



**THE PROJECT TO PROMOTE EFFICIENT WATER RESOURCES  
MANAGEMENT TECHNIQUES AMONG VULNERABLE  
COMMUNITIES IN BHUTAN THEREBY REDUCE POVERTY**

**(WACREP ACTIVITY NO 2.5.1)**

by  
Bhutan Water Partnership  
in collaboration with  
Royal Society of Protection of Nature (RSPN) and Engineering Division of Department of  
Agriculture, Ministry of Agriculture and Forests,  
Bhutan

## Background

Bhutan is well endowed with freshwater resources and has one of the highest per capita water availability in the world. This resource is being harnessed for generation of hydro-power, which is the major source of the country's income. However, due to the uneven spatial and temporal distribution of the water bodies many areas face water shortage for both drinking and irrigation.

The irrigated area constitutes only 25 per cent of the total arable land owing to lack of irrigation water and infrastructures. Paddy is the dominant crop currently under irrigation and is cultivated on terraced land on the hill slopes and valley bottoms. However, a significant proportion of the paddy land relies on rainfall for crop production. The rice yields are comparatively low (1 MT/acre). Lack of financial resources and capital investments has been the major constraint in creating adequate and efficient irrigation facilities in the country. There is a huge potential to increase domestic agriculture production and in meeting the food self-sufficiency by making major investments in development of irrigation infrastructures.

The Lingmutey-chu watershed is one of the small agriculture areas in Thedtso Block under Wangduephodrang district. The watershed is home to six villages. Farming is the mainstay of its inhabitants. By local standard, the area has a high proportion of paddy land and a source of pride to the local farmers. The Lingmutey-chu stream is the main source of irrigation and drinking water.

## Problem statement

Although perennial, the Lingmutey-chu stream does not have sufficient flow to irrigate the whole agriculture land within its catchment. Local farmers experience severe water shortage during the dry season and paddy transplanting when the Monsoon rains have yet to arrive. Conflicts over water sharing between the upstream and downstream farmers are an annual feature. The long and protracted legal disputes between these parties are known nationally.

## Objectives

This intervention has been identified as must do activity under Water & Climate Resilience Programme of South Asia. RSPN and Ministry of Agriculture and Forest in Bhutan were the collaborative partners who joined hands with BhWP in implementing this activity.

This project has improved irrigation water supply for 31 households of Wangjokha and Thanggo villages under Thedtso Block, which are located at the tail end of Lingmuteychu stream. The project was expected to bring an additional 49.73 hectares of paddy land under irrigation and yet to see observe the impact. The main objectives of the project were;

- To increase rice yield from 1.2 MT/acre to 1.6 MT/acre;
- Resolve the existing conflicts with upstream users of Lingmutey-chu stream

## Activities

The proposed project has financed the purchase and laying of 606 metres of HDPE pipe which has been connected to the existing Bajo Yuwa irrigation canal. The Bajo Yuwa canal has sufficient flow and capacity to carry the additional discharge.

The civil works was outsourced to a local contractor. However, as part of their contribution the beneficiaries provided unpaid labour for trenching of the pipeline.

## Work Plan (2014)

Activity	February	March	April	May
Survey, design and cost estimation				
Quotation call for civil works and contract award				
Laying of new pipeline and concrete works				
Commissioning of new irrigation facility				

## Implementing Agency

The Engineering Division, Department of Agriculture, Ministry of Agriculture and Forests, BHUTAN. MoU between BhWP and Ministry of Agriculture was signed on 6 March 2014.

## Project Completion

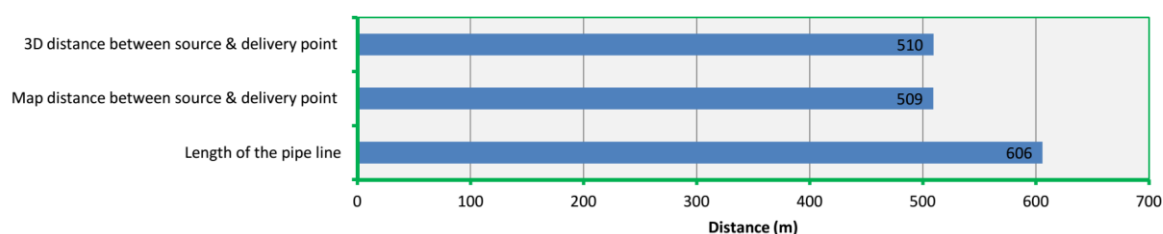
The project was completed and handed over to the communities on 14 September 2014

## Technical details:

General Profile: Bajo Irrigation Channel Siphon Project

- 1 ) Project Title : *Bajo Irrigation Channel Siphon Project*
- 2 ) Location : *Thanggo*
- 3 ) Geog : *Thedtsho*
- 4 ) Dzongkhag : *Wangdue*
- 5 ) Name of the source : *Bajo Irrigation Channel Water*
- 6 ) Type of source : *Irrigation Channel*
- 7 ) Command area : *50 (ha)*
- 8 ) No of Households : *40 (#)*
- 9 ) Minimum flow rate of the source : *260 (lps) (Bajo Yuwa Design flow)*

- 10 ) Maximum flow rate of the source : 0 (lps)
- 11 ) Minimum velocity of the flow : 0.50 (m/s)
- 12 ) Maximum velocity of the flow : 2.50 (m/s)
- 13 ) Pipe cover : 1.5 (m)
- 14 ) Assumed incidental head loss : 2%
- 15 ) Design flow rate : 100 (lps)
- 16 ) Elevation of the source : 499.210 (m)
- 17 ) Elevation of the delivery point : 483.956 (m)
- 18 ) Head difference between source & delivery point : 15.254 (m)
- 19 ) Maximum static head : 46.997 (m)
- 20 ) Length of the pipe line : 606 (m)
- 21 ) Map distance between source & delivery point : 509 (m)
- 22 ) 3D distance between source & delivery point : 510 (m)
- 23 ) Alignment efficiency : 84 (%)



### Command Area & Diversion Requirement Bajo Irrigation Channel Siphon Project at Thanggo, Wangdue

#### Command Area

Portion	Area			*NCA (Ha)	Remark
	(m <sup>2</sup> )	(Ac)	(Ha)		
A1	406,139	100.36	40.61	36.55	
A2	146,401	36.18	14.64	13.18	
A3	51,268	12.67	5.13	4.62	
<b>Total</b>	<b>603,808</b>	<b>149.21</b>	<b>60.38</b>		

\*Assumed Net Command Area is 90% of Gross Command Area

Source: Area estimate from Google Map

#### Command Area by different schemes

Portion	Gross Command Area			NCA (Ha)	Remark
	(m <sup>2</sup> )	(Ac)	(Ha)		
Bajo Yuwa	406,139	100.36	40.61	36.55	
Trashigang Yuwa	603,808	149.21	60.38	54.34	
Realignment- Channel	603,808	149.21	60.38	54.34	
<b>Realignment- Pipe</b>	<b>552,540</b>	<b>136.54</b>	<b>55.25</b>	<b>49.73</b>	
Pumping	552,540	136.54	55.25	49.73	

Source: Area estimate from Google Map

Diversion requirement in Wangdue

Designed net command area (Realignment- Pipe)

Total diversion requirement

Page-34 of Irrigation Design Manual, V-II, DoA-MoAF

2 lps per ha

50 Ha

100 lps

0.100 m<sup>3</sup>/s





**Pipeline Long Section Data**  
**Bajo Irrigation Channel Siphon Project at Thedtsho, Wangdue**

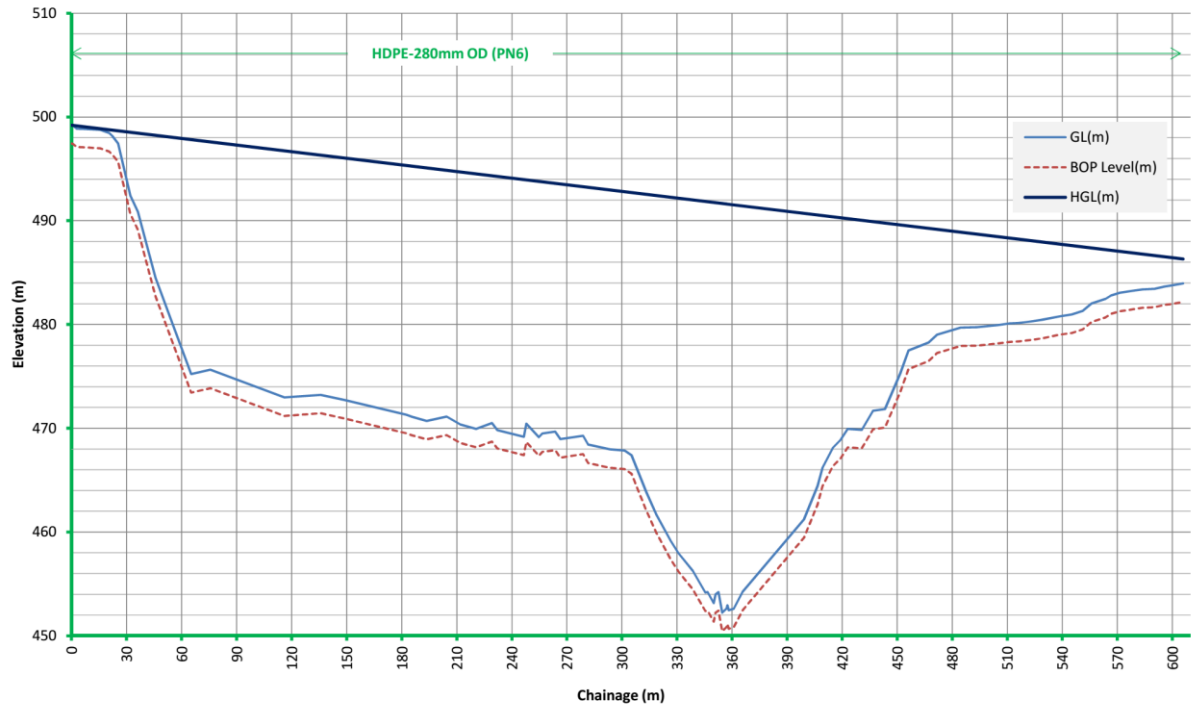
L-Section detail Point description	SN	Chainage CH (m)	Ground level GL (m)	Coordinate		Code	BOP level (m)	HGL (m)	HDPE Pipe Size/Type			Static head (m)	V (m/s)	Surge Check	Remark
				Easting (m)	Northing (m)				OD (mm)	Material	P. Class PN/SDR				
Bajo Yuwa	1	0.000	499.210	510.358	526.155	CA26	497.430	499.210	-	-	-	0.000	0.00	-	
Outlet-Right side	2	0.720	499.186	510.946	526.563	OTR1	497.406	499.195	280	PE100	06.0/26.0	0.024	1.92	Surge-OK!	
	3	2.853	498.871	511.033	528.680	CA28	497.091	499.149	280	PE100	06.0/26.0	0.339	1.92	Surge-OK!	
	4	6.803	498.853	513.628	531.649	CA27	497.073	499.065	280	PE100	06.0/26.0	0.357	1.92	Surge-OK!	
	5	15.674	498.757	520.031	537.784	CA29	496.977	498.876	280	PE100	06.0/26.0	0.453	1.92	Surge-OK!	
	6	20.364	498.457	524.477	539.261	CA30	496.677	498.777	280	PE100	06.0/26.0	0.753	1.92	Surge-OK!	
	7	22.311	498.133	525.420	540.934	CA31	496.353	498.735	280	PE100	06.0/26.0	1.077	1.92	Surge-OK!	
	8	25.370	497.444	525.127	543.896	CA32	495.664	498.670	280	PE100	06.0/26.0	1.766	1.92	Surge-OK!	
	9	32.020	492.458	525.161	548.299	CA33	490.678	498.528	280	PE100	06.0/26.0	6.752	1.92	Surge-OK!	
	10	36.046	490.919	523.105	551.404	CA62	489.139	498.443	280	PE100	06.0/26.0	8.291	1.92	Surge-OK!	
	11	45.821	484.498	521.713	558.637	CA63	482.718	498.235	280	PE100	06.0/26.0	14.712	1.92	Surge-OK!	
	12	65.208	475.214	528.834	574.093	CA38	473.434	497.822	280	PE100	06.0/26.0	23.996	1.92	Surge-OK!	
	13	75.677	475.645	535.154	582.430	C64	473.865	497.599	280	PE100	06.0/26.0	23.565	1.92	Surge-OK!	
	14	115.966	472.970	556.191	616.688	CA39	471.190	496.742	280	PE100	06.0/26.0	26.240	1.92	Surge-OK!	
	15	135.748	473.217	567.307	633.042	C69	471.437	496.321	280	PE100	06.0/26.0	25.993	1.92	Surge-OK!	
	16	149.158	472.708	573.664	644.838	C71	470.928	496.035	280	PE100	06.0/26.0	26.502	1.92	Surge-OK!	
Outlet-Left side	17	182.468	471.300	583.776	676.544	OTL3	469.520	495.326	280	PE100	06.0/26.0	27.910	1.92	Surge-OK!	
	18	185.644	471.100	584.109	679.706	CA40	469.320	495.258	280	PE100	06.0/26.0	28.110	1.92	Surge-OK!	
	19	193.534	470.710	578.051	684.745	CA42	468.930	495.091	280	PE100	06.0/26.0	28.500	1.92	Surge-OK!	
	20	204.522	471.121	582.754	694.658	C91	469.341	494.857	280	PE100	06.0/26.0	28.089	1.92	Surge-OK!	
	21	211.942	470.352	587.679	700.163	CA44	468.572	494.699	280	PE100	06.0/26.0	28.858	1.92	Surge-OK!	
	22	220.512	469.948	594.073	705.847	CA45	468.168	494.516	280	PE100	06.0/26.0	29.262	1.92	Surge-OK!	
	23	229.130	470.498	598.621	713.146	C87	468.718	494.333	280	PE100	06.0/26.0	28.712	1.92	Surge-OK!	
	24	232.038	469.827	600.443	715.311	CA46	468.047	494.271	280	PE100	06.0/26.0	29.383	1.92	Surge-OK!	
	25	246.532	469.184	607.042	728.208	CA47	467.404	493.962	280	PE100	06.0/26.0	30.026	1.92	Surge-OK!	
	26	247.946	470.450	607.512	728.626	C86	468.670	493.932	280	PE100	06.0/26.0	28.760	1.92	Surge-OK!	
	27	254.685	469.138	612.229	733.255	CA48	467.358	493.789	280	PE100	06.0/26.0	30.072	1.92	Surge-OK!	
Outlet-Left side	28	256.640	469.505	612.970	735.028	OTL4	467.725	493.747	280	PE100	06.0/26.0	29.705	1.92	Surge-OK!	
	29	263.572	469.679	618.192	739.579	C83	467.899	493.600	280	PE100	06.0/26.0	29.531	1.92	Surge-OK!	
	30	266.389	468.947	620.232	741.380	CA49	467.167	493.540	280	PE100	06.0/26.0	30.263	1.92	Surge-OK!	
	31	278.833	469.281	628.403	750.761	C81	467.501	493.275	280	PE100	06.0/26.0	29.929	1.92	Surge-OK!	
	32	281.539	468.435	630.150	752.642	CA50	466.655	493.217	280	PE100	06.0/26.0	30.775	1.92	Surge-OK!	

L-Section detail Point description	SN	Chainage CH (m)	Ground level GL (m)	Coordinate		Code	BOP level (m)	HGL (m)	HDPE Pipe Size/Type			Stattice head (m)	V (m/s)	Surge Check	Remark
				Easting (m)	Northing (m)				OD (mm)	Material	P. Class PN/SDR				
	33	293.468	467.964	639.130	760.486	CA51	466.184	492.963	280	PE100	06.0/26.0	31.246	1.92	Surge-OK!	
	34	301.469	467.853	643.065	767.449	CA52	466.073	492.793	280	PE100	06.0/26.0	31.357	1.92	Surge-OK!	
	35	305.235	467.411	645.768	770.029	CA53	465.631	492.713	280	PE100	06.0/26.0	31.799	1.92	Surge-OK!	
	36	313.232	463.849	651.347	774.519	CA55	462.069	492.543	280	PE100	06.0/26.0	35.361	1.92	Surge-OK!	
	37	318.889	461.669	655.836	777.181	CA56	459.889	492.422	280	PE100	06.0/26.0	37.541	1.92	Surge-OK!	
	38	326.564	459.150	661.288	781.969	CA57	457.370	492.259	280	PE100	06.0/26.0	40.060	1.92	Surge-OK!	
	39	330.752	457.976	663.663	785.207	CA58	456.196	492.170	280	PE100	06.0/26.0	41.234	1.92	Surge-OK!	
	40	338.602	456.259	667.674	791.731	CA59	454.479	492.003	280	PE100	06.0/26.0	42.951	1.92	Surge-OK!	
	41	345.411	454.169	668.649	798.135	C105	452.389	491.858	280	PE100	06.0/26.0	45.041	1.92	Surge-OK!	
	42	346.712	454.213	668.602	799.439	CA61	452.433	491.830	280	PE100	06.0/26.0	44.997	1.92	Surge-OK!	
	43	349.936	453.140	668.340	802.465	CA64	451.360	491.761	280	PE100	06.0/26.0	46.070	1.92	Surge-OK!	
	44	350.975	453.995	668.259	803.049	CA65	452.215	491.739	280	PE100	06.0/26.0	45.215	1.92	Surge-OK!	
	45	352.599	454.206	668.019	804.641	CA66	452.426	491.705	280	PE100	06.0/26.0	45.004	1.92	Surge-OK!	
Stream crossing	46	354.634	452.213	668.236	804.987	CA67	450.433	491.661	280	PE100	06.0/26.0	46.997	1.92	Surge-OK!	
Stream crossing	47	357.030	452.627	668.219	807.347	CA68	450.847	491.610	280	PE100	06.0/26.0	46.583	1.92	Surge-OK!	
	48	357.481	452.945	668.341	807.648	C104	451.165	491.601	280	PE100	06.0/26.0	46.265	1.92	Surge-OK!	
	49	358.118	452.458	668.516	808.018	CA83	450.678	491.587	280	PE100	06.0/26.0	46.752	1.92	Surge-OK!	
	50	360.931	452.597	669.146	810.761	CA69	450.817	491.527	280	PE100	06.0/26.0	46.613	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA70	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA71	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA72	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA73	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA74	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA75	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	51	365.753	454.249	671.712	814.484	CA76	452.469	491.425	280	PE100	06.0/26.0	44.961	1.92	Surge-OK!	
	58	399.252	461.232	672.302	841.912	CA77	459.452	490.712	280	PE100	06.0/26.0	37.978	1.92	Surge-OK!	
	59	406.631	464.431	669.129	847.752	CA78	462.651	490.555	280	PE100	06.0/26.0	34.779	1.92	Surge-OK!	
	60	409.366	466.207	667.348	848.828	CA79	464.427	490.496	280	PE100	06.0/26.0	33.003	1.92	Surge-OK!	
	61	415.035	468.139	664.559	853.369	CA88	466.359	490.376	280	PE100	06.0/26.0	31.071	1.92	Surge-OK!	
	62	419.184	468.894	663.201	857.220	CA89	467.114	490.287	280	PE100	06.0/26.0	30.316	1.92	Surge-OK!	
	63	423.058	469.939	660.083	859.271	CA90	468.159	490.205	280	PE100	06.0/26.0	29.271	1.92	Surge-OK!	
	64	430.649	469.842	658.213	866.617	CA91	468.062	490.043	280	PE100	06.0/26.0	29.368	1.92	Surge-OK!	
	65	436.793	471.688	655.458	871.799	CA92	469.908	489.913	280	PE100	06.0/26.0	27.522	1.92	Surge-OK!	
	66	443.345	471.842	651.652	877.131	CA93	470.062	489.773	280	PE100	06.0/26.0	27.368	1.92	Surge-OK!	
	67	451.720	475.295	647.677	883.643	CA94	473.515	489.595	280	PE100	06.0/26.0	23.915	1.92	Surge-OK!	
	68	456.171	477.493	644.534	885.890	CA95	475.713	489.500	280	PE100	06.0/26.0	21.717	1.92	Surge-OK!	
	69	467.037	478.250	641.656	896.342	CA96	476.470	489.269	280	PE100	06.0/26.0	20.960	1.92	Surge-OK!	

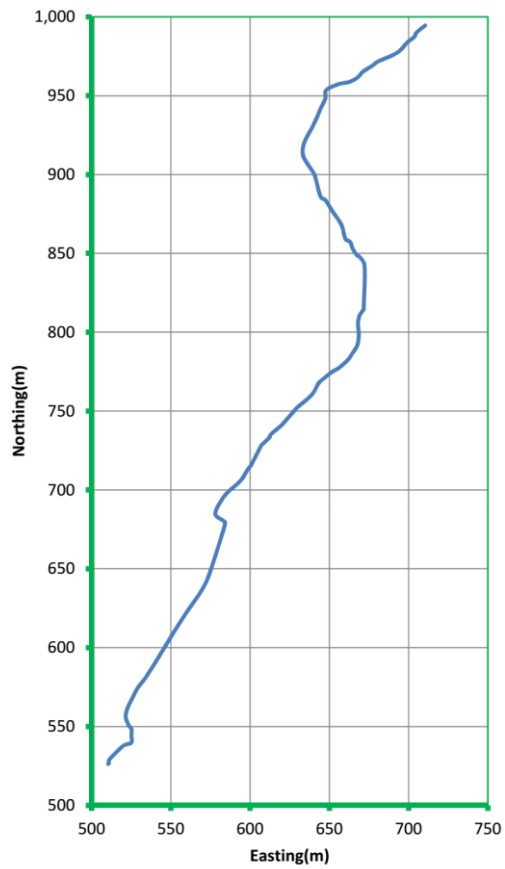
L-Section detail Point description	SN	Chainage CH (m)	Ground level GL (m)	Coordinate		Code	BOP level (m)	HGL (m)	HDPE Pipe Size/Type			Stattice head (m)	V (m/s)	Surge Check	Remark
				Easting (m)	Northing (m)				OD (mm)	Material	P. Class PN/SDR				
	70	471.770	479.022	640.207	900.788	CA97	477.242	489.168	280	PE100	06.0/26.0	20.188	1.92	Surge-OK!	
On Tashigang Yuwa	71	484.628	479.709	633.544	911.757	CA98	477.929	488.894	280	PE100	06.0/26.0	19.501	1.92	Surge-OK!	
Along Tashigang Yuwa	72	493.398	479.742	634.339	920.491	CA99	477.962	488.708	280	PE100	06.0/26.0	19.468	1.92	Surge-OK!	
Along Tashigang Yuwa	73	504.780	479.950	639.599	930.584	CA100	478.170	488.466	280	PE100	06.0/26.0	19.260	1.92	Surge-OK!	
Along Tashigang Yuwa	74	511.132	480.097	642.268	936.346	CA101	478.317	488.330	280	PE100	06.0/26.0	19.113	1.92	Surge-OK!	
Along Tashigang Yuwa	75	516.722	480.165	644.362	941.527	CA102	478.385	488.211	280	PE100	06.0/26.0	19.045	1.92	Surge-OK!	
Along Tashigang Yuwa	76	524.064	480.325	647.506	948.162	CA103	478.545	488.055	280	PE100	06.0/26.0	18.885	1.92	Surge-OK!	
Along Tashigang Yuwa	77	529.466	480.465	648.070	953.537	CA104	478.685	487.940	280	PE100	06.0/26.0	18.745	1.92	Surge-OK!	
Along Tashigang Yuwa	78	538.462	480.792	656.204	957.365	CA105	479.012	487.749	280	PE100	06.0/26.0	18.418	1.92	Surge-OK!	
Along Tashigang Yuwa	79	545.124	480.968	662.717	958.711	CA106	479.188	487.607	280	PE100	06.0/26.0	18.242	1.92	Surge-OK!	
Along Tashigang Yuwa	80	551.063	481.302	667.917	961.571	CA107	479.522	487.480	280	PE100	06.0/26.0	17.908	1.92	Surge-OK!	
Along Tashigang Yuwa	81	555.967	482.026	671.192	965.142	CA108	480.246	487.376	280	PE100	06.0/26.0	17.184	1.92	Surge-OK!	
Along Tashigang Yuwa	82	563.630	482.465	677.631	969.282	CA109	480.685	487.213	280	PE100	06.0/26.0	16.745	1.92	Surge-OK!	
Outlet-Right side	83	566.560	482.804	679.856	971.154	OTR2	481.024	487.151	280	PE100	06.0/26.0	16.406	1.92	Surge-OK!	
Along Tashigang Yuwa	84	571.356	483.051	684.191	973.192	CA110	481.271	487.048	280	PE100	06.0/26.0	16.159	1.92	Surge-OK!	
Along Tashigang Yuwa	85	577.919	483.236	690.248	975.728	CA111	481.456	486.909	280	PE100	06.0/26.0	15.974	1.92	Surge-OK!	
Along Tashigang Yuwa	86	583.611	483.386	694.964	978.905	CA112	481.606	486.788	280	PE100	06.0/26.0	15.824	1.92	Surge-OK!	
Along Tashigang Yuwa	87	590.341	483.444	699.425	983.943	CA113	481.664	486.644	280	PE100	06.0/26.0	15.766	1.92	Surge-OK!	
Along Tashigang Yuwa	88	595.816	483.669	703.740	987.298	CA114	481.889	486.528	280	PE100	06.0/26.0	15.541	1.92	Surge-OK!	
Along Tashigang Yuwa	89	598.737	483.733	704.974	989.945	CA115	481.953	486.466	280	PE100	06.0/26.0	15.477	1.92	Surge-OK!	
Tashigang Yuwa	90	605.910	483.956	710.519	994.493	CA116	482.176	486.313	280	PE100	06.0/26.0	15.254	1.92	Surge-OK!	



**Pipeline Hydraulic Design: *Ground Level, BOP Level and HGL***



**Pipeline: *Alignment Plan***



**Summary of Pipe Sizes by Pressure Class**  
**Bajo Irrigation Channel Siphon Project at Thanggo, Wangdue**

SN	Material	OD mm	Pressure Class			Velocity v m/s	Length L m	Cost		Weight	
			PN	kg/cm <sup>2</sup>	SDR			Rate Nu/m	Total Nu	Unit wt. kg/m	Total kg
1	PE100-PN06.0-SDR26.0-OD0280	0280	PN06.0	06.0	SDR26.0	1.92	605.91	1,362.58	825,600.85	9.21	5,578.37
2											
3											
4											
5											
6											
7											
<b>Total</b>							<b>605.91</b>		<b>825,600.85</b>		<b>5,578.37</b>

***Glimpse of the Activity:***



***Trench dug by local community***



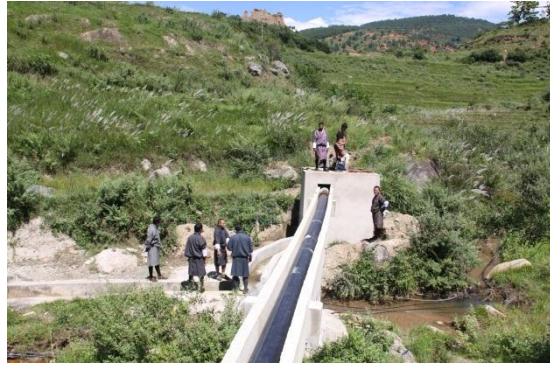
***The intake structure being built***



***Foundation of outlet structure***







Completed structures



Handing over the irrigation project to the communities