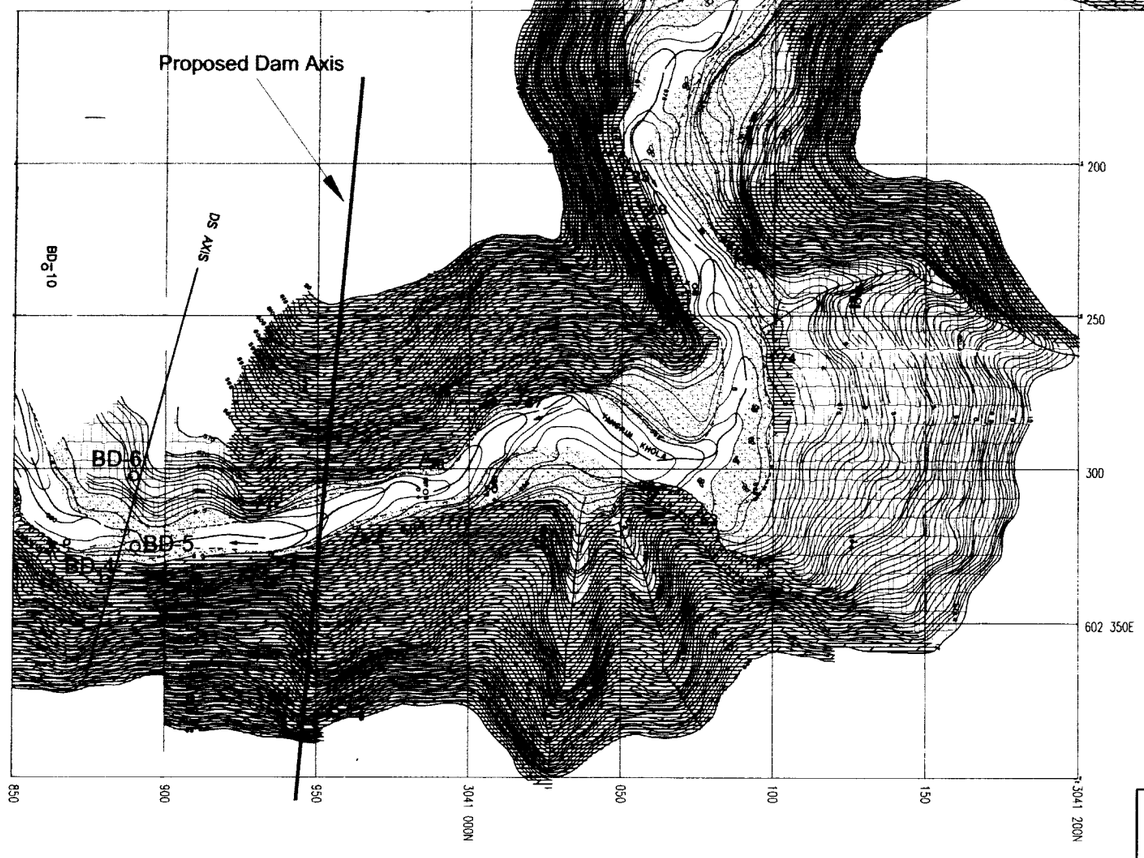
AGE	GROUP	FORMATION	SYMBOL	ROCK TYPE	GEOLOGY
Cenozoic	Recent Deposits		Rd	Riverbed deposits	Sand and gravels with bolders.
			Ta	Talus and/or Terrace	Talus deposits and terrace deposits.
		(Unconformity)			
	Siwalik Group		Sw	Conglomerate, Sandstone, Mudstone	Sandstone, mudstone, and small portions of conglomerates. Relatively soft and fractured near MBT.
		(Main Boundary Thrust)			
Paleozoic	Upper Newakot Group	Robang Formation	Phy (2)	Phyllite (2)	Blue green slatic phyllites, generally chloritic. Intercalation of calcalious beds. Relatively compact in general.
			Qz	Quartzite	Quartzite. Intercalation of thin phyllite at some localities. Massive and compact in general.
			Phy (1)	Phyllite (1)	Blue green phyllites, generally chloritic. Relatively compact in general.
		Maleldu Formation	Ol	Siliceous Dolomite	Light to dark and greenish gray siliceous dolomites. Intercalation of thin crystalline limestone and calc-phyllites. Massive and relatively well bedded.
		Berighat Formation	Sl	Slate(Phyllitic)	Dark gray slates and phyllites together with black carbonaceous slate. Fractured and weathered near MBT.
		(Mahabharat Thrust)			
Pre-Cambrian	Bhimphedi Group	Kalitar Formation	Sq	Schist, Quarzite	Dark green to gray colored two mica and biotite schist with intercalation of quartzite and garnets. Strongly folded and fractured at places.
		Bhaise Dobhan Formation	Mb	Limestone	Coarse crystalline marble, limestone with intercalation of thin schist. Marble and limestone are massive and well bedded.
		Raduwa Formation	Sch	Schist	Coarse-crystaline, highly gametiferous mica schist, gneissic schist. Some quartzites are also seen in this formation.



LEGEND

- Present River-bed Deposits
- Talus and/or Debris
- Phyllite
- Bedding (Dips & Strike)
- Schsitosity and/or Cleavage

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

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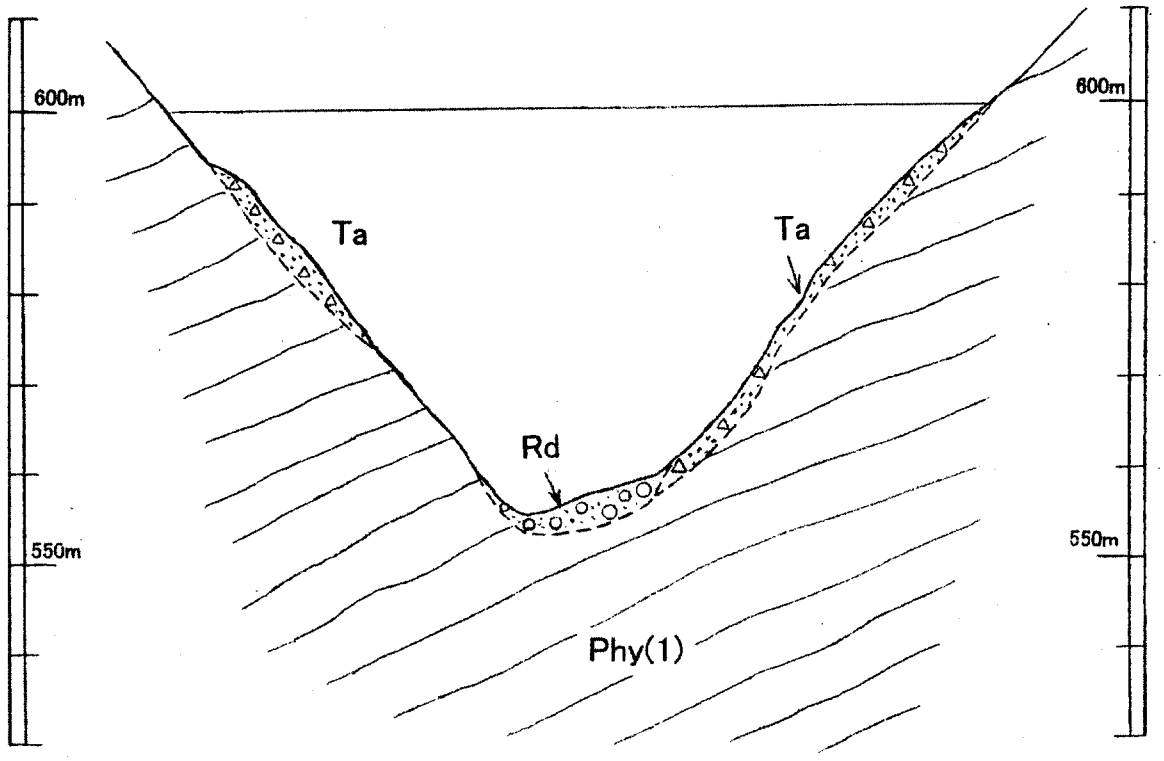
Figure 3.3.17
Geological Map around Damsite and Regulating Pond



Legend

AGE	GROUP	FORMATION	ROCKS	GEOLOGY
Cenozoic		Recent Deposits	Rd Riverbed deposits	Sand, gravels and bolders of phyllites, limestone and schist are mainly distributed. Bolders and gravels and coarse materials are mainly distributed in the river due to high gradients of river-bed.
			Ta Talus deposits	Sand, gravels and bolders of phyllites are generally distributed in the area.
		(Uncomformity)		
Paleozoic	Upper Nawakot Group	Robang Formation	Phy Phyllite (1)	Blue green phyllites, generally chloritic. Relatively compact in general.

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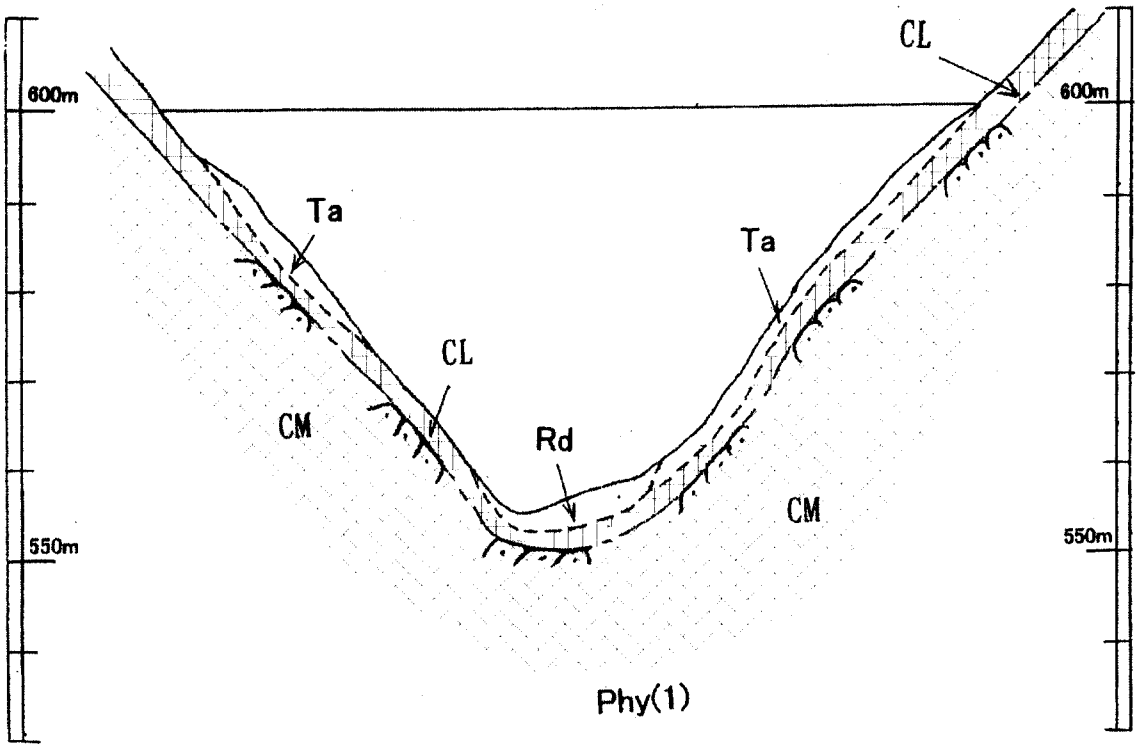
Figure 3.3.18
Geological Profile of Proposed Damsite



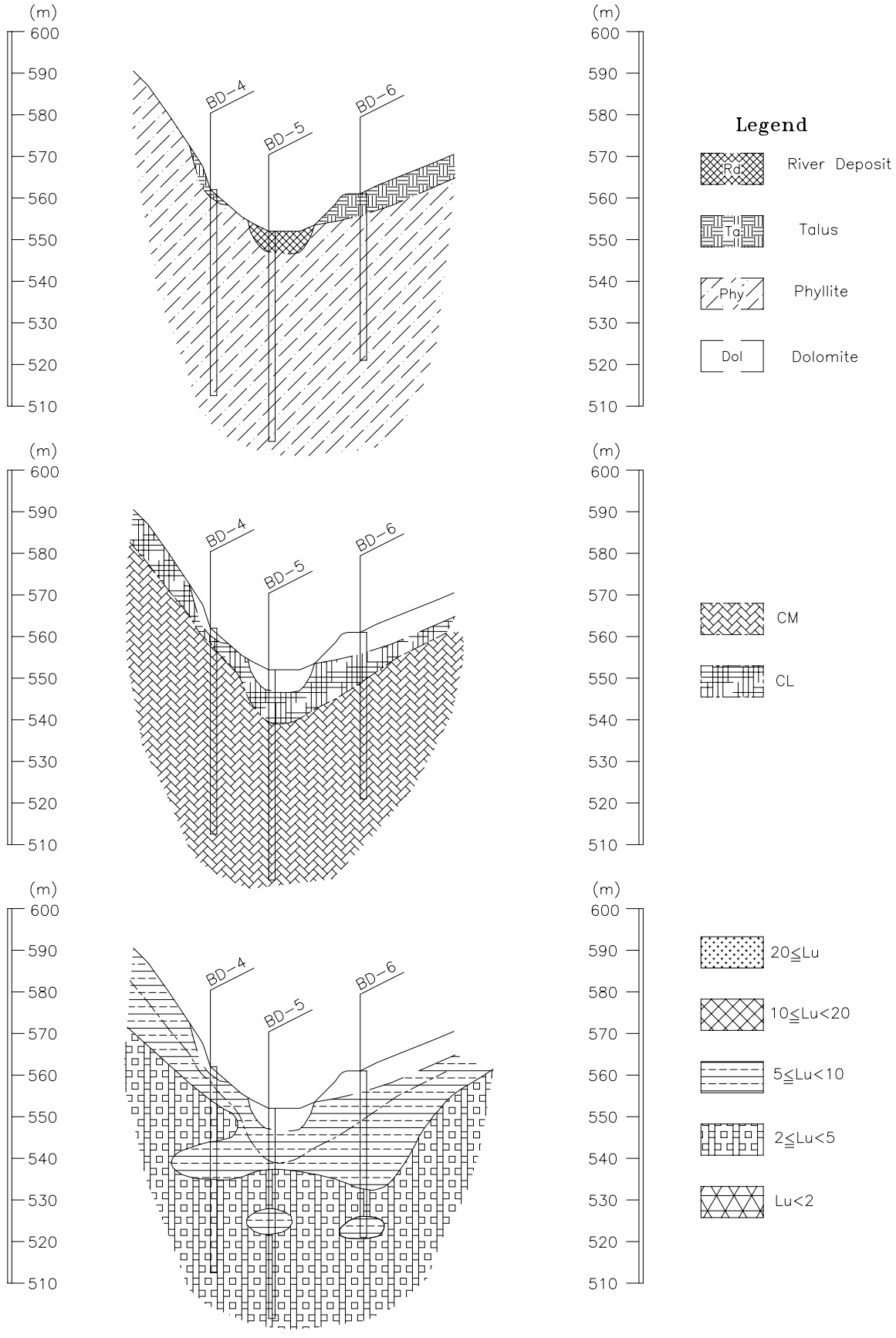
Legend

CM

CL

Excavation Line

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 3.3.19 Geological Profile of Proposed Damsite (Rock Grade)
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 3.3.20 Geological Profile of Upstream Damsite (BD-4, 5, 6)
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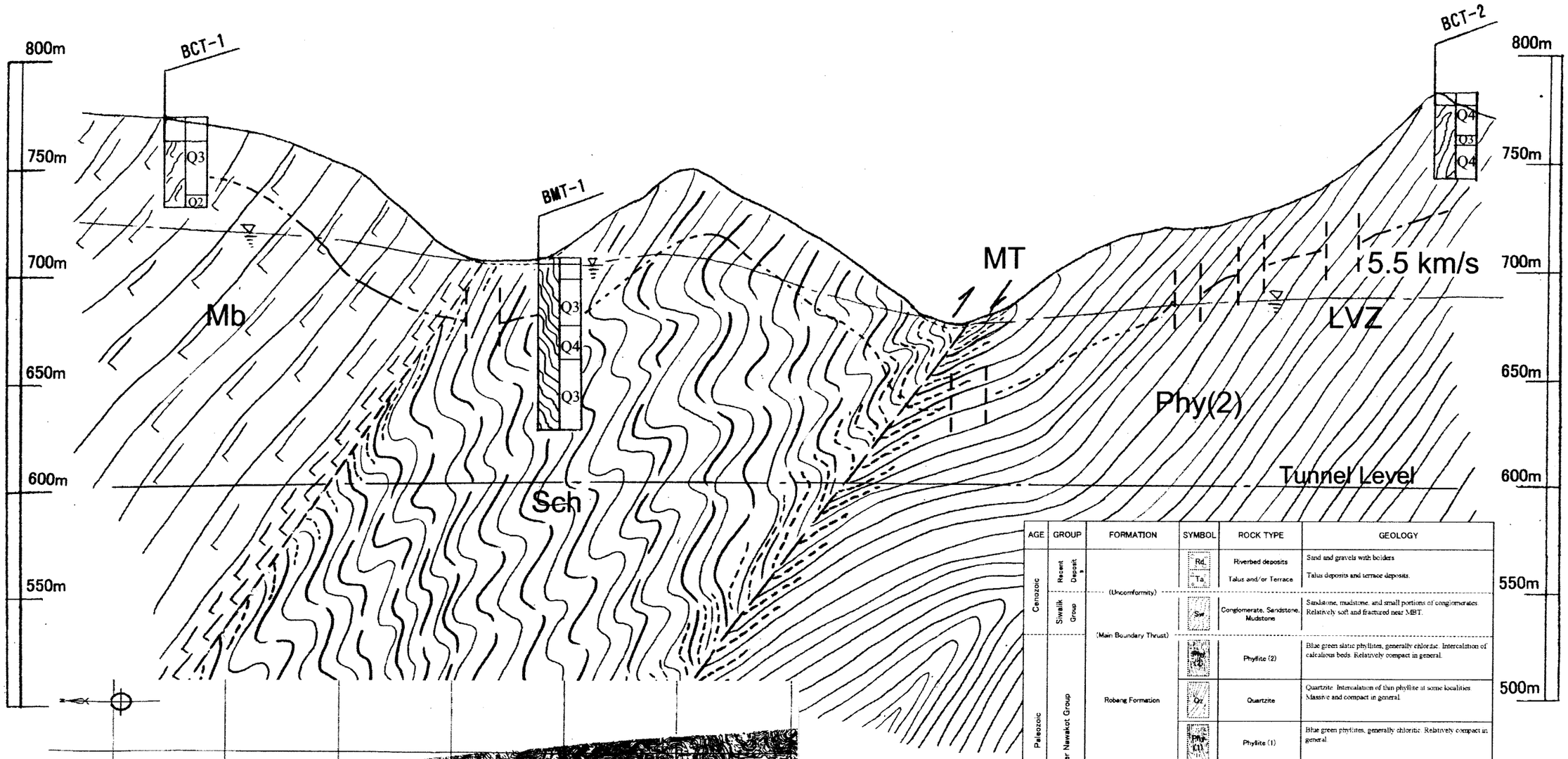

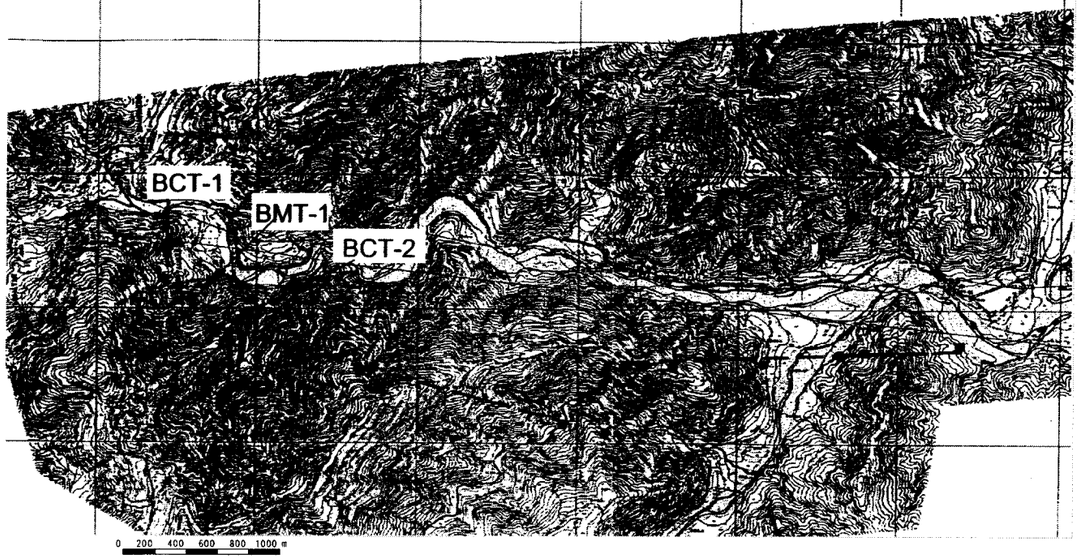

Highest Velocity Layer

LVZ : Low Velocity Zone

AGE	GROUP	FORMATION	SYMBOL	ROCK TYPE	GEOLOGY
Cenozoic	Recent Deposits		Rd, Ta	Riverbed deposits Talus and/or Terrace	Sand and gravels with boilders Talus deposits and terrace deposits.
	Siwalik Group	(Uncomformity)	Sw	Conglomerate, Sandstone, Mudstone	Sandstone, mudstone, and small portions of conglomerates Relatively soft and fractured near MBT.
Paleozoic	Upper Nawakot Group	(Main Boundary Thrust) Robang Formation	Phy (2)	Phyllite (2)	Blue green slatic phyllites, generally chloritic. Intercalation of calcalious beds. Relatively compact in general.
			Qz	Quartzite	Quartzite. Intercalation of thin phyllite at some localities Massive and compact in general.
			Phy (1)	Phyllite (1)	Blue green phyllites, generally chloritic. Relatively compact in general.
		Malekhu Formation	Dl	Siliceous Dolomite	Light-to-dark and greenish gray siliceous dolomites Intercalation of thin crystalline limestone and calc-phyliites Massive and relatrvely well bedded.
		Benighat Formation	Sl	Slate(Phyllitic)	Dark gray slates and phyllites together with black carbonaceous slate. Fractured and weathered near MBT.
		(Mahabharat Thrust)			
Pre-Cambrian	Bhimphedi Group	Kalitar Formation	Sch	Schist, Quarzite	Dark green to gray colored two mica and biotite schist with intercalation of quartzite and garnets. Strongly folded and fractured at places.
		Bhaise Dobhan Formation	Mb	Limestone	Coarse crystalline marble, limestone with intercalation of thin schist. Marble and limestone are massive and well bedded.
		Raduwa Formation	Sch	Schist	Coarse-crystalline, highly garnetiferous mica schist, gneissic schist. Some quartzites are also seen in this formation.

* Mahabharat Thrust (MT) :

Considered as an extension of Main Central Thrust (MCT), which forms the boundary between Higher and Lower Himalayas. Movement of MCT appears to be 5cm/year in recent years. MT is said to be basement thrust of Kathmandu Nappe which includes Bhimphedi Grou

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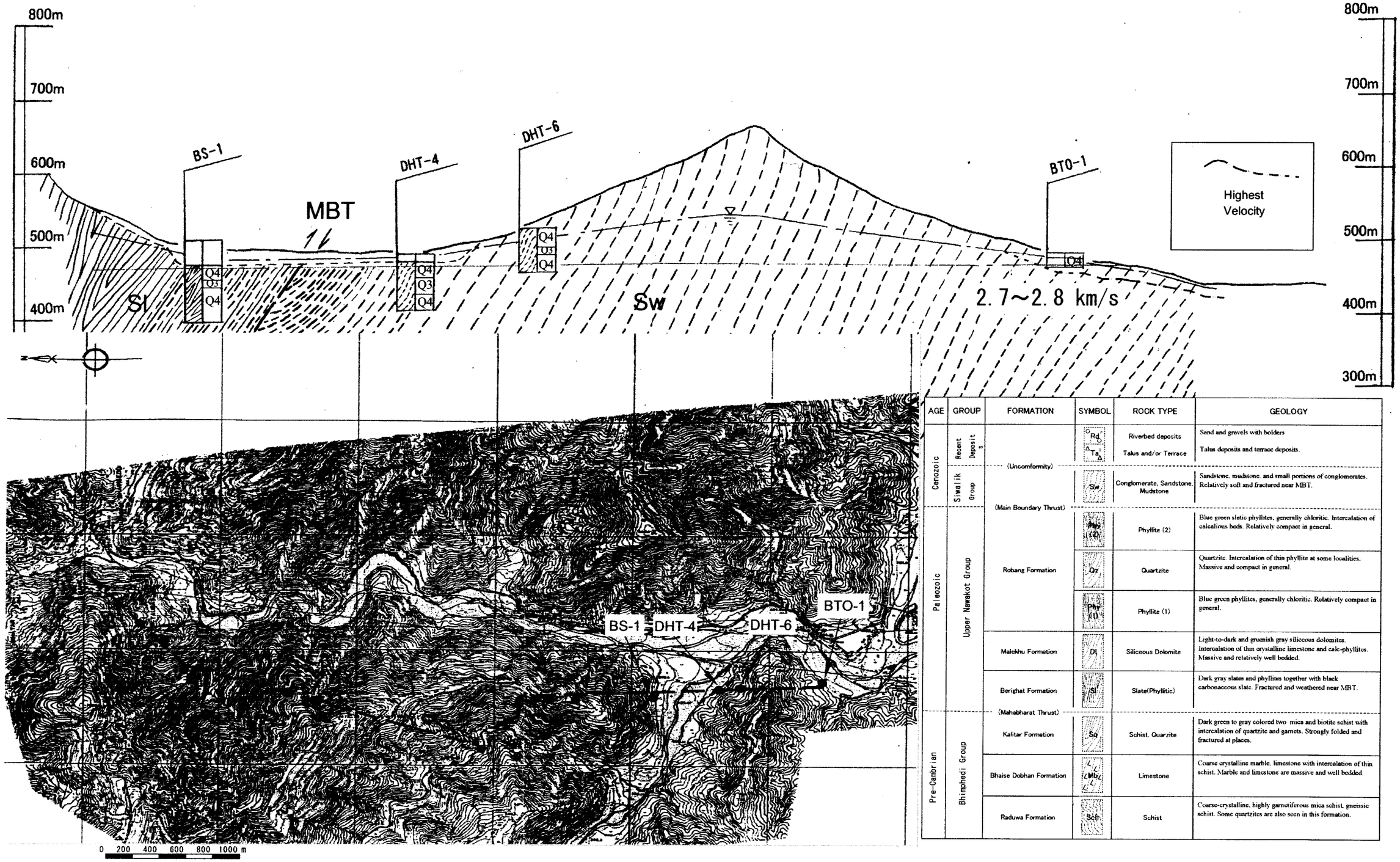
Figure 3.3.21

Geological Condition of Connection Tunnel



AGE	GROUP	FORMATION	SYMBOL	ROCK TYPE	GEOLOGY
Cenozoic	Recent Deposits		Rd Ta	Riverbed deposits Talus and/or Terrace	Sand and gravels with bolders Talus deposits and terrace deposits.
		(Unconformity)			
	Siwalik Group		Sw	Conglomerate, Sandstone, Mudstone	Sandstone, mudstone, and small portions of conglomerates. Relatively soft and fractured near MBT.
		(Main Boundary Thrust)			
Paleozoic	Upper Nawakot Group	Robang Formation	Phy (2)	Phyllite (2)	Blue green slatic phyllites, generally chloritic. Intercalation of calcalious beds. Relatively compact in general.
			Qz	Quartzite	Quartzite. Intercalation of thin phyllite at some localities. Massive and compact in general.
			Phy (1)	Phyllite (1)	Blue green phyllites, generally chloritic. Relatively compact in general.
		Malekhu Formation	Dl	Siliceous Dolomite	Light-to-dark and greenish gray siliceous dolomites. Intercalation of thin crystalline limestone and calc-phyllites. Massive and relatively well bedded.
		Berighat Formation	Sl	Slate(Phyllitic)	Dark gray slates and phyllites together with black carbonaceous slate. Fractured and weathered near MBT.
		(Mahabharat Thrust)			
Pre-Cambrian	Bhimphedi Group	Kalitar Formation	Sq	Schist, Quarzite	Dark green to gray colored two mica and biotite schist with intercalation of quartzite and garnets. Strongly folded and fractured at places.
		Bhaise Dobhan Formation	Mbz	Limestone	Coarse crystalline marble, limestone with intercalation of thin schist. Marble and limestone are massive and well bedded.
		Raduwa Formation	Sch	Schist	Coarse-crystalline, highly garnetiferous mica schist, gneissic schist. Some quartzites are also seen in this formation.

* Main Boundary Thrust (MBT) :

This thrust forms the boundary between Lower and Sub Himalayas. Siwalik sandstone of folded and faulted Tertiary sedimetary rock have been overthrusted in the south of MBT.

0 50 100 150 200 250 m

THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

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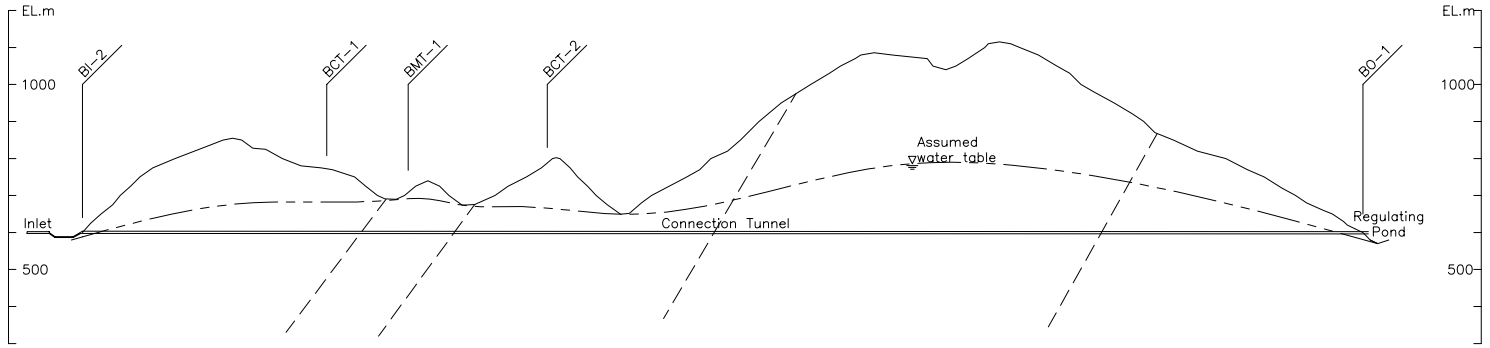
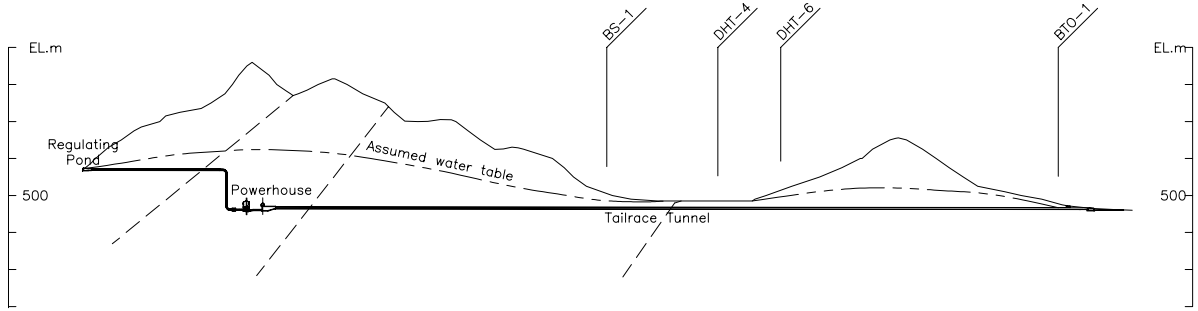
Figure 3.3.22

Geological Condition along Tailrace Tunnel



Additional Distance (m)	500	1000	1500	2000	2500	3000
Rock Grade (interval)	Q2 (685)	Q4 (60) Q3 (205) Q5 (75)	Q3 (590)	Q4 (80)	Q2 (1000)	Q4 (80) Q3 (700)
Geology	Marble	Schist	Phyllite / Quartzitic Phyllite		Quarzite	Phyllite
Groundwater	Medium		Large		Large – Medium	Medium

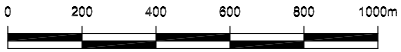
(Inlet To Regulating Pond)



Additional Distance (m)	500	Q5	1000	1500	2000	2500
Rock Grade (interval)	Q3 (315) Q4 (20) Q2 (265)	(25) Q4 (50) Q3 (425)	Q4 (320)	Q5 (280)	Q4 (100) Q3 (820)	Q4 (50)
Geology	Phyllite	Dolomite	Slate		Sandstone	
Groundwater	Medium	Large			Medium	

(Regulating Pond To Tailrace)

Rock Grade	Modulus of Deformation (MPa)	Shear Strength (MPa)	Friction Degree (degree)	Q value by Q system	CRIEPI classification (Reference)
Q1	> 3,000	> 2.5	> 50	> 40	B
Q2	3,000	2.5	50	10 to 40	CH
Q3	1,000	1.2	45	4 to 10	CM
Q4	500	0.6	40	1 to 4	CL
Q5	250	0.1	35	1 >	D



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL

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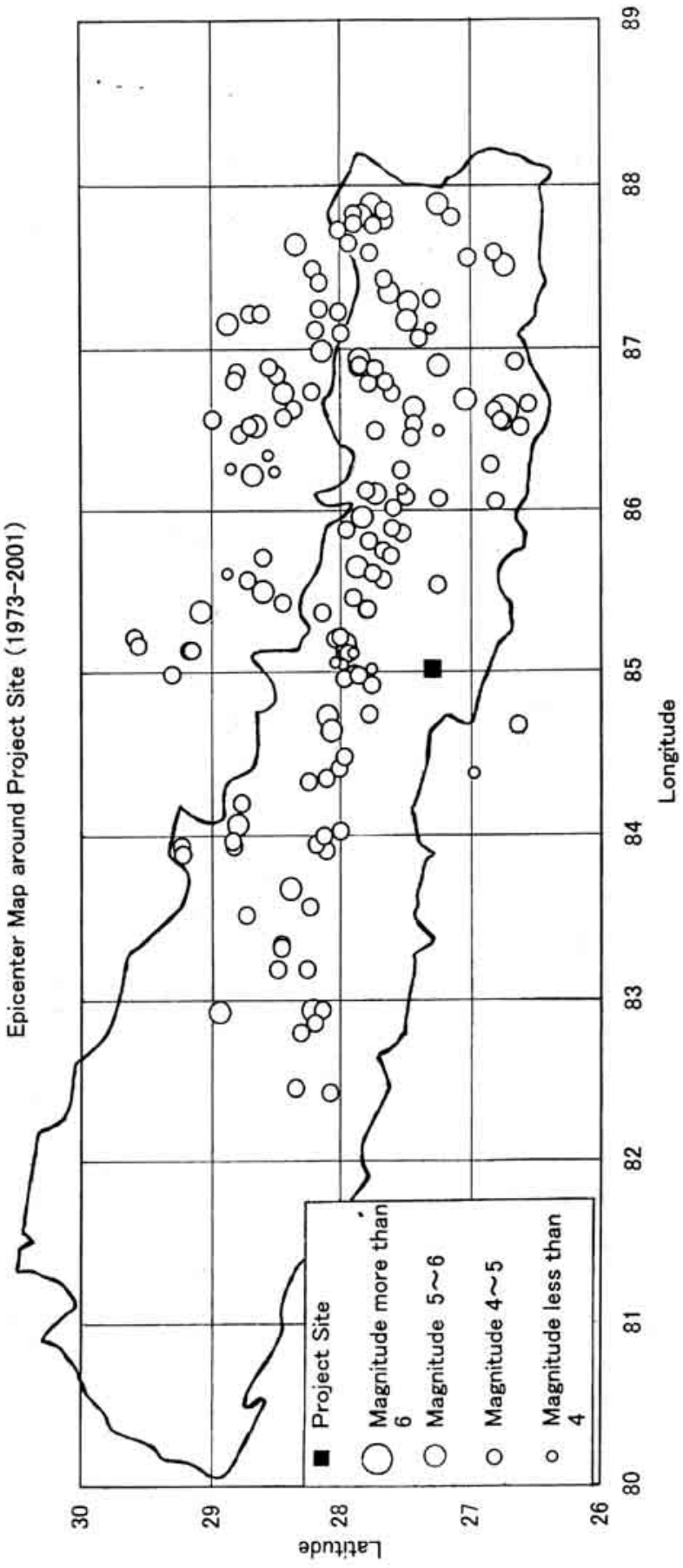
Figure 3.3.23
Rock Condition along Waterway



THE UPGRADING FEASIBILITY STUDY ON THE DEVELOPMENT OF THE KULEKHANI III HYDROPOWER PROJECT IN THE KINGDOM OF NEPAL	Figure 3.3.24 Epicenters around Project Site (1973-2001)
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