SITE VISIT & INCEPTION REPORT

TAKSANG GOMPHA NALLAH
SMALL HYDROELECTRIC PROJECT
(2X800 KW)

September 2018

Developer:

HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED

(A Government of Arunachal Pradesh Undertaking)

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Arunachal Pradesh, India

Consultant:

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Table of Contents

Page

List of Figures

1 General

Hydro Power Development Corporation of Arunachal Pradesh Ltd. (HPCDAPL) is developing Taksang Gompha Nallah Small Hydroelectric Project. The DPR of the project has been prepared by Concept Green Energy Pvt. Ltd. in Dec, 2015.

As per the DPR, the project alignment was spread from downstream of the existing 1x50 KW T Gonpa MHS and the Power House of the project is located at the upstream of the Taksang Gompha, one of the sacred places of Buddhists.. The main structures of the project were 15 m long trench weir, 18 m long RCC Intake channel, 35 m long desilting basin, 1,076 m long power channel, 29 m long forebay tank of 261 cum capacity, 550 mm dia., 255 m long penstock pipe and 30 m x 16 m size surface power house. It was estimated that the project shall utilize the 1.3 cumec of design discharge during a 75% dependable year with gross head of 150 m to generate 6.17 GwH of annual energy at 95% plant availability factor. The generated power will be evacuated from project switchyard to downstream proposed project of 2x1700 KW capacity Taksang Chu SHP through 2 KM long, 33 KV line. From there, the power shall be evacuated to Zemithang, the nearest 33 KV substation.

HPCDAPL has now awarded the works of finalization of structure design, drawings and preparation of tender documents of the project to Concept Green Energy Pvt. Ltd. It was desired by the department to have a review of the project parameters and carryout the Detailed Design works.

The Detailed Project Report was sent to Alternate Hydro Energy Centre (AHEC), Roorkee for its approval. AHEC vide its number AHEC/C-1017/SG/SS/69 and AHEC/C-1017/SG/SS/109 had raised few observations and queries. It was also desired to go through these comments for the needful.

As a first step in the present assignment, Concept Green Energy Pvt. Ltd. (CGEPL) and Hydro Power Development Corporation of Arunachal Pradesh Ltd. (HPCDAPL) teams carried out joint visit to the project site. The purpose of the visit was to freeze project component locations including addressing the concerns of Taksang Gompha and to start the detailed survey works as required for designs. The current report presents the Visit Report covering revalidated assessment of the project.

2 Location

The project is located in Tawang district of Arunachal Pradesh at about 45 km from Tawang, the district Headquarter and about 415 km from Balukpong, the nearest rail head. The project is connected by National Highway upto Tawang and all weather motorable road from Tawang. The power House and the weir shall be made accessible by construction of project motorable and bridle path respectively.

Figure 1: Project Location

The project is located between elevations of 3622 amsl and 3488 amsl. The Power House of the project is located at coordinates 27° 42′ 54″ N, 91° 48′ 19″ E.

HPCDAPL is also implementing a 3 MW Sumba Chu SHP at Zemithang which is about 35 Kms. from Taksang Gompha. This project is under final stages of completion. HPCDAPL is also developing a 3.4 MW Taksang Chu Small Hydroelectric project at downstream of the current project. Both Taksang Gompha Nallah SHP & Taksang Chu SHP shall be taken up concurrently.

There is an existing T Gonpa MHP power house of 50 KW capacity at upstream of the project. The power generated from the project is supplied to Army establishment, Gompha and nearby villages.

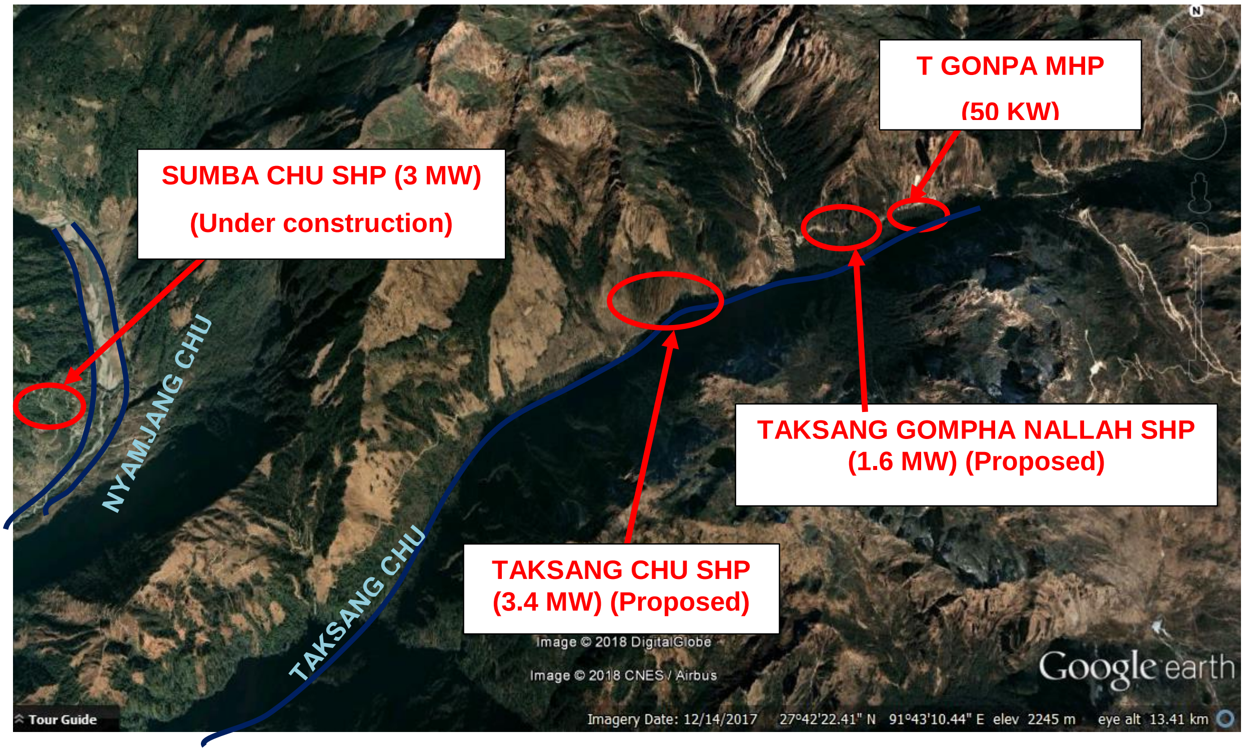


Figure 2: Projects Locations on Satellite image

(Not to Scale)

3 Project Layout and options

3.1 General Geology

The project area is characterized by highly rugged topography with hills and deep gorges. The project area is located on high grade metamorphic rocks of the pre-Cambrian belonging to the Sela Group and Lumla Formation. Bed rock exposures are scanty at the project site. Bed rock in the project area can be grouped into two main classes, viz. gneiss and quartzite's with schist bands. The rocks are highly jointed and fractured; several sets of joints were noticed.

Overburden in the project area comprises large rock blocks of coarse grained granite, granite gneiss, migmatite, etc, set in a matrix of sandy soil. The overburden is interpreted to be reworked glacial drift.

3.2 Options Studied

Post DPR stage it was informed that there are reservations about the location of the Power House site as it is too close to the sacred Gompha premises and Gompha land. Therefore during the site visit of the experts together with GM HPDCAPL, the whole alignment was visited to locate the best alternative that serves as optimal solution. It was found that the Power House site can be suitably shifted upstream site to keep a safe distance from the Gompha.

During the site visit and topographical survey, two locations were identified for placement of Forebay to Power House alignments. These two alternatives are shown below in Figure 3. Alternate-1 was considered after leaving appropriate space from the Gompha Sacred area. Whereas, Alternate-2 was considered at upstream of boulder zone for avoiding the crossing of water conductor through it near forebay.

Available heads at two locations were 134 m and 113 m respectively.

So, considering the availability of maximum possible head, Alternate-1 was selected for the project alignment.

During studies it was also observed that the stream is emanating from a lake that is fed by three major streams. These streams are again emanating from lakes at upstream. Therefore, general hydrology of the project is better than envisaged in the DPR. The actual generation may be higher than estimated in the DPR.

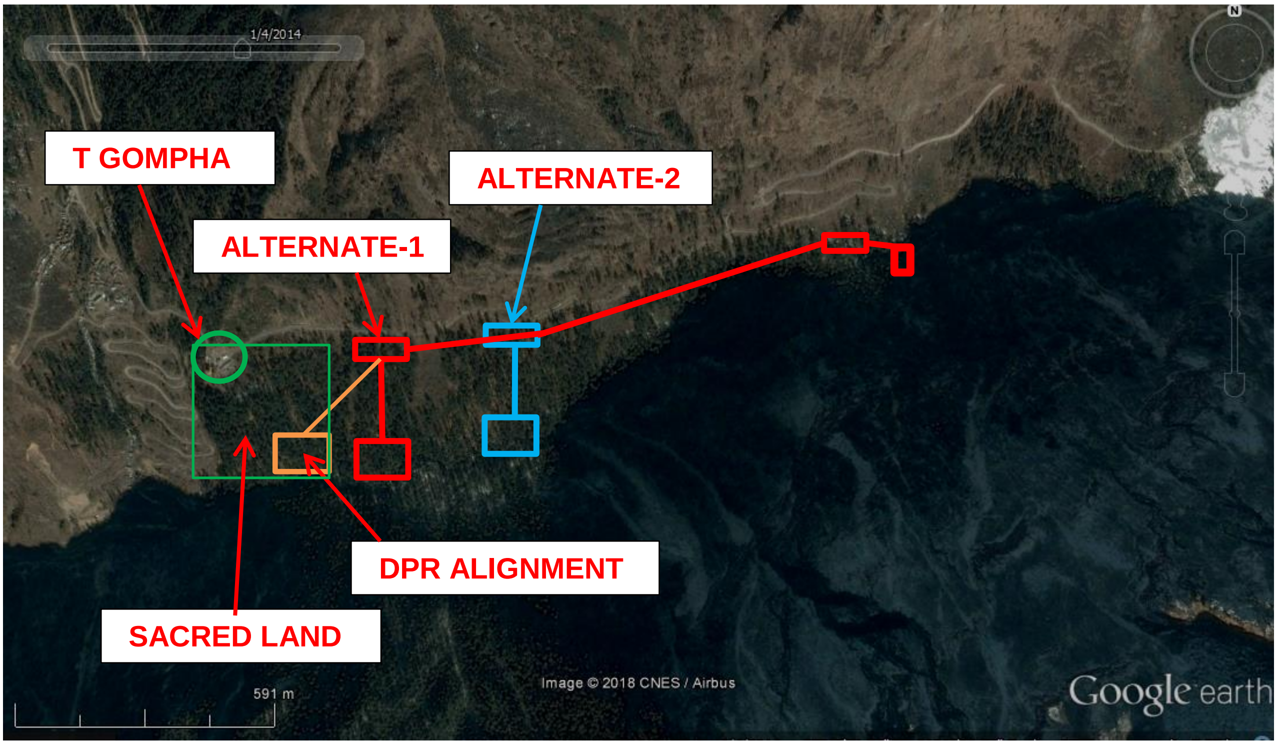


Figure 3: The two alternatives imposed on google earth map

(Not to Scale)

4 Details of Proposed Project Alignment

As per site visit observations followed by the field survey works, the Alternate 1 is considered as revised alternative adopted for further studies. The revised head loss calculation is annexed in Appendix A, the revised power potential studies is summarized in Appendix-B. The salient features for revised layout of the project is summarized in Appendix-C. The adopted layout plan is attached herewith as Appendix-D. Important observations of revised alignment are summarized below:

4.1 Diversion Works

The proposed Diversion works is shifted slightly downstream from the location in DPR. In this reach the river flow is straight and the rock is exposed at one end. New elevation of Weir axis shall be 3622 m. The length of the weir shall be 15 m which is same as that in the DPR. It is narrowest opening between two banks and flares on downstream. Weir shall be founded on overburden, hence concern of rock availability at foundation is not significant.

Since it is a Run of the River project, trench weir type diversion structure is being adopted. It shall be similar to the structure as proposed under the DPR.

The weir shall be constructed in two phases to facilitate the river diversion during construction.

Figure 4: Weir Site

4.2 Feeder channel to Desilting tank

The RCC box type feeder channel of size 1.10 m x 1.40 m will carry water from intake to surface desilting basin. Total length of feeder channel is approximately 24 m. The surface profile is good and no problem is envisaged on this account.

4.3 Desilting Chamber

A RCC type Desilting Chamber of size 27 m (L) x 3.4 m (W) is proposed in place of 35 m x 3.1 m proposed in the DPR.

Figure 5: Desilting Basin Location

4.4 Power Channel

After desilting tank, the water shall be carried through RCC box type channel of size 1.10 m x 1.40 m, which was earlier proposed 1.10 m x 1.30 m in the DPR. Total length of the channel upto Forebay is approx. 1,000 m. The channel passes through gulley with heavy rock overburdens. Suitable measures shall be taken while passing through these reaches.

4.5 Forebay

The RCC forebay with a total capacity of 280 cum shall be designed. Its location has been finalized based on suitable topography, geology and to avoid any major nala in vicinity of the structure.The forebay site is located along the side of existing road. The area profile is sharp and it is the only place where forebay could be located. HPDCAPL has been requested to take up with BRO the road shifting of around 120 m towards the hill.

Figure 6: Boulder zone in power channel alignment

Figure 7: Forebay area

4.6 Penstock

The penstock size is increased to reduce the head loss. Approximately 750 mm dia. circular steel penstock pipe of total length of approximately 255 m shall be laid. The penstock shall be bifurcated into two nos. 530 mm dia. each before entering to powerhouse.

The penstock crosses rock over burden gulleys as shown in layout plan. Suitable safety arrangement shall be made for penstock while crossing the gulley.

4.7 Power House and Tail Race channel

The Power House site is shifted towards the upstream of previous site as taken in DPR. A wide terrace is available at the right bank of river as shown in layout plan. The Surface powerhouse is proposed at this terrace at the bank of Taksang Chu.

Water will be release back in to river through open channel tail race. The tail race for the project has been planned after detailed survey and geological mapping to draw maximum advantage of the allotted project coordinates

Figure 8: Powerhouse Location

4.8 Infrastructure Requirements

The project shall require following infrastructures for development.

4.8.1 Roads & Bridges:

I. **Approach to Power House:** It shall be 4m wide and about 1.5 km long approach road. The road with a ruling gradient of 1:12 shall be capable of carrying heavy loads to power house.

II. **Approach to Forebay:** The forebay shall be located at road side. So no separate road is required. However, suitable protection works shall be carried out to avoid the probability of any accident.

III. **Approach to diversion site and desilting chamber:** It shall be connecting main road to diversion site and desander. Total approximate length of the road shall be about 1 km to facilitate the construction of weir.

4.8.2 Project Colony & establishment:

A project colony, offices, workshops and other associated establishments shall have to be established before start of the project. It is suggested that initially the permanent project colony be constructed and used for construction personnel to save in double establishment cost.

4.8.3 Communication

As the communication system in the area is extremely poor, the office complex shall be provided with internet facility by installation of dish. Communication to site shall be done through walkie-talkie sets of independent frequency.

The required permissions may be taken from Army/ BRO for use of wireless sets.

5 Project Power Parameters

5.1 Hydrology

As per the Detailed Project Report, the catchment area of Taksang Chu at Diversion site is 48.7 sq kM. Taksang Chu originates from Sangester Lake at about ±3710m at about 300 m upstream of the Diversion site. The lake is fed by three perinial streams. Substantial area of the stream is under perpetual snow cover. Since the river originates from a lake, it provides enough stability in terms of discharge. The hydrology considered in the DPR is OK. The ecological release considered in the DPR has been revised to 15% of the average lean season discharge based on the recommendation from AHEC.

5.2 Head

As per Survey report, the gross head of the project is 134 m. The head loss at 100% capacity works out to be approx. 6 M. Thus net head of the project shall be 128 m. The details of head loss has been detailed under Appendix A: Revised Head Loss calculations.

5.3 Power Potential

The power potential studies were re-visited with revised head, head loss and hydrology (ecological release). The efficiency of the generating sets was also updated. After incorporating these factors, the incremental energy versus install capacity curve at 75% dependable year indicates the capacity of the project to remain same as 1.6 MW and the design energy being 6.0 MU against 6.17 MU in the DPR. The details of the power potential studies are enclosed as per Appendix-B. On the basis of power potential studies the design discharge has been adopted as 1.41 cumec. The system shall be able to operate at 10% overloads. The minor loss of energy is due to revision of head, ecological release and efficiency of Turbine-Generator units.

6 Requirements of Field Investigation

6.1 Topographical Survey works

Scope of work

The permanent bench marks have been established at site and details of revised locations have been obtained.

General

All temporary as well as permanent bench marks have been marked on the drawings for easy correlation between maps and site.

All outcrops and small stream especially where water is flowing and crossing the water conductor system been marked on the survey drawings

Trench Weir, Desilting Basin and Silt flushing pipe

Survey has covered the area about 100 m upstream and about 100 m downstream of tentative weir axis (weir axis as shown on the site) in 1 m contour interval. Desilting area has been covered at 0.5 m contour interval. Cross-sections of Taksang Chu (stream) at 10 m upstream, at axis and 10 m downstream of axis respectively and covering up to exiting road level on right bank and about 10 above of left bank. Further cross-sections of Taksang Chu are near outfall of the silt flushing pipe from the bottom of the desilting basin has been taken. In all the cross-sections of the stream water level on the day measurements/ survey has been taken in each section along with flood mark duly surveyed and shown in each section.

Water Conductor System

In order to plan water conductor system with a combination of partially free flow in initial reaches and partially pressures in lower reaches and/ or fully pressurized to avoid as far as possible loose boulder reach in the water conductor system alignment, surveyed to cover both the area. Survey at 2 m contour interval with cross-sections covering about 20 m in elevation from the likely location of Water conductor system on hill side and up to River / Taksang Chu on valley side has been done. These cross-sections are taken at 25 m c/c and covering change in topography especially where there is sharp change in slope and/ or bend in case these locations are not covered in 25 m c/c spacing. Thee cross sections have been marked on the Survey plans also and clearly identifiable with respect to cross-section drawings.

Penstock Pipe

It has been agreed that penstock pipe can be laid away from the boulders lying on the slope on right bank of Taksang Chu. Survey covering about 25 m width is done at 1 m contour interval along with longitudinal section along tentative and most likely pipe alignment.

Powerhouse, Tailrace and Switchyard

Detailed survey covering all possible flat area in the vicinity to prepare the maps /Survey drawings at 0.5 m contour interval.

6.2 Excavation of Pits

It is proposed to excavate exploratory pits (3 m x 3m x 3m) at different locations of the project. Soil samples are to be collected from the pits and tested for soil parameters to ascertain the bearing capacity of the strata as well as general stability of cut slopes.

Proposed exploratory pit locations:-

Trench weir- No pit

Desilting Basin- Two pits one each at inlet and another on outlet side

Water Conductor System – About 8 pits at the likely locations of Anchor Blocks viz. turning points of water conductor

Penstock- About 3 pits along the likely alignment of the pipe

Powerhouse, tailrace and Switchyard- 4 pits at powerhouse complex

Note: Safe path is to be developed for visiting the trench weir and powerhouse site from the existing road.

APPENDIX-A

REVISED HEAD LOSS CALCULATION

PROJECT POTENTIAL

Design Discharge =		1.410	cumecs			
Gross Head =		131.688	m			
Net H =		128.67	m			
P =	9.81 X 0.9013 X 1.41 X 128.68 =				1605	kW
				say	**1600**	**kW**

DIVERSION WEIR

Calculation of HFL (High Flood Level)

Elevation of u/s end of the weir = 3622.00 m

Specific Energy Method

$Q_f = C_d \times L \times E^{3/2}$ (Ref.P.P.362 Open Channel Hydraulics by Ven Te Chow)

Q_f = Flood Discharge in cumecs

C_d = Coefficient of discharge 1.7

E = Specific Energy at the upstream of weir

L = Length of the Trench weir

$E = y + V^2/2g = 3/2\ y$ (since y is critical depth)

Q_f =	350	cumecs
L=	15	m
E =	5.74	m
y =	3.83	m
HFL =	3625.83	m

Required top level of protection wall 3626.3 m

Average river bed level at weir site		=	3622.00	m
Flood Discharge	Q_f	=	350	m^3/s

Slope of river		=	1 in	10
Waterway width		=	15	m
Manning's coefficient	n	=	0.06	
Assuming the water depth		=	2.8	m
Wetted area	A	=	42	m^2
Wetted perimeter	P	=	20.95	m
Hydraulic mean depth	R	=	A/P	
		=	2.00	
velocity	V	=	$R^{2/3} S^{1/2} /n$	
		=	8.38	m/sec
Therefore,	Q	=	A V	
		=	351.95	m^3/s
			>162.7, Hece Safe	
Hence water depth of 2.8m can be adopted				
HFL at weir site		=	3624.8	m
Required top level of Protection wall			3625.8	m
Adopting the safer level top of protection wall			**3626.0**	**m**

Calculation of Length of Trashrack

$$L_g = \frac{Q_w}{\varepsilon C b \sqrt{2gE}}$$

(Refer P.P.338 open channel Hydraulic by Ven Te Chow)

L_g = Length of Trash rack

Q_w = Withdrawal of discharge through the trashrack(m^3/sec)

ε = Ratio of the opening area of the total area of the trashrack surface

C = Coefficient of discharge through the opening

b = Length of trench weir (m)

E = Specific Energy (m)

Q_w =	$C_1\,C_2\,Q_d$		
C_1 =	Coefficient for flushing		
C_2 =	Coefficient for flow concentration		
Q_d =	Design Discharge =	1.410	cumecs
Q_d =	1.833 cumecs (at intake)		
C_1 =	1.25		
C_2 =	1.2		
Q_w =	1.833X1.25X1.2	2.75	cumecs
ε =	$K_1K_2\,(A_1/A_2)$		
K_1 =	Reduction for frame stucture		
K_2 =	Reduction for clogging due to Boulders		
A_1 =	Opening Area		
A_2 =	Total Area		
K_1 =	0.9		
K_2 =	0.5		
A_1/A_2 =	0.32		
∴ ε =	0.9X0.5X0.32 =	0.144	
C =	$0.497\,(0.514)^{1/x}$ (Refer PP 339,open channel Hydraulics by Ven Te Chow)		
1/x =	Slope of trashrack	0.1	
C =	0.465		
$E=(Q_w/cb)^{2/3}$ =	((2.75/(0.465*)^2/3	0.538	
L_g =	2.75/(0.144X0.465XX(2X9.81X0.538)^0.5)		
Lg =	0.843 m		
Provided L_g =	2.0 m >0.843 m (Refer CBIP Publication No. 175) Hence provide 2 m		

Calculation of Scour Depth

R = $1.35\,[q^2/f]^{1/3}$ (Refer IS: 1966-1973 Clause 17)

R = Depth of scour below the HFL
q = Flood Discharge per unit length
q = 350/15 = 23.333 cumecs/m

f = $1.76\sqrt{m}$
(silt factor)

Assume m=size of particle in mm= 15 mm

f = 1.76 X (15)^.5 = 6.817

Let us Assume f = 7

Thus, R = $1.35\,[q^2/f]^{1/3}$ = 5.763 m

Upstream

Depth of protection below HFL = 1.1 R = 1.1 x 5.763 = 6.34

EL of depth of protection below u/s bed = 3625.83 - 6.34 = 3620.26
First upstream key
Provided EL. 3620.24 m

Downstream

Depth of protection below HFL = 1.25 R = 1.25 x 5.763 = 7.204

EL of depth of protection below u/s bed = 3625.83 - 7.204 = 3617.05

Provided EL.	3616.98	m

Head Loss in Trench Weir

Head Loss in trench weir	0.2	m
Head Loss in Bulkhead and Service Gate at intake pipe	0.2	m
Total Head Loss in Trench weir	**0.4**	m

WATER CONDUCTOR SYSTEM (Intake Channel)

1.1	Base Width	
1.14	Depth of water flow	
0.3	Free Board	
0	Side Slope towards Hill Side (Horizontal to 1 Vertical)	
0	Side Slope towards Valley Side (Horizontal to 1 Vertical)	
1.10	Top Width at Water Level	
1.10	Top Width at Canal Top Level	
1.26	Cross Sectional Area of Water Flow	
3.38	Wetted Perimeter	
0.37	Hydraulic Radius	
0.014	Manning's Coefficient 'n'	
24.00	Length of Intake Channel including transistion at inlet of desilting basin	
500	Given Slope (Horizontal to 1 Vertical)	500.00
1.65	Velocity of flow in Power Channel m/s (Manning's)	
1.48	Velocity of flow in Power Channel m/s (Continuity)	
1.11	Ratio of velocity	
2.07	Discharge for above given Slope (Cumec)	

Overall internal dimensions of Channel

1.4	Depth of Intake channel	
1.1	Width of Intake channel	
	Head Loss in Intake Chennel due to slope	0.048
	Head Loss at expansion near Desilting basin	0.139
	Total Head Loss in Intake Channel	**0.187**

Desilting Tank

Design discharge	=	1.86	cumecs

Provided hopper

Width of the silt Catch Drain (m)	1.000
Free Board (m)	0.500
Depth of flow in Vertical portion (m)	1.500
Depth of flow in sloping portion (m)	1.200
Side Slope towards Hill Side (Horizontal to 1 Vertical)	1.000
Side Slope towards Valley Side (Horizontal to 1 Vertical)	1.000
Top Width at Water Level (m)	3.400
Cross Sectional Area of Water Flow($m^{2)}$	7.740
Wetted Perimeter(m)	7.394
Hydraulic Radius(m)	1.047
Given Slope along length (Horizontal to 1 Vertical)	2.85E+04
Velocity of flow in Desilting Tank (m/s)	0.240
Discharge for above given Slope (Cumec)	1.86

Settling velocity (V_s)

V_s = $1/18[(Ps - \rho) / \mu] g d^2$

V_s = Settling velocity in Desilting tank (cm/sec)

P_s		=	Density of particle (g/cm$^{3)}$
ρ		=	Density of Water (g/cm$^{3)}$
μ		=	Absolute viscocity of water at 10°C (g-sec/cm^2)
g		=	Acceleration due to gravity (9.81m/sec^2)
d		=	Diameter of particle (cm)
P_s		=	2.65 g/cm3;
ρ		=	1 g/cm3
μ		=	0.0131 g/sec/cm2 at 10°C
d		=	0.02 cm

∴ Settling velocity of 0.2 mm particle is given by

V_s		=	1/18 x[(2.65-1) / 0.0131]x g x(0.02)^2/100
			0.027 m/s

Time for vertical settling (t_v)

t_v	= d / Vs	=	98.33 sec
t_v		=	Time for vertical settling
d		=	Depth of Desilting chamber (m)
V_s		=	Settling velocity (m/sec)

Length of Desilting Basin

Length = V_h x t_v = 0.283 x 145.45 = 41.16 m	= Vh x tv		23.65	
Provide L	=	27	m	∴ OK

Head Loss in Desilting Basin

Head loss due to expansion

Velocity u/s of expansion	=	0.000	
Velocity d/s of expansion	=	0.240	
Head loss due to expansion	=	0.003	m

Head loss due to Contraction loss

Velocity in Pipe d/s of desilting tank		1.33	
Head loss		0.0180	m
Head Loss due to friction in Desilting Chamber		0.0500	m
Total Head loss	=	**0.071**	m

WATER CONDUCTOR SYSTEM (after Desilting tank,i.e. Power Channel & Pipe)

Head loss in Power Channel

Rated Design discharge	Q	=	1.410	cumec
Design discharge with 10 % overloading		=	1.55	
Width of rectangular Channel	w	=	1.100	m
Depth of flow in rectangular channel	d	=	1.07	m
X-sectional area	A	=	1.18	
Wetted Perimeter	P	=	3.25	
Hydraulic mean Depth	R	=	0.364	
Manning's Coefficient	(n)	=	0.014	
Velocity	V	=	1.329	m/sec
Provided Longitudinal slope	S 1 in	=	750	
Discharge corresponding to provided slope (by encroaching in the free board)		=	1.57	cume

Head Loss computations

Length of Power channel	L	=	1000	m
Head loss due to slope			1.33	
Head loss due to bends in power channel alignment		=	0.250	m
(10 bends have been assumed with loss @ 0.025m)				
Total Head Loss in Power Channel		=	**1.583**	m

FOREBAY

Rated Designed discharge Qd	=	1.410	
Storage time t (minutes)	=	3	

Required capacity of Forebay for 3 minutes

Storage Required	=	254	cumec
Water depth in Forebay	=	2.00	m
Width	=	4	m

Provided Forebay Capacity

Rectangular forebay structure			
Length of Forebay	=	36	m
Width of Forebay	=	4	m
Capacity of the Forebay (Provided)	=	288	m^3
F.S.L in the Forebay	=	3619.69	m
M.D.D.L of Forebay	=	3617.69	m

Bell mouth	=	1.19
Submergence 0	=	0.95
Center line of penstock	**=**	**3616.15**
Invert Level of pipe	**=**	**3615.77**

Head Loss in Forebay

Head Loss at Entrance	=	0.090	m
Head Loss in Forebay	=	0.05	m
Total Head loss in Forebay	=	**0.140**	

Loss of Head at exit of Forebay & in Penstock

Trashrack Loss

	h_t	=	Kt $V^2/(2g)$
Where	K_t	=	$1.45-.45(an/at)-(an/at)^2$
	an	=	net area through trash rack bar
	at	=	Gross area of Opening

	an/at	=	0.450		Refer IS 4880 (Part-III)
There fore	K_t	=	1.045		
Area of trashrack		=	3.300		
Net area through trashrack		=	50 % of gross area of trashrack		
		=	0.5 x3.3	=	1.65
Velocity	V_t	=	0.855	m/s	
	$h_t = K_t V^2/(2g)$	=	**0.039**		

StoplogGate & Gate Groove

K_g	0.08	
w	1.1	m
h	1.1	m

	Area	1.21	m2	
	V_g	1.17	m/s	
	$h_g = K_g V_g^2/(2g)$	**0.014**	m	
Entrance Loss				
	K_e	0.16	m	IS 4880 (Part-III)
	V_e	1.17	m/s	
	$h_e = K_e V_e^2/(2g)$	**0.011**		
Transition Losses				
	Dia.	0.750	m	
	Area	0.442	m2	
	V_1	3.192	m/s	
	V_2	2.507	m/s	
	V_3	1.165	m/s	
Transition from Rectangular to Rectangular				
	$he1 = 0.1*(V_3^2-V_2^2)/(2*9.81)$	0.039		
Transition from Rectangular to Circular				
	$he2 = 0.1*(V_1^2-V_2^2)/(2*9.81)$	0.020		
Total transition losses =he1+ he2		**0.059**		

Frictional Loss (Main Penstock)

$h_f = fLV^2/2gd$

h_f	=	Frictional loss in penstock (m)				
f	=	Loss Coefficient				
V	=	Velocity through penstock=	3.192			
g	=	Acceleration due to gravity = 9.81 m/sec^2				
d	=	Diameter of penstock =	750	=	0.75	m
K_S	=	Loss coefficient =	0.1	m/sec		

K_S/d = 0.000133333

Reynold's Number (R_e) = VD/r = 24,57,905.54 (r = 0.0974 x 10^{-5})

From Moody's diag., f = 0.012 (BIS No. 11625-1986)

L = 255.00 m

h_f = 0.012 X 255 X 3.192^2/(2 X 9.8 1X 0.75) **2.12** m

Frictional Loss (unit penstock)

Unit penstock diameter = 530 mm = 0.530 m

Design Discharge =	0.705		cumecs
Area = $\pi * d^2/4$ =	0.221	m^2	
Velocity(V)=Q/A =	3.191	m/sec	

R_e = VD/r = 3.191 X 0.530330085889911/0.0974 x10-5 = 17,37,457.19

KS/D = 0.000189

From Moody's diag., f = 0.0165

L	=	**15**	m (approx)	
h_f	=	(0.0165 x 15 x (3.191)^2)/ (2 x 9.81 x0.530330085889911)	**0.243**	m

Bend losses (Main Pipe)

R/D	=	6		
V	=	3.192	m/sec	
Loss Coefficient K_b =		.08+.065+.065+.05+.025+.075+.075	(BIS No. 11625-1986)	
		0.435		

$h_b = K_b V^2/(2g)$ **0.226** m

Bend losses (Branch Pipe)

V	=	3.191	m/sec	

2 Bends each of 45^o

K_b	=	.08x2	0.16

$h_b = K_b V^2/(2g)$ **0.084** m

Branches & wyes Loss

V		3.191	m/sec
K_b	=	0.05	

$h_b = K_b V^2/(2g)$ **0.026** m

Reducer loss

Valve diameter	0.5000	m
Velocity in reduced diameter pipe	3.5905	

			0.1176	m
Valve losses				
V	3.9496	m/sec		
K_b	0.10			
$h_b = K_b V^2/(2g)$			**0.080**	m

Head loss in trench weir	=	0.400	m
Head loss in intake channel	=	0.187	m
Head loss in Desilting Basin	=	0.071	m
Head Loss in Forebay	=	0.140	m
Sub-total	=	2.381	m
Total	=	**2.382**	m

1) Trashrack Loss	0.039	m
2) StoplogGate & Gate Groove	0.014	m
3) Entrance Loss	0.011	m
4) Transition Losses	0.059	m
5) Frictional Loss (Main Penstock)	2.119	m
6) Frictional Loss (unit penstock)	0.243	m
7) Bend losses (Main Pipe)	0.226	m
8) Bend losses (Branch Pipe)	0.084	m
9) Losses due to reducer	0.118	
10) Branches & wyes Loss	0.026	m
11) Valve losses	0.080	m
Total	**3.018**	**m**

Forebay at end	**3619.62**	m
Centre Line of Machine / Tail Water Level	3488.00	m
Gross Head	**131.62**	**m**
Net Head	**128.60**	m

Type of Section	Head Loss (m)	Level	FSL	Length (m)	Slope
Trench Weir	0.4	3622.00	3621.6		
Channel	0.19	3621.6	3621.41	0	(1/500)
Desilting Basin	0.07	3621.413	3621.34	27	
Power Channel	1.58	3621.34	3619.76	1000	(1/750)
Forebay	0.14	3619.76	3619.69	36	
Penstock (Rated)	3.02	3619.69	3616.67	255	
Powerhouse		3616.67	3488.00		

APPENDIX-B

REVISED POWER POTENTIAL STUDIES

Table of Contents

1. INPUT DATA

Name of the Project		Taksang Gompha Nallah SHP	
Name of River		Taksang Chu	
Catchment Area of the River		48.7	sq km
Project capacity for PP Study	(Lowest)	1	MW
	(Increment)	0.1	MW
FRL		3622	m
TWL		3488	m
C/L of Machine		3488	m
Head Loss		5.33	m
Gross Head		134	
Net Head		128.67	
Efficiency			
Turbine		92.50%	
Generator		98.50%	
Combine T-G		91.11%	

2. DERIVED FLOW SERIES

Month	Period	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	I	1.12	0.95	1.25	1.09	1.01	0.97	1.21	1.59	0.69	1.27	1.23	1.18	1.35	1.13	1.73	1.60	1.29
JUN	II	1.58	1.09	1.28	1.50	1.14	1.02	1.56	1.87	0.81	1.51	1.38	1.58	1.51	1.51	1.99	1.38	1.40
	III	1.79	1.64	1.42	1.57	1.80	1.95	1.56	3.20	1.38	1.88	1.88	1.58	2.36	2.62	1.60	1.75	1.82
	I	2.24	1.49	1.21	1.34	2.54	1.89	1.98	3.11	1.34	1.48	1.21	2.06	2.74	2.33	1.66	1.89	1.64
JUL	II	2.23	1.64	1.52	1.18	2.14	2.17	1.91	2.91	1.40	1.55	1.51	1.69	2.49	2.59	2.12	1.88	2.46
	III	1.74	1.93	1.65	1.62	1.74	2.05	1.52	2.85	1.77	1.79	1.59	2.38	2.01	2.55	2.19	2.11	4.20
	I	2.39	1.93	2.52	1.45	1.84	1.81	1.77	2.79	1.38	2.05	1.59	1.77	1.94	2.29	2.56	1.57	2.52
AUG	II	2.34	1.66	2.21	1.62	1.90	1.99	2.71	3.78	1.53	1.86	1.50	2.47	1.84	2.19	2.44	1.47	2.84
	III	2.05	2.04	2.19	1.95	1.91	1.61	1.73	3.46	1.94	1.72	2.01	2.49	1.99	1.87	2.27	1.80	2.64
	I	2.18	1.50	1.72	1.59	1.56	1.97	1.98	1.86	1.99	2.00	1.59	1.64	1.96	1.58	1.83	1.36	1.66
SEP	II	1.70	1.49	1.71	1.54	1.54	1.48	1.91	1.36	1.59	1.75	1.50	1.45	2.13	1.06	1.18	1.74	1.22
	III	1.51	1.13	1.50	1.10	1.49	1.38	1.61	1.38	1.17	1.47	1.30	1.38	1.56	1.01	1.04	1.31	1.18
	I	1.16	0.98	1.17	1.04	0.97	1.30	1.00	1.36	1.07	1.06	1.38	1.17	1.36	1.67	1.05	1.06	0.98
OCT	II	0.90	1.15	1.15	0.74	0.98	0.84	0.84	1.25	1.02	0.79	1.19	1.00	1.37	1.36	0.89	0.86	0.94
	III	0.72	0.76	1.05	0.59	0.71	0.78	0.71	0.88	0.95	0.63	0.84	0.84	1.25	0.85	0.94	0.69	0.83
	I	0.64	0.63	0.64	0.63	0.64	0.63	0.57	0.68	0.74	0.51	0.67	0.70	1.18	0.69	0.60	0.61	0.75
NOV	II	0.58	0.58	0.63	0.58	0.62	0.58	0.55	0.42	0.62	0.46	0.55	0.67	1.01	0.60	0.59	0.60	0.64
	III	0.55	0.56	0.61	0.56	0.52	0.55	0.56	0.37	0.39	0.43	0.44	0.60	0.89	0.54	0.52	0.57	0.54
	I	0.32	0.33	0.40	0.33	0.30	0.25	0.28	0.30	0.31	0.31	0.34	0.42	0.59	0.42	0.61	0.43	0.45
DEC	II	0.32	0.30	0.30	0.30	0.27	0.22	0.26	0.26	0.27	0.30	0.32	0.40	0.43	0.40	0.59	0.40	0.39
	III	0.25	0.27	0.25	0.27	0.27	0.20	0.23	0.23	0.25	0.25	0.30	0.35	0.39	0.40	0.55	0.38	0.37
	I	0.20	0.25	0.25	0.22	0.24	0.19	0.19	0.21	0.22	0.24	0.23	0.32	0.36	0.38	0.55	0.38	0.36
JAN	II	0.19	0.24	0.25	0.22	0.23	0.17	0.20	0.18	0.21	0.22	0.23	0.29	0.36	0.36	0.54	0.37	0.36
	III	0.18	0.23	0.23	0.21	0.22	0.17	0.20	0.18	0.21	0.22	0.23	0.29	0.36	0.35	0.56	0.37	0.36
	I	0.17	0.27	0.27	0.22	0.23	0.17	0.21	0.17	0.20	0.23	0.22	0.28	0.35	0.35	0.50	0.33	0.35
FEB	II	0.16	0.27	0.27	0.23	0.24	0.18	0.22	0.17	0.18	0.22	0.22	0.28	0.32	0.35	0.50	0.25	0.35
	III	0.16	0.22	0.23	0.21	0.24	0.18	0.22	0.17	0.18	0.20	0.22	0.28	0.29	0.35	0.51	0.27	0.34
	I	0.19	0.21	0.25	0.22	0.22	0.22	0.21	0.17	0.19	0.19	0.22	0.28	0.38	0.40	0.21	0.30	0.33
MAR	II	0.28	0.22	0.28	0.23	0.35	0.45	0.21	0.18	0.19	0.20	0.23	0.28	0.36	0.39	0.24	0.34	0.39
	III	0.42	0.24	0.38	0.40	0.27	0.36	0.25	0.17	0.21	0.24	0.24	0.28	0.50	0.40	0.25	0.53	0.52
	I	0.36	0.32	0.39	0.35	0.43	0.23	0.34	0.21	0.44	0.22	0.27	0.42	0.39	0.43	0.30	0.68	0.63
APR	II	0.51	0.40	0.74	0.43	0.43	0.32	0.41	0.26	0.40	0.25	0.43	0.49	0.56	0.57	0.39	0.55	0.97
	III	0.42	0.50	0.46	0.59	0.48	0.35	0.57	0.41	0.49	0.39	0.46	0.59	0.62	0.70	0.34	0.66	0.99
	I	0.65	0.76	0.67	0.73	0.71	0.66	0.65	0.36	0.51	0.38	0.51	0.60	0.58	0.61	0.61	0.83	1.01
MAY	II	0.67	0.74	0.67	0.94	0.68	0.77	0.66	0.30	0.74	0.54	0.71	0.56	0.92	0.71	0.68	0.98	1.05
	III	0.64	0.74	0.74	0.81	0.72	0.75	0.69	0.54	0.90	0.70	0.73	0.68	0.90	0.99	0.90	1.21	1.13

All values are in cumecs

3. RANKING OF DEPENDABLE YEARS AS PER ANNUAL INFLOW

S. No	Years	Annual Inflow (Mm³)
1	1991-92	30.68
2	1992-93	27.23
3	1993-94	29.74
4	1994-95	26.24
5	1995-96	28.92
6	1996-97	28.23
7	1997-98	28.94
8	1998-99	36.37
9	1999-00	25.62
10	2000-01	27.03
11	2001-02	27.02
12	2002-03	30.98
13	2003-04	36.21
14	2004-05	33.90
15	2005-06	32.99
16	2006-07	30.73
17	2007-08	36.77

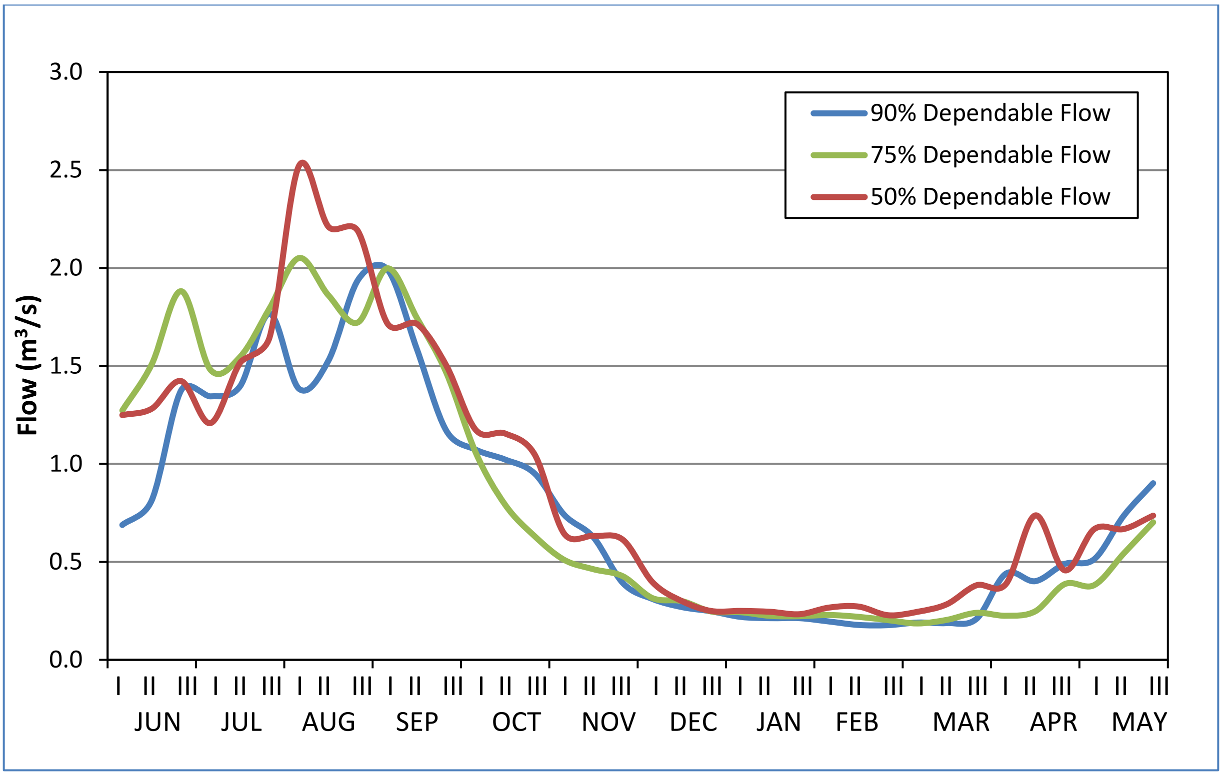
Ranked in Decending Order

Years	Annual Inflow (Mm³)	Rank	Depen-dability	Remark
2007-08	36.77	1		
1998-99	36.37	2	11%	
2003-04	36.21	3	17%	
2004-05	33.90	4	22%	
2005-06	32.99	5	28%	
2002-03	30.98	6	33%	
2006-07	30.73	7	39%	
1991-92	30.68	8	44%	
1993-94	29.74	9	50%	50% Dependable
1997-98	28.94	10	56%	
1995-96	28.92	11	61%	
1996-97	28.23	12	67%	
1992-93	27.23	13	72%	
2000-01	27.03	14	78%	75% Dependable
2001-02	27.02	15	83%	
1994-95	26.24	16	89%	
1999-00	25.62	17	94%	90% Dependable

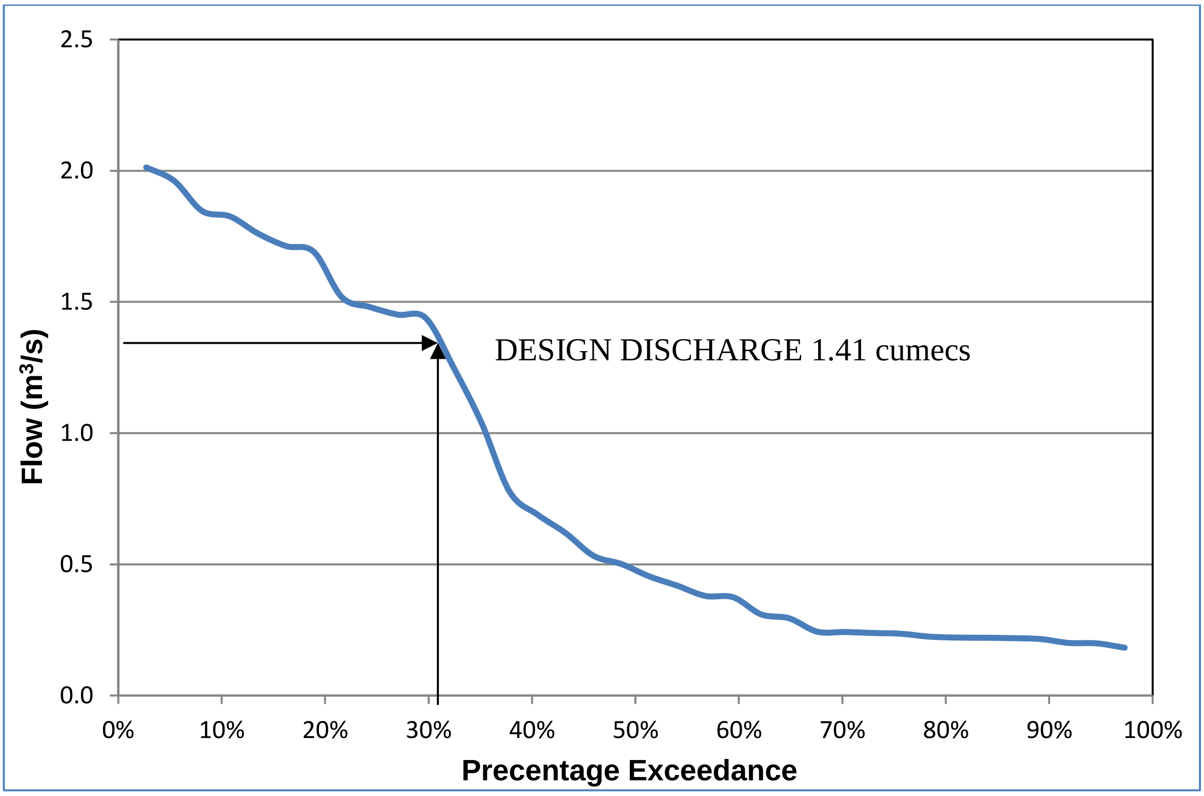
4. FLOW FOR 90%, 75% AND 50% DEPENDABLE YEARS

Month	Period	90% Dependable Flow	75% Dependable Flow	50% Dependable Flow
JUN	I	0.69	1.27	1.25
	II	0.81	1.51	1.28
	III	1.38	1.88	1.42
JUL	I	1.34	1.48	1.21
	II	1.40	1.55	1.52
	III	1.77	1.79	1.65
AUG	I	1.38	2.05	2.52
	II	1.53	1.86	2.21
	III	1.94	1.72	2.19
SEP	I	1.99	2.00	1.72
	II	1.59	1.75	1.71
	III	1.17	1.47	1.50
OCT	I	1.07	1.06	1.17
	II	1.02	0.79	1.15
	III	0.95	0.63	1.05
NOV	I	0.74	0.51	0.64
	II	0.62	0.46	0.63
	III	0.39	0.43	0.61
DEC	I	0.31	0.31	0.40
	II	0.27	0.30	0.30
	III	0.25	0.25	0.25
JAN	I	0.22	0.24	0.25
	II	0.21	0.22	0.25
	III	0.21	0.22	0.23
FEB	I	0.20	0.23	0.27
	II	0.18	0.22	0.27
	III	0.18	0.20	0.23
MAR	I	0.19	0.19	0.25
	II	0.19	0.20	0.28
	III	0.21	0.24	0.38
APR	I	0.44	0.22	0.39
	II	0.40	0.25	0.74
	III	0.49	0.39	0.46
MAY	I	0.51	0.38	0.67
	II	0.74	0.54	0.67
	III	0.90	0.70	0.74
Flow Vol. (Mm^3)		**25.62**	**27.03**	**29.74**

5. FLOW PLOT



6. FLOW DRATION CURVE OF 75% DEPENDABLE YEAR



POWER POTENTIAL STUDY FOR 75% DEPENDABLE YEAR

FRL = 3622 m

TWL = 3488 m

CL of Machine= 3488 m

Gross Head = 134 m

Head Loss = 5.33 m

Net Head = 128.67 m

Machine Availability = 95%

Ecological release = 0.040

Minimum Load % assumed on one m/c= 30%

Turbine Efficiency = 92.50%

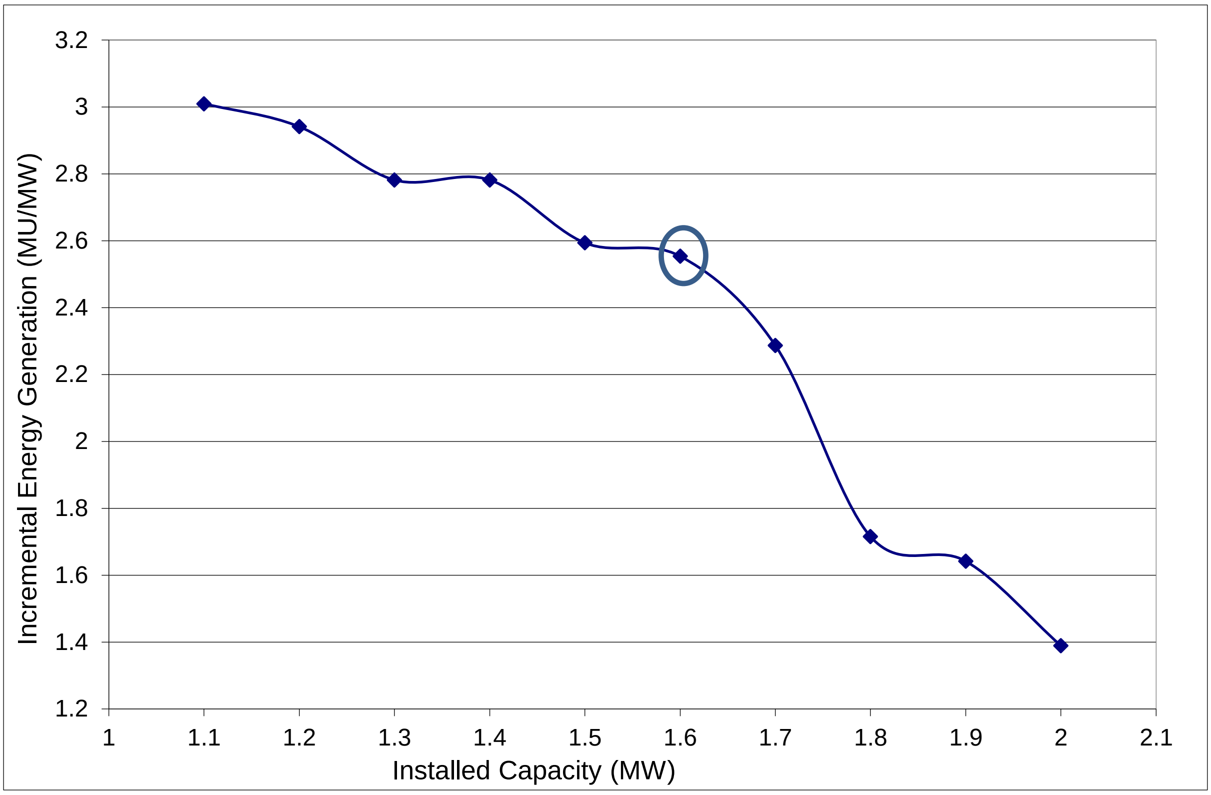
Generator Efficiency = 98.50%

T-G Combines Efficiency = 90.13%

Month		No. of Days	Discharge (Cumecs)	Ecological release (Cumecs)	Available Discharge (Cumecs)	Restricted to Power		1	MW	1.1	MW	1.2	MW	1.3	MW	1.4	MW	1.5	MW	1.6	MW	1.7	MW	1.8	MW	1.9	MW	2	MW
						No. of Machines		2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.	2	Nos.
						Unrestricted Power (MW)	Unrestricted Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)	Power (MW)	Energy (MU)
JUN	I	10	1.27	0.04	1.23	1.40	0.34	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.40	0.34	1.40	0.34	1.40	0.34	1.40	0.34	1.40	0.34	1.40	0.34
	II	10	1.51	0.04	1.47	1.67	0.40	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.67	0.40	1.67	0.40	1.67	0.40	1.67	0.40
	III	10	1.88	0.04	1.84	2.09	0.50	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.80	0.43	1.90	0.46	2.00	0.48
JUL	I	10	1.48	0.04	1.44	1.64	0.39	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.64	0.39	1.64	0.39	1.64	0.39	1.64	0.39
	II	10	1.55	0.04	1.51	1.71	0.41	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.71	0.41	1.71	0.41	1.71	0.41
	III	11	1.79	0.04	1.75	2.00	0.53	1.00	0.26	1.10	0.29	1.20	0.32	1.30	0.34	1.40	0.37	1.50	0.40	1.60	0.42	1.70	0.45	1.80	0.48	1.90	0.50	2.00	0.53
AUG	I	10	2.05	0.04	2.01	2.29	0.55	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.80	0.43	1.90	0.46	2.00	0.48
	II	10	1.86	0.04	1.82	2.07	0.50	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.80	0.43	1.90	0.46	2.00	0.48
	III	11	1.72	0.04	1.68	1.91	0.51	1.00	0.26	1.10	0.29	1.20	0.32	1.30	0.34	1.40	0.37	1.50	0.40	1.60	0.42	1.70	0.45	1.80	0.48	1.90	0.50	1.91	0.51
SEP	I	10	2.00	0.04	1.96	2.23	0.53	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.80	0.43	1.90	0.46	2.00	0.48
	II	10	1.75	0.04	1.71	1.94	0.47	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.70	0.41	1.80	0.43	1.90	0.46	1.94	0.47
	III	10	1.47	0.04	1.43	1.62	0.39	1.00	0.24	1.10	0.26	1.20	0.29	1.30	0.31	1.40	0.34	1.50	0.36	1.60	0.38	1.62	0.39	1.62	0.39	1.62	0.39	1.62	0.39
OCT	I	10	1.06	0.04	1.02	1.16	0.28	1.00	0.24	1.10	0.26	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28	1.16	0.28
	II	10	0.79	0.04	0.75	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21	0.85	0.21
	III	11	0.63	0.04	0.59	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18	0.67	0.18
NOV	I	10	0.51	0.04	0.47	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13	0.54	0.13
	II	10	0.46	0.04	0.42	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12	0.48	0.12
	III	10	0.43	0.04	0.39	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11	0.44	0.11
DEC	I	10	0.31	0.04	0.27	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08	0.31	0.08
	II	10	0.30	0.04	0.26	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.30	0.07	0.00	0.00
	III	11	0.25	0.04	0.21	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JAN	I	10	0.24	0.04	0.20	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	10	0.22	0.04	0.18	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	11	0.22	0.04	0.18	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FEB	I	10	0.23	0.04	0.19	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	10	0.22	0.04	0.18	0.20	0.05	0.20	0.05	0.20	0.05	0.20	0.05	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	8	0.20	0.04	0.16	0.18	0.04	0.18	0.04	0.18	0.04	0.18	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAR	I	10	0.19	0.04	0.15	0.17	0.04	0.17	0.04	0.17	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	10	0.20	0.04	0.16	0.19	0.04	0.19	0.04	0.19	0.04	0.19	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	11	0.24	0.04	0.20	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.23	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
APR	I	10	0.22	0.04	0.18	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.21	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	II	10	0.25	0.04	0.21	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.24	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	III	10	0.39	0.04	0.35	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09
MAY	I	10	0.38	0.04	0.34	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09	0.39	0.09
	II	10	0.54	0.04	0.50	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14	0.57	0.14
	III	11	0.70	0.04	0.66	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20	0.75	0.20
						Total Annual Generation (MU)	**7.80**	**1.00**	**5.18**	**1.10**	**5.50**	**1.20**	**5.76**	**1.30**	**5.98**	**1.40**	**6.11**	**1.50**	**6.28**	**1.60**	**6.32**	**1.70**	**6.54**	**1.80**	**6.72**	**1.90**	**6.89**	**2.00**	**6.96**
						Genaration in Lean Season (Nov-Mar)	1.00		1.00		1.00		0.96		0.88		0.72		0.67		0.50		0.50		0.50		0.50		0.42

Plant Availability	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Net Annual Energy (MU)	4.92	5.22	5.48	5.68	5.81	5.97	6.00	6.22	6.38	6.55	6.61
Ideal Generation	8.76	9.636	10.512	11.388	12.264	13.14	14.016	14.892	15.768	16.644	17.52
Plant Load Factor	56.18%	54.19%	54.83%	49.85%	47.37%	45.42%	42.81%	41.75%	40.49%	39.35%	37.72%
Design Discharge	0.88	0.97	1.05	1.14	1.23	1.32	1.41	1.49	1.58	1.67	1.76
Incremental Energy (MU)	Base	0.32	0.27	0.21	0.14	0.17	0.03	0.23	0.18	0.17	0.06
Δ kWh / Δ kW	Base	3168	2667.56	2125.055036	1387.19	1673.09	345.99	2278.02	1760.63	1728.00	633.84
Percentage Utilisation	66.40%	70.46%	73.88%	76.60%	78.38%	80.53%	80.97%	83.89%	86.15%	88.36%	89.17%

7. INCREMENTAL ENERGY CURVE



8. FLOW CHART

Installed Capacity Selected (IC)= 1.6 MW   Design Discharge= 1.41 m^3/s

Month		No. of Days	Discharge Available	Unrestricted		For IC Selected		Water Utilised	Water Spilled
				Power	Energy	Power	Energy		
			(m^3/s)	(MW)	(GWH)	(MW)	(GWH)	(m^3/s)	(m^3/s)
JUN	**I**	10	1.23	1.40	0.34	1.40	0.34	1.23	0.00
	II	10	1.47	1.67	0.40	1.40	0.34	1.41	0.06
	III	10	1.84	2.09	0.50	1.40	0.34	1.41	0.43
JUL	**I**	10	1.44	1.64	0.39	1.40	0.34	1.41	0.03
	II	10	1.51	1.71	0.41	1.40	0.34	1.41	0.10
	III	11	1.75	2.00	0.53	1.40	0.37	1.41	0.35
AUG	**I**	10	2.01	2.29	0.55	1.40	0.34	1.41	0.60
	II	10	1.82	2.07	0.50	1.40	0.34	1.41	0.41
	III	11	1.68	1.91	0.51	1.40	0.37	1.41	0.28
SEP	**I**	10	1.96	2.23	0.53	1.40	0.34	1.41	0.55
	II	10	1.71	1.94	0.47	1.40	0.34	1.41	0.30
	III	10	1.43	1.62	0.39	1.40	0.34	1.41	0.02
OCT	**I**	10	1.02	1.16	0.28	1.16	0.28	1.02	0.00
	II	10	0.75	0.85	0.21	0.85	0.21	0.75	0.00
	III	11	0.59	0.67	0.18	0.67	0.18	0.59	0.00
NOV	**I**	10	0.47	0.54	0.13	0.54	0.13	0.47	0.00
	II	10	0.42	0.48	0.12	0.48	0.12	0.42	0.00
	III	10	0.39	0.44	0.11	0.44	0.11	0.39	0.00
DEC	**I**	10	0.27	0.31	0.08	0.31	0.08	0.27	0.00
	II	10	0.26	0.30	0.07	0.30	0.07	0.26	0.00
	III	11	0.21	0.24	0.06	0.24	0.06	0.21	0.00
JAN	**I**	10	0.20	0.23	0.06	0.23	0.06	0.20	0.00
	II	10	0.18	0.21	0.05	0.00	0.00	0.18	0.00
	III	11	0.18	0.21	0.05	0.00	0.00	0.18	0.00
FEB	**I**	10	0.19	0.21	0.05	0.21	0.05	0.19	0.00
	II	10	0.18	0.20	0.05	0.00	0.00	0.18	0.00
	III	8	0.16	0.18	0.04	0.00	0.00	0.16	0.00
MAR	**I**	10	0.15	0.17	0.04	0.00	0.00	0.15	0.00
	II	10	0.16	0.19	0.04	0.00	0.00	0.16	0.00
	III	11	0.20	0.23	0.06	0.23	0.06	0.20	0.00
APR	**I**	10	0.18	0.21	0.05	0.21	0.05	0.18	0.00
	II	10	0.21	0.24	0.06	0.24	0.06	0.21	0.00
	III	10	0.35	0.39	0.09	0.39	0.09	0.35	0.00
MAY	**I**	10	0.34	0.39	0.09	0.39	0.09	0.34	0.00
	II	10	0.50	0.57	0.14	0.57	0.14	0.50	0.00
	III	11	0.66	0.75	0.20	0.75	0.20	0.66	0.00

APPENDIX-C

REVISED SALIENT FEATURES

1. LOCATION

i)	State	:-	Arunachal Pradesh
ii)	District	:-	Tawang
iii)	Town	:-	Zemithang (25 km from site)
iv)	Access	:-	Road
v)	Nearby village	:-	T Gompha
vi)	Geographical Coordinates of power house	:-	Latitude = 27˚ 42’ 57” N Longitude = 91˚ 48’ 23” E
vii)	Toposheet Reference	:-	78 M/14
viii)	Nearest Airport	:-	Tezpur, Assam (475 Km from site)
ix)	Nearest Rail Head	:-	Bhalukpong, Assam (about 415 Km from site)

2. HYDROLOGY

i)	Name of the River	:-	Taksang Chu
ii)	River Basin	:-	Tawang Basin
iii)	Catchments Area	:-	48.7 km^2
iv)	Type of River	:-	Perennial
v)	Design Flood	:-	350 m^3/s
vi)	Average Annual Inflow	:-	30.45 MCM
vii)	75% dependable inflow	:-	27.03 MCM
viii)	Design Discharge	:-	1.41 m^3/s

3. TRENCH WEIR

i)	Shape	:-	Rectangular
ii)	Length	:-	15 m
iii)	Width	:-	1.0 m
iv)	Top level of trench	:-	EL 3622.0 m

4. INTAKE CHANNEL

i)	Length	:-	24 m
ii)	Shape	:-	RCC Rectangular Box Section
iii)	Size	:-	1.2 m (W) x 1.4 m (H)

5. DESILTTING BASIN

i)	Type	:-	Gutter type Hopper
ii)	Length	:-	27.0 m
iii)	Width	:-	3.4 m
iv)	No.	:-	1
v)	FSL	:-	3621.42 m

6. WATER CONDUCTOR SYSTEM

RCC Rectangular Box Channel

i)	Length	:-	1,000 m
ii)	Shape	:-	RCC Rectangular Box Channel
iii)	Size	:-	1.1 m (W) x 1.4 m (H)

7. FOREBAY TANK

i)	Size	:-	36.0 m long x 4.0 m wide
ii)	Live Storage	:-	2.0 m (Between FSL and MDDL)
iii)	Storage	:-	3 Minutes
iv)	Capacity	:-	280 m^3
iv)	Full Supply Level	:-	EL 3619.72 m
v)	Max. Draw Down Level	:-	EL 3617.72 m
vi)	C/L of penstock	:-	EL 3616.595 m

8. PENSTOCK

i)	Size	:-	750 mm (ID) bifurcating into 530 mm(ID)
ii)	Length of Main penstock	:-	255 m
iii)	Length of Unit penstock	:-	12 m each
iv)	Liner Thickness	:-	10 mm

9. POWER HOUSE

i)	Type	:-	Surface
ii)	Head	:-	
	Gross		134.0 m
	Design (net)		128.0 m
iii)	Size of Power House	:-	
	Length	:-	30 m
	Width	:-	16 m
	Height from Machine Floor Level	:-	10 m
	Machine center line	:-	EL 3488 m

iv)	Installed Capacity	:-	1600 kW
v)	Turbines		
	Type	:-	Horizontal Pelton
	Number	:-	2 Nos.
	Capacity	:-	800 kW each
vi)	Generator		
	Type	:-	Synchronous
	Voltage	:-	3.3 kV
	Excitation System	:-	Brush less
vii)	Generator Transformer	:-	2 Nos., 3.3/11kV, 880 kVA
viii)	Number of Draft Tube Gates	:-	2 Nos. manually operated
ix)	Power house Crane /Lifting capacity	:-	EOT Crane of 12/3 ton capacity

10. TAIL RACE CHANNEL

i)	Type	:-	Open Channel
ii)	Shape	:-	Rectangular
iii)	Size	:-	1.5 m (W) x 2 m (H)
iv)	Quantity	:-	2 no.
v)	Length	:-	15 m

11. SWITCH YARD

i)	Voltage Level	:-	33 KV
ii)	Size	:-	Outdoor, 30 m X 20 m

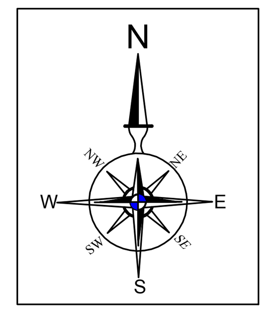
12. GENERATION

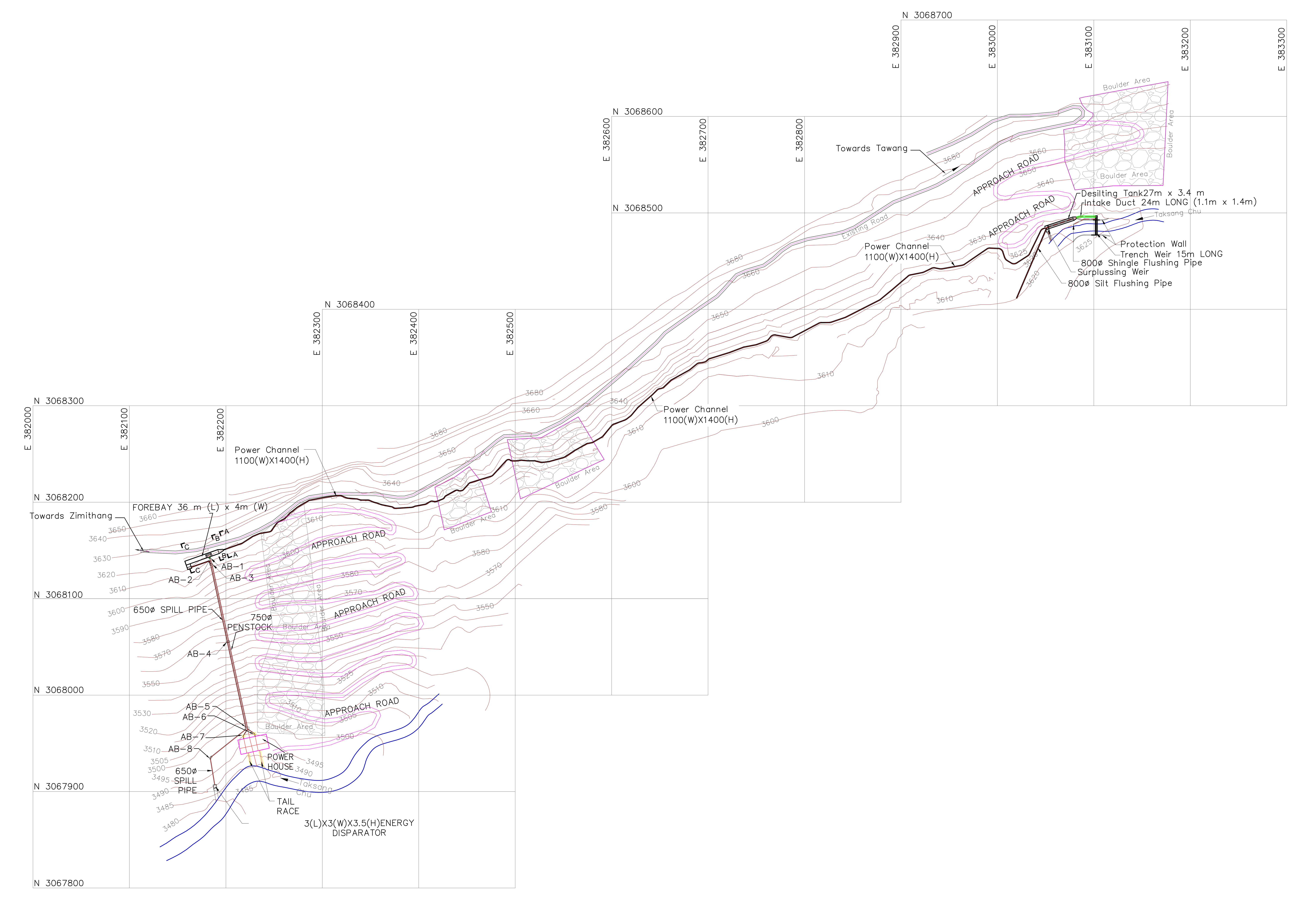
i)	Annual Generation in 75% Dependable Year	:-	6.32 MU

ii)	Design Energy (at 95 % plant Availability)	:-	6.0 MU
iii)	Annual Load Factor (%)	:-	42.81 %
iv)	Generation in Lean Period (Nov.-Mar.)	:-	0.50 MU

APPENDIX-D

REVISED LAYOUT PLAN & L-SECTION





CLIENT	HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED				
SURVEYED	CONCEPT GREEN ENERGY PRIVATE LIMITED CONCEPT VENTURES S-202, 2nd Floor Best Arcade, Plot No - 3 Pocket - 6, Sector - 12 Dwaraka, New Delhi - 110075 Email- contact@conceptventures.in Web.- www.conceptventures.in, Tel. : +91-124-4145847				
PROJECT	TAKSANG GOMPHA NALLAH SHP (2 x 0.8 MW)				
TITLE	GENERAL LAYOUT PLAN				
Drawn by Jacob	Checked By -	Designed -	Approved By -	DATE: SEP. 2018	
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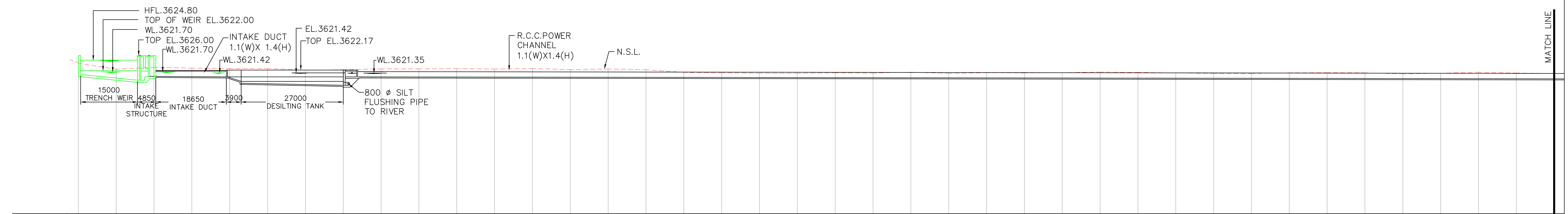
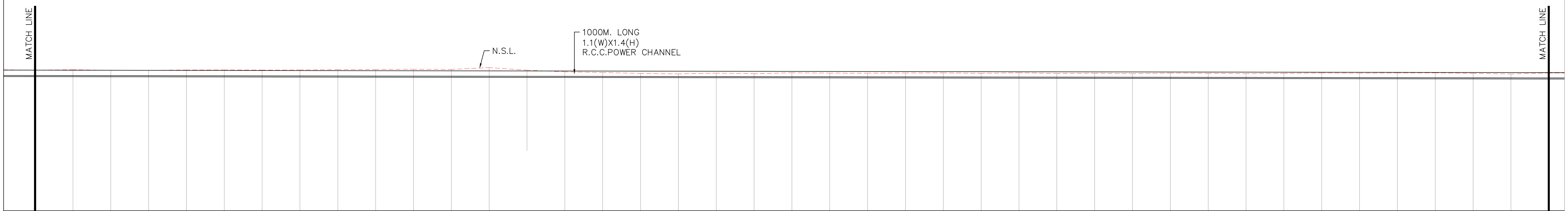


CHAINAGE	ELEVATION
0.000	3624.000
10.000	3622.408
20.000	3622.918
30.000	3622.686
40.000	3622.580
50.000	3622.594
60.000	3622.116
70.000	3622.257
80.000	3622.487
90.000	3622.477
100.000	3622.534
110.000	3622.446
120.000	3622.570
130.000	3622.285
140.000	3622.456
150.000	3622.262
160.000	3621.554
170.000	3621.433
180.000	3621.355
190.000	3621.326
200.000	3621.418
210.000	3621.385
220.000	3621.606
230.000	3621.289
240.000	3621.454
250.000	3621.408
260.000	3621.481
270.000	3621.633
280.000	3621.554
290.000	3621.420
300.000	3621.271
310.000	3621.273
320.000	3621.445
330.000	3621.469
340.000	3621.436
350.000	3621.146
360.000	3621.337
370.000	3621.599
380.000	3621.379
390.000	3621.281



CHAINAGE	ELEVATION
390.000	3621.281
400.000	3621.369
410.000	3621.244
420.000	3621.236
430.000	3621.309
440.000	3621.355
450.000	3621.275
460.000	3621.328
470.000	3621.419
480.000	3621.471
490.000	3621.510
500.000	3621.464
510.000	3621.939
520.000	3621.257
530.000	3620.841
540.000	3620.642
550.000	3620.408
560.000	3620.274
570.000	3620.498
580.000	3620.332
590.000	3620.578
600.000	3620.490
610.000	3620.478
620.000	3620.527
630.000	3620.535
640.000	3620.432
650.000	3620.575
660.000	3620.388
670.000	3620.458
680.000	3620.328
690.000	3620.497
700.000	3620.431
710.000	3620.349
720.000	3620.423
730.000	3620.524
740.000	3620.468
750.000	3620.515
760.000	3620.536
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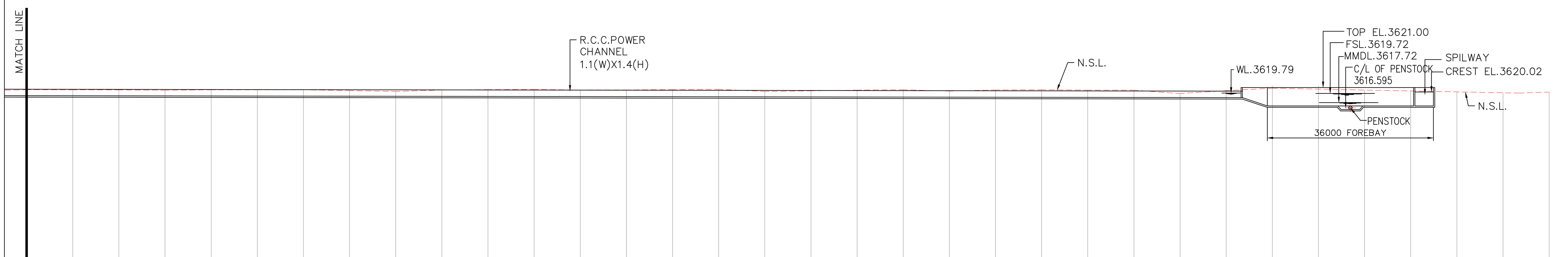
780.000	3620.279
790.000	3620.513



CHAINAGE	ELEVATION
790.000	3620.513
800.000	3620.502
810.000	3620.482
820.000	3620.397
830.000	3620.507
840.000	3620.494
850.000	3620.502
860.000	3620.333
870.000	3620.233
880.000	3620.462
890.000	3620.542
900.000	3620.572
910.000	3620.462
920.000	3620.472
930.000	3620.545
940.000	3620.618
950.000	3620.142
960.000	3620.276
970.000	3620.439
980.000	3620.511
990.000	3620.231
1000.000	3620.463
1010.000	3620.509
1020.000	3620.432
1030.000	3620.424
1040.000	3619.692
1050.000	3620.313
1060.000	3621.356
1070.000	3621.299
1080.000	3612.706
1090.000	3605.272
1100.000	3598.137
1110.000	3592.066
1120.000	3584.572

L-SECTION WATER CONDUCTOR SYSTEM

CLIENT	HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED
SURVEYED	CONCEPT GREEN ENERGY PRIVATE LIMITED S-202, 2nd Floor Best Arcade, Plot No - 3 Pocket - 6, Sector - 12 Dwaraka, New Delhi - 110075 Email- contact@conceptventures.in Web.- www.conceptventures.in, Tel. : +91-124-4145847 CONCEPT VENTURES
PROJECT	TAKSANG GOMPHA NALLAH SHP (2 x 0.8 MW)
TITLE	L- SECTION ALONG WATER CONDUCTOR SYSTEM

Drawn by	Checked By	Designed	Approved By	DATE
Jacob	-	-	-	DATE: SEP. 2018

SCALE	SHEET	DWG. No.	SHEET NO.	REV.
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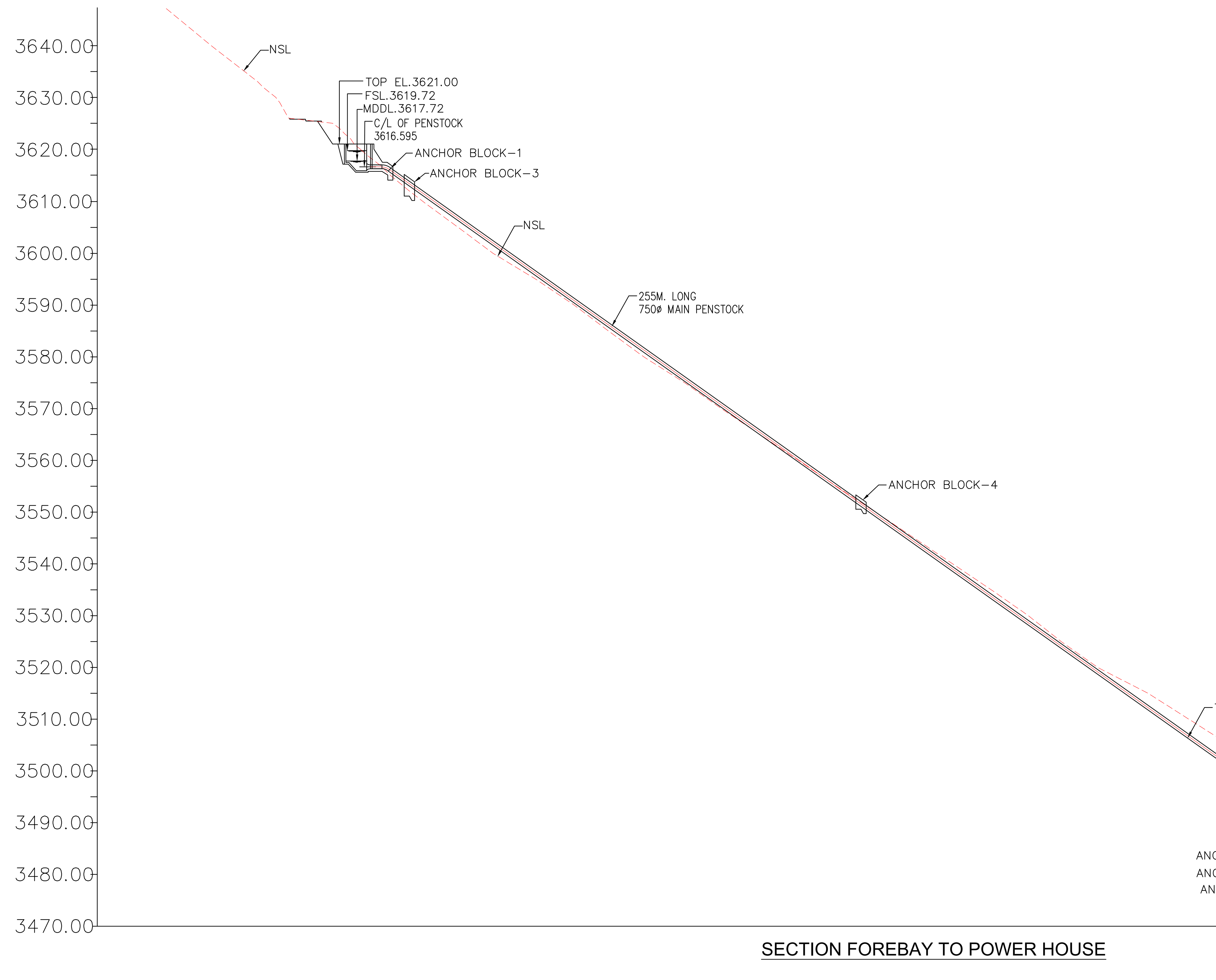
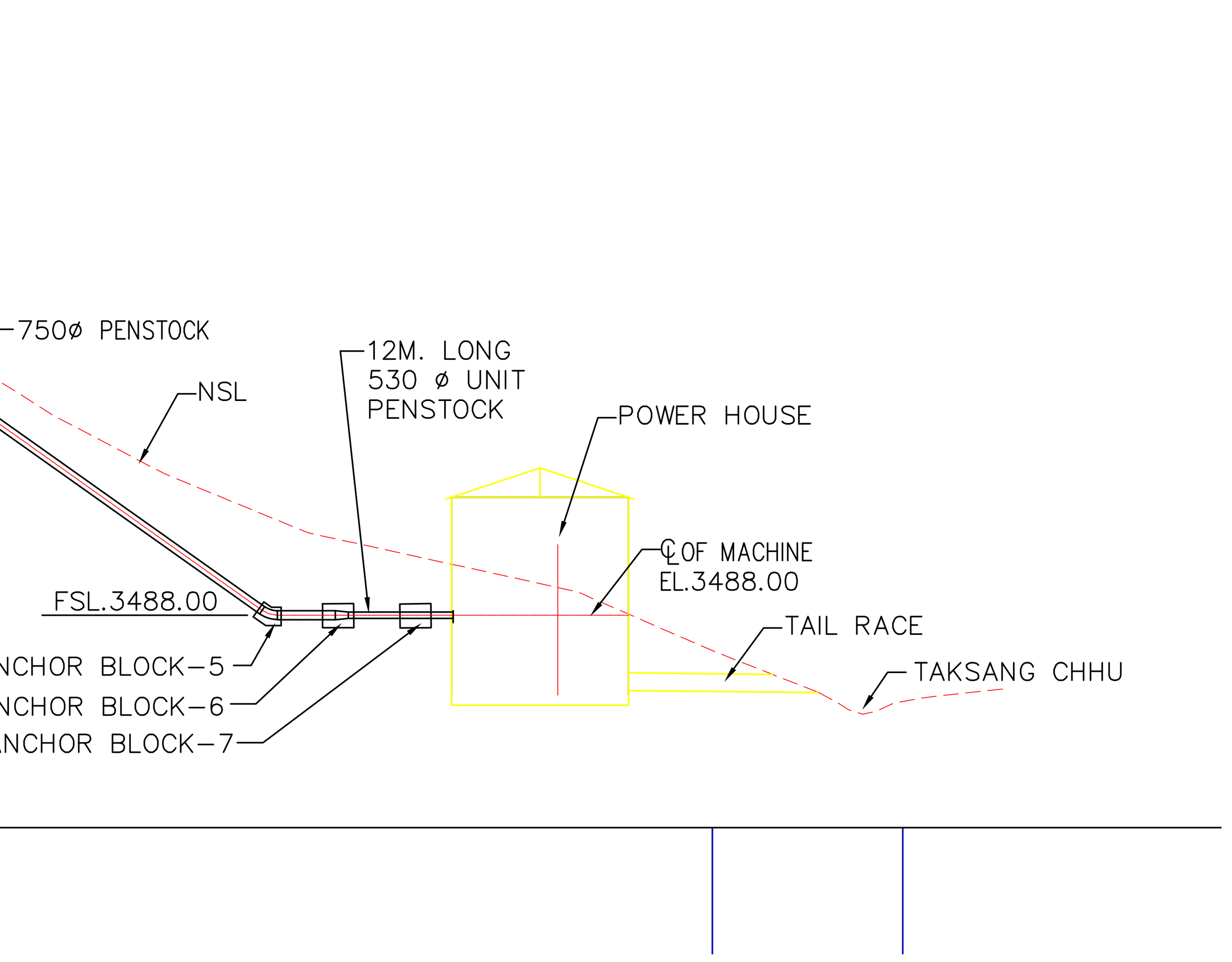
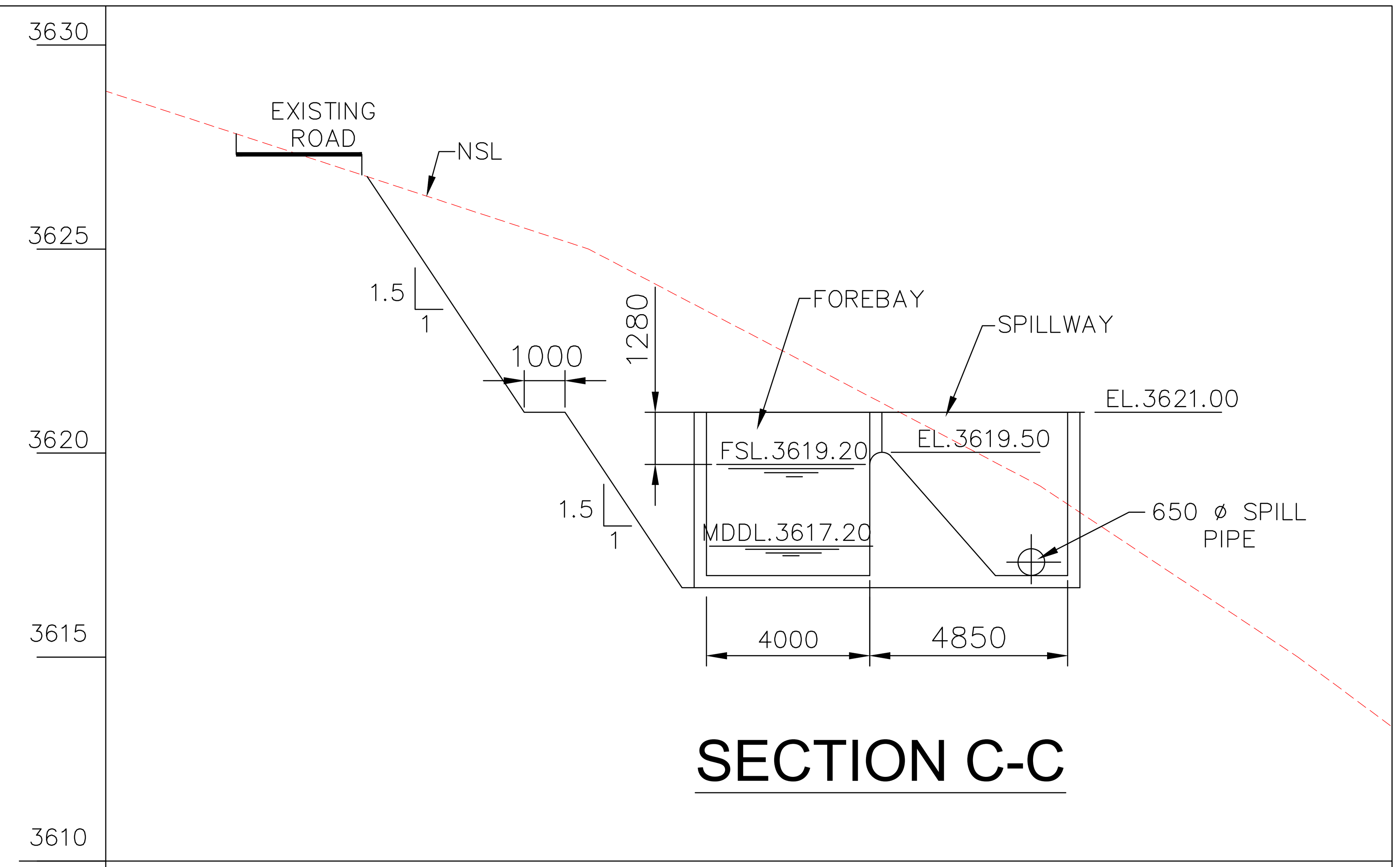
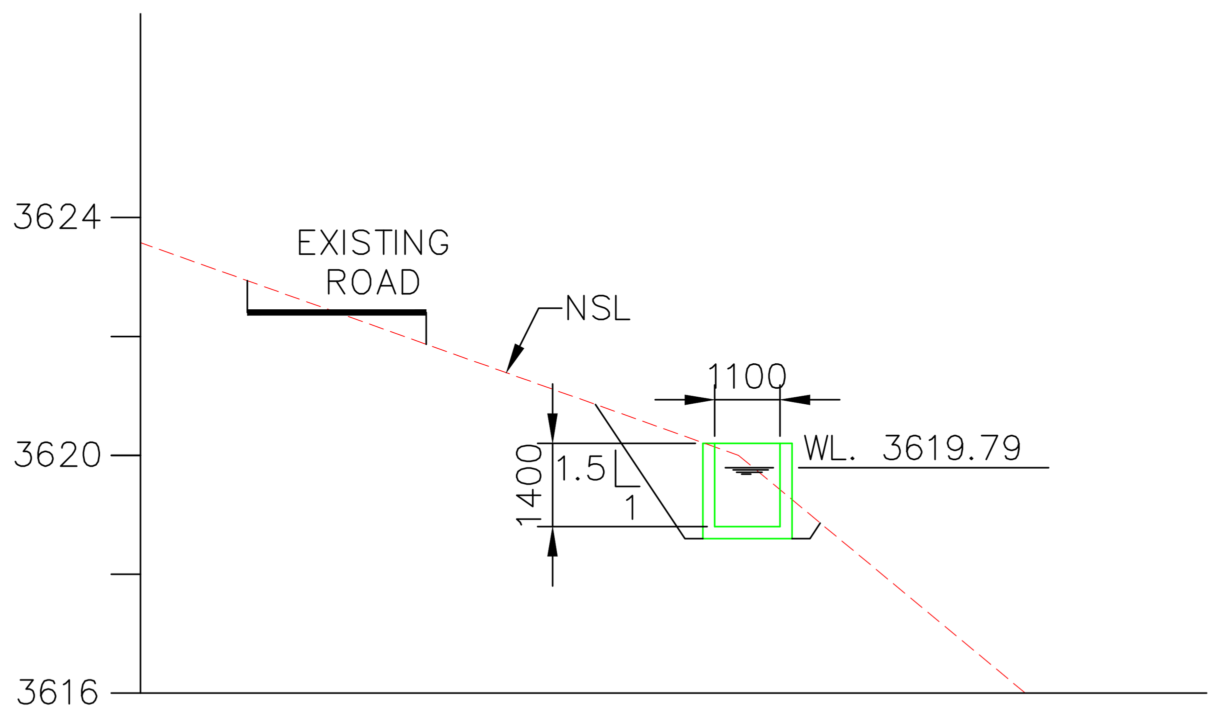



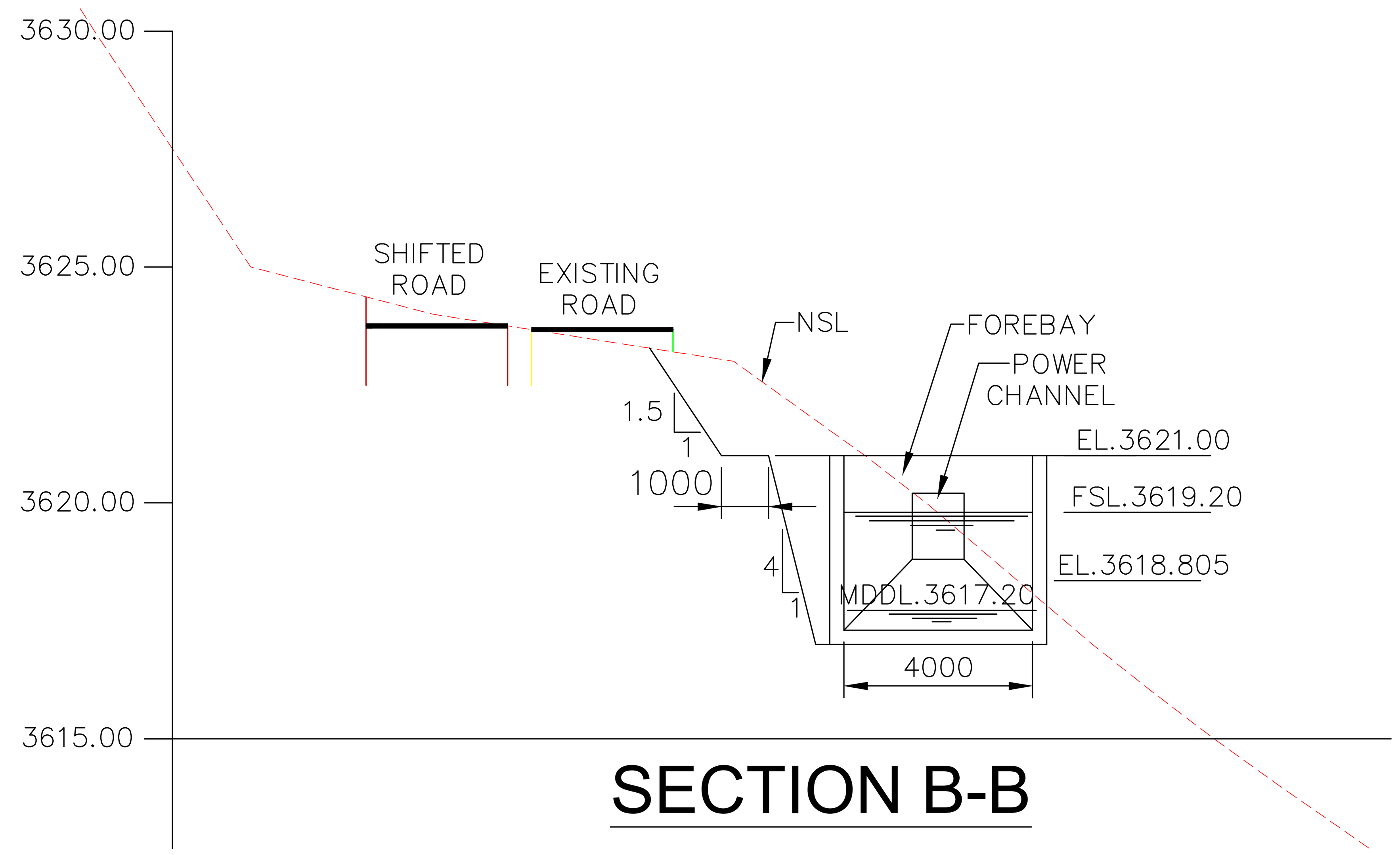
SECTION FOREBAY TO POWER HOUSE



SECTION C-C



SECTION A-A



SECTION B-B

CLIENT	HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED				
SURVEYED	CONCEPT GREEN ENERGY PRIVATE LIMITED S-202, 2nd Floor Best Arcade, Plot No - 3 Pocket - 6, Sector - 12 Dwaraka, New Delhi - 110075 Email- contact@conceptventures.in Web.- www.conceptventures.in, Tel. : +91-124-4145847 CONCEPT VENTURES				
PROJECT	TAKSANG GOMPHA NALLAH SHP (2 x 0.8 MW)				
TITLE	L- SECTION ALONG WATER CONDUCTOR SYSTEM				
Drawn by Jacob	Checked By -	Designed -	Approved By -	DATE: SEP. 2018	
SCALE 1:500	SHEET A1	DWG. No. CGE/TGN/SURVEY/02	SHEET NO. 2 OF 2	REV. 00	