

SITE VISIT & INCEPTION REPORT

TAKSANG CHU SMALL HYDROELECTRIC PROJECT (2 x 1.7 MW)



September 2018

Developer:

**HYDRO POWER DEVELOPMENT CORPORATION OF
ARUNACHAL PRADESH LIMITED**

(A Government of Arunachal Pradesh Undertaking)
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1 General

Hydro Power Development Corporation of Arunachal Pradesh Ltd. (HPCDAPL) is developing Taksang Chu 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 Taksang Chu stream emerges from the outflow of Sangester Lake at Elevation of about 3710 m. A 1x50 KW T Gonpa MHS has been constructed just after the formation of the stream to cater the needs of the Gompha, the villages and military establishments in the area. Another 2 x 0.8 MW Taksang Gompha Nallah SHP has been planned and is under implementation in the reach between Gompha and T Gonpa MHS. Proposed project is planned at the downstream of Taksang Gompha. The main structures of the project as per the DPR were 12 m long trench weir, 40 m long and 3.5 m wide desilting basin, 2,256 m long power channel, 21 m long and 12 m wide forebay tank of 378 cum capacity, 600 mm dia., 421 m long penstock pipe bifurcated at the end into two penstock of 450 mm dia. each to cater both machines, and 30 m x 16 m size surface power house. The power house of the project is located at the downstream of Taksang Gompha, one of the sacred place of Buddhists. It was estimated that the project shall utilize the 1.83 cumec of design discharge during a 75% dependable year with gross head of 224 m to generate 12.94 GWh of annual energy at 95% plant availability factor. The project switchyard shall also receive power generated from upstream project of Taksang Gompha Nallah SHP. The total generated power will be evacuated from project switchyard 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. The water conductor as planned in DPR, passes through grazing land for about 1 Km stretch. To avoid the

disturbance of grazing land, HPDCAPL has proposed to re-align the water conductor. The same view is also conveyed by AHEC team after visiting the project site. In view of the above, the entire layout is being revised.

As a first step in the revised assignment, CGEPL and HPCDAPL teams carried out joint visit to the project site. The purpose of the visit was to freeze the component locations including addressing the concerns of Local villagers and grazing land issues and to start the detailed survey works as required for designs. The current report presents the Visit Report covering re-validated 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 Bhalukpong, 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.

The project is located between elevations of 3344 amsl and 3108 amsl. The Power House of the project is located at coordinates 27° 42' 06" N and 91° 46' 30" 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 stage of completion. HPCDAPL is also developing a 1.8 MW Taksang Gompha Nallah Small Hydroelectric project at upstream of the current project. Both Taksang Chu SHP & Taksang Gompha Nallah 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 1: Project Location

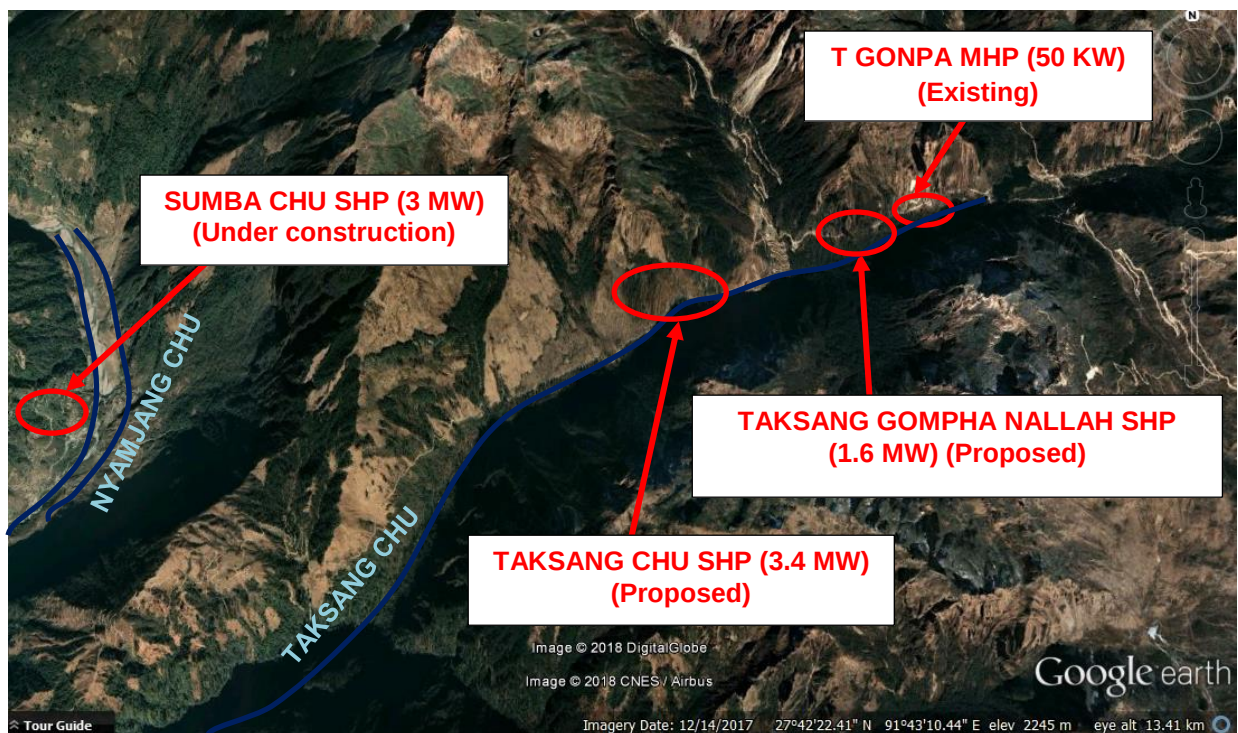


Figure 2: Projects Locations on Satellite image

(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

In the DPR, the water conductor alignment has been planned as open RCC channel. Subsequently, the local inhabitants raised the reservations about the channel alignment of the project as it was passing through the grazing lands being used by the village cattle. Therefore during the site visit of the experts together with the General Manager, HPDCAPL, the whole alignment was visited to identify the best alternative that serves as optimal solution.

As per topography of the area alternate route for power channel is not feasible. Therefore, the best alternative for water conductor of the project found to be the pressure pipe water conductor system. As per proposed project alignment, a direct penstock pipe shall be laid from the desilting-cum-forebay tank near intake to cater the generating machines. Since the penstock pipe length is approximately be 2,585 m against the gross head of 232 m, a surge pipe/tank system shall be provided to absorb the surge due to fluctuations. The surge pipe land is adjacent to a drainage gully and also falling at just outside the edge of the grazing zone. But it shall be a single vertical pipe at one end of the grazing land as compared to water channel running across the grazing land.

During the visit, the arrangement was discussed with locals and the proposed alternate alignment was acceptable to them. The intake location was also shifted slightly upstream to compensate for additional head loss. After detail survey works,

it was found that that gross head available shall be 232 m against the head of 224 m as envisaged in the DPR. The net head available for generation shall be approximately 218 m.

During studies it was also observed that the stream is emanating from a lake that is fed by three major streams, which are also emanating from lakes at upstream. This provides stability to the hydrology of the project and ensures a stable discharge during the lean period of the year.

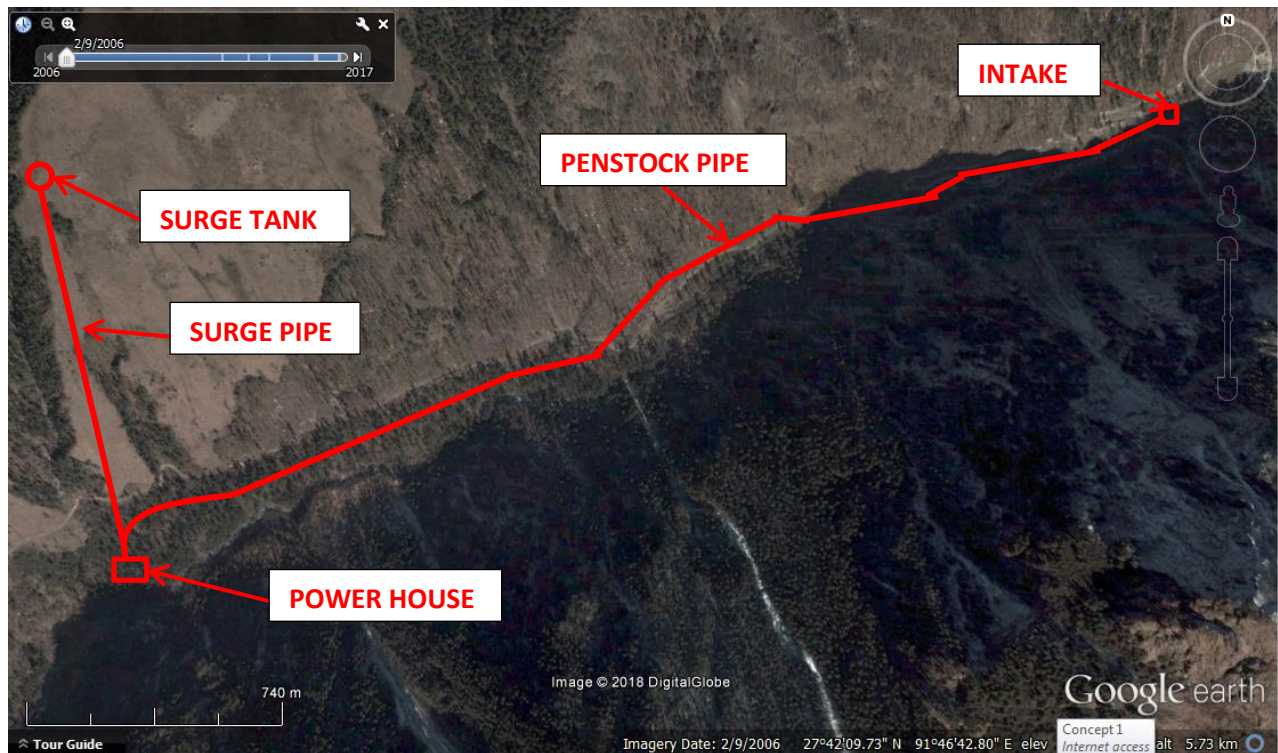


Figure 3: The proposed alignment imposed on google earth map

4 Details of Proposed Project Alignment

As per site visit observations followed by the field survey works, this proposed alignment is considered as revised alternative adopted for further studies. The revised Head Loss calculation as per new alignment is annexed as Appendix-A. The revised Power Potential Studies as per new alignment is annexed as Appendix-B. The revised salient features for new 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 further upstream by 300 m approx against the location indicated in the DPR. In this reach the river flow is straight and the rock is exposed at one end. This location is better suited for a pipe based alignment. Sufficient space is available to house the desilting-cum-forebay structure. New elevation of Weir axis shall be 3344 m. The length of the weir shall be same 12 m as considered 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 is located in proximity to existing road and therefore no transportation related issue is anticipated. The weir shall be constructed in two phases to facilitate the river diversion during construction period.



Figure 4: Weir Site

4.2 Feeder channel to Desilting-cum-Forebay tank

The proposed feeder channel size is same as that proposed under DPR. The RCC box type feeder channel of size 1.4 m (H) x 1.3 m (W) will carry water from intake to surface desilting-cum-forebay tank. Total length of feeder channel is approximately 20 m. The surface profile is good and no problem is envisaged on this account.

4.3 Desilting Tank cum forebay

Since the project is pressure pipe based, there is no requirement of separate forebay structure. The forebay tank and desilting tank is proposed to be a combined structure and would be located on a flat area followed by the penstock leading to the power house on a flat terrace. The geology and terrain is favorable. The forebay is provided to ensure supply of immediate water demand on starting the generating units. This shall result in economy and ease in construction. The location is adjacent to existing main road. This will facilitate smooth construction activity. No major issue is expected during construction of the project.

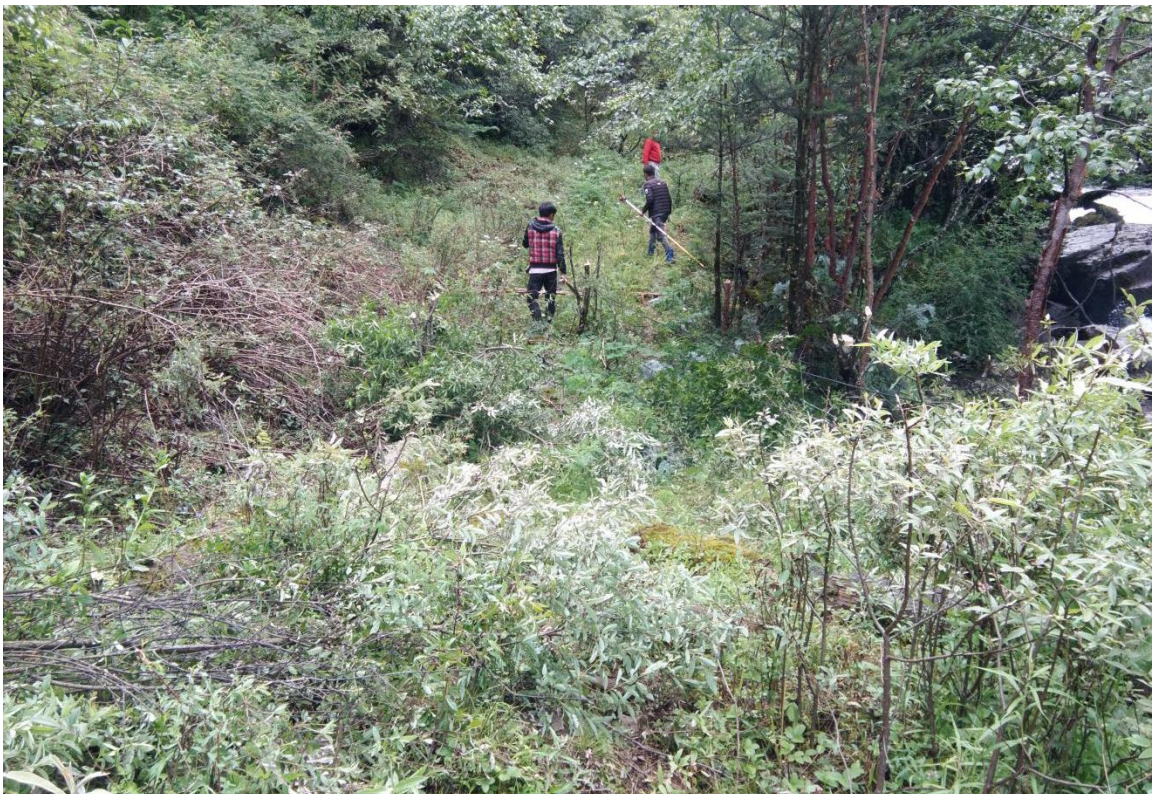


Figure 5: Desilting-cum-Forebay Tank Location

4.4 Pressure Pipe/ Penstock

Approx 1m diameter circular steel penstock pipe of total plan length approximately 2,585 m shall be laid.

The optimization of the pipe diameter, alignment and crossings shall be finalized during detailed design period.

4.5 Surge Pipe/ Surge Shaft

To absorb the fluctuations caused in the long penstock pipe, the surge pipe of 0.75 m diameter with surge tank of 7 m diameter shall be provided connecting the penstock at curve adjacent to Power House area.



Figure 6: Terrace for Surge Tank

4.6 Power House and Tail Race channel

The Power House location is same as that considered in the DPR. A wide terrace is available at the right bank of river as shown in the layout plan. The surface powerhouse is proposed at this terrace at the right bank of Taksang Chu. Water will be release back in to river through open tail race channel. 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 7: Powerhouse Location

4.7 Infrastructure Requirements

The project shall require the following infrastructure for development.

4.7.1 Roads & Bridges:

- I. **Approach to Power House:** It shall be 4 m 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. Suitable protection works and need based small culverts shall be carried out.
- II. **Approach to Diversion weir and Desilting-cum-Forebay :** For diversion weir about 60 m long and 4 m wide approach road shall be constructed. The road shall pass adjacent to the Desilting-cum-Forebay location. So no separate road is required. Suitable protection works shall be carried out to avoid the probability of any accident.

4.7.2 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.

4.7.3 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 Detailed Project Report the catchment area of Taksang Chu at Diversion site is 60.2 sq km. Taksang Chu originates from Sangester Lake at about ± 3710 m at about 2 km 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 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 232 m.

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% probability year indicates the capacity of the project to remain same as 3.4 MW and the design energy at 95% plant availability being 13.31 MU against 12.94 MU in the DPR. The details of the power potential studies are enclosed as per Appendix-B. This change in is due to revision of head, ecological release and efficiency of Turbine-Generator units.

6 Requirement 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 be 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-cum-Forebay Tank 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-cum-Forebay 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. Three cross sections have been marked on the Survey plans also and clearly identifiable with respect to cross-section drawings.

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-cum-Forebay Tank- 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 pipe.

Surge Pipe- 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 Surge Shaft and Power House sites from the existing road.

APPENDIX-A

REVISED HEAD LOSS CALCULATION

A HEAD LOSS FROM WEIR TO FORBAY

1 Head Loss in Trench Weir & Intake

a	Drop of Head in Trench Weir	=	0.30	m
b	Head Loss due to friction in trench weir	=	0.20	m
c	Head Loss in Gate Grooves at Intake Works (Also Refer 4.6 of IS : 4880 (Part III) - 1976)			
	Height of Head Regulator Gate Opening (m)	=	0.70	
	Width of Head Regulator Gate Opening (m)	=	1.10	
	Discharge Through Gate opening (Cumec)	=	3.02	
	A	=	0.77	sqm
	P	=	2.50	m
	R	=	0.31	
	Corresponding Velocity (m/s)	=	2.303	m/s
	Corresponding Head Loss for one slot in m (Assuming Value of 0.1 Loss Factor) =		0.0270	
	Total Head Loss in two gate slots at head regulator (m)	=	0.0540	
	Total Head Loss in Trench weir	=	0.554	m
	Water level in Intake Well	=	3343.446	m

2 Head Loss in Intake Channel

	Velocity corresponding to provided slope	$(R^{2/3}S^{1/2})/n$	=	1.767	m/s
	Velocity before Start of Transisition at rectangular section (m/s)		=	2.303	m/s
	Velocity after transisition in rectangular section (m/s)		=	1.767	m/s
	Head Loss in transisition (Assuming Value of 0.1 Loss Factor)		=	0.0111	m
a	Head Loss in the channel		=	0.040	m
b	Head loss at Exit of Intake channel	$V^2/(2xg)$	=	0.159	m
	Total Head Loss in Intake Channel		=	0.210	m
	Water Level at exit of Intake Channel		=	3343.23	m

3 Head Loss in De-silting Chamber

a	Head Loss due to Bottom Slope (m) =		0.00222	m
b	Head loss due to gradual expansion at entry to Desilting			
		Refer Cl. 4.4.1.1 of IS : 4880 (Part III) - 1976		
	Velocity of Flow at narrow portion (m/s) =		1.767	
	Velocity of flow at wide portion (m/s) =		0.620	
c	Head loss due to gradual expansion =		0.014	m
	FSL in Desilting Basin		3343.21	
d	Head Loss in Transition at exit of Desitling			
	Refer Cl. 4.4.1.1 of IS : 4880 (Part III) - 1976			

Velocity at Start of Transition (m/s)	=	0.620	
Velocity at end of Transition (m/s)	=	1.443	
Corresponding Head Loss in m (Assuming Loss Factor of 0.1)	=	0.009	m
Total Head Loss in Desilting Chamber	=	0.025	m
Water Level at exit of Desilting	=	3343.21	m
TOTAL HEAD LOSS FROM WEIR TO FOREBAY		0.789	

B HEAD LOSS FROM FOREBAY TO POWER HOUSE

Length of forebay	=	40.00	m
Length up to inlet of penstock	=	40.00	m
Width of Forebay	=	6.00	m
Depth of flow in forebay	=	1.50	m
Perimeter of flow	=	9	m
Area of flow	=	9	sqm
mannings n	=	0.015	
Velocity of flow	=	0.224	m/sec
mean hydraulic radius	R	=	1.000
slope	1 in	450000	
	V	=	0.099 =
		0.000088	
Head loss	=	9	m

Entrance Loss

As per IS: 4880 (Part III) - 1976, Clause 4.3

Loss coefficient for entrance	=	0.10	
Diameter of entry	=	1.80	m
C/s area of entry	=	2.54	m ²
Velocity of flow	=	0.791	m/sec
Entrance loss	=	0.0032	m

Trash Rack Loss

As per IS: 4880 (Part III) - 1976, Clause 4.2.

$$h_t = \frac{K_t * v^2}{2 * g}$$

$$K_t = 1.45 - 0.45 * (a_n/a_t) - (a_n/a_t)^2$$

Width of trash rack	=	1.20	m
Length of trash rack	=	1.20	m
Gross area of surface of trash rack	=	1.44	m ²
Gross area of opening/Gross surface area	=	0.7	
Net area of opening	=	1.008	m ²
<i>For No Clogging:</i>			
Net area of opening	=	1.008	m ²
Coefficient of head loss	=	0.645	
Velocity of flow through net area	=	1.997	m/sec
Head loss	=	0.1311	m
<i>For Clogging:</i>			
Net area of opening/Gross area of opening	=	0.75	

Net area of opening	=	0.756	m ²
Coefficient of head loss	=	0.93812	
Velocity of flow through net area	=	2.663	m/sec
Head loss	=	0.3390	m

Head loss in trash rack	=	0.339	m
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Head loss in transition

Coeff of loss	=	0.010	
Diameter at beginning	=	1.000	m
Diameter at end	=	1.800	m
Velocity at start	=	3.000	m/sec
			m/se
Velocity at end	=	0.791	c
Head loss = $K1*(V1^2-V2^2)/2g$	=	0.004	m

Butterfly Valve Loss

As per IS: 11625 - 1986, Clause 4.5.4

Diameter of Valve	=	1.00	m
Velocity of Flow	=	3.00	m/sec
Steady state level in Forebay	=	3341.76	m
Elevation of c/l of Valve	=	3339.66	0
Pressure head acting on Valve	=	2.10	m
			N/m
Pressure on the valve	=	0.021	m ²
Loss Coefficient	=	0.1	
Valve loss	=	0.0756	m

Friction Loss in Main Penstock

Diameter of Penstock	=	1.00	m
Area of flow	=	0.79	m ²
Velocity of flow	=	2.564	m/sec
Manning's coefficient	=	0.01	
Friction factor	=	0.0125	
Length of Penstock	=	2585.00	m
Head loss due to friction	=	10.830	m
Total head loss due to friction	=	10.905	m

Bend Loss in Main Penstock

Assume Bend loss	=	0.120	m
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Properties of Unit Penstock

As per IS: 11625 - 1986, Clause 4.5.5

Diameter of main penstock before bifurcation	=	1.00	m
Number of Unit penstock	=	2	Nos
Diameter of unit penstock	=	0.7	m
Area of flow	=	0.385	m ²
Discharge in Unit pestock	=	1.01	m ³ /sec
Velocity in Branch pipe	=	2.615	m/sec

Branch & Wye Loss

As per IS: 11625 - 1986, Clause 4.5.5

No. of Branching	=	1.00	
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Loss Coefficient	=	0.3	
Branch & Wye loss	=	0.105	m
Total Wye loss	=	0.105	m

Friction Loss in Unit Penstock

Manning's coefficient	=	0.01	
Friction factor	=	0.01407	
Length of Penstock	=	15	m
Head loss due to friction	=	0.105	m

Bend Loss in Branch Penstock

As per IS: 2951 (Part II) - 1965, Clause 2.2 & USBR material

Bend Nos	=	2	no.
Ratio of Radius of bend to Diameter	=	5.0	
Radius of bends	=	3.5	m
Deflection angle	=	45	deg.
Deflection angle in radian	=	0.78539	rad.
Bend loss coefficient	=	0.06645	
Bend loss coefficient adopted	=	0.08307	
Bend loss	=	0.03094	

Butterfly Valve Loss

As per IS: 11625 - 1986, Clause 4.5.4

Velocity of Flow	=	2.615	m/sec
Diameter of Valve	=	0.70	m
Steady state level in Forebay	=	3341.76	m
Elevation of c/l of Valve	=	3339.66	m
Pressure head acting on Valve	=	2.10	m
Pressure on the valve	=	0.0206	N/mm ²
Loss Coefficient	=	0.29	
Valve loss	=	0.10107	m

Head Loss From Forebay to Power house	=	11.790	m
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F.S.L in the Forebay	=	3343.219	m
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M.D.D.L of Forebay	=	3341.719	m
Centre of turbine		3112.00	
Rated water level in river at tail race exit		3110.00	
Loss from Forebay to Power House	=	11.790	
Net Head for power generation	=	218.93	

APPENDIX-B

REVISED POWER POTENTIAL STUDIES

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1. INPUT DATA

Name of the Project	Taksang Chu SHP
Name of River	Taksang Chu
Catchment Area of the River	68.2 sq km
Project capacity for PP Study	(Lowest) 2 MW
	(Increment) 0.2 MW
FRL	3344 m
TWL	3104 m
C/L of Machine	3112 m
Head Loss	14 m
Gross Head	232
Net Head	218
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
JUN	I	1.56	1.34	1.75	1.52	1.41	1.36	1.70	2.23	0.96	1.78	1.72	1.65	1.90	1.58	2.42	2.24	1.80
	II	2.22	1.52	1.79	2.11	1.60	1.43	2.18	2.61	1.14	2.11	1.94	2.22	2.11	2.11	2.78	1.93	1.97
	III	2.51	2.30	1.99	2.20	2.52	2.73	2.18	4.49	1.93	2.63	2.64	2.21	3.30	3.66	2.25	2.44	2.55
JUL	I	3.13	2.08	1.69	1.88	3.56	2.64	2.78	4.36	1.88	2.07	1.69	2.88	3.83	3.26	2.33	2.65	2.30
	II	3.13	2.30	2.12	1.65	2.99	3.04	2.68	4.07	1.96	2.17	2.12	2.36	3.48	3.63	2.97	2.63	3.45
	III	2.44	2.70	2.31	2.27	2.44	2.87	2.12	3.99	2.47	2.51	2.22	3.34	2.81	3.57	3.07	2.95	5.89
AUG	I	3.35	2.70	3.53	2.03	2.58	2.53	2.48	3.90	1.94	2.87	2.23	2.48	2.72	3.21	3.58	2.20	3.54
	II	3.28	2.32	3.09	2.27	2.66	2.79	3.79	5.29	2.14	2.60	2.10	3.46	2.57	3.07	3.42	2.06	3.97
	III	2.88	2.86	3.06	2.73	2.67	2.26	2.42	4.84	2.71	2.41	2.82	3.48	2.78	2.61	3.17	2.52	3.70
SEP	I	3.05	2.10	2.40	2.23	2.18	2.76	2.77	2.61	2.79	2.80	2.23	2.30	2.74	2.21	2.56	1.91	2.33
	II	2.38	2.08	2.40	2.16	2.16	2.07	2.67	1.91	2.22	2.44	2.10	2.03	2.98	1.48	1.65	2.44	1.71
	III	2.12	1.58	2.10	1.53	2.09	1.94	2.25	1.94	1.64	2.05	1.82	1.93	2.18	1.41	1.46	1.83	1.65
OCT	I	1.63	1.37	1.64	1.45	1.36	1.82	1.40	1.91	1.50	1.48	1.93	1.63	1.91	2.34	1.48	1.48	1.37
	II	1.26	1.61	1.62	1.04	1.37	1.18	1.18	1.75	1.43	1.11	1.67	1.40	1.92	1.91	1.24	1.21	1.31
	III	1.01	1.07	1.47	0.83	1.00	1.09	1.00	1.24	1.33	0.88	1.17	1.18	1.76	1.19	1.31	0.97	1.16
NOV	I	0.89	0.88	0.90	0.88	0.90	0.88	0.80	0.95	1.04	0.71	0.94	0.97	1.65	0.97	0.84	0.86	1.05
	II	0.82	0.82	0.89	0.82	0.87	0.81	0.76	0.58	0.87	0.65	0.78	0.94	1.42	0.84	0.82	0.84	0.90
	III	0.78	0.78	0.86	0.78	0.73	0.77	0.78	0.52	0.55	0.60	0.62	0.85	1.24	0.75	0.73	0.80	0.75
DEC	I	0.45	0.47	0.56	0.47	0.42	0.34	0.39	0.42	0.44	0.44	0.47	0.59	0.83	0.59	0.85	0.61	0.63
	II	0.44	0.43	0.42	0.43	0.38	0.31	0.37	0.37	0.38	0.42	0.44	0.56	0.60	0.56	0.82	0.56	0.55
	III	0.35	0.38	0.35	0.38	0.37	0.27	0.33	0.33	0.35	0.35	0.42	0.49	0.54	0.57	0.77	0.53	0.52
JAN	I	0.28	0.35	0.35	0.31	0.33	0.26	0.27	0.29	0.31	0.34	0.33	0.45	0.50	0.53	0.77	0.53	0.51
	II	0.26	0.34	0.34	0.31	0.32	0.24	0.28	0.26	0.30	0.31	0.32	0.40	0.50	0.50	0.75	0.52	0.50
	III	0.25	0.33	0.33	0.30	0.31	0.24	0.28	0.26	0.30	0.31	0.32	0.41	0.50	0.49	0.78	0.52	0.50
FEB	I	0.23	0.37	0.37	0.30	0.32	0.24	0.30	0.23	0.27	0.32	0.30	0.40	0.49	0.49	0.71	0.46	0.49
	II	0.22	0.38	0.38	0.32	0.33	0.25	0.31	0.24	0.25	0.31	0.30	0.39	0.46	0.50	0.70	0.34	0.49
	III	0.22	0.31	0.32	0.30	0.33	0.25	0.31	0.24	0.25	0.28	0.31	0.39	0.41	0.49	0.71	0.37	0.48
MAR	I	0.27	0.30	0.34	0.31	0.31	0.31	0.29	0.23	0.27	0.26	0.31	0.39	0.53	0.55	0.30	0.42	0.47
	II	0.39	0.30	0.40	0.32	0.49	0.63	0.29	0.26	0.26	0.29	0.32	0.40	0.50	0.55	0.33	0.48	0.55
	III	0.59	0.34	0.53	0.56	0.37	0.51	0.35	0.24	0.29	0.34	0.33	0.39	0.69	0.56	0.34	0.75	0.73
APR	I	0.51	0.45	0.54	0.48	0.61	0.33	0.47	0.29	0.62	0.31	0.37	0.59	0.55	0.61	0.42	0.95	0.88
	II	0.72	0.56	1.03	0.60	0.61	0.45	0.58	0.36	0.56	0.35	0.60	0.68	0.79	0.80	0.54	0.77	1.35
	III	0.59	0.70	0.64	0.83	0.67	0.49	0.79	0.58	0.69	0.54	0.64	0.83	0.87	0.98	0.48	0.92	1.39
MAY	I	0.90	1.07	0.93	1.02	1.00	0.92	0.91	0.51	0.72	0.53	0.72	0.84	0.81	0.86	0.85	1.16	1.42
	II	0.94	1.04	0.93	1.32	0.96	1.07	0.93	0.42	1.03	0.76	1.00	0.79	1.28	1.00	0.96	1.37	1.47
	III	0.90	1.03	1.03	1.14	1.01	1.05	0.97	0.76	1.26	0.98	1.02	0.95	1.26	1.39	1.25	1.69	1.58

All values are in cumecs

3. RANKING OF DEPENDABLE YEARS AS PER ANNUAL INFLOW

Years	Annual Inflow (Mm ³)
1991-92	42.97
1992-93	38.13
1993-94	41.65
1994-95	36.75
1995-96	40.50
1996-97	39.53
1997-98	40.52
1998-99	50.93
1999-00	35.87
2000-01	37.85
2001-02	37.84
2002-03	43.39
2003-04	50.71
2004-05	47.47
2005-06	46.20
2006-07	43.03
2007-08	51.49

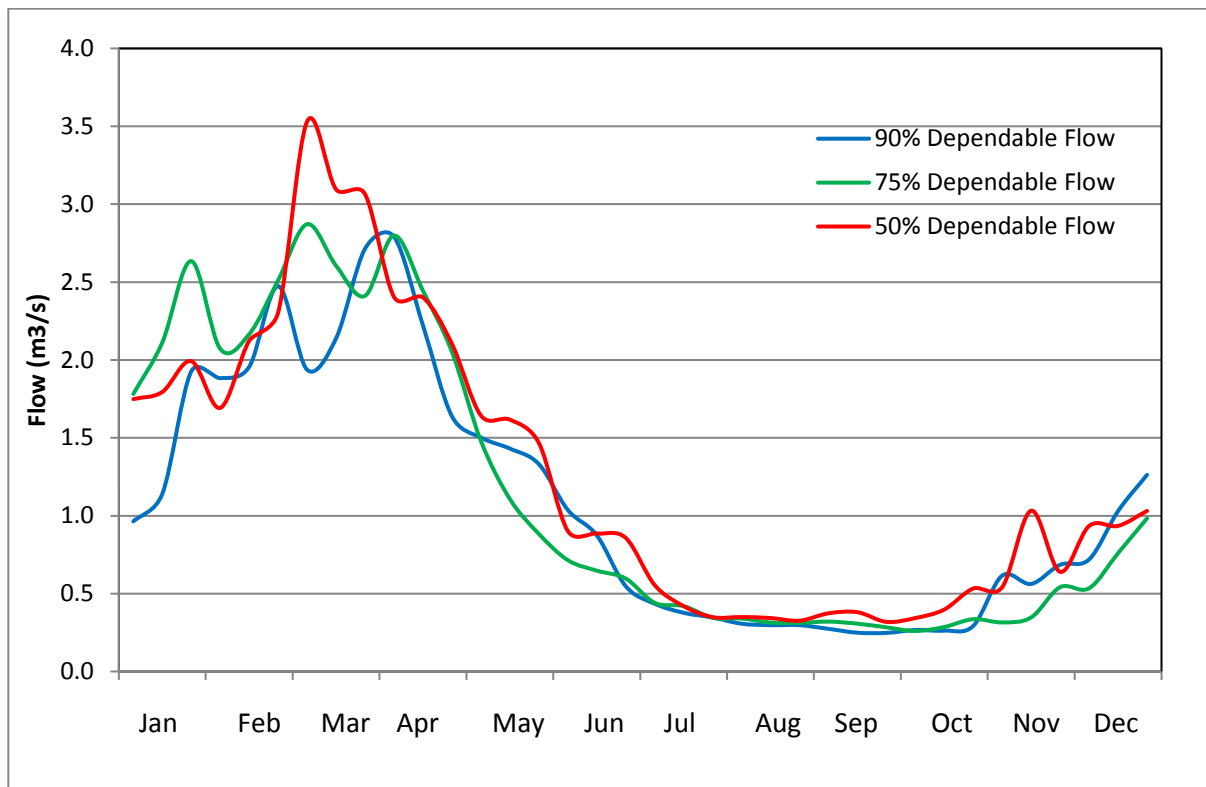
Ranked in Decending Order

Years	Annual Inflow (Mm ³)	Rank	Depen-dability	Remark
2007-08	51.49	1		
1998-99	50.93	2	11%	
2003-04	50.71	3	17%	
2004-05	47.47	4	22%	
2005-06	46.20	5	28%	
2002-03	43.39	6	33%	
2006-07	43.03	7	39%	
1991-92	42.97	8	44%	
1993-94	41.65	9	50%	50% Dependable
1997-98	40.52	10	56%	
1995-96	40.50	11	61%	
1996-97	39.53	12	67%	
1992-93	38.13	13	72%	
2000-01	37.85	14	78%	75% Dependable
2001-02	37.84	15	83%	
1994-95	36.75	16	89%	
1999-00	35.87	17	94%	90% Dependable

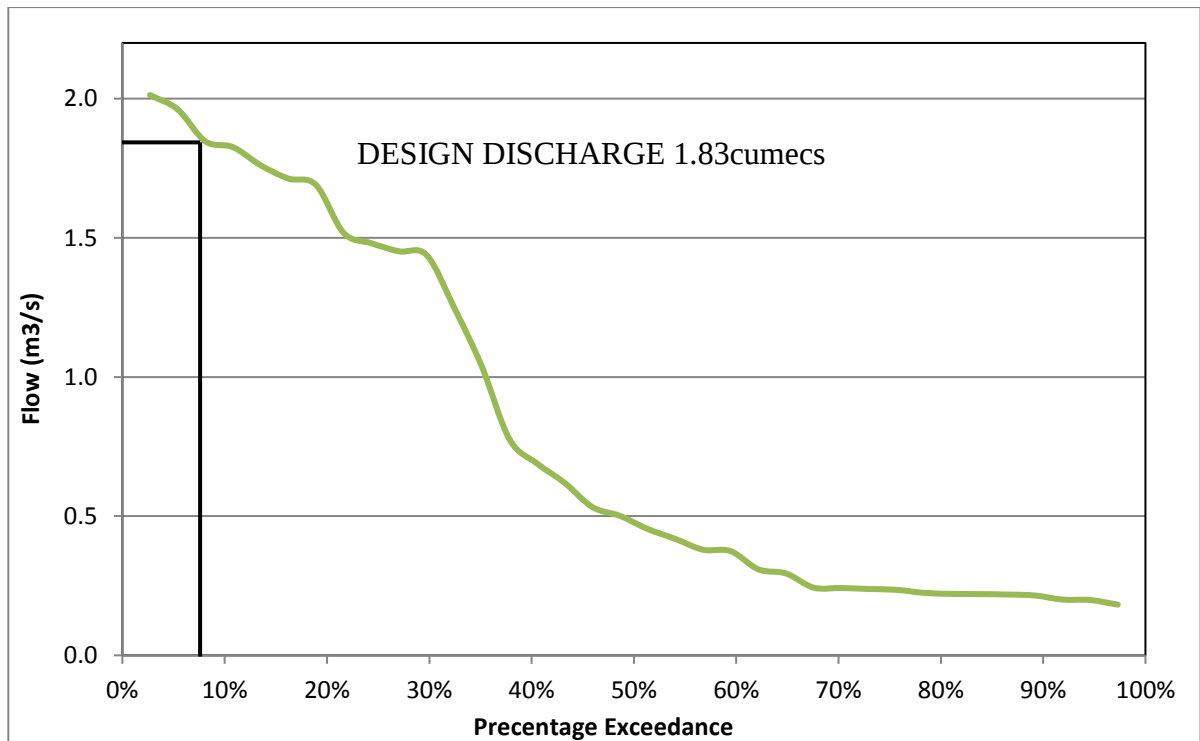
4. FLOW FOR 90%, 75% AND 50% DEPENDABLE YEARS

Month	Period	90% Dependable Flow	75% Dependable Flow	50% Dependable Flow
JUN	I	0.96	1.78	1.75
	II	1.14	2.11	1.79
	III	1.93	2.63	1.99
JUL	I	1.88	2.07	1.69
	II	1.96	2.17	2.12
	III	2.47	2.51	2.31
AUG	I	1.94	2.87	3.53
	II	2.14	2.60	3.09
	III	2.71	2.41	3.06
SEP	I	2.79	2.80	2.40
	II	2.22	2.44	2.40
	III	1.64	2.05	2.10
OCT	I	1.50	1.48	1.64
	II	1.43	1.11	1.62
	III	1.33	0.88	1.47
NOV	I	1.04	0.71	0.90
	II	0.87	0.65	0.89
	III	0.55	0.60	0.86
DEC	I	0.44	0.44	0.56
	II	0.38	0.42	0.42
	III	0.35	0.35	0.35
JAN	I	0.31	0.34	0.35
	II	0.30	0.31	0.34
	III	0.30	0.31	0.33
FEB	I	0.27	0.32	0.37
	II	0.25	0.31	0.38
	III	0.25	0.28	0.32
MAR	I	0.27	0.26	0.34
	II	0.26	0.29	0.40
	III	0.29	0.34	0.53
APR	I	0.62	0.31	0.54
	II	0.56	0.35	1.03
	III	0.69	0.54	0.64
MAY	I	0.72	0.53	0.93
	II	1.03	0.76	0.93
	III	1.26	0.98	1.03
Flow Vol. (Mm ³)		35.87	37.85	41.65

5. FLOW PLOT



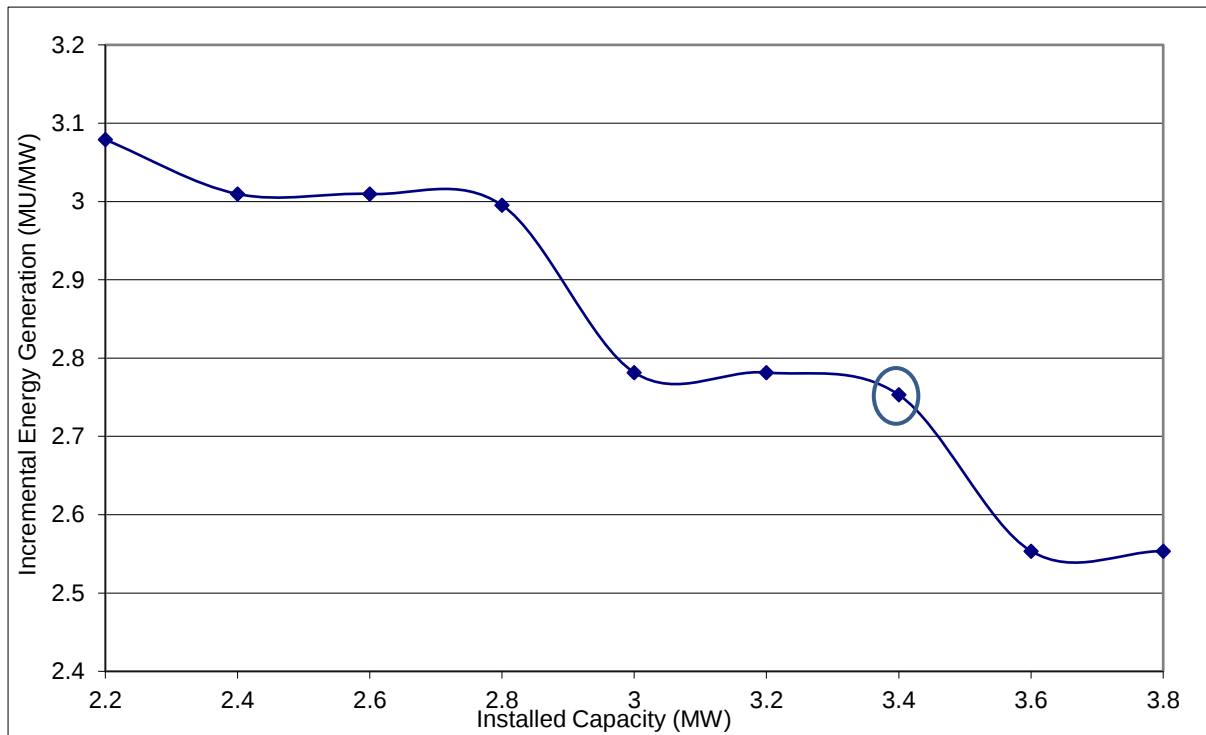
6. FLOW DRATION CURVE OF 75% DEPENDABLE YEAR



FRL =	3344	m	Gross Head =	232	m	Machine Availability =	95%	Turbine Efficiency =	92.50%
TWL =	3112	m	Head Loss =	14	m	Ecological release =	0.05	Generator Efficiency =	98.50%
CL of Machine=	3112	m	Net Head =	218	m	Minimum Load % assumed on one m/c=	40%	T-G Combines Efficiency =	91.11%

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8. INCREMENTAL ENERGY CURVE



9. FLOW CHART

Installed Capacity Selected (IC)= 3.4 MW Design Discharge= 1.83 m³/S

Installed Capacity Selected (IC)			0.4 MW			Design Discharge		1.66 MW	
Month		No. of Days	Discharge Available (m³/S)	Unrestricted		For IC Selected		Water Utilised (m³/S)	Water Spilled (m³/S)
				Power (MW)	Energy (GWH)	Power (MW)	Energy (GWH)		
JUN	I	10	1.60	3.01	0.72	3.01	0.72	1.60	0.00
	II	10	1.90	3.56	0.86	3.40	0.82	1.83	0.07
	III	10	2.37	4.44	1.07	3.40	0.82	1.83	0.54
JUL	I	10	1.86	3.49	0.84	3.40	0.82	1.83	0.03
	II	10	1.95	3.65	0.88	3.40	0.82	1.83	0.12
	III	11	2.26	4.24	1.12	3.40	0.90	1.83	0.43
AUG	I	10	2.58	4.84	1.16	3.40	0.82	1.83	0.75
	II	10	2.34	4.39	1.05	3.40	0.82	1.83	0.51
	III	11	2.17	4.07	1.07	3.40	0.90	1.83	0.34
SEP	I	10	2.52	4.72	1.13	3.40	0.82	1.83	0.69
	II	10	2.20	4.12	0.99	3.40	0.82	1.83	0.37
	III	10	1.85	3.46	0.83	3.40	0.82	1.83	0.02
OCT	I	10	1.33	2.50	0.60	2.50	0.60	1.33	0.00
	II	10	1.00	1.87	0.45	1.87	0.45	1.00	0.00
	III	11	0.80	1.49	0.39	1.49	0.39	0.80	0.00
NOV	I	10	0.64	1.21	0.29	1.21	0.29	0.64	0.00
	II	10	0.58	1.09	0.26	1.09	0.26	0.58	0.00
	III	10	0.54	1.01	0.24	1.01	0.24	0.54	0.00
DEC	I	10	0.40	0.74	0.18	0.74	0.18	0.40	0.00
	II	10	0.38	0.71	0.17	0.71	0.17	0.38	0.00
	III	11	0.31	0.58	0.15	0.00	0.00	0.31	0.00
JAN	I	10	0.31	0.57	0.14	0.00	0.00	0.31	0.00
	II	10	0.28	0.53	0.13	0.00	0.00	0.28	0.00
	III	11	0.28	0.53	0.14	0.00	0.00	0.28	0.00
FEB	I	10	0.29	0.54	0.13	0.00	0.00	0.29	0.00
	II	10	0.28	0.52	0.12	0.00	0.00	0.28	0.00
	III	8	0.26	0.48	0.09	0.00	0.00	0.26	0.00
MAR	I	10	0.23	0.44	0.11	0.00	0.00	0.23	0.00
	II	10	0.26	0.48	0.12	0.00	0.00	0.26	0.00
	III	11	0.30	0.57	0.15	0.00	0.00	0.30	0.00
APR	I	10	0.28	0.53	0.13	0.00	0.00	0.28	0.00
	II	10	0.31	0.59	0.14	0.00	0.00	0.31	0.00
	III	10	0.49	0.91	0.22	0.91	0.22	0.49	0.00
MAY	I	10	0.48	0.90	0.22	0.90	0.22	0.48	0.00
	II	10	0.68	1.28	0.31	1.28	0.31	0.68	0.00
	III	11	0.88	1.66	0.44	1.66	0.44	0.88	0.00

APPENDIX-C

REVISED PROJECT 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' 06" N
Longitude = 91° 46' 30" E |
| vii) | Toposheet Reference | :- | 78 M/14 |
| viii) | Nearest Airport | :- | Tezpur, Assam (475 Km from site) |
| ix) | Nearest Rail Head | :- | Bhalukpong, Assam (about 430 Km from site) |

2. HYDROLOGY

- | | | | |
|-------|-----------------------|----|------------------------|
| i) | Name of the River | :- | Taksang Chu |
| ii) | River Basin | :- | Tawang Basin |
| iii) | Catchments Area | :- | 68.20 km ² |
| iv) | Type of River | :- | Perennial |
| v) | Design Flood | :- | 417 m ³ /s |
| vi) | Average Annual Inflow | :- | 41.65 MCM |
| vii) | 75% dependable inflow | :- | 37.85 MCM |
| viii) | Design Discharge | :- | 1.83 m ³ /s |

3. TRENCH WEIR

- i) Shape :- Rectangular
- ii) Length :- 12 m
- iii) Width :- 1.0 m
- iv) Top level of trench :- EL 3644.0 m
- v) Size of gates :- 1.1 m x 1.0 m
- vi) Invert Level of Intake :- EL 3642.40 m

4. INTAKE CHANNEL

- i) Length :- 20 m
- ii) Shape :- RCC Rectangular Box Section
- iii) Size :- 1.4 m (W) x 1.3 m (H)

5. DESILTING-CUM-FOREBAY TANK

- i) Type :- Gutter type Hopper
- ii) Length :- 40.0 m
- iii) Width :- 6.0 m
- iv) Depth of vertical portion :- 0.6 m
- v) Depth of hopper portion :- 1.5 m
- vi) No. :- 1
- vii) FSL :- 3343.10 m
- viii) Live Storage :- 2.75 m (Between FSL and MDDL)
- ix) Storage :- 3 Minutes
- xi) Capacity :- 360 m³

xii) Max. Draw Down Level :- EL 3340.35 m

xiii) C/L of penstock :- EL 3338.20 m

6. WATER CONDUCTOR SYSTEM

Steel Penstock

i) Length :- 2,585 m

ii) Size :- 1000 mm (ID) bifurcating into 700 mm (ID)

7. POWER HOUSE

i) Type :- Surface

ii) Head :-

Gross 232.0 m

Design (net) 218.0 m

iii) Size of Power House :-

Length :- 30 m

Width :- 16 m

Height from Machine Floor Level :- 10 m

Machine centerline :- EL 3112 m

iv) Installed Capacity :- 3400 kW

v) Turbines

Type :- Horizontal Pelton

Number :- 2 Nos.

Capacity :- 1700 kW each

vi) Generator

Type :- Synchronous

	Voltage	:-	3.3 kV
	Excitation System	:-	Brush less
vii)	Generator Transformer	:-	2 Nos., 3.3/11kV, 1750 kVA
viii)	Number of Draft Tube Gates	:-	2 Nos. manually operated
ix)	Power house Crane /Lifting capacity	:-	EOT Crane of 15/5 ton capacity

8. TAIL RACE CHANNEL

i)	Type	:-	Open Channel
ii)	Shape	:-	Rectangular
iii)	Size	:-	3.5m (W) x 0.9 (H)
iv)	Quantity	:-	1 no.
v)	Length	:-	20 m

9. SWITCH YARD

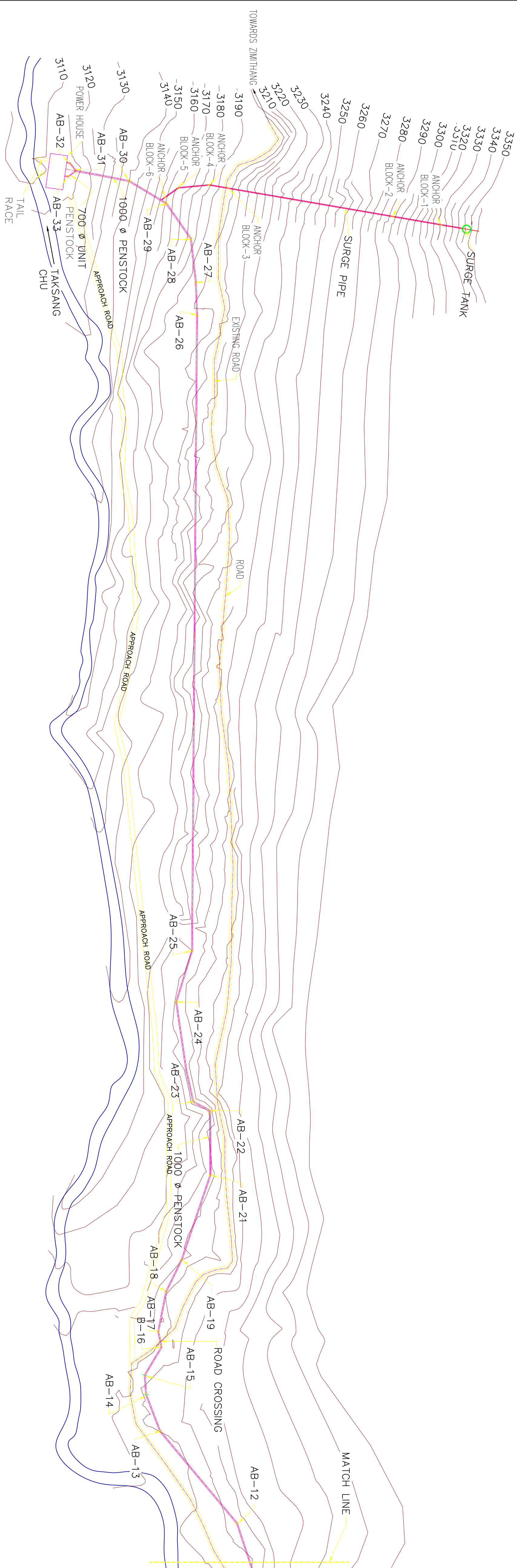
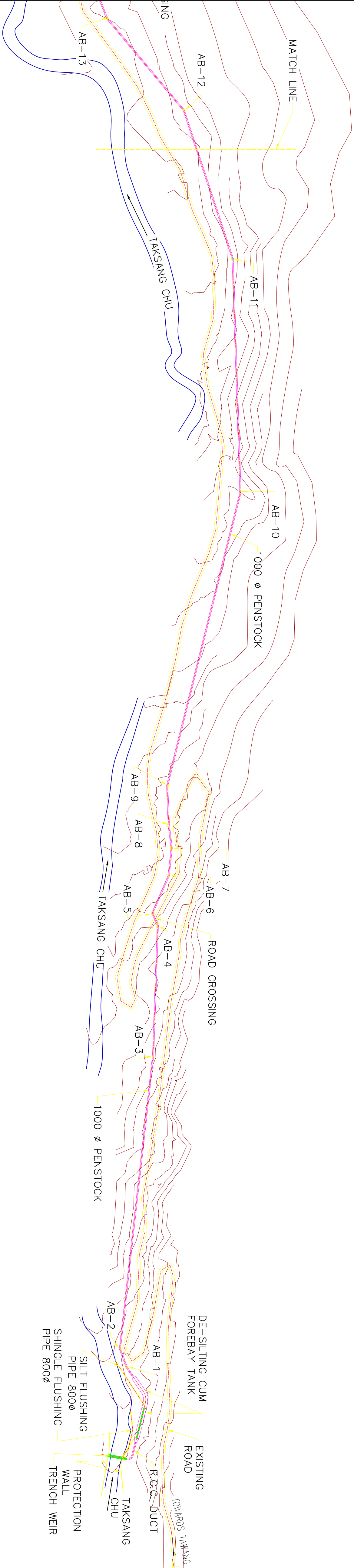
i)	Voltage Level	:-	33 KV
ii)	Size	:-	Outdoor, 30 m X 32 m

10. GENERATION

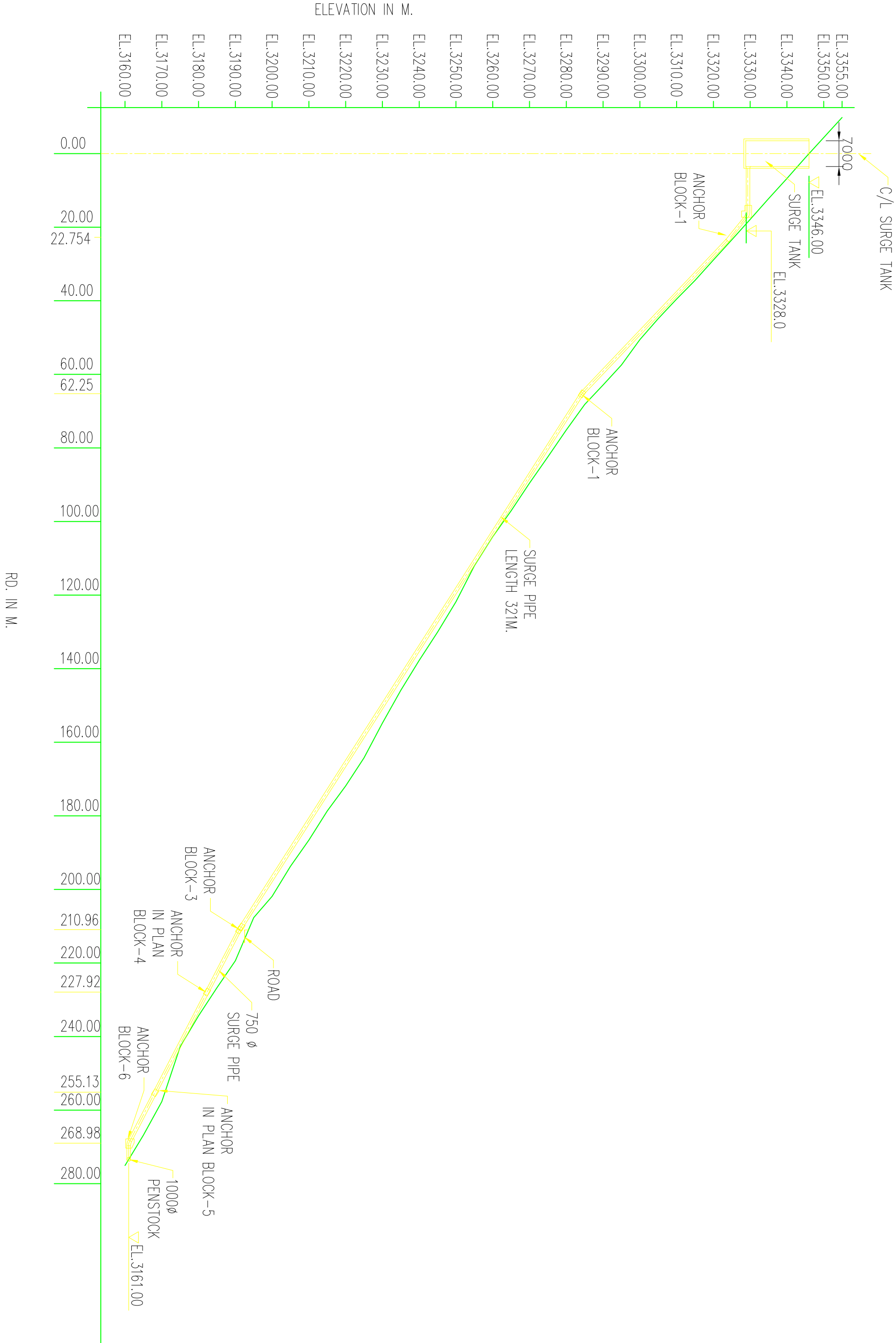
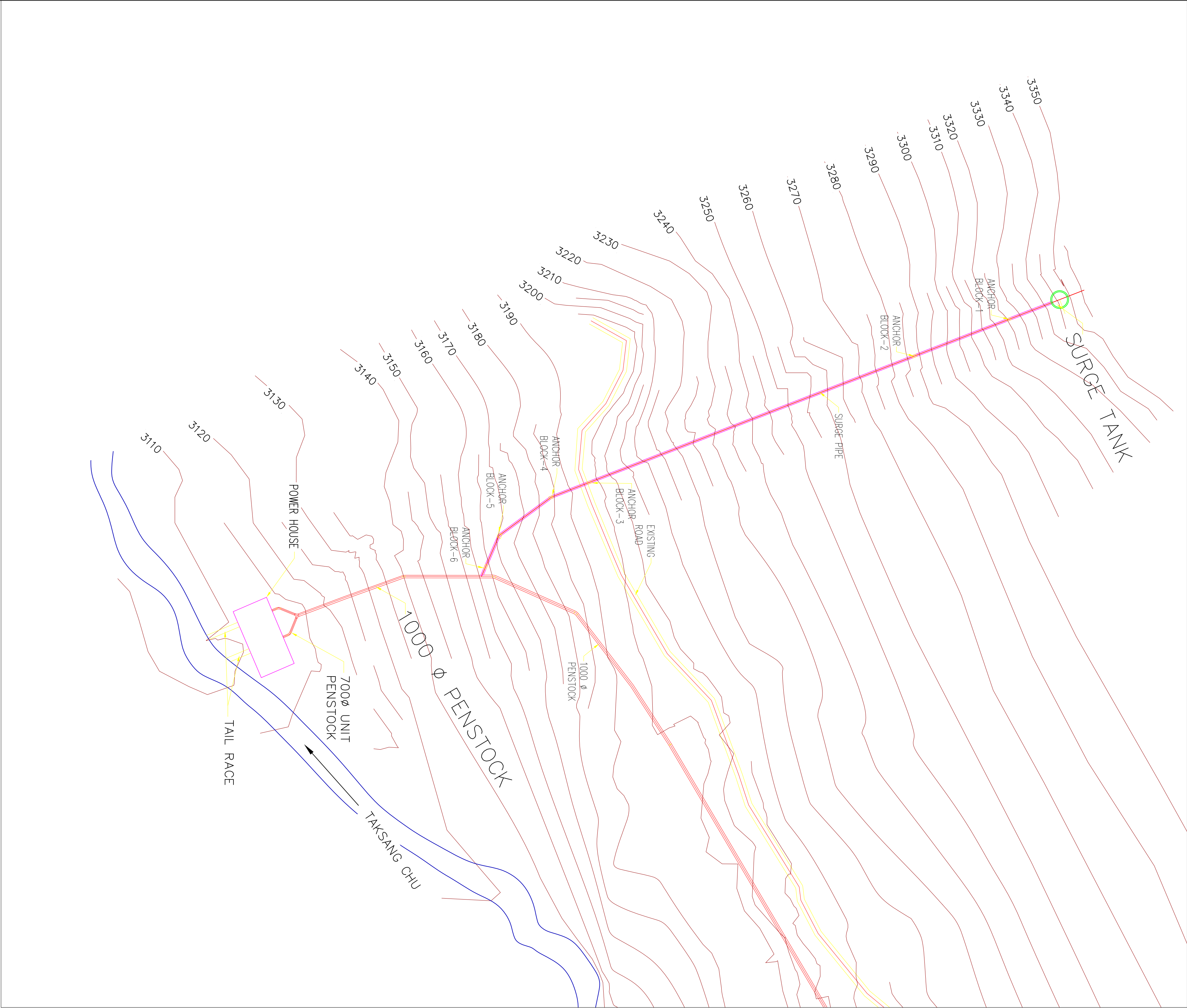
i)	Annual Generation in 75% Dependable Year	:-	14.01 MU
ii)	Design Energy (at 95 % plant Availability)	:-	13.31 MU
iii)	Annual Load Factor (%)	:-	44.69 %
iv)	Generation in Lean Period (Nov.-Mar.)	:-	1.20 MU

APPENDIX-D

REVISED LAYOUT PLAN & L-SECTION



CLIENT	 HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED	
	 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	
SURVEYED	CONCEPT VENTURES	
	PROJECT	
	TAKSANG CHU SHP (2 x 1.7 MW)	
TITLE	GENERAL LAYOUT PLAN	
	Drawn By Jacob	Checked By Approved By DATE: SEP. 2018
	SHEET A1	DWG. No. CCE/TH/SURVEY/01
SCALE 1:1500	0 5 10 15 20 25 30 35 40 45 50	
	0 5 10 15 20 25 30 35 40 45 50	
	0 5 10 15 20 25 30 35 40 45 50	
REV.	00	
	00	
	00	



CLIENT	 HYDRO POWER DEVELOPMENT CORPORATION OF ARUNACHAL PRADESH LIMITED			
SURVEYED	 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 CHU SMALL HYDRO PROJECT			
TITLE	SURGE PIPE AND SURGE TANK PLAN AND L-SECTION			
Drawn By	Checked By	Designed By	Approved By	DATE: SEP. 2018
Jacob				
SCALE: 1:1500	SHEET	DWG. No.	SHEET NO.	REV.
0 6 12 18 24 30 36 42 48	A1			00