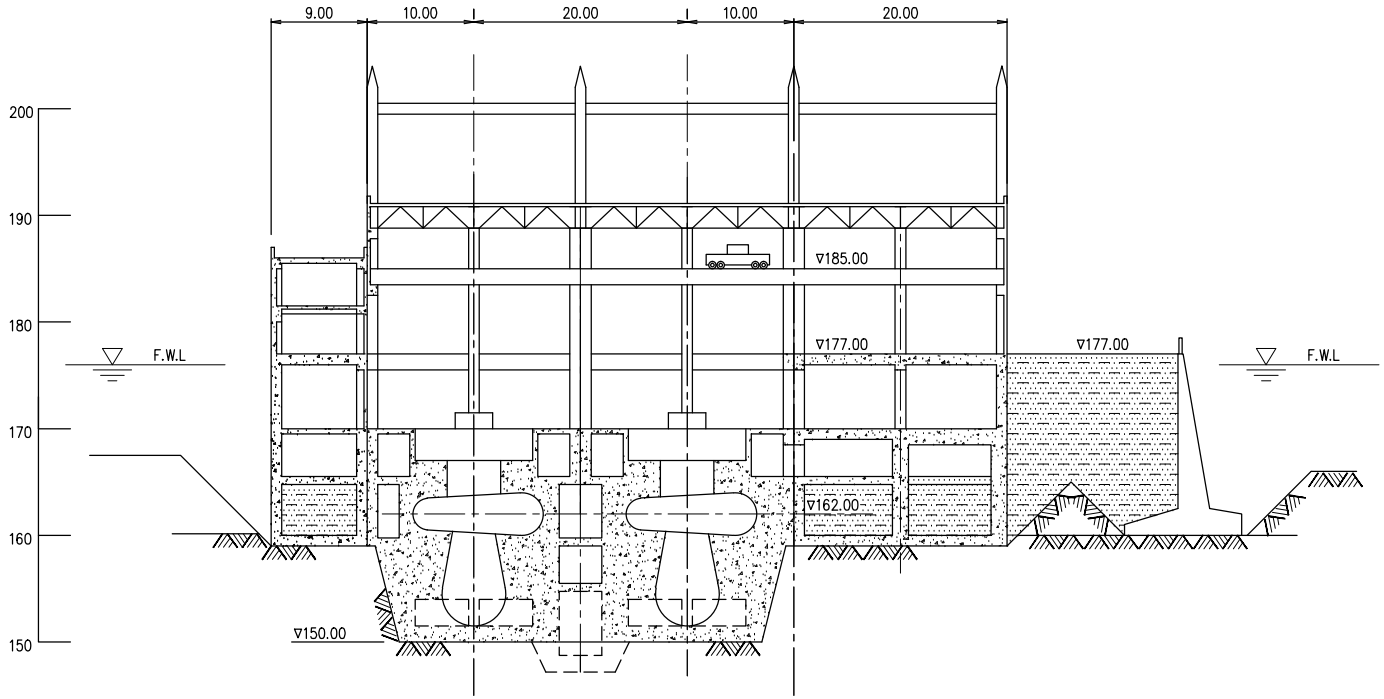
SCALE

PLAN B2'-2

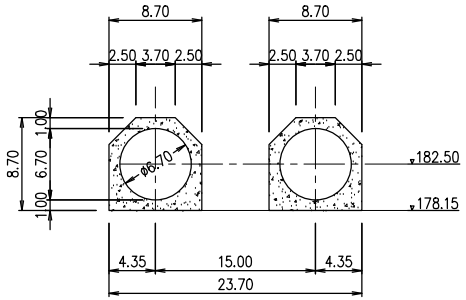
(120 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

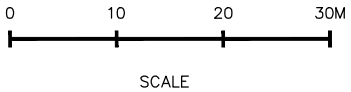
Prepared by: NIPPON KOEI / POWER	Drawing Title: Alternative Plan B2'-2 Profile	Drawing No: B2'-2(2)
		Date: August 2012



SECTION C-C



TYPICAL SECTION D-D



PLAN B2'-2
(120 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

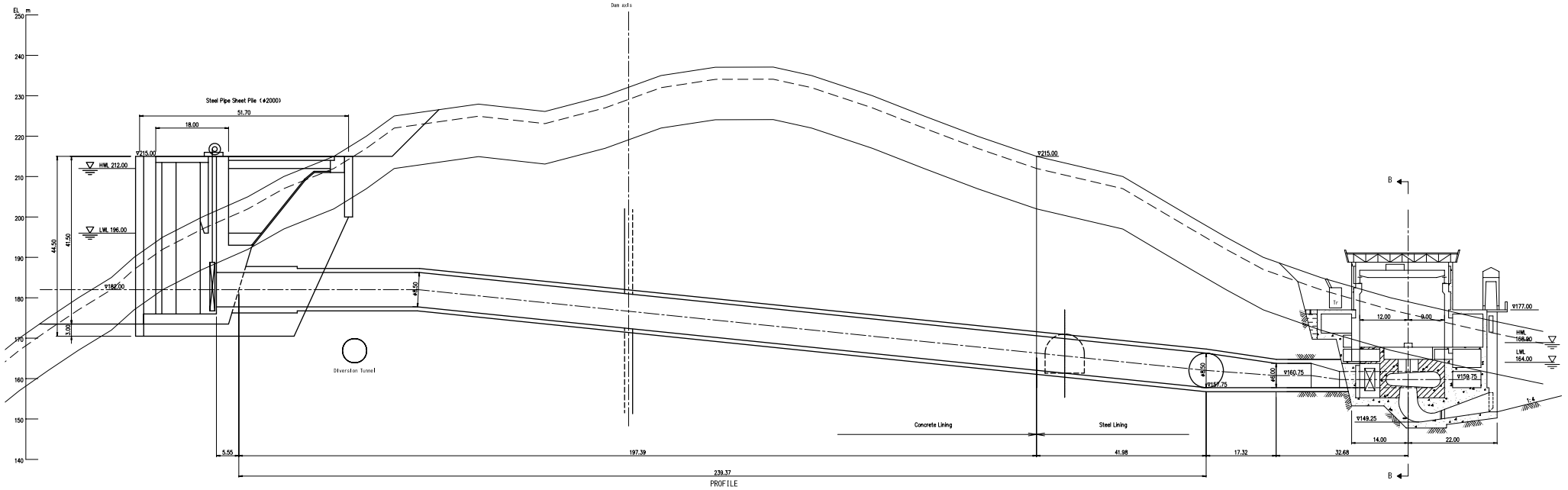
Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI J-POWER	Alternative Plan B2'-2 Profile	B2'-2(3)
		Date: August 2012

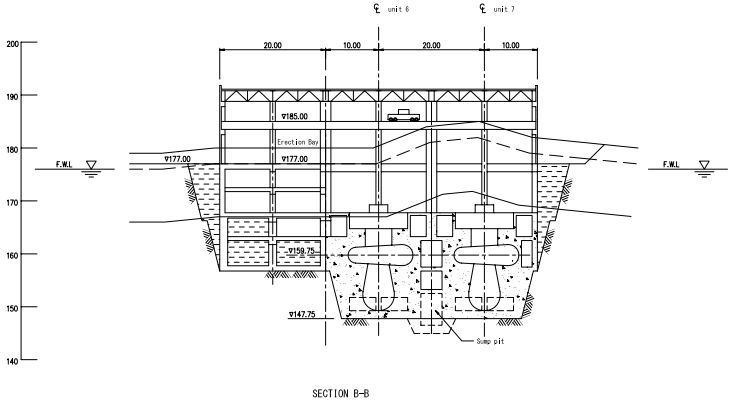
PLAN D2–3
(80 MW)

0 10 20 30M
SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Alternative Plan D2-3 Plan	D2-3(1)
		Date: June 2009





SECTION B-B

0 10 20 30M
SCALE

PLAN D2-3
(80 MW)

JAPAN INTERNATIONAL COOPERATION AGENCY PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION IN LAO PEOPLE'S DEMOCRATIC REPUBLIC		
Prepared by: NIPPON KOEI POWER	Drawing Title: Alternative Plan D2-3 Profile and Sections	Drawing No: D2-3(2) Date: June 2009

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A1 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Preparation of access on the existing draft tube deck	LS			10,632
	b) Relocation of gantry cranes (dam crest & draft tube)	LS			21,264
	Sub-total				31,896
A2	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,622,140
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	1,450	341	494,450
3	Concrete (above El. 177m)	m3	1,130	198	223,740
4	Re-bars	t	48	1,673	80,304
5	Gate tower	No.	1	1,463,354	1,463,354
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			872,557
	Sub-total				9,598,130
A3	**Powerhouse and Tailrace**				
1	Temporary works				
	a) Tailrace coffer structure (incl. grouting and rock anchoring)	LS			65,918
	b) Trestle at EL. 177 m for muck loading	LS			299,333
2	Excavation				
	a) Open excavation, rock, above El. 168m	m3	39,000	13	507,000
	b) Pit excavation, rock, below El. 168m	m3	24,000	40	960,000
	d) Underwater excavation, rock, outside coffer	m3	2,500	42	105,000
	e) Demolition of existing reinforced conc.	m3	400	59	23,600
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	4,300	22	94,600
	b) Shotcrete on cut slope	m3	540	819	442,260
4	Backfill with free draining materials	m3	4,000	7	28,000
5	Cut slope stabilization (spillway side)	LS			148,848
6	Concrete (incl. formwork cost)				
	a) Penstock below El. 177 m	m3	770	198	152,460
	b) Powerhouse	m3	13,100	265	3,471,500
	c) Tailrace	m3	1,100	272	299,200
7	Re-bars	t	840	1,673	1,405,320
8	Steel structures (roof truss, crane beams)	t	98	4,784	468,832
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			404,016
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			266,277
	Sub-total				9,142,164
A4	**Roof Switchyard**				
1	Concrete	m3	30	280	8,400
2	Re-bars	t	2.0	1,673	3,346
3	Miscellaneous works	LS			1,175
	Sub-total				12,921
A5	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			2,683,587

Cost Estimate for Comparison of Alternatives

Plan A1 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
	Total of A				21,500,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	43	7,000	301,000
2	Stoplog	t	18	7,442	133,963
3	Intake gate and hoist	t	57	9,569	545,422
4	Penstock steel pipe	t	100	7,442	744,240
	Sub-total				1,724,625
B2	**Draft Tube Stoplog Facility**				
1	Gantry crane rails & cable extension	LS			31,896
	Sub-total				31,896
	Total of B				1,800,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			7,639,915
2	Generator and auxiliaries	LS			8,734,533
3	Transformers	LS			1,526,113
4	Indoor switchgear	LS			884,038
5	Outdoor switchyard equipment	LS			514,173
6	Control and protection equipment	LS			602,118
7	Auxiliary equipment	LS			281,423
8	Miscellaneous materials	LS			285,284
	Sub-total				20,467,597
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				20,700,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			6,600,000
	Total of D				6,600,000
Grand Total					50,600,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A4-1 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary buildings for power station O&M staff including guard room	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,532
	Sub-total				95,442
A3	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,622,140
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	1,500	341	511,500
3	Concrete (including formwork cost)	m3	1,190	198	235,620
4	Re-bars	t	49	1,673	81,977
5	Gate tower	No.	1	1,463,354	1,463,354
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			875,618
	Sub-total				9,631,794
A4	**Powerhouse**				
1	Under-pinning of existing control building columns	LS			318,960
2	Excavation				
	a) Open excavation above El. 168m(loose)	m3	9,000	6	54,000
	b) Open excavation above El. 168m(rock)	m3	34,000	13	442,000
	c) Pit excavation (rock) below El. 168m	m3	20,000	29	580,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	3,100	22	68,200
	b) Shotcrete on cut slope	m3	590	819	483,210
4	Backfill with free draining materials	m3	12,000	7	84,000
5	Concrete of powerhouse building	m3	19,000	265	5,035,000
6	Concrete of cable duct to GIS room	m3	100	272	27,200
7	Re-bars	t	1,450	1,673	2,425,850
8	Steel structures (roof truss, crane beam)	t	140	4,784	669,816
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			525,221
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			321,404
	Sub-total				11,034,861
A5	**Tailrace**				
1	Temporary works				
	a) Tailrace cellular cofferdam	LS			637,920
	b) Access road to outlet bottom	LS			58,476
2	Excavation				
	a) Open excavation (loose material)	m3	4,000	6	24,000
	b) Open excavation (rock)	m3	17,400	13	226,200
	c) Underwater excavation during coffer removal	m3	1,500	42	63,000
	d) Tunnel excavation for tailrace tunnel	m3	2,200	163	358,600
3	Rock support and slope protection				
	a) Rock bolts	m	1,000	22	22,000

Cost Estimate for Comparison of Alternatives

Plan A4-1 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
	b) Shotcrete	m3	180	819	147,420
4	Backfill with free draining materials	m3	6,600	7	46,200
5	Concrete				
	a) Tunnel lining	m3	520	300	156,000
	b) Outlet structure	m3	2,500	272	680,000
6	Re-bars	t	120	1,673	200,760
7	Consolidation grouting	m	225	70	15,750
8	Miscellaneous works	LS			79,090
	Sub-total				2,715,416
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			3,355,449
	Total of A				26,800,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	43	7,000	301,000
2	Stoplog	t	18	7,442	133,963
3	Intake gate and hoist	t	57	9,569	545,422
4	Penstock steel pipe	t	100	7,442	744,240
	Sub-total				1,724,625
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	56	10,632	595,392
	Sub-total				595,392
	Total of B				2,300,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			8,171,608
2	Generator and auxiliaries	LS			8,956,819
3	Transformers	LS			1,442,752
4	Indoor switchgear	LS			707,316
5	Outdoor switchyard equipment	LS			2,987,653
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			723,400
8	Miscellaneous materials	LS			535,363
	Sub-total				24,185,450
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				24,400,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			8,030,000
	Total of D				8,000,000
Grand Total					61,500,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A4-3 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary buildings for power station O&M staff including guard room	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,532
	Sub-total				95,442
A3	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,622,140
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	1,500	341	511,500
3	Concrete (including formwork cost)	m3	1,190	198	235,620
4	Re-bars	t	49	1,673	81,977
5	Gate tower	No.	1	1,463,354	1,463,354
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			875,618
	Sub-total				9,631,794
A4	**Powerhouse**				
1	Under-pinning of existing control building columns	LS			318,960
2	Excavation				
	a) Open excavation above El. 168m(loose)	m3	9,000	6	54,000
	b) Open excavation above El. 168m(rock)	m3	34,000	13	442,000
	c) Pit excavation (rock) below El. 168m	m3	21,000	29	609,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	3,100	22	68,200
	b) Shotcrete on cut slope	m3	570	819	466,830
4	Backfill with free draining materials	m3	12,000	7	84,000
5	Concrete of powerhouse building	m3	19,000	265	5,035,000
6	Concrete of cable duct to GIS room	m3	100	272	27,200
7	Re-bars	t	1,450	1,673	2,425,850
8	Steel structures (roof truss, crane beam)	t	140	4,784	669,760
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			525,221
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			321,781
	Sub-total				11,047,802
A5	**Tailrace**				
1	Temporary cofferdam and access road	LS			120,000
2	Excavation				
	a) Open excavation (loose material)	m3	4,200	6	25,200
	b) Open excavation (rock)	m3	4,200	13	54,600
	c) Tunnel excavation for tailrace tunnel	m3	5,700	163	929,100
3	Rock support and slope protection				
	a) Rock bolts	m	1,400	22	30,800
	b) Shotcrete	m3	330	819	270,270
4	Backfill with free draining materials	m3	5,400	7	37,800
5	Concrete				

Cost Estimate for Comparison of Alternatives

Plan A4-3 (40MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
	a) Tunnel lining	m3	2,370	300	711,000
	b) Outlet structure	m3	1,330	272	361,760
6	Re-bars	t	161	1,673	269,353
7	Consolidation grouting	m	520	70	36,400
8	Miscellaneous works	LS			81,788
	Sub-total				2,928,071
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			3,387,677
	Total of A				27,100,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	43	7,000	301,000
2	Stoplog	t	18	7,442	133,963
3	Intake gate and hoist	t	57	9,569	545,422
4	Penstock steel pipe	t	100	7,442	744,240
	Sub-total				1,724,625
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	56	10,632	595,392
	Sub-total				595,392
	Total of B				2,300,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			8,171,608
2	Generator and auxiliaries	LS			8,956,819
3	Transformers	LS			1,442,752
4	Indoor switchgear	LS			707,316
5	Outdoor switchyard equipment	LS			2,987,653
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			723,400
8	Miscellaneous materials and services	LS			535,363
	Sub-total				24,185,450
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				24,400,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			8,070,000
	Total of D				8,100,000
Grand Total					61,900,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan B2'-1-1 (40 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary office building for power station O&M (civil) staff	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (220 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,532
	Sub-total				95,442
A3	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,622,140
	b) Platform for dam penetration work	LS			27,408
2	Concrete excavation for dam penetration	m3	1,500	341	511,500
3	Concrete (including formwork cost)	m3	1,190	198	235,620
4	Re-bars	t	49	1,673	81,977
5	Gate tower	No.	1	1,585,618	1,585,618
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			806,426
	Sub-total				8,870,689
A4	**Penstock**				
1	Excavation				
	a) Open excavation (loose materials)	m3	500	6	3,000
	b) Open excavation (Rock)	m3	6,000	13	78,000
2	Rock support and slope protection				
	a) Rock bolts	m	180	22	3,960
	b) Shotcrete	m3	200	819	163,800
3	Concrete				
	a) Concrete for cover pipe	m3	5,700	172	980,400
5	Re-bars	t	180	1,673	301,140
8	Miscellaneous works	LS			45,909
	Sub-total				1,576,209
A5	**Powerhouse and Tailrace**				
1	Temporary cofferdam & access road	LS			318,960
2	Excavation				
	a) Open excavation, loose materials	m3	7,800	6	46,800
	b) Open excavation, rock	m3	18,000	13	234,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	280	22	6,160
	b) Shotcrete on cut slope	m3	140	819	114,660
4	Backfill with free draining materials	m3	12,600	7	88,200
5	Concrete				
	a) Powerhouse building	m3	13,600	265	3,604,000
	b) Tailrace wall and retaining wall	m3	1,450	272	394,400
	c) HV cable culvert and duct	m3	190	272	51,680
6	Re-bars	t	1,100	1,673	1,840,300
7	Steel structures (roof truss, crane beam)	t	110	4,784	526,240
8	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			1,414,056

Cost Estimate for Comparison of Alternatives

Plan B2'-1-1 (40 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
9	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			259,184
	Sub-total				8,898,640
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			2,778,802
	Total of A				22,200,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	43	7,000	301,000
2	Stoplog	t	12	7,442	89,309
3	Intake gate and hoist	t	57	9,569	545,422
4	Penstock steel pipe	t	470	6,379	2,998,224
	Sub-total				3,933,954
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	56	10,632	560,000
	Sub-total				560,000
	Total of B				4,500,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			8,171,609
2	Generator and auxiliaries	LS			8,956,818
3	Transformers	LS			1,442,752
4	Indoor switchgear	LS			707,316
5	Outdoor switchyard equipment	LS			2,987,653
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			723,399
8	Miscellaneous materials	LS			535,363
	Sub-total				24,185,450
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				24,400,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			7,670,000
	Total of D				7,700,000
Grand Total					58,800,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A2 (60MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Preparation of access on the existing draft tube deck	LS			10,632
	b) Relocation of existing equipment (intake and draft tube gantry cranes)	LS			21,264
	Sub-total				31,896
A2	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,816,584
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	2,100	341	716,100
3	Concrete (above El. 177 m)	m3	1,600	198	316,800
4	Re-bars	t	64	1,673	107,072
5	Gate Tower	No.	1	1,808,459	1,808,459
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			779,814
	Sub-total				10,386,414
A3	**Powerhouse and Tailrace**				
1	Temporary works				
	a) Tailrace coffer structure (incl. grouting and anchoring)	LS			95,688
	a) Trestle at EL. 177 m for muck loading	LS			299,333
2	Excavation				
	a) Open excavation, rock, above El. 168m	m3	50,000	13	650,000
	b) Pit excavation, rock, below El. 168m	m3	32,000	40	1,280,000
	d) Underwater excavation, rock, outside coffer	m3	3,400	42	142,800
	e) Demolition of existing reinforced conc.	m3	490	59	28,910
3	Removal of existing roof (Columns 17 to 18)	LS			50,000
4	Slope protection and rock support				
	a) Rock bolts on cut slope	m	7,300	22	160,600
	b) Shotcrete on cut slope	m3	710	819	581,490
5	Backfill with free draining materials	m3	4,600	7	32,200
6	Cut slope stabilization (spillway side)	LS			265,800
7	Concrete (incl. formwork cost)				
	a) Penstock below El. 177 m	m3	950	198	188,100
	b) Powerhouse	m3	18,500	265	4,902,500
	c) Tailrace	m3	1,500	272	408,000
8	Re-bars	t	1,170	1,673	1,957,410
9	Steel structures (roof truss, crane beam)	t	200	4,784	956,880
10	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			606,024
11	Miscellaneous works (metal works, earthing, paving, landscaping, etc.)	LS			378,172
	Sub-total				12,983,907
A4	**Roof Switchyard**				
1	Concrete	m3	50	272	13,600
2	Re-bars	t	3.0	1,673	5,019
3	Miscellaneous works	LS			1,757
	Sub-total				20,376

Cost Estimate for Comparison of Alternatives | **Plan A2 (60MW)**

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A5	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			3,346,085
	Total of A				26,800,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	63	7,000	441,000
2	Stoplog	t	24	7,442	178,618
3	Intake gate and hoist	t	73	11,695	853,750
4	Penstock steel pipe	t	150	7,442	1,116,360
	Sub-total				2,589,727
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	80	10,632	850,560
	Sub-total				850,560
	Total of B				3,400,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			11,378,877
2	Generator and auxiliaries	LS			13,008,400
3	Transformers	LS			2,189,845
4	Indoor switchgear	LS			655,339
5	Outdoor switchyard equipment	LS			534,527
6	Control and protection equipment	LS			504,609
7	Auxiliary equipment	LS			1,013,693
8	Miscellaneous materials	LS			667,163
	Sub-total				29,952,453
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				30,100,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			9,050,000
	Total of D				9,100,000
Grand Total					69,400,000

	Decrease of energy production due to 3 month stoppage of Unit 5 during renewing of roof on spillway side of existing powerhouse.	LS			4,000,000
	Total				**73,400,000**

8.96	cents/kWh (tariff)
3	month stoppage
50.5	% plant factor (dry seasons)
3,909,427	US$ reduction
3,909,000	Rounded US$ reduction

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A4-2 (60MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary buildings for power station O&M staff including guard room	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,532
	Sub-total				95,442
A3	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,816,584
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	2,170	341	739,970
3	Concrete	m3	1,680	198	332,640
4	Re-bars	t	66	1,673	110,418
5	Gate Tower	Nos	1	1,808,459	1,808,459
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			964,966
	Sub-total				10,614,622
A4	**Powerhouse**				
1	Under-pinning of existing control building columns	LS			318,960
2	Excavation				
	a) Open excavation above El. 168m(loose)	m3	10,000	6	60,000
	b) Open excavation above El. 168m(rock)	m3	55,000	13	715,000
	c) Pit excavation (rock) below El. 168m	m3	34,000	29	986,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	4,100	22	90,200
	b) Shotcrete on cut slope	m3	890	819	728,910
4	Backfill with free draining materials	m3	17,000	7	119,000
5	Concrete of powerhouse building	m3	27,000	265	7,155,000
6	Concrete of cable duct to GIS room	m3	300	272	81,600
7	Re-bars	t	2,280	1,673	3,814,440
8	Steel structures (roof truss, crane beam)	t	220	4,784	1,052,480
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			808,032
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			477,889
	Sub-total				16,407,511
A5	**Tailrace**				
1	Temporary works				
	a) Tailrace cellular cofferdam	LS			637,920
	b) Access road to outlet bottom	LS			58,476
2	Excavation				
	a) Open excavation (loose material)	m3	4,700	6	28,200
	b) Open excavation (rock)	m3	19,800	13	257,400
	c) Underwater excavation during coffer removal	m3	1,500	42	63,000
	d) Tunnel excavation for tailrace tunnel	m3	2,200	163	358,600
3	Rock support and slope protection				
	a) Rock bolts	m	1,240	22	27,280
	b) Shotcrete	m3	220	819	180,180

Cost Estimate for Comparison of Alternatives

Plan A4-2 (60MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
3	Backfill with free draining materials	m3	8,200	7	57,400
4	Concrete				
	a) Tunnel lining	m3	470	300	141,000
	b) Outlet structure	m3	3,100	272	843,200
5	Re-bars	t	140	1,673	234,220
6	Consolidation grouting	m	200	70	14,000
7	Miscellaneous works	LS			87,026
	Sub-total				2,987,902
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			4,302,301
	Total of A				34,400,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	63	7,000	441,000
2	Stoplog	t	24	7,442	178,618
3	Intake gate and hoist	t	73	11,695	853,750
4	Penstock steel pipe	t	150	7,442	1,116,360
	Sub-total				2,589,727
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	80	10,632	850,560
	Sub-total				850,560
	Total of B				3,400,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			11,378,877
2	Generator and auxiliaries	LS			13,008,400
3	Transformers	LS			2,189,845
4	Indoor switchgear	LS			733,304
5	Outdoor switchyard equipment	LS			2,989,342
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			1,013,693
8	Miscellaneous materials	LS			724,754
	Sub-total				32,698,754
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				32,900,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			10,610,000
	Total of D				10,600,000
Grand Total					81,300,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan A4-4 (60MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary buildings for power station O&M staff including guard room	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,532
	Sub-total				95,442
A3	**Intake and Penstock**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,816,584
	b) Platform for dam penetration work	LS			841,585
2	Concrete excavation for dam penetration	m3	2,170	341	739,970
3	Concrete (including formwork cost)	m3	1,680	198	332,640
4	Re-bars	t	66	1,673	110,418
5	Gate tower	Nos	1	1,808,459	1,808,459
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			964,966
	Sub-total				10,614,622
A4	**Powerhouse**				
1	Under-pinning of existing control building columns	LS			318,960
2	Excavation				
	a) Open excavation above El. 168m(loose)	m3	10,000	6	60,000
	b) Open excavation above El. 168m(rock)	m3	52,000	13	676,000
	c) Pit excavation (rock) below El. 168m	m3	33,000	29	957,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	3,800	22	83,600
	b) Shotcrete on cut slope	m3	640	819	524,160
4	Backfill with free draining materials	m3	15,000	7	105,000
5	Concrete of powerhouse building	m3	27,000	265	7,155,000
6	Concrete of cable duct to GIS room	m3	300	272	81,600
7	Re-bars	t	2,280	1,673	3,814,440
8	Steel structures (roof truss, crane beam)	t	220	4,784	1,052,480
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			808,032
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			469,088
	Sub-total				16,105,360
A5	**Tailrace**				
1	Temporary cofferdam and access road	LS			120,000
2	Excavation				
	a) Open excavation (loose material)	m3	5,000	6	30,000
	b) Open excavation (rock)	m3	5,000	13	65,000
	c) Tunnel excavation for tailrace tunnel	m3	7,300	163	1,189,900
3	Rock support and slope protection				
	a) Rock bolts	m	2,000	22	44,000
	b) Shotcrete	m3	380	819	311,220
4	Backfill with free draining materials	m3	16,000	7	112,000

Cost Estimate for Comparison of Alternatives

Plan A4-4 (60MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
5	Concrete				
	a) Tunnel lining	m3	3,200	300	960,000
	b) Outlet structure	m3	1,800	272	489,600
6	Re-bars	t	86	1,673	143,878
7	Consolidation grouting	m	600	70	42,000
8	Miscellaneous works	LS			101,628
	Sub-total				3,609,226
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			4,348,000
	Total of A				34,800,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	63	7,000	441,000
2	Stoplog	t	24	7,442	178,618
3	Intake gate and hoist	t	73	11,695	853,750
5	Penstock steel pipe	t	150	7,442	1,116,360
	Sub-total				2,589,727
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	80	10,632	850,560
	Sub-total				850,560
	Total of B				3,400,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			11,378,877
2	Generator and auxiliaries	LS			13,008,400
3	Transformers	LS			2,189,845
4	Indoor switchgear	LS			733,304
5	Outdoor switchyard equipment	LS			2,989,342
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			1,013,693
8	Miscellaneous materials and services	LS			724,754
	Sub-total				32,698,754
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				32,900,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			10,670,000
	Total of D				10,700,000
Grand Total					81,800,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan B2'-2-1 (60 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary office building for power station O&M (civil) staff	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,787
	Sub-total				95,697
A3	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			5,816,584
	b) Platform for dam penetration work	LS			11,947
2	Concrete excavation for dam penetration	m3	2,170	341	739,970
3	Concrete (including formwork cost)	m3	1,660	198	328,680
4	Re-bars	t	65	1,673	108,745
4	Gate towers	Nos.	1	1,808,459	1,808,459
5	Miscellaneous works (metal works, road, landscaping, etc.)	LS			881,439
	Sub-total				9,695,824
A4	**Penstock**				
1	Excavation				
	a) Open excavation (loose materials)	m3	500	6	3,000
	b) Open excavation (Rock)	m3	6,500	13	84,500
2	Rock support and slope protection				
	a) Rock bolts	m	200	22	4,400
	b) Shotcrete	m3	230	819	188,370
4	Concrete				
	a) Concrete for cover pipe	m3	7,000	172	1,204,000
5	Re-bars	t	210	1,673	351,330
8	Miscellaneous works	LS			55,068
	Sub-total				1,890,668
A5	**Powerhouse and Tailrace**				
1	Temporary cofferdam & access road	LS			340,224
2	Excavation				
	a) Open excavation, loose materials	m3	9,500	6	57,000
	b) Open excavation, rock	m3	22,000	13	286,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	340	22	7,480
	b) Shotcrete on cut slope	m3	170	819	139,230
4	Backfill with free draining materials	m3	15,700	7	109,900
5	Concrete				
	a) Powerhouse building	m3	17,000	265	4,505,000
	b) Tailrace wall and retaining wall	m3	1,800	272	489,600
	c) HV cable culvert and duct	m3	240	272	65,280
6	Re-bars	t	1,250	1,673	2,091,250
7	Steel structures (roof truss, crane beam)	t	130	4,784	621,920
8	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			1,212,048

Cost Estimate for Comparison of Alternatives

Plan B2'-2-1 (60 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
9	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			297,748
	Sub-total				10,222,680
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			3,130,786
	Total of A				25,000,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	63	7,000	441,000
2	Stoplog	t	15	7,442	111,636
3	Intake gate and hoist	t	73	11,695	853,750
4	Penstock steel pipe	t	670	6,379	4,274,064
	Sub-total				5,680,450
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	80	10,632	850,560
	Sub-total				850,560
	Total of B				6,500,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			11,378,877
2	Generator and auxiliaries	LS			13,008,400
3	Transformers	LS			2,189,845
4	Indoor switchgear	LS			733,304
5	Outdoor switchyard equipment	LS			2,989,342
6	Control and protection equipment	LS			660,539
7	Auxiliary equipment	LS			1,013,693
8	Miscellaneous materials	LS			724,754
	Sub-total				32,698,754
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**115kV Transmission Line**				
1	Overhead power conductors	LS			0
	Sub-total				0
C4	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				32,900,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			9,660,000
	Total of D				9,700,000
Grand Total					74,100,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan B2-1 (80 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary office building for power station O&M (civil) staff	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	300	6	1,800
2	Concrete for tower foundations and cable ducts	m3	200	230	46,000
3	Re-bars	t	12	1,673	20,076
4	New building for GIS (220 m^2)	LS			175,428
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			7,554
	Sub-total				259,364
A3	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			9,391,584
	b) Platform for dam penetration work	LS			27,408
2	Concrete excavation for dam penetration	m3	3,060	260	795,600
3	Concrete (including formwork cost)	m3	2,430	198	481,140
4	Re-bars	t	99	1,673	165,627
5	Gate tower	No.	2	1,585,618	3,171,236
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			1,403,260
	Sub-total				15,435,855
A4	**Penstock**				
1	Excavation				
	a) Open excavation (loose materials)	m3	14,000	6	84,000
	b) Open excavation (Rock)	m3	22,000	13	286,000
2	Rock support and slope protection				
	a) Rock bolts	m	1,000	22	22,000
	b) Shotcrete	m3	350	819	286,650
3	Concrete				
	a) Concrete for cover pipe	m3	12,300	172	2,115,600
5	Re-bars	t	450	1,673	752,850
8	Miscellaneous works	LS			106,413
	Sub-total				3,653,513
A5	**Powerhouse and Tailrace**				
1	Temporary cofferdam & access road	LS			318,960
2	Excavation				
	a) Open excavation, loose materials	m3	16,000	6	96,000
	b) Open excavation, rock	m3	38,000	13	494,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	880	22	19,360
	b) Shotcrete on cut slope	m3	240	819	196,560
4	Backfill with free draining materials	m3	25,000	7	175,000
5	Concrete				
	a) Powerhouse building	m3	26,000	246	6,396,000
	b) Tailrace wall and retaining wall	m3	4,000	253	1,012,000
	c) HV cable culvert and duct	m3	600	253	151,800
6	Re-bars	t	2,400	1,673	4,015,200
7	Steel structures (roof truss, crane beam)	t	270	4,784	1,291,680
8	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			1,414,056

Cost Estimate for Comparison of Alternatives | **Plan B2-1 (80 MW)**

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
9	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			467,418
	Sub-total				16,048,034
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			5,058,200
	Total of A				40,500,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	86	7,000	602,000
2	Stoplog	t	24	7,442	178,618
3	Intake gate and hoist	t	114	9,569	1,090,843
4	Penstock steel pipe	t	940	6,379	5,996,448
	Sub-total				7,867,909
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	72	10,632	560,000
	Sub-total				560,000
	Total of B				8,400,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			15,979,638
2	Generator and auxiliaries	LS			17,913,636
3	Transformers	LS			3,290,434
4	Indoor switchgear	LS			1,680,640
5	Outdoor switchyard equipment	LS			3,531,627
6	Control and protection equipment	LS			1,479,174
7	Auxiliary equipment	LS			1,096,930
8	Miscellaneous materials	LS			1,020,598
	Sub-total				45,992,677
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**115kV Transmission Line**				
1	Overhead power conductors	LS			5,617,287
	Sub-total				5,617,287
C4	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				51,800,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			15,110,000
	Total of D				15,100,000
Grand Total					115,800,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan D3 (80MW)

(surface powerhouse)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Preparation of permanent access road to intake and powerhouse	LS			212,640
	b) Relocation of intake gantry crane	LS			53,160
	Sub-total				265,800
A2	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			11,099,808
	b) Work platform	LS			11,961,000
2	Open excavation above El. 215 m	m3	15,700	13	204,100
3	Intake channel excavation				
	a) Open excavation	m3	11,600	13	150,800
	b) Underwater excavation	m3	18,600	42	781,200
4	Concrete	m3	10,100	253	2,555,300
5	Re-bars	t	810	1,673	1,355,130
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			2,810,734
	Sub-total				30,918,072
A3	**Headrace Tunnel and Penstocks**				
1	Open excavation at adit portals	m3	3,000	13	39,000
2	Underground excavation, tunnel	m3	40,300	53	2,135,900
3	Rock support and slope protection				
	a) Rock bolts	m	2,000	22	44,000
	b) Shotcrete	m3	1,800	819	1,474,200
4	Concrete				
	a) Invert lining	m3	700	300	210,000
	b) Concrete lining	m3	7,600	300	2,280,000
	c) Filling behind steel liner	m3	3,000	300	900,000
4	Re-bars	t	430	1,673	719,390
5	Curtain grouting	m	480	120	57,600
6	Consolidation grouting	m	3,200	70	224,000
7	Miscellaneous works	LS			808,409
	Sub-total				8,892,499
A4	**Powerhouse & Tailrace**				
1	Temporary cofferdam	LS			106,320
2	Excavation				
	a) Open excavation, loose materials	m3	76,000	6	456,000
	b) Open excavation, rock	m3	36,000	13	468,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	800	22	17,600
	b) Shotcrete on cut slope	m3	300	819	245,700
4	Backfill with free draining materials	m3	40,000	7	280,000
5	Rock riprap on tailrace channel bank slopes	m3	8,000	15	120,000
6	Concrete				
	a) Powerhouse building	m3	28,000	246	6,888,000
	b) Tailrace wall and retaining wall	m3	4,800	253	1,214,400
7	Re-bars	t	2,500	1,673	4,182,500
8	Steel structures (roof truss, crane beam)	t	270	4,784	1,291,680
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			606,024

Cost Estimate for Comparison of Alternatives

Plan D3 (80MW)

(surface powerhouse)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			476,287
	Sub-total				16,352,511
A5	**General Item Cost**				
1	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			8,061,269
	Total of A				64,500,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	34	7,000	238,000
2	Intake gate and hoist	t	120	8,506	1,020,672
3	Penstock steel pipe	t	516	7,442	3,840,278
	Sub-total				5,098,950
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	56	10,632	595,392
	Sub-total				595,392
	Total of B				5,700,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			19,420,400
2	Generator and auxiliaries	LS			17,913,636
3	Transformers	LS			3,290,434
4	Indoor switchgear	LS			1,589,680
5	Outdoor switchyard equipment	LS			952,902
6	Control and protection equipment	LS			1,459,738
7	Auxiliary equipment	LS			1,096,930
8	Miscellaneous materials	LS			1,040,734
	Sub-total				46,764,454
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**115kV Transmission Line**				
1	Overhead power conductors	LS			5,617,287
	Sub-total				5,617,287
C4	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				52,600,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			18,420,000
	Total of D				18,400,000
Grand Total					141,200,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan B2-2 (120 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Temporary office building for power station O&M (civil) staff	LS			10,632
	Sub-total				10,632
A2	**Nam Leuk SS Building Relocation**				
1	Excavation for land preparation at new site	m3	150	6	900
2	Concrete for tower foundations and cable ducts	m3	12	230	2,760
3	Re-bars	t	1	1,673	1,004
4	New building for GIS (150 m^2)	LS			79,740
5	Cable rack along dam crest	LS			8,506
6	Miscellaneous work	LS			2,787
	Sub-total				95,697
A3	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			9,586,029
	b) Platform for dam penetration work	LS			11,947
2	Concrete excavation for dam penetration	m3	4,460	260	1,159,600
3	Concrete (including formwork cost)	m3	3,450	198	683,100
4	Re-bars	t	132	1,673	220,836
4	Gate towers	Nos.	2	1,808,459	3,616,918
5	Miscellaneous works (metal works, road, landscaping, etc.)	LS			1,527,843
	Sub-total				16,806,273
A4	**Penstock**				
1	Excavation				
	a) Open excavation (loose materials)	m3	17,500	6	105,000
	b) Open excavation (Rock)	m3	28,000	13	364,000
2	Rock support and slope protection				
	a) Rock bolts	m	1,300	22	28,600
	b) Shotcrete	m3	450	819	368,550
4	Concrete				
	a) Concrete for cover pipe	m3	18,000	172	3,096,000
5	Re-bars	t	450	1,673	752,850
8	Miscellaneous works	LS			141,450
	Sub-total				4,856,450
A5	**Powerhouse and Tailrace**				
1	Temporary cofferdam & access road	LS			340,224
2	Excavation				
	a) Open excavation, loose materials	m3	20,000	6	120,000
	b) Open excavation, rock	m3	47,000	13	611,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	1,000	22	22,000
	b) Shotcrete on cut slope	m3	310	819	253,890
4	Backfill with free draining materials	m3	35,000	7	245,000
5	Concrete				
	a) Powerhouse building	m3	33,000	246	8,118,000
	b) Tailrace wall and retaining wall	m3	4,500	253	1,138,500
	c) HV cable culvert and duct	m3	800	253	202,400
6	Re-bars	t	2,800	1,673	4,684,400
7	Steel structures (roof truss, crane beam)	t	270	4,784	1,291,680
8	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			1,212,048

Cost Estimate for Comparison of Alternatives

Plan B2-2 (120 MW)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
9	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			547,174
	Sub-total				18,786,316
A6	**General Item Cost**				
	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			5,793,624
	Total of A				46,300,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	126	7,000	882,000
2	Stoplog	t	30	7,442	223,272
3	Intake gate and hoist	t	146	11,695	1,707,499
4	Penstock steel pipe	t	1,340	6,379	8,548,128
	Sub-total				11,360,899
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	104	10,632	1,105,728
	Sub-total				1,105,728
	Total of B				12,500,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			22,394,176
2	Generator and auxiliaries	LS			26,016,800
3	Transformers	LS			4,535,588
4	Indoor switchgear	LS			1,732,618
5	Outdoor switchyard equipment	LS			3,482,195
6	Control and protection equipment	LS			1,583,128
7	Auxiliary equipment	LS			1,387,117
8	Miscellaneous materials	LS			1,387,693
	Sub-total				62,519,315
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**115kV Transmission Line**				
1	Overhead power conductors	LS			5,617,287
	Sub-total				5,617,287
C4	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				68,300,000
D	**ENGINEERING**				
1	Design and construction supervision	LS			19,070,000
	Total of D				19,100,000
Grand Total					146,200,000

Nam Ngum-1 Power Station Expansion

Cost Estimate for Comparison of Alternatives

Plan D4 (120MW)

(surface powerhouse)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
A	**CIVIL WORKS**				
A1	**Preparatory Works**				
	a) Preparation of permanent access road to intake and powerhouse	LS			212,640
	b) Relocation of intake gantry crane	LS			53,160
	Sub-total				265,800
A2	**Intake**				
1	Temporary works				
	a) Intake enclosure structure in reservoir	LS			14,799,744
	b) Work platform	LS			15,948,000
2	Open excavation above El. 215 m	m3	18,800	13	244,400
3	Intake channel excavation				
	a) Open excavation	m3	15,000	13	195,000
	b) Underwater excavation	m3	24,000	42	1,008,000
4	Concrete	m3	13,000	253	3,289,000
5	Re-bars	t	1,100	1,673	1,840,300
6	Miscellaneous works (metal works, road, landscaping, etc.)	LS			3,732,444
	Sub-total				41,056,888
A3	**Headrace Tunnel and Penstocks**				
1	Open excavation at adit portals	m3	4,000	13	52,000
2	Underground excavation, tunnel	m3	52,000	53	2,756,000
3	Rock support and slope protection				
	a) Rock bolts	m	3,000	22	66,000
	b) Shotcrete	m3	2,700	819	2,211,300
4	Concrete				
	a) Invert lining	m3	900	300	270,000
	b) Concrete lining	m3	9,900	300	2,970,000
	c) Filling behind steel liner	m3	4,100	300	1,230,000
4	Re-bars	t	560	1,673	936,880
5	Curtain grouting	m	550	120	66,000
6	Consolidation grouting	m	4,100	70	287,000
7	Miscellaneous works	LS			1,084,518
	Sub-total				11,929,698
A4	**Powerhouse & Tailrace**				
1	Temporary cofferdam	LS			106,320
2	Excavation				
	a) Open excavation, loose materials	m3	98,000	6	588,000
	b) Open excavation, rock	m3	54,000	13	702,000
3	Slope protection and rock support				
	a) Rock bolts on cut slope	m	1,000	22	22,000
	b) Shotcrete on cut slope	m3	500	819	409,500
4	Backfill with free draining materials	m3	50,000	7	350,000
5	Rock riprap on tailrace channel bank slopes	m3	9,000	15	135,000
6	Concrete				
	a) Powerhouse building	m3	33,000	246	8,118,000
	b) Tailrace wall and retaining wall	m3	4,000	253	1,012,000
7	Re-bars	t	2,800	1,673	4,684,400
8	Steel structures (roof truss, crane beam)	t	270	4,784	1,291,680
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	LS			1,212,048

Cost Estimate for Comparison of Alternatives

Plan D4 (120MW)

(surface powerhouse)

Item	Description	Unit	Quantity	Rate (US$)	Cost (US$)
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS			558,928
	Sub-total				19,189,876
A5	**Outdoor Switchyard**				
1	Open excavation	m3	3,000	13	39,000
2	Concrete	m3	800	272	217,600
3	Re-bars	t	40	1,673	66,920
4	Miscellaneous works	LS			16,176
	Sub-total				339,696
A6	**General Item Cost**				
1	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	LS			10,397,423
	Total of A				83,200,000
B	**HYDRAULIC STEEL STRUCTURES**				
B1	**Intake and Penstock**				
1	Trash rack	t	54	7,000	378,000
2	Intake gate and hoist	t	180	8,506	1,531,008
3	Penstock steel pipe	t	764	7,442	5,685,994
	Sub-total				7,595,002
B2	**Draft Tube Stoplog Facility**				
1	Draft tube gates and hoists	t	80	10,632	850,560
	Sub-total				850,560
	Total of B				8,400,000
C	**ELECTRICAL /MECHANICAL EQUIPMENT**				
C1	**Generating Equipment**				
1	Turbine and auxiliaries	LS			27,411,488
2	Generator and auxiliaries	LS			26,016,800
3	Transformers	LS			4,535,588
4	Indoor switchgear	LS			1,732,618
5	Outdoor switchyard equipment	LS			2,081,686
6	Control and protection equipment	LS			1,583,128
7	Auxiliary equipment	LS			1,387,117
8	Miscellaneous materials	LS			1,471,756
	Sub-total				66,220,181
C2	**Thalat Substation Improvement**				
1	Overhead power conductors	LS			0
	Sub-total				0
C3	**115kV Transmission Line**				
1	Overhead power conductors	LS			5,617,287
	Sub-total				5,617,287
C4	**Inspection, Training and Model Test**				
1	Factory inspection by the Employer	LS			61,081
2	Factory training to the Employer	LS			20,360
3	Site instruction	LS			72,716
4	Turbine model test	LS			36,358
	Sub-total				190,515
	Total of C				72,000,000
D	**ENGINEERING & ENVIRONMENTAL WORKS**				
1	Design and construction supervision	LS			24,540,000
	Total of D				24,600,000
Grand Total					188,200,000

Appendix E

Dam Stability Analysis

Appendix E-1 Dam Stability Analysis

1. Analysis case and load conditions

The stress and stability analysis of the dam was made for NO.20 section, assuming the following three different stages and four different load conditions. In case of "Stage B during construction", stability analysis was not made for load condition "Case Ⅱ Unusual_Flood" and "Case Ⅳ Extreme_Earthquake" .

The load condition case for each analysis is shown in **Table E.1.1**.

[Stage]

Stage A current condition
Stage B during construction
Stage C after completion

[Load condition]

Case Ⅰ Usual_
Case Ⅱ Unusual Flood
Case Ⅲ Unusual Earthquake (k=0.061 for OBE)
Case Ⅳ Extreme Earthquake (k=0.215 for MCE)

Table E.1.1 Case of Load Condition for each analysis

Load Condition			Stage A Current Condition	Stage B During Construction	Stage C After Completion
Case Ⅰ	Usual		Load A- Ⅰ	Load B- Ⅰ	Load C- Ⅰ
Case Ⅱ	Unusual	Unusual Flood	Load A- Ⅱ	－	Load C- Ⅱ
Case Ⅲ		Earthquake (k=0.061) OBE	Load A- Ⅲ	Load B- Ⅲ	Load C- Ⅲ
Case Ⅳ	Extreme	Earthquake (k=0.215) MCE	Load A- Ⅳ	－	Load C- Ⅳ

2. Principal feature of NO.20 block

The dimensions of NO.20 section, surrounding water and silt conditions are shown in **Table E.2.1.** The stability analyses are done on the below-mentioned conditions.

1) The dam stability is evaluated totally as the whole No.20 block of 18m width.

2) In Stage B calculation is done with the dam piercing completed and no new concrete placed.

3) In Stage C calculation is done with the intake gate closed

4) The weight and uplift of the temporary enclosure works are neglected in Stage B.

5) The weights of metal works (Intake Screen, Intake Gate ex.) are neglected.

6) Effect of downstream water level is considered only for calculation of uplift.

Table E.2.1 Principal Feature of NO.11 Block

Items		Dimension, Elevation, Slope
Dam crest elevation		EL.215.0m
Bedrock elevation		EL.161.0 m
Height of dam		54 m
Base Length		41.38 m
Block width		18.m
Upstream slope of dam		Vertical above EL.175.0 m 1 to 0.2 below EL.175.0 m
Downstream slope of dam		1 to 0.67
Normal high water level		EL.212.0 m
Flood water level		EL.215.0 m
Sedimentation level in reservoir		EL.180.0 m
Normal tail water level		EL.166.9 m
Flood tail water level		EL.176.4 m
Dam Piercing	Center Elevation	EL.185.25 m
	Length	22.33 m
	Inner Dimension	4.50m×5.50m
	Excavated Dimension	6.10m×7.10m

3. Load combination

Load combination in each load condition case is shown in **Table E.3.1～E.3.3.**

Table E.3.1 Load Combination (Stage A : Current condition)

Load Condition			Loads to be considered								
			Self Weight of dam	Hydro-static Pressure	Silt Pressure	Uplift	Seismic Force	Hydro-dynamic Pressure	Decreased weight due to piercing	Water Weight in Waterway	Weight of newly placed concrete
Load A-Ⅰ	Usual		○	○	○	○	—	—	—	—	—
Load A-Ⅱ	Unusual	Flood	○	○	○	○	—	—	—	—	—
Load A-Ⅲ		Earthquake	○	○	○	○	○	○	—	—	—
Load A-Ⅳ	Extreme	Earthquake	○	○	○	○	○	○	—	—	—

Table E.3.2 Load Combination (Stage B : During Construction)

Load Condition			Loads to be considered								
			Self Weight of dam	Hydro-static Pressure	Silt Pressure	Uplift	Seismic Force	Hydro-dynamic Pressure	Decreased weight due to piercing	Water Weight in Waterway	Weight of newly placed concrete
Load B-Ⅰ	Usual		○	○	○	○	—	—	○	—	—
—	Unusual	Flood	—	—	—	—	—	—	—	—	—
Load B-Ⅲ		Earthquake	○	○	○	○	○	○	○	—	—
—	Extreme	Earthquake	—	—	—	—	—	—	—	—	—

Table E.3.3 Load Combination (Stage C : After Completion)

Load Condition			Loads to be considered								
			Self Weight of dam	Hydro-static Pressure	Silt Pressure	Uplift	Seismic Force	Hydro-dynamic Pressure	Decreased weight due to piercing	Water Weight in Waterway	Weight of newly placed concrete
Load C- Ⅰ	Usual		○	○	○	○	—	—	○	○	○
Load C- Ⅱ	Unusual	Flood	○	○	○	○	—	—	○	○	○
Load C-Ⅲ	Unusual	Earthquake	○	○	○	○	○	○	○	○	○
Load C-Ⅳ	Extreme	Earthquake	○	○	○	○	○	○	○	○	○

4. Formulas for calculation of the loads

The loads for each case are calculated by the following formulas.

1) Hydrostatic pressure : P_w (per unit width)

$$P_w = \frac{1}{2} \times w_0 \times h^2$$

where w_0 : unit weight of water, 1.0t/m^3
h : water depth in meters including wave height
wave height : 0.9m (Case- Ⅰ, Ⅱ), 0.45m (Case- Ⅲ, Ⅳ)

2) Silt pressure : Pe (per unit width)

$$Pe = \frac{1}{2} \times Ce \times We \times d^2$$

where Ce : coefficient of silt pressure, 0.5
d : depth of silt deposit in meters
We : unit weight of silt in water, 0.6t/m^3

3) Hydrodynamic pressure : P_d (per unit width)

$$P_d = \frac{7}{12} \times k \times h^2$$

where h : water depth in meters
k : seismic coefficient, 0.061 for OBE
0.215 for MCE

The hydrodynamic pressure due to the seismic action is considered only in CaseⅢand CaseⅣ. It is considered on the upstream side of dam.

4) Weight of dam : W (per unit width)

$$W = wc \times V + W_E$$

where wc : unit weight of concrete, 2.42 t/m^3
Quoted from test data in "Final Report on Nam Ngum Hydro-electric Project, First Stage" (Nippon Koei Co.,Ltd. 1972) Table32.5.2
V : Volume of concrete

W_E : Weight of steel enclosure etc

The dead weight of each structure is shown in Figure E.4.1.

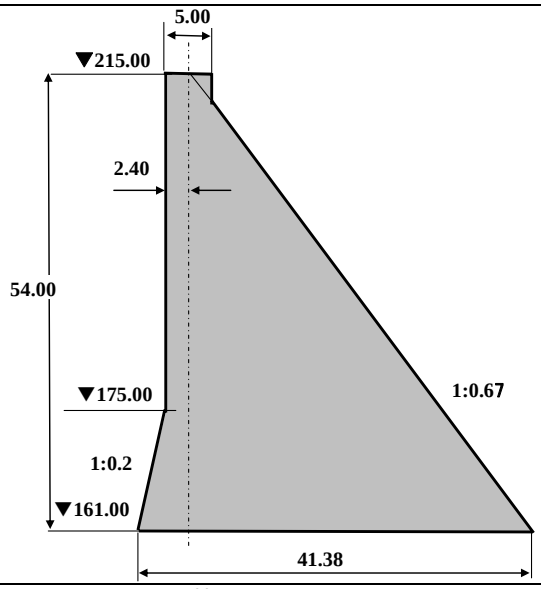
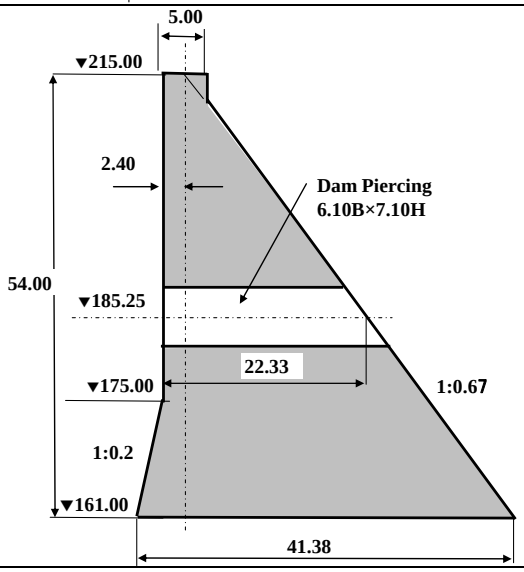
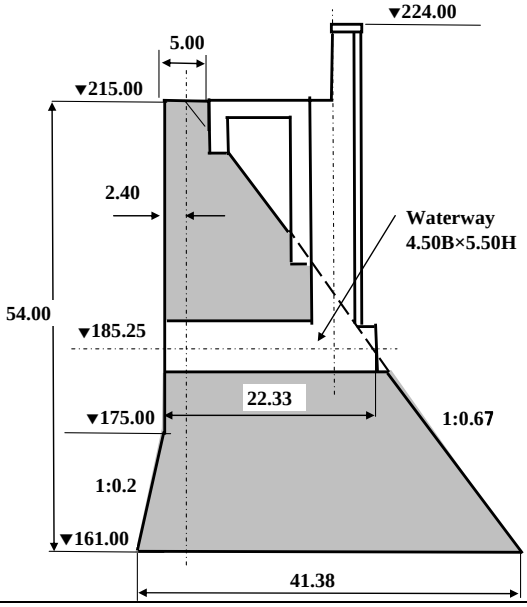
Stage A : **Current condition**	
Stage B : **During Construction**	
Stage C : **After Completion**	

Figure E.4.1 Models for analysis

5) Inertia force of dam due to seismic action : Ws（per unit width）

$$Ws = k \times W$$

where W : weight of dam
k : seismic coefficient, 0.061 for OBE
0.215 for MCE

Inertia force of dam is considered only in CaseⅢ and CaseⅣ.

6) Uplift pressure : U（per unit width）

$$U = w_0 \times h_1 \quad \text{at upstream heel}$$
$$w_0 \times \left(h_2 + \frac{1}{3}(h_1 - h_2)\right) \quad \text{at drain hole}$$
$$w_0 \times h_2 \quad \text{at downstream toe}$$

where w_0 : unit weight of water, 1.0t/m^3
h_1 : water depth of upstream side
h_2 : water depth of downstream side

Uplift pressure is not subject to wave action on the reservoir water surface.

5. Criteria

Criteria for dam stability is based on Lao Electric Power Technical Standards(2004). In case of Extreme condition, the manual of US Army Corps of Engineers is referred. Criteria for dam stability analysis is shown in **Table E.5.1.**

Overturning, Sliding and stress in the foundation rock are calculated by the following formulas.

(1) Overturning

Resultant location "x_0" and distance of eccentricity "e" are calculated by the following formulas.

$$x_0 = \frac{M}{V}$$
$$e = \left| x_0 - L/2 \right|$$

where x_0 : resultant location
e : distance of eccentricity
M : total moment acting on the shear plane per unit width
V : total vertical force acting on the shear plane per unit width
L : base length = 41.38 m

(2) Sliding

Shear friction safety factor "n" is calculated by the following formulas.

$$n = \frac{\tau \times L + f \times V}{H}$$

where n : shear friction safety factor
τ : shearing strength of foundation = 200 tf/m^2
L : base length = 41.38 m
f : internal friction factor = 0.65
V : total vertical force acting on the shear plane per unit width
H : total horizontal force acting on the shear plane per unit width

(3) Stress in the foundation rock

Compressive stress in the foundation rock at downstream end "P_d" is calculated by the following formulas.

$$P_d = \frac{V}{L}\left(1 + \frac{6 \cdot e}{L}\right) \leqq \sigma a$$

where P_d : sum of the moments
e : distance of eccentricity
L : base length = 41.38 m
V : total vertical force acting on the shear plane per unit width
σ a : allowable compressive stress (400 tf/m^2)

Table E.5.1 Criteria for Dam Stability Analysis

Load Condition		Overturning	Sliding	Stress in the Foundation
Usual		Within middle 1/3 ($e \leq L/6$)	$n \geq 3.0$	$P_d \leq$ allowable compression stress
Unusual	Flood	Within Middle 1/2 ($e \leq L/4$)	$n \geq 2.0$	$P_d \leq$ allowable compression stress
	Earthquake (k=0.061)			
Extreme	Earthquake (k=0.215)	Within base※1 ($e \leq L/2$)	$n \geq 1.3$※1	$P_d \leq 1.33 \times$ allowable compression stress※1

※1 Based on the manual of US Army Corps of Engineers

6. Seismic coefficient

In this dam stability analysis, seismic coefficient k is assumed from PGA of design earthquakes for Nam Ngum 2 Dam※1.

・OBE : k = 0.092 × 2/3 = <u>0.061</u>
・MCE : k = 0.322 × 2/3 = <u>0.215</u>

Where

OBE (Operating Basis Earthquake) : Return period 145 years
MCE (Maximum Credible Earthquake) : Return period 10000 years
PGA (Peak Ground Acceleration) : 0.092 for OBE in the study of NN2
0.322 for MCE in the study of NN2

※1 Source : Probabilistic Seismic Hazard Assessment of Nam Ngum 2 Dam Site

7. Analysis Cases and Results

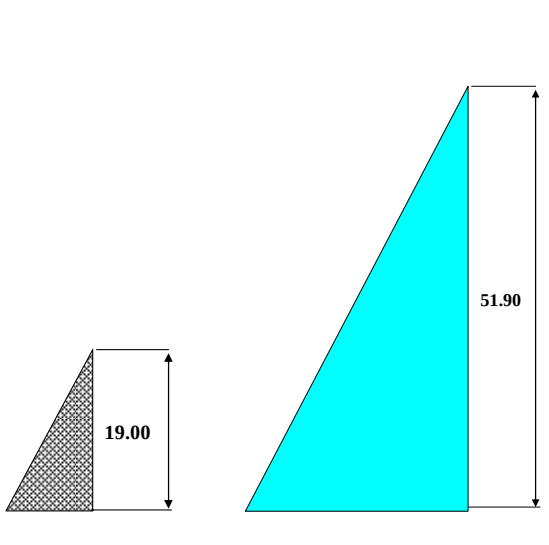
Analysis cases are shown in **Table E.7.1**. The stability of the dam is satisfied in every stage and every loading condition.

Figures of load condition are shown in **Appendix E-2**, and calculation results of load are shown in **Appendix E-3**.

Table E.7.1 Result of Dam Stability Analysis

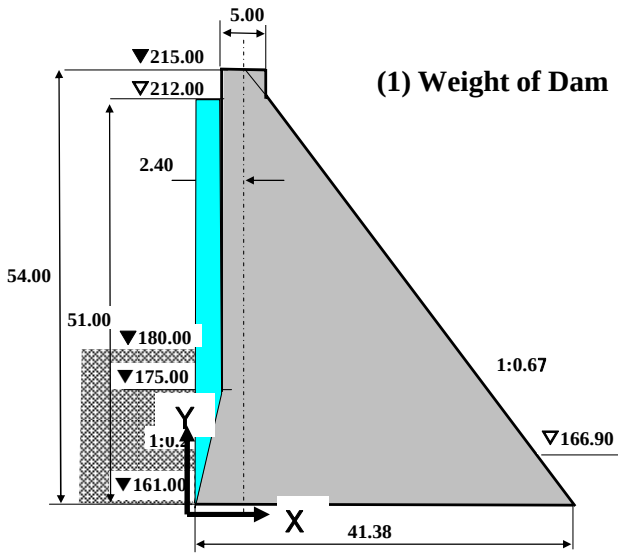
Load Condition	Criteria		Stage-A Current Condition		Stage-B During Construction		Stage-C After Completion	
Load Ⅰ (Usual)	Over-turning	e≦L/6	e=5.15≦	L/6=6.90	e=5.91≦	L/6=6.90	e=4.88≦	L/6=6.90
				OK		OK		OK
	Sliding	n≧3	n= 6.91	≧3	n= 6.85	≧3	n= 6.95	≧3
				OK		OK		OK
	Max. Foundation Stress	σ≦ 400tf/m^2	σ= 91	≦400	σ= 91	≦400	σ= 93	≦400
				OK		OK		OK
Load Ⅱ (Flood)	Over-turning	e≦L/4	e=7.96≦	L/4=10.35			e=7.48≦	L/4=10.35
				OK				OK
	Sliding	n≧2	n= 6.07	≧2			n= 6.11	≧2
				OK				OK
	Max. Foundation Stress	σ≦ 400tf/m^2	σ= 95	≦400			σ= 97	≦400
				OK				OK
Load Ⅲ (OBE)	Over-turning	e≦L/4	e=7.06≦	L/4=10.35	e=7.84≦	L/4=10.35	e=6.78≦	L/4=10.35
				OK		OK		OK
	Sliding	n≧2	n= 5.97	≧2	n= 5.95	≧2	n= 6.01	≧2
				OK		OK		OK
	Max. Foundation Stress	σ≦ 400tf/m^2	σ= 105	≦400	σ= 105	≦400	σ= 108	≦400
				OK		OK		OK
Load Ⅳ (MCE)	Over-turning	e≦L/2	e=13.14≦	L/2=20.69			e=12.86≦	L/2=20.69
				OK				OK
	Sliding	n≧1.3	n= 4.22	≧1.3			n= 4.23	≧1.3
				OK				OK
	Max. Foundation Stress	σ≦1.33× 400tf/m^2	σ= 151	≦400× 1.33			σ= 155	≦400× 1.33
				OK				OK

Appendix E-2 Figures of Load Condition

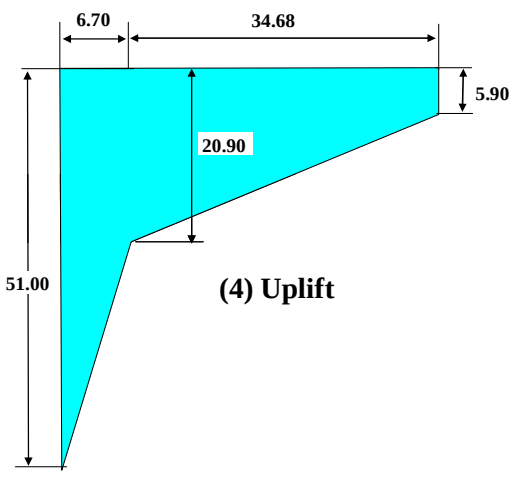


(3) Silt Pressure

(2) Hydrostatic Pressure

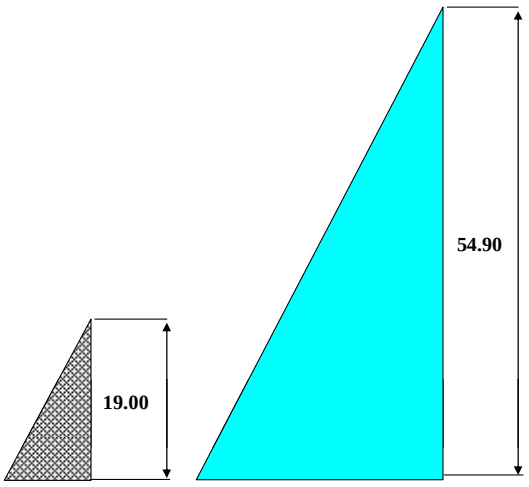


(1) Weight of Dam



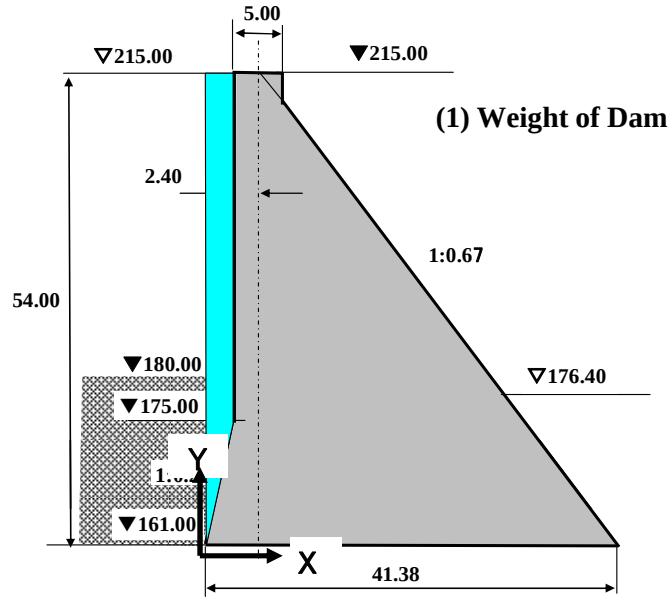
(4) Uplift

Stage-A（Current Condition),

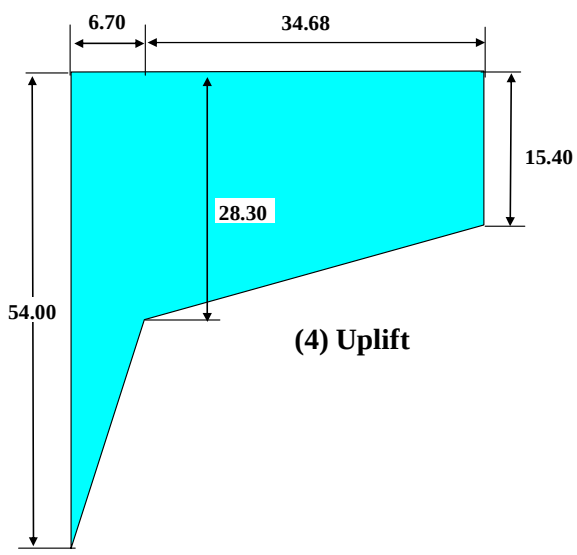


(3) Silt Pressure

(2) Hydrostatic Pressure

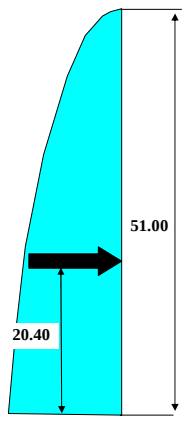


(1) Weight of Dam

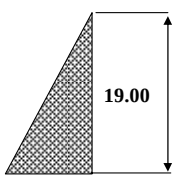


(4) Uplift

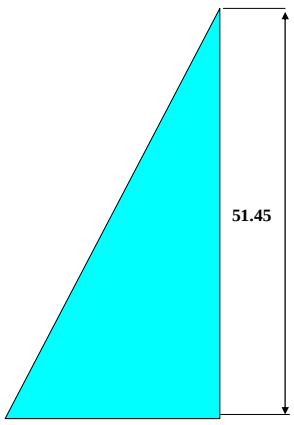
Stage-A（Current Condition),
Load-Ⅱ（Flood）



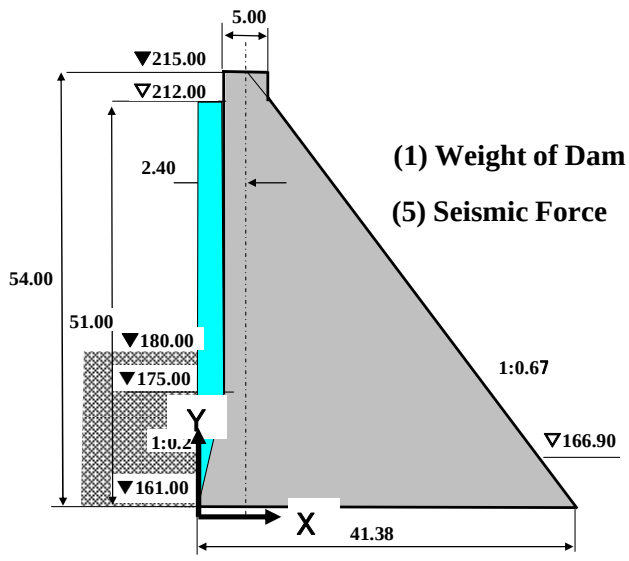
(6) Hydrodynamic Pressure



(3) Silt Pressure

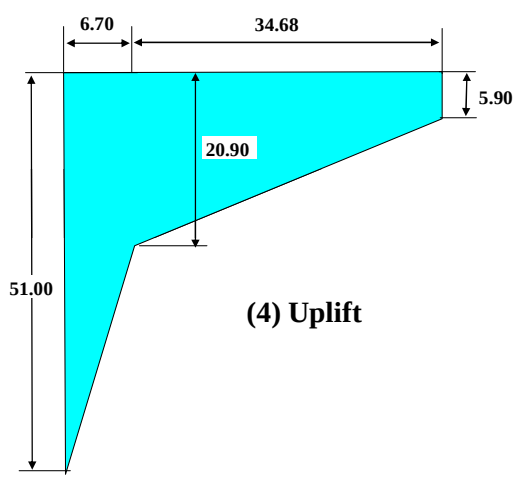


(2) Hydrostatic Pressure



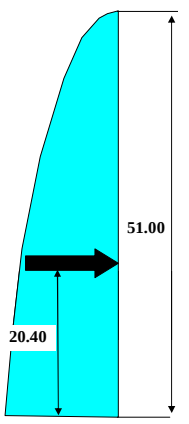
(1) Weight of Dam

(5) Seismic Force

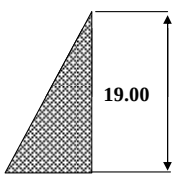


(4) Uplift

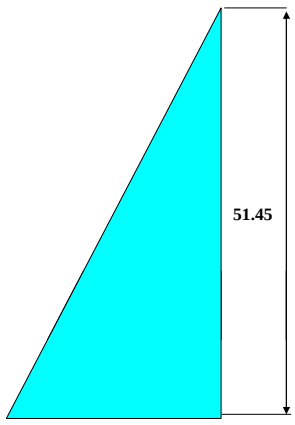
Stage-A（Current Condition),



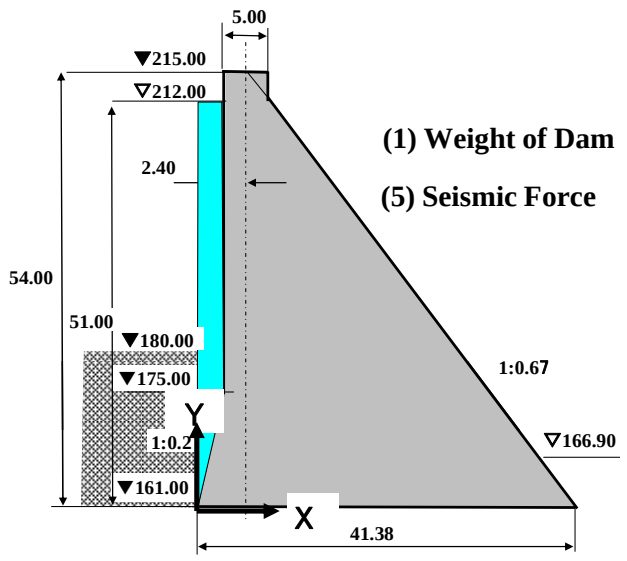
(6) Hydrodynamic Pressure



(3) Silt Pressure

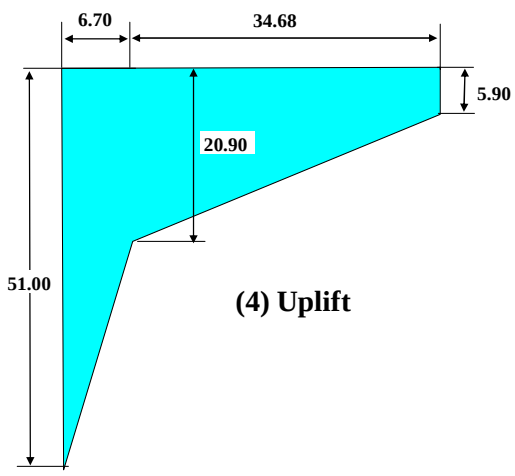


(2) Hydrostatic Pressure



(1) Weight of Dam

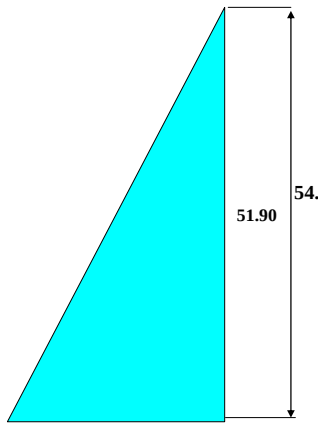
(5) Seismic Force



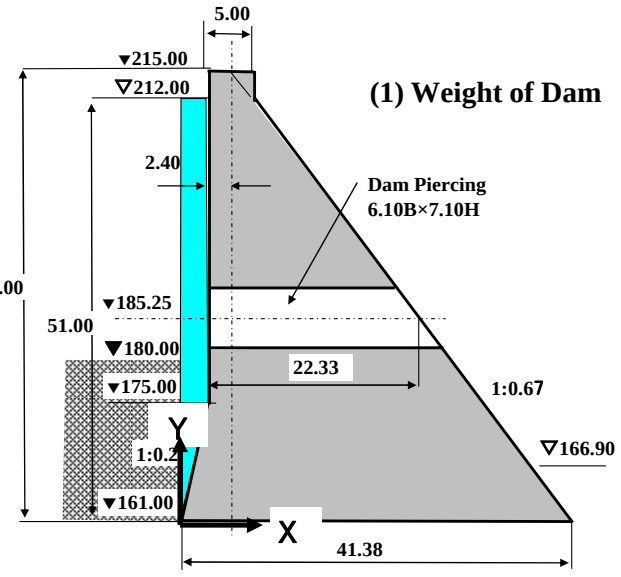
(4) Uplift

Stage-A（Current Condition),

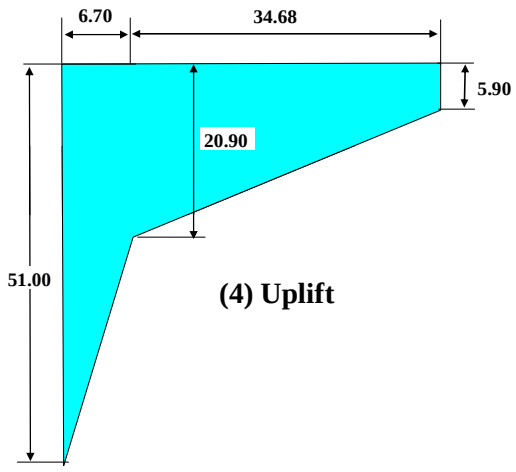
(3) Silt Pressure



(2) Hydrostatic Pressure

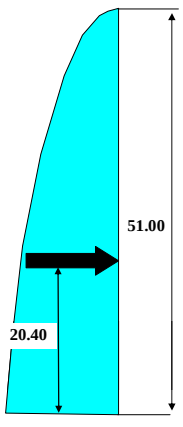


(1) Weight of Dam

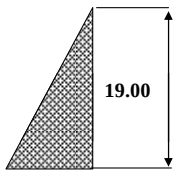


(4) Uplift

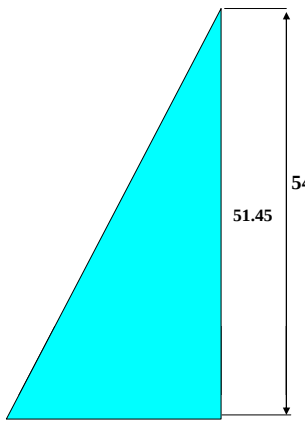
Stage-B（Under Construction),



(6) Hydrodynamic Pressure



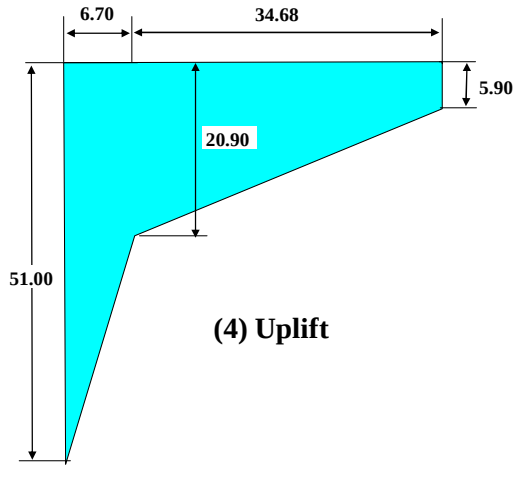
(3) Silt Pressure



(2) Hydrostatic Pressure

(1) Weight of Dam

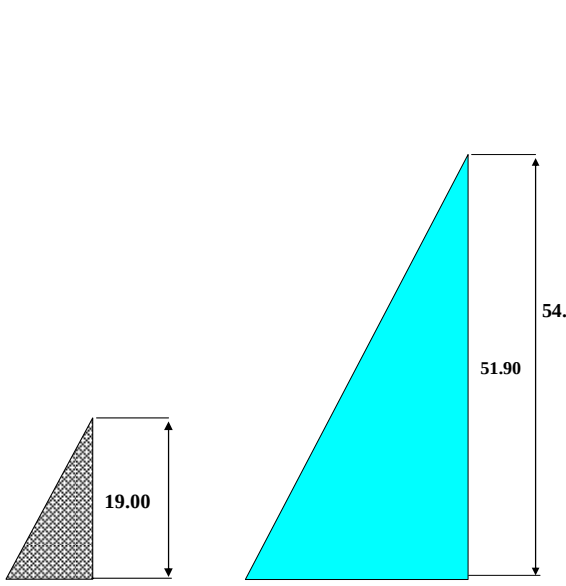
(5) Seismic Force



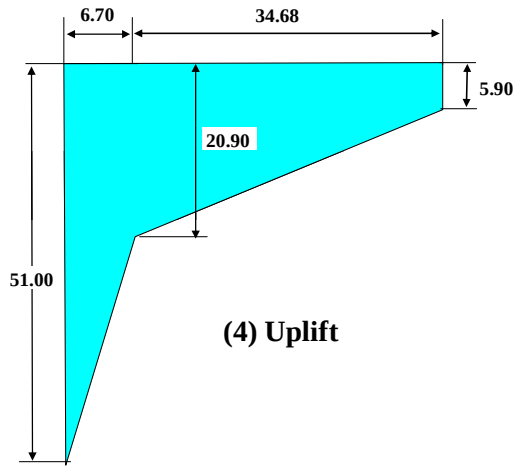
(4) Uplift

Stage-B（Under Construction),

Stage-C（After Completion),

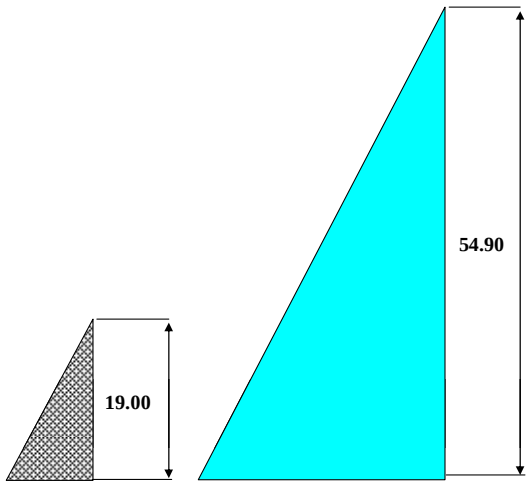


(3) Silt Pressure　　(2) Hydrostatic Pressure　　(1) Weight of Dam

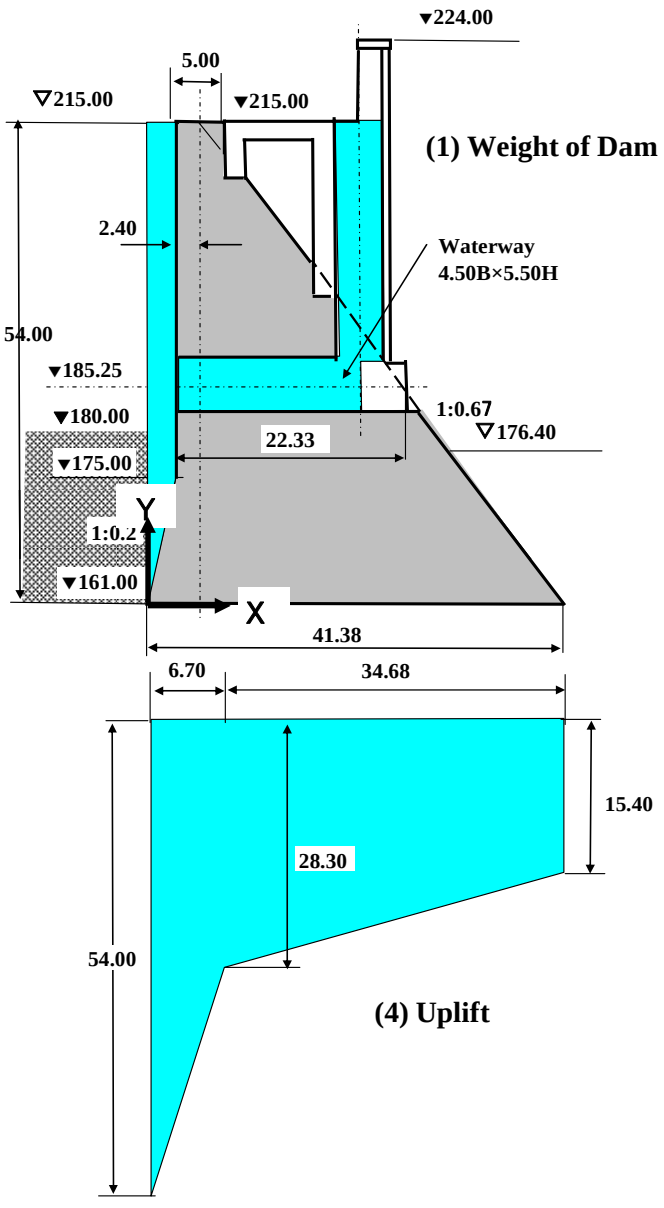


(4) Uplift

Stage-C（After Completion),
Load-Ⅱ（Flood）

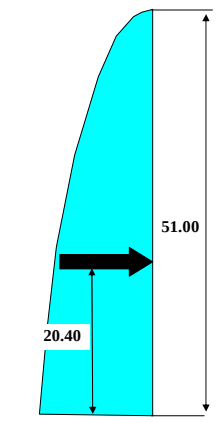


(3) Silt Pressure　　(2) Hydrostatic Pressure

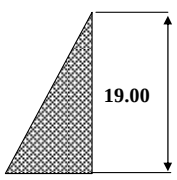


(1) Weight of Dam

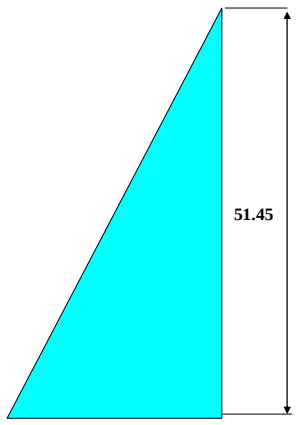
(4) Uplift



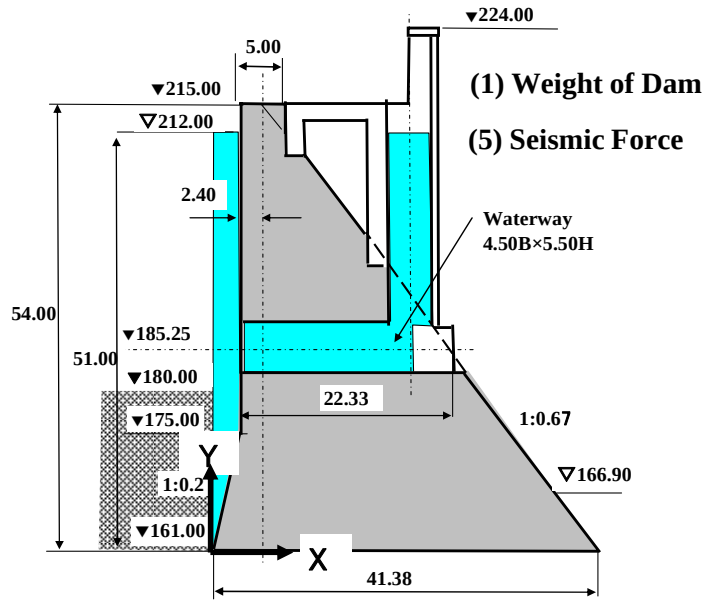
(6) Hydrodynamic Pressure



(3) Silt Pressure

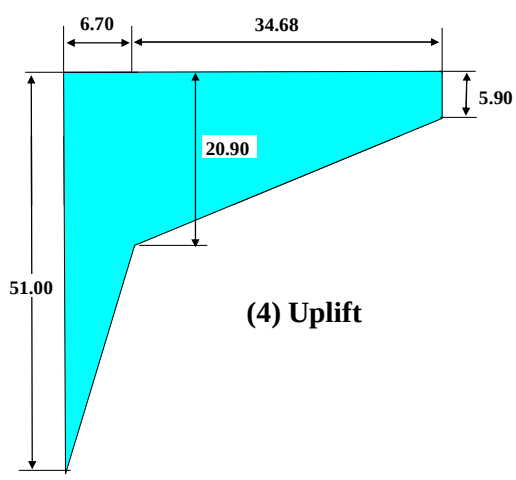


(2) Hydrostatic Pressure



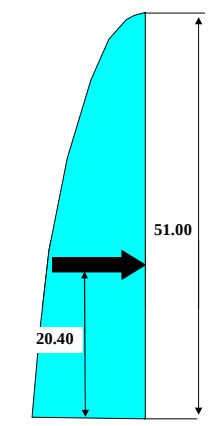
(1) Weight of Dam

(5) Seismic Force

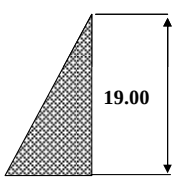


(4) Uplift

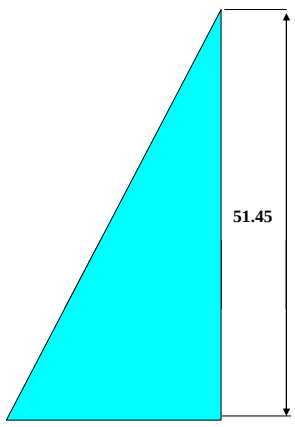
Stage-C（After Completion),



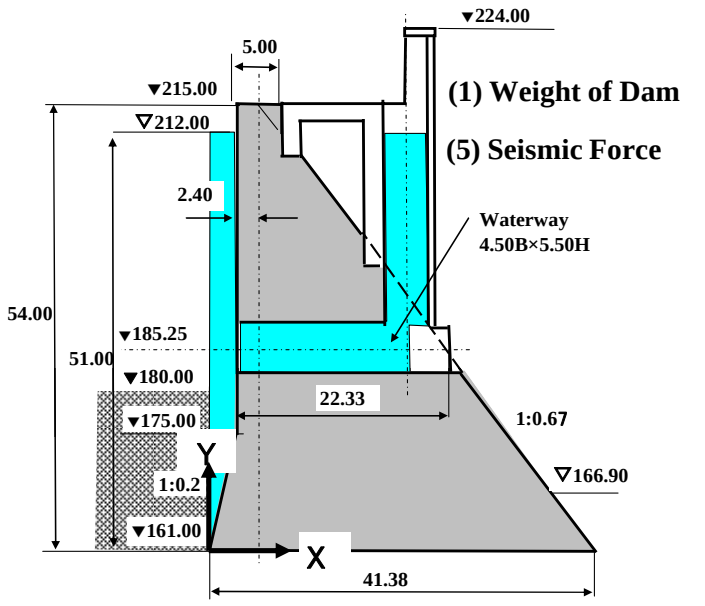
(6) Hydrodynamic Pressure



(3) Silt Pressure

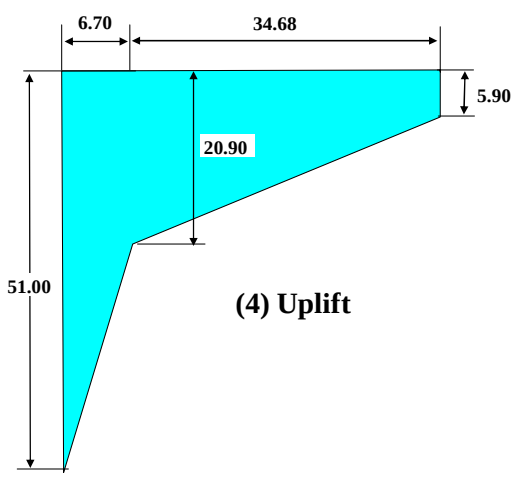


(2) Hydrostatic Pressure



(1) Weight of Dam

(5) Seismic Force



(4) Uplift

Stage-C（After Completion),
Load-Ⅳ（MCE）

Appendix E-3 Calculations of Load

Stage-A (Current condition), Load- Ⅰ (Usual)

		Vertical Load (tf/m)	Holizontal Load (tf/m)	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		—		—		—
Hydro-static Pressure	Pw		1347		17.30		23303
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		—		—		—
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	—		—		—	
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		2154	1401			32014	23645

①Overturning

$e = (Mv+M_H)/V-L/2 = 25.84-20.69 = 5.15 \leqq L/6 = 6.90(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times41.38+0.65\times2154)/1401 = 6.91 \geqq 3$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2154/41.38\times(1+6\times5157/41.38) = 91 \leqq 400\ tf/m^2$ OK

Stage-A (Current condition), Load- Ⅱ (Flood)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2869		14.78		42404	
Seismic Force	Ws		—		—		—
Hydro-static Pressure	Pw		1507		18.30		27578
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		—		—		—
Uplift	U	-1033		17.18		-17747	
Decreased Load due to piercing	Wd	—		—		—	
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		1836	1561			24657	27920

①Overturning

$e = (Mv+M_H)/V-L/2 = 28.64-20.69 = 7.95 \leqq L/4 = 10.35(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times41.38+0.65\times1836)/1561 = 6.07 \geqq 2$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 1836/41.38\times(1+6\times7.95/41.38) = 95 \leqq 400\ tf/m^2$ OK

Stage-A (Current condition), Load-Ⅲ (OBE)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		167		18.96		3166
Hydro-static Pressure	Pw		1324		17.15		22707
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		75		20.40		1530
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	—		—		—	
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		2154	1620			32014	27745

①Overturning

$e = (Mv+M_H)/V-L/2 = 27.74-20.69 = 7.05 \leqq L/4 = 10.35(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times41.38+0.65\times2154)/1620 = 5.97 \geqq 2$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2154/41.38\times(1+6\times7.05/41.38) = 105 \leqq 400\ tf/m^2$ OK

Stage-A (Current condition), Load-Ⅳ (MCE)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		589		18.96		11167
Hydro-static Pressure	Pw		1324		17.15		22707
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		326		20.40		6650
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	—		—		—	
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		2154	2293			32014	40866

①Overturning

$e = (Mv+M_H)/V-L/2 = 33.83-20.69 = 13.14 \leqq L/2 = 20.69(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 2154)/2293 = 4.22 \geqq 1.3$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2154/41.38\times(1+6\times 13.14/41.38) = 151 \leqq 400 \times 1.33 tf/m^2$ OK

Stage-B (During Construction), Load- Ⅰ (Usual)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		—		—		—
Hydro-static Pressure	Pw		1347		17.30		23303
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		—		—		—
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	-130		13.97		-1816	
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		2024	1401			30198	23645

①Overturning

$e = (Mv+M_H)/V-L/2 = 26.60-20.69 = 5.91 \leqq L/6 = 6.90(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 2024)/1401 = 6.85 \geqq 3$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2024/41.38\times(1+6\times 5.91/41.38) = 91 \leqq 400\ tf/m^2$ OK

Stage-B (During Construction), Load-Ⅲ (OBE)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		167		18.96		3166
Hydro-static Pressure	Pw		1324		17.15		22707
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		75		20.40		1530
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	-130	-8	13.97	24.25	-1816	-194
Weight of newly placed concrete	Wn	—		—		—	
Water Weight in Waterway	Ww	—		—		—	
Total		2024	1612			30198	27551

①Overturning

$e = (Mv+M_H)/V-L/2 = 28.53-20.69 = 7.84 \leqq L/4 = 10.35(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 2024)/1612 = 5.95 \geqq 2$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2024/41.38\times(1+6\times 7.84/41.38) = 105 \leqq 400\ tf/m^2$ OK

Stage-C (After Completion), Load- Ⅰ (Usual)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		—		—		—
Hydro-static Pressure	Pw		1347		17.30		23303
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		—		—		—
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	-189		18.20		-3440	
Weight of newly placed concrete	Wn	219		18.85		4128	
Water Weight in Waterway	Ww	61		17.17		1047	
Total		2245	1401			33750	23645

①Overturning

$e = (Mv+M_H)/V-L/2 = 25.57-20.69 = 4.88 \leqq L/6 = 6.90(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 2245)/1401 = 6.95 \geqq 3$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2245/41.38\times(1+6\times 4.88/41.38) = 93 \leqq 400\ tf/m^2$ OK

Stage-C (After Completion), Load- Ⅱ (Flood)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2869		14.78		42404	
Seismic Force	Ws		—		—		—
Hydro-static Pressure	Pw		1507		18.30		27578
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		—		—		—
Uplift	U	-1033		17.18		-17747	
Decreased Load due to piercing	Wd	-189		18.20		-3440	
Weight of newly placed concrete	Wn	219		18.85		4128	
Water Weight in Waterway	Ww	66		17.42		1150	
Total		1932	1561			26495	27920

①Overturning

$e = (Mv+M_H)/V-L/2 = 28.17-20.69 = 7.48 \leqq L/4 = 10.35(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 1932)/1561 = 6.11 \geqq 2$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 1932/41.38\times(1+6\times 7.48/41.38) = 97 \leqq 400\ tf/m^2$ OK

Stage-C (After Completion), Load-Ⅲ (OBE)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		167		18.96		3166
Hydro-static Pressure	Pw		1324		17.15		22707
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		75		20.40		1530
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	-189	-12	18.20	35.48	-3440	-426
Weight of newly placed concrete	Wn	219	13	18.85	46.16	4128	600
Water Weight in Waterway	Ww	61		17.17		1047	
Total		2245	1621			33750	27919

①Overturning

$e = (Mv+M_H)/V-L/2 = 27.47-20.69 = 6.78 \leqq L/4 = 10.35(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times 41.38+0.65\times 2245)/1621 = 6.01 \geqq 2$ OK

③Stress in the foundation rock

$Pd = V/L(1+6e/L) = 2245/41.38\times(1+6\times 6.78/41.38) = 108 \leqq 400\ tf/m^2$ OK

Stage-C (After Completion), Load-Ⅳ (MCE)

		Vertical Load	Holizontal Load	Arm Length (m)		Moment (tf-m/m)	
				Vertical	Horizontal	Vertical	Horizontal
Self Weight of dam	W	2860		14.82		42385	
Seismic Force	Ws		589		18.96		11167
Hydro-static Pressure	Pw		1324		17.15		22707
Silt Pressure	Pe		54		6.33		342
Hydro-dynamic Pressure	Pd		326		20.40		6650
Uplift	U	-706		14.69		-10371	
Decreased Load due to piercing	Wd	-189	-41	18.20	35.48	-3440	-1455
Weight of newly placed concrete	Wn	219	47	18.85	46.16	4128	2170
Water Weight in Waterway	Ww	61		17.17		1047	
Total		2245	2299			33750	41581

①Overturning

$e = (Mv+M_H)/V-L/2 = 33.55-20.69 = 12.86 \leqq L/2 = 20.69(m)$ OK

②Sliding

$n = (\tau L+fV)/H = (200\times41.38+0.65\times2245)/2299 = 4.23 \geqq 1.3$ OK

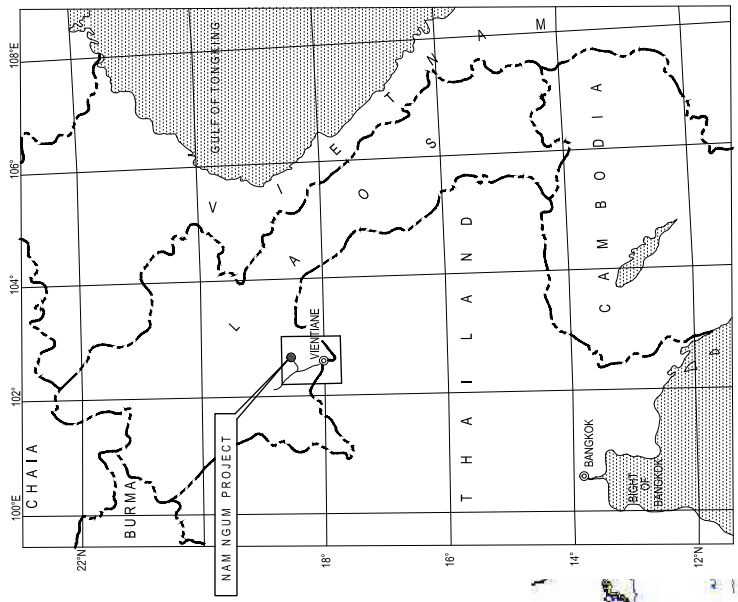
③Stress in the foundation rock

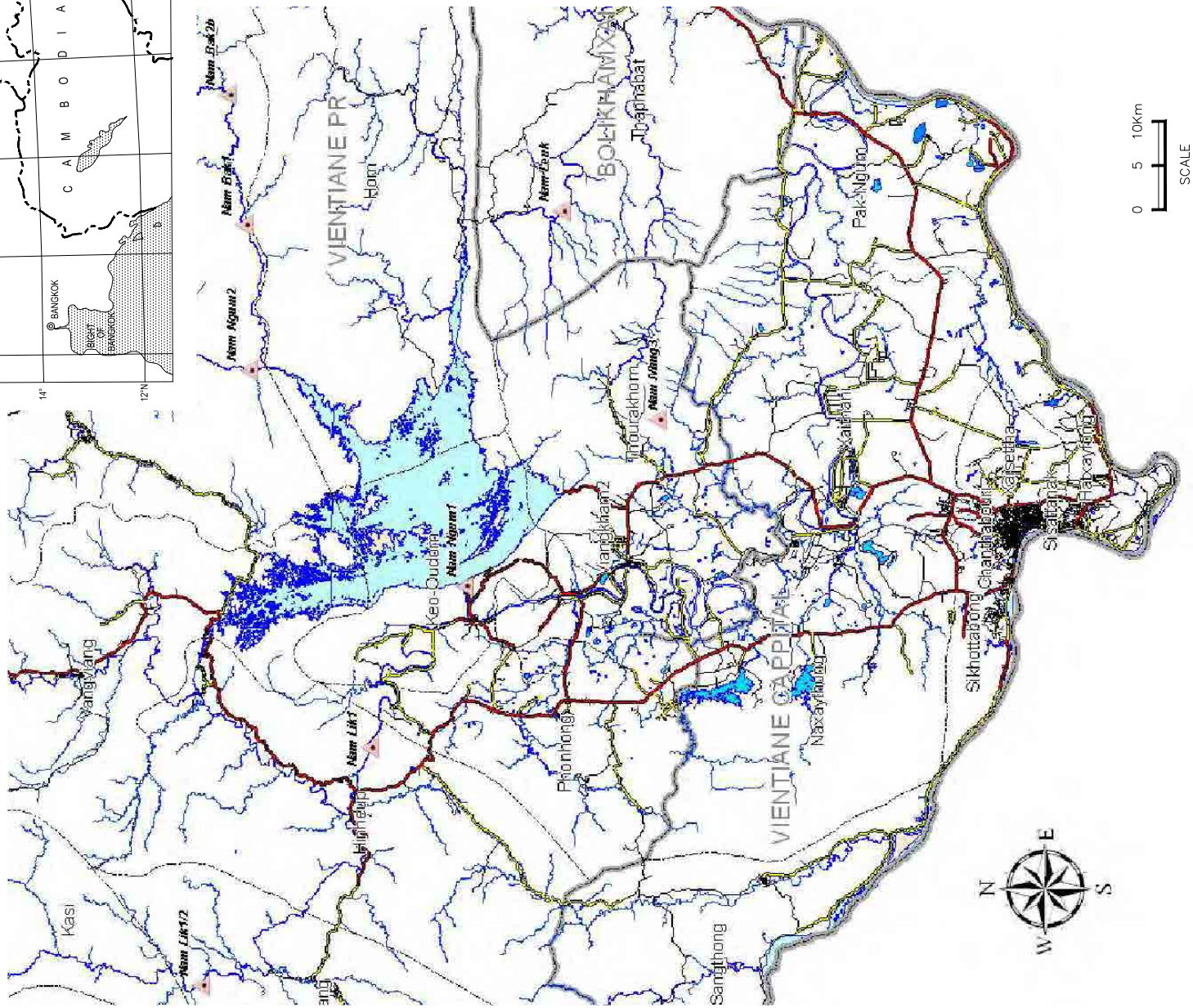
$Pd = V/L(1+6e/L) = 2245/41.38\times(1+6\times12.86/41.38) = 155 \leqq 400\times1.33\ tf/m^2$ OK

Appendix F

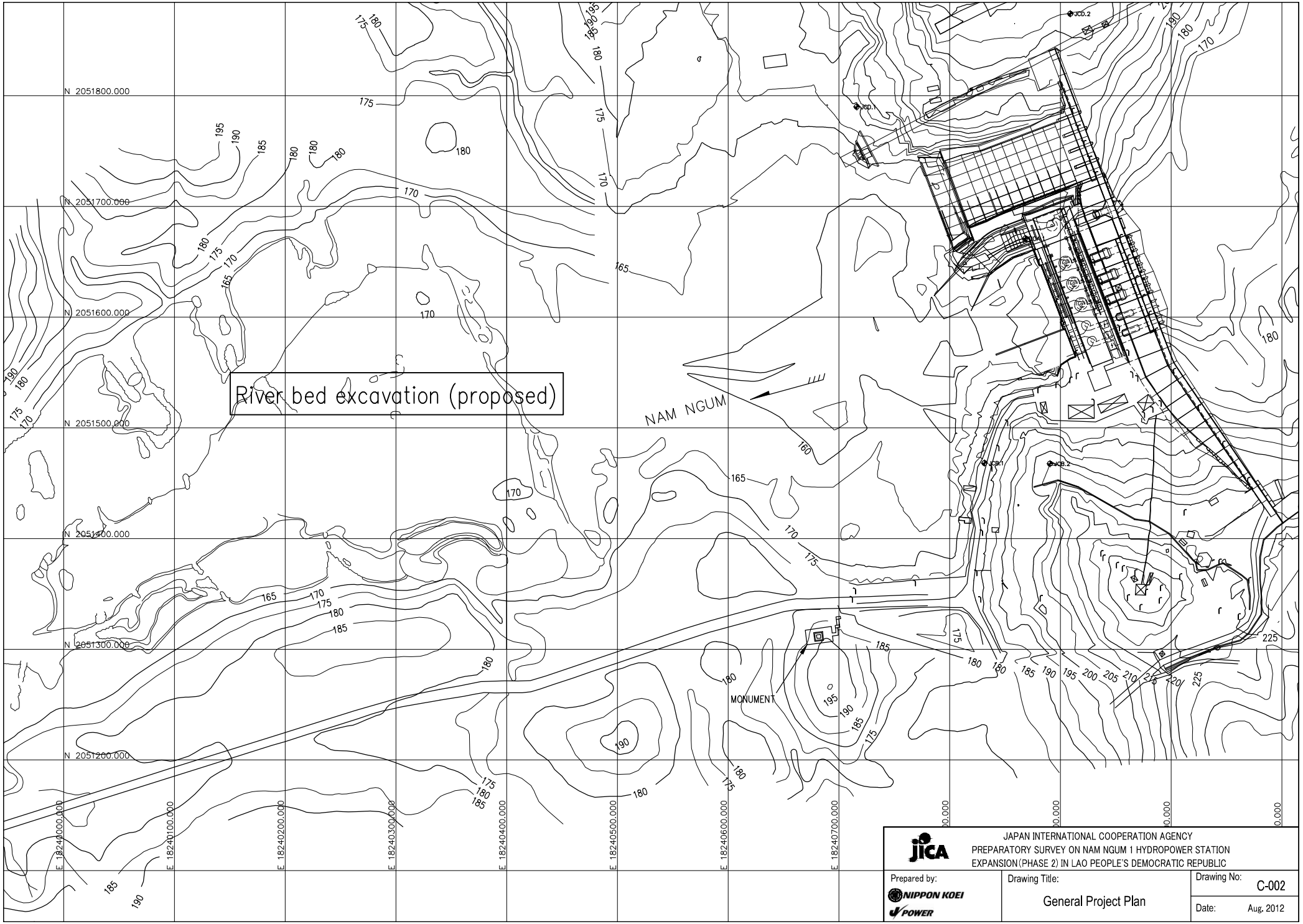
Basic Design Drawings

	Dwg. No.	Title
1	C-001	Location Map (Laos map + Vientiane to dam site)
2	C-002	General Project Plan (dam to downstream river course)
3	C-003	General Arrangement, Before and After Expansion
4	C-004	General Arrangement, Plan, Profile & Sections (intake to tailrace)
5	C-011	Geological Plan
6	C-012	Geological Section
7	C-101	Intake and Penstock, Profile and Front View
8	C-102	Intake, Temporary Enclosure for Construction
9	C-211	Powerhouse, Floor Plan, El. 177.0 m
10	C-212	Powerhouse, Floor Plan, El. 172.5 m & El.168.5m
11	C-213	Powerhouse, Floor Plan, El.164.5m & El. 161.0m
12	C-214	Powerhouse, Floor Plan, El.157.0 m & El. 153.0m
13	C-221	Powerhouse, Cross Section A-A
14	C-222	Powerhouse, Cross Section B-B
15	C-223	Powerhouse, Longitudinal Section C-C
16	C-224	Powerhouse, Longitudinal Section D-D
17	C-225	Powerhouse, Longitudinal Section E-E
18	C-226	Powerhouse, Longitudinal Section F-F
19	C-230	Tailrace Channel, Plan & Sections
20	C-240	Powerhouse and Tailrace, Excavation Plan & Sections
21	H-010	Hydraulic Steel Works, Intake Trashrack
22	H-020	Hydraulic Steel Works, Penstock Pipe
23	H-030	Hydraulic Steel Works, Draft Tube Gate Slot & Gantry Crane
24	E-001	Electrical Connection Diagram (1), Overall Scheme
25	E-002	Electrical Connection Diagram (2), Main Circuits for Unit 6
26	E-003	Electrical Connection Diagram (3), Station Service Circuits
27	E-011	Schematic Diagram (1), Pressure Oil and Compressed Air Supply System
28	E-012	Schematic Diagram (2), Cooling Water Supply and Drainage System
29	E-021	115kV Outdoor Switchyard, Equipment Layout Plan
30	E-022	115kV Outdoor Switchyard, Equipment Layout Section



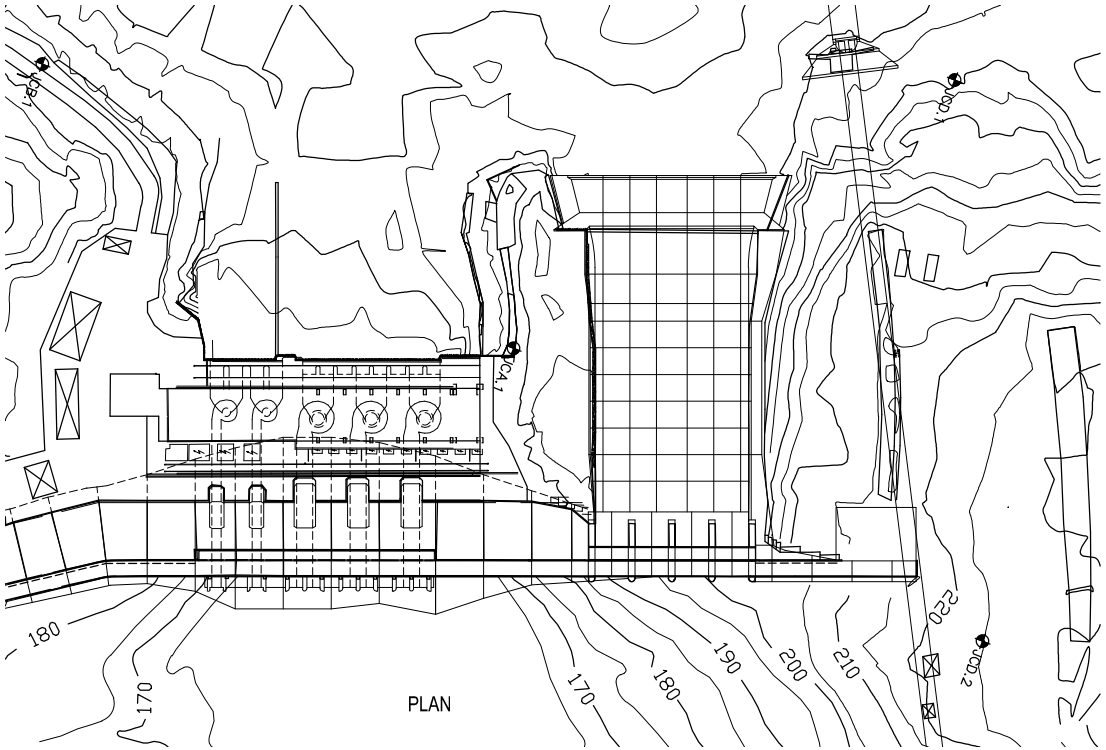


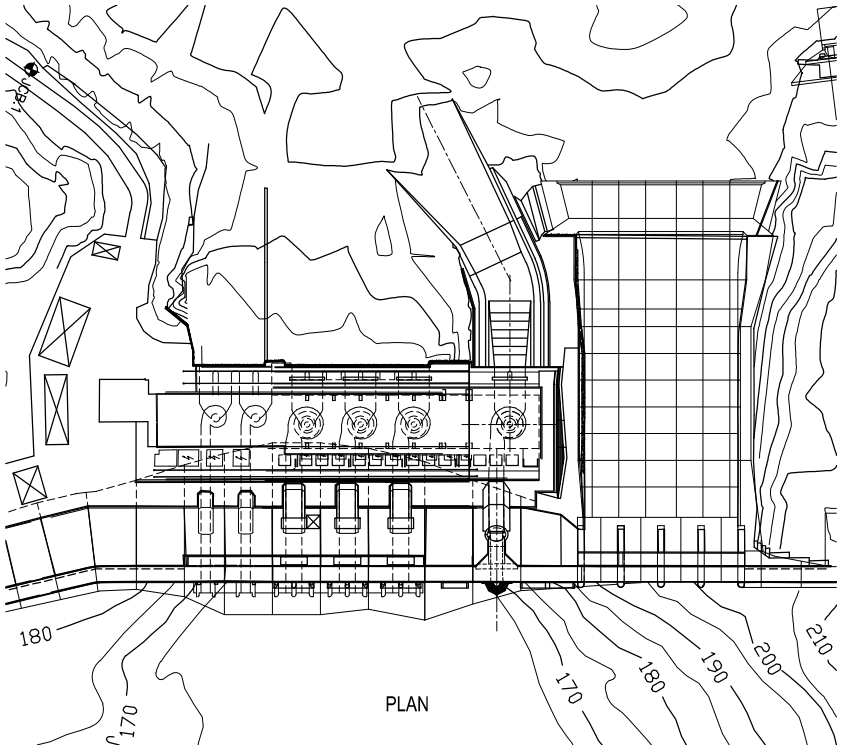
JICA	JAPAN INTERNATIONAL COOPERATION AGENCY PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC	
Prepared by: NIPPON KOEI J-POWER	Drawing Title: Location Map	Drawing No: C-001 Date: Aug. 2012

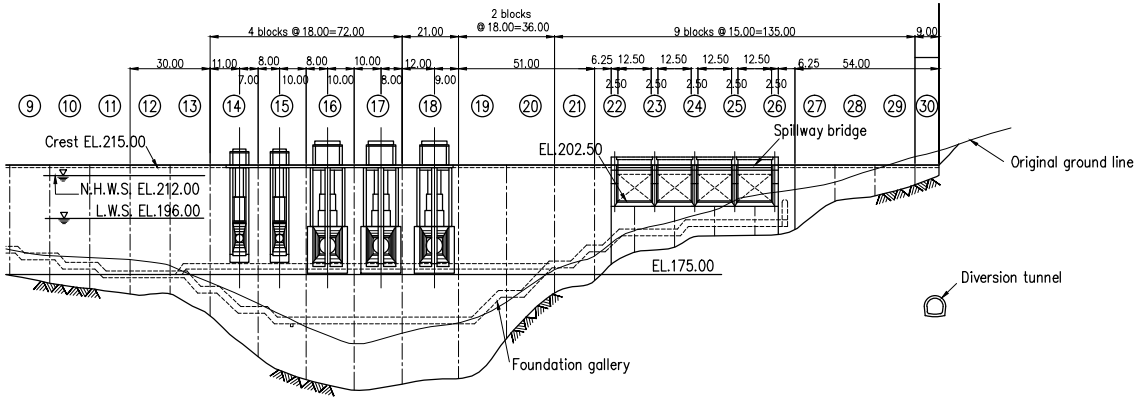


JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	General Project Plan	C-002
		Date: Aug. 2012

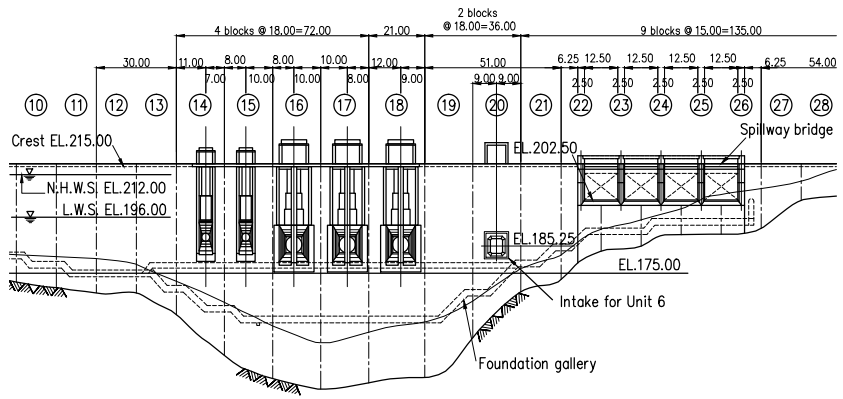






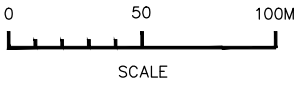
UPSTREAM ELEVATION

BEFORE EXPANSION



UPSTREAM ELEVATION

AFTER EXPANSION



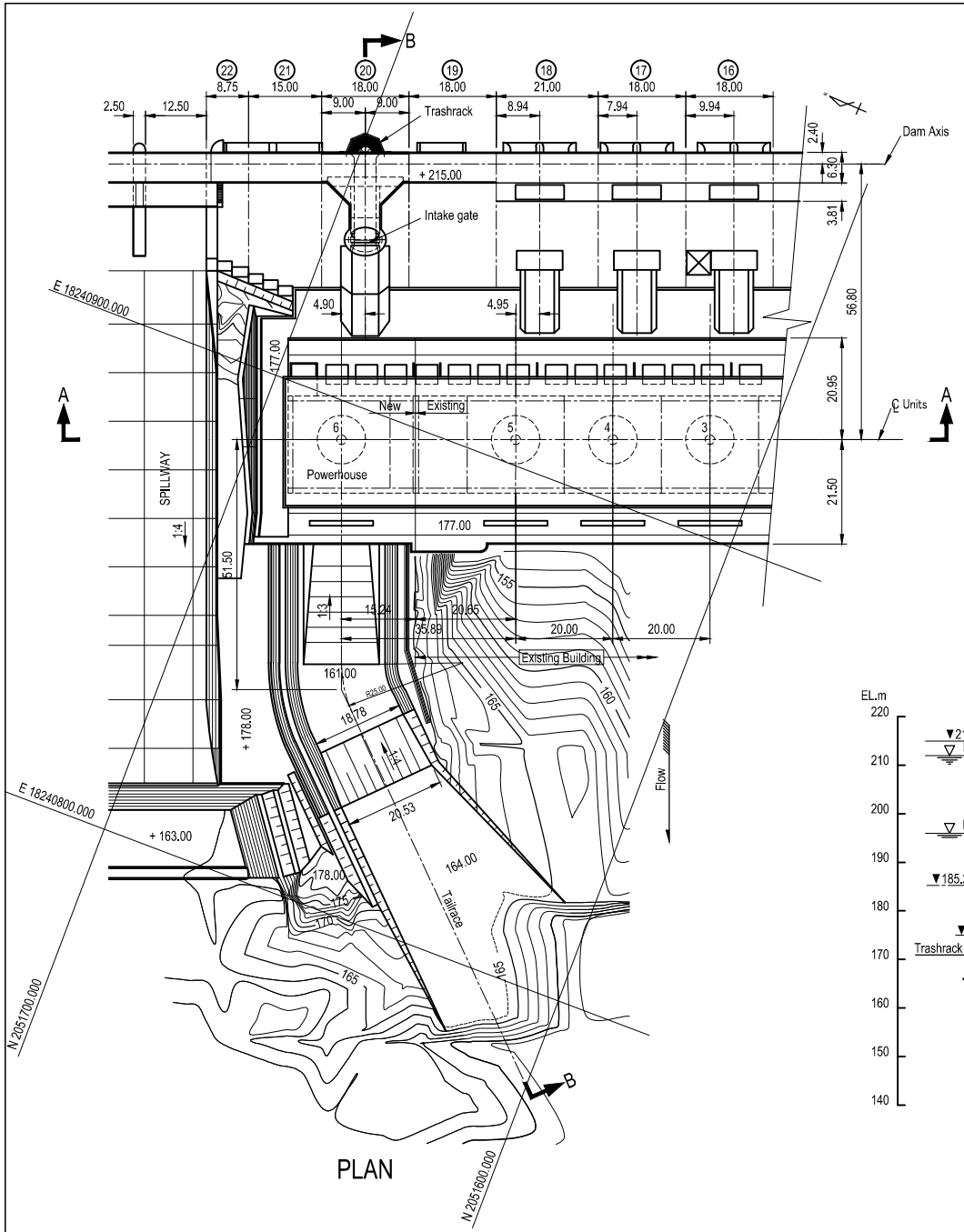
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

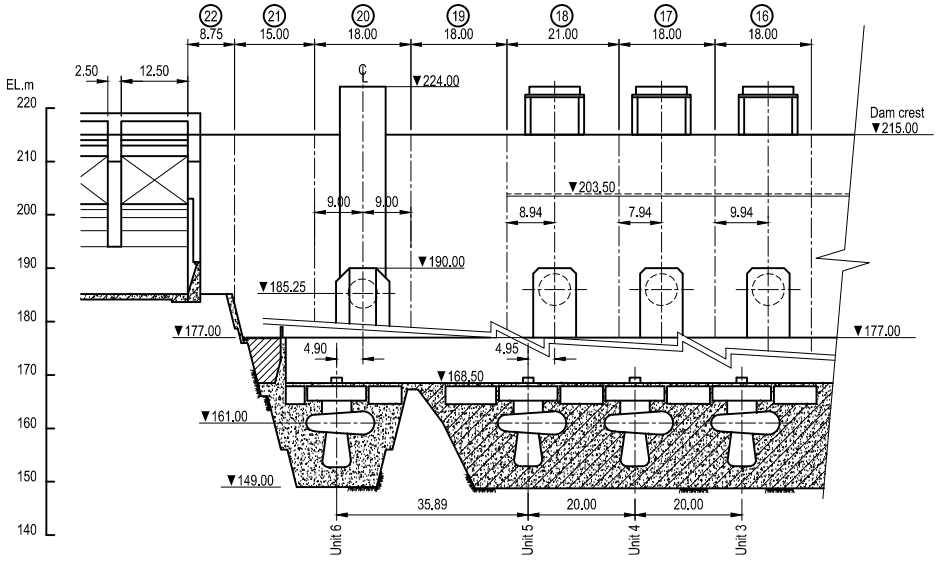
Prepared by: NIPPON KOEI, J-POWER

Drawing Title: General Arrangement Before and After Expansion

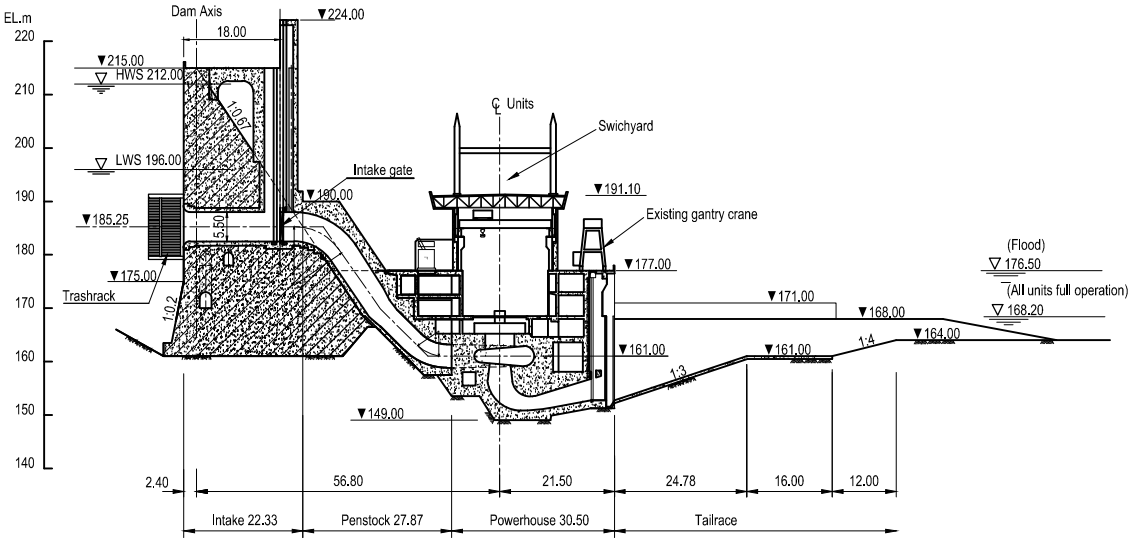
Drawing No: C-003

Date: Aug. 2012

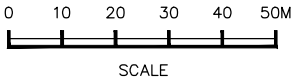




SECTION A-A

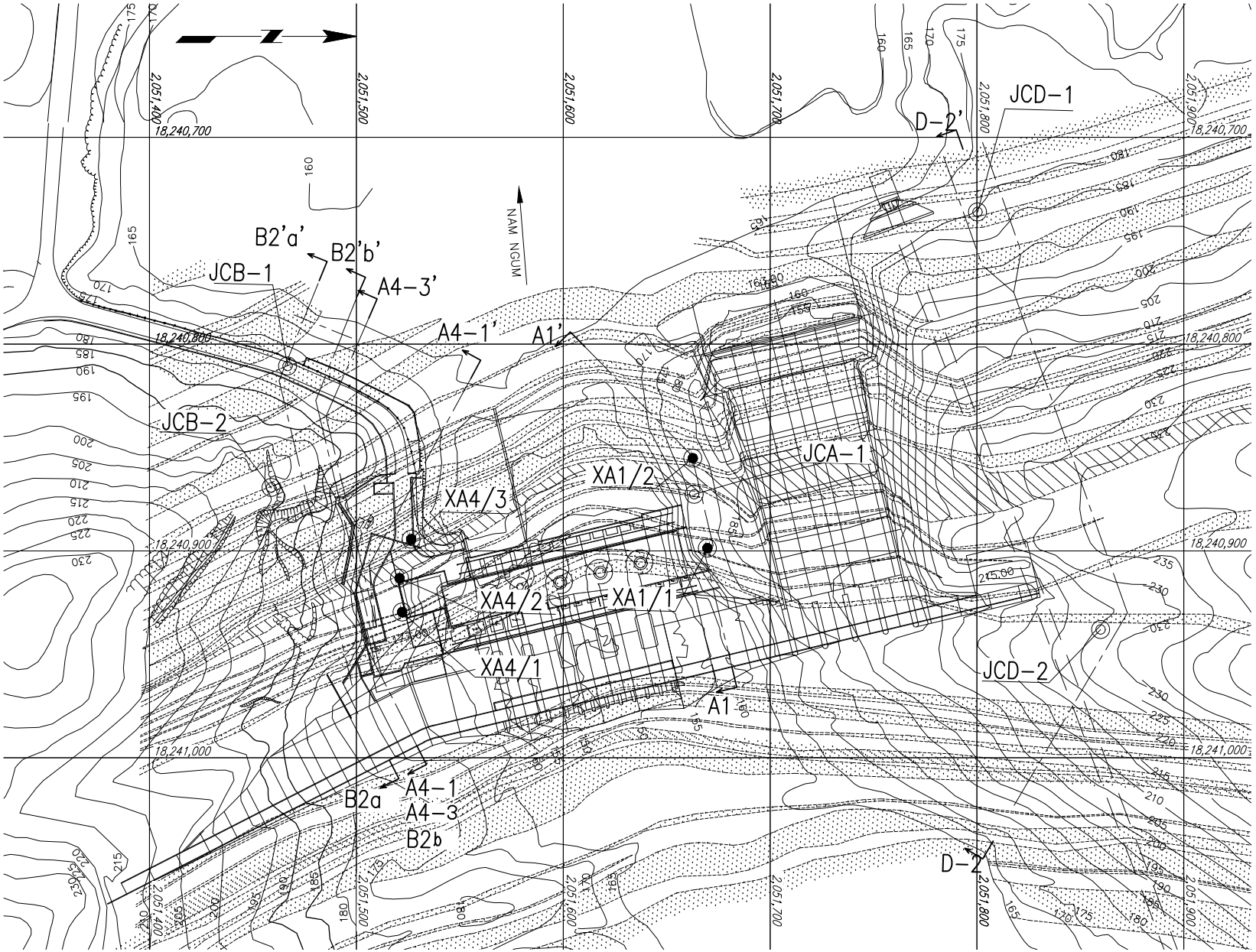


SECTION B-B



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	General Arrangement Plan and Sections	C-004
		Date: Aug. 2012



LEGEND

XA1/2 Drilling Location

Section Location

Boundary of Geology

Geology

- Sandstone
- Mudstone
- Mudstone(weak zone)

Weathering

- Highly Weathered
- Moderately Weathered
- Slightly Weathered

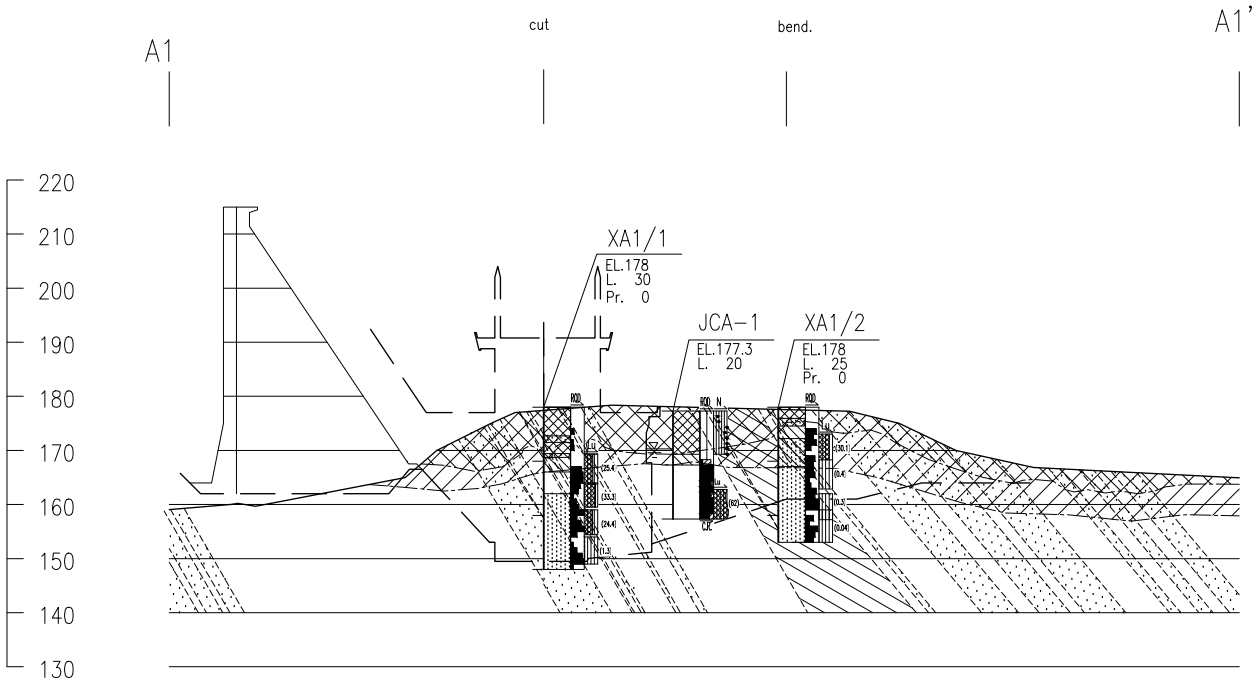
Drillhole (F/S by JICA ,2009)
JCA-1, JCB-1, JCB-2,
JCD-1, JCD-2

Drillhole (F/S by Lahmeyer, 1995)
XA1/1, XA1/2
XA4/1, XA4/2, XA4/3

0 50 100M
SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION(PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No: C-011
NIPPON KOEI / J-POWER	Geological Plan	Date: Aug. 2012



LEGEND

- Boundary of Geology
- Boundary of Weathering
- Section Location
- bend. Bending Point
- cut Omitting Point

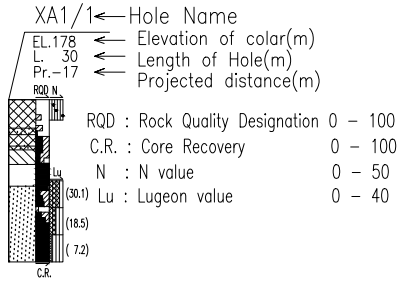
Geology

- Sandstone
- Mudstone
- Mudstone (weak)

Weathering

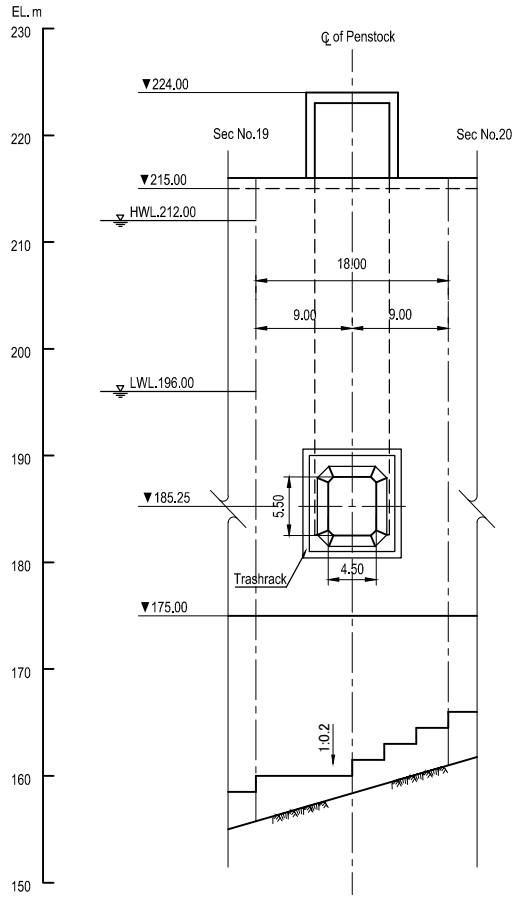
- Highly Weathered
- Moderately Weathered
- Fresh

Geological Log of Drill Hole

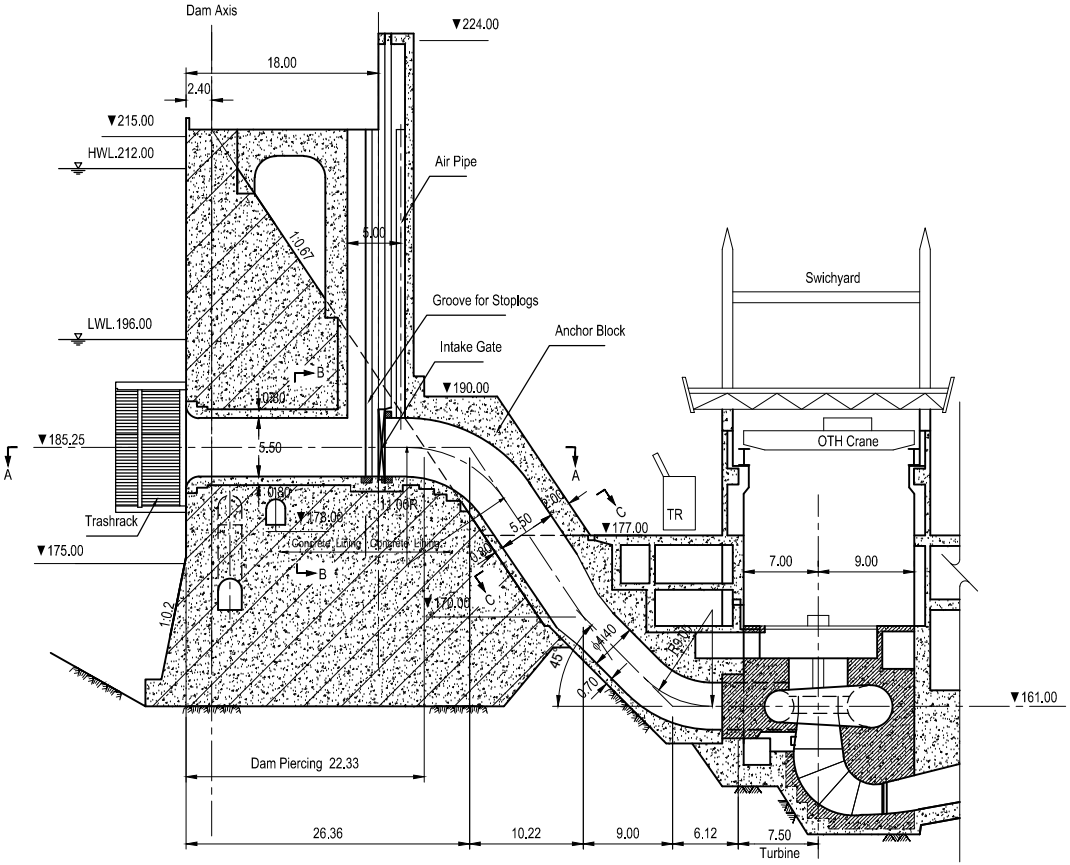


JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

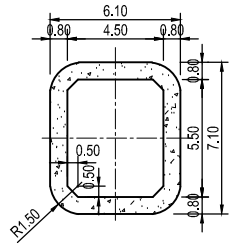
Prepared by:	Drawing Title:	Drawing No: C-012
NIPPON KOEI / J-POWER	Geological Section (A1-A1')	Date: Aug. 2012



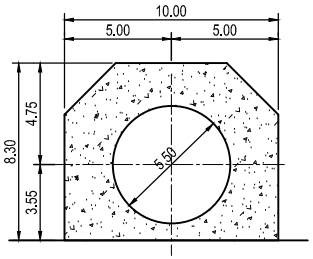
FRONT VIEW



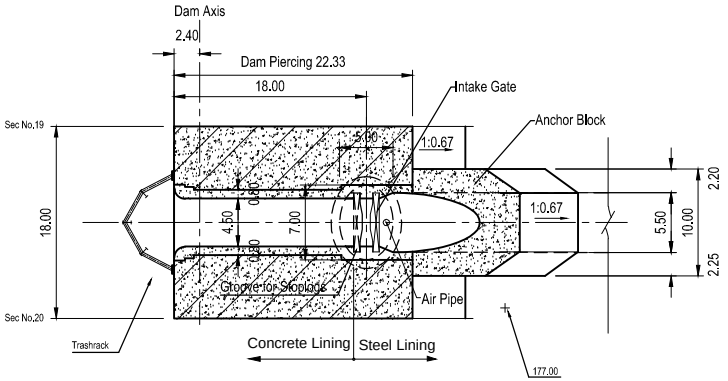
PROFILE



SECTION B-B
(Dam Piercing)

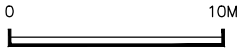


SECTION C-C
(Anchor Block)



SECTION A-A (EL.185.25m)

SECTION B-B, C-C

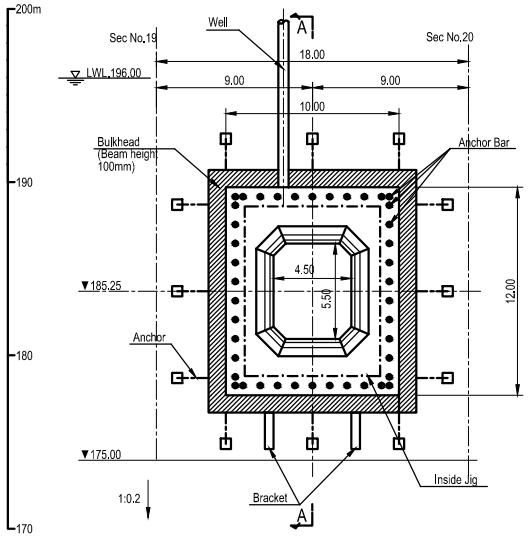


FRONT VIEW, PROFILE and SECTION A-A

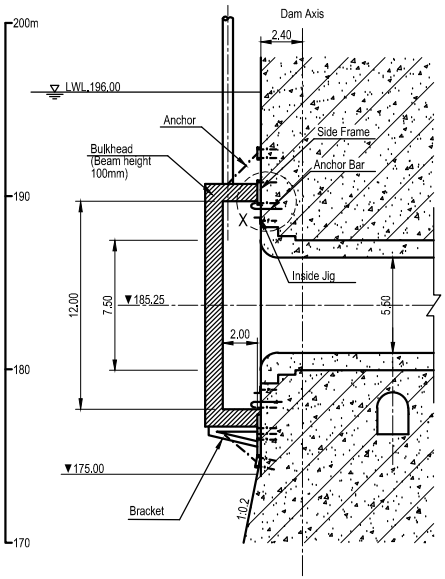
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Intake and Penstock Profile and Front View	C-101
		Date: Aug. 2012

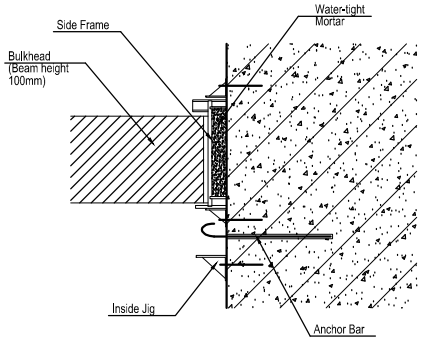
Stage-1 (During Placement of Bulkhead)



FRONT VIEW

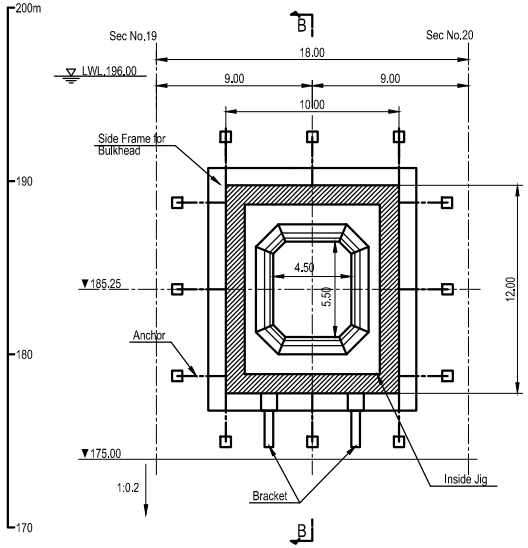


PROFILE (SECTION A-A)

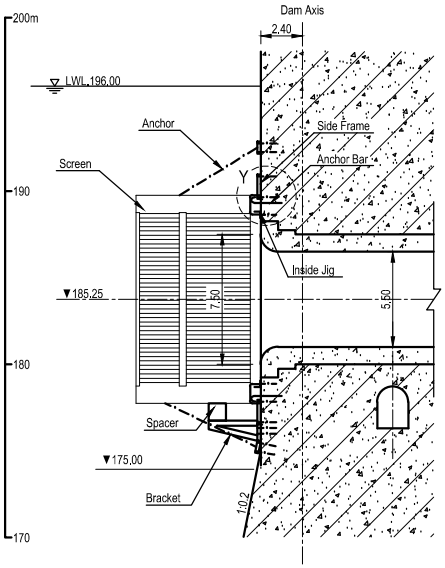


Detail of X

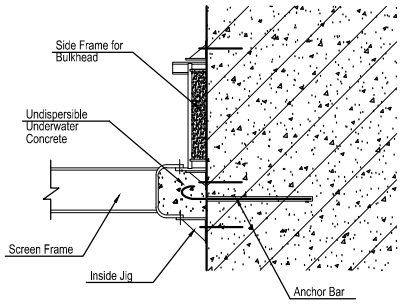
Stage-2 (After Placement of Screen)



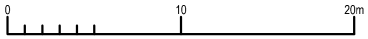
FRONT VIEW



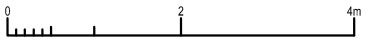
PROFILE (SECTION B-B)



Detail of Y



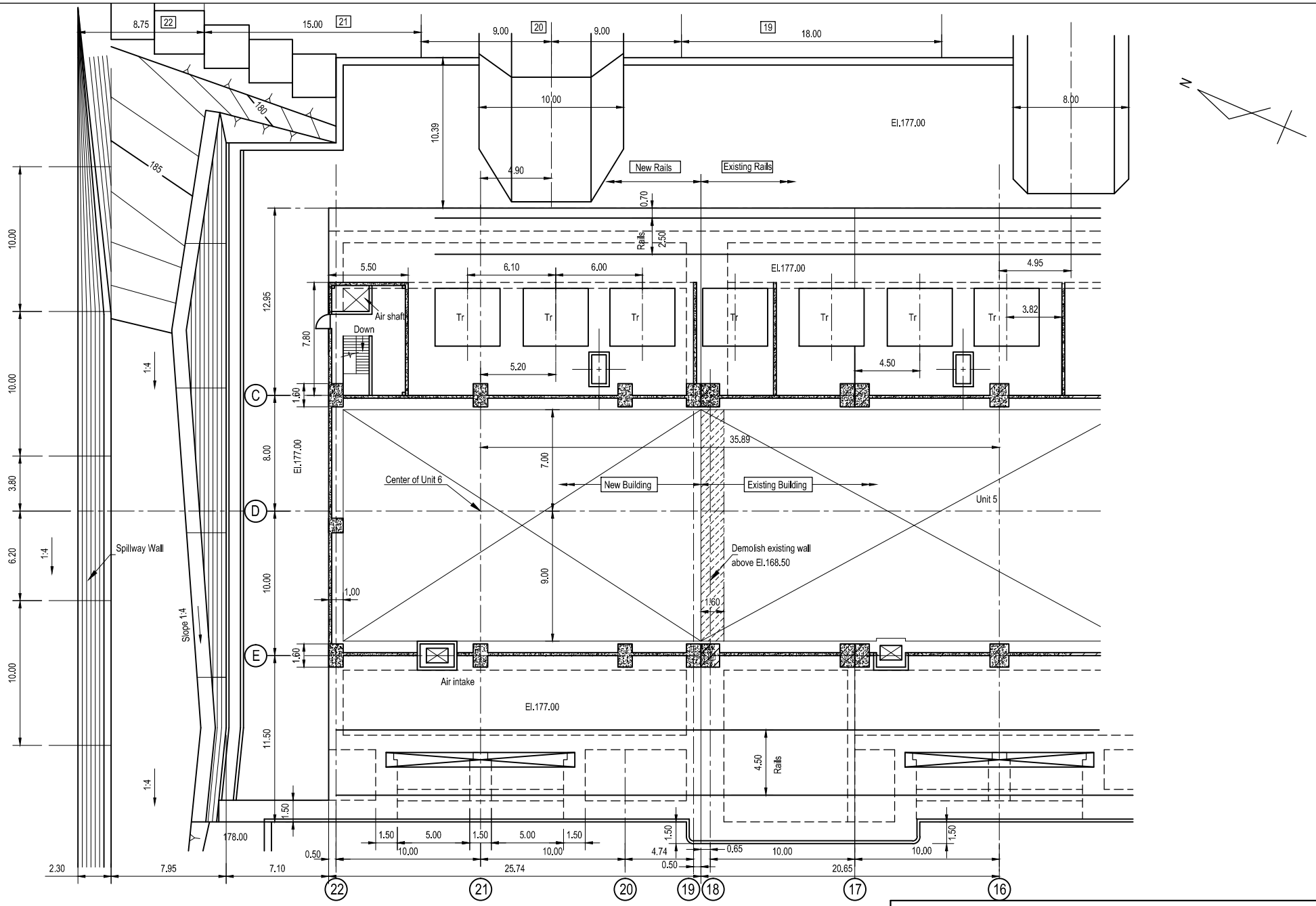
(Front View ,Profile)



(Detail)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No: C-102
NIPPON KOEI / J-POWER	Intake Temporary Enclosure for Consturction	Date: Aug. 2012



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI, POWER

Drawing Title: Powerhouse Floor Plan, El.177.0m

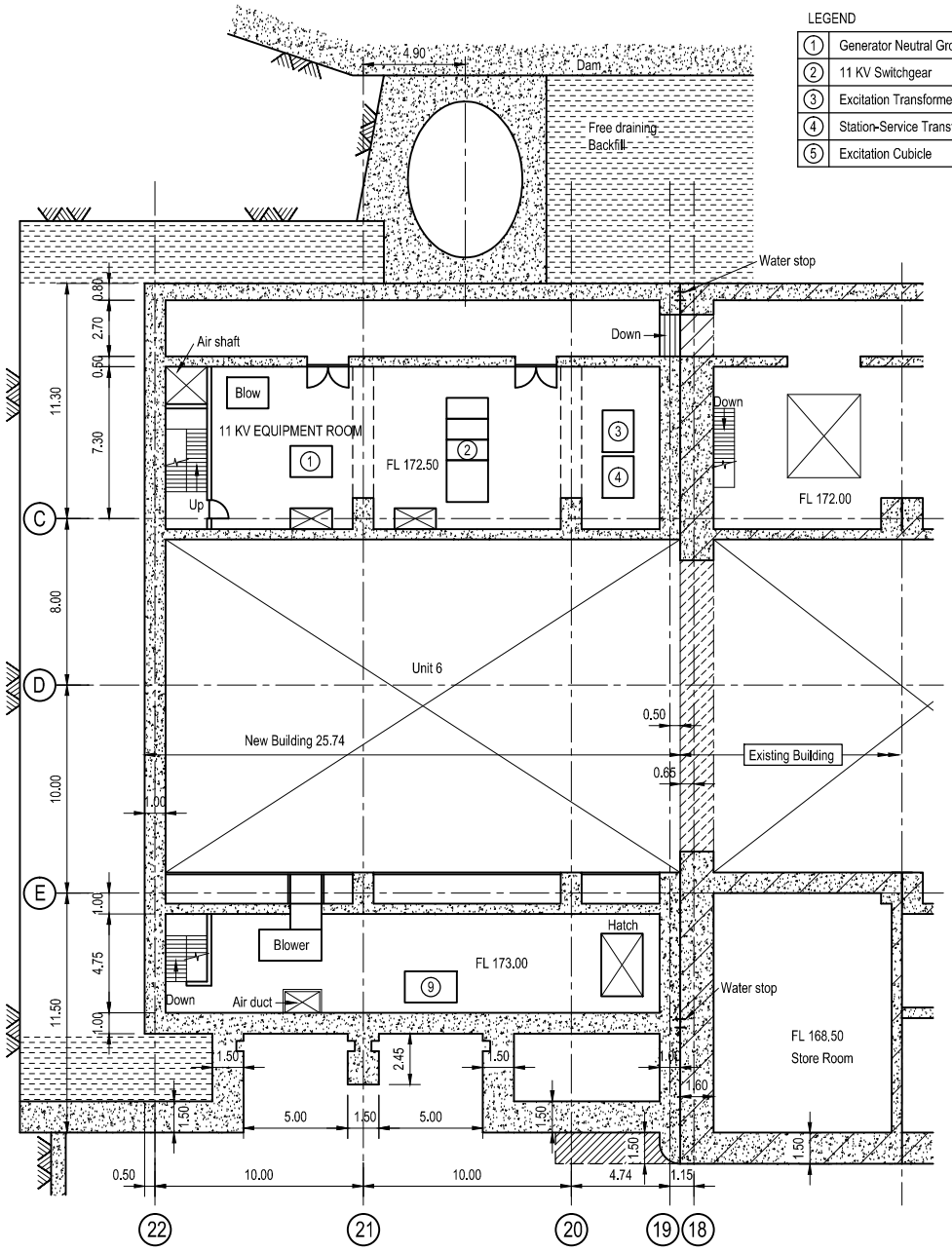
Drawing No: C-211

Date: Aug. 2012

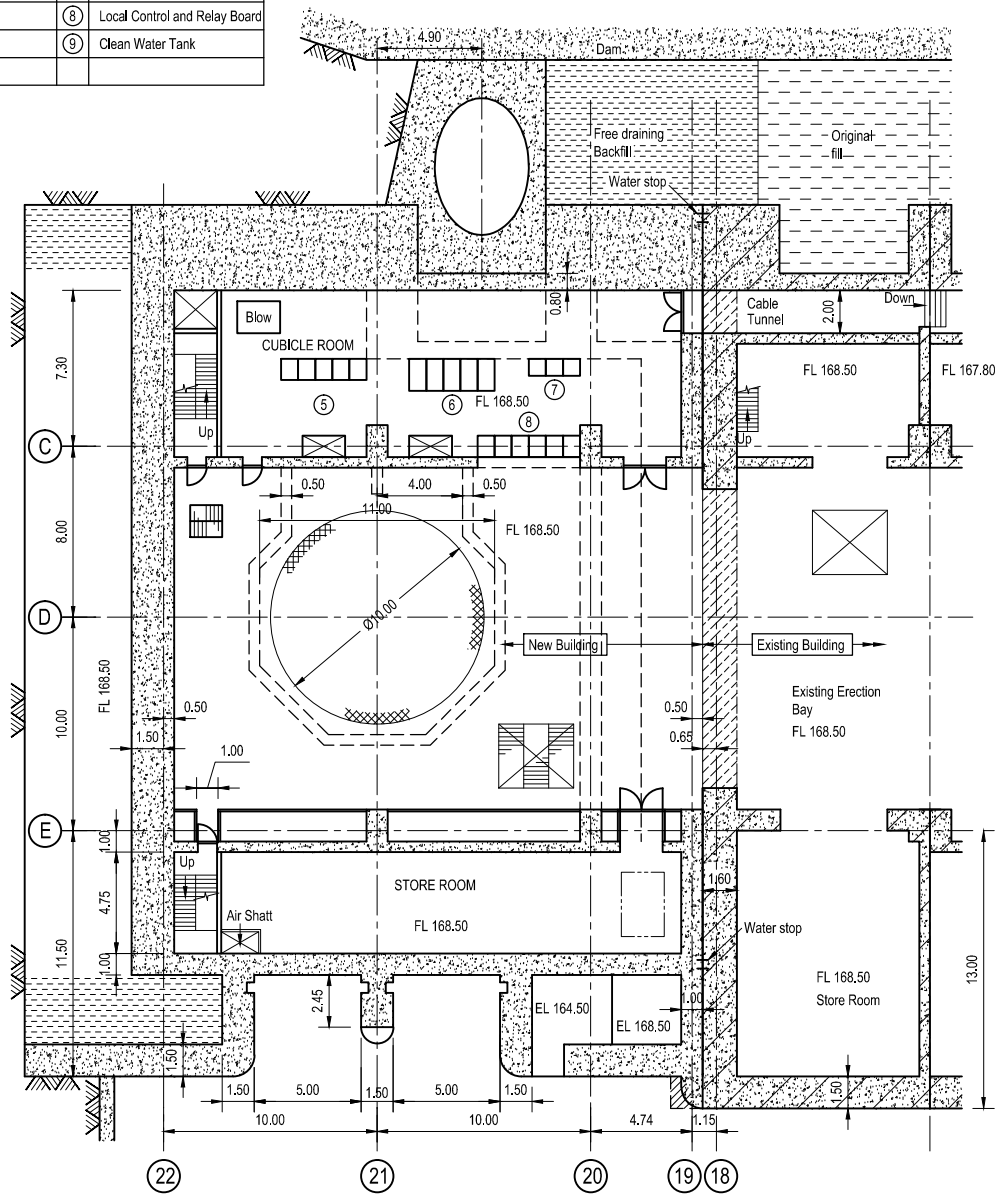
LEGEND

①	Generator Neutral Grounding Transformer	⑥	Low Voltage Switchgear
②	11 KV Switchgear	⑦	AC/DC Distribution Panel
③	Excitation Transformer	⑧	Local Control and Relay Board
④	Station-Service Transformer	⑨	Clean Water Tank
⑤	Excitation Cubicle		

Demolition of Existing Concrete



FLOOR 172.5 &173.0 M



FLOOR 168.5 M

0 5 10M

SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER

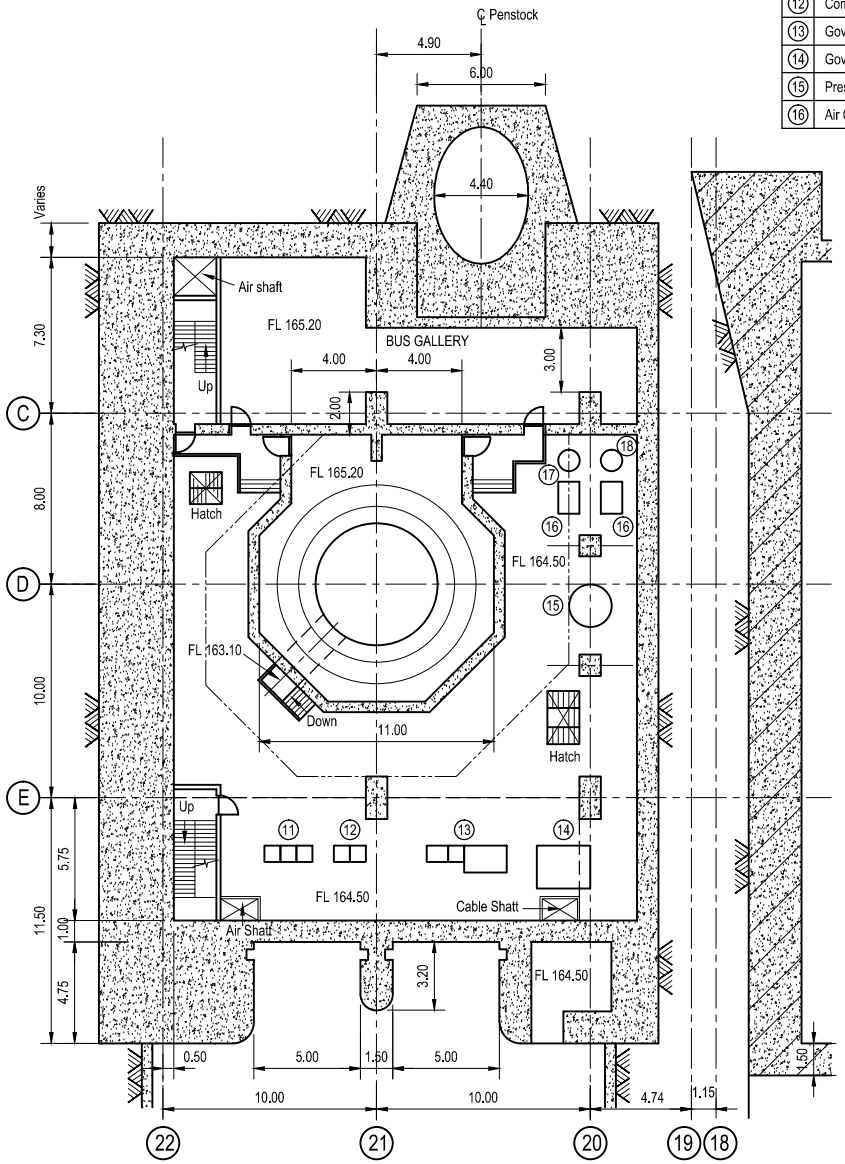
Drawing Title: Powerhouse Floor Plan, El.172.5m & El.168.5m

Drawing No: C-212

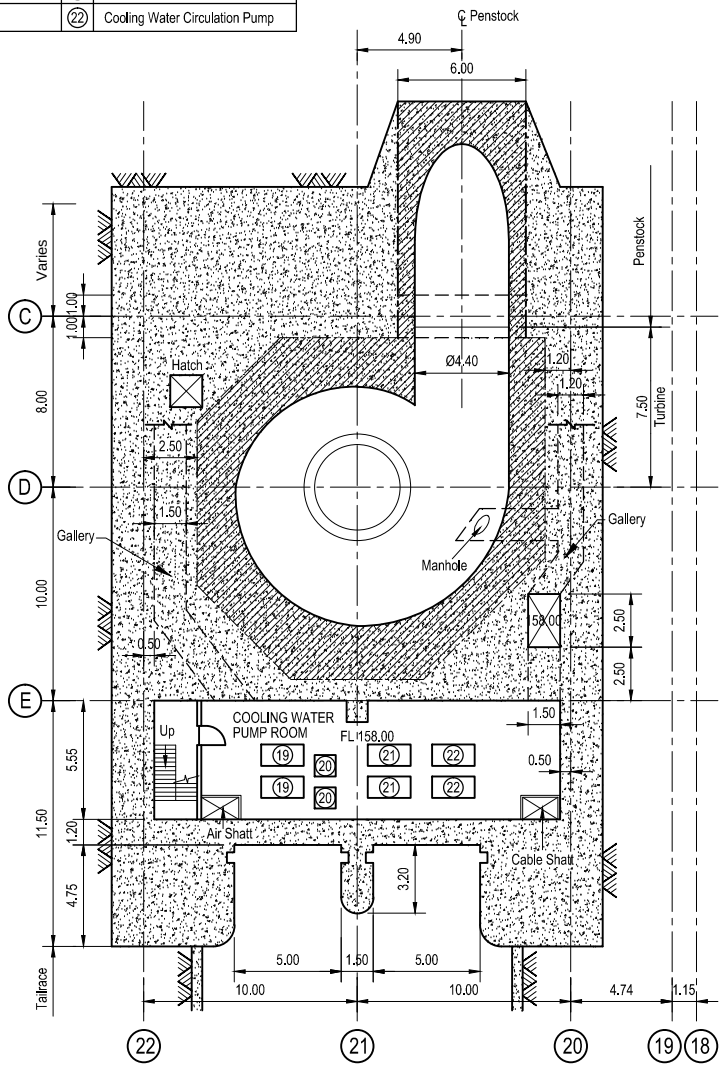
Date: Aug 2012

LEGEND

⑪	Unit Motor Control Center	⑰	Primary Air Tank
⑫	Common Motor Control Center	⑱	Brake Air Tank
⑬	Governon and Turbine Control Panel	⑲	Raw Water Pump
⑭	Governon Oil Sump Tank with Pressure Oil Pumps	⑳	Raw Water Strainer
⑮	Pressure Oil Tank	㉑	Water-to-Water Heat Exchanger
⑯	Air Compressor	㉒	Cooling Water Circulation Pump



FLOOR 164.5 &165.2 M



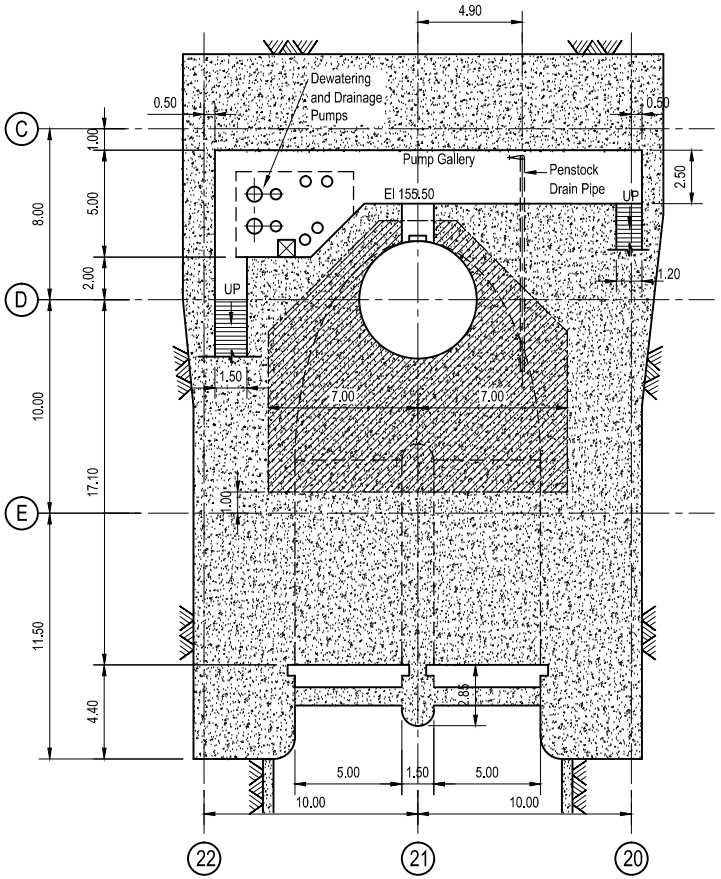
SECTION AT EL.161.0 M

0 5 10M

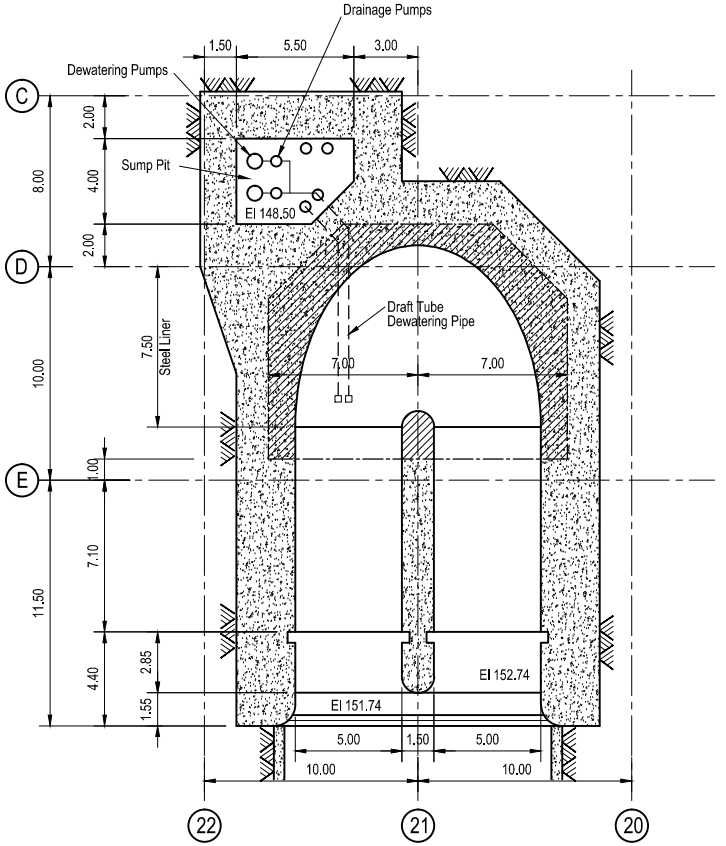
SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER	Drawing Title: Powerhouse Floor Plan, El.164.5m & El.161.0m	Drawing No: C-213
		Date: Aug. 2012



SECTION AT EL. 157 M



SECTION AT EL. 153 M

0 5 10M

SCALE

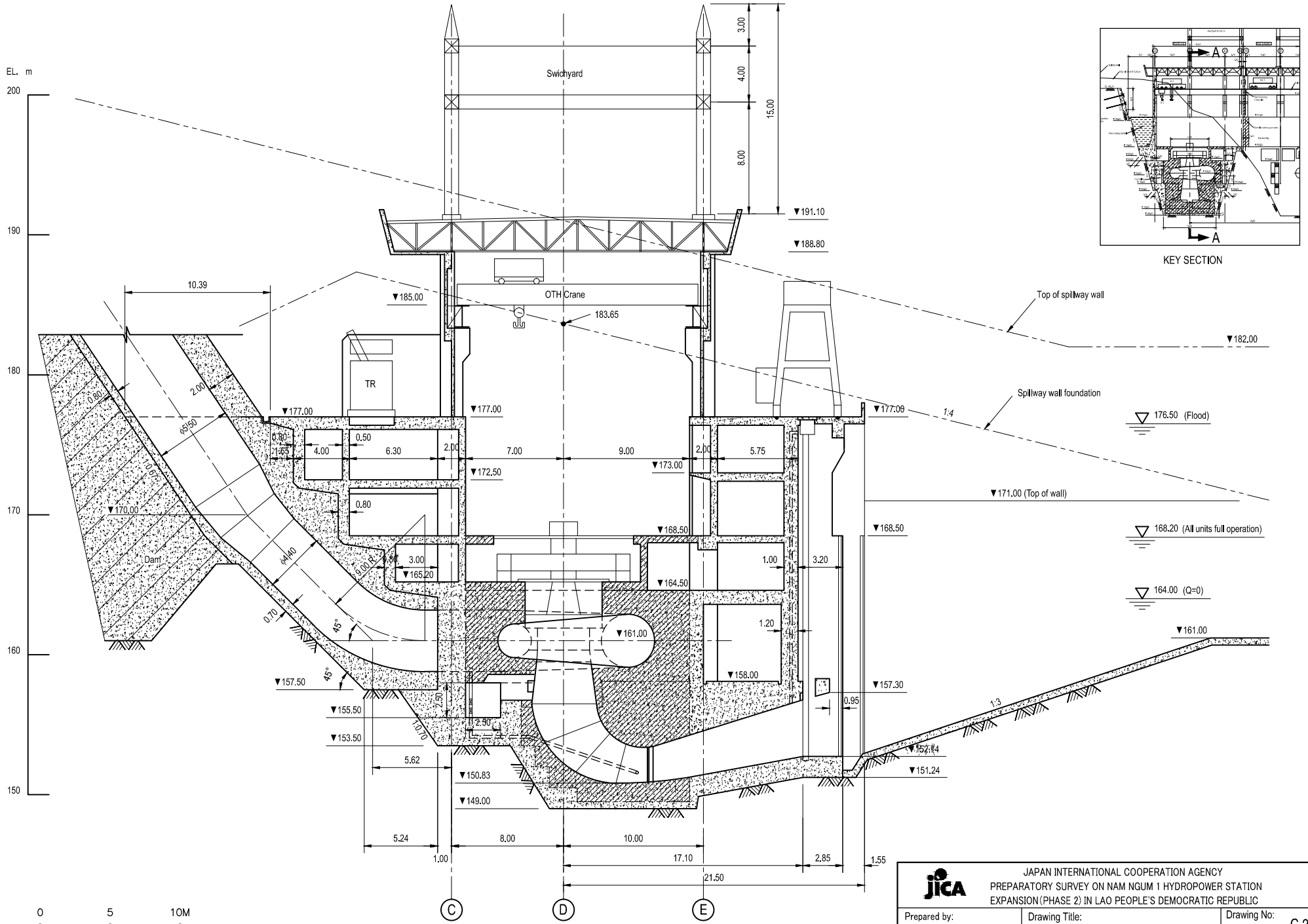
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER

Drawing Title: Powerhouse
Floor Plan, El.157.0m & El.153.0m

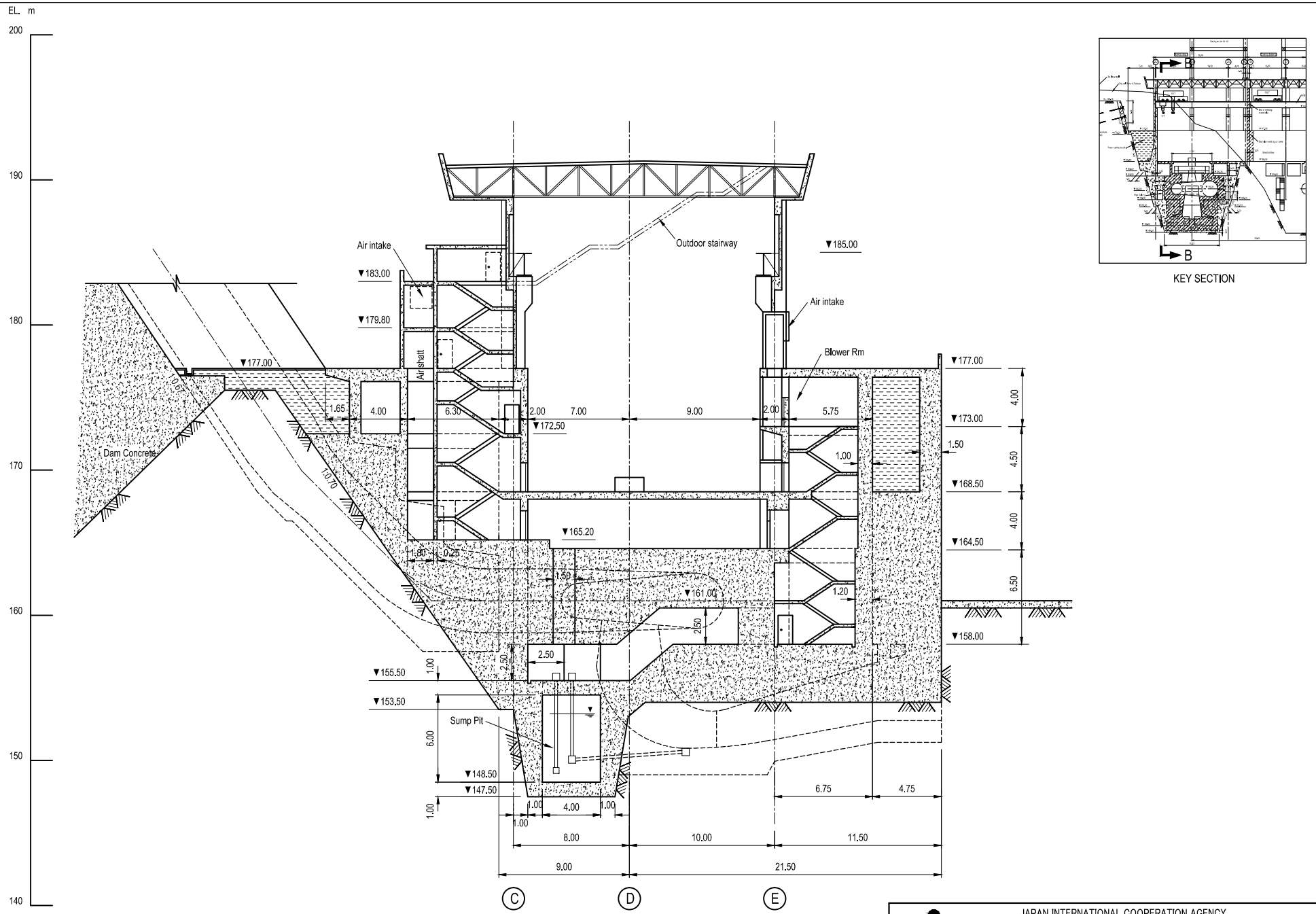
Drawing No: C-214

Date: Aug. 2012



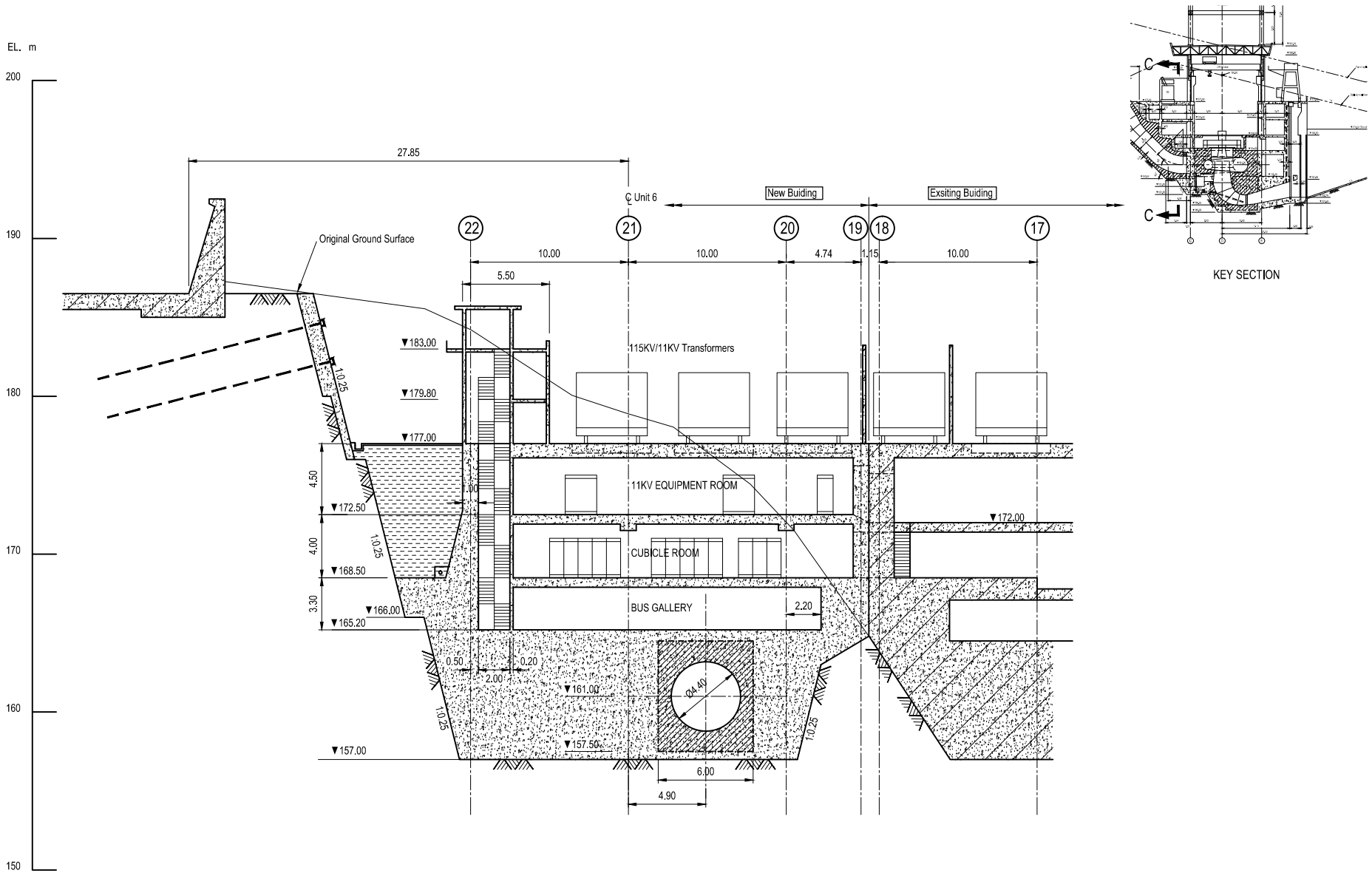
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI POWER	Powerhouse Cross Section A - A	C-221
		Date: Aug. 2012



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER	Drawing Title: Powerhouse Cross Section B - B	Drawing No: C-222
		Date: Aug. 2012



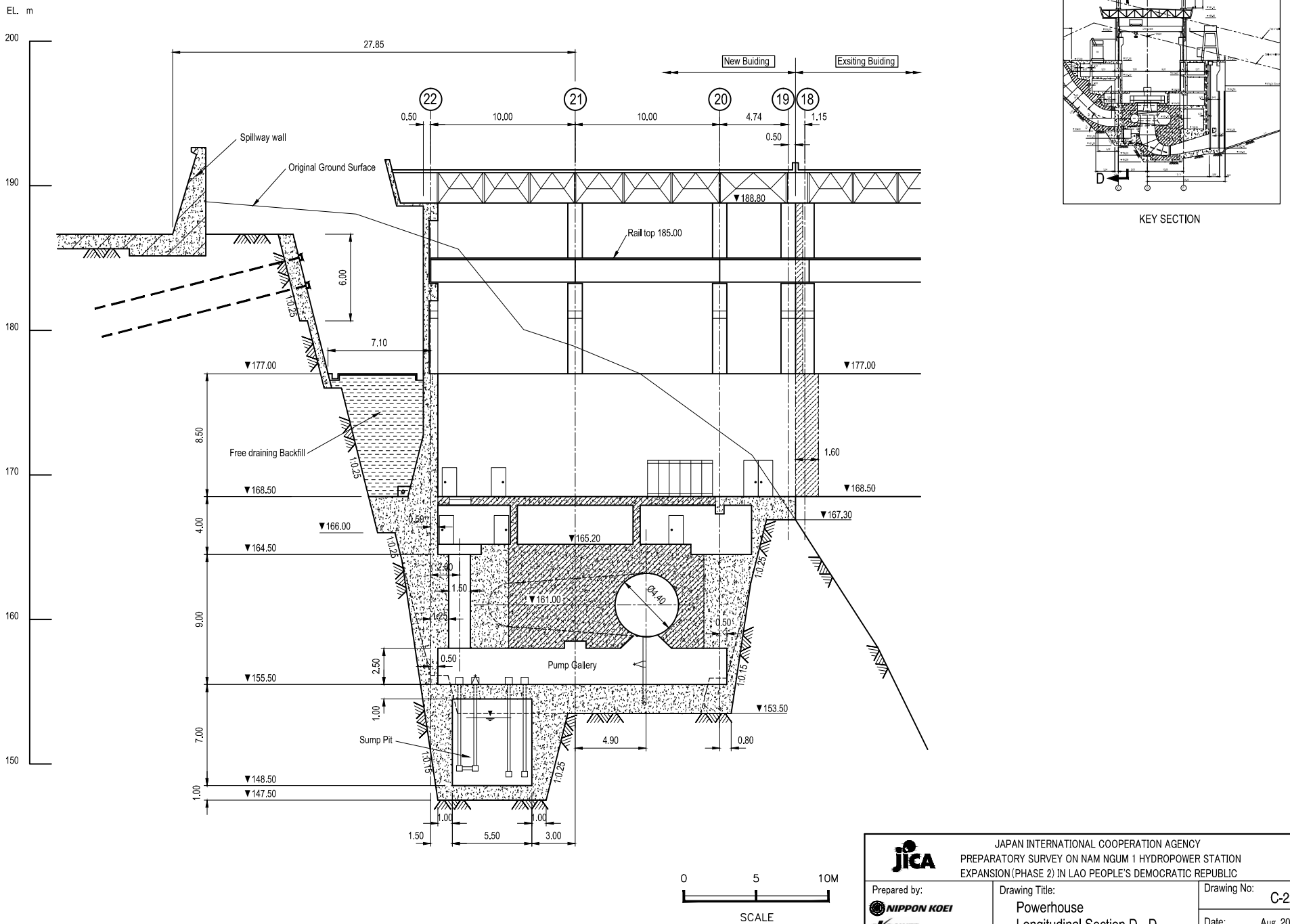
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

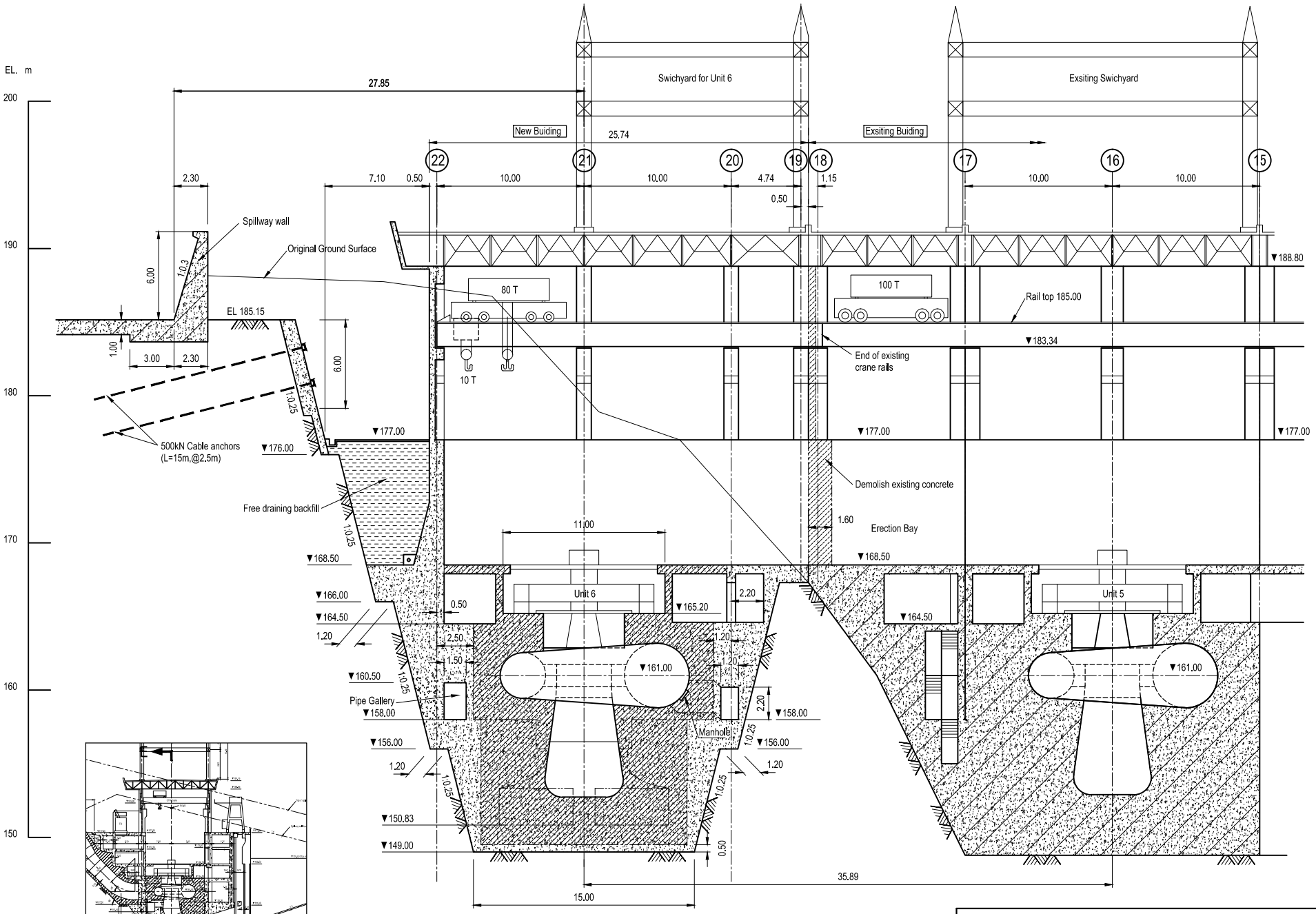
Prepared by: NIPPON KOEI / POWER

Drawing Title: Powerhouse
Longitudinal Section C - C

Drawing No: C-223

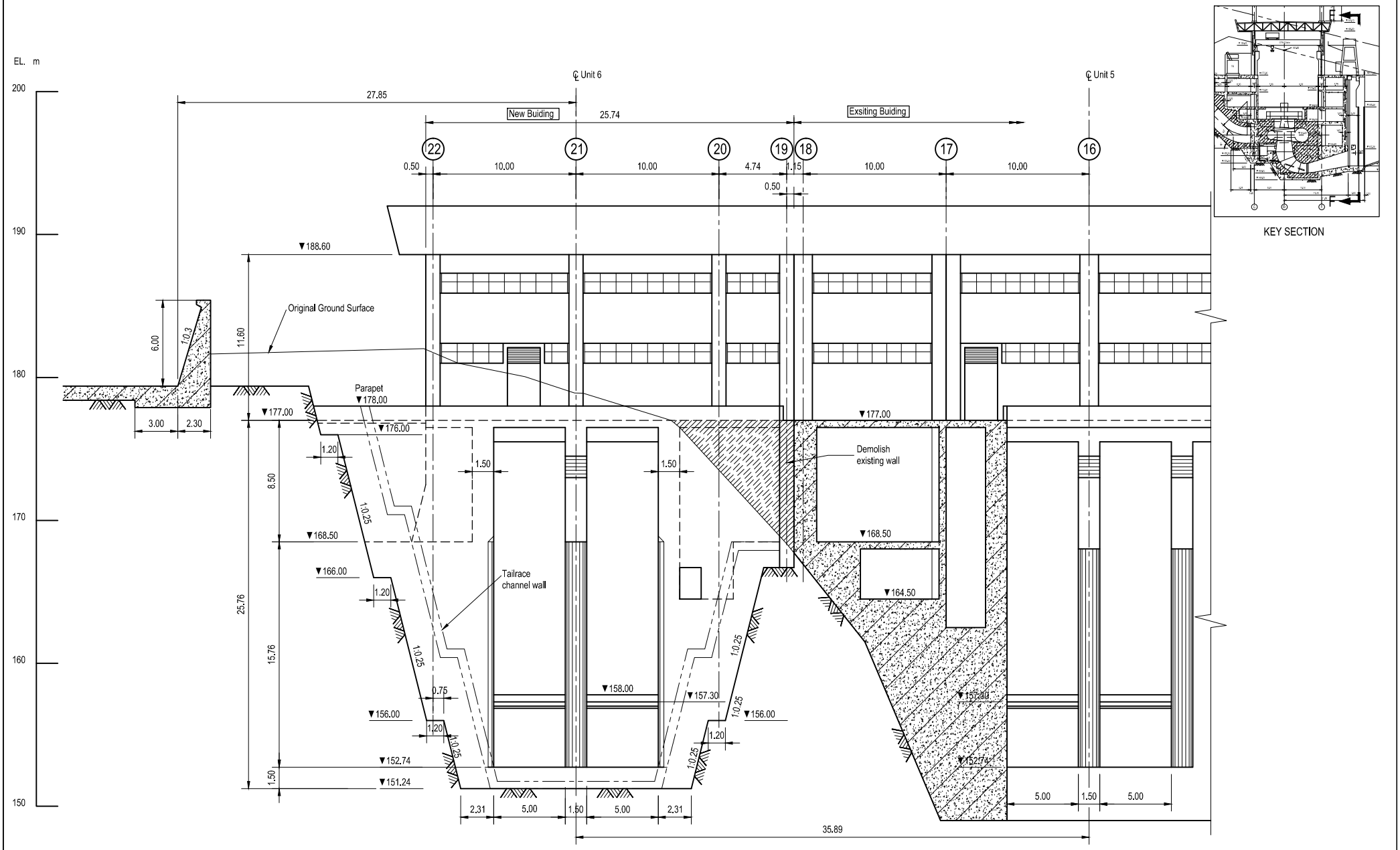
Date: Aug. 2012


EL. m
200
190
180
170
160
150
27.85
New Buiding
Exsiting Buiding
22
21
20
19
18
0.50
10.00
10.00
4.74
1.15
0.50
Spillway wall
Original Ground Surface
▼188.80
Rail top 185.00
6.00
1:0.25
7.10
▼177.00
▼177.00
8.50
Free draining Backfill
1:0.25
1.60
▼168.50
▼168.50
▼167.30
4.00
▼166.00
0.50
▼165.20
▼164.50
1:0.25
2.00
1.50
▼161.00
Ø4.40
1:0.25
9.00
1.25
0.50
0.50
Pump Gallery
2.50
▼155.50
1:0.15
1.00
▼153.50
Sump Pit
4.90
0.80
7.00
1:0.15
1:0.25
▼148.50
▼147.50
1.00
1.00
1.00
1.50
5.50
3.00
D
D
KEY SECTION
0
5
10M
SCALE
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC
Prepared by:
NIPPON KOEI
POWER
Drawing Title:
Powerhouse
Longitudinal Section D - D
Drawing No:
C-224
Date:
Aug. 2012



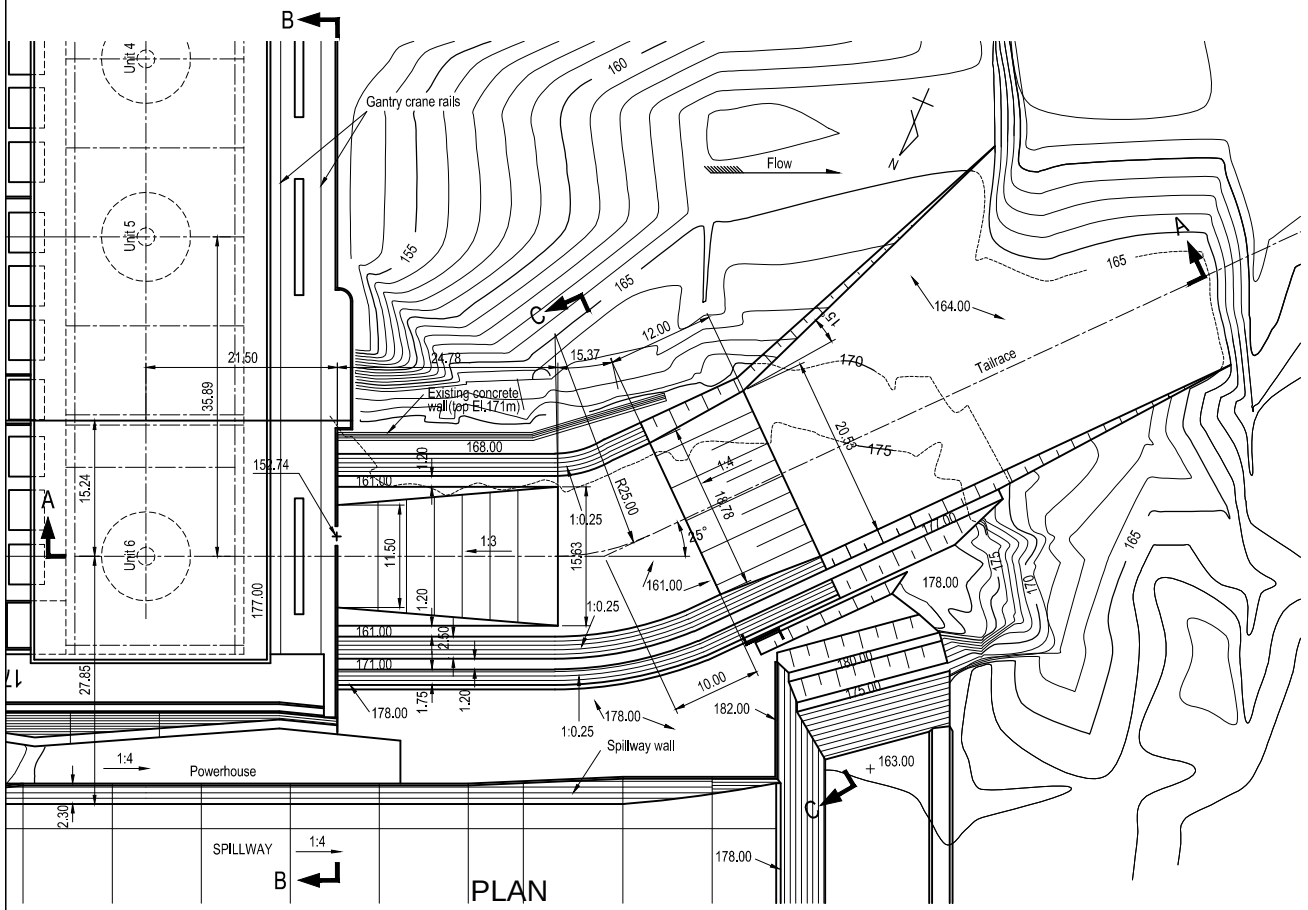
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

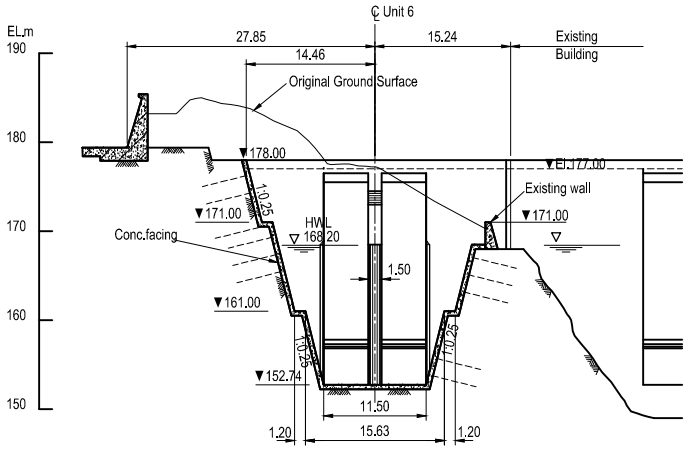
Prepared by: NIPPON KOEI / POWER	Drawing Title: Powerhouse Longitudinal Section E - E	Drawing No: C-225
		Date: Aug. 2012

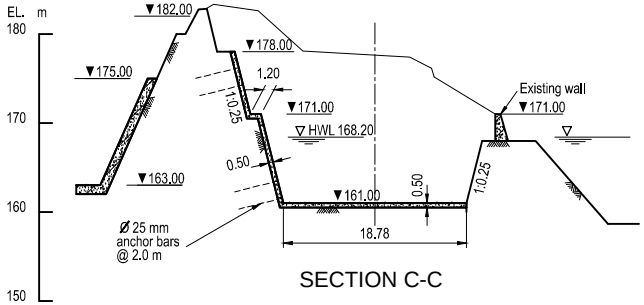


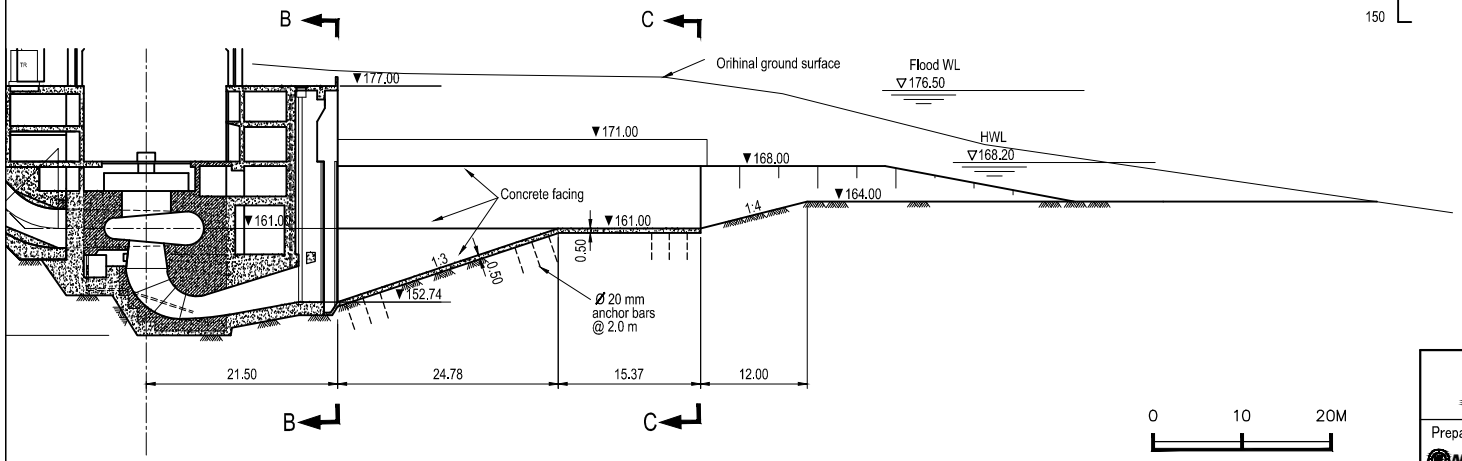
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER	Drawing Title: Powerhouse Longitudinal Section F - F	Drawing No: C-226
		Date: Aug. 2012



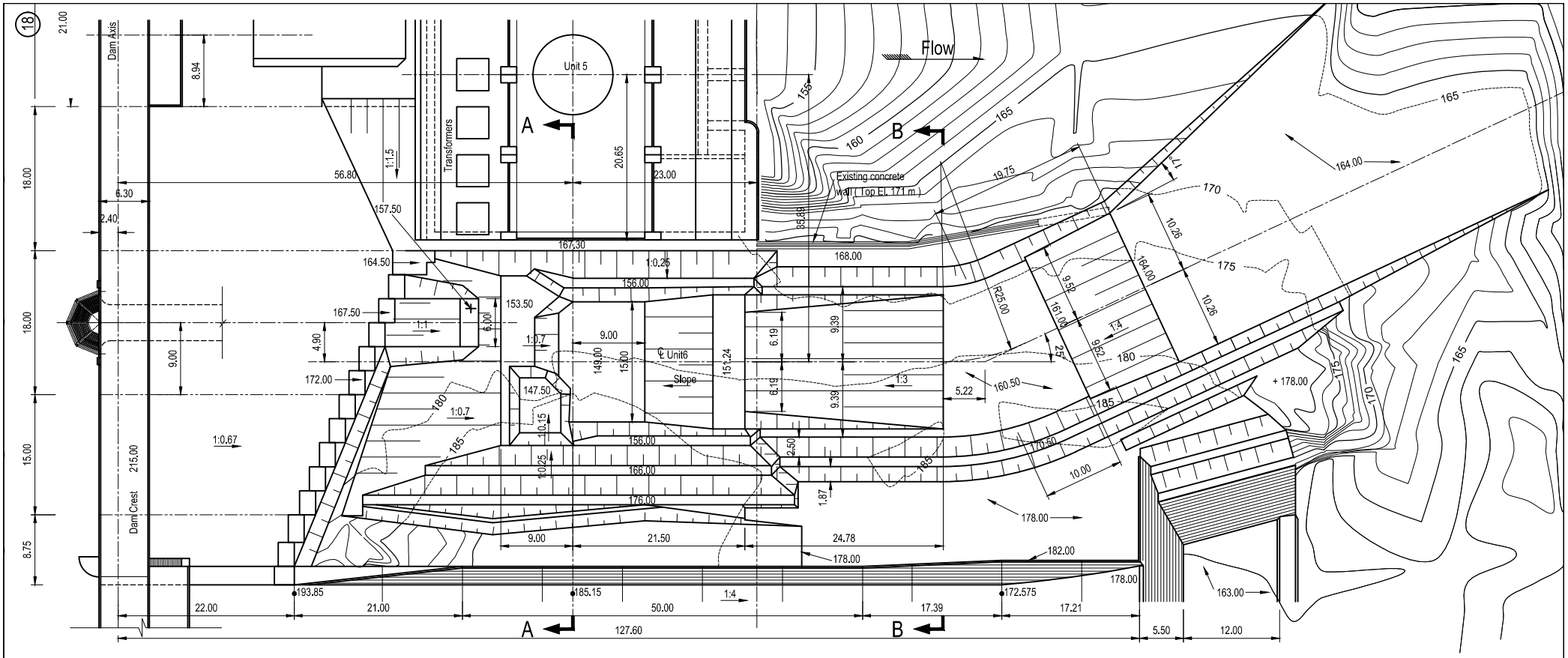






JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Tailrace Channel Plan and Sections	C-230
		Date: Aug. 2012



PLAN

SECTION A-A

SECTION B-B

0 10 20M

SCALE

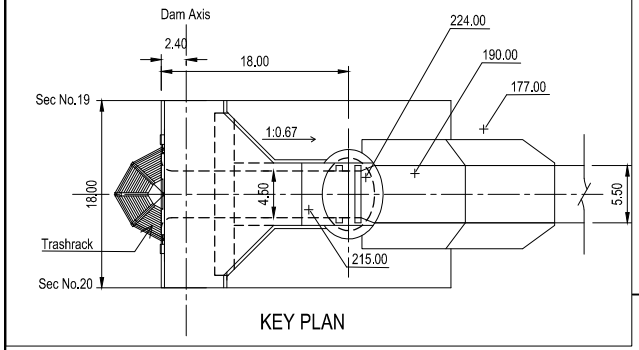
JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by: NIPPON KOEI / POWER

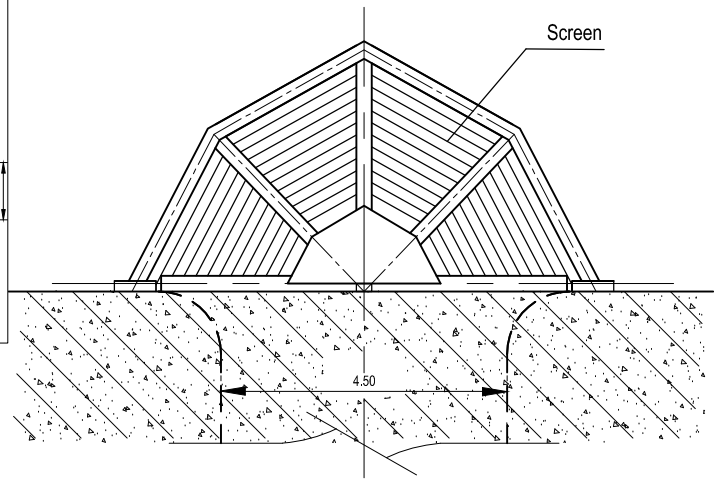
Drawing Title: Powerhouse and Tailrace Excavation Plan & Sections

Drawing No: C-240

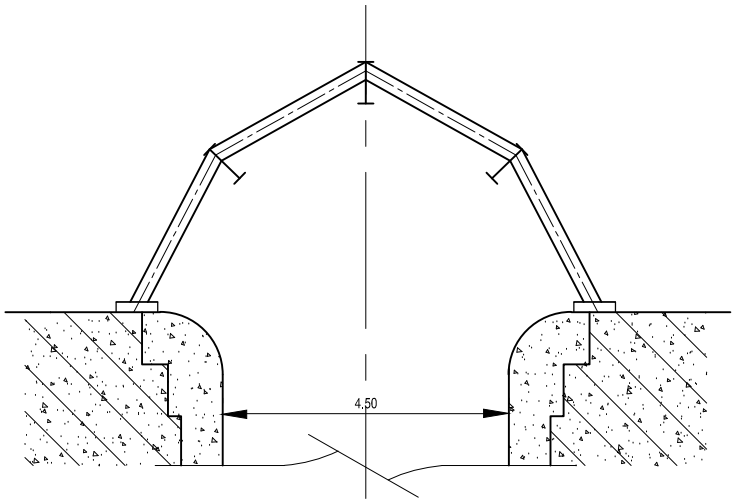
Date: Aug. 2012



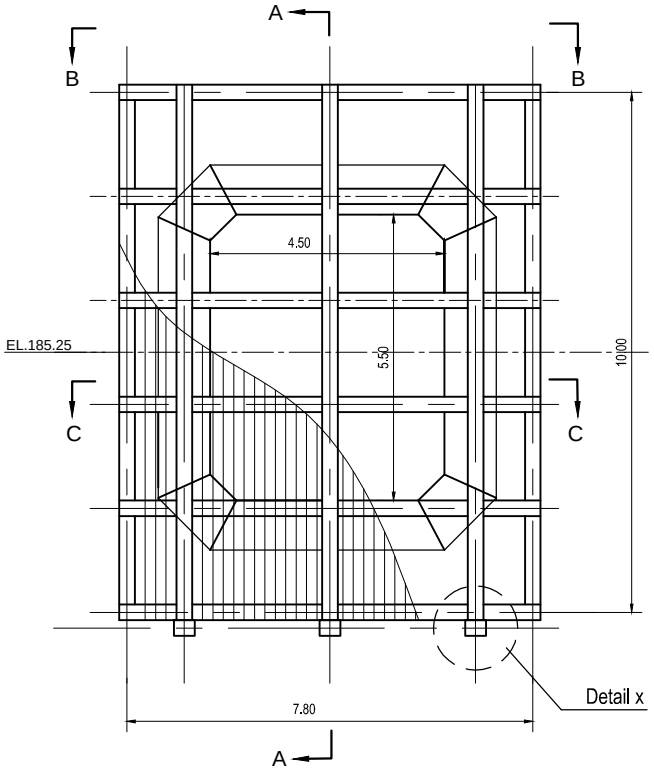
KEY PLAN



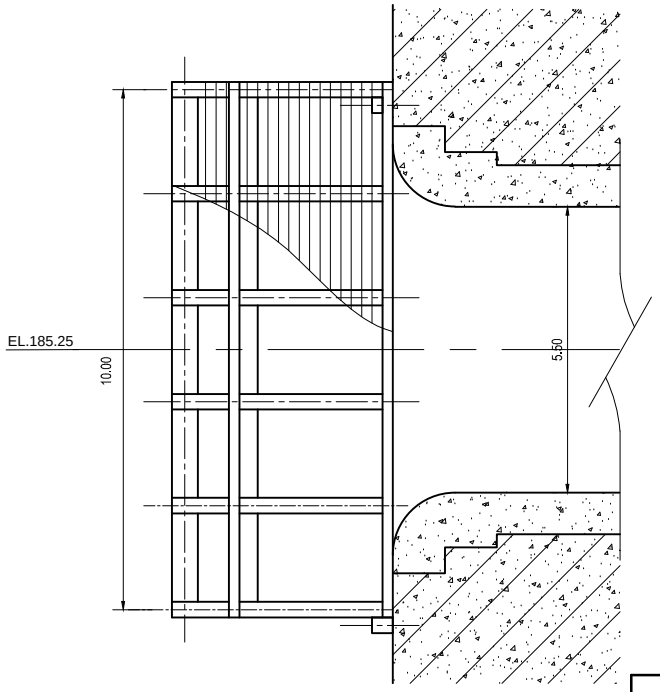
SECTION B-B SCALE A



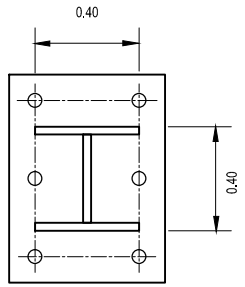
SECTION C-C SCALE A



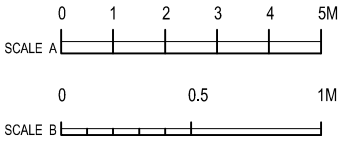
PROFILE SCALE A



SECTION A-A SCALE A

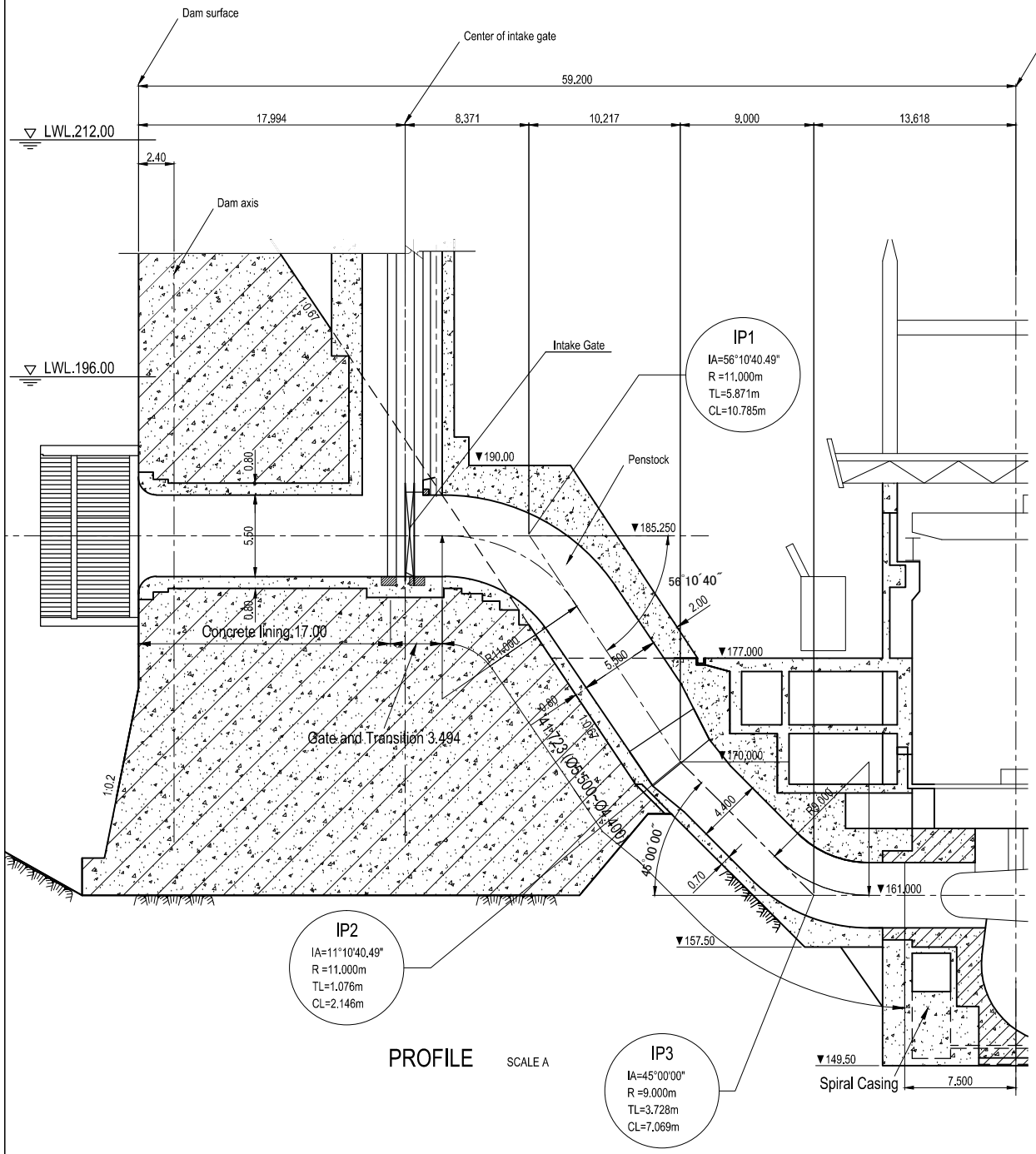


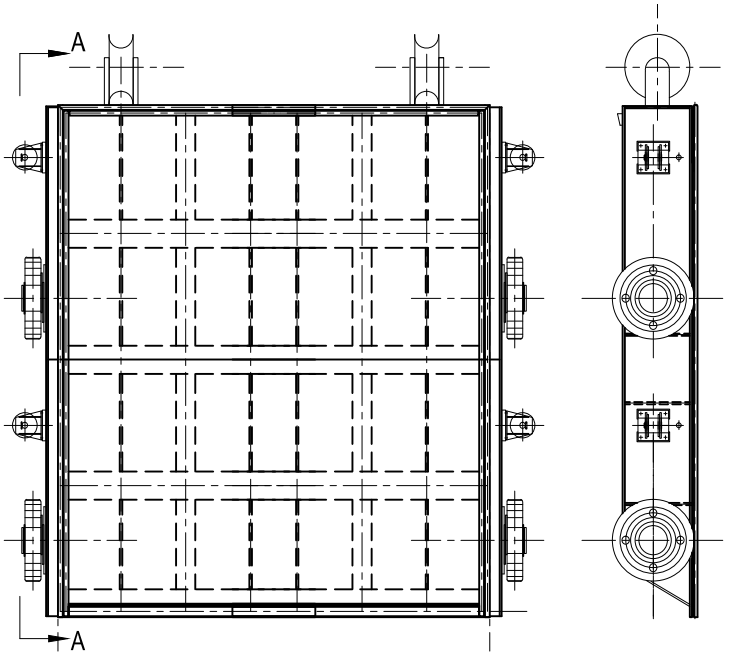
Detail x SCALE B



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Hydraulic Steel Works Intake Trashrack	H-010
		Date: Aug. 2012





Downstream View SCALE B

SECTION A-A SCALE B

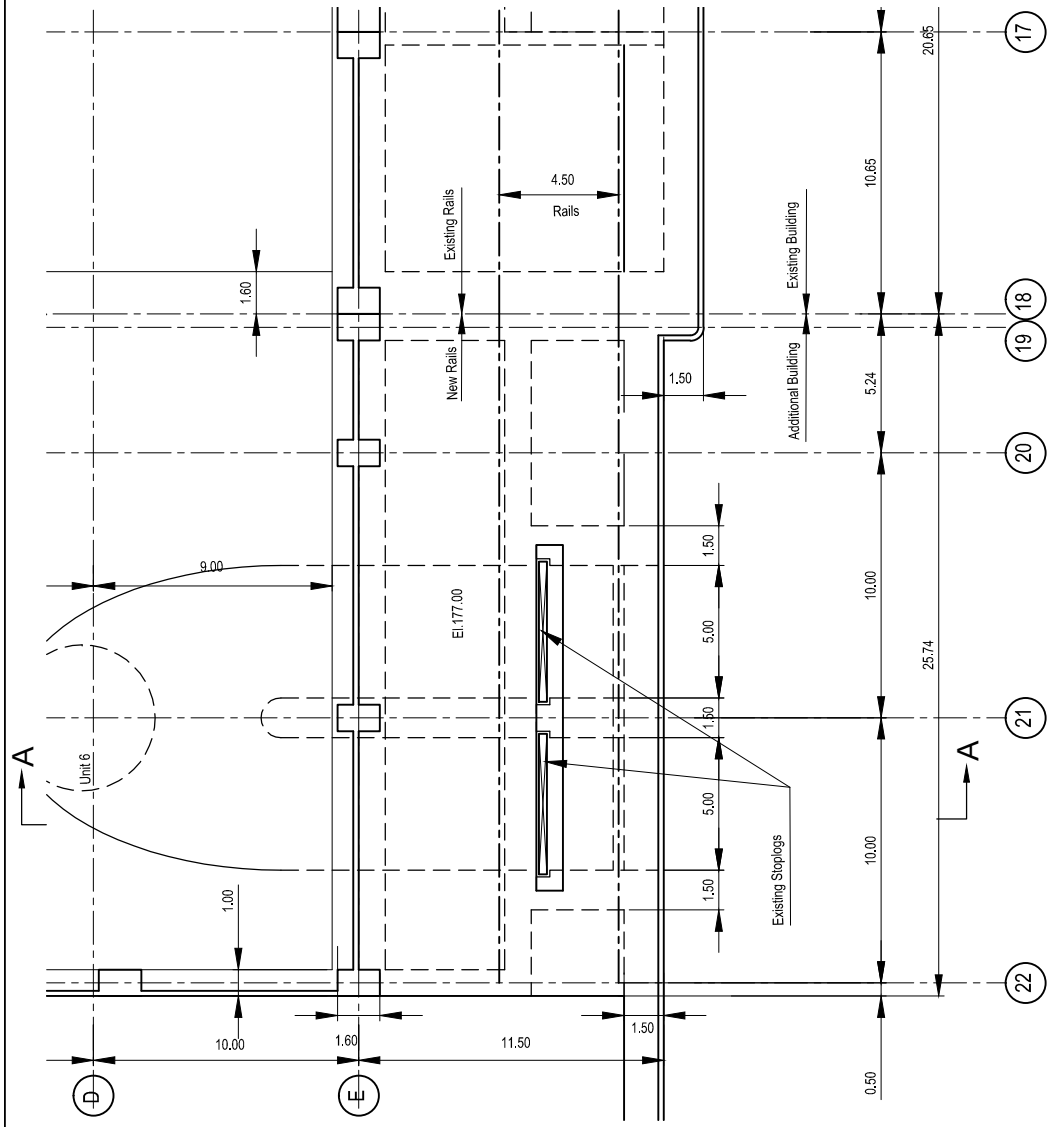
INTAKE GATE

0 5 10 15M
SCALE A

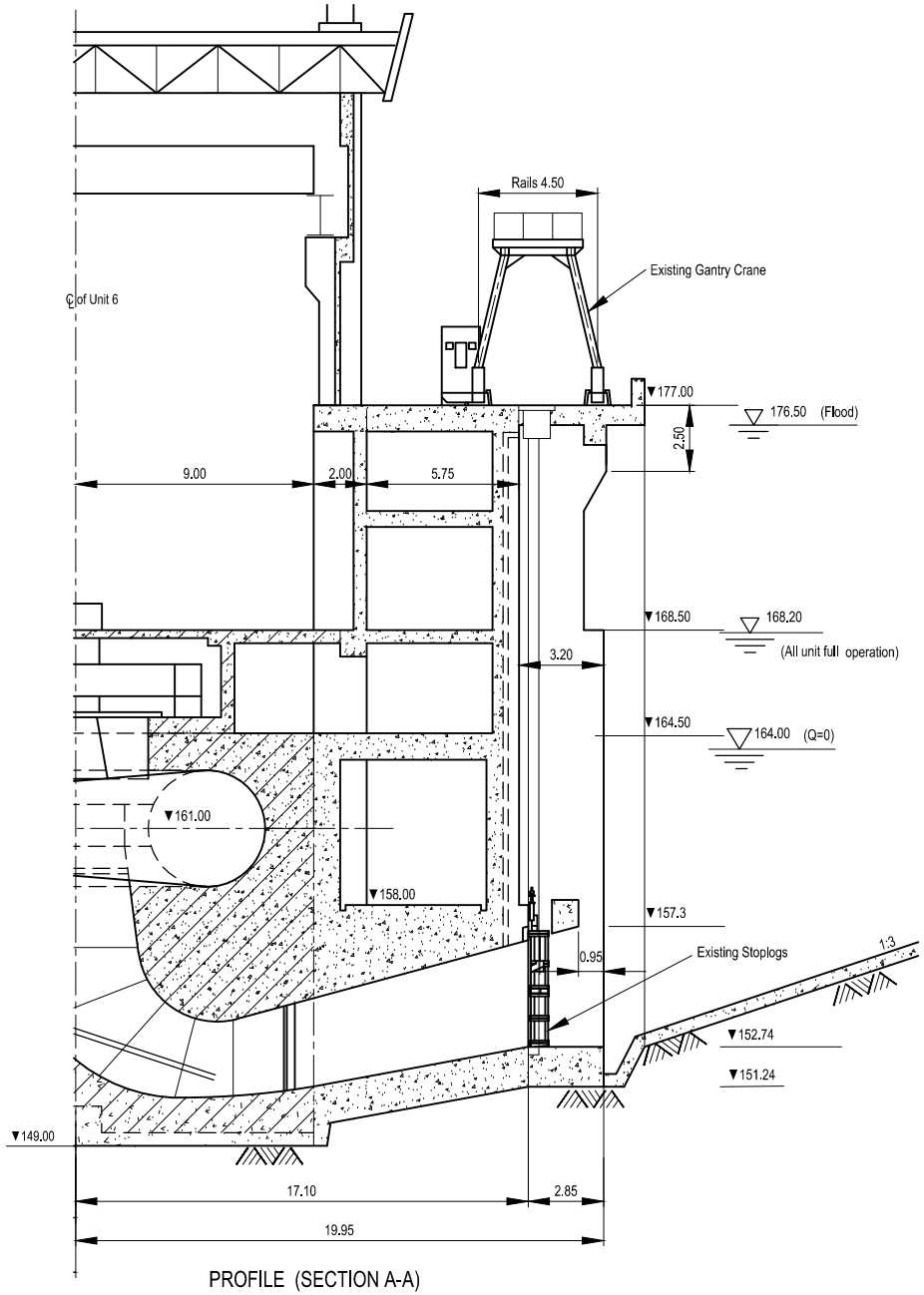
0 1 2 3M
SCALE B

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Hydraulic Steel Works Penstock Pipe	H-020
		Date: Aug. 2012



PLAN



PROFILE (SECTION A-A)

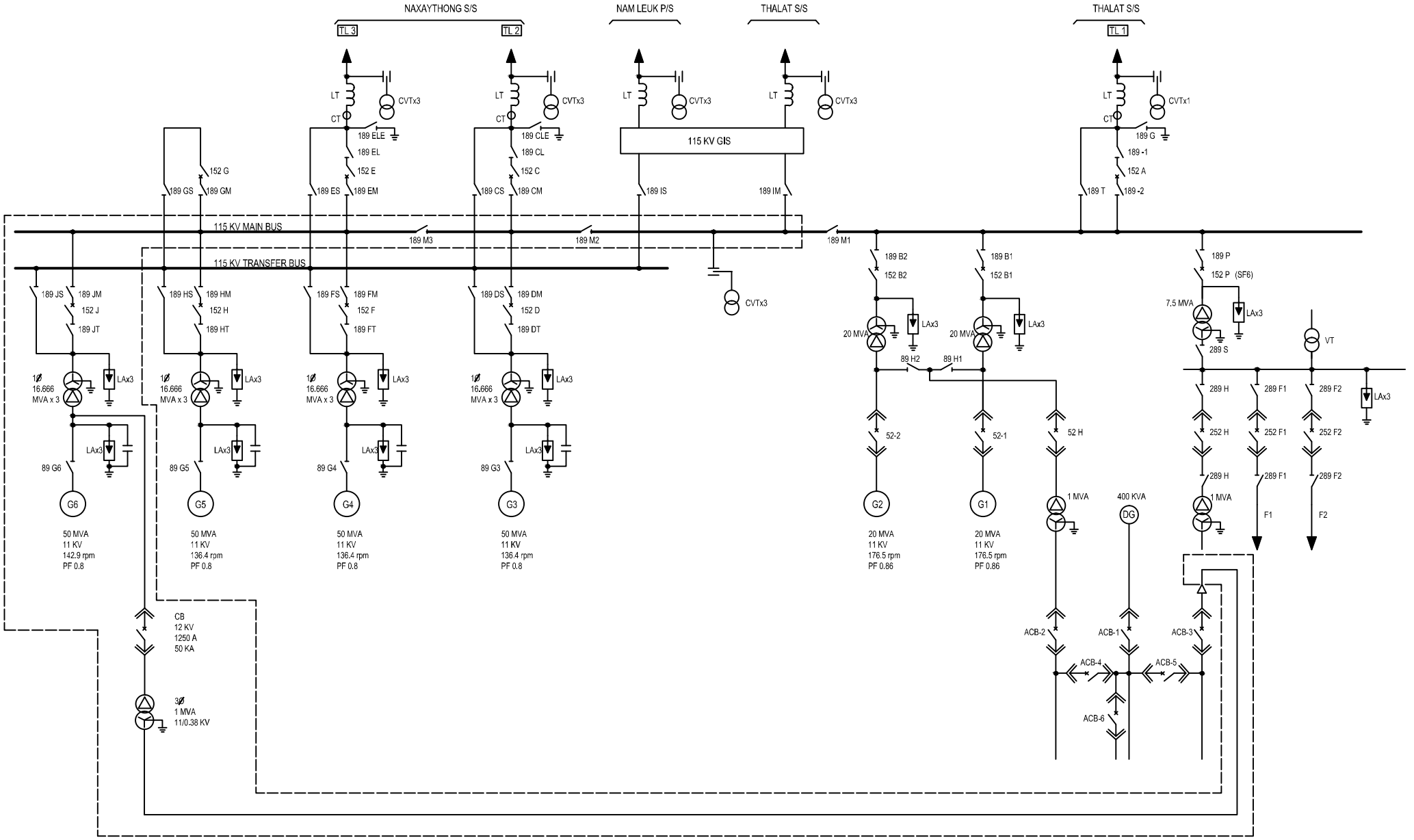
0 10 20M

SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION(PHASE 2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	Hydraulic Steel Works Draft Tube Gate Slot & Gantry Crane	H-030
		Date: Aug. 2012

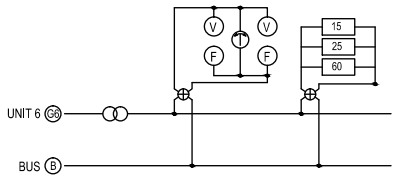
PLATE NO.

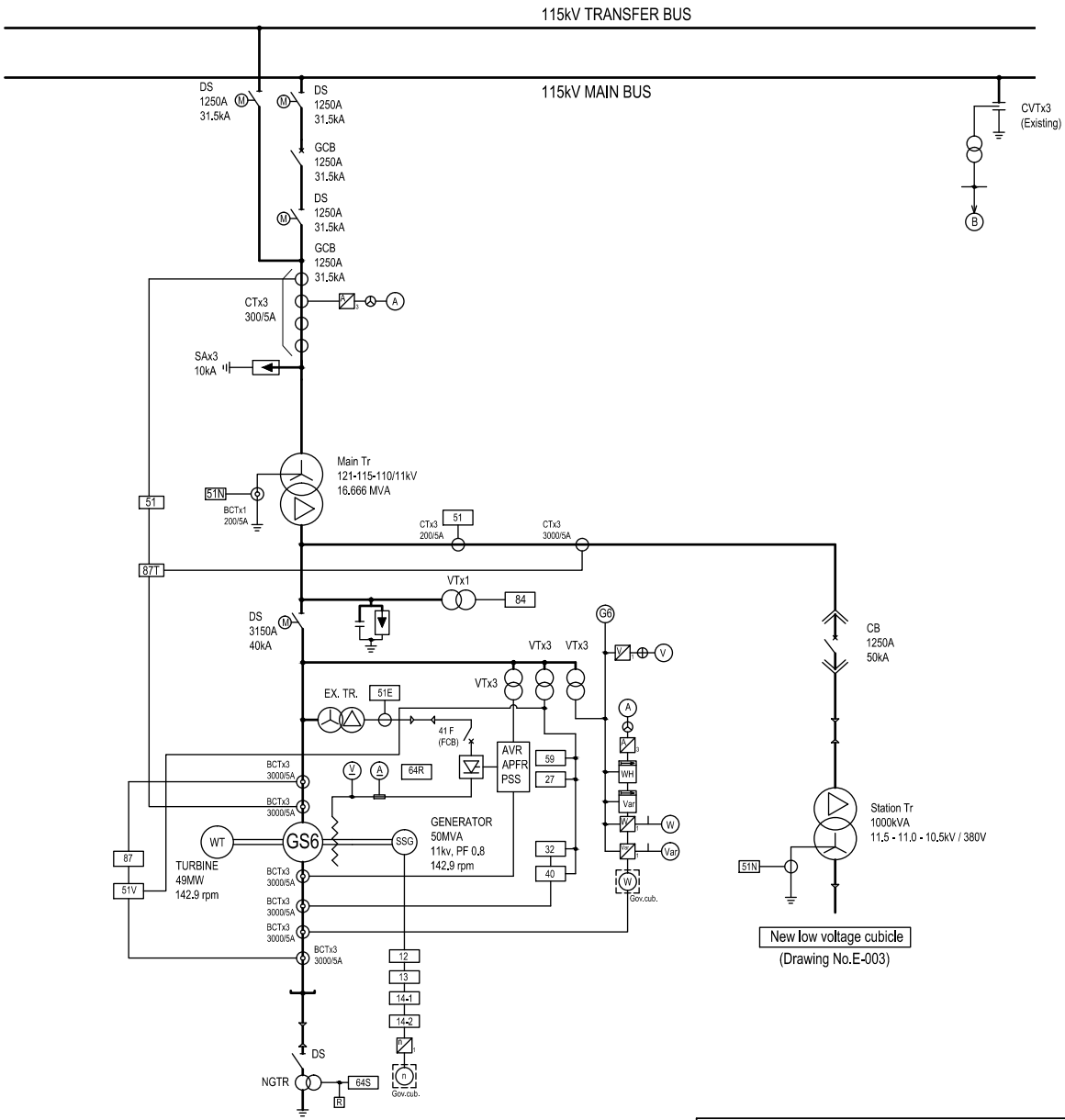


JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / POWER	ELECTRICAL CONNECTION DIAGRAM (1) OVERALL SCHEME	E-001
		Date: Aug. 2012

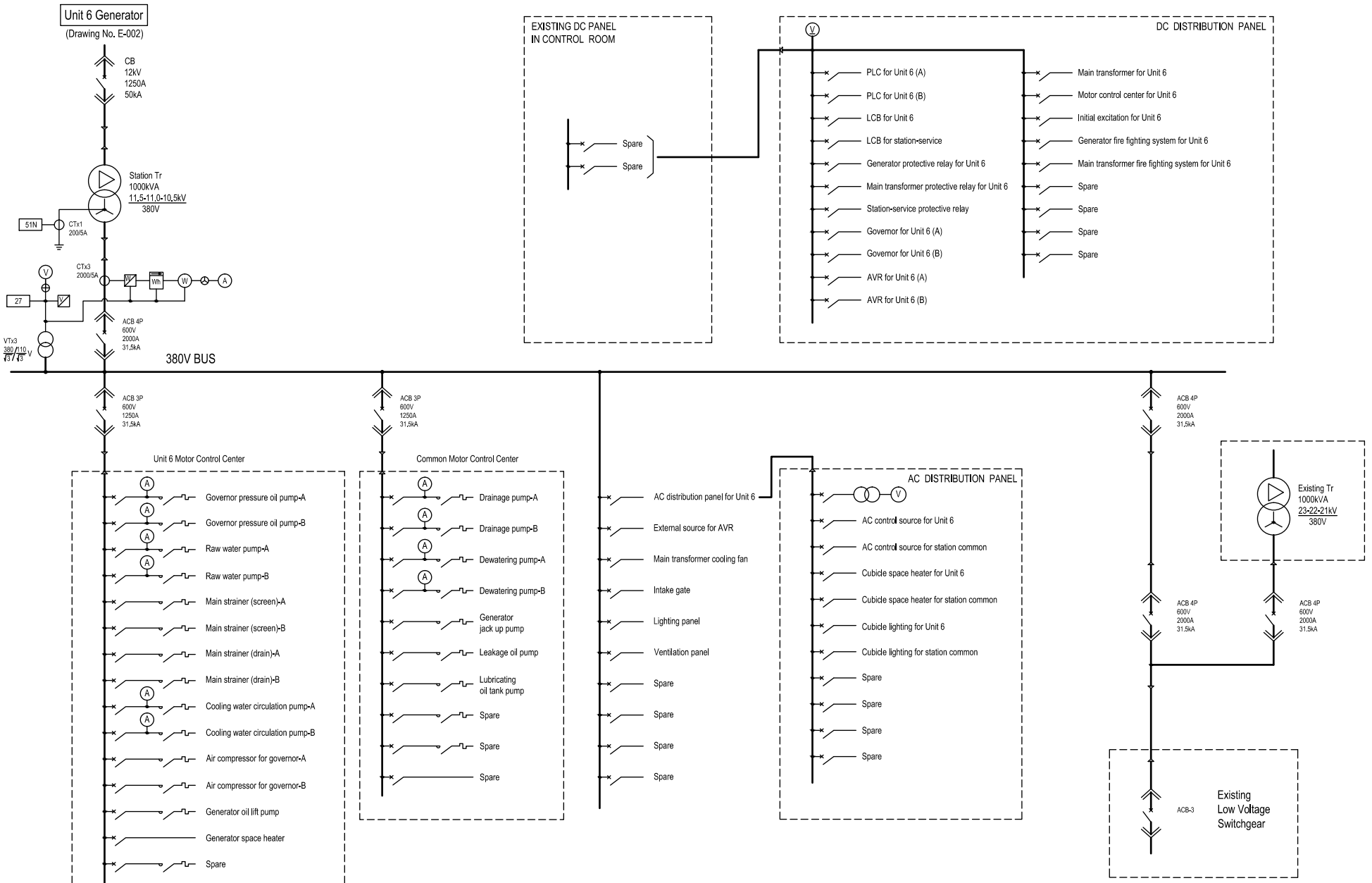
PLATE NO.





JAPAN INTERNATIONAL COOPERATION AGENCY PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC		
Prepared by: NIPPON KOEI J-POWER	Drawing Title: ELECTRICAL CONNECTION DIAGRAM (2) MAIN CIRCUITS FOR UNIT6	Drawing No: E-002 Date: Aug. 2012

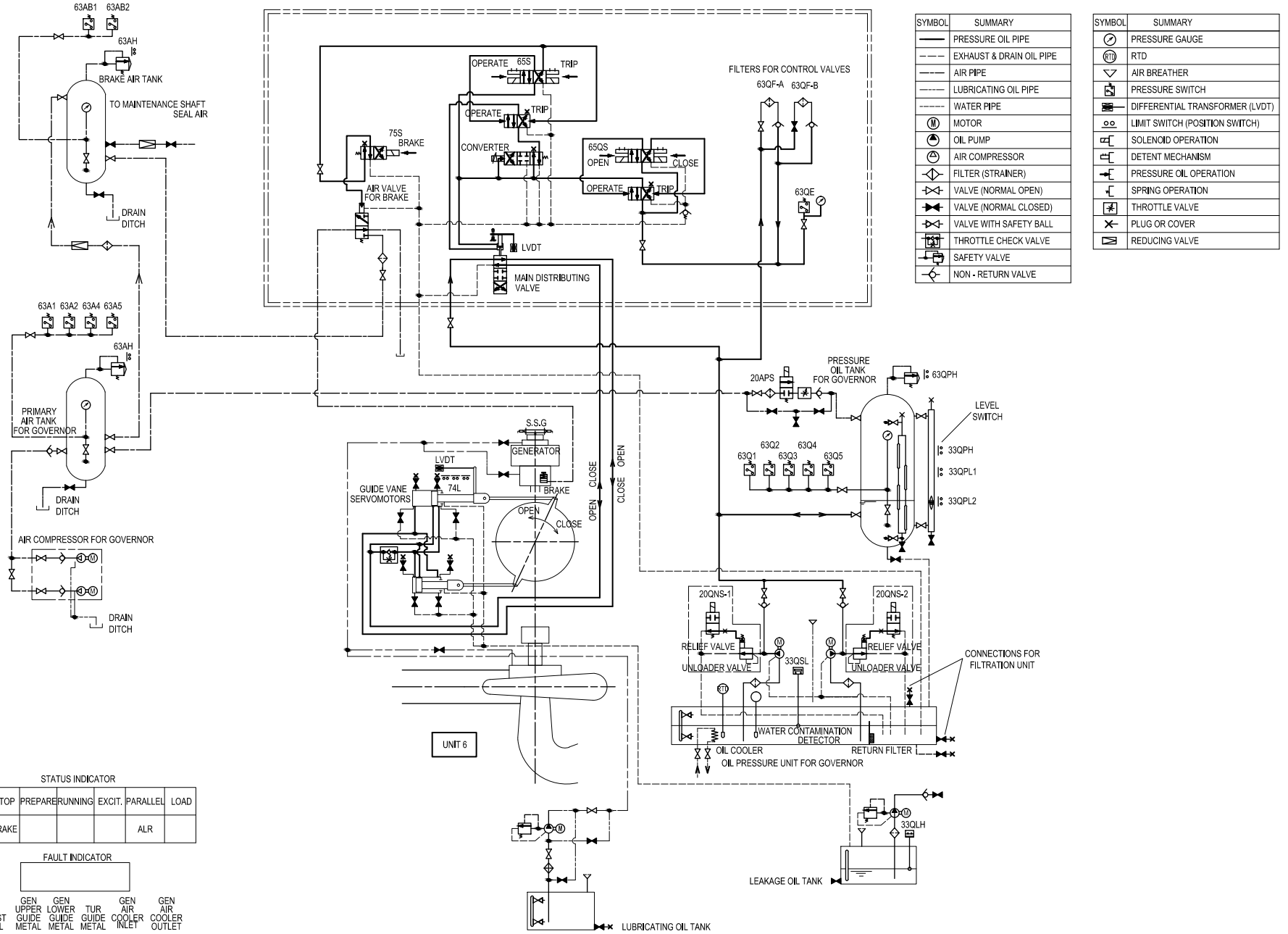
PLATE NO.



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI J-POWER	ELECTRICAL CONNECTION DIAGRAM (3) STATION-SERVICE CIRCUITS	E-003
		Date: Aug. 2012

PLATE NO.



SYMBOL	SUMMARY
	PRESSURE OIL PIPE
	EXHAUST & DRAIN OIL PIPE
	AIR PIPE
	LUBRICATING OIL PIPE
	WATER PIPE
M	MOTOR
	OIL PUMP
	AIR COMPRESSOR
	FILTER (STRAINER)
	VALVE (NORMAL OPEN)
	VALVE (NORMAL CLOSED)
	VALVE WITH SAFETY BALL
	THROTTLE CHECK VALVE
	SAFETY VALVE
	NON - RETURN VALVE

SYMBOL	SUMMARY
	PRESSURE GAUGE
RTD	RTD
	AIR BREATHER
	PRESSURE SWITCH
	DIFFERENTIAL TRANSFORMER (LVDT)
	LIMIT SWITCH (POSITION SWITCH)
	SOLENOID OPERATION
	DETENT MECHANISM
	PRESSURE OIL OPERATION
	SPRING OPERATION
	THROTTLE VALVE
	PLUG OR COVER
	REDUCING VALVE

STATUS INDICATOR

TURBINE MANUAL	STOP	PREPARE	RUNNING	EXCIT.	PARALLEL	LOAD
LINE CHARGE	BRAKE				ALR	

FAULT INDICATOR

GEN THRUST METAL (t) | GEN UPPER GUIDE METAL (t) | GEN LOWER GUIDE METAL (t) | TUR GUIDE METAL (t) | GEN AIR COOLER INLET (t) | GEN AIR COOLER OUTLET (t)

SPIRAL CASE (PG) | RUNNER CROWN (PG) | RUNNER BAND (PG) | DRAFT TUBE (PG)

TACH-METER (n) | POSITION INDICATOR (GV LL) | WATT-METER (W)

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

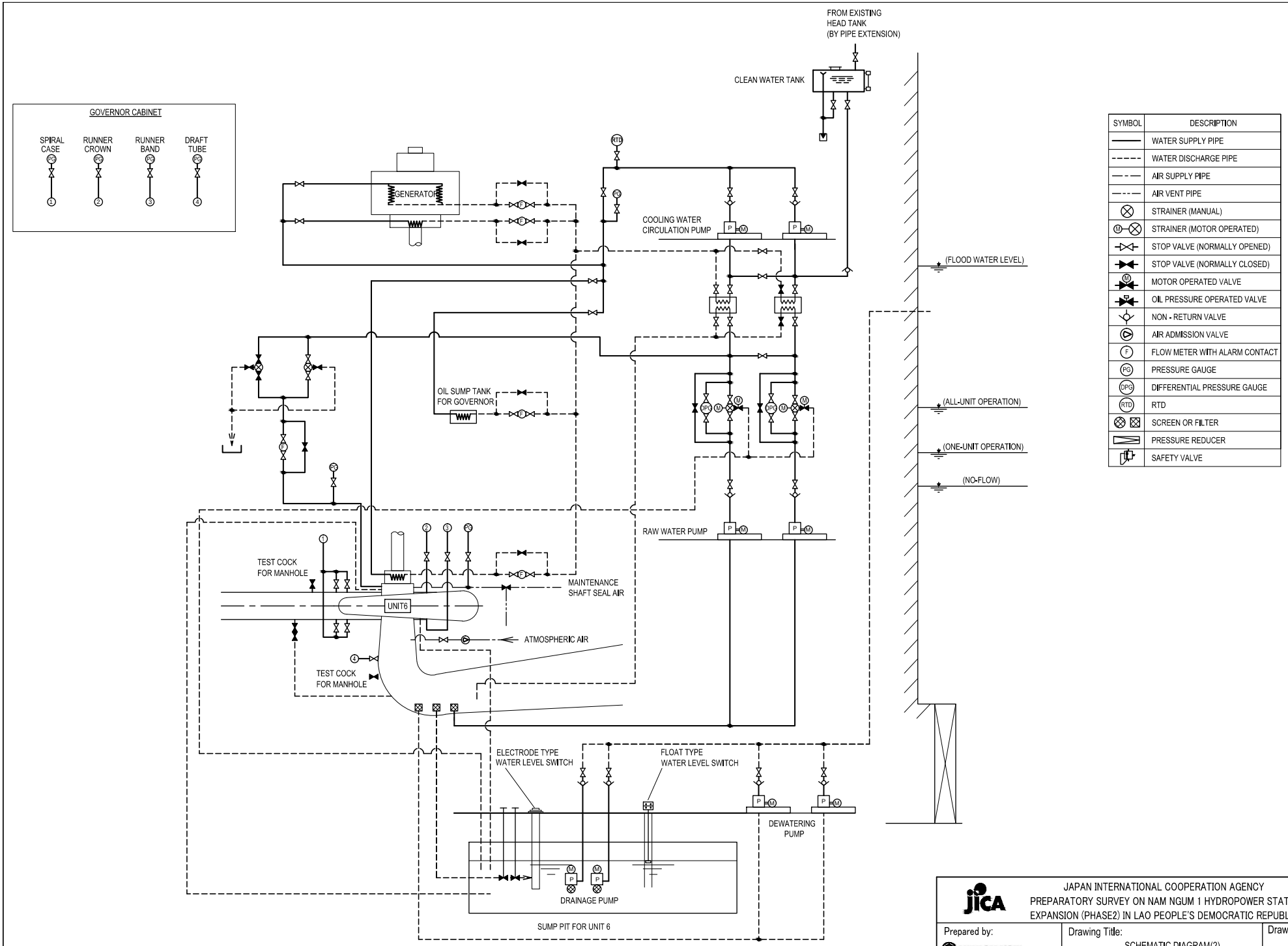
Prepared by: NIPPON KOEI, J-POWER

Drawing Title: SCHEMATIC DIAGRAM(1) PRESSURE OIL AND COMPRESSED AIR SUPPLY SYSTEM

Drawing No: E-011

Date: Aug. 2012

PLATE NO.

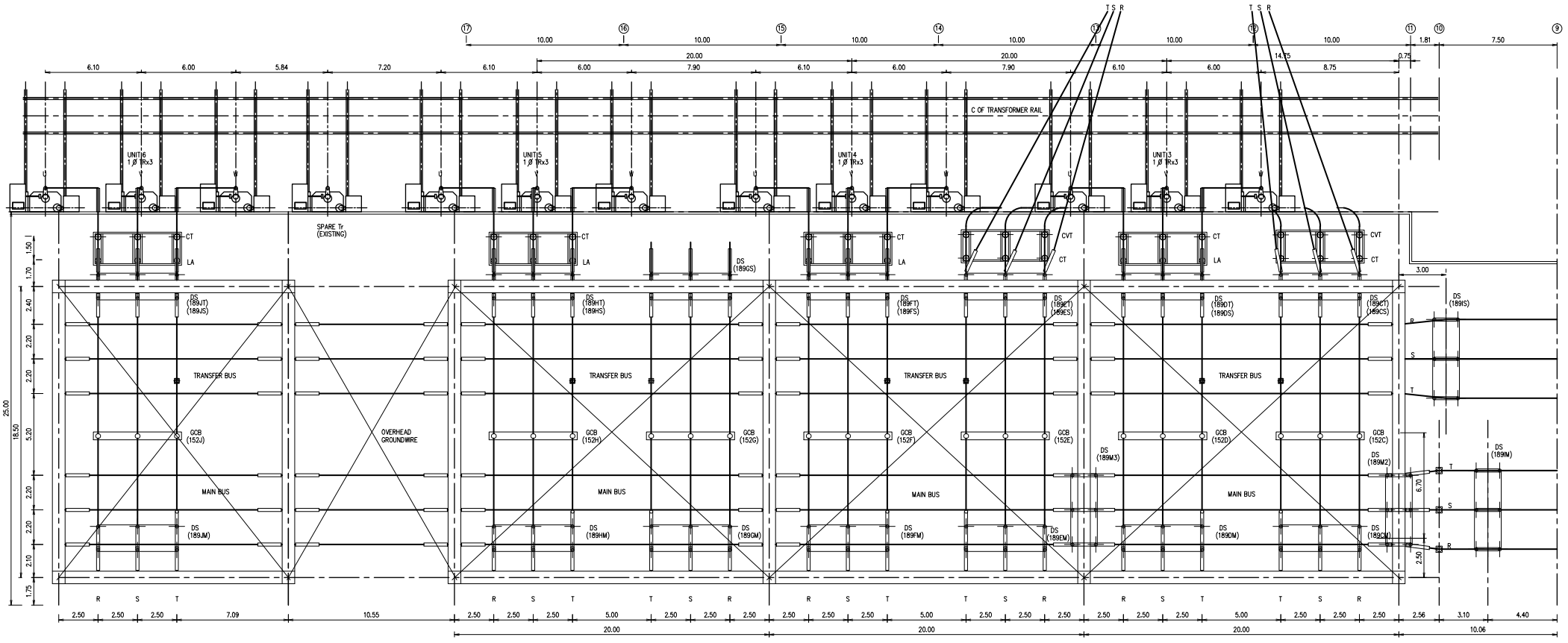


SYMBOL	DESCRIPTION
	WATER SUPPLY PIPE
	WATER DISCHARGE PIPE
	AIR SUPPLY PIPE
	AIR VENT PIPE
	STRAINER (MANUAL)
	STRAINER (MOTOR OPERATED)
	STOP VALVE (NORMALLY OPENED)
	STOP VALVE (NORMALLY CLOSED)
	MOTOR OPERATED VALVE
	OIL PRESSURE OPERATED VALVE
	NON - RETURN VALVE
	AIR ADMISSION VALVE
F	FLOW METER WITH ALARM CONTACT
PG	PRESSURE GAUGE
DPG	DIFFERENTIAL PRESSURE GAUGE
RTD	RTD
	SCREEN OR FILTER
	PRESSURE REDUCER
	SAFETY VALVE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI J-POWER	SCHEMATIC DIAGRAM(2) COOLING WATER SUPPLAY AND DRAINAGE SYSTEM	E-012
		Date: Aug 2012

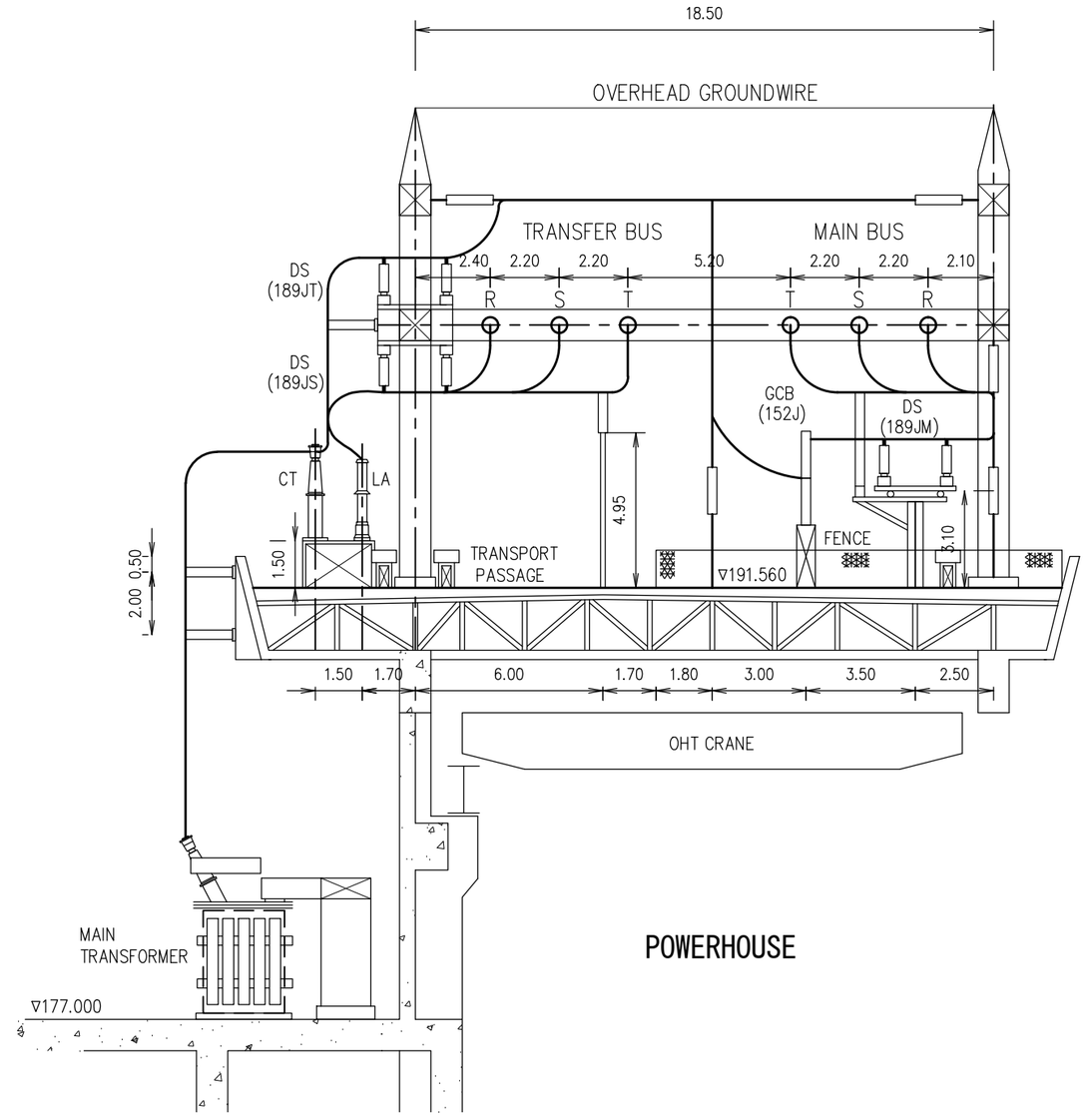
PLATE NO.



JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No:
NIPPON KOEI / J-POWER	115kV OUTDOOR SWITCHYARD EQUIPMENT LAYOUT PLAN	E - 021
		Date: Aug. 2012

PLATE NO.



0 10 20M

SCALE

JAPAN INTERNATIONAL COOPERATION AGENCY
PREPARATORY SURVEY ON NAM NGUM 1 HYDROPOWER STATION
EXPANSION (PHASE2) IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

Prepared by:	Drawing Title:	Drawing No: E-022
NIPPON KOEI J-POWER	115 kV OUTDOOR SWITCHYARD EQUIPMENT LAYOUT SECTION	Date: Aug. 2012

Appendix G

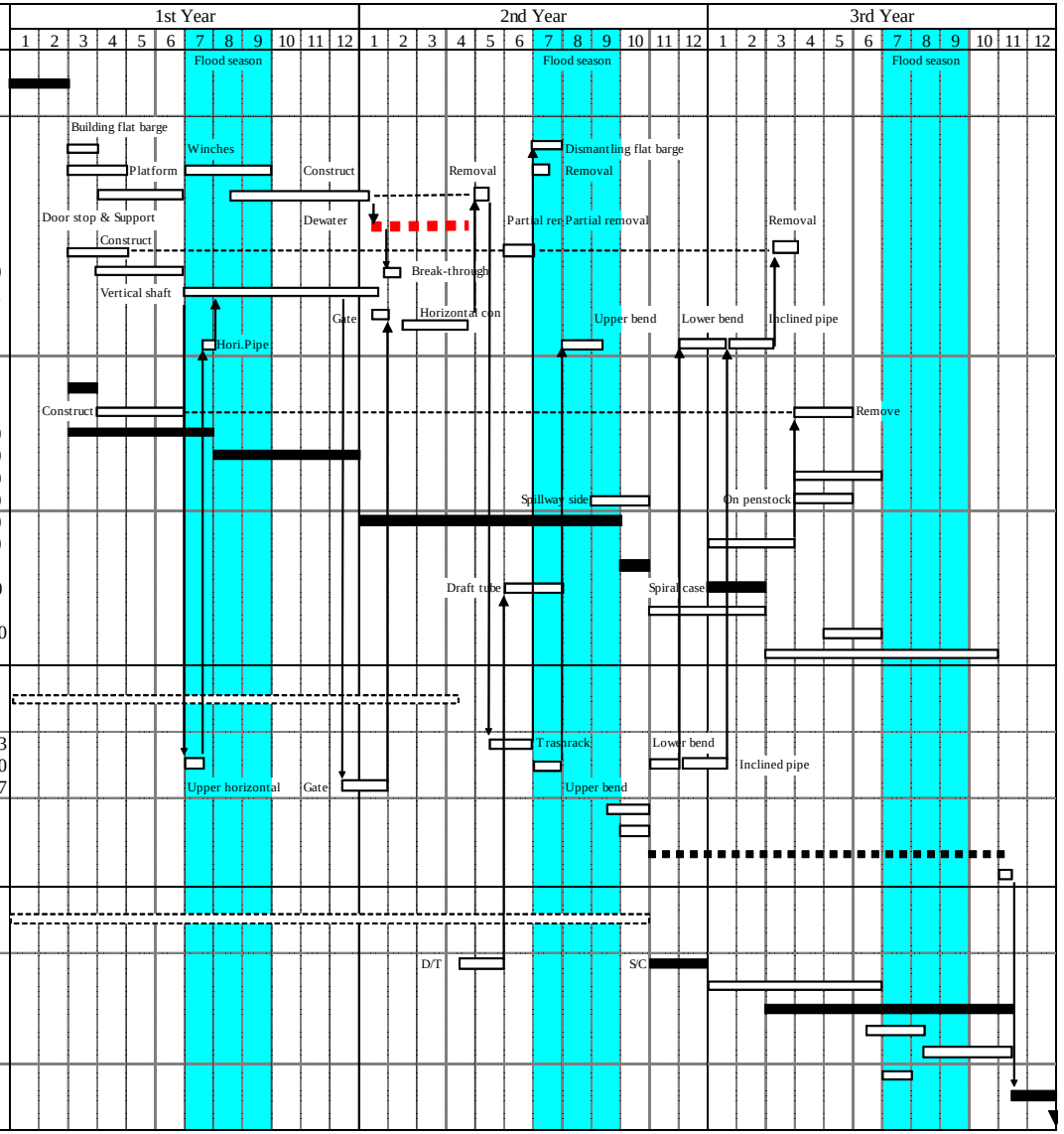
Implementation Plan and Cost Estimate

Appendix G-1 Overall Implementation Schedule

Prepared by the JICA Survey Team

Appendix G-2(40MW) Nam Ngum 1 Expansion Work - Construction Time Schedule

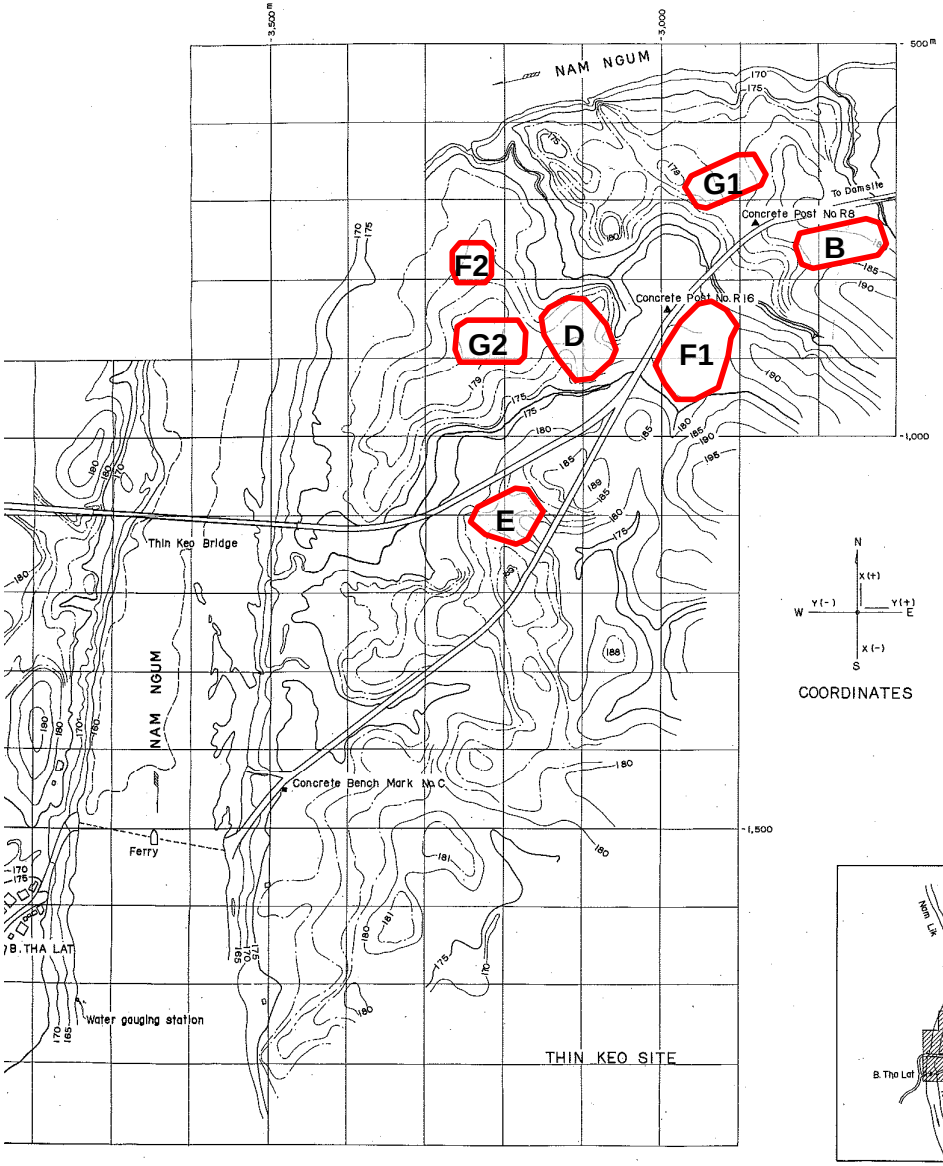
	Description	Unit	Q'ty
1	**Civil Works**		
	1) Mobilization	lot	1
	2) Preparatory works (office, camp, survey, etc.)	lot	1
	3) Intake & Penstock		
	Building flat barge	lot	1
	Platform and Winch trestle	lot	1
	Intake crane relocation & Intake temporary enclosure	lot	1
	Dewatered condition in enclosure		
	Temporary downstream trestle and access ramp	lot	1
	Piercing NN1 dam body	m3	1,450
	Concrete wall for Vertical shaft	LS	1
	Concrete fill (bellmouth to intake gate)	LS	-
	Concrete fill (inclined penstock)	LS	-
	4) Powerhouse and Tailrace		
	Access way preparation (draft tube deck)	lot	1
	Coffer barrier in tailrace (grouting, PS anchors, etc.)	lot	1
	Foundation excavation (above El. 168 m)	m3	39,000
	Foundation excavation (below El. 168 m)	m3	24,000
	Underwater excavation outside tailrace coffer barrier	m3	2,500
	Free draining backfill around powerhouse	m3	4,000
	Building concrete (up to OHT crane runway base)	m3	10,900
	Tailbay concrete	m3	1,100
	Crane runway steel girders	lot	1
	Second stage concrete	m3	2,200
	Roof truss and roof slab	LS	-
	Roof switchyard concrete	m3	30
	Architectural finishing works	lot	1
2	**Hydro-mechanical Works**		
	1) Designing, manufacturing & delivering	LS	-
	2) Installation		
	Trashrack	t	43
	Penstock pipe	t	100
	Intake gate	t	57
	Draft tube stoplog guide frame	lot	1
	Draft tube gantry crane rail extension	lot	1
	Draft tube closure by temporary stoplogs	lot	1
	3) Water filling in penstock and gate operating test	LS	-
3	**Electro-mechanical Works**		
	1) Designing, manufacturing & delivering	LS	-
	2) Installation		
	Draft tube steel liner and spiral casing	lot	1
	Turbine and mechanical auxiliaries	lot	1
	Generator and electrical auxiliaries	lot	1
	Main transformer	lot	1
	Switchyard equipment	lot	1
	3) Improvement of existing roof switchyard	lot	1
	4) Wet test for commissioning	LS	-
	5) Start of commercial operation		

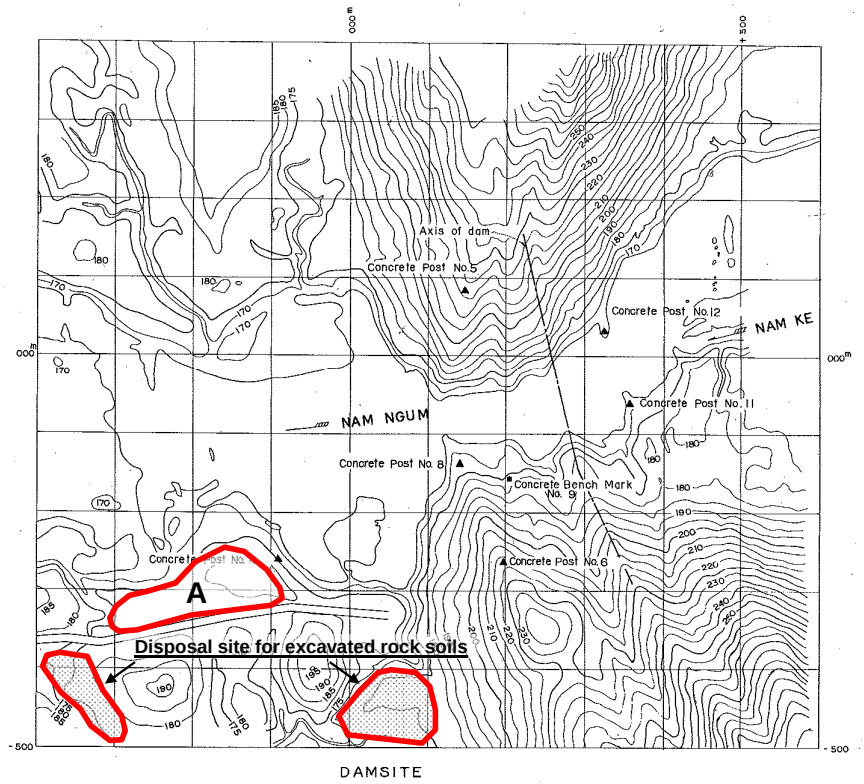


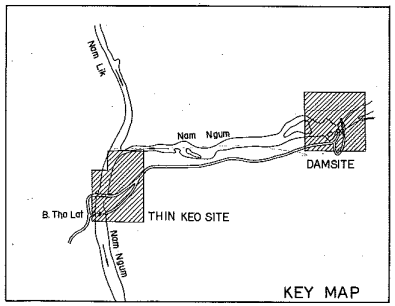
Prepared by the JICA Survey Team

Legend Critical path work

Appendix G-3-1 Layout Plan of Temporary Construction Facilities, Proposed

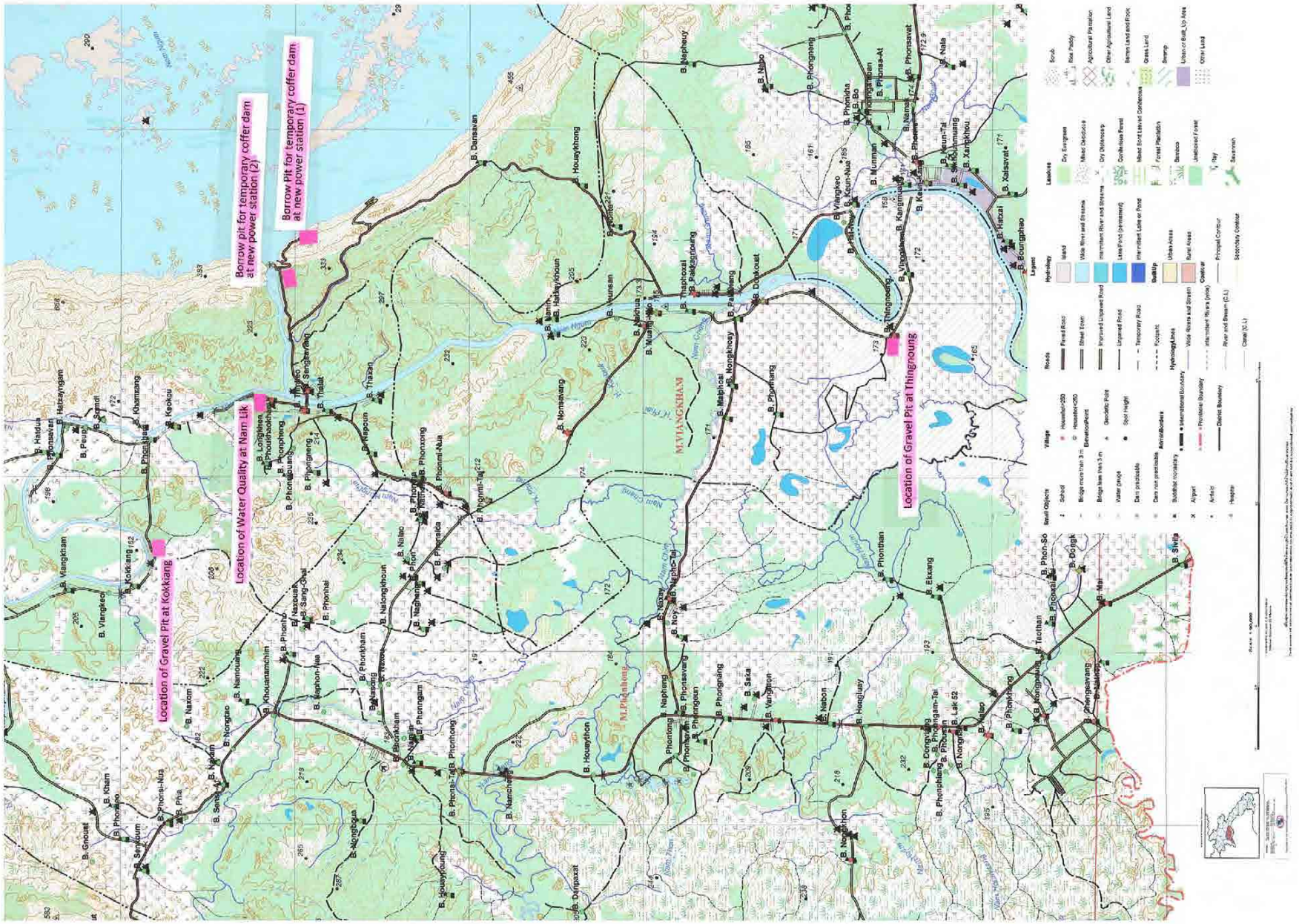






	Temporary Facilities	Area (m2 approx.)
A.	Civil Contractor's Temporary Yard	8,000
B.	Hydro-Mech. & Electro-Mech. Contractor's Yard	6,000
C.	Engineer's office may be set in the powerhouse	---
D.	Civil Contractor's Office & Accomodation	3,000
E.	Hydro-Mech. & Electro-Mech. Contractor's Office & Accomodation	600
F1.	Employer/Engineer's Accomodation - Existing	---
F2.	Candidate Site for Engineer's Guest House	300
G1.	Candidate Site for Contractor's Accomodation	500
G2.	Candidate Site for Contractor's Accomodation	500

Appendix G-3-2 Layout Plan of gravel bit, borrow pit and as Proposed



Appendix G-3-3 Photograph of gravel bit, borrow pit and as Proposed

Borrow pit 1.5km away from a new power hoouse ,land sliding area beside reservoir

Borrow pit and disposal area 0.3km away from

Gravel pit at Kokkiang 12km away from Nam

Gravel pit 22km away from Nam Ngum Dam

Appendix G-4 Total Fund Requirement

Base Year for Cost Estimation:	Sep, 2012		FC : million JPY
Exchange Rates	Kip = Yen	0.0101	LC : million Kip
Price Escalation:	FC: 2.1%	LC: 8.3%	Total : million JPY
Physical Contingency	10%		
Physical Contingency for Consultant	5%		

Item		Total		
		FC	LC	Total
A. ELIGIBLE PORTION				
Ⅰ)	Procurement / Construction	3,338	114,395	4,493
	a. civil works	1,127	65,198	1,786
	b. hydro-mechanical works	119	2,079	140
	c. electro-mechanical works	1,560	9,633	1,657
	Base cost	2,806	76,910	3,583
	Price escalation	228	27,086	502
	Physical contingency	303	10,400	408
Ⅱ)	Consulting services	745	2,838	774
	Base cost	665	2,081	686
	Price escalation	44	622	51
	Physical contingency	35	135	37
Total (Ⅰ + Ⅱ)		4,083	117,233	5,267
B. NON ELIGIBLE PORTION				
a	Procurement / Construction	0	0	0
	Base cost	0	0	0
	Price escalation	0	0	0
	Physical contingency	0	0	0
b	Land Acquisition	0	0	0
	Base cost	0	0	0
	Price escalation	0	0	0
	Physical contingency	0	0	0
c	Administration cost	0	26,073	263
d	VAT	0	0	0
e	Import Tax	0	0	0
Total (a+b+c+d+e)		0	26,073	263
TOTAL (A+B)		4,083	143,306	5,530
C. Interest during Construction		106	0	106
	Interest during Construction(Const.)	105	0	105
	Interest during Construction (Consul.)	0	0	0
D. Commitment Charge		38	0	38
GRAND TOTAL (A+B+C+D)		4,226	143,306	5,673

Administration Cost =	5%	
VAT=	0%	of the expenditure in local currency of the eligible portion
Import Tax=	0%	

Appendix G-5 Priced Bill of Quantities

US$ 1.0 = JPY 79.7
US$ 1.0 = Kip 7,890.3
Kip 1 = JPY 0.0101

No.	Work Item	Unit	Quantity	Unit Rate		Amount		Total
				(JPY)	(Kip)	(10^3JPY)	(10^3Kip)	(10^3JPY)
A	**CIVIL WORKS**							
A1	**Preparatory Works**							
	a) Preparation of access on the existing draft tube deck	lot	1			0	83,890	847
	b) Relocation of gantry cranes (dam crest & draft tube)	lot	1			0	167,779	1,695
	Sub-total					0	251,669	2,542
A2	**Intake and Penstock**							
1	Temporary works							
	a) Intake enclosure structure in reservoir	lot	1			304,408	12,343,083	429,073
	b) Platform for intake closure on dam crest	t	40	242,211	23,487,423	9,616	932,451	19,034
	b) Platform for dam penetration work	t	163	212,879	21,222,625	34,699	3,459,288	69,638
2	Concrete excavation for dam penetration	m3	1,450	21,961	519,963	31,843	753,946	39,458
3	Concrete (above El. 177m)	m3	680	11,715	399,438	7,966	271,618	10,709
4	Re-bars	t	34	1,065	13,092,701	36	445,152	4,532
5	Penstock works for support of trashrack	lot	1			825	151,496	2,355
6	Gate tower	lot	1			63,872	3,935,810	103,624
7	Miscellaneous works (metal works, road, landscaping, etc.)	LS				45,327	2,229,284	67,843
	Sub-total					498,592	24,522,128	746,265
A3	**Powerhouse and Tailrace**							
1	Temporary works							
	a) Tailrace coffer structure (incl. grouting and rock anchoring)	lot	1			4,466	78,017	5,254
	b) Removal method at EL. 177 m for muck loading	m3	24,000	718	27,329	17,232	655,896	23,857
2	Excavation							
	a) Open excavation, rock, above El. 168m	m3	39,000	408	60,507	15,912	2,359,773	39,746
	b) Pit excavation, rock, below El. 168m	m3	24,000	2,126	101,490	51,024	2,435,760	75,625
	d) Underwater excavation, rock, outside coffer	m3	2,500	3,231	174,997	8,078	437,493	12,497
	e) Demolition of existing reinforced conc.	m3	400	3,190	152,236	1,276	60,894	1,891
3	Slope protection and rock support							
	a) Rock bolts on cut slope	m	4,300	1,460	28,214	6,278	121,320	7,503
	b) Shotcrete on cut slope	m3	540	56,083	907,472	30,285	490,035	35,234
4	Backfill with free draining materials	m3	4,000	254	30,323	1,016	121,292	2,241
5	Cut slope stabilization (spillway side)	lot	1			10,084	176,168	11,863
6	Concrete (incl. formwork cost)							
	a) Penstock below El. 177 m	m3	770	11,715	399,438	9,021	307,567	12,127
	b) Powerhouse	m3	13,100	14,328	673,375	187,697	8,821,213	276,791
	c) Tailrace	m3	1,100	14,876	673,376	16,364	740,714	23,845
7	Re-bars	t	840	1,065	13,092,701	895	10,997,869	111,973
8	Steel structures (roof truss, crane beams)	t	98	324,092	5,662,079	31,761	554,884	37,365
9	Architectural works (finishing, windows, doors, roofing, plumbing, lighting, ventilating, etc.)	lot	1			41,055	717,257	48,299
10	Miscellaneous works (metalwork, earthing, paving, landscaping, etc.)	LS				12,973	872,285	21,783
	Sub-total					445,417	29,948,437	747,896
A4	**Roof Switchyard**							
1	Concrete	m3	30	14,876	673,376	446	20,201	650
2	Re-bars	t	2.0	1,065	13,092,701	2	26,185	266
3	Miscellaneous works	LS				45	4,639	92
	Sub-total					493	51,025	1,008
A5	**Removal Cost of Rock Outcrops**							
1	Removal cost of rock outcrops at downstream stretch	m3	13,000	3,231	174,997	42,003	2,274,961	64,980
A6	**General Item Cost**							
1	Contractors' offices, camps, workshop, power/water supply, insurance, bonds, etc.)	lot	1			140,929	8,149,746	223,241
	Total of A					1,127,434	65,197,966	1,785,933

Appendix G-5 (continued)

B	**HYDRAULIC STEEL STRUCTURES**							
B1	**Intake and Penstock**							
1	Trash rack	t	43	474,215	8,284,815	20,391	356,247	23,989
2	Stoplog	t	18	504,185	8,808,415	9,075	158,551	10,676
3	Intake gate and hoist	t	57	648,238	11,325,105	36,950	645,531	43,470
5	Penstock steel pipe, D5.5m	t	100	504,185	8,808,415	50,419	880,842	59,316
	Sub-total					116,835	2,041,171	137,451
B2	**Draft Tube Stoplog Facility**							
1	Gantry crane rails & cable extension	LS				2,161	37,750	2,542
	Sub-total					2,161	37,750	2,542
	Total of B					**118,996**	**2,078,921**	**139,993**
C	**ELECTRICAL /MECHANICAL EQUIPMENT**							
C1	**Generating Equipment**							
1	Turbine and auxiliaries	lot	1			572,489	3,604,784	608,897
2	Generator and auxiliaries	lot	1			654,513	4,121,266	696,138
3	Transformers	lot	1			116,028	554,759	121,631
4	Indoor switchgear	lot	1			66,390	402,733	70,458
5	Outdoor switchyard equipment	lot	1			38,114	283,729	40,980
6	Control and protection equipment	lot	1			54,982	332,942	58,345
7	Auxiliary equipment	lot	1			21,124	129,222	22,429
8	Miscellaneous materials	lot	1			20,917	203,542	22,973
	Sub-total					1,544,557	9,632,977	1,641,850
C2	**Thalat Substation Improvement**							
1	Overhead power conductors	lot	1			0	0	0
	Sub-total					0	0	0
C3	**Inspection, training and model test**							
1	Factory inspection by the Emplyer	lot	1			4,868	0	4,868
2	Factory training to the Employer	lot	1			1,623	0	1,623
3	Site instruction	lot	1			5,795	0	5,795
4	Turbine model test	lot	1			2,898	0	2,898
	Sub-total					15,184	0	15,184
	Total of C					**1,559,741**	**9,632,977**	**1,657,030**
D	**CONSULTING SERVICES**							
1	Design and construction supervision	lot	1			665,374	2,081,196	686,396
	Total of D					**665,374**	**2,081,196**	**686,396**
Grand Total						**3,471,545**	**78,991,060**	**4,269,353**

Appendix G-6 Manning Schedule for Consulting Services

		Position	BillingRate		2013												2014												2015												2016												2017												Total
			F/C Yen	LC/ Kip	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
a	1	Project director	2562000	0				1																		1																																			1				3
a	2	Project manager	2562000	0				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	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	50
a	3	Civil designer 1 (intake)	2562000	0							1	1	1										1	1	1	1					1	1																																			9
a	4	Civil designer 2 (powerhouse)	2562000	0				1			1	1	1	1	1	1							1	1	1	1	1	1	1	1	1								1	1	1	1																		1	1	1				23
a	5	Architectural engineer	2562000	0									1	1																									1	1																									4
a	6	Civil contract engineer	2562000	0									1	1	1			1					1	1		1	1	1	1	1	1														1	1							1	1								1	1	1	1	1	21
a	7	Cost estimate engineer	2562000	0										1	1																																																		2
a	8	Geologist	2562000	0				1		1		1																	1						1		1																												6
a	9	Hydro-mechanical engineer	2562000	0									1	1	1			1					1									1					1						1				1	1	1																11
a	10	Electro-mechanical engineer	2562000	0								1	1	1	1			1					1																			1						1	1	1	1	1	1	1		1	1	1	1	1	1	1	1		22
a	11	Civil construction engineer	2562000	0																						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				29
a	12	Substation/SCADA engineer	2562000	0									1																																											1	1							3
a	13	Environmental engineer	2562000	0							1																1																	1																1					4
b	1	Administrator	300000	0				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	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	57
b	2	Civil engineer 1 (intake)	300000	0							1	1	1										1	1	1	1					1	1																																			9
b	3	Civil engineer 2 (powerhouse)	300000	0				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	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	49
b	4	Structural engineer	300000	0							1	1	1	1									1	1	1	1	1	1																																					10
b	5	Architectural engineer	300000	0									1	1	1										1	1	1											1	1												1	1	1	1	1	1	1	1	1	1				18
b	6	Geologist	300000	0				1	1	1		1																	1		1		1		1		1																												9
b	7	Mechanical engineer	300000	0									1	1	1			1					1									1					1						1				1	1	1											1	1	1	1	1		16
b	8	Electrical engineer	300000	0									1	1	1			1					1																			1						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
b	9	Cad operator	300000	0							2	2	3	3	3	3							3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				79
b	10	Inspector	300000	0																							2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2				91
b	11	Environmental engineer	300000	0							1				1										1	1	1	1	1	1										1	1	1	1	1	1										1	1	1	1	1	1				20
		[Total of Pro-A]			**39**												**33**												**39**												**38**												**38**												**187**
		[Total of Pro-B]			**54**												**60**												**87**												**91**												**89**												**381**
		[Total of Pro-A+Pro-B]			93												93												126												129												127												568
		Total Cost of FC for Each Month(Pro-A)			99,918,000												84,546,000												99,918,000												97,356,000												97,356,000												479,094,000
		Total Cost of FC for Each Month(Pro-B)			16,200,000												18,000,000												26,100,000												27,300,000												26,700,000												114,300,000
		Total Cost of LC for Each Month(Pro-A)			0												0												0												0												0												0
		Total Cost of LC for Each Month(Pro-B)			0												0												0												0												0												0
c	1	secretary	0	3000000				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	93
			0	0																																																													0
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			0	0																																																												0
		[Total of Supporting Staff]			**9**												**15**												**24**												**24**												**21**												**93**
		Total Cost of LC for Each Month(SS)			27,000,000												45,000,000												72,000,000												72,000,000												63,000,000												279,000,000
		Grand Total			**102**												**108**												**150**												**153**												**148**												**661**