Draft

Fish Conservation Management Plan in Seti & Madi River
Tanahu Hydropower Project

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Summary

Construction of dam in Seti River and diversion of its water for electricity generation will create adverse impact on the aquatic resources. It includes blockage of fish migration, loss of microorganism detraction of fish habitat in the downstream and resultant effect on spawning ground of fish. Considerable loss of fish population will be caused due to attraction of fish to the intake and penstock. Eventually fish population will be affected, adversely. Several measures have been proposed to mitigate these adverse impacts of the project. These measures include:

i. establishing a hatchery where water input temperatures are appropriate, for rearing juveniles of the vulnerable fish species, for stocking in the reservoir, especially at the western end, where spawning and rearing habitat will still be available to these species, and in adjacent rivers;

ii. experimentation of a "catch and haul" system in which adult migrating fish are caught (before spawning) below the dam and released at the western end of the reservoir; and also be used as future brood in the hatchery;

iii. fish habitat protection throughout the Seti reservoir catchment and in the Madi River catchment, through effective conservation of breeding and rearing grounds of targeted fish species through legal protection along with water quality monitoring and management, associated with public awareness-raising and education; and,

iv. The minimum required environmental flow (2.4 m^3 /sec) will be released to maintain the downstream aquatic resources.

Detailed work plan for each measure with proper responsibility has been developed. Working schedule for each activity under above mentioned measures is proposed. The schedule covers a ten years' time period. The activities will start from September of the year 2018 and will be continued until the year 2028. Activities are proposed for mitigation of adverse impact on fish fauna during pre-construction, construction and operation phase.

Abbreviations

ADB	Asian Development Bank
AFU	Agriculture and Forestry University
BOD	Bio-chemical Oxygen Demand
CCRF	Code of Conduct for Responsible Fishery
COD	Chemical Bio-oxygen Demand
DNPWL	Department of National Park and Wild Life
DoFD	Directorate of Fisheries Development
EIA	Environmental Impact Assessment
EMP.	Environmental Management Plan
ESMU	Environmental and Social Management Unit
ESSP	Environmental and Social Service Provider
FAO	Food and Agriculture Organization of the United Nations
GoN	Government of Nepal
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
MoLMAC	Ministry of Land Management, Agriculture and Cooperation
NARC	Nepal Agriculture Research Council
NEFIS	Nepal Fisheries Society
NGO	Non-Government Organization
NTNC	National Trust for Natural Conservation
SEA	Strategic Environmental Assessment
THL	Tanahu Hydropower Limited
WWF	World Wild Life Fund

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1 Introduction

1. As it is well accepted standard that species and ecosystem have intrinsic value. They should be conserved in their own right, as well as to provide benefits to human. Some of the main environmental concerns associated with the Tanahu Hydropower Project include the blockage of fish migration in the Seti River, caused by the dam, and the risk of degradation of fish habitat in both the reservoir and the immediate areas downstream of the tailrace (in the Madi River), as well as in the short run of the Seti River before the confluence with the Madi River (about 2 km); these are all documented in the Project. The fish species at risk do occur throughout Nepal, albeit with various levels of status (from commonly occurring, to endangered), but that does not diminish the need for a concerted fish conservation management plan in the vicinity of the Tanahu dam and reservoir, as fish populations in Nepal face obstacles at other hydropower locations in the country. The barrier effect of dam restricts seasonal fish migration to the upper reaches for spawning and in search of food, and returning back downstream. Besides, the intake structure on the right bank might cause entrapment and impingement to the fish. Juveniles will be attracted to the penstock. High velocity will even force the small fish into the intake. It will cause considerable loss to the fish population. It is widely observed that the barrier effect is responsible for the sharp decline in the fish population in the rivers. The situation has become seriously concerning as every river of Nepal has proposals to develop hydropower plants in series by damming of the river. However, in the absence of baseline information on the interlinked migration of fish in the rivers, the government does not have any clue of the cumulative impact of unplanned damming of river on the critical aquatic biodiversity. Strategic environmental assessment (SEA) of the hydropower and irrigation development policy and master plan has not been conducted to analyse the cumulative impact due to damming of the rivers on the populations of migratory fish species.

2. The objective of the projected plan described below is therefore to safeguard adequate quality of fish habitat in the areas adjacent to the project site and to intervene to maintain stocks of migratory and at-risk fish species in the reservoir and upstream areas in the Seti River. The approaches described below are based on a thorough understanding of the fish resources currently in the Seti River (above and downstream of the confluence with the Madi River) and a review of the most practical and successful approaches for fish conservation associated with hydropower projects in similar settings (in Nepal and elsewhere). The plan includes declaration of the specific issues, the proposed objectives and outcomes of the fish conservation management plan, the approach and methodology, implementation arrangements, schedule, and consulting packages.

2 Context, Project Design and Activities, and Potential Residual Impacts on Seti River Fish Populations

3. The basic features of the Tanahu hydropower project, as they pertain to fish populations in the Seti Basin are shown in Figure 1. The dam, with a height of 140 meters, will obstruct upstream migration of fish, and will create a reservoir that is slightly more than 100 meters deep at the dam face. The reservoir will extend about 18 kilometres west of the dam site, with an area of 7.26 km2. It will inundate fish spawning and rearing areas along the Seti River for most of the year. The expected hydraulic regime of the Tanahu dam and reservoir is shown in Table 1. The minimum required environmental flow will be 2.4 m3/sec. This will address the short section of the Seti River before the confluence with the Madi River. From that point downstream, the Madi River discharge more than adequately compensates for the reduced flows from the Seti River, making up about half of the combined discharge that would normally be experienced after the confluence of the two rivers. From the tailrace outflow area, river discharge rates will be more than adequate for fish passage, due to the Madi River discharge and the release from the Seti Reservoir (see Table 1). The reservoir will be drained each June, to flush sediments, and then will be filled again over a period of days. The reservoir will therefore not only have fluctuating water levels, but will revert from a relatively static water body (which has implications for resident

fish populations) to its original state (a flowing river) near the middle of the monsoon each year. This is the context which fish populations in the Seti River will encounter.

4. In addition to the change in the hydraulic regime of the Seti River (which will affect the nature of fish habitat), and the blocking of fish migration, the water quality above and below the dam will likely be affected. For example, during the filling and storage of water in the reservoir, accumulated sediments and nutrients will build up in the reservoir, with a risk of low oxygen levels in deeper parts of the reservoir. In addition, during draining of the entire reservoir over 10 days in mid-to-late June, the released water will be cooler (possibly 4-7°C) and will probably have lower dissolved oxygen levels than the natural Seti River flows expected in mid-June (generally 20-24°C). The release water may also contain higher levels of phosphorus (see the Environmental Addendum 2012, EIA, Volume 1 for more specific details on the possible water quality changes in the reservoir). These possible changes will occur in the context of current seasonal variability in the Seti River, in any case, a situation that local fish species have probably adapted to. For example, Seti River water quality is seasonally variable, ranging from highly turbid during the monsoon season (June-September), and relatively clear during the remainder of the year, apart from storm water runoff that is usually turbid. Water temperature ranges from 15°C in winter to a high of around 24-27°C in the hot late dry season in May. The water is slightly alkaline, and Bio-chemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values reflect relatively good water quality, with minimal organic and chemical inputs (which in turn reflects low population density in the watershed and lack of industrial activity).

Figure-1: Tanahu Hydropower Project: Reservoir Area, Dam site, Tailrace location

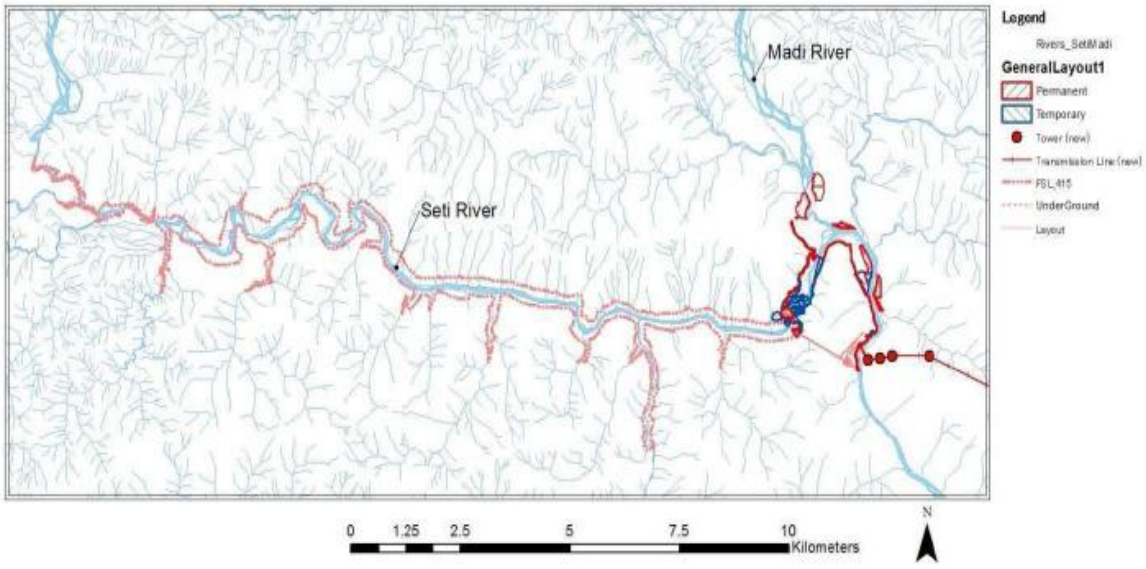


Table 1. Average Monthly Seti River Flow Rate: Existing and with Project Operation (in the first ten years; subsequent to that, annual flushing will be spread out over 40 days in June/July, which will affect the average operation flow rates in those months).

Month	Existing Flow Rate (m^3/s)			Project Operation Flow Rate (m^3/s)					
	Seti River	Madi River	Total	Spill Flow	Generation Release	Environmental Release	Total	While Generating	Not Generating
Jan	26.2	23.0	49.2	0	127.1	2.4	129.5	152.6	25.4
Feb	22.9	20.1	43.0	0	125.4	2.4	127.8	147.9	22.5
Mar	22.9	20.5	43.4	0	122.6	2.4	125.0	145.5	22.9
Apr	26.1	24.0	50.1	0	117.8	2.4	120.2	144.1	26.4
May	41.6	38.5	80.1	0	119.2	2.4	121.6	160.1	40.9
Jun	119.5	102.7	222.2	123.6	120.0	2.4	246.0	348.8	228.8
Jul	290.3	259.9	550.2	287.9	0	2.4	290.3	550.2	550.2
Aug	319.5	278.6	598.1	122.8	119.5	2.4	244.7	523.3	403.8
Sept	227.1	168.4	395.5	97.1	127.4	2.4	226.9	395.3	267.9
Oct	110.6	88.5	199.1	8.6	127.4	2.4	138.4	226.9	99.5
Nov	51.9	43.9	95.8	0	127.4	2.4	129.8	173.7	46.3
Dec	33.5	29.4	62.9	0	127.4	2.4	129.8	159.1	31.8

5. The Seti River is one of the major tributaries of the Trisuli River that drains the central and eastern parts of the Gandaki River basin of the Nepal Himalaya. The Seti River comprises approximately 14% of the Gandaki Basin area and around 11% of the total volume of basin river runoff (Fig. 2). The Seti River is therefore part of the drainage network that provides habitat conditions suitable for fish, both resident species and migrating fish species of the Gandaki River system.

6. The Seti River supports both warm and cold water fish, similar to other drainage networks of the Gandaki Basin (Trisuli, Marsyangdi, Madi, Kaligandaki). Warm water fish species migrate upstream from the Narayani River into the Trisuli, Seti and other rivers to spawn at the onset of the monsoon (June), leaving the eggs and fingerlings in the upstream stretches of these river networks. Cold water fish, however, are confined to the upstream stretches of these rivers, only moving locally upstream and downstream over a limited range, depending upon the rise and fall of water temperatures and flows. The aquatic ecosystem values of the Seti River are similar to other rivers of the Gandaki Basin system, in terms of species diversity and ecological status. In recent years, however, with the rapid expansion of Pokhara, Lekhanath, Bhimad, and Damauli townships in the middle and upstream sections of the Seti River, the ecological status of the river, for fish species, has been greatly compromised due to urban activities, particularly from the discharge of untreated sewage and solid waste. As a result, the middle and upstream sections of the Seti River (above where the reservoir will be located) may not continue to provide pristine fish habitat. On the other hand, the Madi River, which joins the Seti River about 2 km downstream of the dam site, has a catchment free of large urban areas and hence provides better quality habitat for aquatic life found in this river basin, including IUCN Red List species (discussed below). A key part of the Fish Conservation is to commit to protection of the Madi River habitat, as partial compensation for any constraints on fish population in the Seti River, which are already possibly being compromised by urban growth.

Figure-2: Location of Seti River in the Gandaki Basin.

7. Present study indicated that there are at least 69 fish species in the Seti River (Table 2). The most dominant fish species in the Seti River are ***Neolissochilus hexagonolepis*** (copper mahseer, a short- to mid-range migrator), ***Barilius bendelisis*** (Chiple faketa), ***Garra annandalei*** (Lahare buduna), ***Labeo pangusia*** (ghora muikkha), ***Garra gotyla*** (sucker head), and ***Tor putitora*** (putitor mahseer; a long-distance migrator). Other long-distance migratory fish found in the Seti River system include ***Anguilla bengalensis*** (Indian mottled eel), ***Bagarius yarrelli*** (giant devil catfish, or goonch), ***Tor tor*** (mahseer), and ***Clupisoma garua*** (Jalkapur). There are also other short- to mid-range migratory species, including ***Schizothorax progastus*** (dinnawah snowtrout), ***Labeo angra*** (angra labeo), and ***Labeo dero*** (gardi). There are six IUCN Red Listed species (Table 3) in the Seti River, which are also present in other locations in Nepal (in the Gandaki Basin and in a Sapta Koshi River System in the Eastern Nepal, and the Karnali River System. Among the reported fish species, ***Schizothorax richardsonii*** and *Anguilla bengalensis* (Raja bam) were not caught in the project area during present sampling from July 2017 to June 2018 (Table 2). Absence of raj bam ***Anguilla bengalensis*** may be due lack of appropriate fishing gear ((hook & line is an appropriate method to catch this species-personal communication to Lum Bahadur Kumal, the local fishermen). Mostly gill net, caste net and deep nets were used for regular sampling. Abiotic factors such as altitude and temperature ranges of Site River in the reservoir area are probably responsible for the absence of *Schizothorax richardsonii* in the samples of present survey.

Table 2. List of Fish Species Recorded in Seti River

S. N.	Fish species		Present	EIA-JICA	Jha	EIA	John	Local
			2017/18	2006	2006	2001	1986	Info.
	Scientific Name	Local Name	A	B	C	D	E	F
1	*Anguilla bengalensis* (Gray)	Raj Bam	-		-	-	-	*
2	*Chagunius chagunio (Hamilton-Buchanan)*	Rewa/Gadhini	*	*	-	*	-	
3	*Cyprinon semiplotus (McClelland)*	Khurpe/Chepti	-	-	-	*	-	*
4	*Labeo angra (Hamilton-Buchanan)*	Thed	-	*	-	-	-	*
5	*Labeo dero (Hamilton-Buchanan)*	Gardi	*	*	-	*	-	
6	*Labeo dyocheilus (McClelland)*	Gardi	*		-	-	-	
7	*Labeo fimbriatus (Bloch)*	Gardi	*		-	-	-	
8	*Labeo pangusia (Hamilton-Buchanan)*	Rewa	*		-	-	-	

S. N.	Fish species		Present	EIA-JICA	Jha	EIA	John	Local
			2017/18	2006	2006	2001	1986	Info.
	Scientific Name	Local Name	A	B	C	D	E	F
9	*Neolissochilus hexagonolepis (McClelland)*	Katle	*	*	*	*	*	
10	*Puntius conchonius (Hamilton-Buchanan)*	Pothiya/Sidra	*	*	*	*	-	
11	*Puntius guganio (Hamilton-Buchanan)*	Pothiya/Sidra	*					
12	*Puntius sophore (Hamilton-Buchanan)*	Pothiya/Sidra	*		*	-	-	
13	*puntius terio (Hamilton-Buchanan)*	Pothi	*		-	-	-	
14	*puntius ticto (Hamilton-Buchanan)*	Vitte/Pothiya	*		-	-	-	
15	*Tor putitora (Hamilton-Buchanan)*	Sahar	*	*	-	*	-	
16	*Tor tor (Hamilton-Buchanan)*	Sahar	*	-	-	*	-	-
17	*Salmostoma acinaces (Valenciennes)*	Silver belly	*		-	-	-	
18	*Aspidoparia morar (Hamilton-Buchanan)*	Karangi / Tilwa	*					
19	*Barilius barila (Hamilton-Buchanan)*	Faketa	*	*	*	*	-	
20	*Barilius barna (Hamilton-Buchanan)*	Faketa	*	-	-	*	*	*
21	*Barilius bendelensis (Hamilton-Buchanan)*	Faketa	*	*	*	*	*	
22	*Barilius radioatus (Gunther)*	Faketa	*		-	-	-	
23	*Barilius shacra (Hamilton-Buchanan)*	Faketa	*		-	-	-	
24	*Barilius tileo (Hamilton-Buchanan)*	Faketa	*		-	-	-	
25	*Barilius vagra (Hamilton-Buchanan)*	Faketa	*		*	-	-	
26	*Brachydanio rerio (Hamilton-Buchanan)*	Chithari pothi/Sidra	*		*	-	-	
27	*Danio dangila (Hamilton-Buchanan)*	Pothi	-		*	-	-	
28	*Esomus danricus (Hamilton-Buchanan)*	Dedhwa	*		-	-	-	
29	*Schizothoraichthys progastus (McClelland)*	Chuchhe Asla	*		*	*	-	
30	*Schizothorax plagiostomus (Heckel)*	Buchhe Asla	-	-	-	*	*	
31	*Schizothorax richardsonii (Gray)*	Buchhe Asla	-	*	-	*	*	
32	*Crossocheilus latius (Hamilton-Buchanan)*	Lohari	*		-	-	-	*
33	*Garra annandalei (Hora)*	Buduna/ Naktuwa	*	*	*	*	-	
34	*Garra gotyla (Gray)*	Buduna	*	*	*	*	*	
35	*Gara mullya (Sykes)*	Buduna	*		-	-	-	
36	*Psilorhynchus pseudecheneis (Menon & Datta)*	Buduna/Tite	*		-	-	-	*
37	*Acanthocobotis botia (Hamilton-Buchanan)*	Gadela/Baghi	*	-	*	*	*	*
38	*Nemacheilus corica (Hamilton-Buchanan)*	Rai Gadelo	*		-	-	-	
39	*Schistura beavani (Gunther)*	Gadela	-	-	*	-	*	*
40	*Schistura rupecola (McClelland)*	Gadela	-	*	*	-	-	*
41	*Schistura savona (Hamilton-Buchanan)*	Gadela	*	*	-	-	-	
42	*Botia almorhae (Gray)*	Baghi	*	*	-	*	-	

S. N.	Fish species		Present	EIA-JICA	Jha	EIA	John	Local
			2017/18	2006	2006	2001	1986	Info.
	Scientific Name	Local Name	A	B	C	D	E	F
43	*Botia geto (Hamilton-Buchanan)*	Baghi	*		-	-	-	
44	*Botia lohachata (Chaudhari)*	Baghi	*		-	-	-	
45	*Mystus tengara (Hamilton-Buchanan)*	Tangra	*	*	-	-	-	
46	*Clupisoma garua (Hamilton-Buchanan)*	Jalkapur	*	*	-	-	-	*
47	*Clupisoma montana (Hora)*	Jalkapur	*		-	-	-	
48	*Amblyceps mangois (Hamilton-Buchanan)*	Bijjur	*	*	-	*	*	
49	*Bagarius bagarius* (Hamilton-Buchanan)	Gonch	-		-	-	-	*
50	*Bagarius yarrelli (Sykes)*	Gonch	*		-	-	-	
51	*Gagata cenia (Hamilton-Buchanan)*	Gagata/ Tyangra	*		-	-	-	
52	*Glyptosternum blythii*	Til-Kavre	-	-	-	-	*	*
53	*Glyptothorax alaknandi Tilak)*	Kavre	*		-	-	-	*
54	*Glyptothorax annandalei (Hora)*	Kavre	*		-	-	-	*
55	*Glyptothorax cavia (Hamilton-Buchanan)*	Vedro/Kapre	*	*	-	-	-	*
56	*Glyptothorax garhwali (Tilak)*	Katanga/ Kapre	*					
57	*Glyptothorax gracilis (Gunther)*	Katanga/Kapre	*		-	-	-	*
58	*Glyptothorax pectinopterus (McClelland)*	Kavre	*		-	-	-	*
59	*Glyptothorax telchitta(Hamilton-Buchanan)*	Kavre / Katana	*	*	-	-	-	*
60	*Glyptothorax trilineatus(Blyth)*	Til-Kavre	-	*	-	-	-	
61	*Myersglanis blithy(Day)*	Kavre / Katana	-		*	-	-	
62	*Pseudecheneis sulcatus (McClelland)*	Kavre / Chyabri	*	*	*	-	*	
63	*Hetropneustes fossilis (Bloch)*	Kavre / Chyabri	-		*	-	-	
64	*Mastacembelus armatus(Lacepede)*	Chuchche Bam	*	*	-	*	-	
65	*Oreochromis niloticus (Linnaeus)*	Nile Tilapia	*		-	-	-	
66	*Channa barca (Hamilton-Buchanan)*	Hile / Bhoti	*					
67	*Channa orientalis (Bloch & Schneider)*	Hile / Bhoti	*	*	*	*	*	
68	*Channa punctatus* (Bloch)	Hile	-	*	-	-	*	
69	*Channa striatus (Bloch)*	Hile	*		-	-	*	*
	Total		**55**	**24**	**18**	**20**	**14**	**19**

A= Present Study-2017/18, B= EIA Survey- JICA-2006, C= PH.D. Study-B.R. Jha-2006, D= EIA Study-2001, E= Reported by- John-1986, F= Local Information in different survey

8. Most migratory species migrate upstream at the start of monsoon (May through June) and migrate downstream towards the end of the monsoon (September through November). River hydrology (the flow regime) and temperature is the basic factors that influence fish migration, which coincides with the general spawning season of the long-

distant migratory fish. Immediately after upstream migration, most fish species spawn in the clean, oxygenated waters of tributaries then migrate downstream as river/stream flows reduce in the late monsoon. Mid-distant migratory fish also spawn in the monsoon season; however some species, particularly ***Schizothorax*** species, spawn in the early pre-monsoon period (March-April), as snow ion high altitudes melts.

Table 3. IUCN Red List fish species present in the Seti River system.

Scientific Name	Nepali Name/ English Name	Present Study	Reported by John 1986	NEA Survey 2001	EIA Upgrade Survey 2006	PPTA Survey 2011	Migratory Status	IUCN Red List Category	Global Status
Tor putitora	Pahelo Sahar / putitor mahseer	*	-	*	*	*	LD	EN	EN
Schizothorax richardsonii	Asala / snowtrout	-	-	-	*	*	MD	VU	VU
Bagarius yarrelli	Gounch /giant devil catfish	*	-			*	LD	NT	NT
Neolissochilus hexagonolepis	Katle / copper mahseer	*	*	*	*	*	MD	NT	NT
Tor tor	Sahar /mahseer	*	-	*	*	*	LD	NT	NT
Labeo pangusia	Rewa /ghora muikkha	*	-	-	-	*	R	NT	NT

LD: *long distance migratory species;*

MD: *mid-distance migratory species.*

R: *locally resident species.*

EN: *Endangered - a taxon is endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.*

VU: *Vulnerable - a taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.*

NT: *Near Threatened - a taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.*

(Source: IUCN Standards and Petitions Subcommittee. 2010. Guidelines for Using the IUCN Red List Categories and Criteria. Version

9. The main impacts of the project on fish populations in the Seti River will be as follows:

i. the creation of a barrier preventing upstream and downstream fish migration throughout the year (those species noted above), with possible long-term effects on migratory fish populations and overall fish species diversity;

ii. annual draining of the reservoir that could reduce immediate downstream water temperature over 10 days (in the first ten years) and 40 days each year thereafter (in the mixing area at the tailrace), and will revert the reservoir to a temporary river flow

system (through the sediment flush gates);

iii. replacement of lotic (moving river water) fish species by lentic (relatively still water) fish species in the reservoir stretch (18 km) of the Seti River, with annual stresses on this potentially new fish assemblage caused by annual reservoir flushing (new lentic fish populations may not be stable, as some of these fish will be flushed out during the June reservoir-emptying program);

iv. a reduction of fish between the dam and Madi River confluence (however, in a short stretch of about 2 km); and,

v. possible downstream water quality change (primarily a reduction in temperature during annual flushing, along with increased suspended sediment levels) due to reservoir operation. This also includes a reduction in the nutrient base supplying downstream river sections due to reservoir trapping of organic matter, with possible implications for fish populations and species diversity.

10. The opening of the dam to natural flows over a 10-day period (Years 1-10) and then over 40 days (Year 11 onwards), starting in late June each year after the reservoir has been drained, will create a short "Window" for natural migration of the fish during this early monsoon period (but perhaps just fingerlings moving downstream, rather than mature fish going upstream, given the head difference between the gate and the river bed). Reservoir draining, which will release between 298 and 1,048 m3/s over a 10-day period via the middle and sediment flushing outlets, will release colder water, possibly with lower dissolved oxygen levels, downstream, but in an area that will have been compromised by dam operation anyhow. It is expected that re-oxygenation of the water will occur rapidly in the stream riffles and river bends just below the dam, which will also help with mixing and temperature equilibration over a fairly short distance, before this water enters the Madi River at the confluence (it is also proposed that a boulder field be examined, to enhance re-aeration of the release water).

11. Those fish species which already exist upstream from the dam site will continue to have access to the full range of required habitats (see Figure 2), which indicates that there is an additional 70-80 km of upstream tributaries and river bifurcations which can accommodate short- and medium-range migratory fish). In particular, the copper mahseer (*Neolissochilus hexagonolepis*) and snow trout (*Schizothorax richardsonii*) will continue to have scope in a relatively large river habitat. The migration and upstream access to spawning grounds by the mahseer (*Tor Tor*), golden mahseer (*Tor putitora*), and giant devil catfish (*Bagarius yarrelli*, long-range migrators) will be obstructed, except when the dam is open to natural flows in June of each year (although still facing a challenge to make it through the gates). These fish species, which also occur in the Madi River, will need protection along with their habitat, in compensation for potential losses in the Seti River.

3 Objectives and Expected Outcomes of the Fish Conservation Management Plan

12. The main concern with the Tanahu Hydropower project, with regard to fish populations, is the obstruction of migration of the long-ranging species. Therefore, the main effort in the proposed fish conservation management plan is to ensure that these migratory species (*Tor putitora, Bagarius yarrelli, Tor tor*) continue to have some form of access to areas upstream from the Seti dam and that their access to spawning and rearing areas on the Madi River upstream from the Seti-Madi confluence is fully guaranteed for the foreseeable future, as a compensation (offset) measure. This will require:

i. establishing a hatchery where water input temperatures are appropriate, for rearing juveniles of the vulnerable fish species, for stocking in the reservoir, especially at the western end, where spawning and rearing habitat will still be available to these species, and in adjacent rivers;

ii. experimentation of a "catch and haul" system in which adult migrating fish are caught (before spawning) below the dam and released at the western end of the reservoir;

iii. fish and their habitat protection throughout the Seti reservoir catchment and in the Madi River catchment, through formulation of appropriate legislation with by-laws (directions),effective land use management, water quality monitoring and management, and associated public awareness-raising and education; and,

13. The EIA Addendum 2012 (Vol. ii) suggested a fourth activity in addition to these three activities, which was the installation of a fish pass/fish ladder, should be examined in more detail. The task to examine the feasibility and practicality of a “switchback” fish pass is included in the scope of work for a consultancy which is currently being tendered. Without prejudice to the outcome of this examination this Fish Conservation Management Plan we assume that for the specific case of Tanahu dam and HPP, the operation of a fish ladder/pass is unlikely to be successful. We assume that the fish pass will be found technically and/or economically unfeasible and therefore recommend that the project concentrates its resources on the more promising and cost-effective activities i) to iii). Installation and successful operation of a fish pass through Tanahu dam appears not practical for the following reasons.

14 A functional fish ladder would have to be constructed in a way that makes it possible for fish during their upstream migration to find the entrance point, overcome the elevation difference and reach to the upstream waters. This would have to be achieved without significant loss of time and energy for the migrating fish, and without causing them additional stress or exposing them to dangers. For the Tanahu dam, such conditions are not likely to be achieved, due to:

i. Height of the dam, which creates +140 meter gradient between upstream and downstream reaches and would require a very long fish ladder (>2.0 km). The climb would cost the fish significant additional time and energy, creating unfavourable conditions for fish migration.

ii. It appears doubtful that the fish would find the entrance to the fish pass. Given that only a small volume of water would be flowing over the fish pass, the migratory fish would be much more likely to follow the stronger current of the Madi river at the confluence point. Fish will always choose the bigger volume and well oxygenated water for migration. Madi river will be an attractive option of the fish. They never prefer narrow channel for migration.

iii. During their passage through the fish ladder, fish would be more exposed to their predators, including human fishers.

15 Moreover, the fish pass will require additional water release from the reservoir in addition to proposed 2.4 cubic meter/second environmental flow, and the construction of the long pass (>2.0 km) will require additional land acquisition, causing additional forest losses. Both factors will also affect the economic outcomes of the project negatively.

16 To establish the feasibility of a biodiversity offset for the endangered migratory fish species, an analysis of options to establish a fish habitat reserve or protection area will be undertaken (with a priority focus on the Madi River). This will inform the design of a fish habitat offset, providing suitable habitat for the protection of migratory fish species and their spawning grounds. The fish habitat offset design will be prepared through appropriate consultation with the Government of Nepal and other relevant stakeholders. Following agreement on the design, the fish habitat offset will be established as part of the EMP.

17 The expected outcomes of the fish conservation management plan include:

i. measurable continued presence (although possibly diminished) of viable populations of long-ranging fish species (those on the IUCN Red List) in the area upstream from the Seti dam (determined through regular monitoring);

ii. measurable stable populations of these long-ranging fish species in the Madi River system upstream from the Seti-Madi confluence (monitored as above, along with habitat quality assessment);

iii. alternatives are explored and implemented to enhance the population of endangered fish species in other favourable habitat conditions within Nepal's River System; and

iv. increased understanding and capacity of local residents to protect fish habitats and to exploit the fisheries in sustainable manner, with a reduction in use of illegal fishing methods.

4 Rationales for Proposed Approach

18 Experience at other hydropower dam sites indicates that a multi-pronged approach in a fish conservation management plan can be successful (for example, salmonid and bass migration in obstructed rivers in Sweden and North America). These approaches include protection of fish habitat, enhancement of fish movements where feasible (fish pass, as well as a catch-and-haul program), and hatchery subsidies to the natural population. Considering the unlikelihood of functioning of fish pass (as mentioned above) at the existing geographical situation, remaining three measures (Fish hatchery, Catch and Haul and Fish habitat protection) are proposed in present Fish Conservation Management Plan.

19 Establishment of a fish hatchery is one of the common measures for mitigating the impact of dam on the native fish. Hatchery can play an important role in fish conservation. With regard to hatchery subsidies to natural fish populations, the experience at the Kali Gandaki, Trishuli and Pokhara Fish Hatchery has been quite well documented, and indicates that at least *Tor putitora*, *Schizothorax richardsonii*, and *Neolissochilus hexagonolepis* (as well as several other species, such as *Labeo pangusia*), can be spawned and reared in a hatchery (for example, 202,000 fingerlings of these species were raised and released in one of the first years of operation of the Kali Gandaki Fish Hatchery).*Tor tor* is under domestication there, but has not been bred yet. This indicates that concerns for at least four of the five IUCN Red List migratory fish species can be addressed through the proposed hatchery program. There are no conclusive data for hatchery rearing of *Bagarius yarrelli* (giant devil catfish), which is apparently a long-distance migratory fish, so this species needs more attention in the proposed hatchery program (it has been domesticated at the Kali Gandaki hatchery, but not yet bred).

20 *Catch and Haul* is an alternative mitigation measure for maintaining fish populations in upstream reaches where passage of fishes is blocked by dam. Trapping and transportation could be a more long-term measure in the case of dams where the construction of a pass would be impractical. In this mechanism, a collection facility below the dam will be developed to hold fish, which will be later, transported and release at upstream to reach their feeding or breeding grounds. This method is labour intensive and stressful to fish, which may increase their mortality. Nevertheless, if handled properly, this is one of the effective measures for mitigating the barrier effect of dam for conservation of important migratory fish species. Local fishermen will be used for the work. It will also generate employment to local fishers. Catch and haul will also be helpful to collect brood stock for the hatchery.

21 Most of the rivers of Nepal are inhabited by long and short distance migratory species. Different studies in the past have clearly indicated that fish population is adversely affected by blockage in the river system due to construction of dam. Reduction in fish populations is a cumulative effect of restriction in free passage due to construction of dam, illegal fishing, soil erosion, habitat destruction, water pollution, river bed mining, and nutrient from agriculture fields, and industrial effluents discharged without treatment. Maintenance of north –south biological connectivity between tributaries of the of river basins, declaration of certain important river stretches as aquatic life conservation area and implementation of in-situ and ex-situ conservation plan for threatened and economically valuable species are the

reasonable measures to mitigate the adverse effect of the dam on fish fauna. Since most of the fish species and other environmental parameters are common to Seti and Madi, successful conservation of Madi fish habitat will definitely compensate the population depletion of fish in Seti due to formation of dam. However, achieving the conservation of the Seti –Madi river will require long term concerted actions of a range of stakeholders whose decisions and activities influence the status of Madi river. It is proposed that Tanahu HPP shall make best efforts to identify, initiate, support and sustain such actions of the relevant stakeholders. Specific activities and methodologies for above mentioned mitigation measures are described below.

22 Throughout the duration of implementing the Fish Conservation Management Plan, an aquatic ecology monitoring program will be implemented, by which the baseline conditions and changes during project implementation and operation will be recorded. This will include long term monitoring of fish population, habitat conditions, water quality, and fishing pressure, and will measure the changes due to project impacts as well as the outcomes of the mitigation measures.

5 Activities and Methodology

23 **Proposed Fish Hatchery for Migratory Species**: The proposed fish hatchery is a key feature of the fish conservation management plan. It will comprise several steps to ensure that it is effective in supplementing the natural populations of migratory fish in the Seti River area. Steps which have been undertaken to date include the identification of potential hatchery sites and study of site conditions. Remaining steps include:

i. Confirming the appropriate hatchery techniques for the target species (*Bagarius yarrelli, Tor putitora, Schizothorax richardsonii, Neolissochilus hexagonolepis*, *Labeo pangusia* and *Tor tor*);

ii. THL to take decision to finalize the most suitable site for establishment of the fish hatchery;

iii. Detailed survey and procurement of the land;

iv. Detailed design and cost estimate of the hatchery complex;

v. Construction of the fish hatchery;

vi. Operation of the fish hatchery; and

vii. Annual distribution of fingerlings in the western reservoir area and in the rivers.

24 These steps are further described below.

25 Confirming the appropriate hatchery techniques: THL will select (within the scope of work for a consultancy which is currently being tendered) a qualified Hatchery specialist to examine and confirm the most appropriate hatchery techniques for the target species (*Tor putitora, Neolissochilus hexagonolepis*, *Tor tor*, and which have been spawned and reared at the Kali Gandaki hatchery, Pokhara hatchery and Trishuli Fish Hatchery, *Bagarius yarrelli* can be experimented with. Moreover, *Schizothorax richardsonii,* which was recorded in EIA, probably from upstream of the proposed reservoir was not observed throughout the year around sampling from 2017 to 2018 in the project area. Therefore breeding and rearing activities will be focused on the reaming four species. This initial work will involve review of the annual hatchery data and assessment of the most successful spawning and rearing methods of each of the target species, as well as detailed review of the relevant technical literature. Special attention will be paid to water temperature and quality as they pertain to successful fertilization of eggs and hatchery site for the Seti fish hatchery.

Field survey and identification of a fish hatchery sites:

Two potential hatchery sites have been identified. The basic requirements for the proposed hatchery such as size of land area, reliable water resources with suitable quality, proximity to the proposed reservoir, approach road and availability of electricity have been taken into consideration and found favourable.

Figure:3A Potential hatchery site 1

Figure: 3B Site-1

Site # 1: About 4 ha land for proposed fish hatchery has been identified within Byas Municipality area in ward no 2. This is very close to Seti River and proposed dam site. The land is situated between two streams namely Sange and Gunadi. In general the land seems suitable. However, detail investigation needs to be carried out. The soil texture of the land will also be examined before detail design and finalization of the hatchery site. Proposed hatchery site is shown in Fig. 3A and B.

Site # 2: Similarly, an alternative site has been identified in Bhimad Municipality. This site is located at Buduwa Fant adjacent to the upper end of the reservoir. It is connected with future inundated area of the reservoir (fig 3C). Water can be supplied from Buduwa stream but has to be shared with other farmers. In the meanwhile reservoir water could be pumped up for hatchery. Smooth quality water supply might be disturbed at times because of excessive silt and annual drawdown of the reservoir and sharing the stream water with other users.

Figure: 3C Site-2

The expert will review the proposed sites and select the best hatchery site for the target cold water fish species, based on their experience at Kali Gandaki and also Trisuli. Approximately 2.5-3 hectares is required for the proposed hatchery. The fish hatchery facility will consist of a hatchery complex, raceways, feed plant, training complex, laboratory facility, and office and residences (Figure 4). The design goal of the fish hatchery will be 30,000,000 eggs, 10,000,000 fry, and 2,000,000 fingerings (spread amongst the four species, on an annual basis; the physical set-up and timing to handle four species concurrently will have to be carefully determined).

26 The process of siting the fish hatchery will include:

i. selecting the optimal site on the basis of criteria for practicality of operation, ease in construction, cost, and minimal residual environmental and social impacts;

ii. preparing site layout drawings for the site

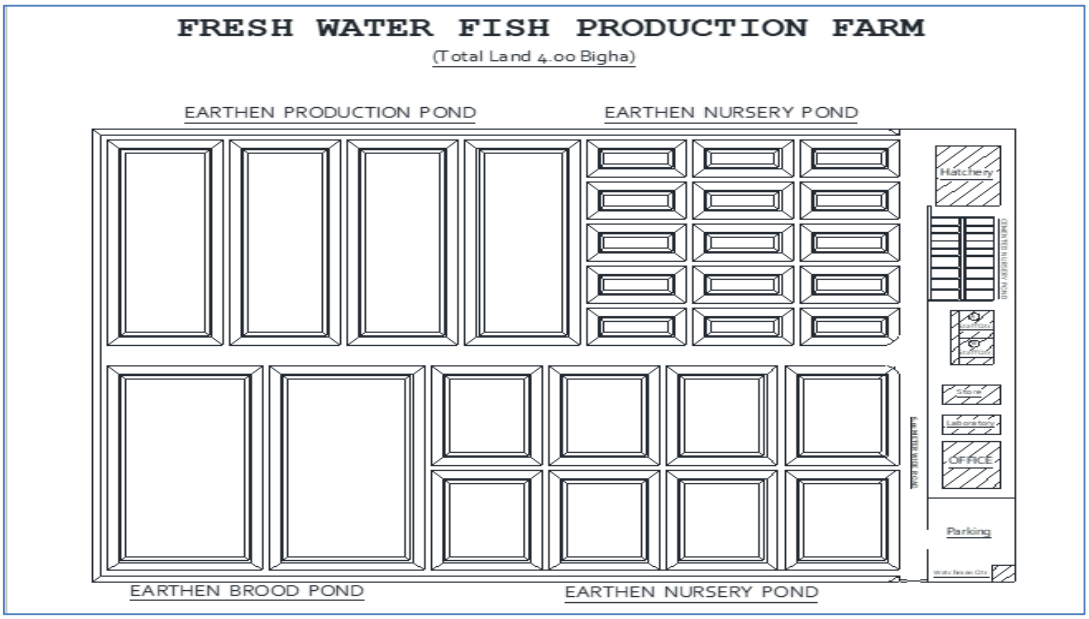
iii. examining land ownership and use at each site, and the possible requirements for compensation;

iv. undertaking an IEE and benefit-cost analysis for each of at least two sites;

v. detailed designing of the fish hatchery; and,

vi. acquiring the land.

Figure-4. Tentative layout of the Seti fish hatchery and the current hatchery.



21 Construction of the fish hatchery: Three years will be allocated for construction of the fish hatchery. The hatchery needs to be in operation for at least two years before the Seti River is impounded (so that fingerlings are available for the first year of the dam/reservoir operation). THL will contract out the construction work.

22 Hatchery operation: The Seti fish hatchery will be operated by the selected agency such as NARC or DoFD of Ministry of Agriculture, Land Management and Cooperatives. The hatchery operation (once constructed) will involve the following steps, in sequence:

i. preparing the organizational structure for the hatchery (identifying different functions, staff responsibilities, and time sequence of tasks);

ii. preparing the operational plan for the hatchery, including the catch-hatch-release schedule for each target fish species;

iii. integrating the Seti hatchery plan with the other hatcheries in Nepal, including establishing a fish procurement and selling plan;

iv. THL might hand over the hatchery complex to public sector agency (NARC/ MALMC) with a condition of fulfilling its original objectives;

v. purchase experimental instruments, technical equipment, consumables supply, reagents, and ingredients for fish food;

vi. set up a training program for the hatchery workers;

vii. testing all hatchery systems (electrical, water supply, pumps, filters, etc.); and,

viii. Exposing the Seti fish hatchery to the [public, through a series of "Open houses" in the few months of operation.

23 Routine operation of the Seti fish hatchery (regular production of fingerlings of the five target species) will involve the following activities:

i. catching the mature fish of each target species in the migration season, in the Seti and Madi Rivers, for bolstering of the fish domestication program;

ii. breeding these fish (extracting the eggs and fertilizing); raising the fingerlings at the hatchery;

iii. releasing the fingerlings of the five target species (IUCN Red List; at the upper end of the reservoir, at the western end of the Seti reservoir (for acclimatization to the reservoir), and in the Madi River;

iv. releasing the mature fish at the upstream end of the reservoir (for onward upstream migration);

v. providing fingerlings to other hatcheries in Nepal;

vi. releasing excess fingerlings to other degraded rivers in the vicinity;

vii. selling commercial fishes at the local fish market (those grown to maturity and in excess of hatchery needs);

viii. establishment and implementation of protocols for monitoring and preventing diseases within the fish hatchery;

ix. monitoring hatchery operations and fish stocks in the Seti reservoir, Madi River, and downstream areas below the tailrace (compared to a solid set of baseline data, to be collected in the 3-5 years before dam operation); and,

x. publishing annual reports and minutes of meetings with collaborating agencies.

24 While the hatchery systems for at least four of the five target species are quite well defined and tested, the effective release and survival of fingerlings is less well-known. Restocking a river or sub-basin with fingerlings produced in a hatchery needs careful planning (e.g., timing and location) to be effective in supplementing wild populations. There will therefore have to be on-going monitoring of both the natural and supplemented populations of the target species in the Seti reservoir, upstream reaches of the Seti River, and the Madi River. This will require field surveys, anatomical examination of fish, identification of spawning areas of the target fish species, detailed habitat survey in those locations (including water quality, current velocity, bottom sediments, vegetation, and so on).

25 The introduction of invasive fish species is a significant and recognized threat to the conservation of native fish species in Nepal. Attention will therefore be given to this issue, to ensure that invasive species are not introduced as a result of the project. To address this risk, and tied to the monitoring tasks noted immediately above, there will be active monitoring and management of invasive species (which will be identified and described in training sessions for project and hatchery staff). This will be supported with education and awareness-raising activities on invasive species for local communities as well. The objective is to ensure that the fish hatchery does not breed or introduce invasive species into the reservoir or any river systems in Nepal.

26 **Experimentation with "Catch and haul" system**: "Catch and haul" system will be implemented/ practiced as a back-up to the hatchery stocking plan described above. The point here is that unless it is tried and monitored, there is a risk that an alternative fish conservation measure may be abandoned unnecessarily.

27 The hatchery program will require the capture of mature target fish species for breeding. Catch and haul system will involve the following steps:

i. Identification of local advance fishing gears, collection tanks and transporting vehicles and fishing techniques;

ii. procurement of appropriate fishing, collecting and transporting equipment

iii. Orient the local fishers in catching live fish and handling and restocking them

28 This program can be expanded to ensure that additional specimens are caught below the dam and below the tailrace, maintained in tanks, then transported (by oxygenated truck

or by boat) to areas at the western end of the reservoir and released, in an area where these fish will encounter spawning and rearing habitat that is not directly affected by the reservoir. This approach would be one of the three prongs in the fish conservation management plan, but, as noted above, requires some experimentation and monitoring (involving tagging of released fish) before being assumed as a regular activity within the overall programme. If it proves to have merit, the catch and haul system can then be expanded with input from local people, which would involve paying a set price for mature specimens of each target species during the pre-spawning season only. This would require careful management (specified quotas) to avoid over-exploitation of individual species, which would then run counter to the overall intention of the program. The Catch and haul system can be managed in adjunct activity with the staff of proposed Seti fish hatchery. Related to this is the need to control fishing in general: to establish a compliance/enforcement system that reduces the incidence of electric and dynamite fishing (based on the existing Fisheries Regulations). Catch and haul method has been practiced in Kali Gandaki hydro power project

29 **Fish habitat protection in the Seti and Madi watersheds**: All the other initiatives in the Fish Conservation Management Plan can be optimized if there is a concerted effort to manage fish habitat in the rivers (Seti and Madi), reservoir, and upper reaches of the Seti, beyond the reservoir. Fish habitats can be optimized, as follows:

i. Reconnaissance mission will be assigned to assess the fisheries biology of targeted fish in Madi river (stretch above its confluence with Seti river) and Seti river above the proposed reservoir area to locate the breeding ground of targeted fish species. The mission will identify the sampling stations, parameter and general ecological condition of the river for regular sampling, The length of the river sections to be further studies will be determined by this mission.

ii. Further study will include mapping of suitable habitats, stresses on the fish habitats, fisheries activities, periodic monitoring of fish populations.

iii. Formulation of monitoring and control of point sources of water pollution, which will involve routine river and reservoir water quality monitoring (especially for BOD, total dissolved solids, coliform, dissolved oxygen, ammonia, nitrogen, and phosphorus); this will be undertaken at the identified sampling stations in Madi and Seti river at different depths and during different seasons;

iv. After gathering the biological/ecological information, priority fish habitat areas for future protection will be identified. Findings will be disseminated to concerned agencies like NARC, MoLMAC, Pokhara[1] and Kathmandu, NTNC, DNPWL, IUCN, WWF through a workshop.

v. Based on the findings and feedback from stakeholder consultations, a detailed Fish Habitat Conservation Plan, including proposed fish habitat offset designs, will be formulated and submitted to GON for approval and execution. Habitat conservation plan will address, among others:

vi. Solid waste control, which will involve establish an observation reporting system for disposal of solid waste into the river, onto the river bank, or into the reservoir; as above, this will require coordination with other agencies to ensure effective enforcement and on-going compliance with specified controls;

vii. management of river bed mining, with formulation of new regulations for licensing /permitting of mining activities, which will require periodic patrolling of the Madi and Seti sub-basins, especially in areas that are known to support spawning and rearing of the target fish species; and,

[1] According to new government structure Nepal has been divided into seven provinces with their own government. Tanahu Hydropower project area is located in Gandaki province, which has its own Ministry of Land Management Agriculture and Cooperative. The fishery belongs to this ministry.

viii. fish spawning and rearing habitat, physical features and conditions will be simulated with the design of shore protection work;

ix. Overall action plan to declare river stretches as protected areas will be developed and executed under the broad frame work of Aquatic Animal Protection Act 1961 and regulation for protection of aquatic animal by introducing aquatic biodiversity conservation and sustainable utilization;

x. Specific codes for fisheries management under the framework of FAO's Code of Conduct for Responsible Fisheries (CCRF) will be developed and introduced for controlling fishing efforts and the existing fish act and regulations will be strengthened through stronger community participation;

30 As a part and parcel of the Fish Conservation Management Plan, monitoring programs will be designed and implemented, by which the baseline conditions and changes during project implementation will be recorded. The survey programs for aquatic ecology will collect all relevant information to monitor fish populations and their habitats. The survey program shall cover at least, but will not be limited to, the following:

i. Fish habitats in Seti River system (including also the reservoir after its formation) and Madi River system (identification, delineation on maps, description of relevant characteristics and functions, factors influencing habitat quality, etc.);

ii. Fish populations (species composition, status, distribution and abundance of the species, migration patterns, etc.)

iii. Fisheries operations (fishing locations and practices, amounts and species composition of catches, marketing channels, availability of and adherence to fishing regulations, illegal practice; etc.);

iv. In addition to fish, survey shall cover phytoplankton, zooplankton and aquatic insects;

v. Water quality monitoring shall be undertaken in the same locations as the fish survey.

31 The approach and methodology of the aquatic ecology monitoring surveys (numbers and locations of sampling stations, frequencies of sampling, parameters, and sampling methods, etc.) will be further specified. The basic survey program will cover a minimum of 12 sampling locations, which will be sampled 2 times per year.

32 All these proposed measures, as well as the limits and conditions associated with catching the mature specimens of target fish species, will require a good deal of public awareness-raising and education. The local consultants will hired to design and implement the public awareness and education program (involving village visits and brochures), which will include an overview of existing fishing regulations, fish vulnerabilities associated with the dam project, and the obligations and opportunities associated with the Fish Conservation Management Plan.

6 Implementation Arrangements

33 Tanahu Hydropower Limited (THL) will be the Executing Agency for the Tanahu Hydropower Project. An appropriate agency Environmental and Social Service Provider (ESSP) will be responsible for coordination and implementation of the Fish Conservation Management Plan under the supervision of the Environmental Sub-Unit of the Environmental and Social Management Unit ESMU of THL with consultant support as needed for technical inputs to each of the three prongs of the plan (to be set up as consultancy services).THL will seek advisory support of IUCN,WWF and NEFIS in preparing action plan with effective regulations for fish habitat protection in Madi and Seti rivers. Relevant government institutions, such as the Nepal Agriculture Research Council NARC, Directorate of Fisheries Development DoFD, of MoALMC, Fisheries Unit of Ministry of Agriculture, Gandaki

Provincial Government and NTNC will also be actively involved to ensure the successful implementation of Fish Conservation Management Plan. That the fish hatchery approach and formulation of Fish Habitat Management Plan in Madi and Seti rivers. In this manner, sufficient technical oversight will be provided to ensure successful implementation of the Fish Conservation Management Plan. Arrangements will be worked out to hand over the fish hatchery to either fisheries unit of Ministry of Agriculture, Gandaki Provincial Government or to NARC for operation. Working modality will be designed in due course of time.

34 It is expected that the management plan will require International and National consultants during pre-construction and construction and operation phase of the hydropower project. The consultants will address the technical requirements and design aspects of each of the three prongs in the plan, and will be engaged according to ADB Guidelines on the Use of Consultants. The equipment will be procured according to ADB's procurement Guidelines. The study is expected to be implemented over 10 years, from 2018 to 2028.

7. Schedule:

35 Detail schedule of Fish conservation management plan is presented in Table 4.

Table 4. Schedule of Fish Conservation Management Plan

S.N.	Activities	Pre-construction								Construction																				Operation												Remarks
		2017				2018				2019				2020				2021				2022				2023				2024				2025				2026				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1	**Fish Hatchery**																																									
1.1	**Field survey and identification of a fish hatchery site.**																																									
1.1.1	Confirming the fish fauna of project area including limnological parameters.		X	X	X	X	X																																		
1.1.2	Finalize of site selection							X	X																																
1.1.3	Land procurement procedure management									X	X																														
1.1.4	Design and estimate of the hatchery complex										X	X																														
1.2	**Construction of the fish hatchery.**																																									
1.2.1	Process (tendering and contract award) of hatchery construction											X	X																													
1.2.2	Construction of the complete fish hatchery complex.													X	X	X	X	X	X	X	X																				
1.2.3	Preparation of specification and procurement of hatchery equipment																	X	X	X	X																				
1.3	Negotiation and finalization about hatchery operations with Government Fisheries agencies																		X	X																				
1.4	Establishment of trained manpower.																		X	X	X	X																		
1.5	**Hatchery operation.**																																									
1.5.1	Brood collection and management																					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C
1.5.2	Propagation of target fish species																									X	X			X	X			X	X			X	X			C

S.N.	Activities	Pre-construction								Construction																Operation												Remarks
		2017				2018				2019				2020				2021				2022				2023				2024				2025				2026				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1.5.3	Nursing and rearing																																									C
1.6	Annual fish seed release/distribution of fry/fingerlings in the reservoir area and in the rivers.																																									C
1.7	Provision of capacity building to the Seti Fish Hatchery staff.																																									A
1.8	**Exploration of aquaculture/ fisheries enhancement in Reservoir through local fishers**																																									
1.8.1	Feasibility study																																									A
1.8.2	Group formation and training																																									A
1.8.3	Aquaculture/Fisheries enhancement activities																																									C
2	**Experimentation with a "catch -and- haul" system**																																									
2.1	Selection effective fishing gears, tags and accessories																																									A
2.2	Examination of the feasibility and potential effectiveness of a "catch –and haul" system																																									
2.3	Selection and procurement of fish collection tank and live fish transportation vehicle with oxygen supplying device.																																									
2.4	Design and implementation of a trial "catch –and haul" system.																																									C
2.5	Monitoring of the survivability of the fish moved to the reservoir.																																									C
3	**Fish habitat protection in the Seti and Madi watersheds**																																									

S.N.	Activities	Pre-construction								Construction																				Operation								Remarks
		2017				2018				2019				2020				2021				2022				2023				2024				2025				2026			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
3.1	Formation of reconnaissance mission.								X	X																														
3.2	Preparation of study plan										X	X																												
3.3	Sharing findings with concerned agencies like MoLMAC(Pokhara), NARC, MoLMaC, NTNC, DNPWL, IUCN, WWF through a workshop.											X																												
3.4	Preparation of Fish Habitat Conservation Plan												X																											
3.5	Formulation of regulations for permitting of mining activities.												X																											
3,6	Completion over all action plan to declare river stretches as protect area.													X																										
3.7	Implementation of the action plan.														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C
3.4	Periodic monitoring of natural populations with indigenous fish and their habitat.																											X				X				X				
3.5	Conduct public awareness-raising/ education programs related to fish habitat conservation					X			X				X			X				X				X			X			X			X			X			X	C
3.6	Recommendations for improvements in regulations.								X				X			X				X				X			X			X			X			X			X	C

Note: **C**= Continuous, **A**= as per required