Environmental Impact Assessment

September 2019

PAK: Balakot Hydropower Development Project

Volume C – Supporting Studies

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Hagler Bailly Pakistan

Balakot Hydropower Development Project

Environmental Impact Assessment

Volume VI – Supporting Studies
Final

August 1, 2019

EFlow Assessment Report

Hagler Bailly Pakistan

Balakot Hydropower Development Project

Environmental Flow Assessment

Final Report

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Balakot Hydropower Development Project

Biodiversity Action Plan

Final

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1. Introduction

Biological diversity, or biodiversity, is the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems (UN Convention on Biological Diversity, Article 2).[1] Biodiversity provides us with a host of raw materials, foods and medicines and is the basis for the life support system of our planet by for example, underpinning the continued availability of clean air and fresh water. Interwoven with these functional aspects are spiritual, cultural and recreational elements. These elements are more difficult to value, but in many countries and cultures they are considered to be at least as important as the more functional aspects of biodiversity.

Where biodiversity values of importance to conservation are associated with a project site or its area of influence, the preparation of a Biodiversity Management Plan (BMP) and/or a Biodiversity Action Plan (BAP) provides a useful means to focus a project's mitigation and management strategy. The development of a BMP/BAP might be required under a company's own biodiversity policy, or International Finance Institutions (IFI or "Lenders") might request a BMP/BAP to help demonstrate compliance with Lender standards. Other parties, such as government agencies, conservation organizations or Affected Communities, might also be interested in the development of a BAP/BMP to address a specific topic of concern.[2]

1.1 Background and Rationale for Developing BAP

The Pakhtunkhwa Energy Development Organization (PEDO) intends to construct a 300 megawatt (MW) run-of-river hydropower plant (referred to as "Project" in this report) at Balakot, in Mansehra District of Khyber Pakhtunkhwa (KP), Pakistan. The Project called Balakot Hydropower Development Project (BHDP) or Balakot Hydropower Project (BAHPP), referred to as Project in this report, will be located on the Kunhar River about 18.6 kilometer (km) upstream of the town of Balakot. (**Exhibit 1.1**). The Asian Development Bank (ADB) is evaluating the Project for financing under its Hydropower Investment Development Program.

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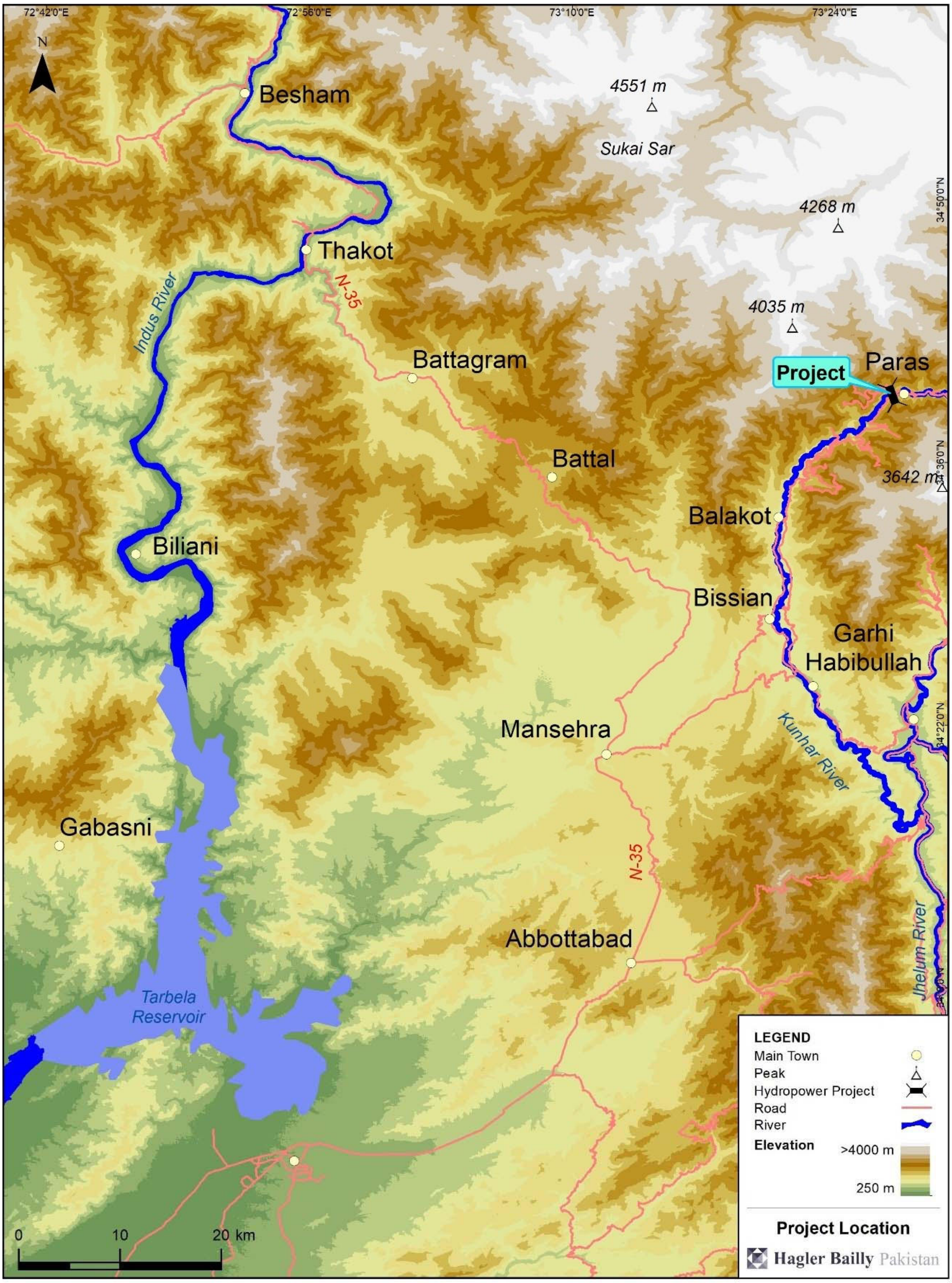
[1] The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is an international legally binding treaty. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.

[2] Policy on Social and Environmental Sustainability, January 2012. Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

Exhibit 1.1: Project Location



A Critical Habitat Assessment was carried out as part the Environment Impact Assessment (EIA) of Balakot Hydropower Development Project (**Section 4.2.8**)[3]. According to the International Finance Corporation's Performance Standard (IFC PS6)[4], it was determined that the Project is located in a Critical Habitat due to the presence of valued aquatic biological resources, including the restricted range or endemic fish species[5] Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*, both of which will be affected by Project construction and operation (**Section 7.2** of **EIA of Balakot Hydropower Development Project**)[6]. BAP also includes measures to In addition, biodiversity values in the Kunhar River include the Vulnerable Alwan Snow Trout *Schizothorax richardsonii* which is migratory fish.

In Critical Habitats, Net Gain is required for those values for which Critical Habitat has been designated under IFC PS6[7] which is defined as 'additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated.' The PS further defines how the Net Gains can be achieved: 'Net Gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of this Performance Standard without a biodiversity offset, the client should achieve Net Gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity.'

This Biodiversity Action Plan (BAP) has, therefore, been prepared to support the corporate commitments of the Pakhtunkhwa Energy Development Organization (PEDO) for conserving biodiversity as well as to meet the requirements of IFCs PS6 and ADB's Safeguard Policy Statement 2009 for the Balakot Hydropower Development Project.

The BAP includes a set of actions for the conservation and enhancement of biodiversity in a defined area where aquatic biodiversity will be directly impacted by the Project (**Section 1.4,** *Geographic Scope of the Biodiversity Action Plan*). Specific objectives of the BAP are to ensure that the Project:

- Implements the mitigation and monitoring of biodiversity as proposed in the EIA, and as refined and/or modified by the BAP itself
- Complies with national legislation and policy requirements
- Complies with lender and other international requirements
- Addresses the concerns and expectations of the stakeholders

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[3] Hagler Baily Pakistan, 2019, Environmental Impact Assessment of the Balakot Hydropower Development Project, Final Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

[4] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

[5] Endemic refers to endemic to the Jhelum Basin

[6] Hagler Baily Pakistan, 2017, Environmental Impact Assessment of the Balakot Hydropower Development Project, Final Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

[7] Biodiversity Conservation and Sustainable Management of Living Natural Resources, Performance Standard 6, International Finance Corporation, 2012

- Implements best practice and sustainable solutions

The BAP will become effective immediately following approval of the Khyber Pakhtunkhwa Government and will remain in effect through the life of the Project, inclusive of construction and operation, until the dam is decommissioned and removed. The biodiversity monitoring will also take place through the life of the Project, while the BAP is being implemented.

1.2 Regional Overview

The Kunhar River originates from the glaciers above Lulusar Lake in the Kaghan Valley of KP. Glaciers of Malka Parbat and Makra Peak and the waters of Saiful Maluk Lake feed the river. It passes through Jalkhand, and meets Jhelum River at Rarra. The drainage area of the river is 2,535 km^2, with elevation ranging from 600 to 5,000 m.[8] The Kunhar River is one of the biggest tributaries of the Jhelum River Basin and the only main tributary situated entirely in Pakistan's territory. Snowmelt from the Kunhar Basin contributes 65% of the total discharge of the Kunhar River and 20-40% of the Jhelum River at Mangla.[9] The hydrology of the Kunhar River is largely controlled by snowmelt from the Himalaya range in the spring and the southwest monsoon on the Indian subcontinent that brings heavy rains from June to September.[10]

The weather in the Area of Management (**Section 1.4,** *Geographic Scope of the Biodiversity Action Plan*) can be categorized into four seasons:

- Summer (mid-March to mid-June) is characterized by high temperatures (daily maximum temperature between 19°C and 35°C and daily minimum between 8°C to 21°C) moderate rainfalls with moderate humidity and high speed-winds.
- Summer monsoon (mid-June to mid-September) which is characterized by high temperatures (daily maximum temperature between 30°C and 32°C while daily minimum temperature between 17°C and 21°C), significantly high rainfalls with high humidity and moderate speed-winds.
- The Post-Monsoon summer (mid-September to mid-November) is characterized by moderate temperatures (Daily maximum temperature averages between 21°C and 27°C while daily minimum temperature can be as low as 6°C), low rainfalls with moderate humidity and low speed-winds.
- Winter (mid-November to mid-March) has low temperatures (daily maximum temperature averages between 14°C and 16°C while daily minimum temperature averages between 2°C and 4°C), moderate rainfalls, with an increasing amount of rainfall at the end of the winter.

The Kunhar River has two temperature regimes. Upstream of Kaghan the water is cooler with average summer temperatures of 8-10°C, whereas downstream of Kaghan

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[8] Mahmood R, Jia S, Babel M. S., January 16, 2016, Potential Impacts of Climate Change on Water Resources in the Kunhar River Basin, *Water, Multidisciplinary Digital Publishing Institute*, Basel, Switzerland

[9] Ibid

[10] Ibid

temperatures are higher and near 12-13°C. The Jhelum River at its confluence with the Kunhar has a temperature of 16-17°C and the cooler waters of the Kunhar have a moderating influence on the Jhelum.[11]

The mean annual precipitation in the Area of Management is reported as 1,671 mm. The precipitation is reported to range from 44.7 mm in November to 359 mm in July.[12] Approximately 45% of total rainfall occurs in monsoons with maximum amount of rainfall observed in July (359 mm).

A number of hydropower projects are either currently under construction or proposed within the Kunhar River basin (**Exhibit 5.1**). The Patrind Hydropower Project (HPP) located close the confluence of Kunhar River with Jhelum River is already constructed and operating. The Sukki Kinari HPP located upstream of the Project is under construction. The Naran and Batakundi HPPs are presently in planning stages. A Cumulative Impact Assessment of the Project (**Section 7.13** of **EIA of Balakot Hydropower Development Project**) was conducted to assess the combined impacts of these developments on the biodiversity of the Kunhar River.

1.3 Project Description

Exhibit 1.2 illustrates the layout of the Project. The Project is a run-of-the-river hydropower project to be constructed on the Kunhar River. The catchment area of Kunhar River at the proposed dam site is 2,535 square kilometer (km^2), at an elevation ranging from 600 to 5,000 m. The Project Dam is located near the village of Rahter while the Powerhouse is located near the village of Barkot.

1.3.1 Power Generation Capacity

The proposed Project is designed to operate with the reservoir at maximum operating level of 1,288 m above mean sea level (amsl) with a reservoir capacity of 3.6 million m^3. At these conditions, the total installed capacity of the hydropower station will be 300 MW. The average annual energy generation of the main power station will be 1,143 Giga Watt hour (GWh).

1.3.2 Land Requirement

The total land requirement is 32.8 hectare. Out of total 32.8 hectares of required land 3.05 hectare will be required for staff colony, 3.05 hectare will be required for 2 construction camps, 1.32 hectare will be required for access roads and 23.36 hectare will be required for reservoir and dam.

1.3.3 Main Components of the Project

Dam and Reservoir

The dam will be a concrete dam with a maximum height of 35 m. The reservoir will have a length of approximately 2.2 km. During the low flow periods, the live storage will be

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[11] Hagler Baily Pakistan, 2017, Environmental Impact Assessment of the Balakot Hydropower Development Project, Final Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

[12] Ibid

used to store water during off peak hours to improve the flows for power generation in peak hours. It has been estimated that 1.2 million m^3 net storage would provide additional flows in four peak hours.

Reservoir Sediment Flushing

Reservoir capacity can be preserved by annual flushing increasing the life of the Project. when required with the discharge of about 100 cubic meter per second.

Lateral Power Intake

This will be located on the left bank of Kunhar River and will comprise 4 bays split by three vertical piers to provide a design discharge of 154 m^3/s. It will include trash racks for passing the design discharge.

Headrace and Tailrace Tunnels

This will be a length of about 9.1 km and a diameter of 8 m.

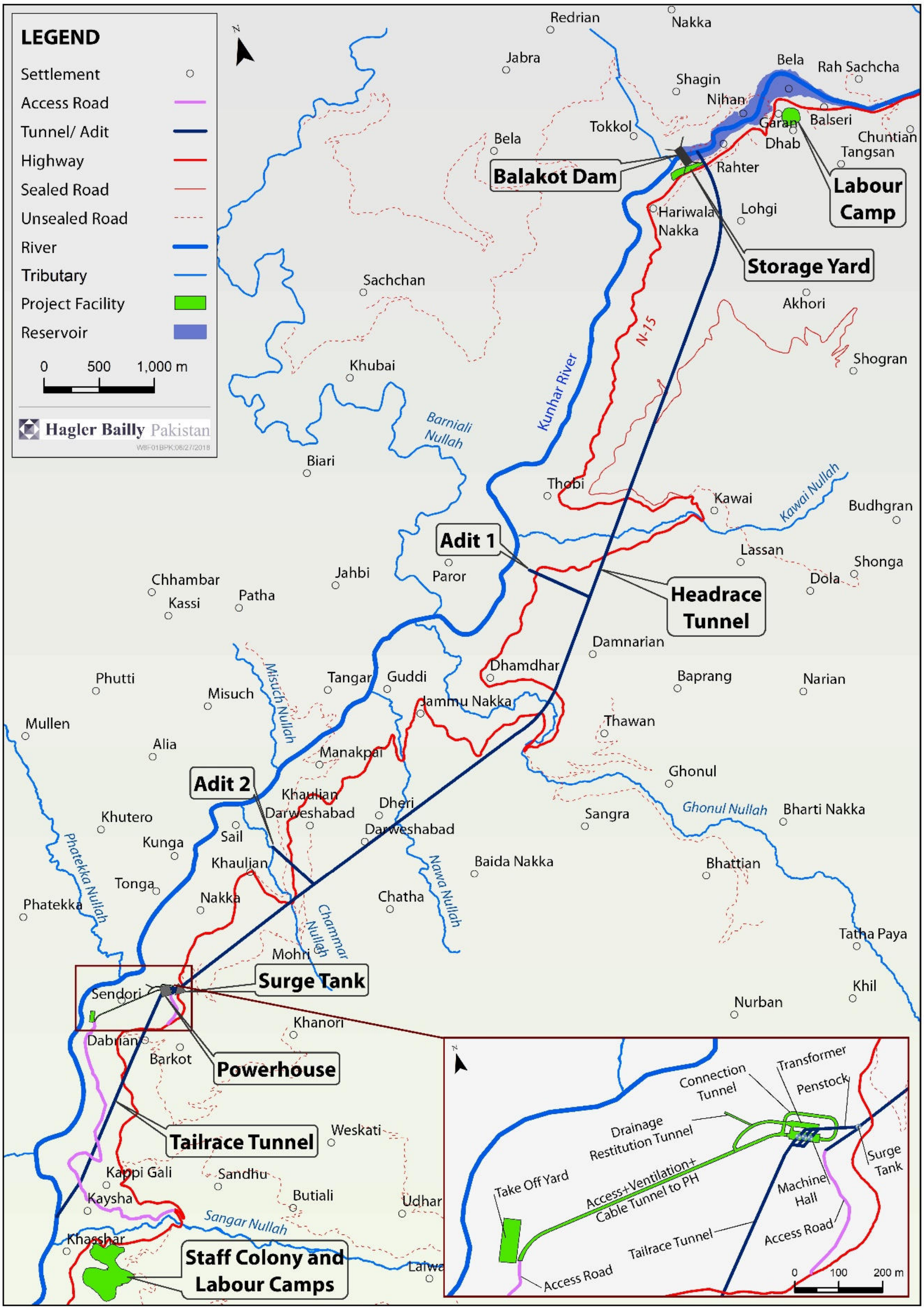
Powerhouse

The powerhouse design comprises three Francis type turbines and generators. The transformer hall cavern will have dimensions of length 88 m, width 14 m and height 20 m. Geographic Information Systems (GIS) equipment and the facility for transfer of the power cable to the cable tunnel will also be provided.

Construction Material and Waste

Materials required to carry out the construction of civil works for the Project include concrete aggregate, cement, pozzolans, various types of fill materials, construction chemicals, steel products etc.

Exhibit 1.2: Project Layout



1.4 Geographic Scope of the Biodiversity Action Plan

An overview of the aquatic and terrestrial ecological resources in the Area of Management, including habitat assessment and Critical Habitat Assessment, is provided in **Section 4,** (*Biodiversity Values)* while **Section 5,** (*Impact of Project on Aquatic Biodiversity)* provides a summary of the impact of the proposed Project on the valued aquatic ecological resources in the Area of Management. More detailed information is available in the EIA of the Balakot Hydropower Development Project.

The selection of geographic scope of the BAP has been defined to incorporate an area where biodiversity will be directly impacted by the Project. This area is defined as the Area of Management, and includes an impact zone of about 45 km length of river. The Area of Management includes the reservoir of the Project, 4 km upstream of where the Project dam will be constructed, and extends to 5 km upstream of the Patrind dam but excluding the reservoir of Patrind HPP. The Area of Management also includes segments of the Barniali, Ghonul, Jalora, and Shisha Nullahs. **Exhibit 1.3** illustrates a map showing the Area of Management.

Protection of the terrestrial ecological resources in the Area of Management has not been included in the BAP. This is because as discussed in the EIA[13], Project construction and operation impacts on terrestrial mammal, bird, reptile, and amphibian species are not likely to be significant (**Section 7.3** of the **EIA of Balakot Hydropower Development Project**). In addition, there are no Protected Areas near the Area of Management. Any potential impacts on the terrestrial biodiversity will be mitigated and managed through the implementation of the Environment Management Plan (**Section 9** of the **EIA of Balakot Hydropower Development Project).**

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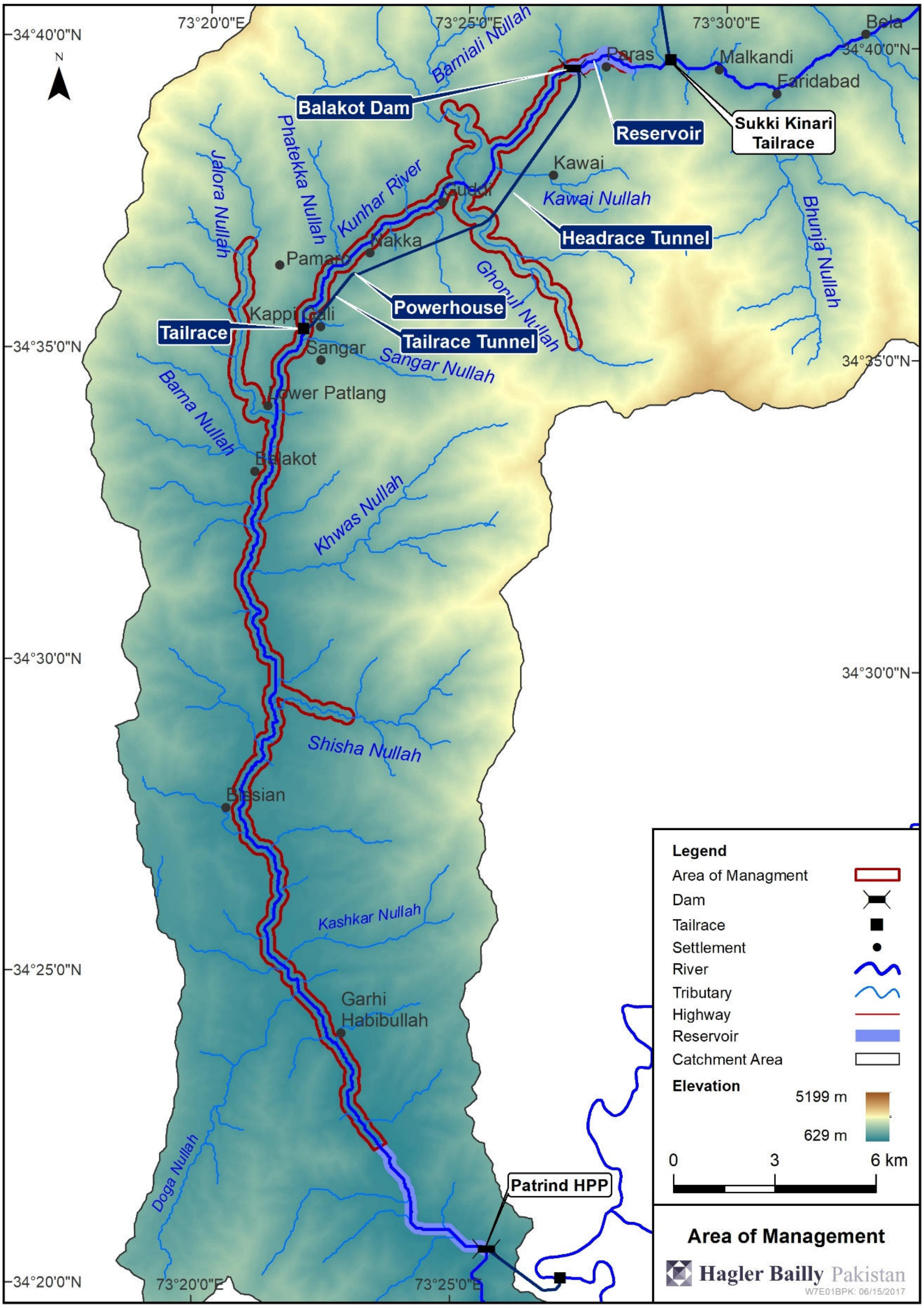
[13] Hagler Baily Pakistan, 2017, Environmental Impact Assessment of the Balakot Hydropower Development Project, Final Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

Exhibit 1.3: Geographic Scope of the BAP (Area of Management)



1.5 Objectives and Scope of the BAP

This section describes the scope of the BAP and actions that will be taken to mitigate the negative impacts of Project operations on the aquatic biodiversity.

1.5.1 Actions to Mitigate the Impact of Changes in Flow Regime and Barrier Created by the Dam

The BAP includes the following actions to mitigate the direct impact of changes in flow regime and barrier created by the dam as identified in the EIA.

- Actions to protect fish species of conservation importance, and to achieve Net Gain for species that trigger the Critical Habitat and No Net Loss in biodiversity, where feasible, required in Natural Habitat:
  - Two operational scenarios are recommended for consideration of the stakeholders: preferred case that includes a baseload operation with an EFlow of 1.5 m^3/s and the alternate case for peaking operation with an EFlow of 6.1 m^3/s (**Section 5**, *Impact of Project on Aquatic Biodiversity*).
  - Implementation of High Protection (HP) to reduce pressures on biodiversity of the Kunhar River and its tributaries, mainly unregulated fishing and sand mining (**Section 5**, *Impact of Project on Aquatic Biodiversity*).
- Barrier related mitigation, i.e., physical transportation of migratory and non-migratory fish from downstream to upstream of the dam if needed to prevent genetic isolation in the long term.
- Experimental captive breeding of fish species of conservation importance on which the impacts of the Project are significant, and stocking in river reaches where populations need to be restored.

1.5.2 Actions Arising out of Cumulative Impact Assessment

A Cumulative Impact Assessment (CIA) of existing and planned hydropower projects on the ecological resources and ecosystem services of the Kunhar River was undertaken for the EIA of the Balakot Hydropower Development Project (**Section 7.13)**. In addition, a Cumulative Impact Assessment of the hydropower projects on the Jhelum River were undertaken as part of the ESIA of the Kohala Hydropower Project[14]. This BAP, therefore includes some basin wide measures that are important for the protection of biodiversity in the long term. These include:

- Actions to be taken collectively by the hydropower industry and the government to ensure the protection of aquatic biodiversity in the long term, and
- Actions that the government can take to further enhance the status of biodiversity.

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[14] Hagler Baily Pakistan, 2017, Environmental Impact Assessment of the Kohala Hydropower Project, Draft Report, Kohala Hydropower Company Ltd.

The following is a summary of these actions:

Establishment of an Institute for Research on River Ecology

The CIA recommends research and development for selection and installation of fish passages suited to local species, river conditions, and dam designs, captive breeding and re-stocking of fish of conservation importance that are impacted by hydropower projects, assessment of impacts on river biodiversity at sub-basin level, use of environmental flow models such as DRIFT to assess cumulative impacts of hydropower projects, and genetic studies to determine and mitigate risk of in-breeding caused by barriers created by dams. An Institute for Research on River Ecology (IRRE) has been proposed in the CIA prepared for the Karot HPP as a part of the project ESIA, which has been approved by the concerned EPA. The same approach has been incorporated into the BAP prepared for the Kohala HPP.[15] The IRRE is proposed as a basin wide institution in which all the developers of HPPs in the basin contribute to establishment and operation of the institute, and jointly benefit from the research outputs. The initiative is the outcome of the International Finance Corporation of the World Bank (IFC) initiative to set up a Hydropower Working Group for the basin, through which the project owners can cooperate and collaborate to collectively manage the basin in a sustainable manner. The proposed institute will help the project owners in maintaining ecological databases and research and analysis capabilities that will benefit them individually by lowering their environmental management costs. The role and contribution of PEDO in establishment and operation of this institution is described in this BAP. PEDO will contribute to the establishment and operation of an Institute for Research on River Ecology (IRRE), subject to approval of associated costs in the tariff by the National Electric Power Regulatory Authority (NEPRA).[16]

Establishment of Watershed Management Program

The Watershed Management Program (WMP) will primarily focus on improvement of water quality in the Kunhar basin that is critical for protection of biodiversity in the long term. The institutional and financial model for setting up watershed management institutions will be similar to that proposed for the Institute for Research on River Ecology. The support provided by PEDO and project owners in this case, however, will be limited, as additional support and resources will be mobilized from the participating government departments which will include forests, wildlife, agriculture, and irrigation. Action areas may include, but not be limited to, land use management and reforestation to reduce erosion and risk of landslides and to meet community needs for fuel wood and timber, management of water use, and control of water quality. As in the case of the IRRE, PEDO will contribute to the establishment and operation of a WMP subject to approval of associated costs in the tariff by the NEPRA.

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[15] The Karot and Kohala HPPs are investments of the Chine Three Gorges South Asia Investments Ltd. (CSAIL) in which IFC holds and equity position. IFC is also a lender to the Karot HPP.

[16] This is the model for financing of biodiversity actions agreed upon by the Kohala Hydropower Company Ltd. (KHCL) with the GoJK. KHCL will shortly initiate discussions with NEPRA for formal approval of inclusion of all BAP related costs into the project costs for purposes of tariff calculation.

Actions and Measures that the Governments can take to Protect and Enhance the Biodiversity in the Kunhar Basin

Specific actions recommended in the CIA that will directly benefit the biodiversity in the area of impact of the Kunhar HPP and are in the purview of the government include requirement for future projects in the basin to achieve Net Gain in population of key fish species such as the endemic fish species[17] Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*. In addition to this, where technically and economically feasible, the CIA recommends the operation of other HPP projects such as the Patrind HPP at baseload (an additional Net Gain of about 10% in population of key fish species can be achieved through this measure downstream of the tailrace of the powerhouse) to avoid the impact of a peaking operation on the river.[18]

1.6 Outline of BAP

The structure of this BAP is as follows:

Section 2 provides the legal, regulatory requirements and obligations under international treaties

Section 3 provides a summary of the stakeholder consultations.

Section 4 provides an overview of the baseline status of the ecological resources and threats to them.

Section 5 provides a summary of the anticipated impacts of the Project on the aquatic ecological resources of conservation importance

Section 6 provides information about the proposed conservation measures.

Section 7 describes the institutional arrangements for the implementation of the BAP.

Section 8 provides the implementation plan.

Section 9 provides a framework for the monitoring and evaluation of key parameters.

Section 10 provides budget for implementation of the proposed measures.

Section 11 provides the details of adaptive management that will be used.

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[17] Endemic refers to endemic to the Jhelum Basin

[18] Peaking operation of a hydropower plant results in daily variations in flow downstream of the power houses in the low flow or winter season due to storage of water during the day and release for a limited period in the evening to meet the peak power demand. Such imposed variations in flow can be detrimental to the survival of aquatic life in the river.

2. Regulatory and Institutional Framework

The Balakot Hydropower Development Project is located in the province of Khyber Pakhtunkhwa (KP) where the Biodiversity Action Plan will be implemented. This section summarizes national and provincial regulatory requirements for protection and enhancement of biodiversity applicable in the KP province. In addition, the institutional framework for conservation of the ecological resources in the province are described. The international conventions and obligations related to biodiversity that Pakistan has ratified are also included.

2.1 National Regulatory Framework

The Pakistan Environmental Protection Act, 1997 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. The Act's relevance to biodiversity conservation is primarily through its environmental assessment screening process for proposed projects which makes it mandatory to undertake the environmental assessment prior to initiation of developmental projects and address the biodiversity conservation and protection related issues. The national regulatory requirements relevant to biodiversity protection and enhancement are outlined below.

The National Biodiversity Action Plan, 2000

Pakistan is a signatory to the Convention on Biological Diversity, and is thereby obligated to develop a national strategy for the conservation of biodiversity. The Government of Pakistan constituted a Biodiversity Working Group, under the auspices of the Ministry of Environment, to develop a Biodiversity Action Plan for the country, which was completed after an extensive consultative exercise. The major aims of the Plan are to create a policy framework that fosters the sustainable use of biological resources; to strengthen and promote National Biodiversity Conservation Programs and develop international and regional cooperation; to create conditions and incentives for biodiversity conservation at the local community level; to strengthen and apply more broadly the tools and technologies for conserving biodiversity; and to strengthen human knowledge, will and capacity to conserve biodiversity.

National Environmental Policy, 2005

The National Environmental Policy was implemented in 2005 by the Ministry of Environment, Government of Pakistan. The basic goal of Policy was to protect, conserve and restore Pakistan's Environment in order to improve the quality of life of the citizens through sustainable development and to ensure effective implementation of Biodiversity Action Plan. The policy covers all sectors and a wide range of means for promoting conservation and environmental protection in water, air and waste management, forestry, and transport. The policy aims to promote protection of the environment, the honoring of international obligations, sustainable management of resources, and economic growth.

National Climate Change Policy, 2012

The National Climate Change Policy, approved by the Government in 2012 has the overall goal ‘to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development’. One of the major objectives of this policy is conservation of natural resources and long term sustainability further elaborated through specific measures under forestry, biodiversity, and other vulnerable ecosystems. With respect to forestry, the National Climate Change Policy (NCCP) outlines the need to restore and enhance Pakistan’s forest cover under sustainable forest management to ‘withstand present and probable future impacts of climate change.’ Biodiversity-related policy measures include setting national biodiversity indicators and provision of requisite financial resources for implementation of the BAP (2000).

To support the Climate Change Policy, in 2013 the Government prepared a Framework for Implementation of the Climate Change Policy (2014-2030) which lists priority, short-term, medium-term and long-term actions to be implemented in various sectors.

Draft National Forest Policy, 2015

The objective of the Forest Policy is to ‘expand the national coverage of forests, protected areas, natural habitats and green areas for restoration of ecological functions and maximize economic benefits while meeting Pakistan’s obligations to international agreements related to forests.’ This policy has recently been approved by the Council of Common Interests but has not yet been ratified by the Parliament.

2.2 Provincial Regulations and Requirements

The laws and regulations relevant to biodiversity in KP are summarized below.

The Khyber Pakhtunkhwa Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015

This law was enacted to consolidate the laws relating to protection, preservation, conservation and management of wildlife in KP. It classifies wildlife by degree of protection, i.e., animals that may be hunted on a permit or special license, and species that are protected and cannot be hunted under any circumstances. The Act specifies restrictions on hunting and trade in animals, trophies, or meat. The Act also defines various categories of wildlife-protected areas, i.e., National Parks, Wildlife Sanctuaries, and Game Reserves. Its objectives include the following:

a. “strengthening the administration of the organization to effectively manage wild animals and their habitats;
b. to holistically manage Protected Areas in a sustainable manners for the best interest of the indigenous communities and local stakeholders;
c. securing appropriately the goods and services produced from wild animals and their habitats at the level of local communities;
d. fulfilling the obligations envisaged under the biodiversity related multilateral environmental agreements ratified by the Government of Pakistan;

e. promotion of public awareness and capacity building for proper appreciation of the environmental significance and socio-economic values of wildlife; and

f. conservation of biological diversity and realization of its intrinsic and extrinsic values through sustainable use and community participation.”

Some parts of the Kunhar River are declared as protected for the purpose of stocking fish for sports fishing. This is usually along a 10 km stretch of the river but the protected stretch may vary from year to year. There are also some protected terrestrial areas within the Mansehra District. The Project staff will have to ensure they do not violate the rules and regulations outlined in this Act.

Forest Ordinance, 2002

The Forest Ordinance, 2002 was enacted to protect, conserve, manage and sustainably develop forests and other renewable natural resources. The Ordinance authorizes provincial forest departments to establish forest reserves and protected forests. It prohibits any person from: setting fires in the forest; quarrying stone; removal of any forest produce; causing any damage to the forest by cutting trees or clearing areas for cultivation; or any other purpose without express permission of the relevant provincial forest department.

The Project area is not located in any forest reserve or protected forests established by the provincial forest department. However, it is important to ensure that Project related activities do not encroach on these forests, and the Project staff do not engage in the collection or trade of forest produce.

Forest Development Corporation Ordinance, 1980

The Forest Development Corporation has been established under this ordinance. The corporation functions to “make suitable arrangements for the (i) economic and scientific exploitation of forests; (ii) sale of forest produce; (iii) establishment of primary wood-processing units; (iv) regeneration in areas to be specified by Government; and (v) performance of such other functions as may be assigned to it by Government.”

Project staff should not violate this ordinance for example engage in the trade of forest products.

Forestry Commission Act, 1999

The Act aimed at establishing a Forestry Commission to improve the protection, management sustainable development of forests in KP. Under this Act, the Commission established was empowered and entrusted to further this aim by taking steps such as giving vision and a framework for the sustainable development of forests in KP, overseeing the process of institutional and legislative reforms in the Department, advocating policies for sustainable development of forests etc. This Act is not likely to impact this Project directly. However, any initiatives undertaken by the Commission may be of interest to the Project for biodiversity management and mitigation.

Rivers Protection Ordinance, 2002

The ordinance was instated in view of the increasing developments along the rivers in KP to provide for the protection of aquatic ecology, water quality as well as economic and environmental value of the river and their tributaries in KP. The rules laid out in the ordinance relate mainly to encroachment onto the river and pollution of the river. It is important that Project-related activities do not pollute the river and that all construction activities along the river banks be carried out within the area designated for them.

Integrated Water Resources Management Board Ordinance, 2002

The Integrated Water Resources Management Board has been established to devise and oversee the implementation of an integrated water resources management strategy aimed at sustainable economic, social and environmental returns on water resource development. Under the ordinance, a Board has been established, the functions of which include conducting studies to accurately assess the demands of water for consumptive or non-consumptive use including hydropower generation. The Ordinance also provides guidelines for fisheries, water-related sports, environmental sustainability, forestry, lakes and water bodies. The Managing Director of PEDO is a member of the Board.

The Project will need to comply with the policies, rules and procedures put in place by the Board with regard to watershed management.

NWFP Fisheries Rules 1976

This law prohibits destruction of fish by explosives, poisoning water and the hunting of protected fish species. The law also forbids the use of net or fixed engine traps without a permit or license. The law grants power to the Director General (DG) Fisheries to issue permits to catch fish. It protects fish against destruction of fish by explosives, and by poisoning water. This law was applicable to the Project as there was a possibility of catching fish as sustenance by the Project staff and also makes it obligatory to obtain a license from the fisheries department before commencing any fishing activities.

2.3 Federal and Provincial Conservation Strategies

Pakistan National Conservation Strategy (PNCS)[19] was prepared jointly by the then federal Ministry of Environment with assistance from the International Union for the Conservation of Nature (IUCN). It was approved by the federal cabinet in 1992 as the basic policy document on environmental sustainability. The PNCS was the first policy framework for biodiversity and conservation and as such had three objectives: (1) Conservation of natural resources; (2) Sustainable development; (c) Improved efficiency in the use and management of resources. Of these, ‘biodiversity conservation’ was one of the fourteen programme areas for priority work action, and the NCS had a central influence in mainstreaming environmental and sustainability dimensions in other policies, plans, and strategies.

The Sarhad Provincial Conservation Strategy (SPCS)[20] was prepared by the Government of KP with assistance from IUCN. It was approved by the provincial cabinet in 1996 and was considered a sustainable development action plan for the KP.

Both these documents are no longer used for planning purposes and as such are obsolete as a policy document. However, they can be used where relevant as a guideline.

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[19] The Pakistan National Conservation Strategy, 1992.

[20] The Sarhad Provincial Conservation Strategy, 1996, Government of North West Frontier Province in collaboration with IUCN–The World Conservation Union.

2.4 Obligations under International Treaties

Pakistan is a party to a number of conventions in relation to biodiversity, including the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES), the Convention on Wetlands of International Importance (Ramsar Convention) and the United Nations Convention on Biological Diversity (CBD).

The CBD defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems". As a signatory country, Pakistan has a responsibility to:

- Safeguard its biodiversity.
- Introduce procedures requiring environmental impact assessment (EIA) for projects likely to have significant impacts on biological diversity.
- Introduce legislative provisions that ensure environmental policies and procedures are duly taken into account.

A list of international conventions that focus on biodiversity issues is given in **Exhibit 2.1**. With shared goals of conservation and sustainable use of biological resources, the biodiversity-related conventions work to implement actions at the national, regional and international level. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem-based) and operational tools (e.g., programs of work, trade permits and certificates, multilateral system for access and benefit-sharing, regional agreements, site listings, funds).

Exhibit 2.1: International Agreements on Biodiversity and Status of Entry into Force

Convention	*Date of Treaty*	*Entry into Force in Pakistan*
Convention on Biological Diversity (CBD)	1993	26 Jul 1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	19 Jul 1976
Convention on Conservation of Migratory Species (CMS)	1979	01 Dec 1987
International Treaty on Plant Genetic Resources for Food and Agriculture	2004	02 Sep 2003
Convention on Wetlands of International Importance especially as Waterfowl Habitat	1971	23 Nov 1976
Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC)	1972	08 Dec 2011

Convention on Biological Diversity (CBD), Rio De Janiero, 1993

Convention on Biological Diversity, known informally as the Biodiversity Convention covers ecosystems, species, and genetic resources and also the field of biotechnology.

The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.

The Convention has three main goals:

- conservation of biological diversity;
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from genetic resources.

The objective of the convention is to conserve biological diversity, promote the sustainable use of its components, and encourage equitable sharing of the benefits arising out of the utilization of genetic resources. Such equitable sharing includes appropriate access to genetic resources, as well as appropriate transfer of technology, taking into account existing rights over such resources and such technology. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, 1975

The convention aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It protects certain endangered species from over-exploitation by means of a system of import/export permits. Through its three appendices, the Convention accords varying degrees of protection to more than 30,000 plant and animal species.

Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 1979

The Convention on the Conservation of Migratory Species of Wild Animals also known as Bonn Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. Parties to the CMS work together to conserve migratory species and their habitats by providing strict protection for the most endangered migratory species, by concluding regional multilateral agreements for the conservation and management of specific species or categories of species, and by undertaking co-operative research and conservation activities.

International Treaty on Plant Genetic Resources for Food and Agriculture, 2004

The objectives of the treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. The treaty covers all plant genetic resources for food and agriculture, while it’s Multilateral System of Access and Benefit-sharing covers a specific list of 64 crops and forages. The treaty also includes provisions on Farmers' Rights.

Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, 1971

Popularly known as the Ramsar Convention, provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention covers all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities.

2.5 Sustainable Development Goals (SDG)

At the Millennium Summit in September 2000, several nations, including Pakistan adopted the UN Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets. The eight Millennium Development Goals were set to expire by the end of 2015, and therefore the Heads of States met in the United Nations on September 25th 2015, and adopted a new set of sustainable development agenda (SDG) goals to **end poverty, protect the planet,** and **ensure prosperity by** 2030. The 17 SDGs have specific targets to achieve over 15 years period 2016 -2030. The following two goals deal specifically with conservation and sustainable use of biodiversity in water and on land:

- SDG 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- SDG 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

2.6 ADB's Safeguard Policy Statement 2009

Built upon the three previous safeguard policies on the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998) and the Environment Policy (2002), the Safeguard Policy Statement was approved in 2009. The safeguard policies are operational policies that seek to avoid, minimize or mitigate adverse environmental and social impacts including protecting the rights of those likely to be affected or marginalized by the developmental process.

According to Section 8, Biodiversity Conservation and Sustainable Natural Resource Management of ADB’s Safeguard Policy Statement 2009, “the borrower/client will assess the significance of project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process. The assessment will focus on the major threats to biodiversity, which include destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner. The borrower/client will need to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.”

Critical Habitat is defined by ADB’s SPS 2009 as follows: Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization’s world natural heritage sites.

No project activity will be implemented in areas of critical habitat unless the following requirements are met:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
- Any lesser impacts are mitigated in accordance with paragraph 27, “Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by indigenous peoples or traditional communities, and compensation to direct users of biodiversity.”

When the project involves activities in a critical habitat, the borrower/client will retain qualified and experienced external experts to assist in conducting the assessment.

ADB's safeguard policy framework consists of three operational policies on the environment, indigenous peoples and involuntary resettlement. A brief detail of all three operational policies has been mentioned below:

Environmental Safeguard: This safeguard is meant to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.

Involuntary Resettlement Safeguard: This safeguard has been placed in order to avoid involuntary resettlement whenever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre- project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

Indigenous Peoples Safeguard: This safeguard looks at designing and implementing projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems and cultural uniqueness as defined by the Indigenous Peoples themselves so that they receive culturally appropriate social and economic benefits; do not suffer adverse impacts as a result of projects; and participate actively in projects that affect them.

Information, Consultation and Disclosure: Consultation and participation are essential in achieving the safeguard policy objectives. This implies that there is a need for prior and informed consultation with affected persons and communities in the context of safeguard planning and for continued consultation during project implementation to identify and help address safeguard issues that may arise. The consultation process begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle. It provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people and is undertaken in an atmosphere free of intimidation or coercion. In addition, it is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups and enables the incorporation of all relevant views of affected people and other stakeholders into decision making.

2.7 IFC's Requirements

This section summarizes the IFC's requirements and standards that the client is to meet throughout the life of an investment by IFC or other relevant financial institution. The IFC, established in 1956, is known as the private sector arm of the World Bank Group. IFC's Environment and Social (E&S) requirements for projects are established in IFC's Policy on Environmental and Social Sustainability and embodied within the eight Performance Standards (PS) of 2012.

International Finance Corporation applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, these Performance Standards establish standards that the client is required to meet throughout the life by IFC or other relevant financial institution.

- Performance Standard 1: Social and Environmental Assessment and Management System
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Pollution Prevention and Abatement
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

Even though the Project has not been financed by the IFC, these standards are internationally accepted and recognized to manage social and environmental risks and impacts.

The PS relevant to the Biodiversity Action Plan is PS 6, Biodiversity Conservation and Sustainable Management of Living Natural Resources. The PS 6 aims at protecting and conserving biodiversity, the variety of life in all its forms, including genetic, species and ecosystem diversity and its ability to change and evolve, is fundamental to sustainable development. This PS addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as incorporate sustainable management of renewable natural resources.

The PS6 defines a Critical Habitat as outlined below.

Critical Habitat is designated by the International Finance Corporation (IFC) Performance Standards 6[21] and is described as having a high biodiversity value, as defined by:

- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted-range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision will be evaluated on a case-by-case basis. Examples are as follows:

- Areas required for the reintroduction of CR and EN species and refuge sites for these species (habitat used during periods of stress (e.g., flood, drought or fire)).
- Ecosystems of known special significance to EN or CR species for climate adaptation purposes.
- Concentrations of Vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status of the species may be EN or CR.
- Areas of primary/old-growth/pristine forests and/or other areas with especially high levels of species diversity.
- Landscape and ecological processes (e.g., water catchments, areas critical to erosion control, disturbance regimes (e.g., fire, flood)) required for maintaining critical habitat.
- Habitat necessary for the survival of keystone species.
- Areas of high scientific value such as those containing concentrations of species new and/or little known to science.

In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;

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[21] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;[12]
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

In such cases where a client is able to meet the requirements defined in paragraph, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains[15] of those biodiversity values for which the critical habitat was designated. In instances where biodiversity offsets are proposed as part of the mitigation strategy, the client must demonstrate through an assessment that the project's significant residual impacts on biodiversity will be adequately mitigated to meet the requirements outlined above.

2.8 Requirements under the EIA

The Environmental Impact Assessment (EIA) conducted by Hagler Bailly Pakistan, provided a detailed account of the biodiversity of the Project area and the possible impacts of the Project on it. The EIA followed the guidelines provided by IFC Performance Standards and highlighted compliance to the following parameters:

- National Biodiversity Action Plan (national BAP) developed in 2000, is a *de facto* biodiversity policy instrument for the country. It takes care of required components of the CBD convention.
- IFC PS6 requires that a conservation value is allocated to the ecological features (protected areas, habitats and species) which are likely to be directly or indirectly impacted by the Project. Under the aforementioned IFC PS6 a project is required to assess significance of project impacts on all levels of biodiversity as an integral part of the social and environmental assessment process and take into account differing values attached to biodiversity by specific stakeholders. It also reinforces to assess major threats to biodiversity, especially habitat destruction and invasive alien species.

2.9 Institutional Framework and Responsibilities

The natural resources within KP are the responsibility of specific government departments such as wildlife and fisheries departments and forestry departments. Together these form the instructional framework for governance and regulation of natural biological resources. The relevant departments in KP, their roles and their relevance to protecting biodiversity are described in this sub-section.

2.9.1 Wildlife Department, KP

The Forestry, Environment, and Wildlife Department of Khyber Pakhtunkhwa (referred to as Wildlife Department, KP) is headed by the Chief Conservator Wildlife, KP. The

Department enforces the provisions of the Khyber Pakhtunkhwa Wildlife and Biodiversity Act, 2015 to meet its objectives which include strengthening the administration of the organization to effectively manage wild animals and their habitats, to fulfil the obligations of the government under its commitments to managing biodiversity, and promote public awareness for the value of wildlife and conservation. All wildlife is under the jurisdiction of this department.

While protection of fish is in the mandate of the Fisheries Department (see **Section 2.9.2**), legally the all other aquatic wildlife including macro-invertebrates, periphyton, and aquatic habitats fall in the mandate of the Wildlife Department. The Wildlife Department therefore needs to be informed of Project related impacts on wildlife and they need to agree to related mitigation measures.

2.9.2 Fisheries Department, KP

The Fisheries Department, KP falls under the Agriculture, Livestock and Cooperatives Department of the province. It is headed by the Director Fisheries and represented by District Officer Fisheries in each district. It has the authority to enforce the laws and regulations provided in the Fisheries Rules, 1976. This includes regulation of fishing methods using permits and licenses, the species that can be caught and associated penalties for violation of regulations pertaining to wild fish.

All wild fish fauna is under the jurisdiction of the Fisheries Department; therefore, they need to be informed about any impacts on fish fauna and related mitigation measures need to be agreed with them.

2.9.3 Forest Department

The Forest Department KP is headed by Conservator Forest with Divisional Forest Officer in each district. Since its inception, Forest Department has been working for development and promotion of forestry, soil conservation works, watershed management, wildlife conservation and sericulture/moriculture.

The Forest Department enforces the provisions of the Forest Ordinance, 2002 to meet its objectives which include protection, conservation, management and sustainable development of forests by engaging the community and defining the role of the government. All forest areas including reserved forests, village forests, protected forests, guzara forests and wastelands, and produce from forests, is under the jurisdiction of this department. They need to be informed about impacts on forests and they need to agree with related mitigation measures.

3. Summary of Stakeholder Consultations

Successful implementation of the proposed Biodiversity Action Plan (BAP) requires a management strategy centered on effective understanding of the stakeholders and their concerns.

As part of the EIA process, consultations were undertaken with communities and institutions that may have interest in the proposed project or may be affected by it. **Section 6** of the **EIA of Balakot Hydropower Development Project** documents the consultation process followed as well as the issues and concerns raised by the stakeholders. The Background Information Document shared with the stakeholders is included in **Appendix A**. The Consultation Logs are included in **Appendix B**.

This section provides an overview of the biodiversity r elated concerns and suggestions of the institutional stakeholders as well as the relevant NGOs working in the area that have been instrumental in defining the scope and contents of the BAP.

3.1 Objective of Consultations

Stakeholders are groups or individuals that can affect or take affect from a project's outcome. SPS 2009[22] and IFC Performance Standards[23] specifically identifies affected people, concerned nongovernment organizations (NGOs) and government as prospective stakeholders to a project. Public consultation is also mandated under Pakistan's environmental law (Pakistan Environmental Protection Act 1997) as part of the ESIA requirements.

Stakeholder consultation is a means of involving those affected due to an activity in the decision-making process, in order to ensure that their concerns are addressed at the design stage. These consultations, if conducted in a participatory and objective manner, are a means of enhancing sustainability and ensuring environmental compliance.

The objective of the consultations held for the BAP of the Project were as follows:

- Provide information to the stakeholders regarding the Project and the anticipated impacts of the Project on the biological resources of the Kunhar River basin.
- Document the concerns of the stakeholders regarding the impact of Project construction and operation on the biological resources of the Kunhar River
- Gather data and information regarding the dependence of the local communities on these biological resources
- Ensure involvement of the stakeholders in Project planning, EIA processes and development of the Biodiversity Action Plan

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[22] Safeguard Policy Statement, Asian Development Bank, June 2009

[23] IFC Performance Standards, International Finance Corporation, January 2012

- Seek input from the stakeholders and biodiversity experts on the contents of the Biodiversity Action Plan, its implementation mechanism, implementing partners and monitoring framework.

3.2 Summary of Consultations

The consultations for the Project have been undertaken in compliance with relevant national legislation set by Pakistan Environmental Protection Agency, IFC Performance Standards on social and environmental sustainability, and the environmental and social safeguards laid out under ADB's safeguard policy (SPS 2009). The details are provided in **Section 8** of the EIA of Balakot Hydropower Development Project.

This section provides a summary of the concerns relevant to biodiversity, ecology and the Biodiversity Action Plan raised during the institutional consultations. These included consultations carried out between April to June 2017 with government organizations, NGOs and private sector organizations. Concerns raised by the communities are outlined in the **Appendix O Stakeholder Engagement Plan** of the **EIA of Balakot Hydropower Development Project** and have been taken in to consideration for development of the BAP.

3.2.1 Government Institutions

Wildlife Department, KP

Violations*:* Wildlife violations including those which affect the aquatic habitat are being handled by the Wildlife Department. This should be taken in to consideration during the BAP design.

Reservoir: The reservoir is a concern. This is mainly due to inundation of vegetation and loss of habitat. Due to the reservoir, wetland will be established which will change bird fauna. There will also be changes to flora and fauna in the riparian zone.

Lack of data: There is limited data on wildlife especially on key species, such as the Common Leopard and The Indian Palm Civet. There is a focus on game species but a lack of data on those species that are not game animals. The department lacks the resources to go into extensive details of wildlife management and research.

Infrastructure development: The development of infrastructure will affect the fragile ecosystem.

Species of importance: This is a very important area for Chakhor and Khaleej Pheasant. The population of the Khaleej Pheasant is of particular concern. Passerine birds are important as well.

Non-Project related pressures: These include habitat loss and fragmentation due to expansion of settlements, and the human wildlife conflict especially for the Common Leopard and the Black Bear. After the earthquake, people have moved to lower elevation areas allowing more space for wild animals. As a result the animal populations have increased and hence they extend their ranges and come into conflict with people.

Lack of staff: There is a lack of staff which results in very few watchers.

Lack of awareness: There is a lack of awareness amongst locals regarding the importance of wildlife, as well as the economic benefits and sustainable use of wildlife.

The need for surveys: There is lack of data on wildlife. Detailed wildlife surveys should be carried out to assess the baseline conditions at the proposed project location. The Wildlife Department should be included in these surveys.

Staff capacity building: There is a need to build the capacity of the staff of the Wildlife Department.

Closure of areas: There are forested areas that are closed off to all activity. This is to facilitate regeneration. 120 such areas have been established in Kaghan Valley, with each ranging from 40 ha to 100 ha. However, the proposed Project does not lie in these forests.

Fisheries Department, KP

Disturbance: The ecosystem already developed will be disturbed due to the Project construction and operation.

Spawning grounds: The spawning grounds of fish will be affected due to changes in flows particularly for the endemic fish. Spawning grounds of the Alwan Snow Trout are a concern.

Fishing licensing: Fish licenses are provided for fishing in this area. Changes in fish fauna will affect fishing in the area.

Flushing: This is a concern that flushing of the dam will affect fish fauna of the reservoir. However, since flushing is normally done in the flooding season the impact may be somewhat less pronounced.

Fish Ladder: Fish ladder may not be a feasible option for this project. Strong fish may be able to move over the ladder but the weaker ones will not. There is usually an estimated success rate of 25-30% of the fish making it over.

Pressures: Pressures other than those associated with the Project include fishing, and human population growth which has increased pollution and effluent discharge into the river. The pH of water in some areas has increased as a result of this, making it unsuitable for fish. The fishing pressure in the Kunhar River has increased substantially. Earlier hundreds of people came to fish, now thousands show up. This is partly due to better access as a result of road extension. Fish distribution has changed in some sections of the river due to pollution. The Brown Trout is an example, which shows prominent coloration in areas near Jalkhad where the water is less polluted compared to Balakot, where this species shows a less prominent coloration. However, there are differences in the food chain as well, so pollution may not be the only cause.

Climate change: Abrupt changes in temperature affect the ecosystem. Climate change may exacerbate the impacts caused by the Project construction and operation.

Lack of research: There has been no research on the effects of pollution on fish fauna. Mutations may be a concern although such abnormalities have not been observed. Growth of fish has not changed.

Minimum Flow: The flow from the Project needs to be maintained as per the agreement.

Reservoir: The 2.8 km stretch of the reservoir should be used for stocking of fish and angling but invasive species should be avoided.

Hatcheries: An alternative to protection and preservation is the use of hatcheries. These should be supported. The Alwan Snow Trout has been bred successfully in other countries and a hatchery exists in Swat.

Monitoring: Weekly pH monitoring of river water is recommended.

Forest Department, KP

Relocation of people: People will be relocated as a result of the Project and are likely to want to move to lower elevations. From the perspective of the Department, this is positive as it leaves more forested area untouched at higher elevations.

Existing disturbance: The habitat in Project vicinity is already fragmented due to human activity. The locals have modified the forest area and there is a high level of disturbance.

Project footprint: The forested area in the Project footprint is not of concern because Project-related activities will not result in degradation of large forested areas.

Reserve Forests: Project is not located in a reserve forest. There are some reserve forests at a distance from the Project infrastructure but these will not be impacted by the Project.

Replantation: Compensatory replantation should be done for any loss of trees due to Project-related activities. The Department can carry out these activities on behalf of PEDO.

Environmental Protection Agency, KP

Sewage: Sewage dumping in the river is an existing issue. But with influx of more Project staff this will be worsened.

Tree cutting: Cutting of trees for road construction is a concern. Deforestation of thick forests will occur.

Environmental Flows: It is important to maintain minimum Environmental Flows from the Project.

Fish ladders: Fish ladders may be used to conserve the fish.

Submergence of areas: There will be submergence of certain areas and this is a concern.

Terrestrial ecology impacts: A colony will be created for workers and labor which could have adverse impacts on terrestrial habitats.

Kaghan Development Authority

Tourism: The area in which the Project infrastructure is located falls within the jurisdiction of the Kaghan Development Authority. The Project impacts on the natural scenic beauty of the area are of concern as changes may impact tourism.

Development of Project facilities: Economic and commercial activity is likely to increase as a result of Project construction and operation. The ensuing increase in pollution is a cause for concern.

Sharing of information: Progress on the development of the Project should be shared with the Kaghan Development Authority regularly.

Capacity Building: The Project should make a contribution to the Kaghan Development Authority to promote capacity building and support effective working of the organization.

3.2.2 Non-Government Organizations

Himalayan Wildlife Foundation (HWF)

Fish Species of Conservation Importance: It is important to conserve the fish species of conservation importance in the Kunhar River.

Support: HWF will be happy to provide advice and support for protection of biodiversity.

World Wildlife Fund, Pakistan

Construction phase disturbances: Road construction for the Project will result in loss of forests including reserve forests. These forests are Himalayan moist temperate forests and highly sensitive areas for wildlife.

Project Location: The Project is located in the vicinity of Protected Areas. Here floral and faunal diversity is important because there is an overlap between moist temperate and dry temperate forests. Animals will be displaced because of the Project. Areas of importance around the Project include Kaghan, Paras, Siri Pai, Allai and Kawai.

Terrestrial species of conservation importance: This is a very critical area for wildlife. Just above Paras is a very sensitive habitat. In particular, there is a very large population of the Himalayan Grey Langur. Black Bear is found here and signs of Brown Bear have also been observed. There are 7-8 important bird species including for example the Western Tragopan, the Long-tailed Tip, Khaleej Pheasant, Kokhlas Pheasant. Vulture species are also found here including the Griffon Vulture. This is also part of the range of the Common Leopard, Ibex, Muntjak Deer, Grey Goral. Focused studies are recommended especially on Taxus species, Western Tragopan and Musk Deer.

Seasonal Risks: There is altitudinal migration here. Species come down to the vicinity of the Project area and maybe at risk.

Slow development of Himalayan Ecosystems: Himalayan Ecosystems develop over a long period of time. The impacts of this Project will be short-term but will damage the ecosystems.

Pollution: Air and dust pollution are a concern for wildlife.

Timing of construction: The winter season is better than the summer season for construction because in winter there is less breeding.

Exploitation of Flora: Strict controls on flora and fauna exploitation by Project workers is required particularly plant species.

Hunting: Strict guidelines should be given to Project staff on avoiding hunting.

Forest conservation: Forest restoration and conservation is important. This will also help in preventing landslides. Protection of upstream forests is important. Taxus species should not be removed.

Watershed Management Programs: It is recommended that investments be made in Watershed Management Programs. A close eye should be kept on water quality.

3.2.3 Private Sector

Star Hydro Power Limited (SHPL)

Operational impacts: The most important concern is the modification to environmental flows that will result due to Project operations.

Sediment flushing: Sedimentation and flushing of sediments, including timing and quantity, is a concern.

Impacts on ecology: There are concerns about the presence of fish species of conservation importance and impacts on river ecology.

International Finance Corporation

Impact Assessment: There must be a robust impact assessment that covers potential impacts of the project on not only the Kunhar River but also the Jhelum River downstream of the confluence of the two rivers. This should address the potential impacts of peaking flows and of sediment discharges.

Peaking alternatives: The alternatives analysis in the EIA should cover different approaches to peaking flows, ranging from run-of-river to two- or four-hour daily peaking discharges. We also recommend that seasonal limitations on peaking be considered as well. IFC encourages developers to consult with relevant authority to discuss the possibility that Balakot could be operated as a run-of-river project without peaking discharges during the entire year or during key biodiversity periods of the year.

Cumulative Impact Analysis on fish of importance: There will need to be a cumulative impact analysis that considers the cumulative impacts of overall hydropower development in the basin on endemic and endangered aquatic species that are of conservation concern. This would include impacts in the lower Jhelum River as well as in the Kunhar River.

Integrated approach: There is a need to develop a framework on integrated fish monitoring plan, biodiversity management, sand and gravel mining management that will require joint implementation by key stakeholders.

3.3 Addressing Stakeholder Concerns

The following issues related to biodiversity have been addressed in the EIA:

- Environmental flow assessment including impacts of environmental flow on aquatic biodiversity
- Long term impacts of the project on community
- Impacts on terrestrial and aquatic biodiversity

- Eutrophication effects of reservoir

The following aspects of biodiversity management stated as important by the stakeholders and relevant in the Area of Management of the BAP have been addressed in this BAP:

- Environmental flow management
- Protection of aquatic biodiversity with special attention to the endemic or restricted fish species
- Capacity building and awareness raising
- Financing of BAP
- Monitoring of impacts of the Project on biodiversity

The following aspects of biodiversity management fall outside the scope of the BAP as they include projects and areas located outside of the Area of Management of the BAP (**Section 1.4**, *Geographic Scope of the Biodiversity Action Plan*).

- Cumulative impacts of hydropower projects in the basin (**Section 7.13** of the **EIA of Balakot Hydropower Development Project**)
- Basin Level Biodiversity Plan including landscape level strategy and response
- Master Plan for water bodies in view of multiple projects
- Strengthening of the Khyber Pakhtunkhwa Wildlife and Biodiversity Board.

4. Biodiversity Values

The biological resources within the area around the Project have been divided into aquatic and terrestrial for the purpose of establishing baselines and to document threats to it. The baseline status of the biological resources draws on:

- Hagler Bailly Pakistan, June 2019, Environmental Impact Assessment (EIA), Report of the 300 MW Balakot Hydropower Development Project for the Asian Development Bank (ADB)
- Hagler Bailly Pakistan, September 2016, Biodiversity Strategy for Jhelum-Poonch River Basin – Preparatory Phase, Fish Surveys in Tributaries, for the International Finance Corporation.

4.1 Aquatic Biodiversity

As described in **Section 4.2** (*Ecological Baseline*) of the EIA of Project[24], the main aspects of the aquatic biodiversity in the Area of Management include the fish fauna, macro-invertebrates and riparian vegetation. This section describes the aquatic fauna in the area.

4.1.1 Overview of Fish Fauna in Kunhar River

The long distance migratory species Alwan Snow Trout *Schizothorax richardsonii,* Himalayan Catfish *Glyptosternum reticulatum* and Kashmir Hillstream Loach *Triplopysa Kashmirensis* are widely distributed species and found in the Kunhar River upstream and downstream of the proposed Project. The species Nalbant's Loach *Schistura nalbanti*, Stone Barb *Schistura alepidota*, Arif's Loach *Shistura arifi* and Flat Head Catfish *Glyptothorax pectinopterus* are mainly found in Kunhar River and tributaries downstream of the proposed Project dam but they are also recorded from few places upstream. The species Kunar Snow Trout *Schizothorax labiatus* is exclusively found in Kunhar River downstream of the proposed dam site. They tend to migrate in summers towards upper parts of the river. Two introduced species Brown Trout *Salmo trutta fario* and Rainbow Trout *Oncorhynchus mykiss* are found exclusively upstream of the proposed dam. These two are cold water species and of high food value. There is an extensive raceways[25] culture of Rainbow Trout in the areas upstream and downstream of the proposed dam. Alwan Snow Trout (both upstream and downstream of the dam) and Kunar Snow Trout (mostly downstream of the dam) are two other species of food value. They are not cultured but are captured from the river.

A total of ten species have been reported from the Kunhar River based on the surveys carried out in February 2017 and May 2017 conducted as part of the EIA of Project as well as the July 2016 surveys conducted as a part of Jhelum-Poonch Biodiversity

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[24] Hagler Baily Pakistan, 2019, Environmental Impact Assessment of the Balakot Hydropower Development Project, Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

[25] Raceway is based on the continuous water flowing through the culture tanks

Strategy – Preparatory Phase,[26] and advice from Dr Muhammad Rafique, a fish expert with the Pakistan Museum of Natural History (PMNH). Out of these one species is a long distance migratory species and two are endemic to the Jhelum Basin. The complete list of fish species which reported from the Kunhar River is given in **Exhibit 4.1**, along with information on their IUCN Red List Status, endemism and migratory behavior.

Exhibit 4.1: List of Species Reported from the Kunhar River

1	*Scientific Name*	*Common Name*	*IUCN Status*	*Endemic*	*Migratory*
1.	*Glyptosternum reticulatum*	Himalayan Catfish	Not Assessed		
2.	*Glyptothorax pectinopterus*	Flat Head Catfish	Not Assessed		
3.	*Salmo trutta fario*	Brown Trout	Not Assessed		
4.	*Oncorhynchus mykiss*	Rainbow Trout	Not Assessed		
5.	*Schistura alepidota*	Stone Barb	Not Assessed		
6.	*Schistura arifi*	Arif's Loach	Not Assessed		
7.	*Schistura nalbanti*	Nalbant's Loach	Not Assessed	✓	
8.	*Schizothorax labiatus*	Kunar Snow Trout	Not Assessed		
9.	*Schizothorax richardsonii*	Alwan Snow Trout	**Vulnerable**		✓
10.	*Triplophysa kashmirensis*	Kashmir Hillstream Loach	Not Assessed	✓	

Note: All species, except the Kunar Snow Trout were observed during the surveys (July 2016, February 2017 and May 2017). In the opinion of Dr Muhammad Rafique, a fish expert with the Pakistan Museum of Natural History (PMNH), the Kunar Snow Trout is also present in the Kunhar River.

4.1.2 Fish Diversity in Area of Management

The species reported from the Area of Management of the BAP are the ones listed in **Exhibit 4.2**.

Most of the fish fauna was observed either in the tributaries or at the confluences of the main river with the tributaries. The tributaries and confluences are considered sites of key intrinsic ecological value with unusual physical characteristics that support an increased diversity of organisms compared to the main stream of many rivers.[27] The physical heterogeneity resulting from the interaction of tributaries and main channels has implications for the ecology of river systems because increased habitat heterogeneity leads to an increase in fish biodiversity.[28] Tributary confluence points are often associated with increased productivity due to the supply of nutrients, drift and detritus from the tributary. The tributaries also increase energy subsidies in the form of organic matter and nutrients resulting in an increase in taxonomic diversity and productivity of aquatic system.[29]

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[26] Hagler Bailly Pakistan, September 2016. Jhelum Poonch basin Biodiversity Strategy – Preparatory Phase for the International Finance Corporation, Washington D.C.

[27] Rice, S. P., Kiffney, P., Greene, C. and Pess, G. R. (2008). The ecological importance of tributaries and confluences. In: River Confluences, Tributaries and the Fluvial Network. (eds. Rice, S. P., Roy, A. G. and Rhoads, B. L.), pp. 209-242. John Wiley and Sons.

[28] Downes, B. J., Lake, P. S., Schreiber, A. G. and Glaister, A. (1998). Habitat structure and regulation of local species diversity in a stony upland stream. Ecological Monographs 68, 237-257.

[29] Rice, S. P., Greenwood, M. T. and Joyce, C. B. (2001). Tributaries, sediment sources and the longitudinal organisation of macroinvertebrate fauna along river systems. Canadian Journal of Fisheries and Aquatic Science 58, 824-840.

Exhibit 4.2: List of Species of Conservation Importance

No.	*Scientific Name*	*Common Name*	*IUCN Status*	*Endemic/ Restricted Range*	** Locations where it was captured in Area of Management (**Exhibit 1.3**)*	*Distribution for Endemic/Restricted Range Species*	*Percentage out of global population in Aquatic Study Area (%)*	*Migratory*	*Commercial Importance*
1.	*Schistura nalbanti*	Nalbant's Loach	Not Assessed	✓	1. Kunhar River near Sangar 2. Jalora Nullah 3. Barna Nullah 4. Shisha Nullah near Confluence	Widespread but restricted to Jhelum Basin i.e. Downstream areas of Kunhar and Neelum rivers and whole stretch of Jhelum and Poonch rivers	10-15%		Low
2.	*Triplophysa kashmirensis*	Kashmir Hillstream Loach	Not Assessed	✓	1. Kunhar River near Confluence of Shisha Nullah	Widespread but restricted to Jhelum Basin i.e. Downstream areas of Kunhar river, throughout Neelum river and upstream stretch of Jhelum river	25-30%		Low
3.	*Schizothorax richardsonii*	Alwan Snow Trout	Vulnerable		1. Upstream Paras Town 2. Kunhar River near 3. Kunhar River near Sangar 4. Kunhar River near Confluence of Shisha Nullah 5. Bhonja Nullah Near Bhonja 6. Barniali Nullah near Confluence of Kunhar River 7. Jalora Nullah 8. Barna Nullah 9. Shisha Nullah near Confluence		<1%	✓	High

Source: Hagler Bailly Pakistan, June 2019, Environmental Impact Assessment (EIA), Report of the 300 MW Balakot Hydropower Development Project for the Asian Development Bank (ADB)

* Detailed Sampling Locations where range restricted species were captured in Aquatic Study Area is given in **Section 4.2.6** of the **EIA of Balakot Hydropower Development Project.**

4.1.3 Fish Migration and Movement Patterns in Kunhar River

During the low flow season (December and January), the main water channel contracts, but the flow in the river remains swift due to the steep river gradient. Thus the oxygen concentration is high in winter and hence is not a limiting factor. However the combination of low water temperature and the fast current make the river almost unfit for the survival of most of the fish species. This forces them to migrate and the species adopt different modes of migration to cope with the severe winters in the mountainous areas.

Three types of migration takes place at the onset of winter season, longitudinal, lateral and local migration. Longitudinal migration is long distance migration, shown by fish which have strong pectoral fins and streamlined bodies such as Alwan Snow Trout *Schizothorax richardsonii* and Kunar Snow Trout *Schizothorax labiatus*. To avoid the extreme cold conditions, the Alwan Snow Trout migrate downstream in different parts of Kunhar River, side nullahs (tributaries) which are comparatively warm and also take refuge in crevices and trenches in the slow moving areas of the river.

Lateral and local migration is demonstrated by fish which have no strong pectoral fins and their bodies are also not streamlined enough to cope with the flow of the river. Thus the species of the genera *Schistura* and *Triplophysa* show lateral migration as they move from the main river channel and nullah to side streams having comparatively higher temperature and slower water currents. They also occupy the crevices, boulder areas and trenches along the river bed. The species *Glyptosternum reticulatum* show local short migration and move to more suitable habitats occurring within the main river channel. These fish have adhesive apparatus in their thoracic region, which helps them to cling to the rock crevices and underneath large boulders where the water current is correspondingly lower.

During February – March, when the temperature of the Kunhar River starts to rise (7 °C – 9 °C), fish which have moved to side streams (lateral migration) return to the main river channel. The sub-mountainous fish fauna, that have a moderate temperature tolerance, now start their upstream migration which is of variable distances depending on their temperature preference.

During May and June, the variations that occur in water temperature becomes of primary importance in determining fish distribution within the Kunhar River. The water temperature rises up to 13-15°C. With the rise in temperature in June, the river upstream and downstream of Balakot is inhabited by Kashmir Hillstream Loach, which together with Alwan Snow Trout becomes the most common species of the river during this season. This situation remains persistent during summer up to the advent of monsoon. With the onset of cold weather, the cool water fish fauna gradually start to migrate downstream to spend winter in suitable areas where they can find warm water habitats. However, some fish which are trapped in warmer side pools fed by springs and side streams/nullahs cannot migrate downstream and instead overwinter in these areas.

The fish species Brown Trout and Rainbow Trout (cold water species) which inhabit the upper reaches of river most of the year, also start downstream migration during end of November and start of December. The temperature at the upper reaches drops to 4-5°C and during this season these species can be found up to Balakot. They spend winter in these areas and then they start upstream migration during early springs when temperature is 7-8°C in the main river.

4.1.4 Fish Species Recommended for Consideration in the BAP

Exhibit 4.2 lists species of conservation importance based on the IUCN Red List of Threatened Species, as well as endemic and migratory species expected or reported in the Area of Management. Information about their commercial importance is also provided in this exhibit.

The distribution of the three species of conservation importance is shown in **Exhibit 4.3, Exhibit 4.4** and **Exhibit 4.5**. Of the species, two are recommended for consideration in the BAP. These include the endemic or restricted range species Nalbant's Loach and Kashmir Hillstream Loach, for which the Kunhar River provides Critical Habitat. More information on the Critical Habitat Assessment carried out for these species is provided in **Section 4.1.6** (*Habitat Assessment)*.

Exhibit 4.3: Distribution of the Nalbant's Loach

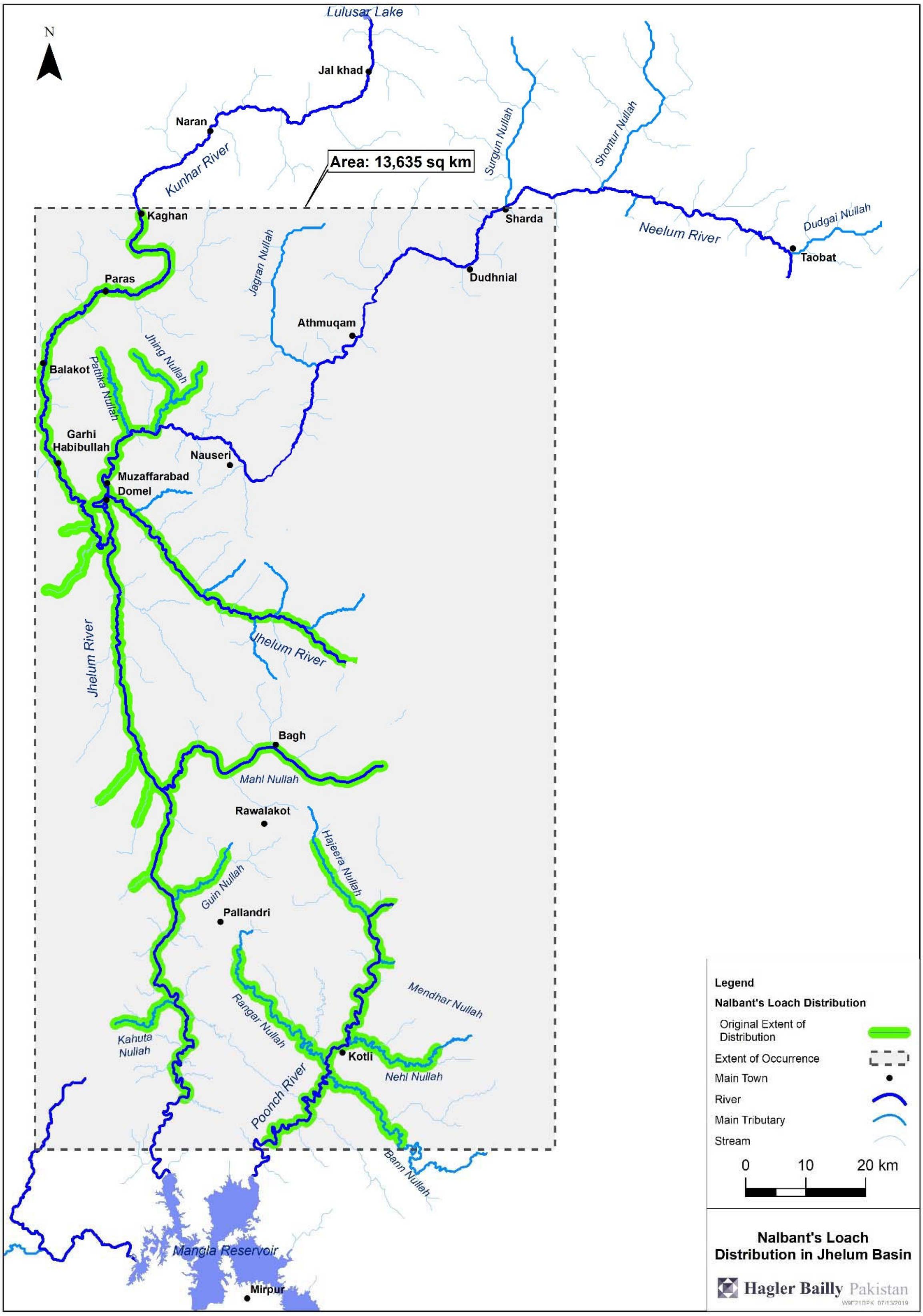


Exhibit 4.4: Distribution of the Kashmir Hillstream Loach

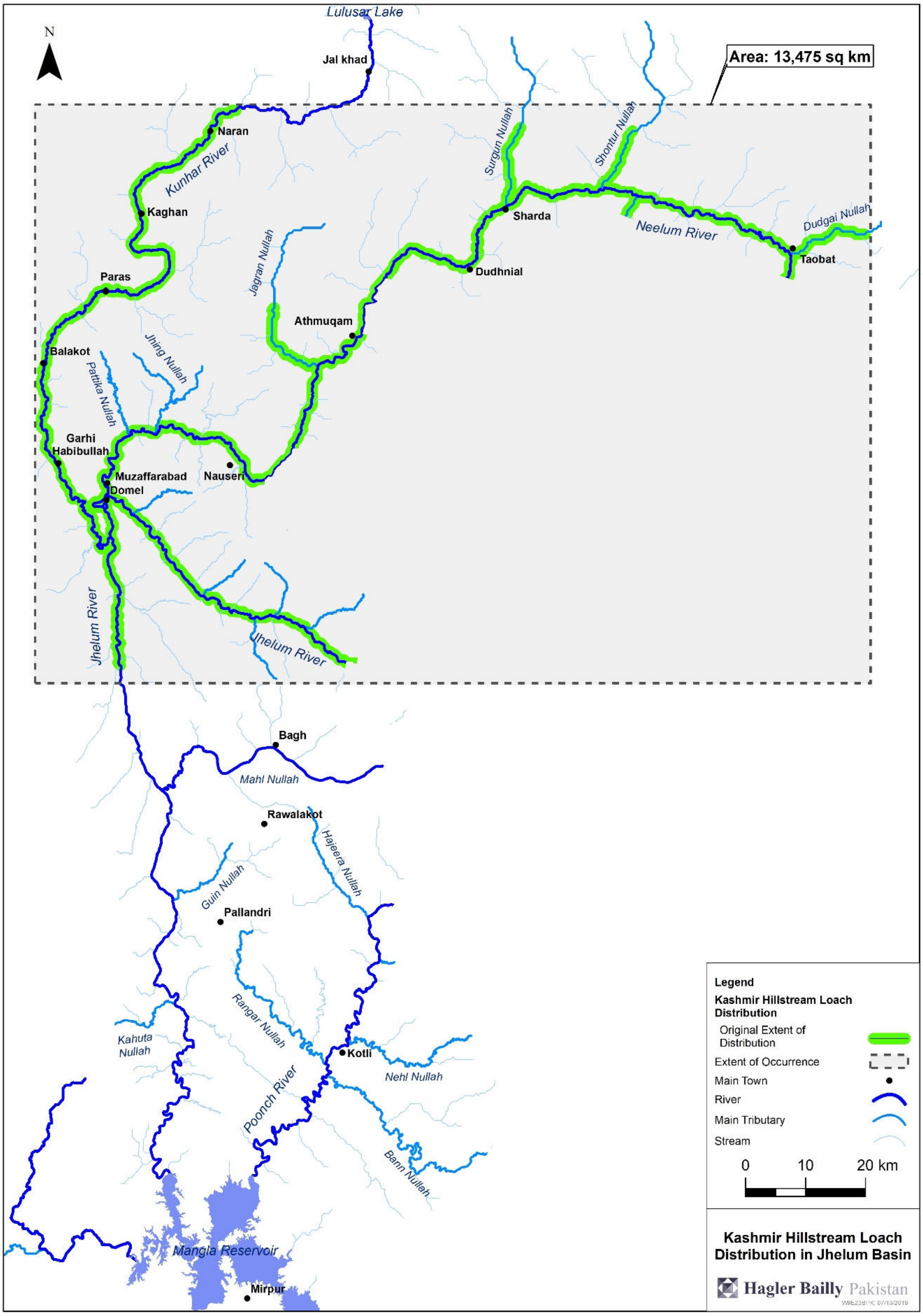
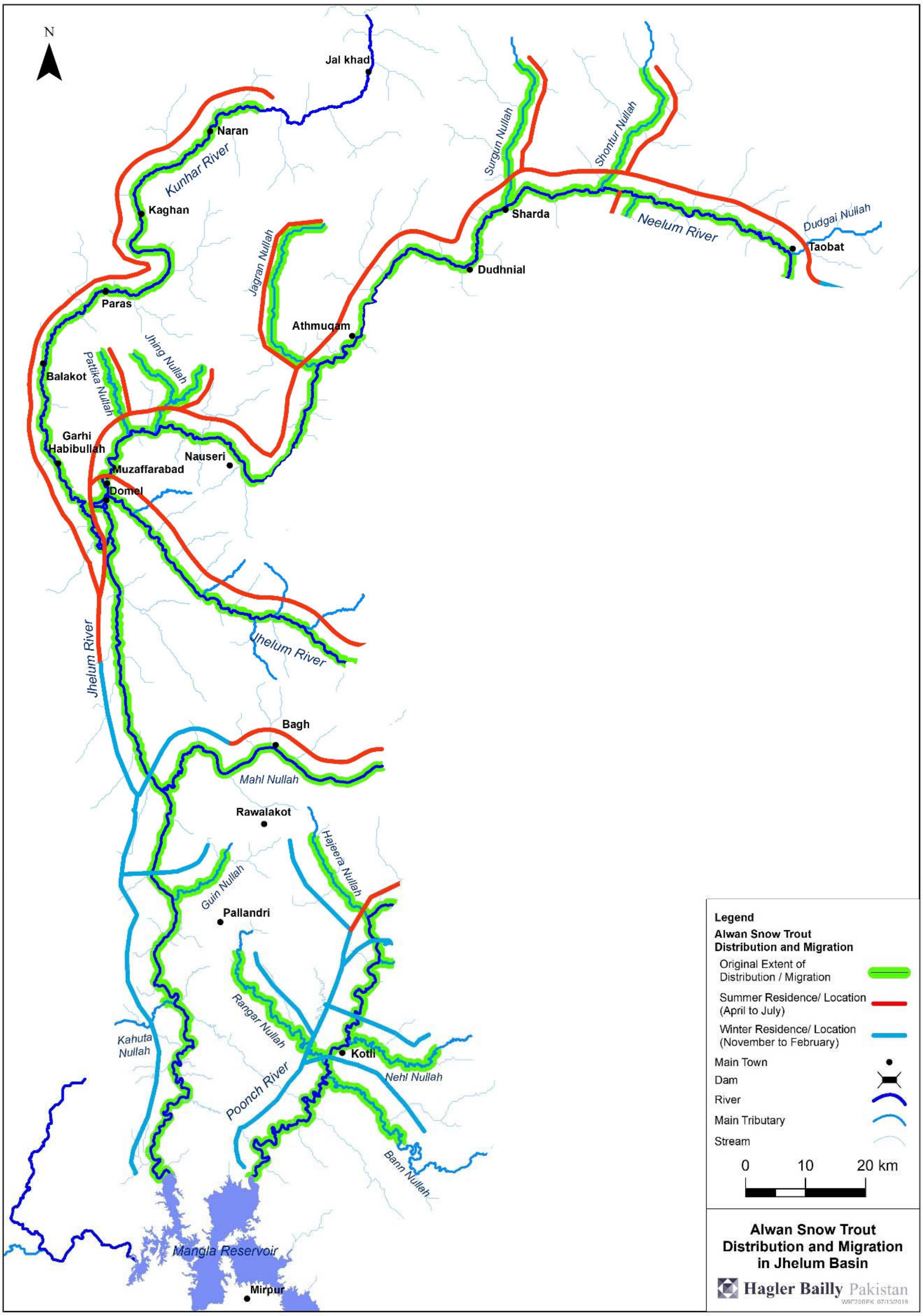


Exhibit 4.5: Distribution of the Alwan Snow Trout



The Area of Management is of significant importance to endemic species. There are two endemic and restricted range fish species found here including the Kashmir Hillstream Loach and the Nalbant's Loach, both of which were reported during the surveys carried out in February 2017 and May 2017.

Surveys for fish fauna were carried out in the Kunhar River and its tributaries in July 2016, February 2017 and May 2017 for the EIA of the Project. The results of these surveys are reported in the EIA (**Section 4.2** of the **EIA of Balakot Hydropower Development Project**).

During the July 2016 Survey, the highest relative abundance of the Kashmir Hillstream Loach was observed at Sampling Location K143.9, located upstream of Banda Balola Village at Kunhar River. No specimens of Nalbant's Loach were observed during the July 2016 Survey. During the February 2017 and May 2017 Surveys, the highest relative abundance of the Kashmir Hillstream Loach was observed at Sampling Location K139.0, located at the main Kunhar River near the confluence of Shisha Nullah. The highest relative abundance for the Nalbant's Loach was observed at Sampling Location BAR5.2, located in Barna Nullah near the confluence of main Kunhar River. **Exhibit 4.6** and **Exhibit 4.7** show the relative abundance of the Nalbant's Loach and Kashmir Hillstream Loach respectively, observed during the February 2017 and May 2017 Survey. Data from sampling carried out in July 2016 as part of the Biodiversity Strategy for Jhelum Poonch River basin – Preparatory Phase[30] was used to determine the presence of the two species downstream of Bissian. The Kashmir Hillstream Loach was observed downstream of Bissian in sampling carried out in July 2016. This is also shown in **Exhibit 4.6**. The Nalbant's Loach was not observed in the area downstream of Bissian during the July 2016 Surveys.

Migratory Fish Species

A single migratory species is reported and was observed in the Kunhar River during the surveys, the Alwan Snow Trout *Schizothorax richardsonii*. It was observed in both the main river and the tributaries. The Alwan Snow Trout is listed as Vulnerable on the IUCN Red List of Threatened Species. Its distribution ranges from the Himalayan region of India, Sikkim, Bhutan, Nepal, Pakistan and Afghanistan.

The species migrates to areas of lower elevations during winters to avoid extremely cold conditions at higher elevations. It migrates downstream to different parts of the Jhelum River up to Mangla Reservoir, and to the nullahs, which are comparatively warmer. It also takes refuge in crevices and trenches in the slow moving areas of the River. During early summers (end of March or start of April), it migrates back to its spawning grounds at higher elevations. It is quite common in the region and has sufficient populations, both upstream and downstream of the Project dam. The dam will create a barrier for migration of this species, but its population will not be significantly affected as there are sufficient breeding and spawning areas upstream and downstream of the dam.

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[30] Hagler Bailly Pakistan, September 2016. Biodiversity Strategy for Jhelum Poonch River basin – Preparatory Phase, for the International Finance Corporation, Washington D.C.

Exhibit 4.6: Abundance of Nalbant's Loach in the Area of Management, February 2017 and May 2017 Survey

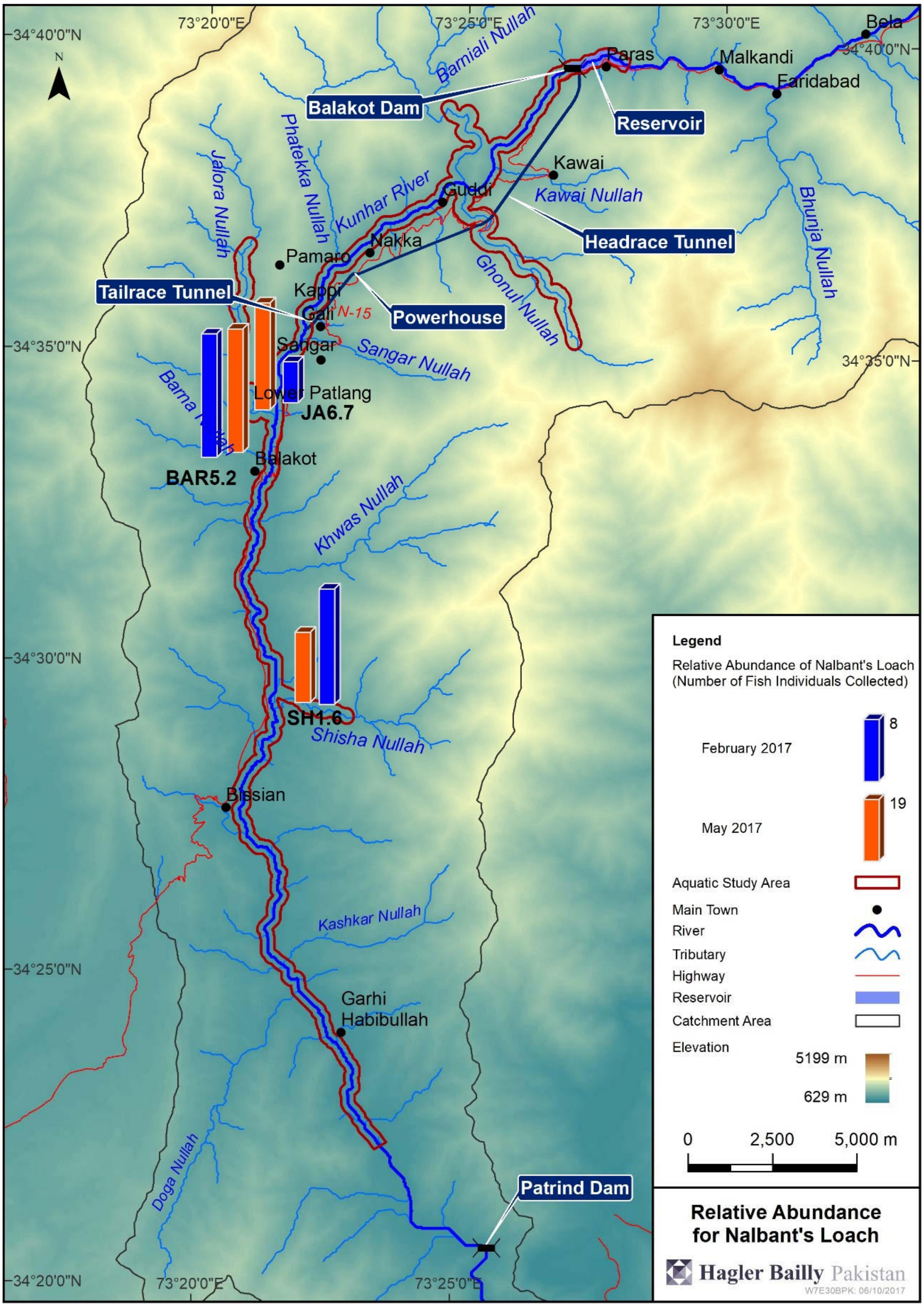
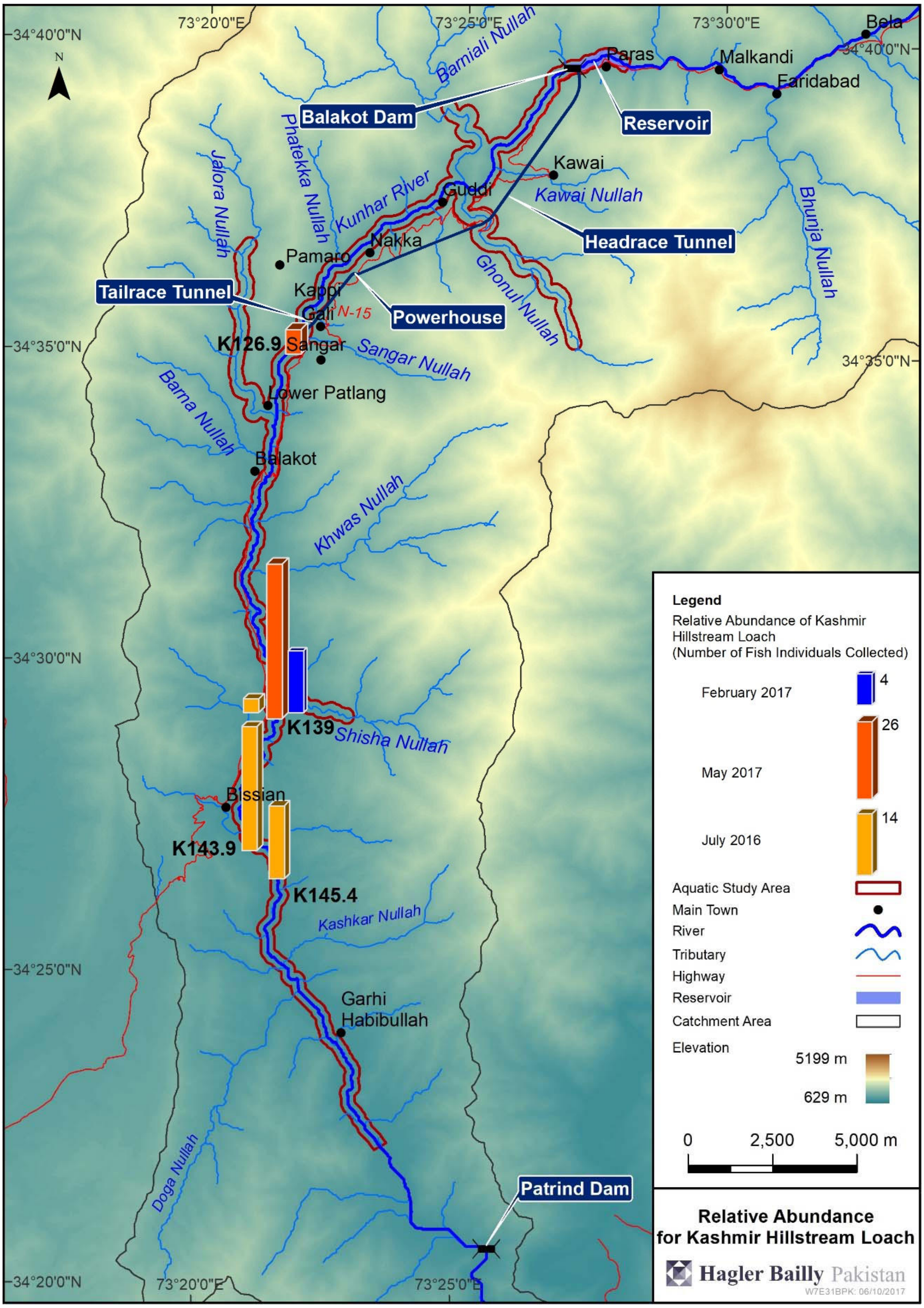


Exhibit 4.7: Abundance of Kashmir Hillstream Loach in the Area of Management, May 2017, February 2017 and July 2016 Survey



A total of 436 specimens of the Alwan Snow Trout were observed during the February and May 2017 Surveys, with 161 observed in the main river and 275 observed in the tributaries. A total of 137 specimens of the Alwan Snow Trout were observed during the February 2017 Survey and a total of 299 were observed during the May 2017 Survey. During both surveys, the relative abundance was higher in the tributaries than in the main river. The highest number of specimens, 70, were observed in Jalora Nullah during the May 2017 Survey. The second highest number, 40 specimens, were observed in Shisha Nullah near the confluence during the February 2017 Survey.

The Alwan Snow Trout was considered in the habitat assessment carried out as part of the Ecological Baseline for the EIA (**Section 4.2.6** of the **EIA of Balakot Hydropower Development Project**), under the criteria to assess migratory species. Based on expert judgment about population estimates, the species did not trigger Critical Habitat. More information on the Critical Habitat Assessment carried out for this species is provided in **Section 4.1.6** (*Habitat Assessment*).

Fish Species of Commercial Importance

The surveys carried out for the EIA of Project identified three species as being of commercial importance. These include the Alwan Snow Trout, Rainbow Trout and Brown Trout. Both the Brown Trout and Rainbow Trout are stocked in the River by the Fisheries Department, KP. The Brown Trout has a lower abundance than the Rainbow Trout. These are also the fish species of commercial importance that occur in the Area of Management.

4.1.5 Threats to Fish Fauna

The baseline status for illegal fishing and sand, gravel and cobble mining was determined by surveys carried out by the socioeconomic survey team in the Socio-economic Study Area. This extends from the tailrace tunnel of Suki Kinari HPP, upstream of the Project dam, to the start of reservoir of the Patrind HPP, downstream of the Project Dam (see **Section 4.3.1** of the **EIA of Balakot Hydropower Development Project**). A part of these surveys was to gather information on the river-dependent socioeconomic activities. In summary, pilot surveys were carried out to determine the river-dependent communities along the river. On average 36% of communities within each rural zone were covered through settlement level surveys. Out of these, 31 communities were surveyed to prepare the socioeconomic baseline.

Illegal Fishing

An analysis of quantity of fish caught in different segments of Kunhar River in the Area of Management, and income and livelihood dependence of communities on fishing is included in **Section 4.3.4** of the **EIA of Balakot Hydropower Development Project**. Intensity of illegal fishing in the Area of Management is illustrated in **Exhibit 4.8**.The entire stretch of the Kunhar River along with its tributaries is subject to illegal fishing. The Fisheries Department, KP allows angling and the use of cast nets to catch fish and issues permits for this purpose. The use of gill nets, fine mesh seine nets, and lines are banned. The number of permits issued by the Department is small, and none of the fishermen observed during the surveys carried out for the Project EIA, had a permit.

Pools in the River are preferred fishing areas. This is because the relatively deeper areas provide refuge to the larger fish that are the preferred catch. Fishing is limited by accessibility of locations. The impact of fishing pressure on the river ecosystem is dependent on the methods used, number of fishermen, and the location and timing of the fishing activities. In general, fishing in the tributaries, particularly during breeding migrations, is more harmful to fish populations than fishing at other locations and other times of the year. Fishing methods can be categorized into two broad headings[31].

- *Selective fishing pressure*: fishing using selective gear such as gill nets, cast nets and fishing rods. This type of fishing tends to target specific species and the adult populations including Alwan Snow Trout and Rainbow Trout.
- *Non–Selective fishing pressure*: fishing using non–selective methods such as explosives and poisons. This type of fishing tends to result in large collateral losses of non–target fish and other aquatic species, as well as indiscriminate loss of early fish life stages (fry, fingerlings, eggs and larvae) especially if done during the breeding season of fish. This includes loss of fish of conservation and commercial importance such as Alwan Snow Trout, Kashmir Hillstream Loach and Nalbant's Loach. It may also cause localized habitat destruction. The use of finer nets called gill nets is included in non–selective fishing. Other methods of non-selective fishing include use of poisons, dynamite, electrocution, and gill nets.

Based on an analysis of data collected as part of the ESIA of Kohala HPP, fishing pressure is expected to increase along the Kunhar River, as has been observed along other rivers in the basin, including the Jhelum and Neelum Rivers, from 2013 to 2016. An increasing trend in fishing pressure was also highlighted by Mohammad Tanvir, Assistant Director, Mansehra of the Fisheries Department, KP.

Photographs of illegal fishing activities and illegally caught fish are shown in **Exhibit 4.9**. Some of the species observed to be caught from illegal fishing included the Alwan Snow Trout and Brown Trout. Illegal fishing was observed at sites near Hisari, Karnol, Bissian and Paras (**Exhibit 4.8**).

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[31] Hagler Bailly Pakistan, October 2015. Biodiversity Action Plan of Gulpur Hydropower Project prepared for Mira Power Ltd.

Exhibit 4.8 Fishing Intensity

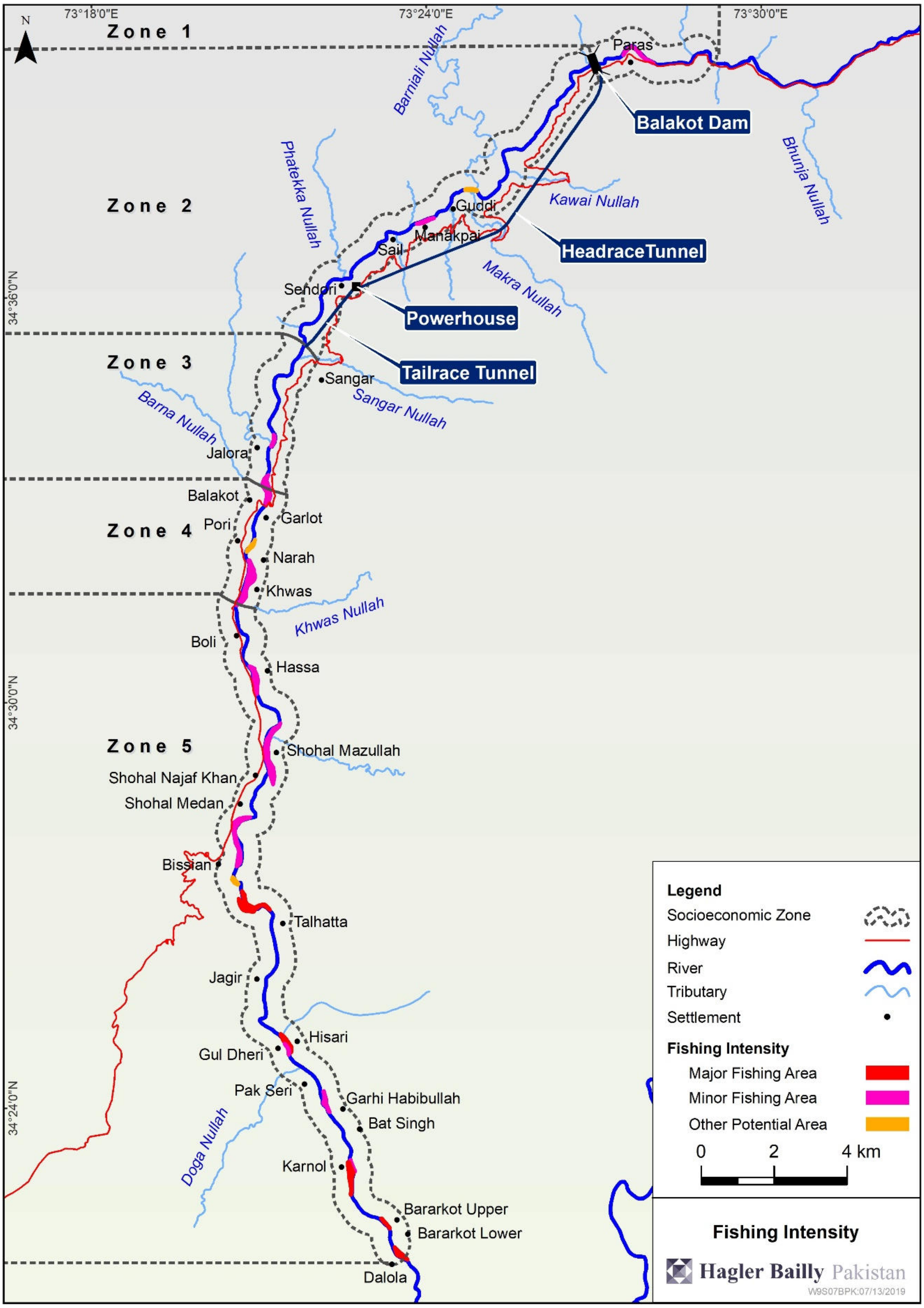
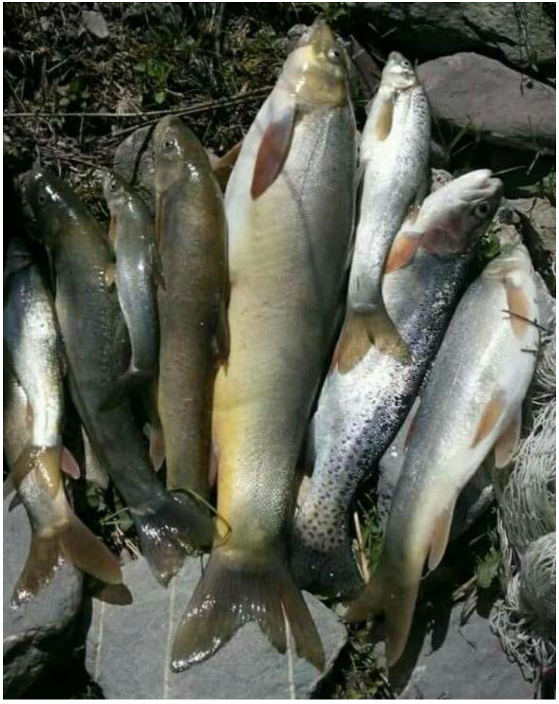


Exhibit 4.9: Illegal Fishing

Illegal fishing using rod at Hisari

Illegal fishing using cast net upstream of Bissian

Illegal fishing using gill net downstream of Bissian



Illegal fish at Paras. Species include Alwan Snow Trout and Brown Trout

Illegal fish at Paras. Alwan Snow Trout observed at Bissian

About 2% of the households in the Study Area for the socioeconomic baseline of the EIA are engaged in fishing, and fishing accounts for only 0.01% of their total incomes (**Section 4.3.4** of the **EIA of Balakot Hydropower Development Project**). Information collected for the socioeconomic baseline shows that overall 88% of the fish caught is self-consumed which is the reason for the low level of income generated from fishing.

Unregulated Sediment Mining

An analysis of sediment (sand, gravel and cobble) mined in different segments of Kunhar River in the Area of Management, and income and livelihood dependence of communities on mining is included in **Section 4.3.4** of the **EIA of Balakot Hydropower Development Project**. The demand for river sediment is driven by the construction of roads (boulders and cobbles), and new homes (building sand). The expansion of the road network and increased stability and accessibility has led to considerably increased mining activities in the last 10–20 years in similar basins in the region.[32] The improved road network can also open up additional areas for access for sediment mining.

In-stream mining results in the destruction of aquatic and riparian habitat through large changes in the river bed and channel morphology. Impacts include bed degradation, bed coarsening, lowered water tables near the streambed, and channel instability. These physical impacts cause degradation of riparian and aquatic biota.

Sediment mining not only destroys aquatic habitats at the point of mining activities but also changes the size and amount of sediment that is distributed downstream, which can affect aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock–on effects on the fish and other biota.

Mining results in physical destruction of fishing grounds and results in loss of important spawning or nursing ground areas for fish. Fish communities are potentially impacted by changes in turbidity and sediment erosion, transport and deposition. Increased turbidity can impact fish by reducing their feeding efficiency and increasing their overall physiological stress. Increased sediment loads can disrupt fish reproductive success by interfering with the viability of their eggs and fry.[33]

In addition to the fish, the benthic invertebrates that provide food for most of the carnivorous fish of the river are also impacted negatively by mining. A change in the river turbidity, caused by mining, causes a decline in species diversity, abundance, and productivity of the macro-invertebrates.

Data collected as part of the socioeconomic baseline in the EIA found that 467,030 m^3 of sediment is mined annually within the socioeconomic Study Area[34] (**Section 4.3.4** of the **EIA of Balakot Hydropower Development Project**). The majority (98%) is extracted in

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[32] Based on an analysis of data collected as part of the ESIA of Kohala HPP, sediment extraction is expected to increase along the Kunhar River as has been observed along other rivers in the basin including the Jhelum and Neelum Rivers from 2013 to 2016.

[33] M.J Robertson et al, 2006. Effects of Sediment on freshwater fish and Fish Habitats, Canadian Technical Report Of Fisheries and Aquatic Sciences 2644

[34] This extends from the tailrace tunnel of Suki Kinari HPP, upstream of the Project dam, to the start of reservoir of the Patrind HPP, downstream of the Project dam.

Zone 5, between the stretch from Shahator Village (2.5 km downstream of Balakot Town) to Dalola Village.

Exhibit 4.10 shows the intensity of sand mining in the socioeconomic Study Area. **Exhibit 4.11** shows photographs of sand mining activities at locations along the Kunhar River, at Hisari, Barakot, Shohal Medan, Tarnol, Bissian, Paras, Garhi Habibullah and Dolal (**Exhibit 4.10)**.

Water Quality

An analysis of water quality and an assessment of impacts on it, was carried out as part of the EIA of Project. The results are provided in **Section 4.1.7** of the **EIA of Balakot Hydropower Development Project**. The concerns with respect to water quality, as presented in the EIA, are summarized here.

The Kunhar River receives wastewater and contaminated seepage associated with household and commercial water use in its catchment. Pollutants associated with human settlements include nitrates, phosphates and biological oxygen demand (BOD). At present the population density is relatively low in the catchment and the level of contamination is indicated by a low BOD and high levels of dissolved oxygen.

The water quality results found that the water in both the main River and tributaries is bacteriologically contaminated and unsatisfactory for drinking due to fecal contamination. Amongst heavy metals, aluminum was found to be above NEQs and WHO standards at a sampling location near Talhatta, which can be attributed to higher colloidal particles in river water. Contamination levels in the river will increase in the long term with population and economic growth, especially during the dry season when the capacity of the river to flush and dilute contaminants from a large urban area declines. Deforestation and change in land use patterns will also increase erosion and consequentially turbidity of water in the long term.

Exhibit 4.10: Sand Mining Intensity

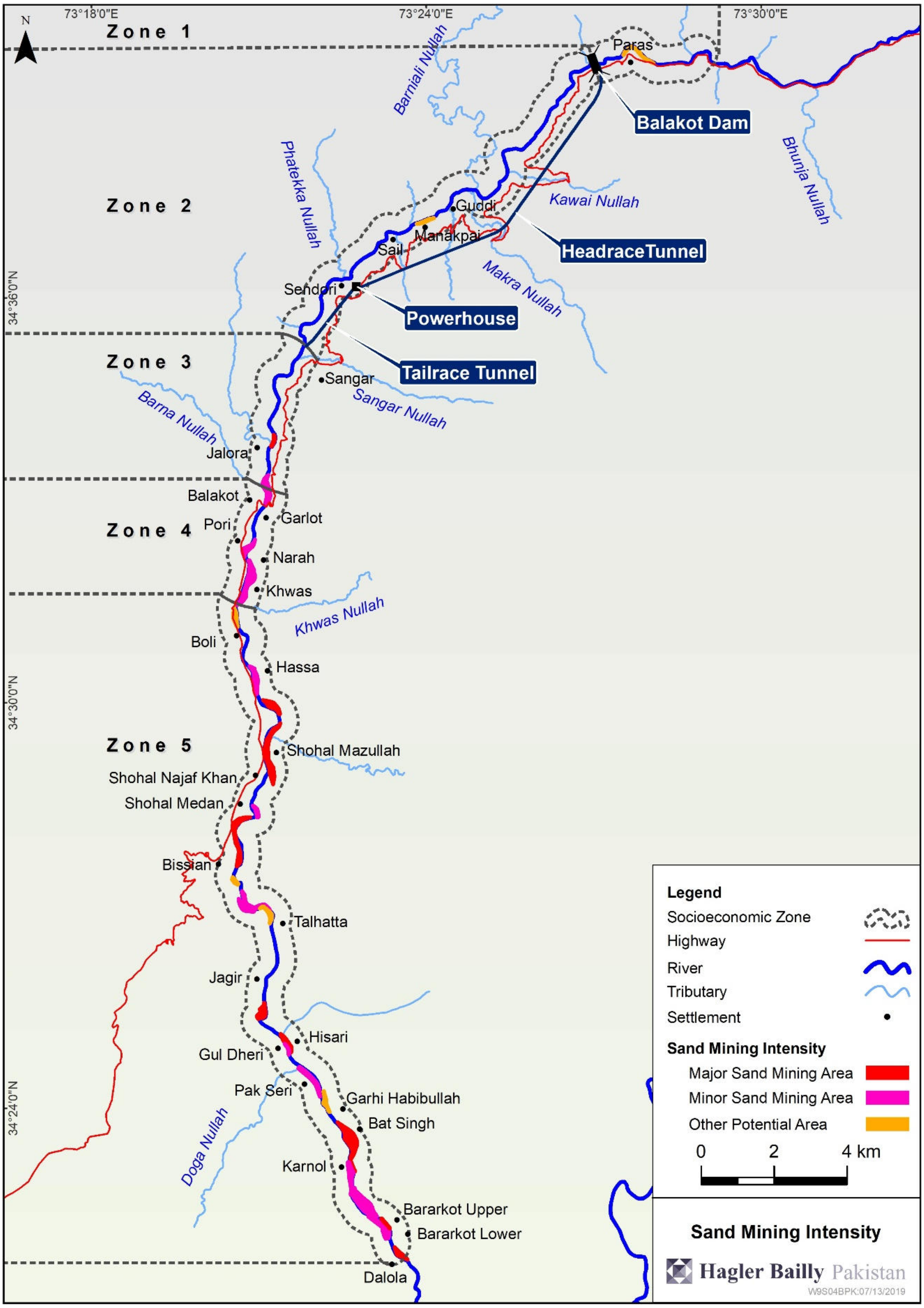

Exhibit 4.11: Photographs of Sand Mining Activities


Boulder mining at Hisari


Sand mining using heavy machinery at Barakot


Sand mining at Shohal Medan


Mining at Tarnol


Sand mining at Bissian


Sand mining evidence at Paras Village


Sand mining at Garhi Habibullah


Sand mining at Dalola Village

4.1.6 Habitat Assessment

A habitat assessment was carried out in **Section 4.2.8** of the **EIA of Balakot Hydropower Development Project** under the guidelines provided in IFC PS6.[35] It involves assessments to determine whether the Project area is a Natural or Modified Habitat and if the Project is located in a Critical Habitat. These are defined below.

Natural Habitat, Modified Habitat and Requirement of No Net Loss

The definitions of Natural Habitat and Modified Habitat are provided below.

Natural Habitat: Land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions.[36]

Modified Habitat: Natural habitat that has been altered as a result of human activities such as agricultural, forestry or urban development, or through the introduction of alien species.[37]

The Habitat Assessment carried out as part of the Project EIA (see **Section 4.2.8** of the **EIA of Balakot Hydropower Development Project**) concluded that both the Aquatic Study Area[38] and the Terrestrial Study Area[39] is Modified Habitat, not Natural Habitat. Therefore, habitat in the Area of Management is also Modified Habitat.

The Aquatic Study Area is considered a Modified Habitat because of the changes in flows as a result of regulation of the river. This is due to development of the under-construction Sukki Kinari HPP upstream of the Project and the Patrind HPP downstream of the Project. Therefore, the requirement to ensure no net loss for the Biodiversity Values under IFC PS6 does not apply in this case.

Critical Habitat Assessment and Requirement of Net Gain

Critical Habitat:

The criteria for Critical Habitat Assessment are as follows;

1. Habitat of significant importance to Critically Endangered and/or Endangered species
2. Habitat of significant importance to endemic and/or restricted-range species
3. Habitat supporting globally significant concentrations of migratory species and/or congregatory species

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[35] Hagler Baily Pakistan, August, 2016. Environmental and Social Impact Assessment (ESIA) Report of the 1,124 MW Kohala Hydropower Project for Kohala Power Company (Pvt) Limited.

[36] International Finance Corporation (IFC). January 2012. Policy on Social and Environmental Sustainability, Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, The World Bank Group.

[37] Ibid

[38] The part of the Kunhar River starting from Faridabad upstream of the Project to Bissian downstream of the Project

[39] The Terrestrial Study Area includes the proposed Project facilities and a 1 km buffer around locations where Project-related facilities are to be located.

4. Highly threatened and/or unique ecosystems
5. Areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services

The biodiversity studies conducted for the Project indicate presence of valued aquatic biological resources, including the endemic[40] and restricted range[41] Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*, both of which will be affected by the Project. The Kunhar River provides Critical Habitat for both these species based on Criteria 2, 'Habitat of significant importance to endemic and/or restricted-range species' (see **Section 4.2.8** of the **EIA of Balakot Hydropower Development Project**). This is because the Kunhar River provided habitat for:

- ≥ 1 percent but < 95 percent of the global population of the Nalbant's Loach and Kashmir Hillstream Loach triggering Critical Habitat under Tier 2 sub-criteria for Criterion 2 (habitat to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where the habitat could be considered a part of the discrete management unit for that species, where data are available and/or based on expert judgement).

The Discrete Management Unit (DMU) used for Critical Habitat Assessment for these restricted range species is shown in **Exhibit 4.12**. These have been determined based on the maximum range of the species upstream of the Project and to the dam of the existing Patrind HPP. The ranges of both species extend into the Jhelum River as well, however, due to the presence of the Patrind HPP, the DMU has not been extended to the Jhelum River. Based on expert judgement, the habitat in this DMU is known to sustain ≥ 1 percent but < 95 percent of the global population of both endemic species, therefore, Tier 2 sub-criteria for Criterion 2 is triggered, making this a Critical Habitat. Loss of such a habitat could potentially impact the long term survivability of the species.

The DMU for the Alwan Snow Trout is shown in **Exhibit 4.13**. It extend from the maximum range of the Alwan Snow Trout upstream of the Project to the dam of the Patrind HPP, which creates a barrier for its migration. This species is also found in India, Nepal and Bhutan.[42] Based on expert judgement, the habitat within the DMU consists of less than 1% of the global population of the species. As a result, the Kunhar River does not provide Critical Habitat for this species.

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[40] Endemic refers to endemic to the Jhelum Basin

[41] Having an extent of occurrence of less than 20,000 sq km

[42] Vishwanath, W. 2010. Schizothorax richardsonii. The IUCN Red List of Threatened Species 2010: e.T166525A6228314. http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166525A6228314.en. Downloaded on 07 June 2017.

Exhibit 4.12: Discrete Management Unit for the Nalbant's Loach and Kashmir Hillstream Loach

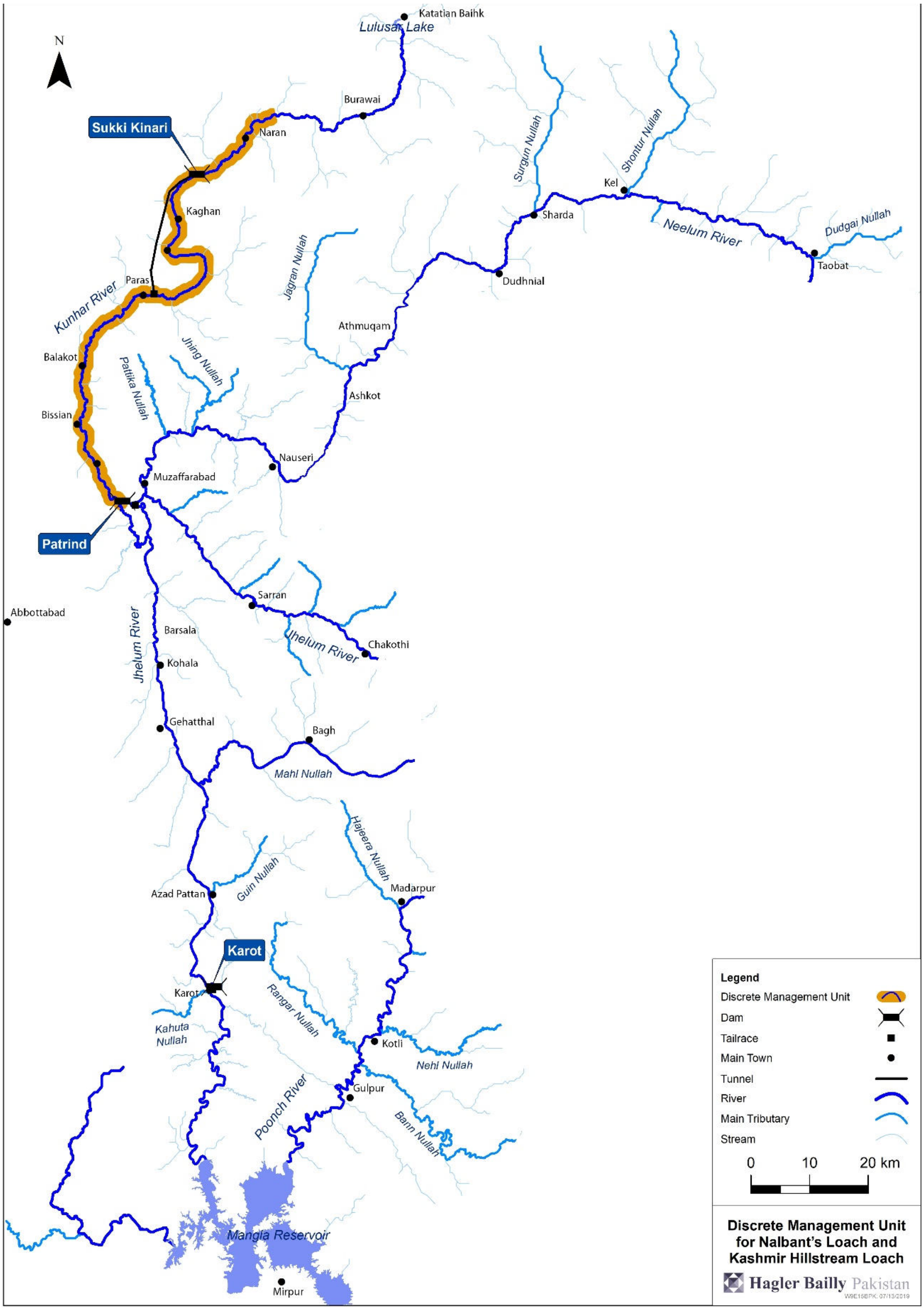
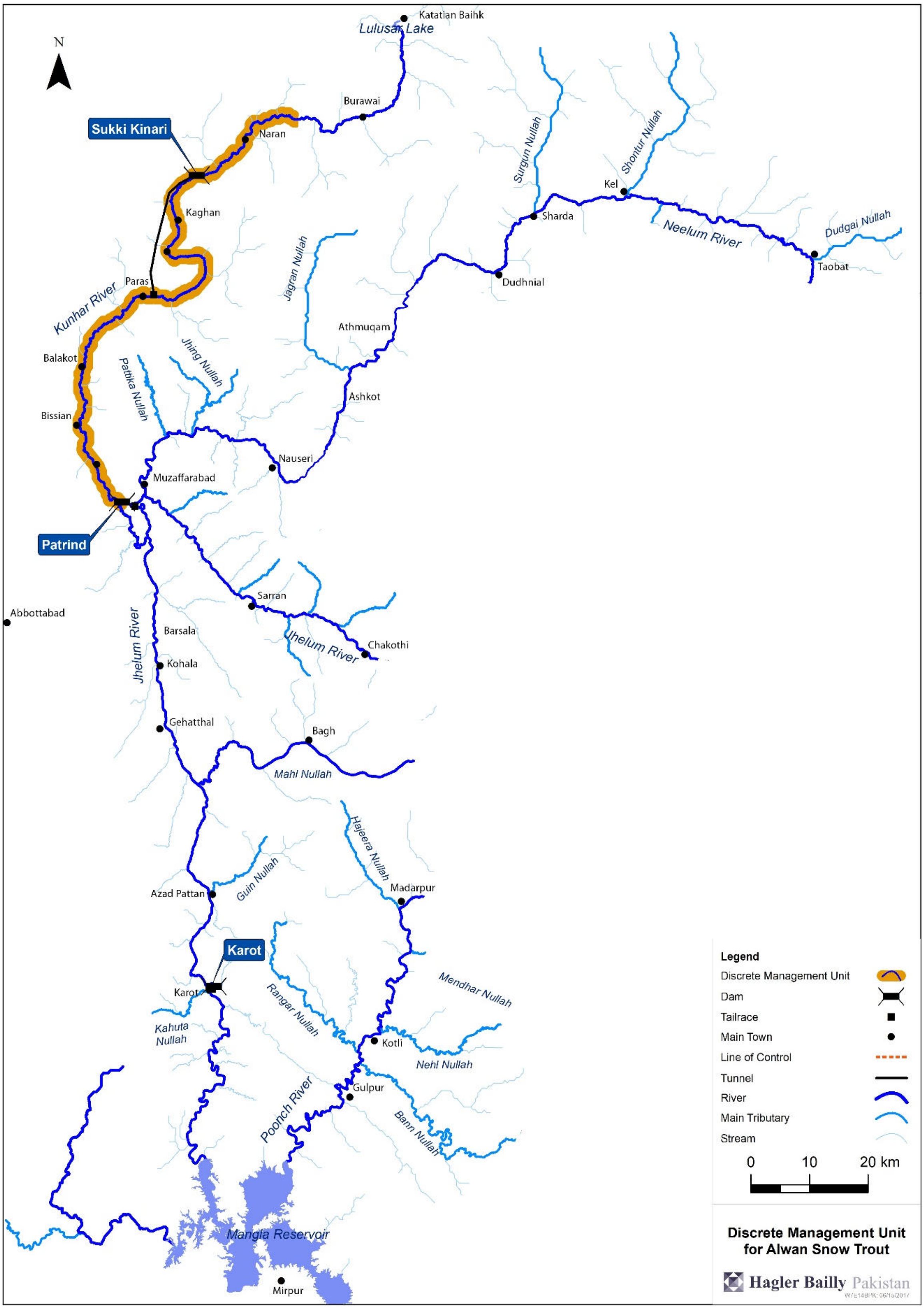


Exhibit 4.13: Discrete Management Unit for the Alwan Snow Trout



Once the Project becomes operational, the habitat downstream of the dam will be exposed to lower flows due to diversion of the river flow into the power generation tunnels. Habitat upstream of the dam will be affected due to inundation by the reservoir created by the dam. Habitat downstream of the tailrace tunnel will be affected due to the changes in flow as a result of release of water from the powerhouse.

According to IFC PS6, Net Gain is required for those ecological resources that for which the DMU provides critical habitat - in this case the Nalbant's Loach and Kashmir Hillstream Loach.[43] Under PS6 "Net Gains" are defined as "additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated." The PS further defines how the Net Gains can be achieved: "Net Gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of this Performance Standard without a biodiversity offset, the client should achieve Net Gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity." This BAP has therefore been designed to show increase in population for the two fish species: Kashmir Hillstream Loach and Nalbant's Loach. Even though the Kunhar River does not provide Critical Habitat for the Alwan Snow Trout, the BAP includes measures to conserve this species in view of the fact that it is a migratory species listed as Vulnerable in the IUCN Red List.

4.1.7 Macro-invertebrates

The abundance and richness of various macro-invertebrate taxa has been reported in the EIA of Project based on surveys carried out in May 2017 for the EIA (see **Section 4.2.6** of the **EIA of Balakot Hydropower Development Project**). The abundance was found to be higher in areas upstream of Balakot Town as compared to downstream. The most abundant macro-invertebrate taxa observed include *Baetis sp* followed by and *Rhithrogena sp*. This is a common observation around the world as these taxa can live in a variety of habitat including running and standing water. They also have a relatively high tolerance for pollution, thereby, surviving with increased anthropogenic activity.[44] The abundance of the taxa *Chironomidae* was found to be low. According to a macro-invertebrate expert from the Pakistan Museum of Natural History (PMNH) this can be attributed to the relatively faster flow of water in the area during the summer months.

4.1.8 Riparian Vegetation

The dominant plant species in the riparian zone of the Terrestrial Study Area, reported in the EIA of the Project, include *Parthenium hysterophorus*. *Conyza Canadensis* and *Rumex dissectus* (see **Section 4.2.6** of the **EIA of Balakot Hydropower Development Project**). Vegetation cover in the Terrestrial Study Area was reported as ranging between 0.37% and 0.13%, average plant count was 27.50 and floral diversity was reported as 3.25 species per sampling location.

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[43] Biodiversity Conservation and Sustainable Management of Living Natural Resources, Performance Standard 6, International Finance Corporation, 2012

[44] Hagler Bailly Pakistan, July 2019. Environmental and Impact Assessment (EIA) Report of the 300 MW Balakot Hydropower Development Project for Asian Development Bank (ADB)

The EIA of the Project reported that the riparian vegetation is naturally sparse as it is eroded by floods when the velocity of water is high. It is further degraded by extraction of wood and grazing along the banks that are easily accessible to the local community.

4.2 Terrestrial Biodiversity

The terrestrial biodiversity section briefly describes the terrestrial habitat in the Project area and focuses on plant, mammal, birds, and herpetofauna species. The baseline status for these biological resources has been developed drawing on the information and analysis in the EIA of the Project (see **Section 4.2.7** of the **EIA of Balakot Hydropower Development Project**). The Terrestrial Study Area defined for the EIA included the proposed Project facilities and a 1 km buffer around locations where Project-related facilities are to be located

The habitat within the area acquired for the Project is designated as Modified Habitat as human activity has modified the land use and vegetation within most of it, even at higher elevations. There are patches of forests, mainly on very steep slopes, where access by people is limited. The locals report that wild animals such as the Common Leopard and Black Bear are common in the area, especially at higher elevations.

The area acquired for the Project is calculated as 47.6 ha. Based on ***Google Earth™*** satellite imagery, the total area of the different habitat types that are within the acquired area include 14.4 ha of Agricultural Area habitat, 18.4 ha of Scrub Forest habitat and 6.1 ha of Pine Forest habitat (see **Section 4.2.7** of the **EIA of Balakot Hydropower Development Project**).

4.2.1 Terrestrial Flora

The EIA of the Project provides a description of the vegetation in the area surrounding the Project. Floristically, the Terrestrial Study Area falls in the Sino-Japanese Region. Within Pakistan this area is mountainous and comprises the outer ranges of the Himalayas. The elevation within the region ranges from 600 m to 4,800 m. The Area of Management has an elevation range of 1,000 m to 1,500 m.[45]

The EIA divided the area around the Project facilities and infrastructure into three main type, Agricultural Area, Scrub Forest and Pine Forest. The area is dominated by Scrub Forest habitat, with Agricultural Area and Pine Forest habitat occupying about equal percentage of the rest of the area. The Scrub Forest habitat was reported to have a plant cover of 10.8% to 4.2% with a species diversity of 4.60. The Agricultural Area habitat was reported to have a plant cover of 6.6% to 4.0% with species diversity of 7.50, while the Pine Forest habitat was reported to have a plant cover of 18.8% to 6.8% and species diversity of 5.33.

The surveys carried out in May 2017, as part of the EIA of Project, identified a total of 32 plant species. None of the species observed in the area around the Project site were found to be globally/nationally threatened species, endemic species or protected species, with

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[45] Nasir, Yasin J., and Rubina A. Rafiq. "Wild flowers of Pakistan."Karachi: Oxford University Press xxxiii, 298p., 104p. of plates-illus., col. illus. ISBN195775848 (1995).

the exception of Common Walnut *Juglans regia*, which is Near Threatened based on the IUCN Red List.[46]

The dominant species based on habitat type were identified in the EIA. In Agricultural Area habitat the dominant species include *Juglans regia*, *Berberis sp.*, and *Fragaria vesca*. In Scrub Forest habitat the dominant species include *Rumex dissectus* followed by *Cannabis sativa* and *Ficus carica*, while in the Pine Forest habitat the dominant species include *Pinus roxburghii*, *Pinus wallichiana*, and *Cedrus deodara*.

Invasive Species

An alien or non-native plant or animal species is one that is introduced beyond its original range of distribution. Invasive alien species are non-native species that may become invasive or spread rapidly by outcompeting other native plants and animals when they are introduced into a new habitat that lacks their controlling factors as determined by natural evolution.[47]

A total of seven invasive species were reported in the EIA. These include the following:

- Parthenium Weed *Parthenium hysterophorus*
- Common Weed *Phragmites karka*
- Castor Oil Plant *Ricinus communis*
- Cannabis *Cannabis sativa*
- Tree-of-heaven *Ailanthus altissima*
- Black Locust *Robinia pseudoacacia*
- Pink Cheeseweed *Malva parviflora*

A risk assessment was carried out as part of the EIA of Project (**Section 4.2.7** of the **EIA of Balakot Hydropower Development Project**). Most of the Project-related activities will take place in Scrub Forest habitat. Invasive species found in this habitat type include Tree-of-heaven, Cannabis, Pink Cheeseweed and Black Locust. The invasive species were ranked based on Importance Value Index (IVI) and Relative Cover in Terrestrial Habitats (Agriculture Area, Scrub Forest and Pine Forest habitats) and Riparian habitat. The dominant invasive species based on IVI and Relative Cover in each habitat type are provided in **Exhibit 4.14** and **Exhibit 4.15**.

Exhibit 4.14: Importance Value Index (IVI)

Ranking	*Terrestrial Habitats (Agriculture Area, Scrub Forest and Pine Forest habitats)*	*Riparian Habitat*
1.	Cannabis *Cannabis sativa*	Parthenium Weed *Parthenium hysterophorus*

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[46] Ibid

[47] International Finance Corporation, 2012, Guidance Note 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources

Ranking	Terrestrial Habitats (Agriculture Area, Scrub Forest and Pine Forest habitats)	Riparian Habitat
2.	Tree-of-heaven *Ailanthus altissima*	Common Weed *Phragmites karka*
3.	Black Locust *Robinia pseudoacacia*	Castor Oil Plant *Ricinus communis*
4.	Pink Cheeseweed *Malva parviflora*	

Exhibit 4.15: Relative Cover (C3)

Ranking	Terrestrial Habitats (Agriculture Area, Scrub Forest, and Pine Forest habitats)	Riparian Habitat
1.	Tree-of-heaven *Ailanthus altissima*	Parthenium Weed *Parthenium hysterophorus*
2.	Black Locust *Robinia pseudoacacia*	Common Weed *Phragmites karka*
3.	Cannabis *Cannabis sativa*	Castor Oil Plant *Ricinus communis*
4.	Pink Cheeseweed *Malva parviflora*	

The habitat found to be most at risk is the Riparian Habitat. The dominant species in this habitat type is Parthenium Weed (based on IVI) which spreads as a result of disturbance. This also indicates that the Riparian Habitat is most disturbed.

Ethnobotany

Studies have been carried out on the ethnobotanical value of plants in the Mansehra District. The areas selected for the studies that are closest to the Terrestrial Study Area and representative of the fauna include Siran, Shogran and Kaghan Valleys.

Studies have shown that Siran has about 123 species, while Shogran hosts 117 species of plants having high ethno botanical and medicinal importance.[48] Many of these plants have been found to have more than one local use. These include use as fuel wood, forage/fodder, medicinal, edible, shelter making, timber wood and furniture wood. Medicinal plants are used in the treatment of skin disorders and respiratory disorders, as diuretics, expectorants, digestives, and anti-inflammatory agents.

4.2.2 Mammals

The forests of the area provide habitat for mammal species including Yellow-throated Marten *Martes flavigula*, Giant Red Flying Squirrel *Petaurista petaurista*, Flying Squirrel *Hylopetes fimbriatus*, Leopard Cat *Prionailurus bergalensis*. Grey Langur *Semnopithecus entellus*, Rhesus Macaque *Macaca mulatta*, Common Leopard *Panthera pardus*, Himalayan Black Bear *Ursus thibetanus*, Grey Goral *Nemorhaedus goral*, Porcupine *Hystrix indica*. Murree Vole *Hyperacrius wynnei*. Turkestan Rat *Rattus turkestanicus*,

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[48] Hassan Sher, Haidar Ali And Shafiqur Rehman, Identification And Conservation of Important Plant Areas (IPAS) For The Distribution Of Medicinal, Aromatic And Economic Plants In The Hindukush-Himalaya Mountain Range, Pak. J. Bot., 44: 187-194, Special Issue May 2012

Long-tailed Field Mouse *Apodemus sylvaticus*. Whiskered Bat *Myotis muricola* and Grey Long-eared Bat *Plecotus austriacus*.[49,50]

Some of the species reported are included in the IUCN Red List 2017.[51] The Musk Deer *Moschus leucogaster* and Himalayan Grey Langur *Semnopithecus ajaxlis* are listed as Endangered, Black Bear *Ursus thibetanus* is listed as Vulnerable while the Common Leopard *Panthera pardus* and Grey Goral *Naemorhedus goral* are listed as Near Threatened.[52]

A total of four mammal species were observed (or signs observed) during the surveys carried out as part of the EIA of Project, none of which are of conservation importance. These species and their IUCN status are listed in **Exhibit 4.16**.

Exhibit 4.16: Abundance of Mammal Signs and Sightings, May 2017 Survey

No	*Scientific Name*	*Common Name*	*IUCN Status*[53]
	Canidae		
1.	*Canis aureus*	Asiatic Jackal	Least Concern
2.	*Vulpes vulpes*	Red Fox	Least Concern
	Hystricidae		
3.	*Hystrix indica*	Indian Crested Porcupine	Least Concern
	Herpestidae		
4.	*Herpestes javanicus*	Small Asian Mongoose	Least Concern

Locals report that the Asiatic Jackal, Red Fox, Common Leopard and Wild Boar are common in the area. They emphasized the fact that Wild Boar is damaging for crops. Of these, the mammals reported to be harmful to livestock included the Asiatic Jackal, Common Leopard, Monkey and Wild Boar. The Sub-Divisional Forest Officer (SDFO), Balakot, Sarmad Shah stated that the Black Bear is also common in the area.

No small mammals were trapped during the surveys carried out as part of the EIA of Project. No sightings or signs of small mammals were found either.

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[49] United Nations Development Programme, Pakistan (UNDP), Forests & Biodiversity Information/Data Report, [not dated].

[50] Hamid Sarfraz, Ashiq Ahmad Khan, Dr. Nasim Javed, Dr. Shahid Ahmad, Dr. Inam ur Rahim & Dr. M. Rafiq, Khyber Pakhtunkhwa Biodiversity Strategy & Action Plan, Final Draft, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Registered offices, Islamabad, June 26, 2016

[51] The IUCN Red List of Threatened Species. Version 2014.3. <http://www.iucnredlist.org>. Downloaded on 25 May 2017.

[52] Ibid

[53] The IUCN Red List of Threatened Species. Version 2014.3. <http://www.iucnredlist.org>. Downloaded on 25 May 2017.

4.2.3 Birds

The resident birds reported from the Terrestrial Study Area include species belonging to the Palearctic zoogeographical region.[54] Bird species breeding in the Palearctic region migrate south to Pakistan and India to overwinter. The bird species in the northern mountains start descending when conditions become extremely cold. These species normally remain in the lower valleys and nearby plains during the winter. In spring they migrate to their breeding grounds in the northern latitudes.[55]

The area where the Project is located consists of diverse habitat types including scrub forests, Chir Pine forests, agricultural lands, urban settlements, rocky slopes and water channels. This provides suitable habitats for both resident and non-resident bird species.

Based on the survey for avifauna carried out as part of the EIA of Project, a total of 48 bird species were reported. Highest abundance and species diversity were found at sampling locations in Pine Forest habitat type. Abundant bird species include the Common Raven *Corvus corax*, the Bank Myna *Acridotheres ginginianus*, the White-cheeked Bulbul *Pycnonotus leucotis*, Black Drongo *Dicrurus macrocercus*, and Great Tit *Parus major*.

Of the bird species reported in the EIA of Project none were found to be of conservation importance based on the IUCN Red List of Species. One species, the Rufous-vented Prinia P*rinia burnesii*, observed during the May 2017 Survey is listed as Near Threatened. Also, four species observed during the May 2017 Survey are included in the CITES Species Appendices[56] including the Black Kite *Milvus migrans*, the Common Kestrel *Falco tinnunculus*, the Common Crane *Grus grus* and the European Honey Buzzard *Pernis apivorus*, all listed in Appendix II. All four species show migratory behavior and congregatory behavior based on the IUCN Red List of Threatened Species database.[57]

The locals reported the presence of vultures in the area, however, none were observed during the May 2017 Survey.

4.2.4 Herpetofauna

Herpetofauna is a term which is used for amphibians and reptiles, collectively. In Pakistan, frogs and toads represent the amphibians whereas; reptiles are represented by crocodilians (crocodiles), chelonians (turtles and tortoises), lacertilians (lizards) and serpents (snakes). Amphibians and reptiles are very important animals among the vertebrates and important components of any living system. They may act as excellent biological indicators of any ecosystem.[58]

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[54] Z. B. Mirza and H. Wasiq, 2007. A Field Guide to Birds of Pakistan, WWF-Pakistan, Bookland Lahore

[55] Ibid

[56] UNEP-WCMC. SPECIES+ CITES database. <http://www.speciesplus.net/species>, accessed May 29, 2017

[57] IUCN 2015. *The IUCN Red List of Threatened Species. Version 2015-4.* <http://www.iucnredlist.org>, accessed May 29, 2017.

[58] Mott Macdonald, July 2015. Environmental and Social Impact Assessment of the 720MW Karot Hydropower Project Pakistan for the Karot Power Company (Pvt) Limited

The survey carried out as part of the EIA reported a total of six species of reptiles (see **Section 4.2.7** of the **EIA of Balakot Hydropower Development Project**). The highest reptile density and abundance was observed in Pine Forest habitat type. None of the six species observed are of conservation importance based on the IUCN Red List of Species. However, three of the observed species are found on the CITES Species Appendices including the Jan's Cliff Racer *Platyceps rhodorachis* (I), the Caspian Cobra *Naja oxiana* (II) and Checkered Keelback *Xenochrophis piscator* (III). None of the species observed are endemic.

The construction activities in the Project area may affect reptiles and amphibians through habitat loss, degradation, and fragmentation. The changes in hydrological regime and the presence of people, artificial lighting and noise may also disturb reptile and amphibian species found in the project area. Construction work including excavation and blasting may result in injury or death of reptiles and amphibians. Development activities can result in trapping of reptiles and amphibians in pits and deep depressions during construction. Temporary changes in hydrology and reduction in water quality during construction are also likely to pose a risk to amphibians. The most affected area with respect to herpetofauna would be the dam, tunnels' entries/exits, staff camps, spoil disposal, and other associated facilities in the Project area.

As discussed in the EIA, construction impacts on reptile and amphibian species are considered to be of minor magnitude and the resulting adverse effect is therefore minor and not significant in the absence of mitigation.

4.2.5 Threats to Terrestrial Biodiversity

Threats to Vegetation

Threats to vegetation include spread of invasive species and landsliding. The EIA reported the presence of invasive species in the terrestrial habitat within the Project area. The risk of earthquakes and subsequent landslides is also high in the Project area.

The invasive species Parthenium Weed, Tree-of-heaven, Black Locust and Cannabis are widespread in the area. In particular, the species Parthenium Weed is the dominant plant in the Riparian habitat plant community. Other dominant invasive species include Tree-of-heaven and Cannabis which are dominant within the Scrub Forest habitat plant community.

Mansehra District is prone to landslide because of climate conditions, and geological and geomorphic characteristics of the region. In October 2005, earthquakes triggered several thousand landslides in the Himalaya region of Northern Pakistan and India.[59]

Human-Wildlife Conflict

While the EIA has reported the presence of human-wildlife conflict, the conflict between communities and wildlife has not been identified as an important conservation related issue within the wider area of the Project. The species reported to be most commonly involved in the human-wildlife conflict include the Asiatic Jackal *Canis aureus*, the Wild Boar *Sus scrofa* and the Red Fox *Vulpes vulpes*. The Common Leopard *Panthera pardus*

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[59] Abbas, Ghulam; Ahmad, Ijaz; Parvez, Shahid, June 2012, Landslide hazard assessment in Mansehra District using remote sensing and GIS, Journal of Himalayan Earth Science;2012, Vol. 45 Issue 2, p1

has also been reported but to a lesser extent. The Wild Boar has been known to cause crop damage whilst the three predators, Asiatic Jackal, Red Fox and Common Leopard are known for livestock depredation.

4.3 Protected Areas or Areas of Special Importance for Biodiversity

There are some aquatic and terrestrial areas near the Project that are either protected or of special importance to biodiversity.

The part of the Kunhar River above Balakot Bridge (**Exhibit 4.17**) is categorized as protected. This includes protected status of the river and riparian areas, however, the exact area within the terrestrial areas is not known. There are also terrestrial Protected Areas within the Mansehra District including the Manshi Wildlife Sanctuary, located 5 km away from the dam site and the Saif-ul-Maluk National Park, located 23.5 km from the dam site.

A map showing the terrestrial Protected Areas and areas of special importance for biodiversity is provided in **Exhibit 4.17**. A map showing the Important Bird Areas (IBAs)[60] is shown in **Exhibit 4.18**.

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[60] Places of international significance for the conservation of birds and other biodiversity.

Exhibit 4.17: Map of Protected Areas

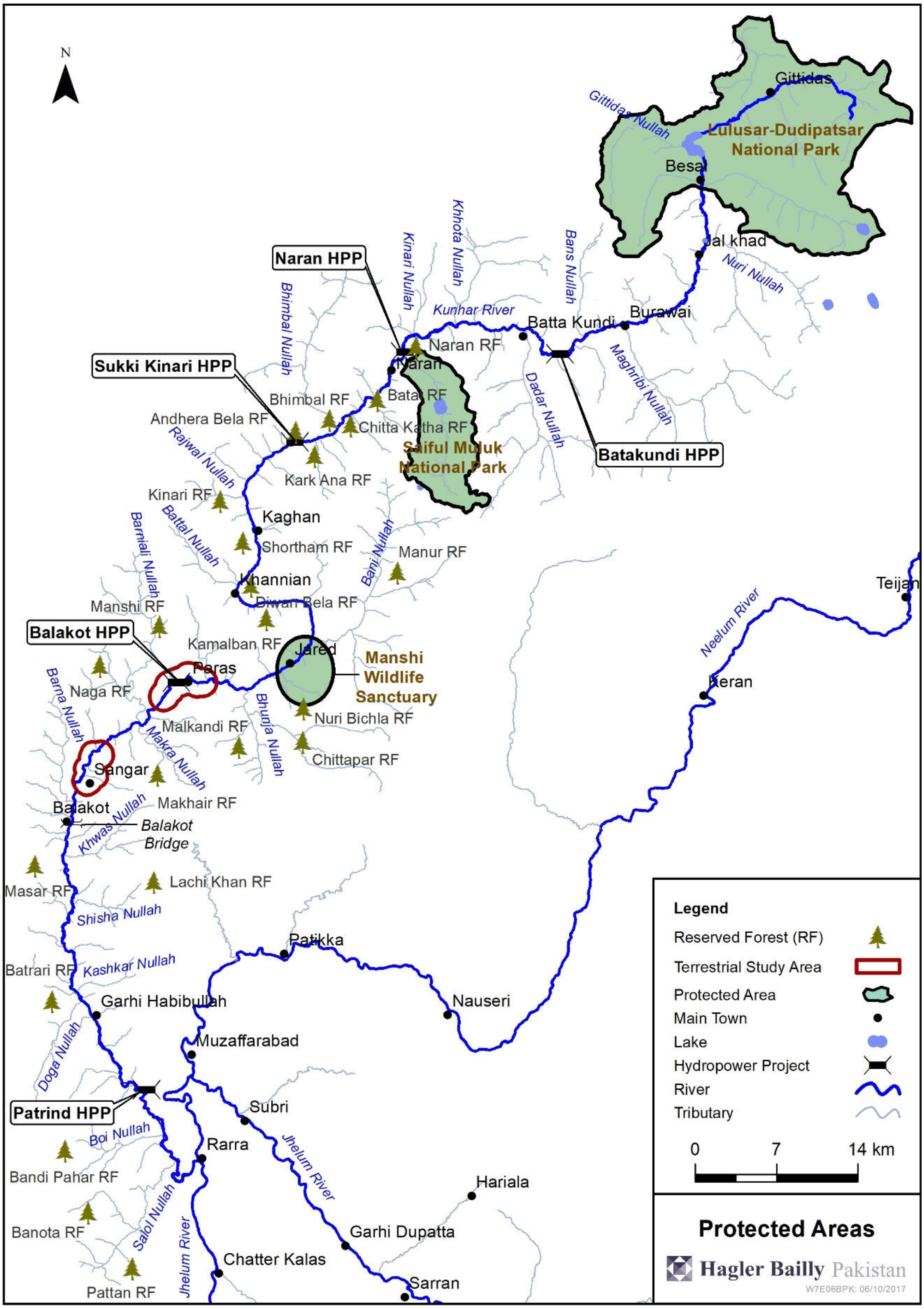
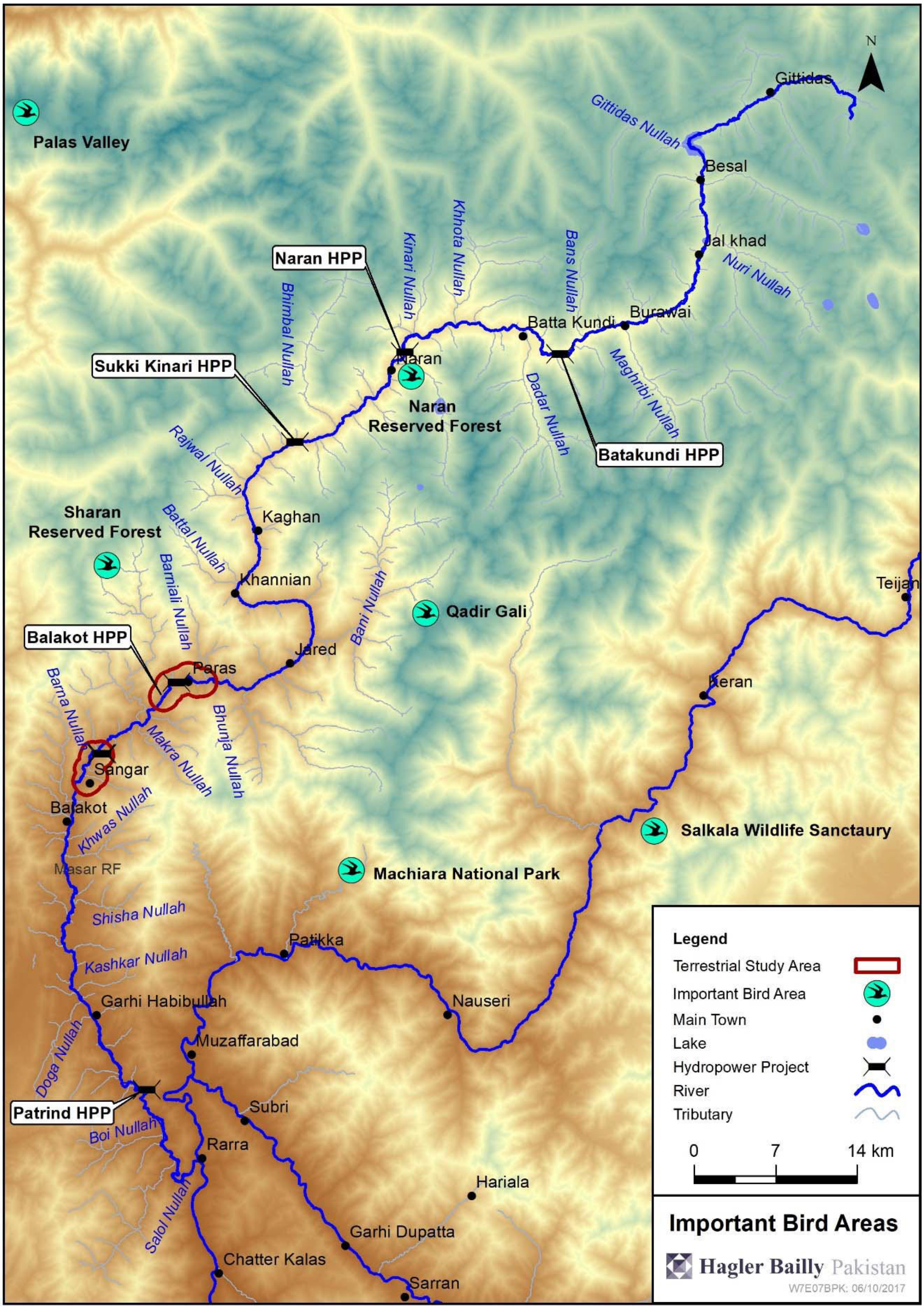


Exhibit 4.18: Map of Important Bird Areas



5. Overview of Impacts on Aquatic Biodiversity

An Environmental Flow (EFlow) assessment for the Kunhar River upstream and downstream of the proposed Project was carried out as part of the EIA[61]. The objectives of the EFlow assessment were to assess power Project (BAHPP) on the ecology of the river over the life of the Project. The Downstream Response to Imposed Flow Transformations (DRIFT) decision support system (DSS) developed by Southern Waters was used for EFlow assessment, with special emphasis on impact of fish species of conservation importance (see **Volume 2C** of the **EIA**). A brief summary is outlined below.

5.1 Overview of Impacts of Hydropower Development in Kunhar River

A number of hydropower projects are either currently under construction or proposed within the Kunhar River basin. The Project will be part of a cascade of five large hydropower schemes on the Kunhar River. It will be located upstream of the Patrind Hydropower Project and downstream of the Sukki Kinari, Naran and Batakundi Hydropower Projects (HPP) (**Exhibit 5.1**).

All hydropower projects mentioned are proposed along the main stem of the Kunhar River. The biodiversity studies conducted for the Project indicate presence of valued aquatic biological resources, particularly the endemic[62] fish species Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*, both of which will be affected by the Project. The Critical Habitat Assessment carried out as part of the EIA of the Project determined that the Project is located in a Critical Habitat based on the fact that the River provides 'Habitat of significant importance to endemic and/or restricted-range species' (**Section 4,** *Biodiversity Values*) for two fish species: Nalbant's Loach and Kashmir Hillstream Loach.

All HPPs will have diurnal storage capacity, and will have provision for peaking in the dry season. The Patrind HPP is likely to operate as a baseload plant to avoid impact of peaking operations on river biodiversity.

An approximate stretch of 141.2 km of the main Kunhar River, will be impacted by the development of these projects. This will result in alteration of the natural flow characteristics and habitats of that part of the river. The residence time of water within reservoirs is expected to be low due to limited storage capacity, therefore, deterioration in water quality across all the reservoirs is expected to be minimal with no associated cumulative impacts expected. In the short term there are likely to be impacts on water quality during the construction phase, which are expected to be localized. However, prolonged construction is likely to cumulatively impact water quality in the longer term.

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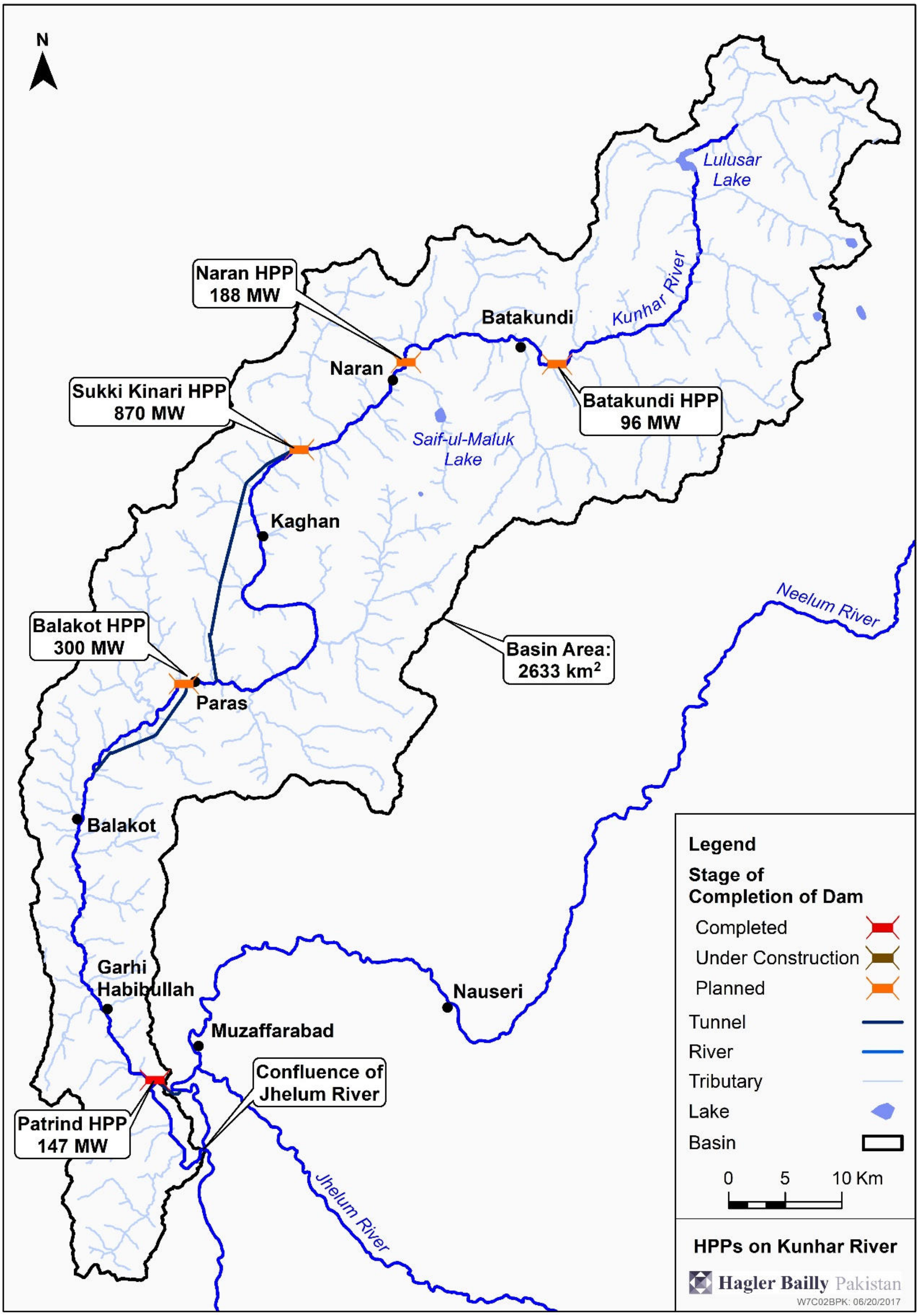
[61] Hagler Baily Pakistan, 2019, Environmental and Social Impact Assessment of the Balakot Hydropower Development Project, Final Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

[62] Endemic refers to endemic to the Jhelum Basin

Exhibit 5.1: Cascade of Hydropower Projects along the Kunhar River



Developments of the hydropower projects along the Kunhar River main stem will result in loss of lotic or flowing water habitats and creation of lentic or static water systems. The part of the river between the reservoirs will result in changes in flow variability. Changes to fish community compositions will occur with rheophilic[63] species being adversely affected. Species requiring well-oxygenated, flowing water will be limited to the tributaries. Fish species better adapted to lentic habitats will benefit from these habitat changes. The barrier effect of the reservoirs will result in habitat fragmentation and isolation of fish populations. For certain species this will prevent access to spawning grounds.

5.2 Construction and Selection of Scenarios for Environmental Flow Assessment

The Project will have unavoidable impacts on aquatic biodiversity, particularly due to loss of connectivity of habitats as a result of construction of dam and flushing of sediments from the dam. The other major potential impacts of the Project will be those associated with creation of a reservoir upstream of the dam and variations in flows downstream of the dam, particularly in dry or low flow season. The environmental flow (EFlow) assessment for the Project was carried out assess the impact of flow modifications and the barrier to flow imposed by the Project. The EFlow Report (see **Volume 2C** of the **EIA**) provides an overview of the methodology used for EFlow assessment and the results of assessment. **Section 7.2** of the **EIA of Balakot Hydropower Development Project**, summarizes the impacts of the Project on fish fauna and other aspects of the ecosystem under various operational and management scenarios. The fish indicators selected and their flow related needs are given in **Appendix C.**

In addition to flow and barrier related impacts, there are a number of non-flow related pressures on the river ecosystem that are impacting the biodiversity. These are described in **Section 3.2** of the Environmental Flow Assessment Report (see **Volume 2C** of the **EIA**). Of these, the following are the principal ones that were incorporated into the DRIFT EFlow assessment model:

1. Fishing pressure in terms of quantity of fish caught (linked to all fish indicators and invertebrate indicators).
2. Sediment mining in terms of quantities of sand, gravel and boulders extracted from aquatic habitats (linked to relevant geomorphological indicators).
3. Nutrient enrichment associated mainly with urban effluents (linked to relevant water quality indicators).

Given the dynamic nature of both the impact of the dam as well as the non-flow related pressures on the river ecosystem, impacts were simulated for a period of 51 years post commissioning of the dam, corresponding to the 51 years hydrological record available (1963-2014). A number of scenarios were simulated to assess the impact on a range ecosystem indicators. These included:

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[63] Preferring or living in flowing water

Baseline scenarios which included the predicted fish abundance under existing and growing anthropogenic pressures.

Minimum Eflow release scenarios of 1.5 m^3/s, 3.5 m^3/s, 4.5 m^3/s and 6.1 m^3/s. The EFlow of 1.5 m^3/s was considered in the feasibility study while the remaining flows correspond to 25%, 35% and 50% of the minimum 5 day dry season flow.

Peaking and baseload scenarios which took into account the different dam operating rules.

The strategy and approach adopted for protection of biodiversity for the Project and incorporated into the BAP prepared for the Project follows the design of the BAP for the Gulpur Hydropower Project[64] which is being implemented on the Poonch River located in the Jhelum Basin. The Poonch River was notified as a national park by the Fisheries and Wildlife Department in 2010 to protect the fish fauna in the river that includes the Endangered Mahaseer and the Critically Endangered Kashmir Catfish. The sensitivity in case of the Area of Management of the BAP for the Project is comparatively lower as the area is not notified as a national park. However, the issues in protection are similar in nature, and the habitat in both cases is classified as Critical Habitat under IFC PS6. The justification for selection of scenarios of the four protection levels considered is provided below.

Business as Usual Protection (BAU)

Present protection levels resulting in increase in non-flow-related pressures in line with 2017 trends, or doubling of pressures over a 51 years period. The number of watchers provided by the Wildlife Department, KP are currently inadequate to provide adequate protection to the Kunhar River and tributaries. Given the current allocation of funds for wildlife protection and keeping in view the acute scarcity of financial resources and competing demands from other sectors, this scenario is likely to continue in future.

Based on an analysis of data for other major rivers in the Jhelum Basin, namely the Jhelum and Neelum Rivers, an increasing trend in sediment mining and fishing pressures in the Kunhar Basin is expected. A survey of fishing activities in Neelum and Jhelum Rivers was carried out in early 2013 as a part of EFlow assessment for the NJHP.[65] While the intensity of extraction at about 7,000 kg/km/year observed in 2016 as a part of the ESIA of the Kohala HPP has increased only slightly just upstream of Muzaffarabad compared to that in 2013, fishing has now spread to the whole of Jhelum River, where it was practically non-existent before, and where it ranges from 700 to 1,300 kg/km/year now. As stated in **Section 4.1.5** (*Threats to Fish Fauna*), there is an expectation that fishing pressure along the Kunhar River will increase in future. The assumption made in the DRIFT model that fishing pressures would double in the next 51 years under the Business as Usual scenario can therefore be considered as plausible and possibly conservative.

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[64] Biodiversity Action Plan for the Gulpur Hydropower Project, prepared by Hagler Bailly Pakistan for Mira Power Company Ltd., October 2015.

[65] Environmental Flow Assessment for Neelum-Jhelum Hydroelectric Project, Socioeconomic Baseline and Impact Assessment, prepared for Pakistan Commissioner for Indus Waters, Hagler Bailly Pakistan, Southern Waters, and Anchor Environmental, March 2015.

Similar to the survey for fishing, a survey of sediment mining activities in Neelum and Jhelum Rivers was carried out in early 2013 as a part of EFlow assessment for the NJHP. In the segments upstream and downstream of confluence at Muzaffarabad, increase in average quantity of sediment mined observed in 2016 as a part of the ESIA for the Kohala HPP ranged from none to 2,500 m^3/km/year, to 20,000 to 25,000 m^3/km/year. In 2013, sediment mining in Neelum River upstream of Muzaffarabad and downstream of Nauseri where the NJHP dam is located was observed to be very high, of the order of 120,000 m^3/km/year. Apparently, the mining activities which were previously confined mainly to the Neelum River which is possibly easier to mine and has higher level of sediment flows has now spread to all over the Jhelum River. As stated in **Section 4.1.5** (*Threats to Fish Fauna*), there is an expectation that sediment mining along the Kunhar River will increase in future due to an increase in demand from the construction industry. Based on these observations, the assumption made in the DRIFT model that sediment mining pressures would double in the next 51 years under the Business as Usual scenario can therefore be considered as conservative.

Low Protection (LP)

The 2017 levels of non-flow-related pressures maintained on the river; i.e., no increase in human-induced catchment pressures over time. The pressures related to illegal fishing and unregulated sediment mining are increasing with time in response to increase in population and demand for ecosystem services driven by economic growth.

Moderate Protection (MP)

The 2017 levels of non-flow-related pressures reduced by 50% over the next 5 years and then keep stable at that level for the next 46 years. Experience in implementation of MP or Moderate Protection scenario in Poonch Basin shows that enforcement has to be near complete for it to be effective, and in reality, the protection effort at Poonch River is now focused on achieving a HP or High Protection level. Maintaining pressures at 50% of the present day has also been observed to result in a dynamic situation where the level of pressure fluctuates as the violators continuously test and challenge the protection system. Increasing the number of guards is being considered, particularly for protection in the tributaries. There is a high level of emphasis on community awareness and participation, and there is active engagement with the police and judiciary.

High Protection (HP)

The 2017 levels of non-flow-related pressures reduced by 90% over the next 5 years and then kept stable at that level for the next 46 years. As indicated above for MP protection level, this scenario reflects the ‘all or nothing’ paradigm for protection and is considered as realistic in view of the experience in the Poonch River.

5.2.1 Conclusions of Environmental Flow Assessment

Impact of Protection on Fish Populations

Prediction of expected changes in fish populations over a 51 year period were based on observed long term trends in similar rivers in the region where dams have not been constructed. Essentially, the relevant experts provided an estimate of change in abundance of each indicator (if at all) from its known or predicted condition 31 years ago (considered as the historic baseline) and what have been the main drivers of change. They were also asked what abundance level they would expect it to reach in the future under the three protection scenarios (LP, MP and HP). The values provided were targets only, as the eventual values predicted by the DRIFT model depended on the interaction of a multitude of factors, protection level being just one.

A list of fish species of conservation importance in the Area of Management is provided in **Exhibit 4.2**. These include two species that triggered Critical Habitat, Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*, for which the impact of the Project is discussed below. Both species are endemic to the Jhelum basin. In addition, biodiversity values in the Kunhar River include the Vulnerable Alwan Snow Trout *Schizothorax richardsonii* which is migratory fish. The impact of the Project on these three species was studied under the following alternative baseline protection scenarios:

- A Business as Usual Protection or BAU as baseline was considered in view of the fact that the KP Wildlife Department has only limited number of guards to patrol the Kunhar River. Illegal fishing is widely prevalent, and unregulated mining of sand and gravel is on the increase. The KP Wildlife Department presently has no plans to improve protection.
- A Low Protection or LP level of protection under which the KP Wildlife Department puts some resources in place in future to maintain the pressures at the present day level, though highly unlikely given the present trends, was also considered.

The impact of variations in protection levels on fish populations is shown in **Exhibit 5.2** (see **Section 5.2** of the **Environmental Flow Assessment Report** for the **Balakot Hydropower Development Project** in **Volume 2C**). For illustrative purposes, the impacts are shown for the segment downstream of the tailrace under baseload operation where variations in flow will be minimal, in comparison to the BAU and LP baselines. The barrier effect of the dam on the migratory fish, however, will apply. The following is a summary of observations:

- Under the Business as usual (BAU) Scenario, without the dam in place, the decline in fish populations will average at 66% of present day populations due to pressures related to unregulated fishing and sediment mining whereas the decline is predicted at 45% under the Moderate Protection (MP) baseline.
- After the Project is put in place with Moderate Protection (MP), fish populations will improve by an average of about 70% compared to the BAU baseline and 48% compared to the MP baseline. The increase is expected to be highest for the non-migratory Kashmir Hillstream Loach.
- With High Protection (HP), fish populations are predicted to improve by an average of 80% compared to the BAU Scenario. The increase is expected to be highest for the Alwan Snow Trout at close to an 88% increase over the baseline
- Increasing protection from Moderate Protection to High Protection results in an increase in population by an average of 12%, irrespective of the baseline scenario chosen for comparison.

Exhibit 5.2: Impact of Variation in Protection on Fish Population, Downstream of Tailrace (Baseload Generation with EFlow of 3.5 m^3/s)

Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	Projected Change in Population					
	(% change from Present Day Populations)					
Fish	*Baseline*		*With Project*			
	BAU	*LP*	*B3BAU*	*B3LP*	*B3MP*	*B3HP*
Biophysical Results						
Alwan Snow Trout	-68.7	-54	-75.6	-64.9	-1.4	19.0
Nalbant Loach	-56.8	-27.1	-55.6	-25.9	5.7	12.0
Kashmir Hillstream Loach	-72.8	-55	-72.3	-54.4	2.5	11.9
Average	**-66.1**	**-45.4**	**-67.8**	**-48.4**	**2.3**	**14.3**
Incremental Gain compared to Business as Usual Baseline, %						
Alwan Snow Trout			-6.9	3.8	67.3	87.7
Nalbant Loach			1.2	30.9	62.5	68.8
Kashmir Hillstream Loach			0.5	18.4	75.3	84.7
Average			**-1.7**	**17.7**	**68.4**	**80.4**
Incremental Gain compared to Low Protection Baseline, %						
Alwan Snow Trout			-21.6	-10.9	52.6	73.0
Nalbant Loach			-28.5	1.2	32.8	39.1
Kashmir Hillstream Loach			-17.3	0.6	57.5	66.9
Average			**-22.5**	**-3.0**	**47.6**	**59.7**

Assessment of Net Gain and No Net Loss

As discussed in **Section 1.1** (*Background and Rationale for Developing BAP*), under IFC PS6, Net Gain is required for the biodiversity values that triggered Critical Habitat, namely the Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*.

Exhibit 5.3 shows Net Gain/No Net Loss for key fish species for the selected EFlows under the High Protection scenario assessed in the EIA.

Net gain was calculated based on the length of the reach represented by the EFlow site multiplied by the predicted changed in abundance at that particular EFlow site. Distribution of fish populations between the main river and the tributaries was also taken into account, as both the main river and tributaries will benefit from protection.

The predicted abundances were compared against baselines with two different levels of protection (Business as Usual Protection and Low Protection). These dynamic baselines represent the expected fish abundances in the absence of the Project.

Exhibit 5.4 and **Exhibit 5.5** provide an illustration of Net Gain/No Net Loss for the selected scenarios of EFlow of 1.5 m^3/s and baseload operation and an EFlow of 6.1 m^3/s and peaking operation respectively. **Section 6.2** of the Environmental Flow Assessment Report (see **Volume 2C** of the **EIA**) provides details of calculations for Net Gain/No Net Loss. Predictions of DRIFT model are subject to an uncertainty of the order of 15% above and below the predicted mean[66], which is indicated as a line in the graphs.

The scenarios considered feasible for achieving the required net gain are discussed below:

Baseload Generation with Eflow of 1.5m^3/s and High Protection

This scenario is recommended as robust gains are observed for all fish indicator species compared to the BAU baseline. Compared to the more conservative LP baseline the gains are robust and remain positive.

Peaking Generation with Eflow of 6.1 m^3/s and High Protection

If peaking power carries a premium then this option can be considered. Net gains are weak compared to the BAU baseline (with only a 7% gain for the Kashmir Hillstream Loach). This is lower than the 15% limit of uncertainty.

Exhibit 5.3: Assessment of Net Gain/No Net Loss in Key Fish Species

Green = Gain greater than 15%, Red= Net Loss

	Baseload Generation with Eflow of 1.5m^3/s and High Protection	*Peaking Generation with Eflow of 6.1 m^3/s and High Protection*
Net Gain Against Business as Usual Baseline		
Alwan Snow Trout	79%	38%
Nalbant Loach	60%	54%
Kashmir Hillstream Loach	43%	7%
Net Gain Against Low Protection Baseline		
Alwan Snow Trout	60%	19%
Nalbant Loach	29%	24%
Kashmir Hillstream Loach	24%	-12%

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[66] Based on results from Kohala Hydropower Plant Environmental Flow Assessment, Technical Report. Southern Waters in Association with Hagler Bailly Pakistan, November 2016

Exhibit 5.4: Net Gain in Fish Population,
Baseload Operation with EFlow of 1.5 m^3/s and High Protection Scenario

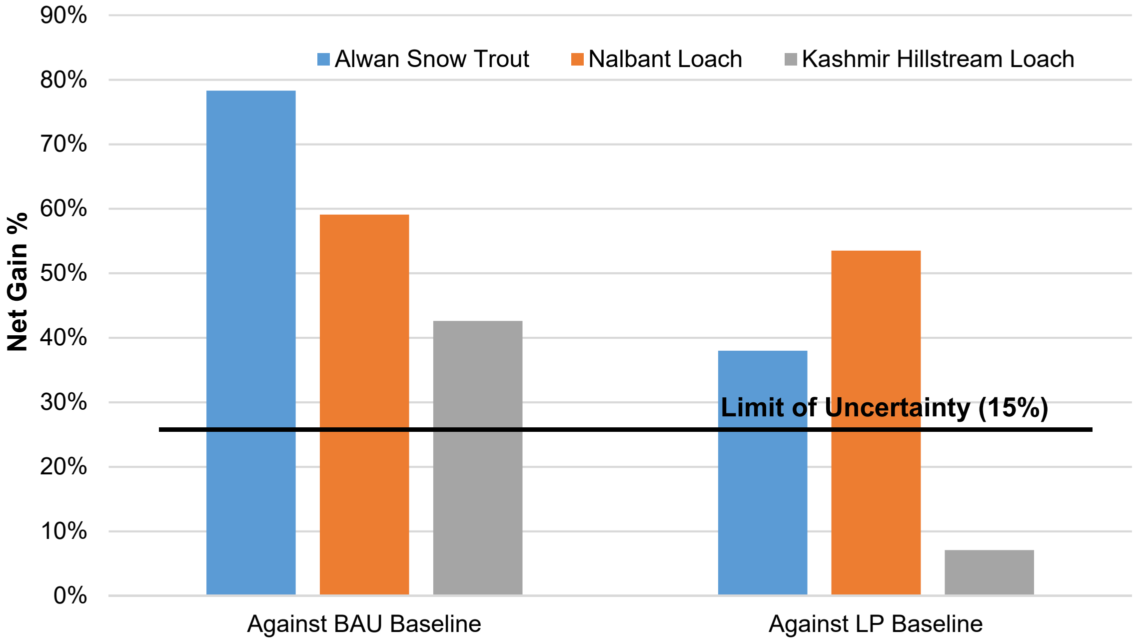
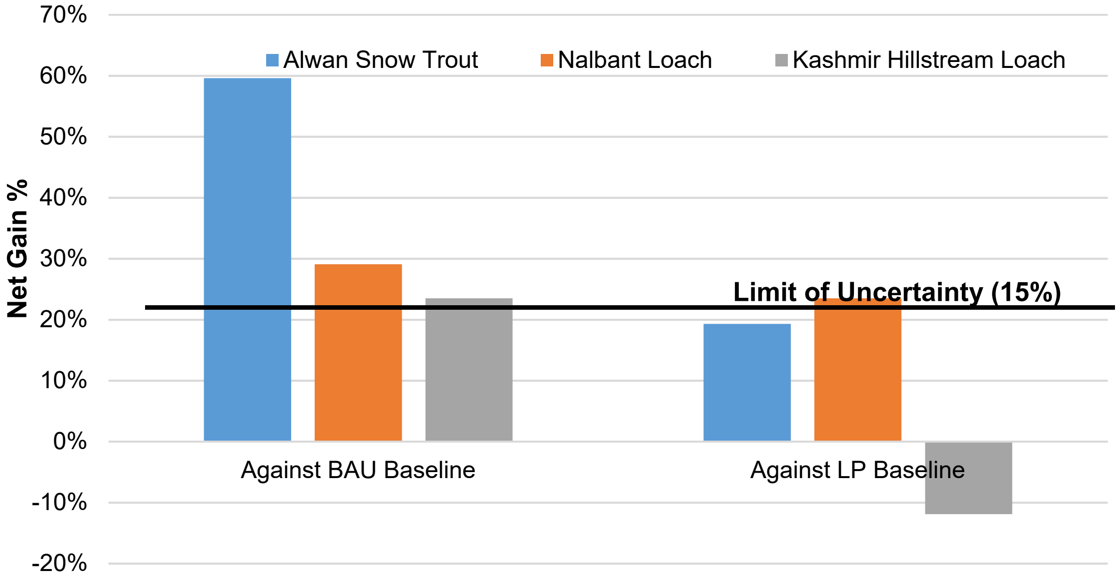


Exhibit 5.5: Net Gain in Fish Population,
Peaking Operation with EFlow of 6.1 m^3/s and High Protection Scenario



6. Proposed Conservation Measures

This Biodiversity Management Plan (BAP) was developed to achieve a 'Net Gain' in biodiversity in alignment with IFC Performance Standard 6 with special attention to fish species of conservation importance. These include the two fish species endemic to the Kunhar and Jhelum Basin: Nalbant's Loach *Schistura nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis* for which the Kunhar River is a critical habitat. Though not required under PS6, the BAP also aims to achieve a no net loss for the migratory fish, Alwan Snow Trout *Schizothorax richardsonii* which is listed as Vulnerable in the IUCN Red List 2017.

The EFlow assessment of the Project (see **Volume 2C** of the **EIA**) evaluated various options to address both flow and non-flow related pressures on the river ecology in the Area of Management. **Section 4** (*Biodiversity Values*) described major threats to the biological resources in the Area of Management. The CIA (**Section 7.13** of the **EIA of Balakot Hydropower Development Project**) describes threats to the biodiversity at the basin level, and suggests measures for integrated management of biodiversity to strengthen the implementation of the BAP and to further enhance conservation of biodiversity. This section outlines the necessary measures for protection and conservation of fish species of conservation importance to achieve target population levels and Net Gain/No Net Loss as specified in the EIA.

6.1 Protection of Biodiversity

The strategy and approach adopted for protection of biodiversity for the Project follows the design of the BAP for the GHPP (Gulpur BAP).[67] Sustainability aspects of biodiversity management were studied in the Gulpur BAP, and the BAP was then designed to manage risks in implementation. Section 9 of the BAP for the GHPP 'Sustainable Management of National Park' includes a detailed discussion on this subject. The national park referred to in the BAP of GHPP is the Poonch River Mahaseer National Park, inclusive of tributaries that are important breeding areas for the fish. The sensitivity in case of the Area of Management of the BAP for Balakot Hydropower Development Project is comparatively lower as the area is not notified as a national park. Pressures on biodiversity in Jhelum River are also comparatively lower as the river is wider and deeper which makes fishing and sediment mining relatively difficult. However, the issues in protection are similar in nature, and the habitat in both cases is classified as Critical Habitat. Sustainability aspects that were addressed in the BAP for GHPP included:

1. **Sustainable livelihoods, including fishing, sediment mining, and tourism:** Adopting an inclusive and participatory approach towards the community such that their livelihoods are protected in balance with the need to protect biodiversity following the principles of sustainable development.

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[67] Biodiversity Action Plan for the Gulpur Hydropower Project, prepared by Hagler Bailly Pakistan for Mira Power Company Ltd., October 2015

2. **Sustainable financial management:** Ensuring financing for protection and management over the life of the Project with funds provided by the Project.
3. **Institutional strengthening of the JK Fisheries and Wildlife Department (JKFWD:** Providing staff and capacities to JKFWD for protection in the near term, and adding staff and capacities in the Department in the long term to enable the Department to internalize and take over protection and management instead of depending on external capacity.
4. **Institutional arrangements for implementation of BAP:** Recognizing lack of capacity in JKFWD, contracting with qualified and experienced third parties to deliver protection and to conduct monitoring and evaluation under supervision of the JKFWD and with oversight from a Management Committee that has representation from the government, the Project owner, and other key stakeholders including the local community.

Implementation of the BAP in the Poonch River Basin was initiated in March 2016, while monitoring and evaluation was started in October 2015 to collect data prior to creation of a barrier to flow by construction of a coffer dam. Additional experience in management of risks will, therefore, be available for adjusting the design of the BAP for the Project by the time its implementation is initiated, which will be sometime towards the end of 2017.

A similar approach outlined above will be adopted for the Balakot Hydropower Development Project in the Area of Management and is discussed in detail below. The identification of key threats and their appropriate management is central to keeping the integrity of the Area of Management of the BAP intact. An increase in surveillance and improved watch and ward will:

- curtail illegal fishing including non-selective fishing, fishing in breeding season of fish, fishing in river tributaries. (**Section 4.1.5**).
- regulate sediment mining to maintain it at sustainable levels and prevent sediment mining from ecologically sensitive locations (**Section 4.1.5**).

The focus of the watch and ward will be on protecting the aquatic ecological resources. However, the improved watch and ward will benefit the terrestrial ecological resources by preventing illegal hunting and killing of large mammals particularly Common Leopard and Black Bear.

6.1.1 Measures for Control and Management of Fishing

The current practice is that the KP Fisheries Department issues fishing permits to locals and tourists particularly for trout fishing upstream of the city of Balakot. To protect the local livelihoods and the tourism industry, this current practice that allows fishing with permits using rods and cast nets can be continued. However, fish catch and populations need to be monitored (see **Section 9**, *Monitoring and Evaluation*) to ensure that the harvesting remains within the limits of sustainability. The number of permits issued can be regulated to maintain the fish populations.

The following measures will be implemented by the Fisheries Department, KP and Wildlife Department, KP (referred to as Departments in this report) with support from

Balakot Hydropower Development Project for conserving the fish populations of the Kunhar River.

- Non-selective fishing using fine mesh gill nets, poisons and dynamites will be completely controlled in the entire stretch of the Kunhar River.
- Fishing in the tributaries that are breeding grounds of fish will be banned.
- Fishing during the breeding season of the fish (May – August) will be banned.
- Fishing in habitats identified as sensitive particularly for the fish species of conservation importance will be restricted or banned, with special attention to sections of tributaries that are breeding grounds of fish.
- Commercial fishing will not be allowed either in the river and its tributaries or in the reservoir.
- The above rules and regulations will be strictly implemented with an efficient and effective watch and ward system.
- Subsistence fishing using rods and cast nets with limited weights will be allowed through a permitting system in the reservoir created upstream of the dam, and downstream of the dam when the KP Fisheries Department considers the fish populations to have recovered.
- Angling will be allowed to attract visitors and develop the educational and recreational value of the river when the KP Fisheries considers the fish populations to have recovered.

6.1.2 Measures for Regulation of Sediment Mining

Options for control of impact of sediment mining include:

- a complete ban on the activity, or
- regulation of the activity to achieve a balance between meeting community needs and reducing its impact on aquatic ecology

The total quantity of sediment being mined from the Kunhar River is of the order of 17% of the total sediment load (**Section 7.11.4** of the **EIA of Balakot Hydropower Development Project**). Sand mining contributes to the livelihood of about 4% of the households in the Study Area and it accounts for only 3.60% of the total income (**Section 4.3.4** of the **EIA of Balakot Hydropower Development Project**). The sand and gravel is sold for use of households in the construction of homes. The locations are determined mainly by the size of sediment deposits, ease of access, and demand from nearby towns. **Section 4.1.5** (*Threats to Fish Fauna*) includes photographs of mining activities on the Kunhar River.

Discussions with local communities indicated that a complete ban on sand and gravel mining would adversely affect households as construction costs will become unaffordable. Once the Project becomes operational, quantities of sediment likely to be deposited upstream of the dam annually will far exceed the preliminary estimates of demand for sediment and probably exceed demand for quite some time to come (see **Section 7.11.4** of the **EIA of Balakot Hydropower Development Project**).

While the current pressure related to sediment mining is relatively low. However, anticipating growth in extraction as has happened in Poonch and Jhelum Basins in recent past, an approach similar to the one being followed in the Gulpur BAP is suggested for this BAP. Some initiatives are been undertaken in the Poonch River by the Fisheries and Wildlife Department to control destructive sediment mining practices. These include steps being taken to stop 'wet mining', or mining directly from the flowing river. Notices are being issued in coordination with the Environmental Protection Agency (JK EPA) to stop wet mining. Similar actions are proposed for this BAP of the Kunhar River in the Area of Management and will include the following:

- The M&E Consultant with support from international experts will prepare Sediment Mining Guidelines for the Kunhar River, and its tributaries in the Area of Management that have important breeding areas located in them.
- Sediment mining will only be allowed in designated areas and banned from ecologically sensitive areas such as habitat of fish of conservation importance, and fish breeding locations in tributaries.

An Outline for Sediment Mining Management Guidelines is provided in **Appendix D**. The Sediment Mining Guidelines will ensure that a balance is achieved between meeting community needs for sand and gravel as well as the integrity of aquatic habitat in the Area of Management such that the habitat is not excessively damaged due to uncontrolled mining activities on the river bed. In view of these considerations, the social risk associated with management of mining operations is expected to be low.

6.1.3 Awareness and Education

Removal of bankside vegetation, illegal fishing, sediment mining, and pollution continue in many parts of the river and its tributaries. One of the reasons for this is that local communities that reside in the Kunhar River basin are largely unaware of the detrimental impacts of their activities on the river ecology. They do not fully appreciate the fact that the area contains resources of conservation and socio-economic importance. Education and awareness, particularly at the local level, is therefore a critical factor in generating support among local communities for conservation and management initiatives.

Activities to promote awareness and education related to biodiversity is presented in this section. The activities are designed to contribute to biodiversity conservation through information sharing, education and capacity building of the concerned population groups i.e. the local communities and visitors. The purpose is to empower people to participate in conservation measures in an informed, committed, and skilled manner, contributing to the achievement of 'Net Gain' where feasible. The scope of activities covers the Areas of Management, and includes aquatic as well as terrestrial biodiversity. Given the nature of the awareness and education activities, it is not possible to focus the plan on the aquatic biodiversity alone which is directly impacted by the Project.

Local Communities

Teacher Training Workshops

Training teachers will ensure that conservation education becomes part of the classroom teaching process and is integrated into the local school system. Gaining the support of schoolteachers and their students will not only help change the outlook of future community members but also provide a focus for the more immediate spread of information. Social Mobilizers will be engaged to conduct teacher training workshop in the local schools and provide information to the teachers regarding:

- The aquatic and semi-aquatic ecological resources of the Kunhar Basin.
- Threats to these biological resources including over-fishing, use of destructive fishing means, deforestation and illegal hunting.
- Steps that community members can take to minimize the negative impact on the environment and biological resources.

The workshops will be delivered using the following tools:

- Slide shows
- Posters and postcards
- Field visits

School Activities

School teachers will organize debates, drawing competitions, quiz competitions on various aspects of conservation. Social Mobilizers will facilitate these events and present certificates to the winners. The aim will be to raise environmental awareness among school children in a fun and interactive way.

Community Outreach

The Social Mobilizers with support from the protection staff will conduct non-formal awareness and education programs for the local communities. Separate events will be organized for men and women. During these sessions, the conservation significance of the Jhelum River and its tributaries will be highlighted with recommendations on how the detrimental impact of anthropogenic activities on the biological resources of the area can be minimized.

Visitors and General Public

Awareness and education tools for visitors to the area and the general public will include the items described below.

Posters and Brochures

Posters and brochures will be prepared on the following themes:

- Importance of the Kunhar River including pictures of aquatic fauna of conservation importance particularly fish such as Alwan Snow Trout and the endemic fish species Nalbant’s Loach and Kashmir Hillstream Loach.
- Wildlife of conservation importance including pictures of mammals found in the area such as Musk Deer, Himalayan Grey Langur, Black Bear, Common Leopard, Grey Goral as well as birds such as Black Kite, Common Kestrel, Common Crane and European Honey Buzzard
- Threats to the biological resources of the Kunhar River basin.

- The rules and regulations and do's and don'ts related to Jhelum River.

Sign Boards

At least 12 large and 36 small sign boards will be prepared on some of the following themes:

- Warning sign not to cause disturbance to, or remove vegetation from, the fish hotspots.
- Warning sign not to engage in illegal fishing particularly using gill nets, dynamite and poisons.
- Warning signs not to remove sand and gravel from the ecologically sensitive areas such as river tributaries.

Media

Involvement of print and visual media would be very helpful in promoting awareness on importance of conservation. Local and national newspapers as well as local radio channels can be engaged to increase environmental awareness and to promote conservation.

Media involvement ensures that reporting is quick, reliable and unbiased and leads to greater accountability. This could be particularly important if conservation objectives are not being met or there is political influence that impedes the successful implementation of the BAP.

6.1.4 Requirements for Protection

Aspects of the watch-and-ward system that require development are:

- Additional staff
- Surveillance coverage
- Reporting and information management
- Field offices
- Additional equipment and material
- Communication and coordination
- Staff training

Existing Watch and Ward Setup

In Khyber Pakhtunkhwa (KP), the responsibility for watch and ward of the terrestrial and aquatic ecological resources lies with the Wildlife Department, while the Fisheries Department regulates recreational fishing and is also responsible for management of water quality. It is therefore not clear which department will take the lead in supporting the BAP implementation. For the purpose of this Draft BAP, both organizations have been proposed and a decision can be taken by the KP Government about which department will finally be designated.

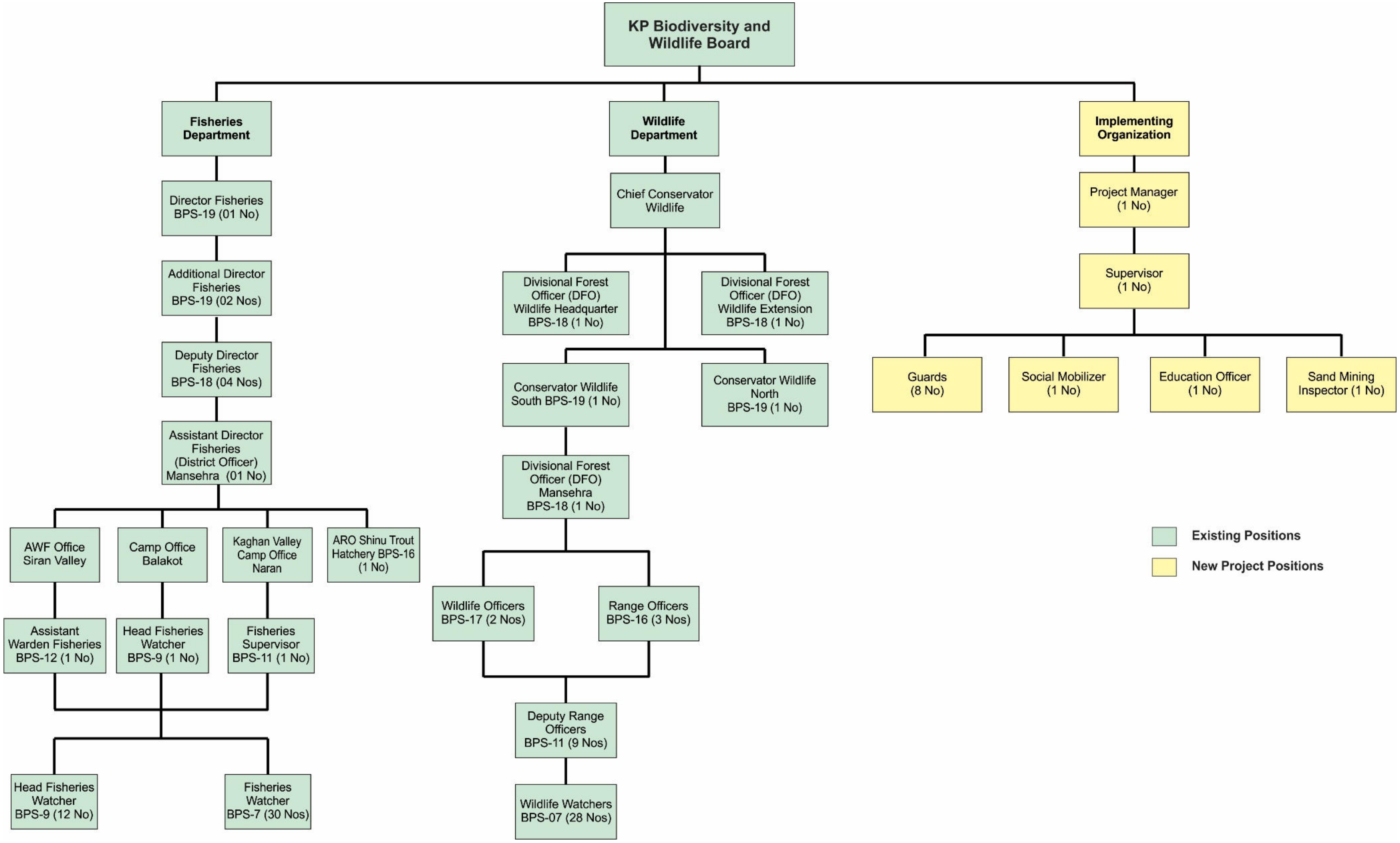
An organogram of the KP Wildlife and KP Fisheries Department is given in **Exhibit 6.1**. The KP Wildlife Department is headed by the Chief Conservator Wildlife and supported by two Divisional Forest Officers (DFOs) for Wildlife Headquarters and Wildlife Extension respectively, as well as two Conservators, one each for North and South. Each division of the province is headed by one DFO. The Area of Management for the BAP falls in the jurisdiction of the Mansehra Division. Thus the organogram in **Exhibit 6.1** presents the positions in the Mansehra Division of the Wildlife Department, the seniority level (Government grade - BPS) of each position and the number of persons holding that position. Staff reporting to DFO Mansehra includes 2 Wildlife Officers (BPS-17), 3 Range Officers (BPS 16) as well as 9 Deputy Range Officers (BPS-11) and 28 Wildlife Watchers (BPS-07). This staff is responsible for patrolling, surveying and preventing illegal hunting and fishing.

The KP Fisheries Department is headed by the Director Fisheries (BPS-19) and supported by 2 Additional Directors (BPS-19) and 4 Deputy Directors. There is one Assistant Director Fisheries that heads each division in the province including the Assistant Director (District Officer) for Mansehra Division where the Project is located. The field staff in Mansehra Division is divided between three offices: AWF Office Siran Valley, Camp Office Balakot, Kaghan Valley Camp Office and ARO Shinu Trout Hatchery. Besides the hatchery staff, there is 1 Assistant Warden Fisheries (BPS-12), 1 Head Fisheries Watcher (BPS-9), 1 Fisheries Supervisor (BPS-11) as well as 12 Head Fisheries Watchers (BPS-9) and 30 Fisheries Watchers (BPS-7). The staff of the KP Fisheries Department regulates fishing methods using permits and licenses, the species that can be caught and associated penalties for violation of regulations pertaining to wild fish.

Additional Staff Requirements under the BAP

Based on the discussions with the stakeholders, a total of 8 additional guards/watchers are required to implement the conservation measures outlined in the BAP. Each watcher will be responsible for patrolling approximately 5 km stretch of the Area of Management of the Kunhar River. Also required will be one Supervisor who can oversee the tasks assigned to the watchers as well as one Manager (Project Manager). In addition, 1 Mining Inspector will be hired to control sand and gravel extraction from ecologically sensitive locations, as well as 1 Education Officer and 1 Social Mobilizer. The Education Officer will work on a regular basis to organize teacher training workshops, school activities, and educational programs. The Social Mobilizer will be a female and in a conservative segregated society prevailing in the Project area will be in a better position to reach, communicate with and educate the community women. Also required will be one vehicle drivers and one Administrative Assistant. A Fish Expert/Advisor is proposed to provide expert advice on management and research to the KP Wildlife/Fisheries Department (Departments) as well as the Implementation Organization. Funds for the additional staff proposed will be contributed by PEDO as part of the BAP.

Exhibit 6.1: Organogram of KP Wildlife and KP Fisheries Department and Proposed Support under BAP



Coordination arrangements of the staff managed by the Implementation Organization and that of the Wildlife Department/Fisheries Department will be finalized after selection of one or both of the departments for implementing the BAP.

Patrolling and Reporting

The Watchers will carry out regular patrols of the entire Area of Management, its tributaries and adjacent terrestrial habitats during both day and night.[68] Their activities will be supervised by the Supervisors. The Watchers will be responsible for enforcing the fisheries and wildlife regulations and reporting violations. All violations will be noted, logged and reported to the Supervisor every day. In case of an emergency or major violation, the Project Manager will be informed immediately and will visit the site to constitute a team to inquire into and rectify the matter. The Implementation Organization in consultation with the Departments will develop a management information system for collection, analysis, and reporting of watch and ward data.

Management Offices

Two Field Offices will be set up. One office will be located near the powerhouse of the Project, 10 km upstream of Balakot, near Kapi Gali Village on land already owned by PEDO. The other office will be located near Garhi Habibullah village (**Exhibit 1.3** in **Section 1**) and land for this office will be donated by the KP Government. Construction costs as well as required furniture and equipment will be supported by PEDO under the BAP agreement. There will be 4 rooms in the field offices that will include 2 rooms for watch and ward staff, 1 room for office and a guest room for visitors. There will also be a bathroom, kitchen and store.

Required Equipment and Materials

For effective implementation of protection measures and efficient watch and ward, the staff will require the following additional equipment and facilities.

- 4WD Vehicles – 1
- Motorbikes – 10
- Boat, rafts, gear, life jackets – 1
- Uniform - 24
- Field gear - 24
- Night Vision Binoculars – 2
- Binoculars - 12
- Global Positioning System (GPS) - 3
- Video Camera - 1
- Digital Cameras – 4
- First Aid Box - 2

The following office equipment will be required:

- Computers – 2

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[68] Most of the illegal fishing takes place in the dark when detection is difficult

- Laptop/Notepads - 2
- Printers – 2

Communication and Coordination

A communication network is vital for the proper functioning of the watch-and-ward system. Each of the two field offices will have a telephone and a computer. Email/internet facilities will be added depending on the availability of communication networks. For field communication, the Watchers will use their cellular phones and a monthly allowance will be given to the Watchers for their phone bills.

Awareness and Education

The basic responsibility for the awareness raising program will lie with the KP Wildlife/Fisheries Department and the Implementing Organization. Requirements for education and awareness activities are given in in **Exhibit 6.2.**

Exhibit 6.2: Requirements for Promoting Education and Awareness

No	*Action*		*Frequency*
1.	**Local Communities:**		
	1.1	Teacher training workshops	One workshop a month
	1.2	School activities	Two events a month
	1.3	Community outreach programs	Two events a month
2.	**General Public**		
	2.1	Posters and brochures	After every 10 years
	2.2	Sign boards	After every 10 years

Staff Training

Training of new and existing staff is central to the success of implementing the proposed High Protection (HP) Scenario (Section 5, *Impact of Project on Aquatic Biodiversity*). A course will be designed for the watch and ward team that will include information regarding:

- Important biological resources of the area, the conservation importance of these species and need for their protection.
- Legal framework as well as the applicable rules and regulations.
- Guidelines and procedures patrolling, coordination, and efficient watch-and-ward.

The course will be organized by the Implementation Organization and delivered by a leading conservation biologist and fish expert; a legal expert; and a senior official of the Department or an NGO with experience in management of wildlife in the area.

6.2 Structures to Assist Fish Passage across the Dam

Structures that assist fish to pass dams are variously called fishways, fish ladders or fish-passes. They are of two types. In the first, the fish swim upstream, aided by the device. In the second, the fish enter a storage compartment and are transferred to the reservoir above the dam without expenditure of energy on their part.[69]

The first group includes pool and weir, and pool and orifice types of fish-pass. Pool and weir type fish-passes are used where the dam to be surmounted is less than 10 m high, while pool and orifice fish-passes may be used up to 40 m. The structures of this group are used mainly by strong swimmers e.g. salmon.[70]

The second group includes sluice[71] fish-passes, useful up to 10m, fish locks, used up to 40m, and mechanical lifts which store and transport fish, and may be used to up to any height. Fish-lifts typically comprise:

- a collection gallery,
- an operation chamber containing a fish-retention grid, where fish may be counted and samples taken; and
- a moving and a releasing device.

The passage of water through the dam's turbine and the collection gallery creates a plume in the tail-water below the dam. This attracts fish which swim up the plume and enter the collection gallery. After a fixed time interval the gallery inlet is closed by a retaining and crowding device, which is usually a frame covered with netting. This prevents the fish from drifting back into the tail-water pond. The crowding device is then moved towards the dam when the fish are shepherded into the operation chamber. Subsequently they move from this chamber into fish-pass sluices, or into the containers of fish locks, or into hydraulic fish-lifts. The outlet chutes of fish-pass sluices are designed to create conditions which both assist the release of the fish into the reservoir above the dam and favor their onward migration.[72]

The first fish passes built in Latin America were pool-and-weir types, used in the northern hemisphere for passing salmonids. More recently, fish locks and mechanical fish lifts based on Russian experience described by Pavlov (1989) have been built for obstacles over 20 m in height.[73]

The main advantages of fish lifts compared to other types of fish passage facilities lie in their cost, which is practically independent of the height of the dam, in the little space needed and in their low sensitivity to variations in the upstream water level. They are also considered to be more efficient for some species, such as shad, which have difficulties in using more traditional fish passes.

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[69] Pavlov D.S., 1989. Structures assisting the migration of non-salmonid fish. USSE. FAO Fish. Tech. Pap. No. 308. Rome, FAO. 997

[70] Ibid

[71] A sliding gate or other device for controlling the flow of water, especially one in a lock gate.

[72] Pavlov D.S., 1989. Structures assisting the migration of non-salmonid fish. USSE. FAO Fish. Tech. Pap. No. 308. Rome, FAO. 997

[73] Larinier M. Marmulla G., 2003. Fish Passes: Types, Principles and Geographical Distribution an Overview. In**:** Robin L. Welcomme and T. Petr (eds.). *Proceedings of the second international Symposium on the Management of large rivers for fisheries, Volume 2, Sustaining livelihoods and biodiversity in the new millennium*

The main disadvantages lie in the higher cost of operation and maintenance. Furthermore, the efficiency of lifts for small individuals (e.g. young eel) is generally low because sufficiently fine screens cannot be used for operational reasons.[74]

In the case of high dams, when there are numerous species of poorly-known variable swimming abilities, migratory behavior and population size, it is best to initially concentrate mitigation efforts on the lower part of the fish pass, i.e. to construct and optimize the fish collection system including the entrance, the complementary attraction flow and a holding pool which can be used to capture fish to subsequently transport them upstream, at least in an initial stage.[75]

The height of the dam is about 45 m from the foundation. In order to make a fish passage workable, a water channel of more than 450 m will be required assuming a slope of 1:10. Construction of channel will be challenging due to presence of steep banks at the location of the dam. For reference, in the case of Uri II HPP located on Jhelum River upstream of the LoC, the dam has a height of 52 m, which is probably the reason for the absence of a fish passage, construction of which would have been difficult in any case due to steep slopes of the river banks. On the other hand, the dam of Uri I HPP located further upstream of Uri II has a height of 20 m, the river is very wide and there are no gorges, and a fish passage has been constructed. Documented results for success of this fish passage are not available.

At the Project, even if a fish channel is constructed, it will be challenging for fish to negotiate. Traveling and drifting through an extended water channel under strong pressure from the current will exhaust the fish if they are able to swim upstream at all, and injure them possibly resulting in mortalities. Moreover, if some of the fish are successful in reaching the reservoir, they will be in new territory, under unfamiliar conditions. Alwan Snow Trout is not a reservoir fish, it will be adversely affected. In Pakistan there is no experience with the use of fish passages except in river barrages. Even in those cases they are non-functional and no success has been reported.

In the absence of tested and proven techniques for automatic transportation of fish upstream of the dam to a height of more than 40 m which is the case with the Project, physical transport of fingerlings of migratory fish captured downstream to the river upstream of the dam is recommended. This will help in maintaining the diversity in the gene pool if the monitoring program indicates a need for this action. Experimentation with emerging methods and techniques to transport fish upstream of the dam such as Whoosh Transport System[76] is recommended in the CIA.

6.3 Other Actions and Measures to Protect and Enhance the Biodiversity in the Kunhar Basin

Specific actions recommended in the Cumulative Impact Assessment (CIA) that will directly benefit the biodiversity in the area of impact of the Project and are in the purview of the government include:

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[74] Ibid

[75] Ibid

[76] Whoosh Innovations <http://www.whooshh.com/advantages.html>, accessed November 22, 2016

- Requirement for future projects in the basin to achieve Net Gain in population of key fish species such as the endemic fish species Nalbant's Loach and Kashmir Hillstream Loach. This condition can be communicated by the Wildlife Department KP to the KP Environmental Protection Agency (EPA) as applicable for future hydropower projects in the section of the Kunhar River that constitutes the habitat for these loaches.
- Where technically and economically feasible, operation of other HPP projects such as the Patrind HPP and Sukki Kinari at baseload to avoid the impact of a peaking operation on the river.[77] The imposition of these conditions falls in the mandate of KP EPA, and they can apply this condition after discussion of technical and economic viability of these conditions with the project owners.

The CIA also includes recommendations for actions by the KP government at the basin level to maintain the integrity of the ecosystem. These actions are important as in a regulatory perspective it would not rational to apply environmental standards and controls for other hydropower projects that are less stringent than those applied for the Project through the EIA and conditions of environmental approval granted by the KP EPA. Examples of such actions are:

- Preparing guidelines for EIAs and BMP/BAPs for hydropower projects following accepted international best practices
- Making preparation of BMPs mandatory for hydropower developers in the Kunhar Basin
- Preparing and implementing guidelines for EFlow assessments

The KP EPA has the mandate to take these actions. Consultation with the industry and experts will be required, and the process will benefit from external technical assistance to incorporate best international practices.

6.4 Contributions to Institute for Research on River Ecology

The Biodiversity Action Plan for Kohala Hydropower Project[78] recommends setting up an Institute for Research on River Ecology (IRRE) in the Jhelum River basin. The institute will carry out research and development activities in collaboration with relevant government organizations on river ecosystems, fish breeding behavior, fish genetic studies, fish passages suited to local species, dam designs as well as an assessment of impacts and cumulative impacts of various hydropower projects in the basin. The IRRE will also include an experimental captive breeding facility for the endemic fish loaches of the Kunhar River.

The IRRE will require support from project developers and operators of hydropower projects operating in the Jhelum, Poonch and Kunhar basin for setting up and managing

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[77] Peaking operation of a hydropower plant results in daily variations in flow downstream of the power houses in the low flow or winter season due to storage of water during the day and release for a limited period in the evening to meet the peak power demand. Such imposed variations in flow can be detrimental to the survival of aquatic life in the river.

[78] Hagler Bailly Pakistan, 2017, Biodiversity Action Plan for the Kohala Hydropower Project, Kohala Hydro Company Limited.

the institution. It has been proposed that the hydropower project developers in the basin particularly the Karot, Kohala, and Mahl HPPs (**Section 7.13** of the **EIA of Balakot Hydropower Development Project**) contribute towards the IRRE given the similar issues they face in biodiversity management. The Balakot Hydropower Development Project will also contribute towards the establishment and operations of the IRRE subject to approval of associated costs in the tariff by NEPRA. The proposed institute will help the project owners in maintaining ecological databases and research and analysis capabilities that will benefit them individually by lowering their environmental management costs, and improving the quality and effectiveness of environmental management.

Some issues that the IRRE will focus on include the following:

- Captive breeding and stocking of fish of conservation importance that are impacted by projects
- Genetic studies to determine risk of in-breeding and actions to reduce the risks
- Assessment of impacts on river biodiversity at sub-basin level by integrating data collected through implementation of Monitoring and Evaluation Plans included in the Biodiversity Managements Plans of individual projects
- Use of environmental flow models such as DRIFT to assess cumulative impacts of projects
- Identification of suitable fish passages for fish to navigate up the river after construction of river obstructions by hydropower projects.

6.4.1 Management Approach

The following approach developed in consultation with key experts and professionals is recommended:

1. The Institute will be managed by an independent organization which will report to a Committee that will have representation from the government, the JK, Punjab, and KPK that share the river, and the hydropower industry. Management by one of the governments is not considered feasible given the technical nature of the operations, procedural requirements for hiring and incurring expenditures, and the track record of the governments in setting up and managing similar facilities.
2. The Institute can be set up as an entity registered with one of the governments, or the management can be contracted to a private sector organization or an NGO that has capability and track record for managing similar operations.
3. The hydropower industry will appoint a Coordinator which can be one of the participating companies. The Coordinator will be responsible for pooling up financial resources from the participating companies and management of all contracts related to the Institute. The most suitable choice for the Coordinator will be the company on whose premises the Institute is located. The Coordinator can charge administrative fees from the participating companies subject to mutual agreement of the industry

4. The institute will be centrally located so it is easily accessible from the participating provinces and the JK.
5. An independent review by international and local experts will be conducted periodically.
6. The Institute will coordinate with watershed management and basin biodiversity management organizations that may be established collectively by the hydropower industry.
7. In the long term, the Institute could take over M&E functions for various projects in the basin to displace the M&E entities contracted by individual HPPs under their BMPs in the basin.
8. Collaborative experiments may be set up at the hatcheries of the wildlife departments located elsewhere, such as the one being constructed at Moli Nullah, the hatcheries in the Neelum Valley, and hatcheries located in Punjab and KPK.
9. The Institute will collaborate with universities, research institutions, and concerned government departments in other provinces to bring in interns, researchers, and officials on deputation.
10. A detailed design and operation plan for the institute inclusive of budgets and an M&E plan will be developed prior to implementation.

6.4.2 Design and Requirements

The Institute will have a central facility where the research facilities will be maintained.

It is assumed that land acquired for temporary facilities at construction sites of hydropower plants, both at dam sites and powers houses, will be become free towards the end of the construction period. One of the HPPs will provide land, utilities, and maintenance support for the Institute. The option of using construction camp buildings for the Institute will also be considered to reduce construction costs. As land for temporary construction facilities will be acquired for the project (no short term leases are feasible under local regulations) and will become surplus when construction ends, there will be no additional cost to the project for allowing the Institute to use the land.

Two locations for IRRE were considered in the Biodiversity Action Plan of Kohala Hydropower project. One at the Kohala Dam, and at the other at the powerhouse of Kohala HPP. The main reason for considering these locations is the temperature of water from the Jhelum River (23°C in summer) which falls in the middle of range of temperatures experienced by the rivers and the tributaries. These include cool water streams such as Neelum and Kunhar Rivers and Jhelum closer to Wular Lake (14-15 °C in summer), and warmer water in Jhelum River closer to Mangla Reservoir (27 °C in summer). Water drawn from the reservoir will have low sediment concentration and will thus be suitable for use in the research facilities. Location of IRRE at the site of the powerhouse of Kohala HPP is recommended as it is easily accessible from Punjab and KPK, and Islamabad where back up support from other institutions such as the Pakistan Museum of Natural History will be available. The professional staff, along with numbers for each, is listed in **Exhibit 6.3**.

Exhibit 6.3: Professional Staff of IRRE

Staff Member	*No.*
Director	1
Principal Research Officers	3
Research Officers	6
Technicians/Assistants	6
Admin	1
Accounts	1

Land requirement is estimated at 1.5 hectares. It is assumed that power, water supply, and other maintenance services will be provided by the project where the facility is located.

6.5 Watershed Management Program

The existing causes of decline in water quality in the Area of Management are described in **Section 4.1.5** (*Threats to Fish Fauna*). It is proposed to set up a Watershed Management Program (WMP) for the Kunhar River basin that will primarily focus on improvement of water quality in the basin that is critical for protection of biodiversity in the long term.[79]

The institutional and financial model for setting up watershed management institutions can be similar to that proposed for the IRRE but will be restricted to the Kunhar basin. The support provided by the project owners in this case, however, will be limited, as the hydropower projects on Kunhar River will have limited impact on the water quality of the river in the construction phase, and insignificant impact during the operation phase. Additional support and resources will have to be mobilized from the participating government departments which will include forests, wildlife, agriculture, and irrigation. It would be also beneficial to route CSR investments through the Institutions to maximize the benefit from investments for both the industry and the communities.

The watershed management program will focus on the following areas:

- Reforestation to meet community requirements for fuel wood and timber remaining within the limits of sustainable harvesting to reduce erosion and risk of landslides
- Land use management
- Management of water use in both agriculture and households
- Management of water quality including treatment of effluent at households and municipal level and maintaining water quality in open streams that ultimately drain into river

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[79] Hagler Bailly Pakistan, 2017, Biodiversity Action Plan for the Kohala Hydropower Project, Kohala Hydro Company Limited.

- In case CSR investments are included, then investments can be made in areas such as clean drinking water, health, livestock, and improvements in agricultural productivity

Project developers of the Balakot Hydropower Development Project, Pakhtunkhwa Energy Development Organization (PEDO), will contribute to the establishment and operation of a Watershed Management Plan for the Kunhar basin subject to approval of associated costs in the tariff by NEPRA. PEDO will make efforts through the KP Environmental Protection Agency (EPA) and the departments of fisheries and wildlife to persuade the developers of Patrind, Sukki Kinari, Naran, and Batakundi HPPs located in the Kunhar Basin to adopt a framework for biodiversity management similar to the one proposed in this BAP, and in BAPs/BMPs of other HPPs in Jhelum Basin.

6.5.1 Management Approach

The following approach has been developed in consultation with key experts and professionals.

1. The basic approach adopted will be that of the Rural Support Programs (RSPs) in Pakistan which has been successfully tested and scaled up in practically all the provinces. The approach is based on social mobilization and community participation, and complimentary investments by community to improve ownership.
2. Local watershed management institutions (WMIs) will be set up and managed by an independent organization which will report to a Committee that will have representation from the government of KP, and the hydropower industry. Management by governments is not considered feasible given the need for community participation, procedural requirements for hiring and incurring expenditures, and the track record of the governments in setting up and managing similar facilities.
3. The management can be contracted to a private sector organization or an NGO such as the National Rural Support Program that has capability and track record for managing similar operations.
4. A Central Office will coordinate the activities of Field Units and will be responsible for providing technical support to the Field Units and coordination with the government institutions. The Central Office will also be responsible for M&E of Field Units.
5. The Central Office will be located so it is easily accessible. Field Units will be located in the areas of operations. Co-location of the Central Office with the IRRE is recommended. This will help in lowering the cost of operations, and will also improve coordination with the hydropower industry.
6. In addition to government departments, activities will be coordinated with the Implementation Organization responsible for implementation of the BAP, especially for social mobilization.
7. An independent review by a local M&E organization will be conducted periodically.

8. A detailed design of the Watershed Management Program (WMP) will be developed prior to implementation to develop the plans and budgets.

6.5.2 Design and Requirements

A Central Office and about six Field Offices are envisaged, each Field Office being responsible for about two forest ranges as organized under the forest departments. Staffing envisaged for the central office is summarized in **Exhibit 6.4**.

Exhibit 6.4: Staff for Central Office

Staff Member	*No*
Project Director	1
Coordinator- Forester	1
M&E Specialists	2
Office Assistant	1
Drivers	2
Watershed Management Units	
Coordinator	1
Female Social Mobilizers	2
Supervisors	2
Office Assistant	1

7. Institutional Arrangements for Implementation of BAP

The institutional model for implementation of the Biodiversity Action Plan (BAP) of the Kunhar River is based on the model followed in the BAP for the Gulpur Hydropower Project. The BAP for the Gulpur Hydropower Project is being successfully implemented in the Poonch River Basin which is part of the Jhelum River Basin, and was set up after extensive discussions and consultations with the key stakeholders and a comprehensive assessment of risks under various implementation options. A similar model of BAP has also been proposed for the Kohala Hydropower Project.

7.1 Institutional Arrangement for Management of Protection

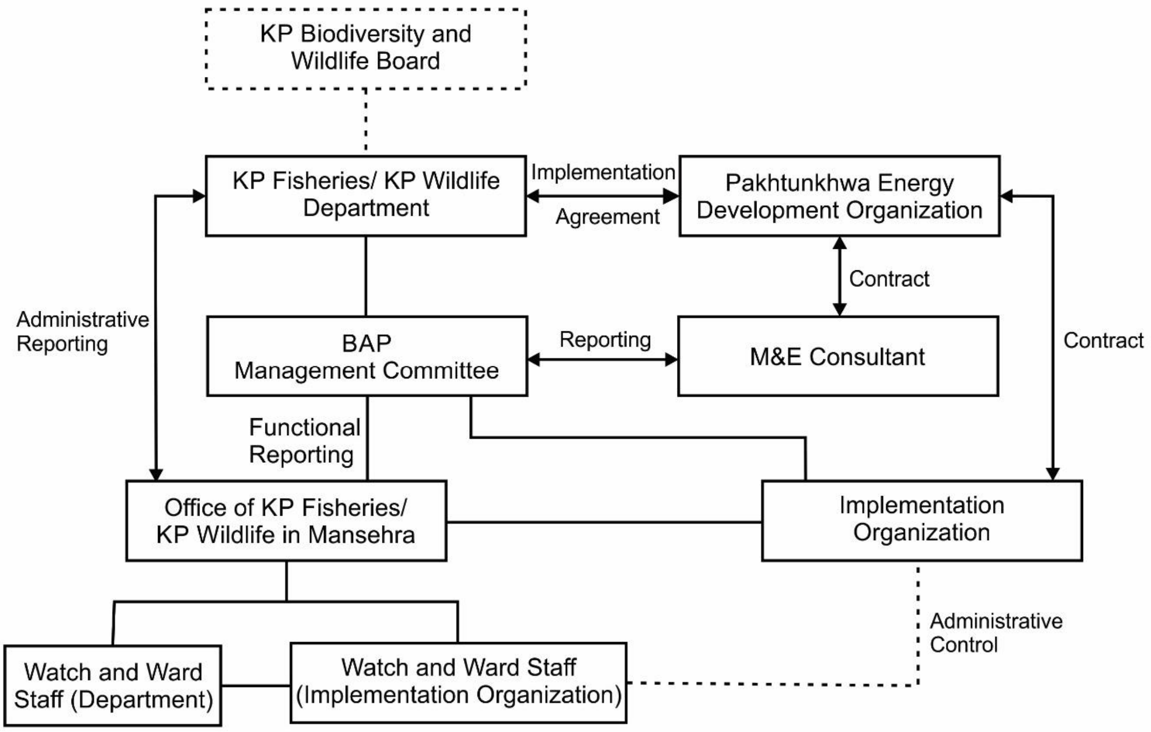
As outlined in **Section 6** (*Proposed Conservation Measures*), in Khyber Pakhtunkhwa (KP), the responsibility for watch and ward of the terrestrial and aquatic ecological resources lies with the Wildlife Department, while the Fisheries Department regulates recreational fishing and is also responsible for management of water quality of the river. It is therefore not clear which department will take the lead in supporting implementation of the BAP. For the purpose of this Draft BAP, both organizations have been proposed and a decision can be taken by the KP Government about which department will finally be designated.

Based on discussions with the stakeholders (**Section 3,** *Summary of Stakeholder Consultations*) in KP, mainly, the Wildlife Department, Fisheries Department, Forest Department, and the NGOs, the strategy to be adopted for management of protection under the BAP is outlined below.

- Putting in place a protection system for the Area of Management with financing from the Project to fill the gaps in the existing system
- Implementation by an independent Implementation Organization
- Active support from the Wildlife and Fisheries Department, KP by making available existing staff for protection, assistance in coordination with other government line departments such as police and district administration
- Commitment by the Wildlife Department/Fisheries Department to provide legal authority to the staff of the Independent Organization for exercising powers under wildlife legislation
- Regular oversight and monitoring by a Management Committee set up for the BAP
- Establishment of field wildlife management offices along the Kunhar River to provide a base for the watch and ward staff to operate from
- Monitoring on a long term basis by an independent Monitoring and Evaluation (M&E) Consultant

Exhibit 7.1 illustrates the institutional and contractual arrangements for implementation of protection under the BAP. These are summarized below. This BAP also includes recommendations for strengthening the implementation partners, so that they can play a more effective role in implementation of BAP.

Exhibit 7.1: Institutional Arrangements for Management of Protection



7.1.1 Implementation Arrangement

PEDO will obtain a policy approval from the Government of KP for implementation of the BAP. PEDO will then enter into agreements with the departments (Wildlife Department/Fisheries Department) for BAP implementation. Drawing on the experience gained in the Gulpur Hydropower Project, a draft agreement that provides the essential features of the obligations of the parties to the agreement, namely the government departments and PEDO, is included in **Appendix E**. The agreement assigns responsibilities to the departments for implementation of the BAP actions, and for PEDO to contract and provide the implementation and monitoring resources. The draft will be finalized through consultation by the parties and will incorporate the inputs from the law departments and the legal counsel of PEDO. It is not within the scope of the BAP to prepare the final legal instrument.

7.1.2 Management Committee

The BAP Management Committee in KP will be established by the KP government through a notification. The Committee will have the following constitution:

- Chief Conservator Wildlife - Advisor to Management Committee

- Director Wildlife or Director Fisheries KP – Chair
- Project Manager of Implementation Organization - Secretary
- Representative of PEDO – Member
- Representative of KPK Fisheries Department – Member
- Representative of KPK Forest Department – Member
- District Coordination Officers - Member
- Representative of Civil Society - Member
- Representative of Environmental Protection Agency (EPA) - Member
- Recognized Expert on Freshwater Ecology - Member

The membership of the Management Committee could be amended by mutual consent of the departments and PEDO. Depending on the issues and threats being faced, additional representatives from organizations such as the Police Department and the Mines and Minerals Department may be included by invitation in the Management Committee.

The Management Committee will be responsible for:

- Reviewing the reports submitted by the Implementation Organization
- Reviewing the reports submitted by the M&E Consultant
- Organizing and conducting field inspections as and when warranted
- Reporting to on an annual basis and coordination with a high level oversight bodies such as KP Biodiversity and Wildlife Management Board.
- Providing directions to the staff of the Department, Implementation Organization, and the M&E Consultant for improving the effectiveness of the implementation of the BAP.

7.1.3 KP Wildlife Department / KP Fisheries Department

Responsibilities of the KP Wildlife Department / KP Fisheries Department (Departments) are summarized as follows:

- Enforce the provisions of the Khyber Pakhtunkhwa Fisheries/Wildlife legislation and other applicable legislation in the Area of Management as authorized in the law.
- Make available existing staff for protection, and coordinate with other government line departments such as police and district administration.
- Establish a Management Committee for oversight and monitoring of implementation of the BAP.
- Provide legal authority to the staff of the Implementation Organization for exercising powers as permissible under the legislation and as approved by the Management Committee.

- Assess the adequacy and effectiveness of the wildlife management systems in place for achievement of the objectives of the BAP.
- Evaluate the pressures on wildlife resources in the achievement of the objectives of the BAP and emerging threats (hunting and trapping, fishing, grazing, visitors, traffic, violations of rules, construction of infrastructure, and pollution).
- Use available resources to collect and share data on wildlife relevant to the BAP.
- Promote and support implementation of conservation projects, mobilization of local communities, and coverage in local media
- Provide land for and facilitate construction of field offices.
- Place a system for registration and review of complaints and follow up conducted to address the complaints related to implementation of the BAP.

7.1.4 Implementation Organization

PEDO will contract with an Implementation Organization with demonstrated interest and experience in biodiversity protection in the field for delivery of services and materials required for implementation and within its scope of responsibility. The Implementation Organization will be responsible for supporting the Departments in maintaining an effective watch and ward system for protection of the aquatic biodiversity in the Area of Management. Specifically, the Implementation Organization will provide the following support:

- Hire and manage the staff indicated in **Section 6.1.4** (*Requirements for Protection*) for protection activities
- Procure and maintain equipment and materials required for supporting the watch and ward as listed in **Section 6.1.4** (*Requirements for Protection*).
- Collect data and prepare reports on watch and ward and management of sediment mining, and submit the reports to the Management Committee and the M&E Consultant.
- Provide training to the staff of the Wildlife Department in protection and management of wildlife.
- Maintain contact with local communities and stakeholders and promote awareness on biodiversity protection among them.
- Advise the Management Committee and the M&E Consultant on ways and means for improving the effectiveness of BAP.

7.1.5 M&E Consultant

PEDO will contract with an M&E Consultant with experience in biodiversity assessment who will be responsible for performing tasks described in **Section 9**, *Monitoring and Evaluation*. The M&E Consultant will provide a consolidated picture to PEDO and the Departments on the effectiveness of the BAP in the Area of Management. The scope of services to be provided by the M&E Consultant is summarized below:

- Conducting field surveys and investigations to assess the effectiveness of implementation of the BAP, and
- Preparation of the Annual M&E Report and periodic assessment reports for submission to the Management Committees.

The M&E Consultant will engage local biodiversity specialists and wildlife management specialists for supervision of data collection, analysis, and report writing, and for advising the Implementation Organization and the Management Committee on improvement of protection strategies and adopting measures for adaptive management. The M&E Consultant will also set up the M&E data collection and reporting systems.

7.1.6 The KP Biodiversity and Wildlife Board

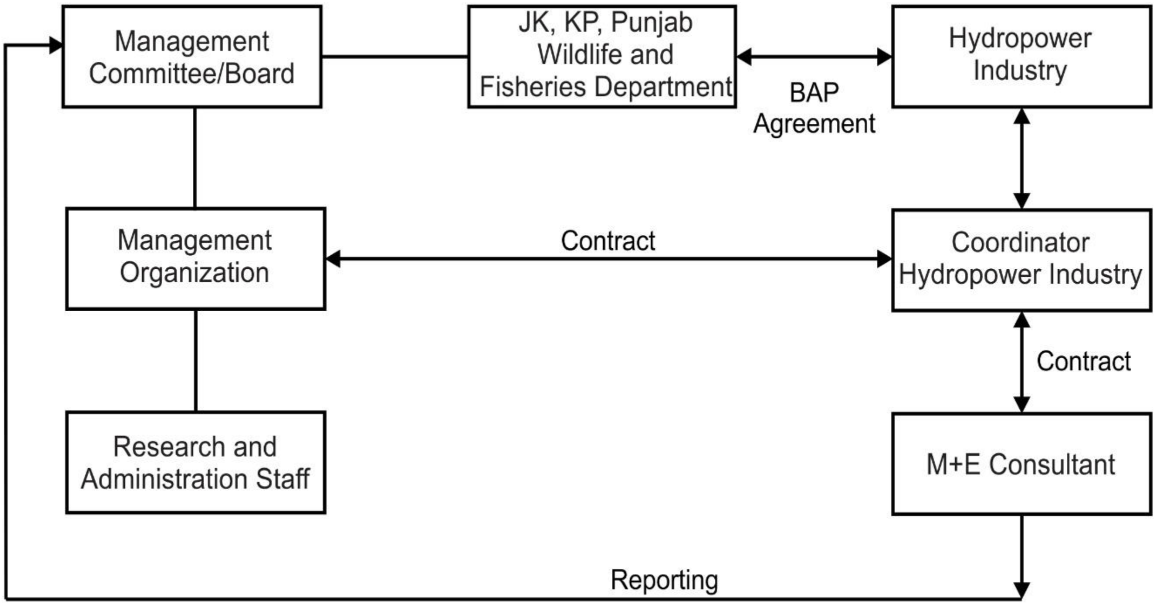
The KP Wildlife and Biodiversity (Protection, Preservation, Conservation and Management) Act, 2015 established a Biodiversity and Wildlife Board. This Board will oversee the organizations implementing the BAP and provide direction and support as needed (**Exhibit 7.1**).

7.2 Institutional Arrangements for Institute for Research on River Ecology

As mentioned in **Section 5**, the Biodiversity Action Plan for Kohala Hydropower Project recommends setting up an Institute for Research on River Ecology (IRRE) in the Jhelum River basin, most probably in JK. The Project will contribute towards the establishment and operations of the IRRE subject to approval of associated costs in the tariff by NEPRA.

Exhibit 7.2 illustrates the institutional arrangement for management of the Institute for Research on River Ecology (IRRE) (referred to as 'Institute').

Exhibit 7.2: Institutional Arrangement for Management of the Institute for Research on River Ecology



Following are the salient features of the proposed arrangement.

- The Institute will be managed by the hydropower industry as an independent Management Organization, which will be the direct beneficiary of its outputs and will provide financing for its establishment and operations.
- The requirement for the hydropower industry to finance and operate the Institute will be incorporated into the BAP/BMP agreements entered into by the industry with the respective governments. Similar to the requirements for protection, responsibilities of the industry and the government will be listed in the agreements. As indicated in **Section 10.3** (*Budget for the Institute for Research on River Ecology*), the recommended share of PEDO in the financing of the IRRE in view of the capacity of the Project is 10%, subject to approval of associated costs in the tariff by NEPRA.
- The hydropower industry will appoint a Coordinator which can be one of the participating companies. The Coordinator will be responsible for pooling up financial resources from the participating companies and management of all contracts related to the Institute. As suggested in **Section 6.4.1** (*Management Approach*), the most suitable choice for the Coordinator will be the company on whose premises the Institute is located. The Coordinator can charge administrative fees from the participating companies subject to mutual agreement of the industry.
- The Coordinator will contract with a Management Organization which will be an independent corporate entity or a registered NGO. The Management Organization will be responsible for establishment and operation of the Institute under the direction of the BAP Management Committee (see **Section 6.1.2**, *Measures for Regulation of Sediment Mining*).
- The wildlife and fisheries departments of JK, KP and Punjab, as well as the EPAs will participate in management of the Institute. The wildlife and fisheries departments will ensure that the terms of the agreements under which the Institute is established are fulfilled, while the EPAs will ensure that the conditions of approval of the EIA of the Project related to the institute are complied with.
- An M&E Consultant will be engaged for evaluation of the performance of the Institute under an arrangement similar to that for evaluation of protection activities. In view of the similarities in the technical aspects of monitoring, the responsibility for monitoring the performance of the Institute and that for protection could be entrusted to one entity.

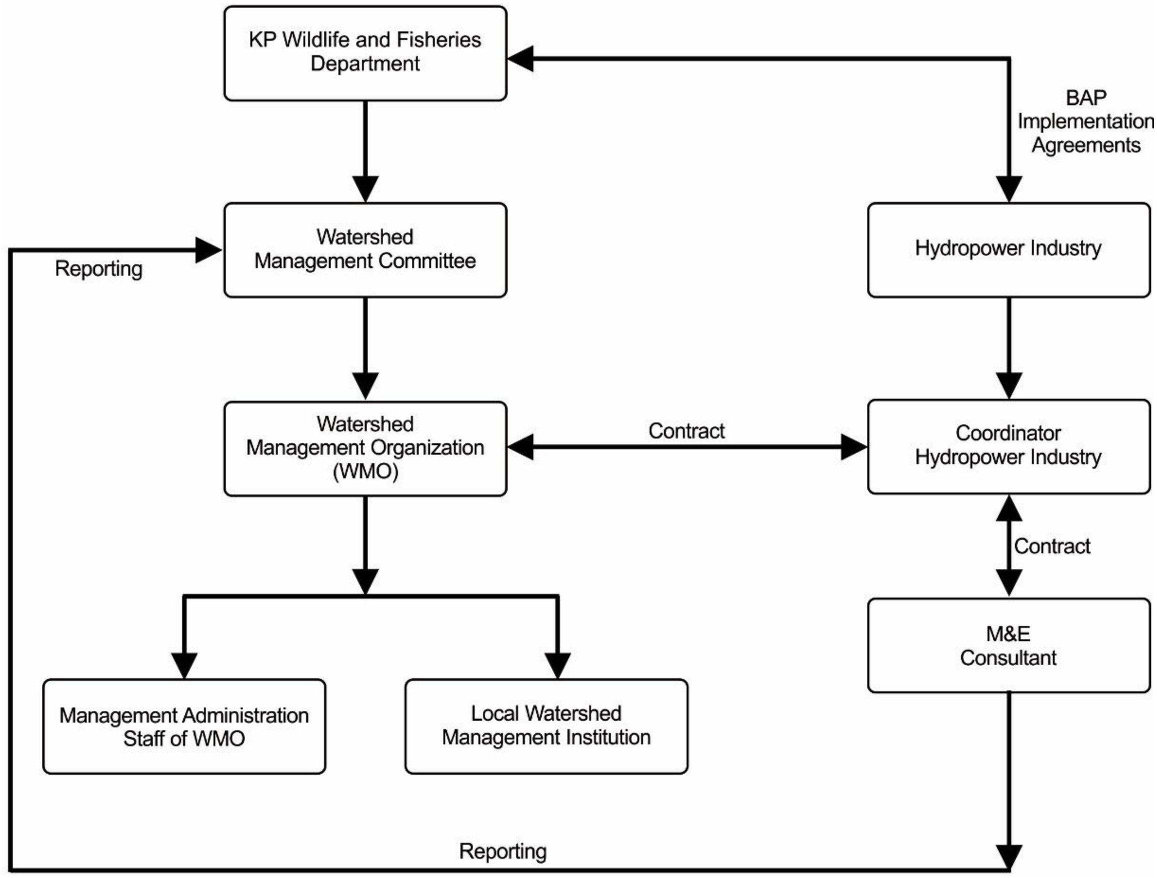
A detailed plan for the design and operation of the Institute will be prepared under a contract entered into by the Coordinator with a suitably qualified entity. The plan will be submitted to the Management Committee for approval prior to implementation.

7.3 Institutional Arrangements for Watershed Management

Exhibit 7.3 illustrates the institutional arrangement for watershed management in the Kunhar Basin. The basic approach suggested is similar to that suggested in the previous section for management of the IRRE. Following are the salient features of the proposed arrangement.

- Management will be entrusted by the hydropower industry to an independent Watershed Management Organization (WMO). As suggested in **Section 6.5,** management can be contracted to a private sector organization or an NGO that has capability and track record for managing similar operations.
- The requirement for the hydropower industry to finance and operate the watershed management institutions will be incorporated into the BAP/BMP agreements entered into by PEDO with the Departments. Similar to the requirements for protection, responsibilities of the industry and the government will be listed in the agreements. As indicated in **Section 10.4** (*Budget for Watershed Management*), the recommended share of PEDO in the financing of the WMO is 25%, subject to approval of associated costs in the tariff by NEPRA.
- The hydropower industry will appoint a Coordinator which can be one of the participating companies. The Coordinator will be responsible for pooling up financial resources from the participating companies and management of all contracts related to the WMO. The Coordinator can charge administrative fees from the participating companies subject to mutual agreement of the industry.
- The Coordinator will contract with a WMO which will be an independent corporate entity or a registered NGO. The WMO will be responsible for establishment and operation of the local watershed management institutions under the direction of the Watershed Management Committee.
- In addition to forest and wildlife departments, the Watershed Management Committee will have representation from the district administrations, the hydropower industry through the Coordinator.
- The KP Integrated Water Resources Management Board will oversee the working of the Watershed Management Committee.
- The forest and wildlife departments of JK, KP and Punjab, as well as the EPAs will play a pivotal role in management of the WMO. The departments will ensure that the terms of the agreements under which the WMO is established are fulfilled, while the EPAs will ensure that the conditions of approval of the EIA of the Project related to the WMO are complied with.
- An M&E Consultant will be engaged for evaluation of the performance of the WMO and the local watershed management institutions. In view of the similarities in the technical aspects of monitoring, the responsibility for monitoring the performance of protection, the IRRE, and the watershed management activities could be entrusted to one entity.

Exhibit 7.3: Institutional Arrangement for Watershed Management



A detailed plan for the design of watershed management will be prepared under a contract entered into by the Coordinator with a suitably qualified entity. The plan will be submitted to the Watershed Management Committee for approval prior to implementation.

7.4 Review of BAP Implementation

Status of implementation of the BAP will be evaluated biannually for the first three years and once every year thereafter to assess its effectiveness and ascertain whether the targets set for Net Gain/No Net Loss in biodiversity as envisaged in the BAP, and performance of the IRRE and watershed management institutions as specified in their plans are being achieved. Recommendations for improvement of the BAP will be presented as a part of assessment reports prepared by the M&E Consultant. The Management Committee will review the recommendations of the M&E Consultant and may amend the implementation plans to improve their effectiveness through changes in actions and activities and allocation of resources.

In view of the experience gained in implementation of the BAP for the Gulpur Hydropower Project, in addition to completion of actions listed in **Section 7**, special attention will have to be paid to the following to manage the risks in implementation of the BAP:

1. PEDO, and the Departments should maintain regular contact at the Secretary level to ensure that high level support from the government is available and leadership is exercised.
2. The counterpart staff assigned by the Departments should diligently perform the duties assigned to them. The attitude that the contracted staff of the management and implementation organizations is there to work so the staff assigned by the government need not attend and participate can seriously impact the performance of the organizations and institutions responsible for implementation of the BAP.
3. The meetings of Management Committee should be held regularly on quarterly basis and should be properly attended.
4. In addition to monitoring by the M&E Consultant, the Environmental Managers of participating hydropower companies should maintain contact with the organization contracted for implementation to review its performance on a continuing basis and to ensure that they are properly supported.

7.5 Capacity Building of the KP Wildlife Department and KP Fisheries Department

Since both the KP Wildlife Department and KP Fisheries Department play a pivotal role in protecting the aquatic and terrestrial resources of the Kunhar River basin, annual trainings and capacity building of the staff should be carried out for research, data collection, monitoring of ecological resources as well as management. The trainings can be conducted by organizations contracted for implementation, management, and monitoring and evaluation of the BAP.

7.6 Institutional Arrangement for the BAP in the Long Term

The institutional arrangements outlined in **Exhibit 7.1, Exhibit 7.2,** and **Exhibit 7.3** require continuous coordination between the government, organizations contracted for management and implementation, and M&E Consultants. While these institutional models aim to provide a structure for achievement of BAP objectives, strong and capable government departments, particularly the KP Wildlife and KP Fisheries Department that integrate all the management functions within them would be the appropriate arrangement for long term sustainable management.

The strategy adopted in the BAP relies on filling the budgetary gaps for management of biodiversity and watersheds. The M&E Consultants and the management and implementation organizations will be funded directly by PEDO and other participating hydropower companies, and supplemental funds for operations provided by the industry will also be spent through the contracted management and implementation organizations. This approach was designed to ensure availability of resources and funds for management, while maintaining transparency and avoiding administrative delays in utilization of funds provided by the hydropower companies.

In the long term as the capacities in the government are built and the concerned departments are strengthened, first the management and implementation organizations could be phased out with the government departments taking over these functions. PEDO and the hydropower industry at that stage could provide funds either directly to the government departments under the supervision and scrutiny of the Management Committees or higher level institutions such as the KP Biodiversity and Wildlife Board.

At a later stage, the M&E function could also be managed by the government departments which is their mandate, and the allocation for the M&E Consultants could also be transferred by the hydropower industry to the government. PEDO and the hydropower industry would be well advised to maintain a position in the Management Committees to ensure that the commitments of the companies under the EIA are met. During the tenure of the loans, any such change in arrangement will require an approval from the lenders as well.

8. Implementation Plan

A list of action items along with responsibilities, requirements and completion deadlines are provided in **Exhibit 8.1** to facilitate implementation and accountability.

Exhibit 8.1: Key Actions, Responsibilities, and Milestones for Implementation of this BAP

No.	Action	Responsibility	Requirement	Completion Deadline
	Finalization and Signing of BAP Agreement			
1	Submittal of BAP (Biodiversity Action Plan) by PEDO (Pakhtunkhwa Energy Development Organization) to GoKP (Government of Khyber Pakhtunkhwa) for Approval	PEDO	Immediately on finalization with lenders, forward BAP to Departments and environmental regulators for approval	September 2018 (or earlier if finalized by lenders)
2	Approval of the BAP by Government of KP	KP Wildlife/Fisheries Department (Departments)	Follow up by PEDO to address concerns of the government if any	6 months after submission of BAP by PEDO
3	Signing of BAP Implementation Agreement by PEDO with GoKP	PEDO and Government	Follow up by PEDO to address the concerns of the government if any on the agreement draft	2 months after approval of BAP by GoKP
	Protection			
1	Award of Contract to Implementation Organization for Protection (IOP)	PEDO	Management of procurement of services	3 months after signing of BAP Implementation Agreement with GoKP
2	Award of Contract to Monitoring and Evaluation Organization	PEDO	Management of procurement of services	1 year before construction of coffer dam
3	Award of Contract for Preparation of Sediment Mining Plan	PEDO	Management of procurement of services	3 months after Financial Close
4	Provision of Land by Department for Construction of Field Office	Departments	The KP Government will provide government owned land for construction of field office at an appropriate location	6 months after submission of signing of BAP agreement
5	Assigning Counterpart Staff and Authorization of IOP Staff	Departments	A minimum number of counterpart staff (about 20% of IOP staff) that	6 months after signing of BAP

No.	*Action*	*Responsibility*	*Requirement*	*Completion Deadline*
			can work with the staff of the IOP will be required.	
6	Quarterly Progress Reports for Protection Submitted to BAP Management Committee	IOP	IOP will provide updates on achievements and constraints	Quarterly
7	Annual Progress Report for Protection Submitted to BAP Management Committee	IOP	Quarterly reports are to be combined and presented as an annual report at the year end	Annually
8	Quarterly and Annual Meetings of BAP Management Committee to Review Performance of IOP	BAP Management Committee	BAP Management Committee to meet regularly to review performance and provide support and guidance to IOP	Quarterly and Annually
	Institute for Research on River Ecology (IRRE)			
1	Award of Contract for Preparation of Design and Operation Plan for IRRE, subject to approval of associated costs in the tariff by NEPRA.	KHCL*	Management of procurement of services	3 months after Financial Close of Kohala Hydropower Project
2	Award of Contract to Management Organization of IRRE (MO IRRE) for setting up and operation of Institute for Research on River Ecology (IRRE)	KHCL	Management of procurement of services	9 months after Financial Close of Kohala Hydropower Project
3	Start of Construction of IRRE	MO IRRE	Setting up the infrastructure as specified in the Design and Operation Plan for IRRE	3 months after award of contract to MO IRRE
4	Fully Functioning IRRE	MO IRRE	Setting up the institution inclusive of staff and facilities as specified in the Design and Operation Plan for IRRE	1 year after award of contract to MO IRRE
5	Quarterly Progress Report for IRRE	MO IRRE	The activities of IRRE will be reported focusing on progress on research and issues	Quarterly

No.	*Action*	*Responsibility*	*Requirement*	*Completion Deadline*
6	Annual Progress Report for IRRE	MO IRRE	The activities of IRRE will be reported focusing on results in key research areas, issues, plans, and financials.	Annually
7	Quarterly and Annual Meetings of BAP Management Committee to Review Performance of IRRE	BAP Management Committee	BAP Management Committee to meet regularly to review performance and provide guidance to IRRE	Quarterly and Annually
	Watershed Management Program			
1	Award of Contract for Preparation of Design of Watershed Management Program (WMP), subject to approval of associated costs in the tariff by NEPRA.	PEDO	Management of procurement of services	3 months after Financial Close
2	Award of Contract to Watershed Management Organization (WMO)	PEDO	The scope of work for support to be provided will be finalized with the Go KP.	9 months after financial close
3	Fully functioning Watershed Management Institutions (WMIs)	WMO	Social mobilization of the communities, formation of WMIs, finalizing watershed management agreements between communities and government.	1 year after award of contract to WMO
4	Quarterly Progress Report for WMP	WMO	The activities of WMP will be reported focusing on progress on research and issues	Quarterly
5	Annual Progress Report for WMP	WMO	The activities of WMP will be reported focusing on results in key research areas, issues, plans, and financials.	Annually
6	Quarterly and Annual Meetings of BAP Management Committee to Review Performance of IOP	Watershed Management Committee	Watershed Management Committee to meet regularly to	Quarterly and Annually

No.	*Action*	*Responsibility*	*Requirement*	*Completion Deadline*
			review performance and provide support and guidance to WMP	
	Other Actions Arising out of Cumulative Impact Assessment			
1	Permission from Power Purchaser to Operate on Baseload	PEDO	Follow up by PEDO with Central Power Purchasing Agency (Guarantee) Limited (CPPA-G) to get permission to operate on baseload	Within 3 months of approval of EIA for BAHPP (Balakot Hydropower Project) by KP EPA (KP Environmental Protection Agency)
3	Issuance of Guidelines for EIA of Hydropower Projects, BAP/BMPs, Cumulative Impact Assessments (CIA)s, and EFlow Assessment	KP EPA	KP EPA to manage procurement of services for preparation of guidelines	24 months after signing of BAP agreement
4	Requirement for Hydropower Projects to Achieve Net Gain for Key Fish Species in Kunhar Basin	KP EPA and Fisheries Department	To apply same conditions for protection of biodiversity as those in EIA of Balakot Hydropower Development Project on other hydropower projects that may be planned in the basin.	6 months after approval of EIA for BAHPP

*The main responsibility for setting up IRRE will be with Kohala Hydro Company (Pvt.) Ltd (KHCL) as the facility will be located on the land to be provided by KHCL close to the power house of Kohala Hydropower Project. PEDO will work with (KHCL) and concerned Environmental Protection Agency to ensure that KHCL meets its commitments under the BAP of the project in a timely manner so establishment of the IRRE is not delayed.

9. Monitoring and Evaluation Framework

As stated in **Section 1**, *Introduction*, the BAP has been prepared to provide a framework and an action plan for achieving Net Gain/No Net Loss consisting of River Kunhar and its tributaries in the Area of Management (**Section 1.1**, *Background and Rationale for Developing BAP*) under IFC Performance Standards and ADB's SPS 2009 (Section 2, Regulatory Framework). This section provides the scope and framework for monitoring and evaluation to determine if the objectives of the BAP are being achieved through the life of the Project. The complete Monitoring and Evaluation Plan is given in **Appendix F**. The approach proposed is the same as used in the Monitoring and Evaluation Plan of the Gulpur Hydropower Project and builds on the experience gained in its implementation. This section also outlines the related institutional arrangements, procedures for reporting and review, and budgetary requirements.

The monitoring and evaluation framework presented in this section should be considered as an evolving document. The Monitoring and Evaluation Consultant (**Section 7.1.5**, *M&E Consultant*) will be expected to review the framework before initiating the activities, and periodically review and improve it as experience is gained in implementation of the BAP. The Monitoring and Evaluation Consultant will also be responsible for finalizing data collection forms and protocols, and developing information management systems to support the compilation of data and preparation of reports.

9.1 Analytical Framework for Monitoring and Evaluation

To assess whether or not Net Gain in biodiversity has been achieved, comparisons will be made with the Pre-Project conditions (referred to as baseline conditions in **Section 4,** *Biodiversity Values*). Pre-Project conditions for the purpose of assessment of effectiveness of the BAP will be defined as conditions prevailing in the ecosystems preceding the start of construction activities that could directly impact the aquatic or terrestrial ecosystems. Data and information from the first set of sampling that will form the reference point for the BAP will be used to define the pre-Project conditions. Baseline data from the EIA will not be used for assessment of effectiveness of implementation of the BAP. The reasons for adopting this approach are:

- To screen out any deterioration or improvement in the ecosystems that may have taken place between the time the sampling was done for the EIA, and when the project impacts actually begin to occur.
- To further refine the sampling approach in view of the stakeholder comments received during the preparation of the BAP.

A Pressure-State-Response (PSR) framework will be used for monitoring purposes.[80] The PSR framework lays out the basic relationships amongst:

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[80] Pressure-State-Response Framework and Environmental Indicators, http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/refer/envindi.htm

- the pressures human society puts on the environment
- the resulting state or condition of the environment, and
- the response of society to these conditions to ease or prevent negative impacts resulting from the pressures

9.2 Scope of the Monitoring and Research Programme

Following the PSR framework, the framework for monitoring is described in the sections below. Details of the indicator description, method of data collection and analysis, as well as frequency and timing are provided in **Appendix F**, Monitoring and Evaluation Plan.

9.2.1 Monitoring Indicators – Pressure

Exhibit 9.1 summarizes the monitoring requirements for indicators of pressure on biodiversity. The following is an overview of the types of pressures that need to be managed, and the associated indicators that can be used to monitor the pressures:

Exhibit 9.1: Framework for Monitoring of Pressure Indicators

Pressure Aspect	*Scope/Coverage*	*What to Monitor*	*Comments*
Harvesting from river for food	Permitted fishing using cast nets	Number of fishing permits issued in a period	Cast nets are primarily used for subsistence fishing, the Fisheries Department issues permits for use of cast nets in Kunhar River
	Illegal fishing	Number of instances of illegal fishing reported or observed	This includes use of gill nets, explosives, and poisons for harvesting fish
River related recreation and Tourism	Trout species are artisanal and recreationally caught fish species	Number of fishing permits issued for rods in a year	The Department allows recreational fishing in Kunhar River against permits
Extraction of sand and gravel from riverbeds	Regulated and unregulated mining of sand and gravel from river bed for use as construction materials	Quantity and distribution of sand and gravel mining from river beds	Focus will be on extent of mining in areas identified as sensitive in the Sediment Management Guidelines
Hunting and trapping of species of concern	Terrestrial habitats in Area of Management	Species of concern	This will be the responsibility of the KP Wildlife Department at the watershed level. Monitoring on Project site is covered in the EMMP of the EIA.

Pressures on Aquatic Ecology

Illegal and unregulated fishing, and sand and gravel mining from the river bed to meet the local demand for construction materials were identified as principle threats to aquatic biodiversity (**Section 4.1.5**, *Threats to Fish Fauna*). The type of indicators proposed for monitoring these pressures are:

1. The total amount of fish by species being harvested in a year, for subsistence and recreational purposes, through legal as well as illegal means.

2. Total amount of sand and gravel extracted from the river and tributaries, separately reported or estimated for extraction through legal means (with permits at designated mining sites) and through illegal means (without permits).

The above information will be reported on a quarterly basis. The Implementation Organization will prepare systems for collection and reporting of information related to violations as described in **Section 7**.

Pressures on Terrestrial Ecology

Monitoring and reporting of pressures on terrestrial wildlife including hunting, trapping, or disturbance for the species of concern such as Common Leopard, Black Bear will be the responsibility of the KP Wildlife Department.

9.2.2 Monitoring Indicators – State

Exhibit 9.2 summarizes the framework for monitoring the indicators of state. The M&E Consultant will be responsible for collection and reporting of information. Information on the following indicators will be collected and reported.

- Hydrology
- Water quality
- Geomorphology
- Fish

The method of data collection, frequency and timing of collection as well as data analysis is included in **Appendix F**, Monitoring and Evaluation Plan. The methodologies will be adjusted and adapted over time where required to facilitate assessment as described further in **Section 11,** (*Adaptive Management*). This is particularly true for monitoring of fish migration patterns, where, in addition to simple tagging and recapture suggested in **Exhibit 9.2**, there is a need to test and apply advanced techniques such as PIT Telemetry, Active Telemetry, Underwater video, Vaki River watcher, and ARIS camera.

Isolation of fish populations between dams and in tributaries leading to a drop in genetic diversity is a possible risk that needs to be addressed. Special studies will be required to assess this risk and to formulate remedial measures.

Exhibit 9.2: Framework for Monitoring of Indicators of State

No	*Aspects*	*Indicator*	*Data required*	*Method*	*Monitoring Responsibility*
1.	Hydrology	Discharge time series	Average daily discharge	Obtain from gauging stations/loggers utilized for operations. Water level probe (e.g. solonist) and logger	Operator
2.	Water Quality and Temperature	Temperature time series	Temperature of water	Obtain using continuous temperature logger	Operator
		Water quality	Concentration of major anions, cations and some heavy metals in collected water samples	Methodology for Surface Water Collection in USEPA, Environmental Investigations – SOPs and Quality Assurance Manual	M&E Consultant
3.	Geomorphology	Channel planform	Fixed point photographs at specific locations at monitoring sites downstream of dam	Fixed point photographs.	M&E Consultant
		Channel shape (cross-section profiles)	Surveyed cross-sectional profiles at monitoring sites downstream of dam	For wet section: Use depth sounder to take measurements of depths at periodic intervals along the width of the channel. For dry section: Use total station to survey cross sectional topography.	M&E Consultant
		Bed sediment size	Bed-surface sediment size distribution of sensitive habitat at monitoring sites downstream of dam.	Bed-surface sediment size distribution of sensitive (secondary channel) habitat using composite of multiple subsamples at each sampling location.	M&E Consultant
		Habitat classification		Based on the visual assessment of habitat, the suitability of habitat will be determined, especially for the Kashmir Catfish	M&E Consultant

No	*Aspects*	*Indicator*	*Data required*	*Method*	*Monitoring Responsibility*
4.	Fish	Fish community composition, and population size distribution	Catch per unit effort and relative abundance of all fish particularly indicator fish species, species diversity, population size structure, fish size distribution	Gill netting, and cast netting, and electrofishing in tributaries where water levels are low Measure weight, total length of fish collected	M&E Consultant
		Migration patterns of Alwan Snow Trout	Locations of tagged (marked) individuals recaptured at different locations later in the seasons	Gill netting and cast netting	
		Fish Health	Number of lesions, lost scales, parasite loads and deformities in fish	Gill netting, fyke netting and cast netting in river and tributaries	
		Reproductive maturity stage	Stage of gonad development	Dissect fish and identify stage of gonad development.	
5.	Terrestrial vegetation	Terrestrial vegetation community structure	Vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the plant species	Transect method	Department
6.	Terrestrial Fauna	Terrestrial fauna community structure	Species richness (number of species observed) and abundance (number of individuals of each species observed)	Transect method	Department

9.2.3 Monitoring Indicators – Response

Exhibit 9.3 summarizes the monitoring framework for indicators of response to the implementation of BAP. The M&E Consultant will be responsible for collection and reporting of information. Information on the following indicators will be collected and reported.

- Institutional capacity
- Awareness among stakeholders and their concerns
- Progress on fish research including fish passage, and watershed management as recommended in CIA

A combination of qualitative and quantitative techniques will be employed. Reports will be prepared and discussed with the key stakeholders once every year.

Exhibit 9.3: Framework for Monitoring of Response Indicators

Response Aspect	*Scope/Coverage*	*What to monitor*	*Method*
Awareness	Awareness among primary stakeholders including communities and secondary stakeholders including civil society in Area of Management on value and importance of biodiversity	Extent and coverage of awareness programs conducted and effectiveness of the programs	Report on the extent and coverage of awareness programs Sample surveys in target communities to determine degree of awareness

9.2.4 Monitoring of IRRE Performance

The following areas for research have been identified in this document:

- Identification and testing of fish passage technologies
- Estimation of fish populations and behavior of fish particularly the endemic fish species of the Jhelum Basin - Nalbant’s Loach and Kashmir Hillstream Loach
- Study of fish migration patterns, focusing on Alwan Snow Trout (of concern in the Area of Management of the BAP of this Project).
- Study of genetic diversity of fish species to assess risk of inbreeding collapse

The M&E plan for IRRE will be prepared as a part of the Design and Operation Plan for the IRRE (see **Section 6.4,** *Contributions to Institute for Research on River Ecology*).

9.2.5 Monitoring of Watershed Management Program

The M&E framework for the Watershed Management Program (WMP) will be prepared as a part of the design of the WMP (see **Section 6.5**, *Watershed Management Program*).

9.2.6 Setting up the Monitoring and Reporting System for Biodiversity Assessment

A data collection, monitoring, and reporting system will be set up in the first year of project construction, and will define the framework for the production of Annual Biodiversity Assessment Report. This exercise will consist of:

Design:

- Finalize indicators from DRIFT database and elsewhere for inclusion in the monitoring program.
- Finalize monitoring techniques for indicators identified above.
- Where applicable and possible, in conjunction with PEDO and/or other responsible authorities, review and amend standard monitoring procedures to ensure that internationally accepted norms are adhered to.
- Finalize design of program: objectives and scope; finalize allocation of tasks, sites, sampling times, methods, and budget.

Organization:

- Appoint suitable management, analysis, field and reporting staff.
- Source accredited laboratories for water quality and sediment analyses. Ensure field data/samples collected as agreed, and immediately analyzed and formally interpreted/integrated. Develop reporting templates.
- Set up quality control measures, such as duplicate/blank samples for water quality analysis, cross check biological species identifications, identify and appoint reviewers.

Site and Infrastructure Setup:

- Check data collection and logging systems.
- Full discipline team visits to each site to establish extent and access, to place markers, locations for sampling, including: fixed-point photographs; cross-sections; habitat mapping; Establish sampling routines to be followed by technical staff.

9.3 Reports and Reporting Frequency

The scope and frequency of the reports are summarized in **Exhibit 9.4**.

Exhibit 9.4: Monitoring and Evaluation Reports

Report No.	*Title of the Report*	*Prepared by*	*Scope*	*Review by*	*Frequency and Timing*
	Protection				
1	Quarterly Watch and Ward Report	Implementation Organization for Protection (IOP)	Summary of violations and incidences of special concern Quantity and distribution of sand and gravel mining, and related violations	BAP Management Committee	Two weeks after the end of the quarter
2	Biodiversity Monitoring Reports	M&E Consultant	Data report outlining data sets, graphs, quality control issues and measures implemented.	BAP Management Committee	Reports for Spring/Summer, Fall, and Winter surveys
3	Annual Socioeconomic Report	M&E Consultant	Independent assessment of community use of river resources, watch and ward reports prepared by IOP, and survey based assessment of community perceptions	BAP Management Committee	March every year
4	Annual Biodiversity Assessment Report	M&E Consultant	Review of pressure, state, and response indicators, trends, and key developments Recommendations for adaptive management with focus on response indicators.	BAP Management Committee and Key Stakeholders	March every year. Frequency may be decreased to once in two or three years if the conditions stabilize and targets are achieved.
	Institute for Research on River Ecology				
5	Mid-Year IRRE Performance Review Report	M&E Consultant	Assessment of performance against plans, with details on specific research activities	BAP Management Committee	July every year

Report No.	*Title of the Report*	*Prepared by*	*Scope*	*Review by*	*Frequency and Timing*
6	Annual IRRE Performance Review Report	M&E Consultant	Assessment of performance against plans, with details on specific research activities	BAP Management Committee	March every year
	Watershed Management Program (WMP)				
7	Mid-Year WMP Performance Review Report	M&E Consultant	Assessment of performance of Watershed Management Institutions against plans	Watershed Management Committee	July every year
8	Annual WMP Performance Review Report	M&E Consultant	Assessment of performance of Watershed Management Institutions against plans	Watershed Management Committee	March every year

10. Budget for Implementation

10.1 Options for Financing

The need for providing supplemental support to the Departments under the BAP framework for biodiversity management in Kunhar River and its tributaries indicates a shortage of financial resources for biodiversity management in KP. A mechanism to ensure institutional and financial sustainability for implementation of the BAP is presented in **Section 7** (*Institutional Arrangement for Implementation of BAP)*. **Section 6** (*Proposed Conservation Measures*) presents the basis for the development of the budget. This sections provides the details of funding required for various actions, activities, and programs recommended in this BAP including Monitoring and Evaluation.

10.1.1 Existing Sources

In addition to the budgetary support provided by the government, the Department generates revenues from the following resources:

- Permits for recreational and subsistence fishing issued by KP Fisheries Department in Kunhar River
- Fines collected for violations of wildlife and fisheries rules issued by KP Wildlife Department
- Occasional support from donors and NGOs

The collections from issuing permits and fines for fishing in Kunhar River are very limited. Moreover, no NGO as yet has provided support to the Fisheries Department for protection of aquatic biodiversity in this area. The KP Wildlife and Biodiversity Act 2015 allowed a financial mechanism in the form of a Biodiversity and Wildlife Fund. The Fund was to be opened with such seed money as the Government may determine and later be supplemented by donations and funds raised from the national and international organizations; donations from philanthropists, conservationists, wildlife lovers; receipts from visitors and rental of various facilities in all forms of Protected Areas; resource extraction fee to include licensing fee obtained from sale or auction of any resources extracted from the Protected Area; and any other sources as to be notified by the Government.

The Fund is meant to be administered by the Khyber Pakhtunkhwa Wildlife and Biodiversity Board. The Board is meant to advise Government on policy decisions relating to protection, promotion, preservation, conservation and management of wildlife in the Province; review the progress of development activities in the field of wildlife promotion, protection, preservation, conservation and management in the Province; and, undertake such other functions as may be prescribed. However, since the Board is still undergoing transformation, the Biodiversity and Wildlife Fund is not yet operational.

10.1.2 Proposed Financing Arrangement

The BAP assumes that core costs for supervision of protection of the ecological resources of the Area of Management in the Kunhar River of staff, infrastructure, and operating costs will be provided by the governments. The funding provided by PEDO and other hydropower projects (for biodiversity protection and management as outlined in this BAP in their respective areas of management) will be supplemental and is expected to fill in critical gaps that arise mainly due to lack of resources for implementation, and the systems and procedures for making government funds available for conservation in a timely and efficient manner. This section describes the supplemental support that PEDO and other participating hydropower companies will provide to the Departments[81] to ensure realization of enhanced protection under the HP scenario in the Area of Management, operation of the IRRE, and watershed management.

10.2 Budget for Protection

Exhibit 10.1 and Exhibit 10.2 present budgets for capital and onetime costs and for annual operating or recurring costs respectively for implementation of protection in the Area of Management. Implementation will be initiated following the financial close of the Project.

10.3 Budget for the Institute for Research on River Ecology

Exhibit 10.3 and Exhibit 10.4 present budgets for capital and onetime costs and for annual operating or recurring costs respectively for setting up and operation of the IRRE. The IRRE is proposed as a collaborative effort between the governments and the hydropower units impacting the Jhelum River (including the Kunhar River that is a tributary of Jhelum River).

The Biodiversity Action Plan of the Kohala Hydropower Project assuming equal participation from the five participating hydropower companies, namely the owners of the Neelum Jhelum Hydropower Project (NJHP), Karot Hydropower Project (KHPP), Mahl Hydropower Project (MHPP), Azad Pattan Hydropower Project (APHPP), and Kohala Hydropower Project (KAHP), suggested a contribution of 20% from each of these five HPP project proponents. However, PEDO can also contribute to the IRRE and the corresponding contribution of the other HPPs will go down. The exact contribution of each company can be discussed in its Management Committee and the contributions of each company can be adjusted as the Committee considers appropriate. PEDO can contribute approximately 10% of the budget for the establishment and operation of an Institute for Research on River Ecology (IRRE), subject to approval of associated costs in the tariff by the National Electric Power Regulatory Authority (NEPRA). Costs are provided in United States Dollar (USD) and the exchange rate used is 1 USD = 105 PKR.

10.4 Budget for Watershed Management

Exhibit 10.5 and Exhibit 10.6 present budgets for capital and onetime costs and for annual operating or recurring costs respectively for watershed management. Budgets were prepared for the watershed of the Kunhar River Basin extending from the Lulusar Lake to the confluence of the River Kunhar with River Jhelum, corresponding to the

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[81] The BAP assumes that the support for protection in Kunhar River and its tributaries will be provided for the life of the Project, which is defined in the power purchase agreement entered into by PEDO with the government of Pakistan. The tenure of this agreement is 25 years. The BAP also calls for a periodic review of requirements to make adjustments if needed to maintain target protection levels.

Study Area for the Cumulative Impact Assessment (**Section 7.13** of the **EIA of Balakot Hydropower Development Project**). The length of the Kunhar River in this watershed is 166 km. Watershed management is proposed as a collaborative effort between the governments and the hydropower units impacting the Jhelum River. The length of the river impacted by the Project is 45 km, extending from the reservoir of the Project, the low flow section downstream of the dam, and the stretch downstream of the tailrace outlet that will be impacted by peaking operations (if carried out). It does not include the reservoir of the Patrind Hydropower Project. A contribution of 25% from PEDO to the total budget for watershed management is proposed in view of the length of the river impacted by the Project. The exact contribution of each company for watershed management in the basin can be discussed in the Watershed Management Committee and the contributions of each company can be adjusted as the Committee considers appropriate. PEDO will contribute to the establishment and operation of the WMP, subject to approval of associated costs in the tariff by NEPRA.

10.5 Budget for Monitoring and Evaluation

The M&E Consultant will prepare the Quarterly Biodiversity Monitoring Reports and the Annual Biodiversity Assessment Report (see **Section 9,** *Monitoring and Evaluation Framework*). The ecology and water quality surveys will be conducted at least once before the operation of the dam to re-establish the baseline conditions following the monitoring and evaluation set up. Subsequently, the surveys will be conducted as scheduled for the five years following the creation of obstruction in the river to get a better understanding of the impacts of the Project on ecology. The frequency of the surveys may be decreased to once in two or three years, depending on the achievement of Net Gain/No Net Loss and confidence developed in the results.

The indicative budget for monitoring and evaluation is given in **Exhibit 10.7**.

10.6 Summary of BAP Implementation Budget

A summary of the budgetary requirements for implementation of the BAP is provided in **Exhibit 10.8**, including suggested share of PEDO in actions to be taken collectively by the concerned hydropower companies.

Exhibit 10.1: Capital and One Time Costs for Protection

(Exclusive of Taxes) 1USD= 105PKR

	Capital and One Time Costs					
Activity	*Number*	*Unit Cost PKR*	*Contribution by PEDO*		*Contribution by Departments*	
			Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
1. Plantation and Re–vegetation in Watershed		–	–	–	–	–
2. Staff Training			–	–		
Development of training material for staff	1	60,000	60,000	571	–	–
Delivery of training	2	150,000	300,000	2857	–	–
Subtotal Staff Training			360,000	3,429		
3. Buildings and Offices			–	–		
Rental of field office during construction period	2	15,000	30,000	286		
Land for field offices	1	2,000,000		0	2,000,000	19,048
Civil works field offices	2	2,000,000	4,000,000	38,095	–	–
Furniture & fixture for field offices	2	150,000	300,000	2,857	–	–
Subtotal Buildings and Offices			**4,330,000**	41,238	**2,000,000**	**19,048**
4. Equipment and Materials						
Vehicles						
4 WD vehicle	1	4,000,000	4,000,000	38,095	–	–
Motor bikes	10	130,000	1,300,000	12,381	–	–
Field and Office Equipment						
First Aid box	2	5,000	10,000	95	–	–
Boat, rafts, gear, life jackets	1	125,000	125,000	1,190	–	–
Night vision binoculars	2	100,000	200,000	1,905	–	–

	Capital and One Time Costs					
Activity	*Number*	*Unit Cost PKR*	*Contribution by PEDO*		*Contribution by Departments*	
			Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
Binoculars	12	4,000	48,000	457	–	–
GPS (Garmin)	3	30,000	90,000	857	–	–
Video camera (Sony)	1	40,000	40,000	381	–	–
Cameras	4	55,000	220,000	2,095	–	–
Computers	2	50,000	100,000	952		–
Laptops	2	70,000	140,000	1,333	–	–
Printers	2	30,000	60,000	571	–	–
Sign Boards, Brochures, and Posters:						
Posters	4000	75	300,000	2,857	–	–
Brochures	4000	30	120,000	1,143	–	–
Signboards (Small)	36	8,000	288,000	2,743	–	–
Signboards (Large)	12	22,000	264,000	2,514	–	–
Subtotal Equipment and Materials			**7,305,000**	**69,571**		**–**
Total Capital and One Time Costs			**11,995,000**	**114,238**	**2,000,000**	**19,048**

Exhibit 10.2: Annual Recurring Cost for Protection

(Exclusive of Taxes) 1USD= 105PKR

Activity	*Time Period*		*Number*	*Unit Cost PKR*	*Contribution by PEDO*		*Contribution by Departments*	
					Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
1. Staffing for Watch and Ward								
Project Manager	12	Months	1	100,000	100,000	952	–	–
Supervisors	12	Months	1	60,000	60,000	571	–	–
Mining Inspectors	12	Months	1	25,000	25,000	238	–	–
Fish/Wildlife Watchers	12	Months	8	18,000	144,000	1,371	–	–
Admin/Accounts Assistants	12	Months	1	30,000	30,000	286	–	–
Education Officer	12	Months	1	18,000	18,000	171		
Female Social Mobilizers	12	Months	1	18,000	18,000	171	–	–
Vehicle Driver	12	Months	1	18,000	18,000	171	–	–
Sub Total, Watch and Ward Staff					**413,000**	**3,933**		
2. Operating Costs								
Fuel for vehicle	12	Months	1	45,000	540,000	5,143	–	–
Fuel for motor bikes	12	Months	10	9,000	1,080,000	10,286	–	–
Running and maintenance vehicle	12	Months	1	10,000	120,000	1,143	–	–
Running and maintenance m/bikes	12	Months	10	2,500	300,000	2,857	–	–
Travelling boarding and lodging charges	12	Months	1	20,000	240,000	2,286	–	–
Printing and stationary	12	Months	1	5,000	60,000	571	–	–
Communication charges	12	Months	2	5000	120,000	1,143	–	–
Uniforms			24	6,000	0	0		–

Activity	*Time Period*		*Number*	*Unit Cost PKR*	*Contribution by PEDO*		*Contribution by Departments*	
					Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
Field gear			24	25,000	0	0		–
Teacher training programs			6	35,000	0	0	–	–
School activities and community outreach programs			12	10,000	0	0	–	–
Office utilities	12	Months	2	20,000	480,000	4,571	–	–
Depreciation on vehicle and equipment				–	400,000	3,810	–	–
Sub Total for Operating Costs					**3,340,000**	**31,810**		**–**
Total for watch and ward and operating costs					**3,753,000**	**35,743**		
3. Management and Overheads*			**15%**		**502,950**	4,790		**–**
Total Annual Recurring Cost					**4,255,950**	**40,533**		**–**

Note: *Management and overheads (15%) don’t apply to depreciation on vehicle and equipment.

Exhibit 10.3: Capital and One Time Costs for Institute for Research on River Ecology

Applicable subject to approval in the tariff by NEPRA

(Exclusive of Taxes) 1USD= 105PKR

Activity	*Time Period*	*Number*	*Contribution by Companies in Cash*			*Contribution by Companies in Kind*	
			Unit Cost PKR	*Total Cost PKR*	*Total in USD*	*Total Cost PKR*	*Total in USD*
1. Buildings and Offices							
Land for facilities		1		–	–	30,000,000	280,374
Civil works		1		3,000,000	28,037	2,000,000	19,608
Furniture & fixtures				2,000,000	18,692	–	–
Subtotal Buildings and Offices				**5,000,000**	**46,729**		
2. Equipment and Materials							
4 WD vehicle		3	4,400,000	13,200,000	123,364	–	–
Office Equipment							
First Aid box		3	5,500	16,500	154	–	–
Boat, rafts, gear, life jackets		3	137,500	412,500	3,855	–	–
Lab and research instruments, equipment and chemicals		1	3,000,000	3,000,000	28,037		
GPS (Garmin)		3	33,000	99,000	925	–	–
Cameras		6	60,500	363,000	3,393	–	–
Computers		10	55,000	550,000	5,140		–
Laptops		3	77,000	231,000	2,159	–	–
Field gear		15	27,500	412,500	3,855		–
Printers		1	33,000	33,000	308	–	–
Subtotal Equipment and Materials				**18,317,500**	**171,192**	**–**	**–**
Design of Institute		**20%**		**3,663,500**	**34,238**		
Total Capital and One Time Costs				**23,317,500**	**217,921**	**32,000,000**	**299,982**
Contribution by PEDO		**10%**		**23,317,50**	**21,792**		

Exhibit 10.4: Annual Recurring Cost for Institute for Research on River Ecology

Applicable subject to approval in the tariff by NEPRA *(Exclusive of Taxes)*

Activity	*Time Period*		*Number*	*Unit Cost PKR*	*Contribution by Companies in Cash*		*Contribution by Companies in Kind*	
					Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
1. Staffing								
Director	12	Months	1	200,000	2,400,000	22,430	–	–
Principal Research Officers (PRO)	12	Months	3	100,000	3,600,000	33,645	–	–
Research Officers	12	Months	6	55,000	3,960,000	37,009	–	–
Technicians/ Assistants	12	Months	6	22,000	1,584,000	14,804	–	–
Administration	12	Months	1	33,000	396,000	3,701	–	–
Accounts	12	Months	1	33,000	396,000	3,701	–	–
Miscellaneous, security, drivers and facility maintenance	12	Months	6	19,800	1,425,600	13,323	–	–
Sub Total, Watch and Ward Staff			**24**		**13,761,600**	**128,613**		
2. Operating Costs								
Fuel and maintenance for vehicle	12	Months	3	27,500	990,000	9,252	–	–
Travelling boarding and lodging charges	12	Months	1	22,000	264,000	2,467	–	–
Printing and stationary	12	Months	1	5,500	66,000	617	–	–
Communication charges	12	Months	24	770	221,760	2,073	–	–
Students internship and training programs			8	25,000	200,000	1,869	–	–
Office utilities	12	Months	4	11,000	528,000	4,935	–	–
Laboratory supplies	12	Months	1	30,000	360,000	3,364		
Hatchery supplies	12	Months	1	30,000	360,000	3,364		
Depreciation on vehicle and equipment				–	1,001,000	9,355	–	–

Activity	*Time Period*		*Number*	*Unit Cost PKR*	*Contribution by Companies in Cash*		*Contribution by Companies in Kind*	
					Total Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
Special Studies					**5,350,000**	**50,000**		
Other expenses	12	Months	1	**50,000**	**600,000**	**5,607**		
Sub Total for Operating Costs					**9,940,760**	**92,904**	**–**	**–**
3. Management and Overheads			**20%**		**1,787,952**	**16,710**		**–**
Total Annual Recurring Cost					**25,490,312**	**238,227**	**–**	**–**
Contribution by PEDO			**10%**		**25,490,31**	**238,22**		

Exhibit 10.5: Capital and One Time Costs for Watershed Management

Applicable subject to approval in the tariff by NEPRA *(Exclusive of Taxes)*

Activity	*Number*	*Contribution in Cash*			*Contribution in Kind*	
		Cost Per Unit	*Total Cost PKR*	*Total in USD*	*Total Cost PKR*	*Total in USD*
1.Buildings and Offices			–	–		
Land for field offices	7	10,000,000		–	70,000,000	654,206
Civil works field offices	7	2,500,000	17,500,000	163,551	–	–
Furniture & fixture for field offices	7	250,000	1,750,000	16,355	–	–
Subtotal Buildings and Offices			19,250,000	179,907		
2.Equipment and Materials		–	–	–	–	–
Vehicles						
4 WD vehicle	8	4,000,000	32,000,000	299,065	–	–
Motor bikes	12	130,000	1,560,000	14,579	–	–
Field and Office Equipment						
First Aid box	7	5,000	35,000	327	–	–
GPS (Garmin)	7	30,000	210,000	1,963	–	–
Cameras	7	55,000	385,000	3,598	–	–
Computers	7	50,000	350,000	3,271		–
Laptops	7	70,000	490,000	4,579	–	–
Printers	7	30,000	210,000	1,963	–	–
Subtotal Equipment and Materials			**35,240,000**	**329,346**	**–**	**–**
Total Capital and One Time Costs			**54,490,000**	**509,252**	**70,000,000**	**654,206**
Contribution of PEDO	**25%**		**13,622,500**	**127,313**	**17,500,000**	**163,551**

Exhibit 10.6: Annual Recurring Cost for Watershed Management

Applicable subject to approval in the tariff by NEPRA *(Exclusive of Taxes)*

Activity	*Number*	*Cost Per Month*	*Contribution in Cash*		*Contribution in Kind*	
			Total Annual Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
1. Staffing						
Central Office						
Project Director	1	200,000	2,400,000	22,430	–	–
Coordinator– Forester	1	100,000	1,200,000	11,215	–	–
M&E Specialists	2	60,000	1,440,000	13,458	–	–
Office Assistant	1	20,000	240,000	2,243		
Drivers	2	20,000	480,000	4,486		
Watershed Management Units			**–**	**–**	**–**	**–**
Coordinator	1	75,000	5,400,000	50,467	–	–
Female Social Mobilizers	2	30,000	2,160,000	20,187	–	–
Supervisors	2	30,000	2,160,000	20,187		
Office Assistant	1	30,000	2,160,000	20,187		
Vehicle Driver	1	18,000	1,296,000	12,112	–	–
Sub Total, Staff			**18,936,000**	**176,972**		
2. Operating Costs						
Fuel and Maintenance for 4 WD Vehicles	8	40,000	3,840,000	35,888	–	–
Fuel and Maintenance for Motorbikes	12	10,000	1,440,000	13,458		
Other Operational Charges	7	30,000	2,520,000	23,551		
Watershed Investments	6		32,100,000	300,000		
Depreciation on vehicle and equipment		–	2,014,000	18,822	–	–

Activity	*Number*	*Cost Per Month*	*Contribution in Cash*		*Contribution in Kind*	
			Total Annual Cost PKR	*Total in USD*	*Total Cost PKR*	*Total in USD*
Sub Total Operating Costs			**41,914,000**	**391,720**	**–**	**–**
3. Management and Overheads	**20%**		**11,767,200**	**109,974**		**–**
Total Annual Recurring Cost			**72,617,200**	**678,665**	**–**	**–**
Contribution of PEDO	**25%**		**18,154,300**	**169,666**		

Exhibit 10.7: Budget for Monitoring and Evaluation

No	*Activity*	*Amount, US $*
Capital/One Time Costs		
Setting up the Monitoring and Reporting System, One Time Cost		$40,000
Preparation of Sediment Management Guidelines		$85,000
	Total Capital/One Time Cost for Setting up M&E System	**$125,000**
Annual M&E Costs		
Protection		
1	Biodiversity Monitoring Reports	$33,540
2	Annual Socioeconomic Report	$15,240
3	Annual Biodiversity Assessment Report	$19,200
4	Hydraulics and channel shape survey (once in three years at EF Site 4)	$8,760
Total M&E Cost for Protection		**$76,740**
Estimated M&E Cost for IRRE		**$15,000**
Estimated M&E Cost for Watershed Management Program		**$15,000**
	Total Annual M&E Cost	**$106,740**

Exhibit 10.8: Summary of the Budgetary Requirements for Implementation of the BAP

	Total Cost (USD)	*Share of PED (USD)*
Capital/One Time Cost		
Protection		114,238
Monitoring and Evaluation of Protection		125,000
Institute for Research on River Ecology @ 10% of Total Cost	217,921	21,792
Watershed Management @ 25% of Total Cost	509,252	127,313
Total Capital/One Time Cost		**388,343**
Annual Recurring Cost		
Protection		40,533
Monitoring and Evaluation of Protection		76,740
Institute for Research on River Ecology @ 10% of Total Cost	238,227	23,822
Watershed Management Program @ 25% of Total Cost	678,665	169,666
Monitoring and Evaluation of IRRE and WMP		30,000
Total Annual Recurring Cost		**340,761**
Budget Estimate for Capitalization Purposes		
Capital/One Time Cost		**388,343**
Recurring Cost for 6.5 Years During Construction		2,214,947
Total Cost for Capitalization		**2,603,290**

11. Adaptive Management

This section outlines the framework for adaptive management that needs to be applied to respond to changing pressures on the ecosystem of the Kunhar River and ecosystem services provided by the river, and unforeseen or unexpected outcomes of the mitigation measures applied.

11.1 Adaptive Management Framework

Adaptive management is defined as "a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives."[82] An adaptive management approach provides a structured process that allows for taking action under uncertain conditions based on the best available science, closely monitoring and evaluating outcomes, and re-evaluating and adjusting decisions as more information is learned. The adaptive management framework encompasses three broad phases: Plan, Do, and Evaluate and Respond. (**Exhibit 11.1**).

The 'Plan' phase of the Biodiversity Action Plan has been completed. Steps 1 – 4 listed **Exhibit 11.1** were completed during the planning stage of the BAP development. Based on this, the objectives of the BAP were identified as follows:

- achieve a 'Net Gain' in biodiversity protection in alignment with IFC PS6 requirements for Nalbant's Loach *Schistura nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis*, which are endemic to the Jhelum and Kunhar Basin.
- implement a 'High Protection' scenario, to put in place a 90% reduction in the current levels of non-flow related pressures on fish populations.

Keeping in view these objectives, this BAP has been developed for PEDO on Kunhar River to protect the threatened aquatic ecological resources (steps 5 and 6 in **Exhibit 11.1**).

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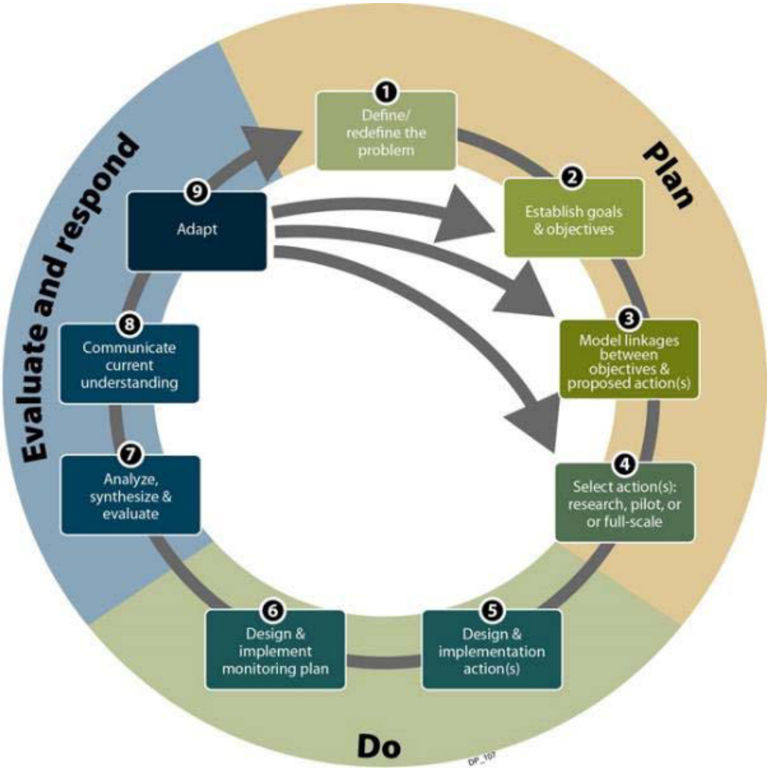
[82] California Department of Fish and Wildlife. Official website. Available at: http://www.dfg.ca.gov/erp/adaptive_management.asp

Exhibit 11.1: Framework for Adaptive Management



11.2 Analysis and Assessment of BAP Implementation

As stated in Step 7 of **Exhibit 11.1**, the success of the BAP will be assessed and analyzed once implementation begins. This will be done using the monitoring and evaluation framework. The objective is to evaluate the extent to which the BAP has contributed to improvements in biodiversity, if any.

Conceptually, assessment of the extent to which "Net Gain" in biodiversity has been achieved can be a challenging task as a number of variables not in control of the Department and PEDO will contribute to improvement in or worsening of biodiversity in the area of concern, mainly the Kunhar River. Examples are hydrology including major flood and drought events, climate change, quantity, quality, and treatment of waste water that flows or seeps into the river and tributaries from the population centers in the Jhelum River, and construction of additional hydropower projects on the Kunhar River. A robust approach to setting up the monitoring and reporting system has been separately budgeted for this BAP.

Following the Pressure-State-Response framework as described in the Monitoring and Evaluation Plan (**Appendix F**) the following approach will be used for assessment of Impacts of the BAP:

- Review and assessment of trends in pressure indicators once every year.
- Review of ecosystem state indicators once every year to assess whether the set narrative and numerical targets for the key indicators of state have been achieved.

This can be reduced to once in two to three years if the Net Gain targets for biodiversity are achieved.

- Review and assessment of trends in response indicators once every year.
- Review of the factors that may have contributed to changes in ecosystem indicators and recommendations for adaptive management.

Data and information on capture, hunting, killing and trapping of wildlife with focus on fish will be analyzed to determine the extent to which the watch and ward system, strengthened under the BAP, has been effective in reducing the pressures. Trends and developments in planning and construction of infrastructure in the project area, and land use patterns, factors that are primarily not in direct control of the BAP, will be reviewed to identify areas in which policy level advocacy and interventions can be initiated by the Department and stakeholders. The objective will be to generate a response that can lead to reduction in pressures in the long term.

Indicators of the state of the ecosystem will be monitored using defined sampling procedures and protocols. A quantitative review of trends (e.g. fish captured at a sampling point, and water quality) will be combined with a qualitative explanation of the factors that could be contributing to the trends observed. The factors could include pressures on the system as reflected by the trends in pressure indicators such as hunting and trapping or hydrological and weather related events such as floods and droughts. An annual assessment of state of the ecology, both terrestrial and aquatic, will be carried out in this manner.

Trends and developments in policy, legal, and institutional frameworks, availability of financing for conservation, and level of awareness among the stakeholders will be assessed to determine their adequacy for supporting conservation and achieving a reduction in pressures in the long term.

11.3 Actions to Adapt

Adaptation is about taking actions based on the results of monitoring to improve any project. If the project actions did not achieve the expected results, it is because either the assumptions were wrong, the actions were poorly executed, the conditions at the project site have changed, the monitoring was faulty or some combination of these problems. Adaptation involves changing assumptions and interventions to respond to the new information obtained through monitoring efforts.

If an assessment of the BAP reveals that the specified targets, particularly for the ecosystem state indicators are not met and the ‘Net Gain’ as envisaged by the BAP is not being achieved, some examples of corrective actions that may be taken by PEDO are outlined below:

- To compensate for any lack of technical capacity in the M&E Consultant, technical advice and support from international consultants may be arranged.
- If a decline in ecological integrity is attributed to low environmental flow releases (EFlow) or peaking from the Project, PEDO may revise the minimum EFlow release and/or peaking arrangement after discussion with stakeholders.

- If the number of game watchers and supervisors assigned for watch and ward responsibilities is inadequate, more finances may be injected for hiring of additional game watchers and supervisors.
- Similarly if targets are not being achieved due to inadequate equipment for watch and ward, more finances may be released by PEDO for procurement of this equipment.
- If the concerned department is unable to provide required support for BAP implementation due to lack of technical capacity, training and capacity building programs for the department may be initiated.
- Political pressure that impedes successful implementation of the BAP may be managed by approaching the governments of KPK through the Secretary or as specified in the Implementation Agreement for the Project between PEDO and the government.
- To minimize opposition from the local communities, Community Based Organizations may be developed that will involve the locals in conservation and protection activities.
- Targets may need to be revised if there is an unexpected large change in climate or hydrology such as unexpected floods or drought. Any changes to the targets will need to be justified and will have to be in line with PEDO's commitment and agreement particularly that of achieving Net Gain, and will have to be approved by the BAP Management Committee.

This is only an indicative list. Strategies for adaptive management will be based on analysis of problems and issues as they arise.

11.4 Responsibility

PEDO will be responsible for making adaptive management decisions after consultation with relevant parties and stakeholders, including the Project lenders, BAP Management Committee, Implementation Organization, M&E Consultant and community stakeholders.

Appendix A: Background Information Document English

The following document, called the BID, was prepared to provide an overview of the Balakot Hydropower Development Project (BHDP) or Balakot Hydropower Project (BAHPP) among the stakeholders. It was shared with the stakeholders in March–April 2017 and June–July 2018 during consultations carried out for the EIA (Environmental Impact Assessment) of the Project. Some changes have been made in the Project design since then by the Project design consultants. However, these changes are minor and do not change the environmental and social impacts of the Project outlined in this document.

Introduction

The Pakhtunkhwa Energy Development Organization (PEDO) intends to construct a 300 megawatt (MW) run-of-river hydropower plant Balakot Hydropower Development Project (BHDP) or Balakot Hydropower Project (BAHPP) with related infrastructure at Balakot, Mansehra district of Khyber Pakhtunkhwa (KP), Pakistan. The Project is located on the Kunhar River. The Project will help in meeting the current shortfall and in increasing demand of electricity in the region through economical and sustainable means.

The Balakot Hydropower Project was identified in 1995 under the study "Identification of Hydropower Potential in Kaghan Valley" by Sarhad Hydel Development Organization (SHYDO) with the technical collaboration of the German Agency for Technical Cooperation (GTZ) as a 190 MW HPP. A Feasibility Study of the Project[1] (FS) was released in October 2013, which included an environmental and social impact assessment section. However, as the Project is being financed by the Asian Development Bank (ADB), it has contracted the services of Hagler Bailly Pakistan (Pvt.) Ltd. (HBP) to carry out an environmental impact assessment (EIA) of the Project and develop a Land Acquisition and Resettlement Plan (LARP) which meets the standards and guidelines prescribed by ADB, and conforms to environmental legislation of KP.

As part of the EIA process, consultations are undertaken with communities and institutions that may have interest in the Project or may be affected by the Project (the "Stakeholders") to record their concerns and to address them in the course of project design and preparation of the EIA. The previous EIA effort included consultations with stakeholders. As part of a due diligence, consultations are being carried out with community stakeholders, as well as with institutional stakeholders that would like to be re-consulted, and institutional stakeholders that are important and were not previously consulted.

For informed consultations with stakeholders, this Background Information Document (BID) has been prepared to provide information on the project design, its setting, EIA

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[1] Mirza Associates Engineering Services (Pvt.) Ltd. (Lead Consultant), December 2013, Feasibility Study of Balakot Hydropower Project, Volume I Main Report for Pakhtunkhwa Hydel Development Organization

process, potential impacts that will be the subject of the Study, and the process to be followed for environmental impact assessment.

The BID is subject to changes as further information on some aspects of the Project become available during the course of the EIA.

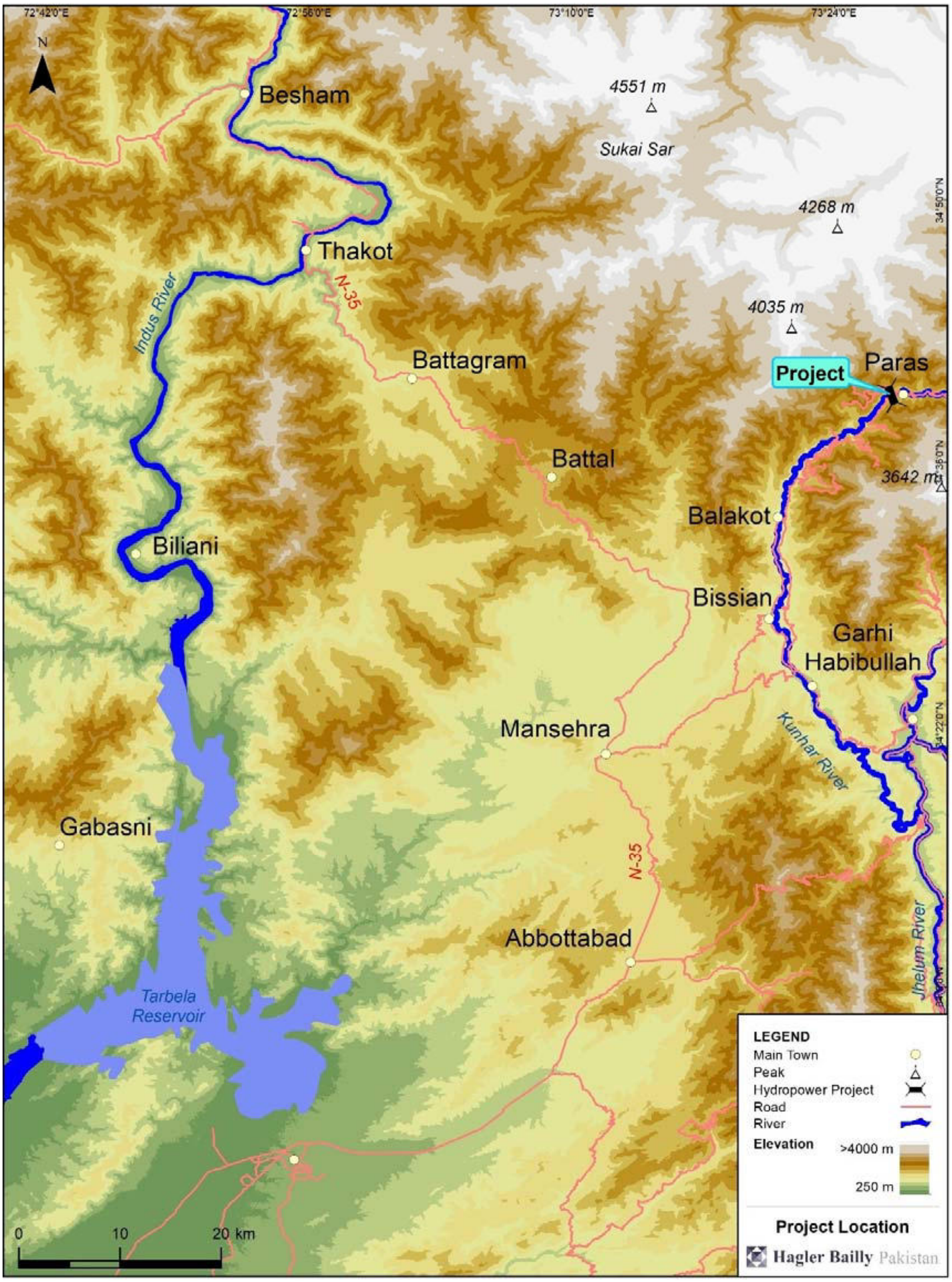
Project Setting

The Project is located on the Kunhar River in the Khyber Pakhtunkhwa (KP) province of Pakistan, in the 12 km stretch from Paras to Sangar Village. The hydel power potential available in the 20 km stretch of the river from Paras to Sangar tributary will be utilized for the Project.

A map showing the location of the Project is provided in **Exhibit A.1**.

All parts of the Project are located on the left bank of the Kunhar River. The dam site (34° 38’ 59”N, 73° 26’ 19”E) is about 17 km upstream of the town of Balakot. The powerhouse (34° 36’ 14”N, 73° 22’ 50”E) is located 10 km upstream of Balakot, near Kapi Gali Village.

Exhibit A.1: Project Location



Project Outline

The layout of the Project is provided in **Exhibit A.2**. The main components of the Project are described briefly in **Exhibit A.3**.

Exhibit A.2: Project Layout

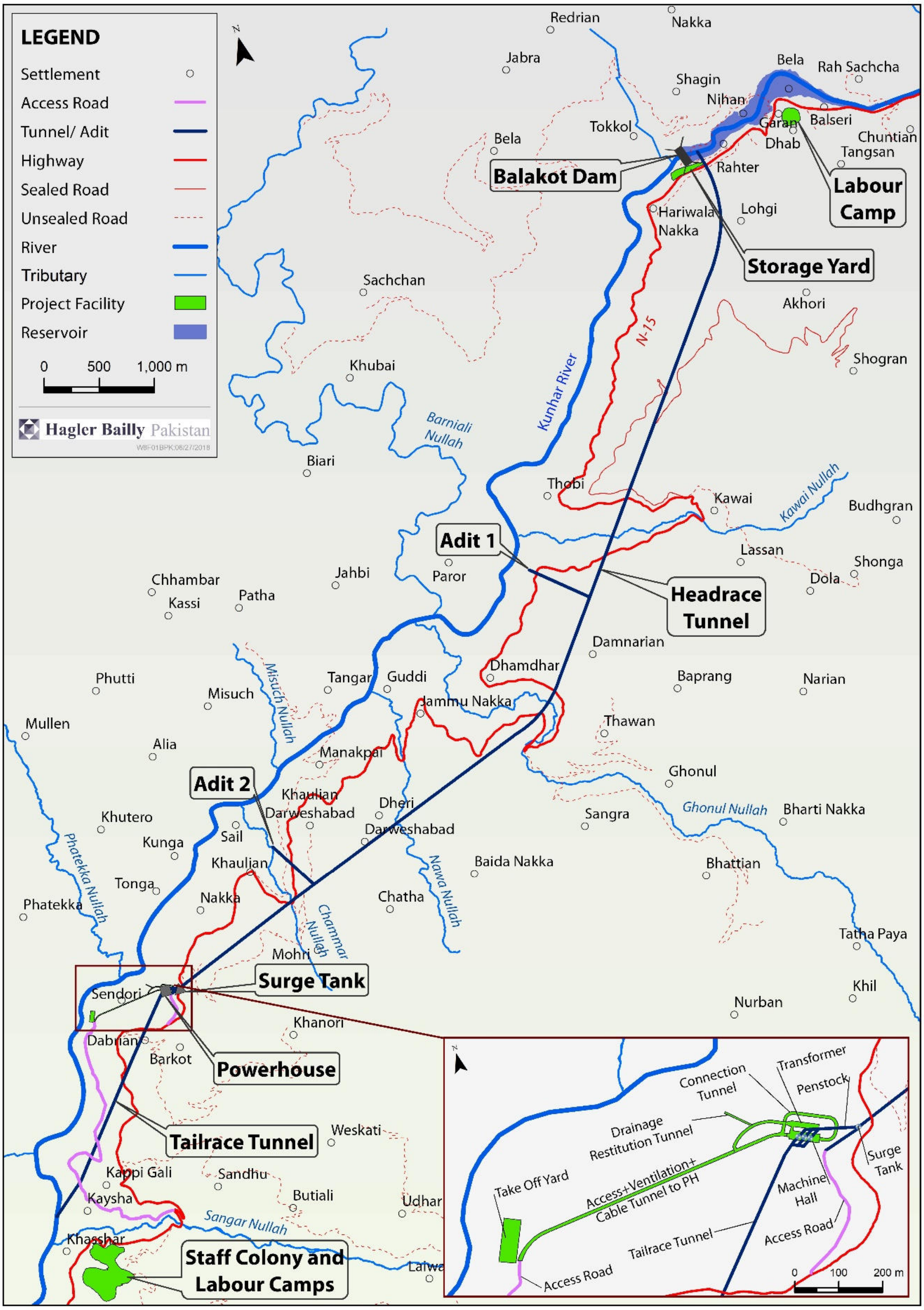


Exhibit A.3: Description of the Project and Facilities

Main Dam

It will be a concrete gravity dam, having a height of 78 m from the river bed, comprising low level/flushing outlets and a gated spillway. It will be equipped with five hydraulically operated radial gates for flood discharge and are set at the crest level of 1,276 meters above sea level (m.a.s.l). Three circular bottom outlets of diameter 5 m will be provided near the river bed for sediment flushing.

Lateral power intake structure

This will be located on the left bank of river. It will comprise three intakes to take the design discharge. A rectangular 8 m wide by 8 m high control gate equipped with upstream sealing will be provided.

Low pressure headrace tunnel

This will be of length 8,420 m and diameter of 8 m. It will be optimized for considering different diameters for the design discharge

Power Complex

An underground power complex has been proposed which will consist of an underground powerhouse cavern, a GIS transformer cavern, a main access tunnel, cable and ventilation tunnel and an open switchyard. The powerhouse will be 83.2 m long, 16.2 m wide and 25 m high from the main inlet valve floor to the arch roof crown.

Key Operational Characteristics

The maximum and minimum reservoir operating levels will be 1,288 m.a.s.l and 1,283 m.a.s.l respectively. The installed capacity will be 300 MW with mean annual energy output (average 51 years) of 1,187 GWh. Sediment flushing will be carried out every year during the summer months, when discharge is above 154 cubic meters per second (cumecs). During the low flow periods, the live storage will be used to store water during off peak hours to improve the flows for power generation in peak hours. It has been estimated that 2.566 million m^3 storage would provide additional flows in four peak hours.

Land Acquisition

The Project will require land acquisition of approximately 137.5 acres. Of this 127.5 acres is for the powerhouse and reservoir while 10 acres is for the Project facilities (including staff colonies). An additional 10 acres will be acquired temporarily for labor camps and contractor offices.

Construction, Requirements and Waste

The total construction period of this Project will be 5 years (60 months).

Materials required to carry out the construction of civil works for the project include concrete aggregate, cement, pozzolans, various types of fill materials, construction chemicals, steel products etc. Deposits for course aggregates have been identified upstream and downstream of the dam site at Mahandri and Paras. Fine aggregate deposits have been established at Paras, Chitta Katha, and Garhi Habibullah. Fine aggregates are being mined in these areas for local use. These sources have a strong potential of being developed into a viable source of fine aggregates. Marble and limestone outcrops are exposed along the road while traveling from the proposed dam site to Naran. These are considered for development of rock quarry for obtaining course aggregates.

Approach to the EIA and LARP

The EIA will be undertaken in compliance with relevant national legislation and keeping in view ADB requirements. The major components of the study include:

- baseline studies to characterize the existing ecological environment in the project area;
- a public consultation process to ensure that project stakeholders are informed of the project development plan and have an opportunity to influence it;
- an analysis of the physical, ecological and socioeconomic impacts of the project, both negative and positive; and,
- suggested mitigation measures to address the identified adverse impacts.

Separate to the EIA settlement level consultations and surveys, household level consultations and surveys, of land owners and households, will be carried out in the areas identified for land acquisition by PEDO to develop the Resettlement Action Plan for the Project.

A brief overview of the conceptual components of an EIA process is given in **Exhibit A.4**, whereas the detailed process to be followed for the study of ecological impacts of the Project is provided in **Exhibit A.5**. A preliminary list of potential environmental and social impacts of the Project and a list of biodiversity issues that will be investigated during the EIA are provided below.

List of potential environmental and social impacts

- Provision of employment to people
- Creation of service-sector jobs, procurement of consumables and the outsourcing to local service providers.
- Construction related impacts such as noise and dust
- Reduction in power outages and revival of the affected economies
- Increase in traffic due to Project related transportation
- Disturbance due to blasting, dust, noise, vibration, road congestion, and safety hazard from heavy traffic
- Damage to infrastructure due to blasting and noise nuisance due to blasting, drilling and batching plant
- Changes to existing social and cultural norms
- Pressure on existing infrastructure as a result of influx of job seekers
- Impact on sand mining and gravel extraction
- Contamination of soil
- Transformation of landscape
- Physical displacement of some households resulting in disruption of existing socioeconomic setup

List of potential biodiversity issues

- Reduction in water quality and quantity
- Changes in sediment load of river

List of potential environmental and social impacts
▶ Changes in the geomorphology of the river
▶ Fragmentation of fish habitat
▶ Damage to natural flora and fauna and river ecosystem
▶ Impact on endangered and migratory species

As impacts on the aquatic ecology due to the project are of importance, HBP, in collaboration with Southern Waters Ecological Research and Consulting, will employ the DRIFT (Downstream Implications of Flow Transformation) Decision Support System (DSS) approach to assess the changes in flow regime of the river on fish and other river dependent wildlife. DRIFT is a holistic approach that employs a multidisciplinary team to analyse the likely effects on a range of flow scenarios, and has been tested in Himalayan rivers. The DRIFT Process is shown in **Exhibit A.6**. Its aim is to predict changes in the form of three streams of information—ecological, economic and social—that represent the three pillars of sustainable development. It incorporates a custom-built Decision Support System (DSS) that holds all the relevant data, understanding and local wisdom about the river provided by the team of river and social specialists.

The four main aims incorporated into the DRIFT process are to:

- Synthesize present relevant knowledge on the river ecosystem;
- Synthesize present relevant knowledge on use of the river;
- Predict how the river ecosystem could change with water-resource development; and
- Predict how these river changes could affect people and the economy.

Exhibit A.4: Conceptual framework of EIA figure.

Component	*Main purpose*	*Activities related to Stakeholder Consultations*
Scoping	▶ Identify the issues on which the EIA should focus. ▶ Identify project alternatives that should be evaluated during the course of the EIA.	▶ Identify institutional and community stakeholders ▶ Engage stakeholders and record issues raised ▶ Provide feedback to the EIA team to incorporate stakeholders' concern in baseline investigations and impact assessment
Baseline investigations	▶ Collect background information on the environmental and social setting of the project.	▶ Incorporate additional issues raised during the baseline survey

Component	*Main purpose*	*Activities related to Stakeholder Consultations*
Impact assessment, studies	▶ Define the potential impacts of the project ▶ Undertake specialist investigations to predict changes to environment due to the project ▶ Determine the significance of the potential impacts ▶ Identify measures for the management of the impacts ▶ Determine the residual impacts of the project after incorporation of the management measures. ▶ Evaluate the overall acceptability of the project (from environmental and social perspectives).	▶ Assess issues raised by stakeholders
Mitigation Measures and management plan	▶ Environmental mitigation and monitoring plan will describe the measures proposed to ensure implementation of the mitigation measures identified during the impact assessment. It will include, for example, specific designs and plans, training requirements, resource requirements, monitoring details (sampling locations, methodology, and frequency), review and reporting requirements and budget.	▶ Assess the acceptability and practicability of the proposed mitigation measures
EIA Report Preparation	▶ After the studies, the EIA team will pull together the detailed assessment of impacts and mitigation measures. This may involve liaison with various specialists to ensure correct interpretation of information and compile EIA report.	▶ Provide stakeholders with a feedback on the EIA specifically communicate how the project proponent proposes to address the issues raised by the stakeholders.
EIA submittal to regulatory authorities and decision making	▶ Submittal and review of the EIA report by regulatory authorities and other interested stakeholders. The reviewers will inform about their decision on the acceptability of the Project from environmental and social perspectives and the conditions of approval for the development	▶ Attend the public hearings and respond to the issues raised during the public hearings.

Exhibit A.5: Biodiversity Assessment and Management Process figure.

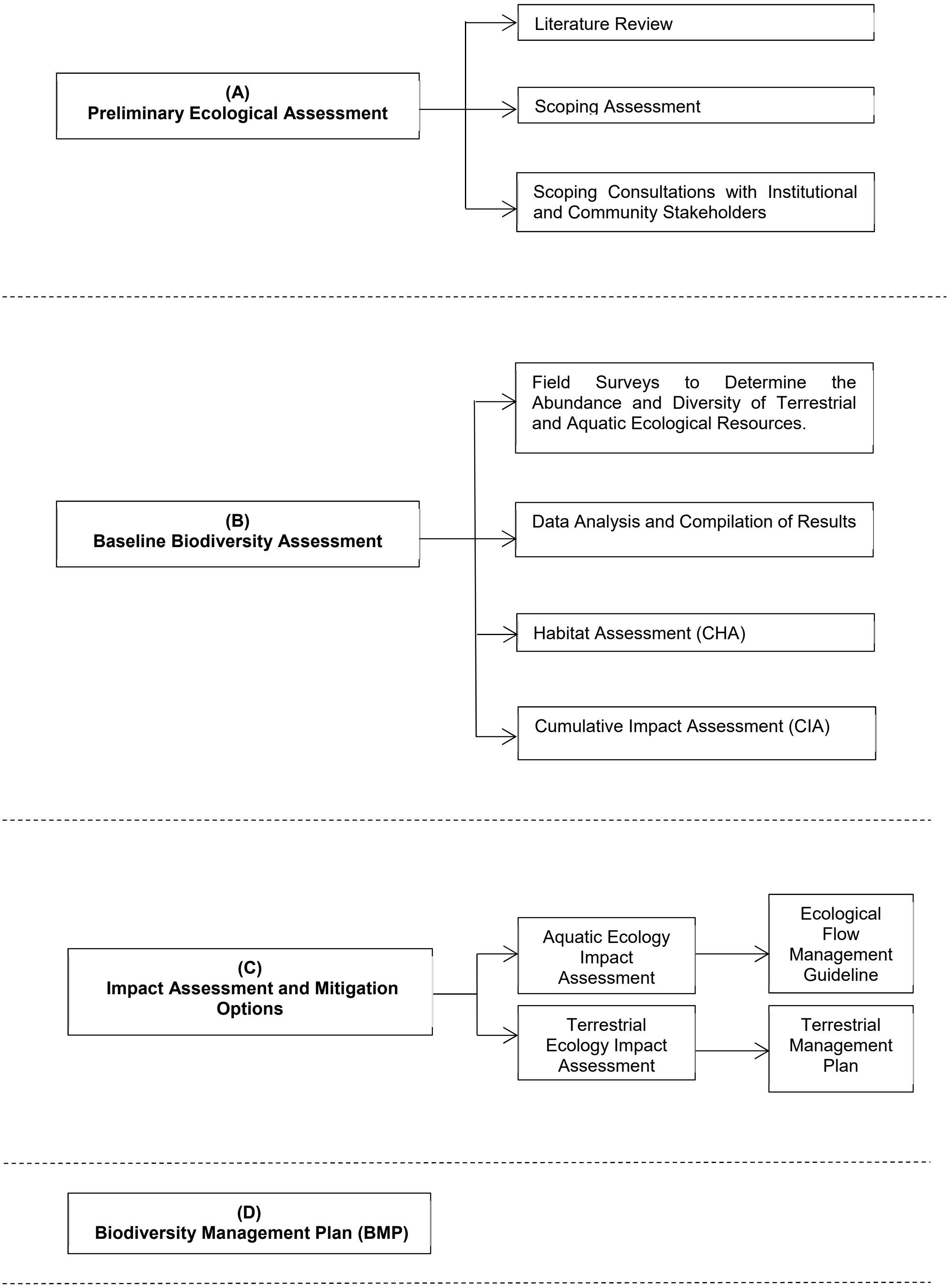
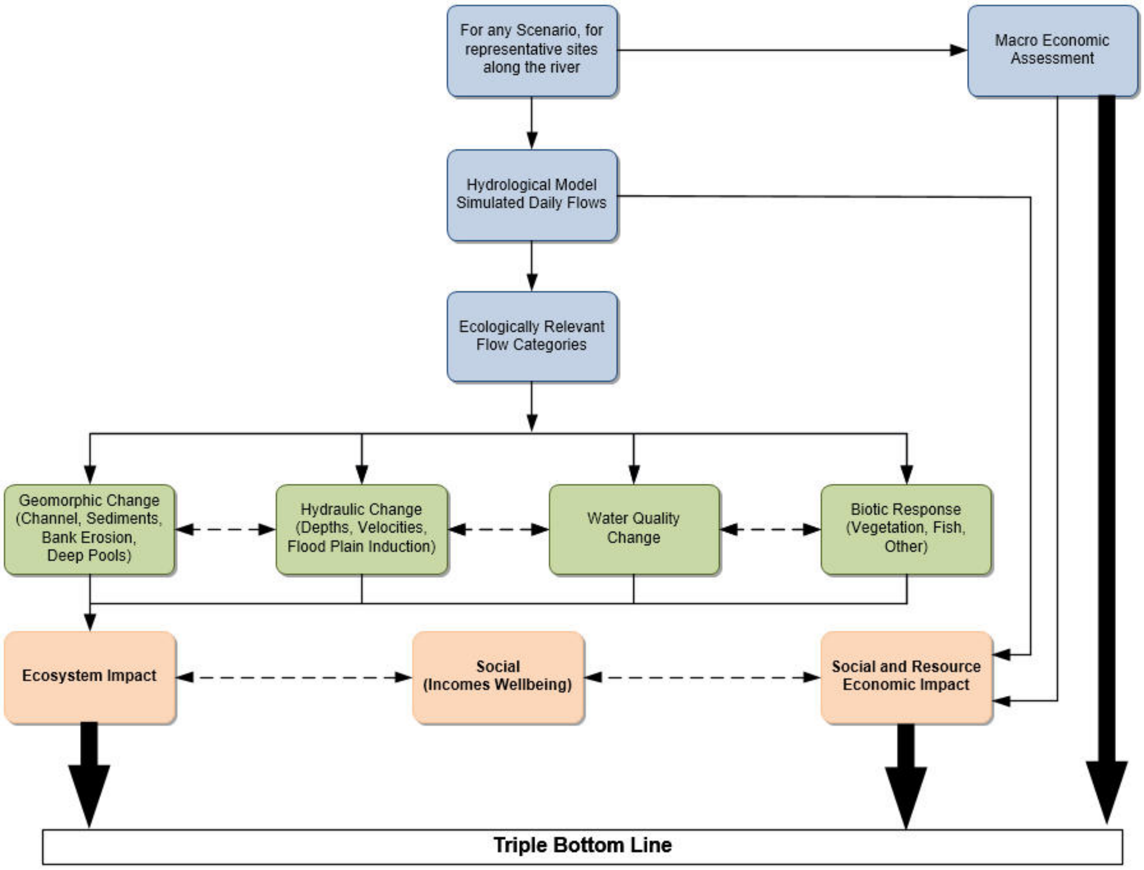


Exhibit A.6: Integrated Scenario Based Approach (DRIFT DSS)



For further information on the study please contact:

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Appendix B: Record of the Consultation Meeting

This document summarizes the consultations undertaken for the EIA of Balakot Hydropower Development Project (BHDP).

Appendix C: Fish Indicators and their Flow–related Needs

The following four species were selected as indicators for Eflow assessment using Downstream Response to Imposed Flow Transformations (DRIFT) model.

- Alwan Snow Trout *Schizothorax richardsonii*
- Kashmir Hill Stream Loach *Triplophysa kashmirensis*
- Nalbant's Loach *Schistura nalbanti*
- Rainbow Trout *Oncorhynchus mykiss*

All species selected as indicators demonstrate a comparatively higher degree of specialization in habitat preference in the Aquatic Study Area. In other words, the habitat range of these species was observed to terminate either moving upstream or downstream within the Aquatic Study Area. Changes in flow regime are therefore likely to have a comparatively higher level of impact on these species.

C.1 Alwan Snow Trout *Shizothorax richardsonii*

Preferences for flow dependent habitat, breeding, and migratory behavior of the *Schizothorax richardsonii* are summarized in **Exhibit C.1. Exhibit C.2** summarizes the annual cycle of breeding and growth of the *Schizothorax richardsonii.*

Exhibit C.1: Preferences for Flow Dependent Habitat, Breeding, and Movement of the *Schizothorax richardsonii*

	Adults	*Juveniles*	*Spawning*
Depth	0. 5 – 1. 5 m	0. 1 – 0. 5m	0. 1 – 0. 3 m
Velocity	1 – 3 m/s	0 – 0. 5 m/s	1 – 2 m/s
Habitat	Swift running water with rocky beds	Quiet parts of the streams or in the side branches of the main streams	Spawns on gravelly / stony ground or on fine pebbles with gravel size of 50-60 mm
Substrate	Rocky/Cobbly/Gravely	Cobble/Gravel	Gravel
Temperature	14 – 20 °C	14 – 20 °C	18 – 22 °C
Dissolved O_2	6 – 8 mg/l and can survive 5-6 mg/l	6 – 8 mg/l	6 – 8 mg/l
Food	Insect larvae and eggs, Detritus	Micro-invertebrates	–

Appendix D: Outline of Sediment Mining Management Guidelines

This document provides an outline of the Sediment Mining Guidelines for the Balakot Hydropower Development Project.

D.1 Management of Impacts of Sediment Mining in the Area of Management

The environmental flow assessment for the Project (**Chapter 7** of **EIA**) includes evaluation of varying protection levels affecting the non-flow related human induced impacts on the riverine ecosystem.

Four management scenarios, which represent the predicted river condition in 51 years under different levels of protection/management were considered. The protection levels considered were:

- **Business as Usual Protection (BAU):** increase non-flow-related pressures[1] in line with current trends, i.e. 2017 pressures double in intensity over the next 51 years.
- **Low Protection (LP):** maintain 2017 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time.
- **Moderate Protection (MP):** reduce 2017 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2017) over time.
- **High Protection (HP)**: reduce 2017 levels of non-flow-related pressures by 90%, i.e., decline in pressures (relative to 2017) over time[2].

Thus, in terms of sediment mining in the Area of Management, the thirty year targets were:

- High Protection (HP) = 90% reduction in mining impacts;
- Moderate Protection = 50% reduction in mining impacts;
- Low Protection = no increase in mining impacts;
- Protection Level BAU = doubling of mining impacts.

Given that it is entirely plausible that the demand for sediment will continue to increase over the next thirty years, achieving the High Protection (HP) will necessitate management and control that will limit the impact of mining on the river in the face of

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[1] The non-flow related pressures and the management actions proposed to reduce them are discussed in **Section 5** of the Biodiversity Action Plan of the Balakot Hydropower Development Project.

[2] Experience in neighboring rivers has shown that it is easier to impose a complete ban on activities such as illegal fishing and mining than it is to reduce these activities by half.

Appendix E: Draft Agreement

See following pages.

AGREEMENT FOR IMPLEMENTATION OF THE BIODIVERSITY ACTION PLAN

This Agreement (the Agreement) is made on this ________day of ________20__

Between

The (Government Department) (hereinafter called “the Department “of the First Part, which expressions shall means and includes its successors and assignees;)

And

(Name of Company), through its Authorized Representation (hereinafter called “ the Company” which expression shall mean and include its successors-in-interest and permitted assignees) of the Second Part.

The Department and the Company are hereinafter called individually as a **“Party”** and collectively as the “Parties”

WHERAS the (Government Department) is responsible for management of the (name of Area)

WHEREAS the Company is developing a (name of hydropower project). To mitigate the damage the Project would cause to the biodiversity of the (name of Area). The Company has prepared a Biodiversity Action Plan (“BAP”) to protect and restore the critical habitats;

AND WHEREAS, the Department and the Company desire to collaborate for the implementation of the BAP upon the terms and conditions contained hereunder.

NOW THEREFORE, in presence of the witnesses, the parties hereto have agreed and declared as follows:

1. This Agreement shall become effective upon the signing date and shall remain valid for a period of ten (10) years. The Parties may extend the term as they deem appropriate.
2. **The Company shall be responsible for:**
   a) Providing assistance to the Department for creating conductive conditions and addressing the threats to the habitat of different species in the (name of Area) generally and in particular around the project;

   b) The company shall develop the BAP in consultation with the Department clearly indicating the roles and responsibilities of all stakeholders and also defining the implementation mechanism of the BAP along with its cost estimates for different activities.

   c) Development, in coordination with the Department, a monitoring and evaluation framework to assess the achievement of the objectives of the BAP and assisting the Department in implementing such framework;

   d) Providing essential equipment for the improvement of the (name of Area) management and operations as envisaged under the BAP;

   e) It shall be ensured that no dumping is made along the river. However, whenever it is unavoidable, the company shall take all protective measures to ensure no spoiling/excavated reaches to the river.

   f) The Company shall make sure the safety and security of wildlife and their habitats at the Project site and its environment with the prior consultation and adhering strictly to the guidelines of the Department.

   g) Providing recommendations to the Department for improvements in the management
3. **The Company shall fulfill the above obligations by:**

a) Making payments in terms of the BAP and at times indicated in the BAP to procure materials and services within the scope and responsibility of the Company;

b) Contracting with an implementation agency that will procure the materials and deliver the services to fulfill the obligations of the Company for implementation of the BAP, after consultation with and approval of the Department; provided that the implementation agency shall preferably be a non-profit and non-governmental organization, having capacity and demonstrated experience of at least ten (10) years in implementing biodiversity conservation programmers in sensitive areas; and

c) Contracting with a monitoring and evaluation services consultant that shall deliver the monitoring and evaluation services required for the implementation of the BAP. The monitoring and evaluation service consultant shall have the capacity and demonstrated experience of at least ten (10) years in conducting aquatic and terrestrial biodiversity surveys and preparing assessment reports for sensitive areas.

4. The Department shall be responsible for the following:

a) Enforce the provisions of all applicable laws

b) Make available all material to its staff, as envisaged in the BAP

c) Establish a management committee for the oversight and monitoring of the implementation of the BAP;

d) Authorize staff of the implementation agency for exercising power as permissible under the applicable law and as approved by the management committee;

e) Assess and improve where required, the existing wildlife management systems to ensure that the same are effective and sufficient for achieving the BAP objectives;

f) Evaluate the prevalent and emerging threats and hindrances to wildlife resources constraining the achievement of the objectives of the BAP (e.g. hunting and trapping, fishing, grazing, visitors, traffic, violations of park rules, construction of infrastructure and pollution) and take necessary actions to prevent such constraints;

g) Use available resources to collect data on wildlife relevant to the BAP and share the same with the Company;

h) Promote and support implementation of conservation programs and mobilize local communities in achieving the same;

i) Arrange media coverage of the steps taken towards implementing the BAP;

j) Construct a hatchery for captive breeding of (name of fish) utilizing supplemental equipment provided by the Company as indicated in the budget of the BAP;

k) To put in place a system for the registration and review of complaints and to conduct a follow up to address the complaints regarding the implementation of the BAP.

5. This Agreement may be amended in writing from time to time by mutual consent of the Parties after prior vetting of Law Department and approval of the Government.

6. All communications pursuant to this Agreement shall be made by:

a) The Company's Manager Environment on behalf of the Company; and

b) The Director on behalf of the Department.

7. All disputes or disagreements of any nature whatsoever under or pursuant to this Agreement (the” Dispute”) shall be resolved amicably by the parties. If the Parties are unable to resolve a Dispute within (30) days then the Parties shall seek advice from the Environmental Protection Agency to resolve the Dispute. Provided that if a Party does not agree to adhere to such advice then such Party may commence legal proceeding in the courts which shall determine such Dispute. The courts shall have jurisdiction to resolve the Dispute. The Parties hereby agree to submit to the jurisdiction of courts. The Parties obligation under this Agreement shall remain unaffected during pendency of the Dispute.

IN WITNESS WHEREOF the Parties hereto have signed this Agreement on the date and place above mentioned in the presences of witnesses.

For and on behalf of the Department	For and on behalf of the Company
________________________________	________________________________
Secretary (Government Department)	

WITNESS #:1	**WITNESS #:2**
Name:________________________	Name:________________________
CNIC#:________________________	CNIC#:________________________
Designation:____________________	Designation:____________________
Address:_______________________	Address:_______________________

increased demand/volumes being abstracted. This could be achieved using one or more of the following strategies:

1. Focus mining activities in non-sensitive areas
2. Ban mining in sensitive areas
3. Implement on-site control and management of mining activities
4. Rehabilitate/restore habitats already destroyed by mining
5. Use of alternatives sources of aggregate for the Project including the following:
   a. reuse spoil
   b. quarries for aggregate

D.1.1 Focus Mining Activities in Non-sensitive Areas

Arguably the best way to achieve the proposed reductions in mining impacts is to focus mining activities in fewer areas where they can be better managed as this will reduce the area of sediment mining, reduce mining in sensitive areas and potential reduce the direct site-specific impacts. The construction of the Project would present an opportunity for doing just this. It is expected that large quantities of sediment will become trapped at or slightly upstream of the upper end of the reservoir in an area that is accessible from the existing road.

Although the feasibility of implementing a large-scale mining operation in the head waters of the Project reservoir is subject to confirmation, initial indications suggest that:

1. the quantities likely to be deposited annually will exceed the demand for sediment and probably exceed demand for quite some time to come;
2. roads could be constructed/existing roads improved to allow for easy and safe access to the area;
3. since sediment loads are highest in the wet season, much of the sediment would probably be deposited above the normal operating level as reservoir levels and backup effects tend to extend upstream in the wet season;
4. if necessary, access to the sediments, particularly the smaller size fractions, could be enhanced by lowering the operating level of the dam in the dry winter months;
5. similar initiatives have been successfully implemented elsewhere, for instance:
   i. at Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir (**Exhibit D.1**).
   ii. in Yorkshire (UK) sediment from reservoirs is used for potting soil, which is sold commercially Halcrow[3].

Outside of the 10-15 km radius, mining operations can also be focused on fewer, better controlled areas that avoid the sensitive habitats. The selection of appropriate sites for

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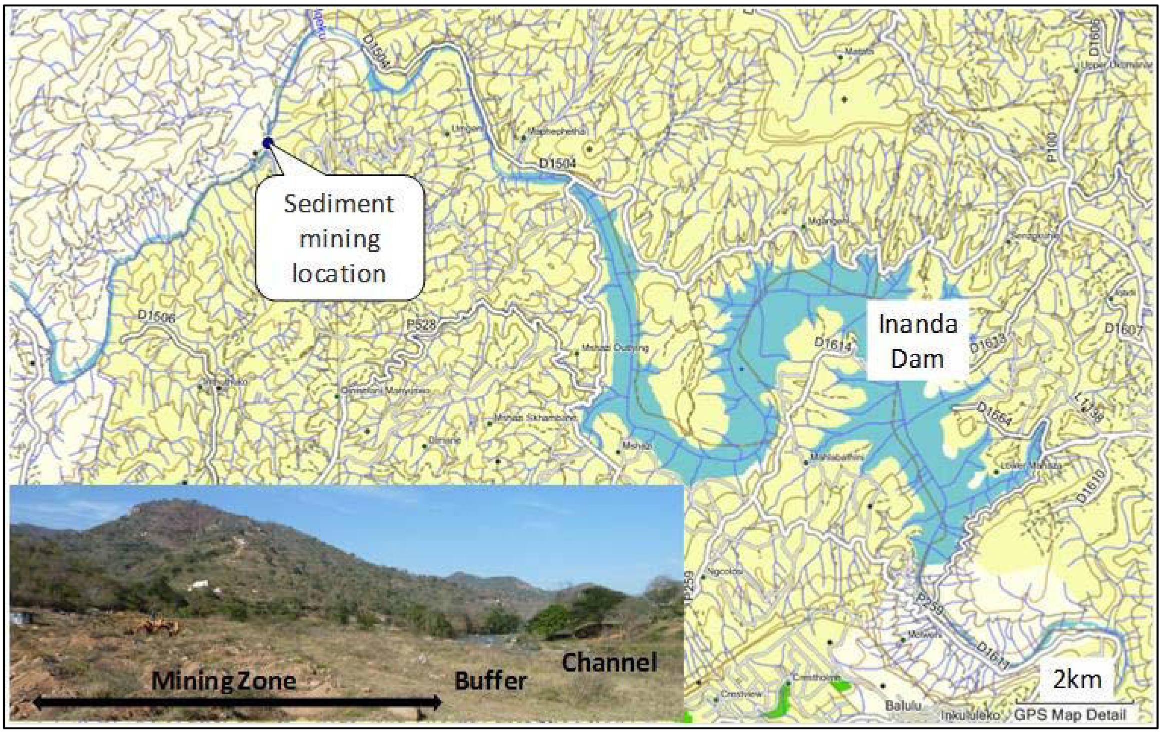
[3] Halcrow Water. 2001. Sedimentation in storage reservoirs. Department of Environment, Transport and the Regions. 82 pp.

sediment mining should be based on local knowledge or information regarding aggradation (sediment deposition) rates; where the proposed operation can minimize disturbance and maximize stability of channel; and where in-stream sites are located where the channel loses gradient or increases in width, and deposition occurs unrelated to regular bar-pool spacing in channel (such as upstream of a bedrock constriction or backwater, or at deltas created near confluences.[4]

Exhibit D.1: Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir



As mentioned above (Inanda Dam), mining sediments from the back-up zone may also reduce sedimentation in Project reservoir, prolonging the life of the dam and/or reducing the need for sediment flushing (Basson and Rooseboom[5]).

D.1.2 Ban Mining in Sensitive Areas

Sensitive areas include areas of the River Kunhar that provide habitats for the restricted range or endemic fish species Nalbant's Loach *Schistura Nalbanti* and Kashmir Hillstream Loach *Triplophysa kashmirensis.* The tributaries are also sensitive as they as they provide breeding habitat for other fish species of the River (**Chapter 4**).

It is unlikely that provision of a focused mining area (or areas) alone will reduce sediment mining in the sensitive areas. This will need to be accompanied by a prohibition

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[4] Garcia River Gravel Management Plan. Philip Williams & Associates, Ltd., San Francisco, 1996.

[5] Basson, G.R. and Rooseboom, A. 1999. Dealing with reservoir sedimentation. South African ICOLD Bulletin 115.

on mining in sensitive areas, particularly in the tributaries and at the confluences between tributaries and the main river. Such a ban could include:

- Limiting access (or implementing road closures using barriers or decommissioning roads) to sensitive zones of the river.
- Policing of the restricted, sensitive breeding areas of the rivers and tributaries.

This could be achieved through development of specific sediment mining guidelines in conjunction with authorities and miners to scale down operations in sensitive areas and relocate those operations to less sensitive reaches (cf. **Exhibit D.1**). The KP Wildlife Department and KP Fisheries Department will enforce the guidelines with support from the Implementation Organization.

D.1.3 Implement on-site Control and Management of Mining Activities

Where sediment mining is allowed, the localized and downstream impacts of operations could be reduced through on-site control and management measures. These could include:

1. License mining activities according to volume based on measured annual replenishment, and with conditions regarding method of mining (following best practice guidelines), location, timing and volumes of extraction permissible[6];
2. Implementation of setbacks and buffer zones (which could include placement of berms) between the sediment extraction areas and the low flow channels in order to reduce low flow season impacts. These should ensure:
   a. that excavations are set back at least 5 m from the main low flow channel bank;
   b. that the maximum depth of mining is > 1 m above natural channel elevation, as determined by pre-mining surveys, to prevent channel shift.
3. Employing more environmentally-friendly extraction methods (**Box 1**);
4. Minimize activities that release fine sediment to the river and tributaries;
5. Avoid the removal of any vegetation on the banks;
6. Retain a buffer (at least 5-10 m) between the low flow channel and the mining operations;
7. Limit in-stream operations to the dry season (DID)[7]; and
8. Implement a program of compliance monitoring and control.

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[6] Garcia River Gravel Management Plan. Philip Williams & Associates, Ltd., San Francisco, 1996.

[7] Department of Irrigation and Drainage (DID). 2009. River Sand Mining Management Guidelines. Department of Irrigation and Drainage, Ministry of Natural Resources and Environment Jalan Sultan Salahuddin, Kuala Lumpur, Malaysia.

Box 1: Less-Damaging Methods for Sediment Removal

Kondolf et al.[8] identified several methods of sand and gravel mining operations that are less damaging than the more commonly employed methods.

Bar scalping or skimming

Bar scalping or skimming is the extraction of sand and gravel from the surface of bars. Historical scalping commonly removed most of the bar above the low flow water levels, leaving an irregular topography. Present methods generally require that surface irregularities be smoothed out and that the extracted material be limited to what could be taken above an imaginary line sloping upwards and away from the water from a specified level above the river's water surface at the time of extraction (typically 0.3 - 0.6 m).

Bar scalping is commonly repeated year after year to maintain the upstream hydraulic control provided by the riffle head. The preferred method of bar scalping is generally to leave the top one-third (approximately) of the bar undisturbed, mining only from the downstream two-thirds.

Bar Excavation

In this sediment extraction method, a pit is excavated at the downstream end of the bar as a source of aggregate and as a site to trap sand and gravel. Upon completion, the pit may be connected to the channel at its downstream end to provide side channel habitat. This method reduces the area of disturbance.

A combination of these measures would assist to regularize the sediment mining activities in the Area of Management, and to reduce the localized and downstream impacts associated with such.

Cooperation could be enhanced through the development of guidelines or best practice principles for sediment mining operations to which an association of sediment miners could subscribe. This should take in to account buffer zones between the mining operation and active (low flow) channels; ecologically sensitive methods of sediment removal, as well as the overarching focus of only removing sediment at appropriate (less sensitive) extraction sites.

D.1.4 Alternatives Sources of Aggregate

A reduction in the sediment mining pressures in the river could be achieved if alternative sources of building aggregate could be found, such as:

1. Reusing surplus spoils: surplus spoils from the construction of the Project could be stockpiled for use.
2. Using open rock quarries on hillsides rather than using river sediment as source of gravels.

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[8] Kondolf, G.M., Smeltzer, M. and Kimball, L. 2001. Freshwater Gravel Mining and Dredging Issues. Washington Departments of Fish and Wildlife, Ecology, and Transportation, Olympia

Neither of these has been considered in any detail at this stage, but can form part of the considerations in developing sediment mining management guidelines for the basin.

D.2 Outline of Key Components of Sediment Mining Management Guidelines

The main challenges in implementing protection measures for sediment mining in the Area of Management are:

1. the level of integration required between technical, legal, administrative and political processes, and the private and government sectors;
2. the need for extensive public participation, and broad governmental and societal support, both during the technical work and for legislating the outcomes; and
3. the need for interventions that depend on people changing their perceptions and behaviour.

To achieve the mining targets for High Protection (HP) (90% reduction in impacts), these challenges will be focused in implementation of Sediment Mining Management Guidelines that are supported by technical data, considers trade-off between ecological protection and the requirements of the miners and the community at large, and enjoys broad-based support from both the community and the authorities that will be responsible for its implementation. The key activities required to implement Sediment Mining Management Guidelines can be placed in the following categories:

1. The institutional (legal and administrative) provisions that need to implement protection measures.
2. The modeling and other technical studies required to determine the location, quality and quantity of sediment deposits linked with BAHPP, and to assist with identification of other focus areas.
3. The confirmation of the key ecological sites or reaches within the system needed to identify no-go or restricted use reaches to inform the trade-offs between ecosystem protection and mining locations.
4. The necessary engagement with the affected mining operators in order to ensure that their needs are considered in, and where possible integrated into, the process.

In reality, however, there will need to be considerable co-operation across these areas to produce the technical information, management mechanisms and buy-in required to ensure successful implementation of the protection measures.

D.2.1.1 Institutional

The key legal and administrative activities required include:

1. Establish/implement sources of funding and financial mechanisms: The Biodiversity Management Plan for BAHPP identifies avenues for generating funds for the implementation of High Protection (HP) measures for fishing, sediment mining and use of riparian vegetation. However, appropriate mechanisms will still need to be designed and implemented for acquisition of

technical information; the formation of stakeholder associations; construction of access roads, and; the ongoing costs of management, administration, monitoring and reporting.

2. Develop implementation and compliance mechanisms.
3. Establish administrative pathways and line functions.

D.2.1.2 Sedimentological

The key technical activities required include:

1. Quantify volume and location of deposits: A two-dimensional hydraulic model will need to be developed based on existing hydrological and sediment records and used to predict the areas and volume of sediment deposition in the backup zone of the Project reservoir. This critical aspect of work should determine the volumes and accessibility of the sediment deposits associated with the proposed reservoir. This information will contribute to an assessment of the feasibility of focusing mining activities in this area, and be used to inform the need for additional focus areas, whether the operation of the Project dam should consider mining and the design of access road and operational areas.
2. Identify other focus mining areas: It may not be possible to relocate mining activities downstream of Project dam to the back-up zone of the dam, but this does not necessarily mean that the impact of these activities could not be reduced by focusing mining in less sensitive reaches. Any decisions with respect to this would need to include:
    a. economic in terms of transportation cost.
    b. ecological considerations as the fish in that section of the river will be cut off from their favored breeding areas in the upper catchment.
3. Liaise with BAHPP operators: if necessary, the possibilities of manipulating the operating levels of the dam to increase dry-season access to smaller sediments should be explored.
4. Undertake an assessment of the access routes and the operational areas: Whether existing routes will do or upgrading or new access roads will be required. Also, are there sufficient spaces to organize operations where the different sediment sizes are deposited, e.g., for boulders, is there an area where stone crushers for producing aggregate can be placed.

D.2.1.3 Ecological

The key technical activities required include:

1. Map and rank priority river reaches: Sensitive and important river reaches in the tributaries and mainstream will need to be identified and ranked to provide input to decisions about where sediment mining should be restricted to protect instream habitat. This information will be needed to evaluate the potential of tradeoffs between mining activities and biodiversity protection.

2. Assess the relative ecological impacts associated with sand and gravel mining versus cobble and boulders mining.
3. Identify mining ban areas. In liaison with miners, authorities and based 1 and 2 above and on data provided by the sedimentological technical studies.
4. Develop monitoring programme to monitor efficacy of control measures.

D.2.1.4 Local community

The buy-in of the local community is possibly the most important aspect of successful implementation of the protection measures directed at sediment mining. There is little doubt that this will require extensive consultation. Development of best practice guidelines is suggested. Guidelines for sediment mining could be developed by the mining authorities in liaison with environmental authorities and conservation bodies. These guidelines could then be translated into on-site management and control measures. The Monitoring and Evaluation program for sediment mining will be included in the M&E Plan of the Biodiversity Action Plan.

	Adults	*Juveniles*	*Spawning*
Breeding Period and Trigger	May-June in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Spawning in side channels in shallow waters (10-30 cm) with boulders and low currents.		
Movement Pattern	Shows limited movement.		
Movement Timing	Limited movement to side channels for spawning.		
Movement Triggers	Availability of side pools with shallow waters, rise in temperature		
Other Flow-related Needs	Is sensitive to pollution. Can tolerate turbidity.		

Exhibit C.2: Annual Cycle of Breeding and Growth of the *Schizothorax richardsonii*

Months	*Flow Conditions*	*Fish Behavior*
May – June	Flood Season	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles. Eggs hatch in this period, and fries and fingerlings remain in shallow waters in side channels under the cobbles.
July – October	Flood Season – Transition-2 and Dry Onset	Spent fish move to areas with boulders, cobbles in its general preferred habitat ranging from a depth of 0. 5 – 1. 0 m. Fries and fingerlings remain in the side channels. Both adult and young fish feed actively in this period to gain fat for wintering.
November – March	Dry Season	Fish move mainly to crevices under cobbles or in pools for overwintering. Food intake drops and also supplemented by fat reserves for survival.
April	Transition-1	Fish become active, takes maximum food and move to areas where it can get maximum food.

C.2 Kashmir Hillstream Loach *Triplophysa kashmirensis*

Preferences for flow dependent habitat, breeding, and migratory behavior of the *Triplophysa kashmirensis* are summarized in **Exhibit C.3**. Annual Cycle of Breeding and Growth of the *Triplophysa kashmirensis* is shown in the **Exhibit C.4** below.

Exhibit C.3: Preferences for Flow–dependent Habitat, Breeding, and Movement of the *Triplophysa kashmirensis*

	Adults	*Juveniles*	*Spawning*
Depth of Water	Banks, shallow riffles (<0. 75 m)	Shallow side pools (<0. 75 m)	Shallow side channels and pools (<0. 30 m)
Velocity	Low to moderate (0 – 2 m/s)	Low to moderate (0 – 2 m/s)	Low to moderate (0 – 2 m/s)
Habitat	Pools, riffles, glides	Banks	Pools, riffles
Substrate	Rocky, stony	Cobbles	Stones, cobbles
Temperature	8 – 14 °C	10 – 12 °C	10 – 12 °C
Dissolved O_2	6–8 mg/l	6–8 mg/l	6–8 mg/l
Food	Earthworms, larvae, slime	Micro–invertebrates	–
Spawning Period	June–August		
Breeding Period and Trigger	May–August in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Breeds both in river as well as in tributaries in suitable habitat.		
Movement Pattern	Does not show any significant movement except for breeding, when it moves to shallow side pools.		
Movement Triggers	Rise in water temperature, swollen river and expansion of habitat.		
Other Flow–related Needs	Is sensitive to pollution.		

Exhibit C.4: Annual Cycle of Breeding and Growth of the *Triplophysa kashmirensis*

Months	*Flow Conditions*	*Fish Behavior*
June – August	Flood Season	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles and gravely beds. Eggs hatch in this season, and fries and fingerlings remain in shallow waters in side channels.
September – October	Transition–2 and Dry Onset	Spent fish move to banks of the mainstream. Fingerlings remain in shallow side channels. Both adult and young fish feed actively in this period.
November – March	Dry Season	Fish move mainly to crevices for overwintering. Food intake drops significantly as fish is inactive and also utilizes fat reserves for survival.

Months	*Flow Conditions*	*Fish Behavior*
April – May	Transition–1 and Flood Season	Fish emerge and move to banks, avoiding fast flows, in search of food to get ready for the breeding season.

C.3 Nalbant's Loach *Schistura nalbanti*

Preferences for flow dependent habitat, breeding, and migratory behavior of the *Schistura nalbanti* are summarized in **Exhibit C.5. Exhibit C.6** summarizes annual cycle of breeding and growth of the *Schistura nalbanti.*

Exhibit C.5: Preferences for Flow Dependent Habitat, Breeding, and Movement of the *Schistura nalbanti*

	Adults	*Juveniles*	*Spawning*
Depth of Water	Banks, shallow riffles (<0. 5 m)	Shallow side pools (<0. 5 m)	Shallow side channels and pools (<0. 30 m)
Velocity	Low to moderate (0–2 m/s)	Low to moderate (0–2 m/s)	Low to moderate (0–2 m/s)
Habitat	Pools, riffles, glides	Banks	Pools, riffles
Substrate	Rocky, stony	Cobbles	Stones, cobbles
Temperature	8 – 20 °C	10 – 20 °C	10 – 20 °C
Dissolved O2	6 – 8 mg/l	6 – 8 mg/l	6 – 8 mg/l
Food	Earthworms, larvae, slime	Micro–invertebrates	–
Spawning Period	June – August		
Breeding Period and Trigger	May – August in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Breeds both in river as well as in tributaries in suitable habitat.		
Movement Pattern	Does not show any significant movement except for breeding, when it moves to shallow side pools.		
Movement Triggers	Rise in water temperature, swollen river and expansion of habitat.		
Other Flow–related Needs	Is sensitive to pollution.		

Exhibit C.6: Annual Cycle of Breeding and Growth of the *Schistura nalbanti*

Months	*Flow Conditions*	*Fish Behavior*
June – August	Flood Season	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles and gravely beds. Eggs hatch in this season, and fries and fingerlings remain in shallow waters in side channels.
September – October	Transition–2 and Dry Onset	Spent fish move to banks of the mainstream. Fingerlings remain in shallow side channels. Both adult and young fish feed actively in this period.
November – March	Dry Season	Fish move mainly to crevices for overwintering. Food intake drops significantly as fish is inactive and also utilizes fat reserves for survival.
April – May	Transition–1 and Flood Season	Fish emerge and move to banks, avoiding fast flows, in search of food to get ready for the breeding season.

C.4 Rainbow Trout *Oncorhynchus mykiss*

Preferences for flow-dependent habitat, breeding, and migratory behaviour of the Rainbow Trout are summarized below in **Exhibit C.7. Exhibit C.8** summarizes the annual cycle of breeding and growth of the Rainbow Trout:

Exhibit C.7: Preferences for Flow-dependent Habitat, Breeding, and Migratory Behavior of the Rainbow Trout *Oncorhynchus mykiss*

	Adults	*Juveniles*	*Spawning*
Depth of Water	Deep (>0.75 m)	Shallow (<0.75 m)	Shallow (0.15 - 0.75 m)
Velocity	Medium to high (>2 m/s)	Low to medium (0-2 m/s)	Low to medium (0-2 m/s)
Habitat	Riffles, pools, glides	Closer to the banks	Riffles
Substratum	Cobbles, also stony to gravely beds	Stony to gravely	Fine gravel
Temperature	6-12°C	6-12°C	<7°C
Dissolved O_2	8-10 mg/l	8-10 mg/l	10 mg/l
Food	Fish (Kashmir hill stream loach, high altitude loach), invertebrates	Invertebrates	–
Breeding Period and Trigger	Breeds in October through December in the Dry Season in continuous moderate flows. Breeding is triggered by drop in temperature below 6-7˚C, typically in October.		

	Adults	*Juveniles*	*Spawning*
Movement Pattern	Migrates to tributaries and travels to suitable breeding grounds in the river to avoid competition and to find shallow clear waters suitable for breeding. Migrates back to the main river for wintering.		
Movement Timings	October-November for breeding, November for wintering.		
Movement Triggers	Change in flow pattern, reduction in turbidity, fall or rise in water temperature.		
Other Flow-related Needs	Is sensitive to pollution and therefore to poorly diluted effluents.		

Exhibit C.8: Annual Cycle of Breeding and Growth of the Rainbow Trout *Oncorhynchus mykiss*

Months	*Flow Conditions*	*Fish Behaviour*
October-December	Dry Season	Breeding is triggered by a drop in temperature below 7-8 °C. The fish move to breeding sites in the main river and the tributaries to lay eggs in beds of fine gravel (redds[1]) in riffle flow.
January-February	Dry Season	Fries emerge after about 70 days and stay in the nursery grounds, mainly in side streams and shallow water, where food is available and the current speed is low. Adult fish migrate back from tributaries into deeper water in the mainstream for survival in the Dry Season.
March-April	Dry Season-Transition Season 1	Fingerlings/juveniles stay in shallow waters near the banks and avoid fast flowing water.
May-July	Flood Season, Snow Melt	Fish avoid turbid waters, and move to clear waters in side streams as well as tributaries.
August-September	Flood Season-Transition Season 2	Fish have relatively uniform distribution in the river and tributaries and concentrate on feeding areas

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[1] A spawning nest made by a fish, especially a salmon or trout.

Record of the Consultation Meeting

Stakeholder/s	Environmental Protection Agency, Khyber Pakhtunkhwa	
Consultation	Stakeholder Consultation for the	
Date	April 10, 2017	
Time	2pm	
Meeting Venue	EPA, KP Office, Peshawar	
Attended By	Dr. Mohammad Bashir Khan	0300-597 9823
	Syed Hidayat Hasan (HH)	0300 856 0713
	Kamran Minai (KM)	0316 298 8319
	Naimat Khan, PEDO	0333 473 7190
	Salman Shahid Khan, ADB	0346 946 5123
HBP Representatives	HH, KM	
Stakeholder Representatives	Dr. Mohammad Bashir Khan	
Conducted by	HH	
Recorded by	KM	
Language	English, Urdu	
Preamble	Dr. Bashir was briefed about the purpose of the meeting. He was up-to-date about the Project because a Background Information Document had been shared with him. The representatives from PEDO and ADB were also part of the meeting. Dr. Bashir was then asked to share his concerns regarding the Project.	

Issues Identified
Sewage dumping in the river is an existing issue.
Cutting of trees for road construction is a concern. Deforestation of thick forests will occur.
It is important to know the Environmental Flows that will result due to the Project.
Fish ladders are recommended.
There will be submergence of certain areas and this is a concern.
A colony will be created for workers and labor which could have adverse impacts.

Record of the Consultation Meeting

Stakeholder/s	World Wildlife Fund, Pakistan	
Consultation	Stakeholder Consultation for the	
Date	April 12, 2017	
Time	12pm	
Meeting Venue	WWF-P Office Islamabad	
Attended By	Rab Nawaz	+92 (344) 254 9384
	Kamran Minai (KM)	+92 (316) 298 8319
	Shakeel Ahmad (SA)	+92 (343) 981 3640
HBP Representatives	KM, SA	
Stakeholder Representatives	Rab Nawaz	
Conducted by	KM, SA	
Recorded by	KM	
Language	English	
Preamble	Rab Nawaz was briefed about the Project and was provided with a Background Information Document which he reviewed before the questions were asked. He was then asked about his concerns regarding the Project and his suggestions for mitigation.	

Issues Identified and Recommendations
Issues and Concerns
Construction Phase disturbances: Reserve forests are a concern, highly sensitive area for wildlife, Himalayan moist temperate forests. Road construction will result in loss of forests including reserve forests.
Project Location: The Project is located between Protected Areas. Here diversity is important because there is an overlap between moist temperate and dry temperate forests. A lot of animals will be displaced because of this Project. Areas of importance around the Project include Kaghan, Paras, Siri Pai, Allai and Kawai.
Species of conservation importance present: These include endemic species and those listed as Endangered or Critically Endangered on the IUCN Red List: They belong to the kingdoms of plants, birds, and mammals. This is a very critical area for wildlife. Just above Paras is a very sensitive habitat. In particular, the Himalayan Grey Langur of which there is a very large population here. Black Bear is also found here and signs of Brown Bear have been observed. There are 7-8 important bird species including for example the Western Trogopan, the Long tailed Tip, Khaleej Pheasant, Kokhlas Pheasant. Vulture spp. are also found here including the Griffon Vulture. This is also part of the range of the Common Leopard. Deer spp. include Ibex, Muntjak Deer, Grey Goral. Local extinctions are possible.
Seasonal Risks: There is altitudinal migration here. Species come down to this area
Slow development of Himalayan Ecosystems: Himalayan Ecosystems develop over a long period of time. The impacts of this Project will be short-term but they will be damaging.
Pollution: Air and dust pollution are a concern for wildlife.

Recommended Mitigation and Management Measures
Timing of construction is very important. The winter season is better than the summer season because in winter there is less breeding.
Strict controls on flora and fauna but especially flora from exploitation by workers.
Strict guidelines on avoiding hunting.
Protection of upstream forests is important.
Forest-targeted restoration and conservation is important. This will help by preventing landslides as well.
Taxus species should not be removed.
It is recommended that investments be made in Watershed Management Programs.
A close eye should be kept on water quality.
Focused studies are recommended especially on Taxus species, Western Trogopan and Musk Deer.

Record of the Consultation Meeting

Stakeholder/s	Star Hydro Power Limited (SHPL)	
Consultation	Stakeholder Consultation for the	
Date	April 12, 2017	
Time	3pm	
Meeting Venue	SHPL Office, Islamabad	
Attended By	Syed Atif Ali Shah	0301 849 8601
	Kamran Minai (KM)	0316 298 8319
HBP Representatives	KM	
Stakeholder Representatives	Syed Atif Ali Shah	
Conducted by	KM	
Recorded by	KM	
Language	English, Urdu	
Preamble	Syed Atif Ali Shah was provided with the Background Information Document and a brief description of the Project was given with details of its key components. As the stakeholder is already involved in development of hydropower in the Kunhar Basin, the representative had read the feasibility study and was aware of the Project location and certain details.	

Issues Identified and Recommendations

Issues

Resettlement is a concern: There are 116 commercial infrastructures, a market place is being affected.

Operational impacts i.e. peaking and changes in Environmental Flows: The most important concern is the modification to environmental flows that will result due to Project operations; the Patrind HPP is downstream of the proposed Project. Both the timing and quantity of release of water are important. Even a 3-4 hour stoppage of water is a concern. In addition, stoppage of water during testing and Project operation is of concern. It is important to know the mean dry season flow after the Project is in place.

Sedimentation and flushing of sediments, including timing and quantity, is also a concern.

Impacts on ecology: There are concerns about the presence of fish species of conservation importance and impacts on river ecology.

Recommendations

Communication between developers: There should be clear communication between developers regarding the timing and level of environmental flows. This includes modification in flows as a result of peaking operations and due to flushing.

Record of the Consultation Meeting

Stakeholder/s:	Himalayan Wildlife Foundation (HWF)	
Consultation	Stakeholder Consultation for the	
Date:	April 19, 2017	
Time:	2pm	
Meeting Venue:	Hagler Bailly Pakistan Office	
Attended By	Dr Anis-ur-Rahman	0300 854 0471
	Kamran Minai	0316 298 8319
HBP Representatives	Kamran Minai (KM)	
Stakeholder Representatives	Dr Anis-ur-Rahman	
Conducted by:	KM	
Recorded by:	KM	
Language:	English	
Preamble:	Dr Rahman was familiar with the Project based on the Background Information Document provided earlier. He was provided with a brief summary of the key technical aspects of the Project design and number of people to be resettled.	

Issues Identified and Recommendations
Issues
Resettlement: The main concern is the people who will need to be relocated as a result of the Project. Their quality of life needs to improve and they need to have value added to their living standards.
Fish Species of Conservation Importance: The fish species that will be affected by the Project are important.
Recommendations
The new housing provided should be based on comprehensive planning. A sectoral approach should be taken such as that adopted in Islamabad. This resettlement should be a model for other villages in the Kaghan Valley which other people will want to emulate.
A town planner should be contracted to carry out planning for the resettlement and add value to the lives of the people. Professional town planners include Sikander Ajam Associates and Dr. M.K. Pasha. There should be planning to provide residential, commercial and amenities plots.
The resettlement being done with proper town planning will mean that the value of the properties of the locals increases.
Commitment should be made to provide the locals with as many jobs related to the Project as possible. This includes technical jobs for which training should begin as soon as possible.
The sourcing of the sediment should be from local sources. Contracts and sub-contracts should be given to the locals as far as possible, not to outsiders.

There should be an agreement with the government to provide 24 hour electricity daily to the local community that is being affected by the Project.
The maximum benefits associated with the Project should be to the locals. The resettled staff should be wealthier, not poorer and their quality of life should see a marked improvement.
HWF is interested in any activities and assistance it can provide with protection of biodiversity.

Record of the Consultation Meeting

Stakeholder/s:	Forest Department, Khyber Pakhtunkhwa	
Consultation	Stakeholder Consultation for the	
Date:	April 27, 2017	
Time:	10am	
Meeting Venue:	Forest Department Office, Mansehra, Khyber Pakhtunkhwa	
Attended By	Sardar Tamor Ilyas, Divisional Forest Officer, Mansehra	+92 (997) 410 020, +92 (331) 800 2000
	Azhar Ali Khan, Conservator of Forests, Lower Hazara	+92 (091) 931 0232
	Kamran Minai (KM)	+92 (316) 298 8319
HBP Representatives	KM	
Stakeholder Representatives	Sardar Tamor Ilyas	
Conducted by:	KM	
Recorded by:	KM	
Language:	Urdu	
Preamble:	The stakeholder representatives were briefed about the Project and its impacts. They were familiar with the area and the trends of behavior of the locals.	

Concerns

Relocation of people: People will be relocated and are likely to want to move downward. This is expected based on past observations and trends in behavior of the locals; in this area people with the means to move, for example, due to improved economic status, generally choose to move to lower areas. From the perspective of the Department, this is positive as it leaves more forested area untouched at higher elevations.

Existing disturbance: The habitat in this area is already fragmented due to human activity. The locals have modified the forest area and there is a high level of disturbance.

Project footprint: The forested area in the Project footprint is not of concern because Project-related activities will not result in degradation of large forested areas.

Reserve Forests: There are no concerns with Reserve Forests as these will not be affected by the Project. Areas further away from the Project infrastructure have Reserve Forests but these will not be affected by the Project.

Size of the Project: The Department supports this development because it will generate much-needed electricity for the country. It is viewed as a positive development in addressing national needs.

Recommendation
Replantation: Compensatory replantation should be done for any loss of trees due to Project-related activities. The Department will use any funds provided for this purpose.
Ratio of replantation: The Forest Department does not have any specific ratio of replantation in mind. The Department has not yet decided whether replantation should be done in a 1:3, 1:5 or 1:10 ratio.

Record of the Consultation Meeting

Stakeholder/s:	Archaeology Department, Hazara University	
Consultation	Stakeholder Consultation for the	
Date:	April 27, 2017	
Time:	1pm	
Meeting Venue:	Archaeology Department, Hazara University	
Attended By	Dr Shakirullah, Assistant Professor	+92 (997) 414 147, +92 (300) 593 8066
	Zafar Ali, Assistant Director, Environment, PEDO	
	Salman Shahid Khan, ADB Project Coordinator	+92 (346) 946 5123
	Kamran Minai (KM)	+92 (316) 298 8319
HBP Representatives	KM	
Stakeholder Representatives	Dr Shakirullah	
Conducted by:	KM, Zafar Ali, Salman Shahid Khan	
Recorded by:	KM, Zafar Ali, Salman Shahid Khan	
Language:	Urdu, English	
Preamble:	Dr Shakirullah was briefed about the Project, including the main infrastructure components and the length of the reservoir area. He was aware of details of the EIA as described in the Background Information Document.	

Concerns
Historical Value: Mansehra is very rich in history. Within Manshera, more than one thousand sites of importance have been identified. There is important Buddhist archaeology here. Also, historically, this area has been important for trade routes.
Downstream impacts: The changes in the flow of the river may be of importance if there are any archaeological sites downstream. In particular, flooding is a concern.
Legislation: The Provincial Antiquities Act has been revised in 2016 and should be taken into consideration.
Recommendations
Need for a survey: It is important to conduct surveys before-hand to determine the archaeological value of an area where development is planned to take place. If there are any archeological artifacts of importance, excavations can be done. Assessing the area, whilst keeping in view the dam, is recommended.
Sharing of Information: Publication of proper reports is recommended once data is collected.

Record of the Consultation Meeting

Stakeholder/s:	Fisheries Department, Khyber Pakhtunkhwa	
Consultation	Stakeholder Consultation for the	
Date:	April 27, 2017	
Time:	3pm	
Meeting Venue:	Office of Fisheries Department, Mansehra, Khyber Pakhtunkhwa	
Attended By	Mohammad Tanvir, Assistant Director Fisheries, District Mansehra	+92 (303) 492 4722
	Zafar Ali, Assistant Director, Environment, PEDO	
	Salman Shahid Khan, ADB Project Coordinator	0346-946 5123
	Kamran Minai (KM)	0316-298 8319
HBP Representatives	KM	
Stakeholder Representatives	Mohammad Tanvir	
Conducted by:	KM, Zafar Ali, Salman Shahid Khan	
Recorded by:	KM, Zafar Ali, Salman Shahid Khan	
Language:	Urdu, English	
Preamble:	Dr Tanvir was aware of the Project and its details as he had attended an Eflow workshop earlier and had read the Background Information Document.	

Concerns
Disturbance: The ecosystem already developed will be disturbed due to the Project.
Spawning grounds: The spawning grounds of fish will be affected due to changes in flows. Native species will be killed due to this. Spawning grounds of the Alwan Snow Trout are a concern. Mr Zafar noted the importance of the two endemic species.
Fishing licensing: Fish licenses are provided for fishing in this area. Changes in fish fauna will affect fishing in the area.
Flushing: This is a concern because it will affect fish fauna of the reservoir. However, it was noted by Mr Salman that flushing is normally done in the flooding season when water needs to be released anyways.
Fish Ladder: Strong fish will be able to move over the ladder but the weaker ones will not. An estimated success rate is 25-30% of the fish making it over.
Options: Japan has removed a dam due to concerns over fish fauna, but we are not in this position.

Pressures: Pressures other than those associated with the Project include human population growth which has increased pollution and effluent discharge into the river. The pH of water in some areas has increased as a result of this, making it unsuitable for fish. There is also noise pollution from construction activities, such as extension of roads.
Changes in the ecosystem: Abrupt changes in temperature affect the ecosystem. Climate Change was mentioned as a possible cause by Mr Salman and recognized as an issue by Dr Tanvir.
Zoning: There are six zones of the river. Of these, one area is a sanctuary where no disturbance is allowed and fish watchers are greater in number. This is important because of the increase in fishing pressure (earlier there were 100s of people coming to fish, now 1000s show up). This is partly due to better access as a result of road extension. The zonation has changed due to impacts of pollution as the fish do not travel to areas where they previously did. The Brown Trout is an example, which shows prominent coloration in areas near Jalkhad where the water is less polluted compared to Balakot, where this species shows a less prominent coloration. However, there are differences in the food chain as well, so pollution may not be the cause.
Lack of research: There has been no research on the effects of pollution on fish fauna. Mutations may be a concern although no such abnormalities have been observed. Growth of fish has not changed.
Recommendations
Fish ladder: A fish ladder is proposed to be a part of the dam design. Mr Zafar stressed the need to explore options to increase the success rate of the fish ladder above 25-30% of the fish making it over. A review of the fish ladder design is recommended.
Flow: The flow needs to be maintained as per the agreement.
Reservoir: The 4.5 km stretch of the reservoir should be used for stocking of fish and angling. Mr Zafar stressed that invasive species should be avoided.
Safe area: A safe area for fish should be established. Mr Salman stated that an option for pond sharing should looked into.
Hatcheries: An alternative to protection and preservation is the use of hatcheries. These should be supported. The Alwan Snow Trout has been bred successfully in other countries and a hatchery exists in Swat. Mr Zafar stated that in Pakistan there are limitations on the breeding of fish due to lack of facilities. He was of the opinion that, of the two options (in vivo and in vitro), the in vivo option is preferable.
Monitoring: Weekly pH monitoring is recommended. The current data for temperature is to be shared with PEDO.

Record of the Consultation Meeting

Stakeholder/s:	Wildlife Department, Khyber Pakhtunkhwa	
Consultation	Stakeholder Consultation for the	
Date:	April 27, 2017	
Time:	4pm	
Meeting Venue:	Office of Wildlife Department, Mansehra, Khyber Pakhtunkhwa	
Attended By	Faiq Khan, DFO, Mansehra	+92 (333) 555 4956
	Zafar Ali, Assistant Director, Environment, PEDO	
	Salman Shahid Khan, ADB Project Coordinator	+92 (346) 946 5123
	Kamran Minai (KM)	+92 (316) 298 8319
HBP Representatives	KM	
Stakeholder Representatives	Faiq Khan	
Conducted by:	KM, Zafar Ali, Salman Shahid Khan	
Recorded by:	KM, Zafar Ali, Salman Shahid Khan	
Language:	Urdu, English	
Preamble:	Mr Khan was aware of the Project as he had read the Background Information Document.	

Concerns
Violations: Wildlife violations including those which affect the aquatic habitat are being handled by the Wildlife Department.
Reservoir: The reservoir is a concern. This is mainly due to inundation of vegetation and loss of habitat. Due to the reservoir, wetland will be established which will change bird fauna. There will also be changes to flora and fauna in the riparian zone.
Lack of data: There is limited data on wildlife especially on key species, such as the Common Leopard and The Indian Palm Civet. There is a focus on game species but a lack of data on those that are not game animals. The department lacks the capacity to go into minute details of wildlife management and research.
Infrastructure development: The development of infrastructure will affect the fragile ecosystem.
Species of importance: This is a very important area for Chakhor and Khaleej Pheasant. The population of the Khaleej Pheasant is of particular concern. Passerine birds are important as well.
Non-Project related pressures: These include habitat loss and fragmentation due to expansion of settlements, and the human wildlife conflict especially for the Common Leopard and the Black Bear. After the earthquake people have moved down resulting in more area for these species to occupy. As a result their populations have increased and hence they extend their ranges and come into conflict with people. As mentioned earlier there is lack of data on wildlife; species data is needed for baseline development and monitoring. There is only regulation on game species.
Lack of staff: There is a lack of staff which results in very few watchers.

Lack of awareness: There is a lack of awareness amongst locals regarding the importance of wildlife. In particular, there is a lack of understanding regarding sustainable use and economic benefits of wildlife.
Recommendations
The need for surveys: Detailed wildlife surveys are needed. The Department needs to be included in these. Mr Zafar stated the importance of government coordination. Entomology should be included in the surveys because the food chain is of importance.
Staff capacity building: There is a need to build the capacity of the staff.
Reservoir: This should be declared a protected wetland.
Closure of areas: There are forested areas that are closed off to all activity. This is to facilitate regeneration. 120 such areas have been established in Kaghan Valley, with each ranging from 40 ha to 100 ha.

Record of the Consultation Meeting

Stakeholder/s:	Adventure Time Pakistan	
Consultation	Stakeholder Consultation for the	
Date:	May 2, 2017	
Time:	9 30am	
Meeting Venue:	Telephonic	
Attended By	Nadeem Akhtar, Director	+92 (311) 746 6171
	Kamran Minai (KM)	+92 (316) 298 8319
HBP Representatives	KM	
Stakeholder Representatives	Nadeem Akhtar	
Conducted by:	KM	
Recorded by:	KM	
Language:	English, Urdu	
Preamble:	Nadeem Akhtar had read the Background Information Document and was aware of the Project. The main infrastructure of the Project was explained to him to refresh his memory of the planned development, most importantly the dam itself, the tunnels and the staff colonies.	

Concerns
High water level: white water rafting is carried out only along the Kunhar River, in two areas. One is between the stretch from Balakot to Garhi Habibullah and the other is in Naran. Therefore, Adventure Time Pakistan would like a high water level to be maintained in this stretch.
Positive impact for tourism: In the Khanpur dam Adventure Time Pakistan organizes events for kids including camps where they are taught about first aid, watersports and where they enjoy still water kayaking. Therefore, the creation of another reservoir is, in the view of the organization, a benefit as it increases opportunities for such activities and draws in more tourists.
Recommendations
Sharing of the schedule of release of water: The schedule for release of water should be shared with everyone so that people can plan their activities accordingly.

Record of the Consultation Meeting

Stakeholder/s:	Social Welfare Department, KP	
Consultation	Stakeholder Consultation for the	
Date:	May 19, 2017	
Time:	10:30am	
Meeting Venue:	Office of District Officer Social Welfare, Mansehra	
Attended By	Abdul Rasheed, Social Welfare Officer, Mansehra	0301-8137172
	Yasmeen Saeed, Social Welfare Officer	NA
	Anwar Fazal Ahmad (AN)	0312 979 1658
	Ms. Rizwana Waraich (RW)	0331-539-6334
HBP Representatives	AN, RW	
Stakeholder Representatives	Abdul Rasheed, Social Welfare Officer, Mansehra, and Yasmeen Saeed, Social Welfare Officer	
Conducted by:	AN, RW	
Recorded by:	AN	
Language:	Urdu	
Preamble:	The Background Information Document (BID) had been shared with the organization. They were also briefed about the Project before obtaining their views.	

Concerns

Impacts on Communities: The Project will have significant impacts on local communities. A number of households will be displaced. The following will be submerged:

- Boys and girls schools.
- Basic Health Unit (BHU).
- Graves of the relatives of the affected households.

Recommendations

All the displaced households should be rehabilitated.

Public infrastructure like schools and BHUs should be relocated.

Graves should be managed with the consent of the communities

Project should provide special assistance to vulnerable households.

Households affected by livelihood should be provided with vocational trainings to get benefits from the project

Record of the Consultation Meeting

Stakeholder/s:	Kaghan Development Authority	
Consultation	Stakeholder Consultation for the	
Date:	May 22, 2017	
Time:	9am	
Meeting Venue:	Kaghan Development Authority Office	
Attended By	Fidat Tanoli, Assistant Director	0333-4300 019
	Nasir Hayat Babar, Project Director	0300-8593 045
	Kamran Minai (KM)	0316-3988 319
HBP Representatives	KM	
Stakeholder Representatives	Fidat Tanoli, Nasir Hayat Babar	
Conducted by:	KM	
Recorded by:	KM	
Language:	Urdu, English	
Preamble:	The stakeholder representative was aware of the Project details as a Background Information Document (BID) was shared with them. A brief discussion on the spatial scope of the Project and the villages near which Project facilities are planned was done to have a shared understanding of the areas that will be affected.	

Concerns

Jurisdiction: The area in which the Project infrastructure is located falls within the jurisdiction of the Kaghan Development Authority, therefore, the organization is keenly interested in this development. Therefore, the Kaghan Development Authority is a main stakeholder and representative of the Government of Khyber Pakhtunkhwa.

The Kaghan Development Authority supports this move by the Provincial Government to develop energy resources in the area, but it should include the Kaghan Development Authority.

Development: The Provincial Government has plans to promote tourism in this area through the Kaghan Development Authority, in particular, international tourism.

The Kaghan Development Authority has started a program for solid waste disposal in the area last year. The program aims to cover the area from Balakot to Babusar. It will provide sanitation, drainage and waste disposal facilities.

A water purification scheme is planned to be introduced in Naran.

A firefighting scheme is planned.

A garbage collection scheme has been started.

Further plans include development of Saif-ul-Muluk and Lulupatsar as well as the establishment of a family park in Naran and Shogran.

Natural beauty of the area: We are concerned about the natural beauty including all wild flora and fauna. Preserving and protecting the vegetation is a priority.

Functions: The functions of the Kaghan Development Authority are as a service provider, building control agency and executing agency for any scheme in the area. Therefore, this development is very important for the Kaghan Development Authority.
Development of Project facilities: As two colonies will be established, there will be increased economic and commercial activity in the area. Therefore, responsibility for the effects of this will need to be taken, for example, controlling pollution. This is the Kaghan Development Authority's area of interest.
Legislation: The Kaghan Development Authority is the owner of the area and coordination with it is required for public sector projects as well as private sector ones.
Recommendations
Sharing of information: Progress on the development of the Project should be shared with the Kaghan Development Authority regularly.
Capacity Building: A fraction of the net income from the Project should be given to the Kaghan Development Authority so that it can function effectively as a service provider. Funding is important. The Kaghan Development Authority will only be bound to provide services if they are taken on board. If the Kaghan Development Authority is provided with funding, they will not have any excuse to provide services.
Environment: The Kaghan Development Authority wants to make this area environmentally friendly.

Record of the Consultation Meeting

Stakeholder/s:	International Finance Corporation
Consultation	Stakeholder Consultation for the
Date:	May 26, 2017
Time:	6:50pm
Meeting Venue:	Communicated by letter
HBP Representatives	Kamran Minai
Stakeholder Representatives	Shahid Lutfi
Language:	English
Preamble:	The Background Information Document (BID) had been shared with the stakeholders. A conversation to discuss the main components of the dam design and the key stakeholders involved was also held. The stakeholders provided their recommendations for the ESIA process and for the Project.

Recommendations
There must be a robust impact assessment that covers potential impacts of the project on not only the Kunhar River but also the Jhelum River downstream of the confluence of the two rivers. This should address the potential impacts of peaking flows and of sediment discharges.
The alternatives analysis in the ESIA should cover different approaches to peaking flows, ranging from run-of-river to two- or four-hour daily peaking discharges. We also recommend that seasonal limitations on peaking be considered as well. IFC encourages developers to consult with relevant authority to discuss the possibility that Balakot could be operated as a run-of-river project without peaking discharges during the entire year or during key biodiversity periods of the year.
The alternatives analysis in the ESIA should cover different approaches to sediment management. This could range from different designs (e.g., dedicated sluicing gates low in the dam vs spillway releases) to different release regimes (e.g., multiple releases in the high-water season vs one or two release periods) to different levels of cooperation and coordination among cascade hydropower operators (e.g., synchronization of releases by upstream and downstream projects to unilateral scheduling of sediment releases).
The ESIA should quantify the excavated soil and rock material that would require off-site disposal. Potential sites for safe disposal of muck material should be reviewed for risks of washout, land sliding, etc. ESIA may also identify a framework to develop a detailed Muck Disposal Plan during construction stage.
The ESIA should review the impacts on downstream projects for multiple scenarios relating to construction activities, failure of cofferdam, accidental release of excavated materials and muck.
There will need to be a cumulative impact analysis that considers the cumulative impacts of overall hydropower development in the basin on endemic and endangered aquatic species that are of conservation concern. This would include impacts in the lower Jhelum River as well as in the Kunhar River. The cumulative impact assessment should also review the (provincial/state) transboundary issues relating to ecological, social, legal, and jurisdictional aspects of the project. The ESIA should take advantage of previous data collection and analyses that may be found in ESIAs and river basin planning documents for other hydropower developments.

The overall ESIA process should essentially be impact and risk based assessment, and under social assessments should include analysis on human rights, community benefit sharing, conflicts & security, etc. With context to PS4: Community Health, Safety and Security, ESIA to include some basic analysis and recommendations on dam break/failure.
The ESIA analysis may also review the project for impacts and risks on and from climate change.
The ESIA may also develop framework on integrated fish monitoring plan, biodiversity management, sand and gravel mining management, conflicts & security management plan, livelihood restoration, etc. that would require joint implementation by key stakeholders.
We encourage the developers of Balakot Hydropower Project to participate in the Hydropower Developers' Working Group, and participate in supporting future activities of the Working Group. This could take the form of participating in Group meetings, direct contributions to various initiatives, as well as participating or even leading certain activities. To that end, we would very much appreciate it if you would provide to us contact information for Balakot project management.

Record of the Consultation Meeting

Stakeholder/s:	Archaeology Department, University of Peshawar	
Consultation	Stakeholder Consultation for the	
Date:	May 30, 2017	
Time:	10 00am	
Meeting Venue:	University of Peshawar	
Attended By	Dr Mukhtar Ali Durrani, Head of Department, Archaeology Department, University of Peshawar	+92 (91) 922 1048
	Dr Jamil Ahmad Chitrali (JC)	+92 (346) 939 3100
HBP Representatives	JC	
Stakeholder Representatives	Dr Mukhtar Ali Durrani	
Conducted by:	JC	
Recorded by:	JC	
Language:	Urdu, Pashto, English	
Preamble:	The Background Information Document (BID) had been shared with Dr Durrani and he was aware of the Project's details.	

Concerns

Lack of evidence with the Department: There is a lack of archaeological evidence for the Project area, therefore, the Department is not aware of any sites of concern. This has been determined in consultation with other professors in the Department including Professor Naeem Khan, Professor Ibrahim Shah and Professor Qazi Naeem.

Lack of secondary data: There is a lack of secondary data about the area as well.

Record of the Consultation Meeting

Stakeholder/s:	Tourism Corporation, Khyber Pakhtunkhwa (TCKP)	
Consultation	Stakeholder Consultation for the	
Date:	June 12, 2017	
Time:	12 30pm	
Meeting Venue:	Office of TCKP	
Attended By	Dr Jamil Ahmad Chitrali (JC)	+92 (346) 939 3100
	Mr. Mushtaq Ahmad, Managing Director (MD), TCKP	+92 (332) 992 2207
	Ms. Haseena Shoukat, In-charge Marketing, TCKP	+92 (300) 932 1297
	Mr. Johar, PSO to MD, TCKP	+92 (334) 968 6805
HBP Representatives	JC	
Stakeholder Representatives	Mr. Mushtaq Ahmad, Ms. Haseena Shoukat, Mr. Johar	
Conducted by:	JC	
Recorded by:	JC	
Language:	Pashto, Urdu, English	
Preamble:	A Background Information Document (BID) was shared with the staff earlier. They were briefed salient components of the Project.	

Concerns

Lack of data: The TCKP has no data on tourism in general and in the area where the Project is located.

Lack of capacity: There is a lack of capacity to deal with major concerns with tourism and with planning-related matters. For a long time they have been working with only 6 staff. Only recently the staff has been increased to over 100 and these people have been sent into the field to collect data.

Plans: Plans to increase domestic tourism include establishing a tourist police force and uplift of roads. The corporation is also looking to submit proposal to various donors including the World Bank to facilitate efforts to create job opportunities, training the local youth on boating, fishing and domestic hotels. They also intend to explore and develop new picnic spots and increase efforts to conserve nature.

Recommendations

Assistance with plans: The corporation is seeking assistance with successful implementation of its plans.

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1. Introduction

The Pakhtunkhwa Energy Development Organization (PEDO) intends to construct a 300 megawatt (MW) run-of-river hydropower plant (referred to as “Project” in this report) at Balakot, in Mansehra District of Khyber Pakhtunkhwa (KP), Pakistan. The Project called Balakot Hydropower Development Project (HDIP) or Balakot Hydropower Project (BAHPP) is located on the Kunhar River about 18.6 kilometer (km) upstream of the town of Balakot. The Asian Development Bank (ADB) is evaluating the Project for financing under its Hydropower Investment Development Program.

1.1 About the Project

The Project site is located on the Kunhar River about 18.6 km upstream of the town of Balakot. The Project setting is shown in **Exhibit 1.1.** The Project is a run-of-river diversion type hydropower plant, located in the 12 km stretch from Paras to Sangar village (see **Exhibit 1.2**). The dam will be a concrete gravity dam with a maximum height of 35 meters (m) from the river bed and dam crest length of 130 m. The dam top elevation will be 1,292 m above mean sea level (amsl). The dam will create a reservoir that will operate between the maximum operating level of 1,288 m and the minimum operating water level of 1,283 m. The surface area of the reservoir will be approximately 28 hectares (ha) and it will extend 2.2 km upstream of the dam. A headrace tunnels extending 9.1 km will divert water from the reservoir created by the dam to the powerhouse. The powerhouse will be underground cavern-type powerhouse. A 1.565-km long tailrace tunnel will discharge the water back to the Kunhar River. The total distance between the dam and the outfall of the tailrace tunnel will be about 13.4 km. The Project is located on Kunhar River which originates from the glaciers above Lulusar Lake in the Kaghan Valley of KP. Glaciers of Malka Parbat and Makra Peak and the waters of Saiful Muluk Lake feed the river. It passes through Jalkhand, and meets Jhelum River at Rarra. The drainage area of the river is 2,535 km^2, with elevation ranging from 600 to 5,000 m.[1] It is one of the larger tributaries of the Jhelum River Basin and the only main tributary situated entirely in Pakistan’s territory. Snowmelt from the Kunhar Basin contributes 65% of the total discharge of the Kunhar River and 20-40% of the Jhelum River at Mangla.[2] An Environmental Flow (EFlow) Assessment was conducted as part of the Environmental Impact Assessment for the Project to determine suitable EFlows from the Project and their resulting impact on the ecosystem. EFlows can be defined as the quantity, timing and quality of the flow of *water, sediment and biota* necessary to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.[3]

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[1] Mahmood R, Jia S, Babel M. S., January 16, 2016, Potential Impacts of Climate Change on Water Resources in the Kunhar River Basin, *Water, Multidisciplinary Digital Publishing Institute*, Basel, Switzerland

[2] Ibid

[3] Amended from Brisbane Declaration, 2007.

Exhibit 1.1: Project Location

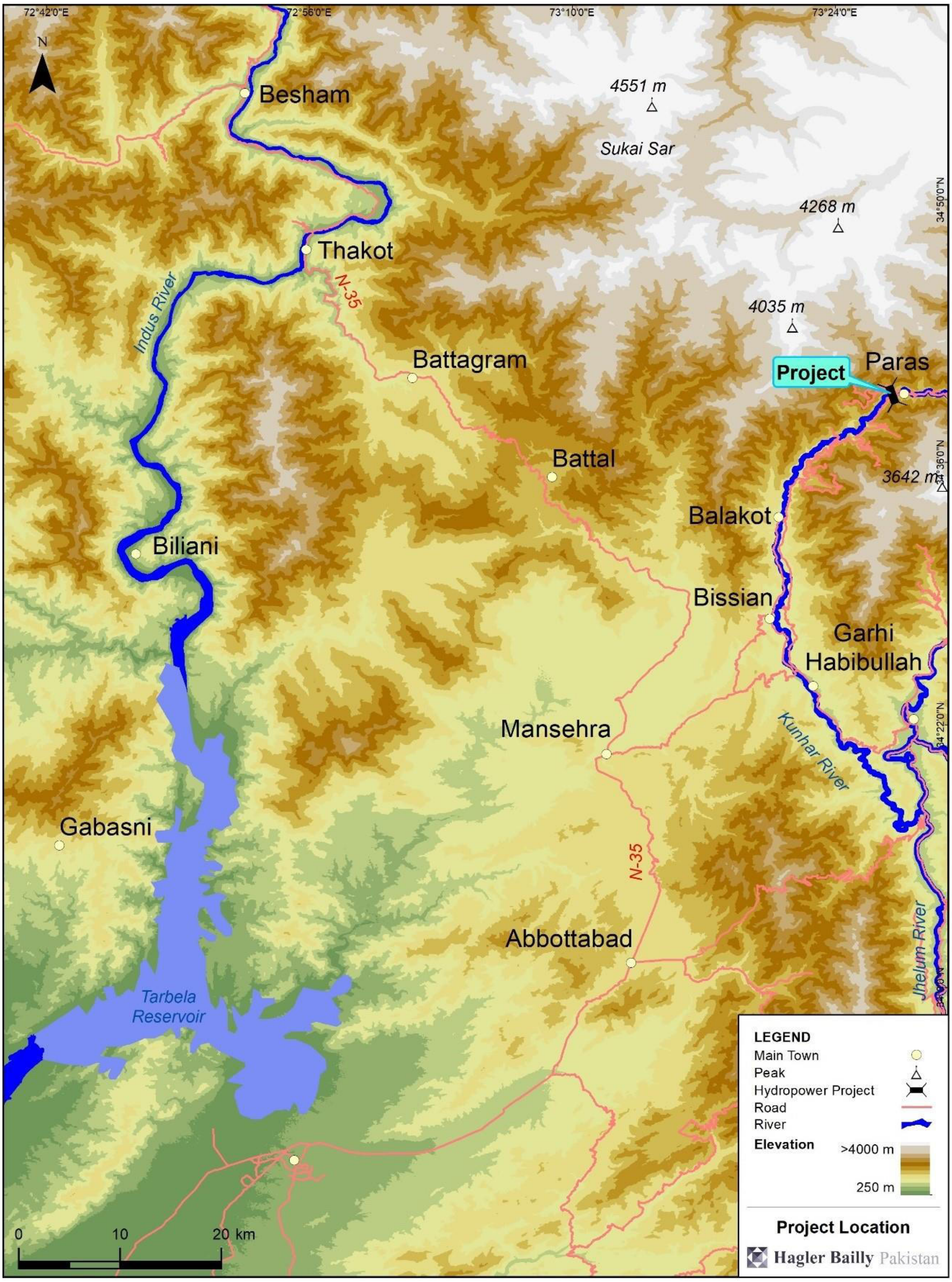
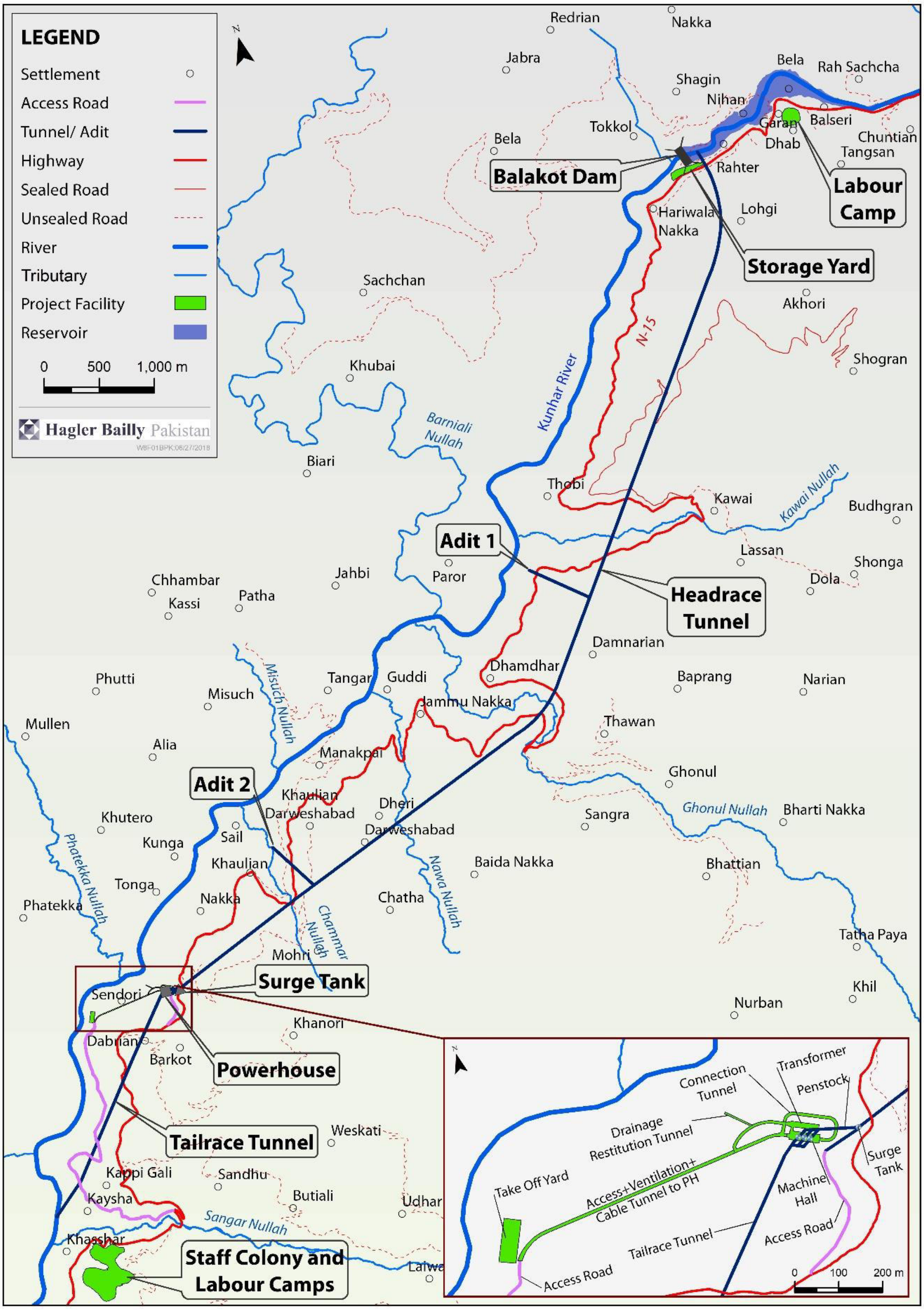


Exhibit 1.2: Project Layout



1.2 Other Hydropower Developments on the Kunhar River

There are several other major hydropower projects (HPPs) under construction on the Kunhar River, and several more are proposed (see **Exhibit 1.3**). A brief description of these HPPs is discussed below:

The following HPPs are under construction:

- **Patrind HPP (PHPP)** is a 147-MW hydropower project being built by Star Hydro Power 30.1 km downstream of Project dam. The diversion from the PHPP enters the Jhelum River just downstream of its confluence with the Neelum River, and upstream of its confluence with the Kunhar River. The PHPP dam height is 43.5 m from the river bed resulting in a 5.2 km long reservoir on the Kunhar River.
- **Sukki Kinari HPP (SKHPP)** is an 870 -MW hydropower project being built by SK Hydro (Pvt.). The SKHPP dam is located 44.6 km upstream of Project dam and has 19.4 km long diversion tunnels, for a low flow section of 38.6 km. Its tailrace outlet is 1.5 km upstream of the Project reservoir. The SKHP dam height is 54.5 m above the riverbed and the reservoir has a length of 3.1 km.

The following HPPs are proposed:

- **Naran HPP (NAHPP)** is proposed to be, according to its December 2013 feasibility study, a 188 MW HPP 59.2 km upstream of the Project dam. It is proposed to have a dam height of 74 m above the riverbed, reservoir length of 3.5 km. There is a 5.5 km dewatered section.
- **Batakundi HPP (BKHPP)** is proposed to be, according to its December 2013 feasibility study, a 96 MW HPP 77.7 km upstream of the Project dam. It is proposed to have a dam height of 58 m above the riverbed, reservoir length of 2.8 km. The diversion tunnel is 4.96 km long for a 5.1 km dewatered section.

All of the HPPs under construction or nearing completion will create barriers to inter alia, fish and sediment movement in the Kunhar Basin. More specifically:

- The PHPP has blocked the passage of migrating fish from the Jhelum River into the Kunhar River;
- SKHPP is expected to operate as a peaking plant it will discharge peaking flows in the 1.5 km reach between its outfall and the Project reservoir; and
- SKHPP will reduce sediment flow downstream and block fish migrations due to its dam.

These influences are not quantitatively modelled into the assessment for the following reasons:

1. The PHPP dam is near completion therefore its impacts are included into the baseline connectivity and resulting fish abundance.
2. SKHPP is taken to operate at baseload as a conservative estimate as peaking rules and its corresponding Eflow assessment is unavailable.

3. If SKHPP does undertake peaking operation, it will only be felt in the short section of 1.5 km upstream of the reservoir. Had the Project not been on the horizon there was a good case for baseload generation at SKHPP.
4. Connectivity impacts due to Sukki Kinari on sediment transport and fish passage are beyond the Study Area for the current assessment.

Further discussion on the cumulative impacts of these developments are presented in **Chapter 7** of the **EIA** Report.[4]

1.3 Objectives of the EFlow assessment

The objectives of the EFlow assessment are:

- to assess the environmental (ecological and social) implications of Project operational and management scenarios on the Kunhar River through the development and use of the Downstream Response to Instream Flow Transformations (DRIFT) Decision Support System (DSS) supported by knowledge and understanding of the basin developed as part of the EFlow assessment for Neelum Jhelum HPP, Karot HPP and Kohala HPP
- to provide stakeholders with the above information to facilitate informed decision making for the selection of environmental flow and protection scenarios
- to provide a defensible EFlow monitoring program for inclusion in the Biodiversity Action Plan (BAP).

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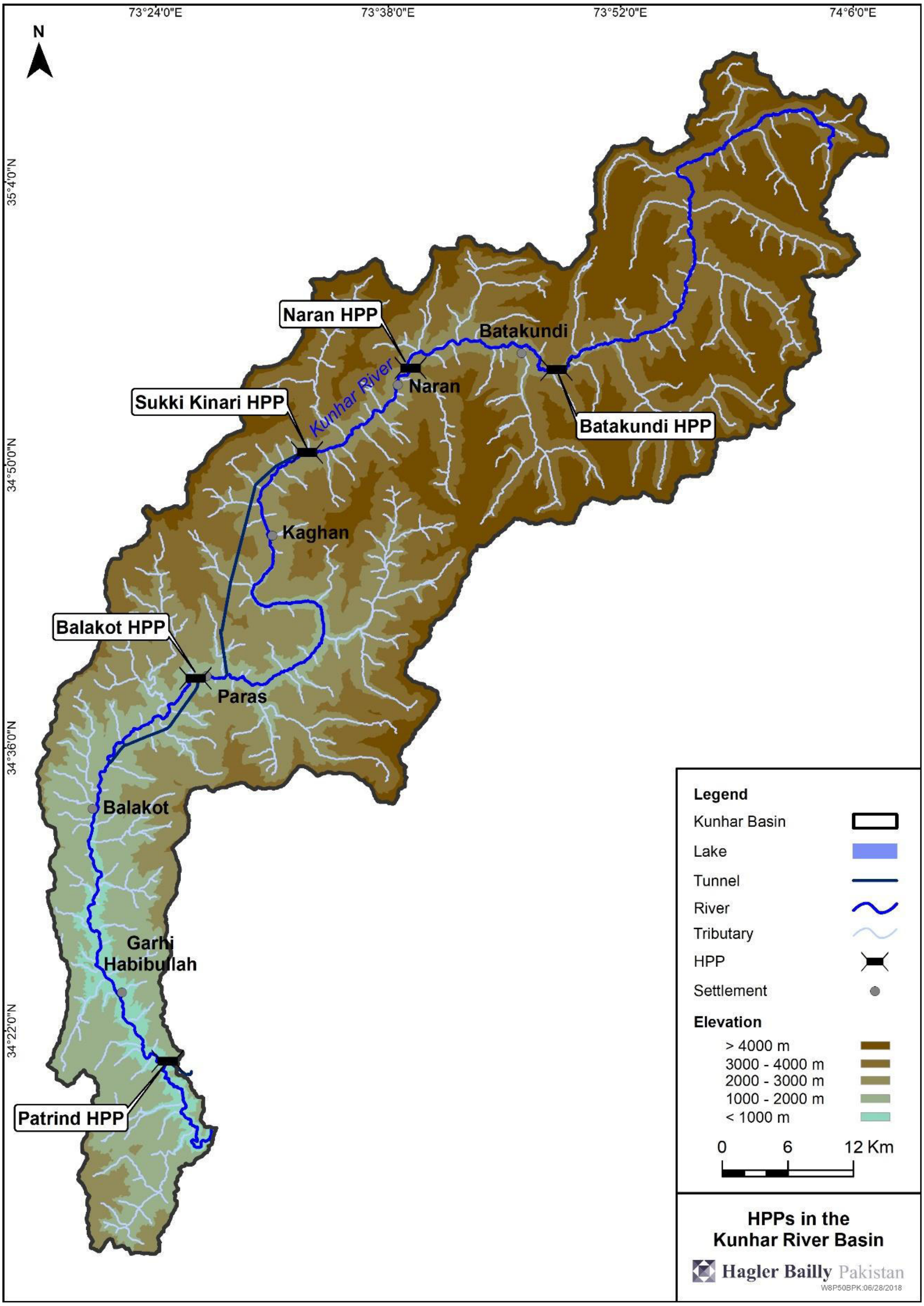
[4] Hagler Baily Pakistan, 2019, Environmental Impact Assessment of the Balakot Hydropower Development Project, Draft Report, Pakhtunkhwa Energy Development Organization (PEDO)

Exhibit 1.3: HPPs on the Kunhar River



1.4 Organization of this Report

Chapter 1 (*Introduction*) provides an introduction of the Project, and outlines the project setting and the study objectives.

Chapter 2 (*EFlow Study Area and Assessment Sites*) describes the EFlow assessment sites, and provides the logic behind catchment delineation into the separate sites.

Chapter 3 (*Assessment Scenarios*) escribes the operational and management scenarios on which the assessment is based.

Chapter 4 (*DRIFT Indicators and Inputs*) provides a summary of the DRIFT DSS and describes the DRIFT biophysical indicators and inputs used in the model.

Chapter 5 (*Biophysical Outputs*) lists the predicted change to the selected biophysical indicators as obtained from the DRIFT model.

Chapter 6 (*Analysis of Results*) compares the various scenarios in terms of the change over the baseline and in terms of the trade of against electricity production. Weighted net gain calculations for key fish indicators are also presented.

Chapter 7 (*Conclusions*) summarizes the findings and recommendations of this EFlow assessment and concludes the report.

Appendix A describes the DRIFT methodology.

Appendix B presents the Reservoir Operations Modelling and hydrological data used in DRIFT.

Appendix C presents the hydraulic data used in DRIFT.

Appendix D provides explanations for the Response Curves used in DRIFT.

1.5 Acknowledgements

Southern Waters Ecological Research & Consulting (Southern Waters), developers of the DRIFT DSS, provided backup support and quality control on the DRIFT model. Southern Waters is a specialist company (currently comprising five experienced consultants), based in Cape Town, South Africa, that has established itself as one of the world’s leading environmental flow consultancies. Southern Waters has been engaged in assignments in Africa, Asia and further afield for over 20 years, and has successfully completed over 350 projects for international funding and aid agencies, and for government organizations and private-sector clients.

The following reports and associated DRIFT DSS models developed by Southern Waters were drawn upon for the development of this assessment:

- Kohala Hydropower Plant Environmental Flow Assessment, Technical Report. Southern Waters in Association with Hagler Bailly Pakistan, November 2016 for Kohala Hydro Company (Pvt.) Ltd.
- Gulpur Hydropower Project Environmental Flow Assessment, Technical Report. Southern Waters in association with Hagler Bailly Pakistan, March 2014.for Mira Power Limited.

2. EFlow Study Area and Assessment Sites

This section provides the rationale and justification for selection of the study area and the EFlow assessment sites selected.

2.1 EFlow Study Area

The study area considers, the Project footprint and the changes it will make to the hydrology and connectivity of the river, and the under construction HPP developments and their impact of the Kunhar river as discussed in **Section 1.3**. For this assessment the "EFlow Study Area" includes the Kunhar River from the SKHPP tailrace outlet to the starting point of the PHPP reservoir. This is a 46.3 km stretch on the Kunhar River.

2.2 Catchment Delineation

Taking into account the geomorphology, biological variations, social uses of the river, and types and levels of impacts likely to be incurred as a result of dam operation; a catchment delineation exercise was performed results of which are provided in **Exhibit 2.1**.

Exhibit 2.1: Catchment Delineation for BHEP EF Study Area*

EF Reach	*Description*	*Valley Width*	*Slope of river*	*Population Density*	*River Length (km)*
Upstream of Dam	From SKHPP Tailrace to Project Dam	Narrow valley (80 m, average is 240 m)	Steep slope of river (24.4m per km, average is 16.9m per km)	Low/ Moderate	6.0
Downstream of Dam	From Project Dam to Tailrace	Narrow valley (90m, average is 240m)	Average slope of river (16.9 m per km, average is 16.9 meters per km)	Low population density	15.4
Downstream of Tailrace	From Tailrace to Balakot Town	Wide valley (330m, average is 240m)	Near average slope of river (13.1 m per km, average is 16.9 meters per km)	Moderate population density	4.7
Downstream of Balakot	From Balakot Town to PHPP Reservoir.	Very wide valley (800m, average is 240m)	Less than average slope of river (7.5 m per km, average is 16.9 meters per km)	High population density	24.9

* See **Chapter 4** of the **EIA** Report for more information on river water hydrology and river dependence of the population

2.3 EFlow Sites

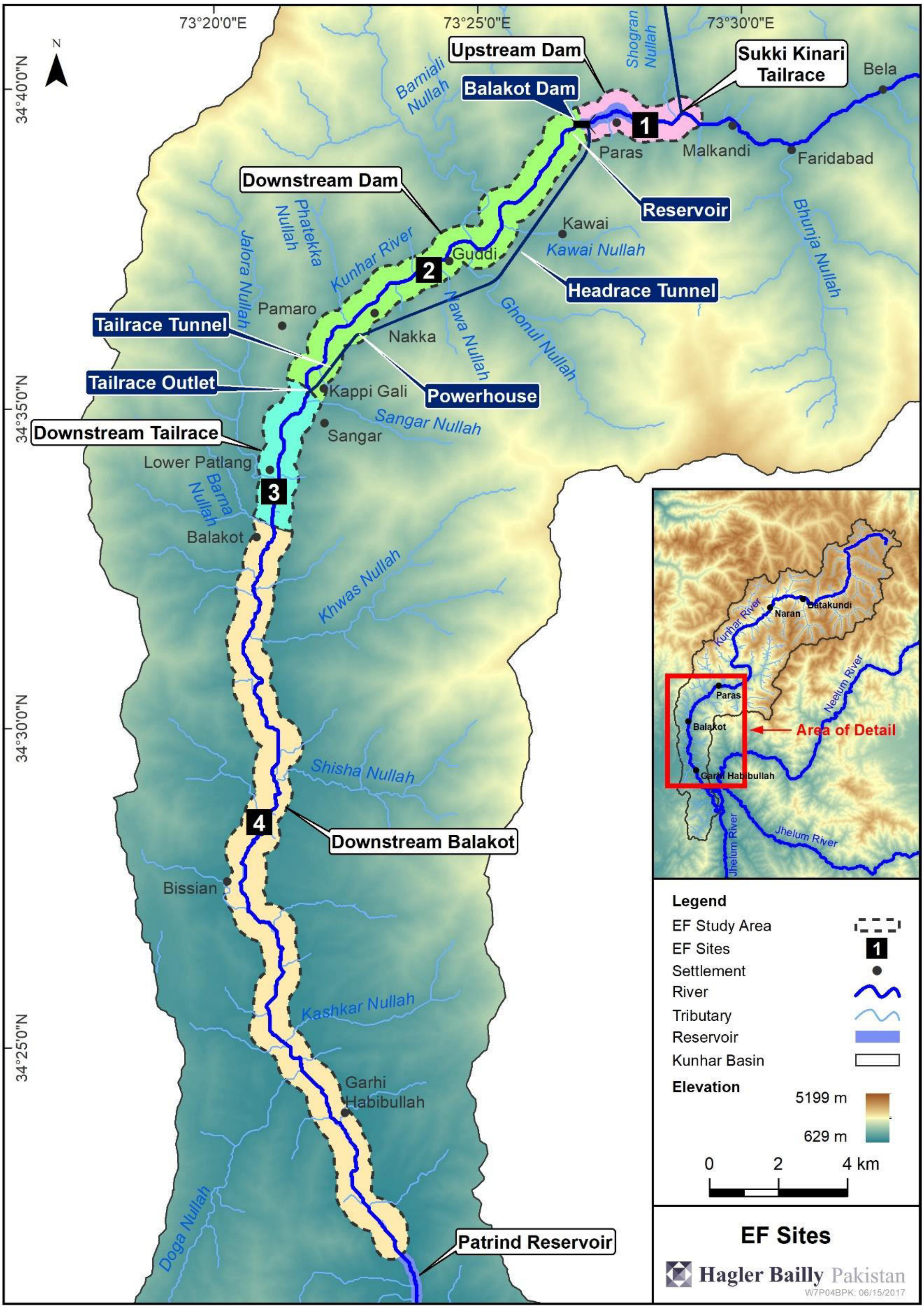
An EFlow assessment site ('EF Site') represent a river reach that is sufficiently uniform that it can reasonably be represented by a single site. The sites are selected to characterize the present flow regimes, and that would best describe future changes due to construction and operation of the Project. DRIFT model results are presented for each EFlow Site. Each section of river or reach discussed in the catchment delineation was represented by an EFlow Site. While the site represents the entire reach, hydraulics and hydrology are determined based on the specific location of the site. **Exhibit 2.2** provides the coordinates of the selected EF sites.

Exhibit 2.2: Selected EFlow Sites for Project EF Assessment

Site ID	*Site Name*	*Location*	*Coordinates*
EF Site 1	Upstream Dam	From SKHPP tailrace to mouth of Project dam	73° 28' 13.6" E 34° 39' 36.3" N
EF Site 2	Downstream Dam	From Project dam to tailrace outlet	73° 24' 09.7" E 34° 37' 17.0" N
EF Site 3	Downstream Tailrace	From Project tailrace outlet to Balakot town	73° 21' 18.0" E 34° 33' 46.6" N
EF Site 4	Downstream Balakot	From Balakot town to mouth of PHPP reservoir.	73° 21' 07.0" E 34° 28' 35.7" N

The map of the Study Area and the location of the EF Sites used in this assessment area **Exhibit 2.3.**

Exhibit 2.3: EFlow Study Area and EF Sites



3. Assessment Scenarios

Assessment scenarios consist of a combination of flow scenarios (determined by the HPP operation including flow diversion and peaking) and management scenarios (determined by the level of human pressures on the river such as fishing, sediment mining and nutrient enrichment).

3.1 Flow Scenarios

Baseline hydrology was established through gauging data from Garhi Habibullah and Talhata gauging stations as described in **Appendix B**. The record is based on measured data from 1960 to 2010. The historical record is used as a 51 year daily flow future projection to account for natural variations in the flow regime.

For Project operational scenarios both baseload and peaking operations were considered. EFlow release was varied at 20%, 35% and 50% of the minimum 5 day dry season flow[5] of 17.4 m^3/s along with the EFlow release of 1.5 m^3/s as suggested in the feasibility study. Operational scenarios are summarized in **Exhibit 3.1** and provided an ID based on whether the scenario has baseload (B) or peaking (P) operation. Details on the calculation of the hydrological time series resulting from the operational flow scenarios is presented in **Appendix B.**

Exhibit 3.1: Project Dam Operational Scenarios and IDs

Environmental Flow Release	*Scenario ID*	
	Baseload	*Peaking*
1.5 m^3/s	B1	P1
3.5 m^3/s	B3	–
4.5 m^3/s	B4	P4
6.1 m^3/s	B6	P6

'– ': scenario was not assessed

3.2 Management Scenarios

Anthropogenic pressures on the Kunhar River, which impact the selected indicators include the following:

1. Selective fishing pressure,
2. Non-selective fishing pressure,
3. Sediment mining:
4. Nutrient enrichment:

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[5] Min 5 day dry season flow is calculated by DRIFT. It calculates the median value of a running 5 day average over the 51 year record.

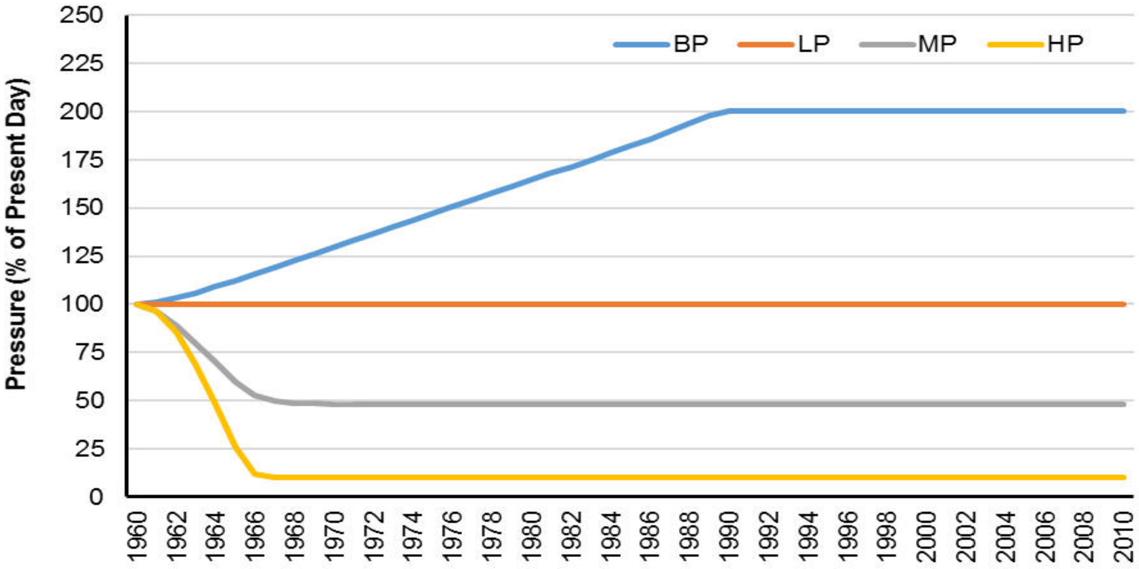
5. Tree cutting:

Four management scenarios, which represent the predicted river condition in 51 years[6] under different levels of protection/management were considered. The protection levels considered were:

- **Business as Usual Protection (BAU):** increase non-flow-related pressures[7] in line with current trends, i.e. 2017 pressures double in intensity over the next 51 years.
- **Low Protection (LP):** maintain 2017 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time.
- **Moderate Protection (MP):** reduce 2017 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2017) over time.
- **High Protection (HP)**: reduce 2017 levels of non-flow-related pressures by 90%, i.e., decline in pressures (relative to 2017) over time[8].

Exhibit 3.2 shows how the pressure levels are operationalized. For higher protection scenarios (MP and HP) the pressures reach their target levels in 5 years (the estimated time to which the institutional and logistical arrangements are effective) whereas the low protection scenario that represents an increase in pressures (due to population growth, increased commercialization of fishing and mining etc.) take 30 years to reach their target levels.

Exhibit 3.2: Pressure Levels over Time as Incorporated into DRIFT



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[6] This is the length of the historical hydrological record that was used in the assessment.

[7] The non-flow related pressures and the management actions proposed to reduce them are discussed in **Section 3.2**.

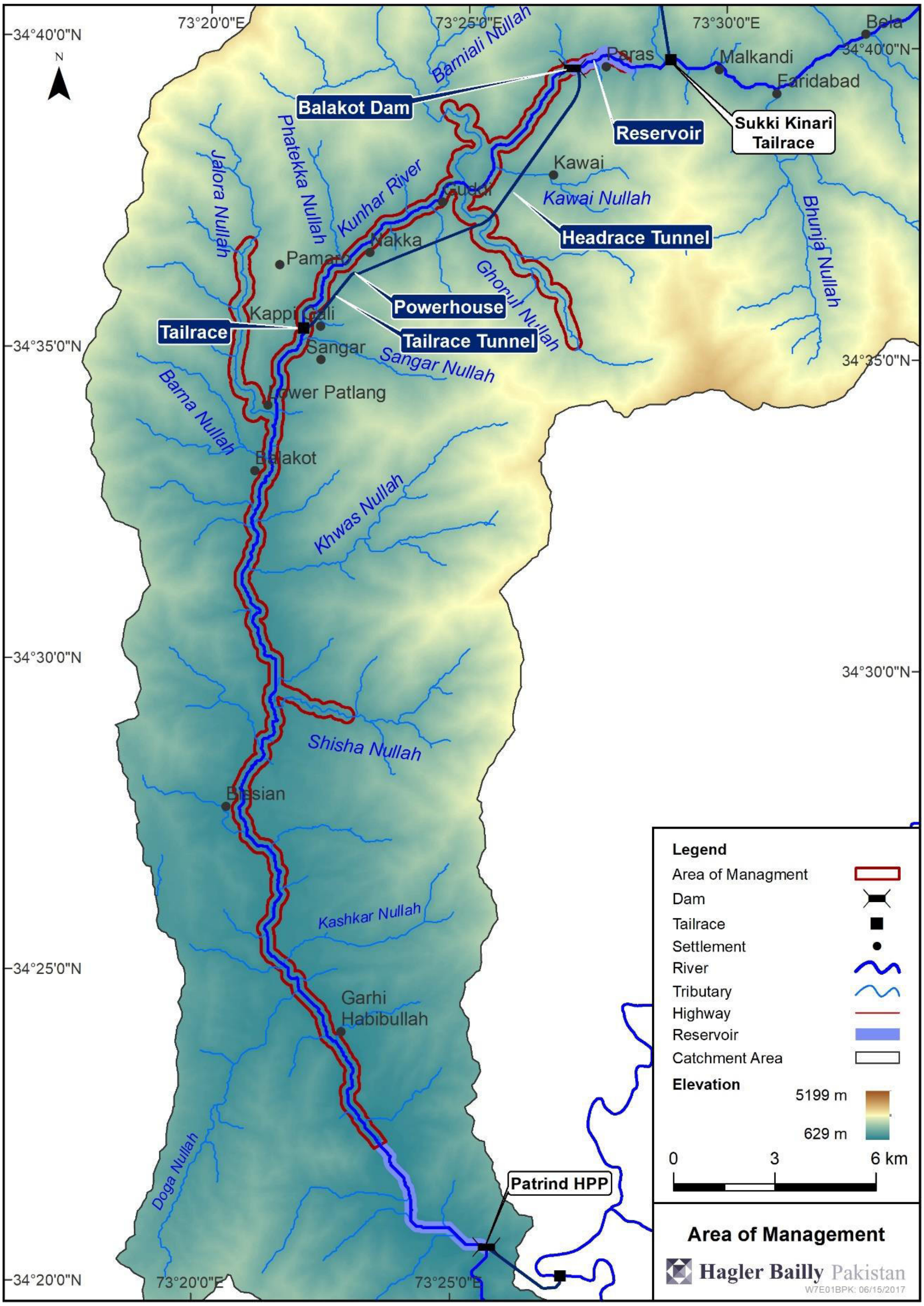
[8] Experience in neighboring rivers has shown that it is easier to impose a complete ban on activities such as illegal fishing and mining than it is to reduce these activities by half.

The Project will implement protection measures in its Area of Management as described in the BAP (see **Volume 2C** of the **EIA**) The Area of Management (see **Exhibit 3.3**) includes the Project reservoir and the section of the Kunhar River down to the next reservoir, which is that of the PHPP. The Area of Management also includes segments of the Barniali Ghonul, Jalora, and Shisha Nullahs, however these are not included in the quantitative assessment. Protection of these nullahs will provide additional benefit over and above that presented in this assessment.

The measures required for achieving protection levels (see the BAP in **Volume 2C** for details) and briefly described below:

- For sand and gravel mining, these levels of protection could be achieved through redirecting mining activities to the coarse sediments trapped in the backup (drop) zone of the weirs, and restricting the collection of sediment for commercial uses at other sensitive sites.
- For fishing, the levels of protection could be achieved through banning (and policing) all non-selective fishing, which could result in an 80-90% reduction in these activities. Fishing pressure could also be reduced by redirecting some of the selective fishing to the reservoir. In some cases though, additional protection measures will be needed simply to maintain current levels of use.
- For nutrients, these levels of protection could be achieved through the construction and operation of sewage effluent treatment plants, and other means of reducing the inflow of raw sewage into the rivers.
- For cutting trees the existing levels of protection are quite high and current measures in place can be further enhanced.

Exhibit 3.3: Area of Management for Project BAP



3.3 Combined Scenarios for Eflow Assessment

3.3.1 Baseline Scenarios

Three dynamic baselines scenarios are established that take into account the existing anthropogenic pressures on the aquatic ecosystem. These are described in **Exhibit 3.4**.

Exhibit 3.4: Baseline Scenarios

Scenario ID	*Flow Scenario*	*Protection Scenario*	*Explanation*
BaseBAU	Baseline hydrology	Business as usual protection	Currently there are only a few fishing guards protecting the stretch of the Kunhar River in the Study Area. Non-selective fishing techniques such as poisons and explosives are also practiced. Future growth in both the local and tourist populations are expected to increase fishing and mining pressures on the river. Easy access to the river is available in large parts of the basin.
BaseLP	Baseline hydrology	Low Protection	This is a conservative baseline as it stabilizes pressures to current day levels. Measures taken by the government, NGOs or other organizations could improve protection and stabilize it to current levels.
BaseMP	Baseline hydrology	Moderate Protection	A moderate protection baseline is highly unlikely given current trends. However, this baseline represents the possible state of the river in the presence of protection and in the absence of a HPP in the reach.

3.3.2 Impact Assessment Scenarios

Impact assessment scenarios considered in this assessment, which are a combination of protection and flow scenarios, are presented in **Exhibit 3.5**.

Exhibit 3.5: Impact Assessment Scenarios and IDs

Dam Operation Type		*Baseload Operation (B)*				*Peaking Operation (P)*		
Environmental Flow m³/s Release		*1.5 (B1)*	*3.5 (B3)*	*4.5 (B4)*	*6.1 (B6)*	*1.5 (P1)*	*4.5 (P4)*	*6.1 (P6)*
Protection Level	Business as Usual (BAU)	–	B3BAU	–	–	–	–	–
	Low Protection (LP)	–	B3LP	–	–	–	–	–
	Moderate Protection (HP)	–	B3MP	–	–	–	–	–
	High Protection (HP)	B1HP	B3HP	B4HP	B6HP	P1HP	P4HP	P6HP

‘– ‘: scenario was not assessed

4. DRIFT Indicators and Inputs

This section provides an overview of the DRIFT DSS and its configuration specific to this assessment. Background on DRIFT and general methodology of the model is presented in **Appendix A**.

4.1 List of Indicators

The indicators for each specialist discipline used in the DRIFT DSS are given in **Exhibit 4.1**. Although a larger set of hydrology indicators is calculated by DRIFT only those linked to indicators from other disciplines through response curves are presented in the exhibit. Management indicators were added to allow the evaluation of non-HPP related impacts and are listed in the Exhibit and detailed in **Section 3.2**.

Exhibit 4.1: Discipline indicators used in the DRIFT DSS

Discipline	*Indicators*	*Reason for selection as indicators*
Hydrology	The hydrology and hydraulic indicators are used only as drivers of change in other aspects of the river ecosystem. They are reported in the results only to provide context for and understanding about the ecosystem responses. They are not used for any of the summary information on ecosystem integrity.	
	Mean annual runoff	Gives an indication of annual abstraction/addition of water, if any.
	Dry season minimum 5-day discharge	Dry season minimum 5-day flows are used as a surrogate for the lowest flows in the dry season
	Dry season onset	Onset and duration of seasons: ▶ link with climatic factors ▶ cues fruiting and flowering ▶ cues migration/breeding ▶ support life-history patterns.
	Dry season duration	The dry season is typically the harshest season for aquatic life to survive. This is the time when flows are low, water quality influences potentially stronger and temperatures (either hot or cold) are most challenging. Increases in the duration of this harsh period can have significant influence on overall chances of survival.
	Dry season average daily volume	Dry periods ▶ promote in-channel growth ▶ support larval stages ▶ maintain intra-annual variability.

Discipline	*Indicators*	*Reason for selection as indicators*
	Wet season onset	Onset and duration of seasons: ▶ link with climatic factors ▶ cues fruiting and flowering ▶ cues migration/breeding ▶ support life-history patterns.
	Wet season duration	Important for supporting life-stages, such as hatching and growth of young. The wet season is also when most erosion and deposition occurs due to the higher shear stress and sediment loads in the river.
	Wet season flood volume	Floods: ▶ dictate channel form ▶ flush and deposit sediment and debris ▶ promotes habitat diversity ▶ support floodplains ▶ distribute seeds ▶ facilitate connectivity ▶ control terrestrial encroachment.
	Within-day range in discharge: Wet, transition and dry seasons	Changes in water level over short periods are important for a number of reasons: ▶ the shear stress changes rapidly as flow rate changes affecting both the water surface slope and the depth of the river. Thus conditions, for erosion but also for animals and plants, change rapidly over this time, often to a point where they can no longer maintain their position in the channel, resulting is wash-aways. ▶ rapid decreases flow can also lead to stranding of animals as flows recede from and area quicker than the animals can respond. ▶ as water levels decrease, riverbanks may not drain as quickly as the river recedes, leading to an over pressuring within the banks that reduces bank stability. Flow changes in the dry and transition seasons are included as this when water resource infrastructure has the potential to exert a large effect on water-level fluctuations. During the wet season, water level changes associated with infrastructure tend to be muted by unregulated inflows. Note: In some cases maximum instantaneous discharge is used as a driving indicator instead of daily range – but the reasons for using it remain similar to those above.

Discipline	*Indicators*	*Reason for selection as indicators*
	Transition 1/2 average daily volume	Dry-wet-dry transitions: ▶ distribute sediments and nutrients flushed from the watershed ▶ distribute seeds ▶ support migration of adults and larvae
	Transition 2 recession shape	Transition 2 recession shape refers to the speed at which the flows change from wet season flows to dry season flows. Under natural conditions this is usually a relatively gentle transition, but this can change with impoundments. If it is a very quick transition then there can be issue of bank collapse and/or stranding similar to those described for 'within-day range in discharge'.
Hydraulics	Minimum 5-day dry season hydraulic habitat	Fish breeding habitat was the number of meters of the cross-section where depth is between 0.25 and 0.5 m, and velocity is between 0.1 and 0.7 m^3s^{-1}. These are important habitat depth and velocity ranges for Mahaseer, but also for the smaller fish.
	Depth	Water depth and velocity are key defining variables for aquatic habitat. They also dictate shear-stress, which partly controls erosion and deposition.
	Average velocity	
Geomorphology	The geomorphology indicators represent habitat quality and diversity, and as such provide the basis for biodiversity. "Habitat is defined as a terrestrial, freshwater, or marine geographical unit or airway that supports assemblages of living organisms and their interactions with the non-living environment" (IFC Performance Standard 6).	
	Active channel width	The active channel is the width of the bankful discharge channel and is a useful indicator channel capacity/size. The Jhelum channel is relatively robust, but small changes in width can be expected due to alterations of flood size and sediment inputs.
	Exposed sand and gravel bars	The availability of exposed bar habitat is included as a geomorphic indicator because it provides important habitat for vegetation, herpetofauna and birds in the dry season, and fish and invertebrates in the wet season. These bars are also targeted by humans for sediment extraction from the river.
	Exposed cobble and boulder bars	
	Median bed sediment size (armouring)	The average bed material sediment grain size is included as a geomorphic indicator due to its importance to ecological processes. The grain-size distribution of bed materials will determine the type(s) of habitat that will exist and be available for aquatic or riparian organisms to occupy or exploit, and shifts in the grain-size distribution will translate into a change in habitat availability and quality. The dry season is targeted for this indicator as this is the season that is most relevant to ecological processes.

Discipline	*Indicators*	*Reason for selection as indicators*
	Depth of pools	Pools are important geomorphic features, providing shelter, refuge and (in some cases) spawning habitat for a variety of fish and other species. The depth of pools indicates the extent of low flow/drought instream habitat refugia.
	Area of secondary channels and backwaters	Secondary channels and backwaters represent important instream habitats and offer refugia during high flow conditions and safety from predation for young. They are also often preferred breeding areas.
	Suspended sediment load	Suspended sediment load is included as a geomorphic indicator because it affects a range of aquatic functions, including: ▶ rate of erosion/deposition (and hence habitats) ▶ light penetration (and hence plant growth) ▶ visibility (both hunting and hiding) ▶ physical effects, such as clogging or gills.
Water quality	Concentration of sewage in the river in the dry season	Most sewage in the valley is discharged untreated into the rivers. Thus, dilution of sewage is an important factor in aquatic ecosystem health and concentration of nutrients. This is particularly so for the rivers in an immediately downstream of Balakot.
	Temperature	Temperature is an important environmental variable for fish and invertebrates. It has a knock-on effect on dissolved oxygen and toxic substances.
	Conductivity	Electrical conductivity is an important “system variable” which indicates the concentration of dissolved salts, potentially indicating impacts from mining, irrigation return-flows and urban/industrial development.
Algae	% Filamentous algae	Algae provide food for instream fauna (fish and invertebrates) and affect habitat quality. Algal growth is favored by reduced water depth and velocity. Higher flows and floods tend to scour the indicator. Changes in nutrient supply and light penetration also have a major impact on algal growth, and as such it is an important indicator of environmental change in its own right. Filamentous algae increase with increase in bed stability and a reduction in flood frequency. This is because filamentous taxa can outcompete single celled taxa under stable conditions. Chl a biomass tends to increase with bed stability and a reduction in flood frequency (assuming nutrients are not limiting).
	Chl a biomass.	
Riparian vegetation	Width of marginal zone	Marginal zone trees are important for bank stabilization, flood attenuation and provide overhanging shelter to instream fauna, particularly fish.
	Recruitment of marginal zone vegetation	

Discipline	*Indicators*	*Reason for selection as indicators*
Macro-invertebrates	Invertebrates constitute an important component of biodiversity, and invertebrate diversity is a useful indicator of environmental stress. They are also a vital food source for fish, birds and aquatic and semi-aquatic vertebrates	
	EPT abundance	Ephemeroptera, Plecoptera and Tricoptera are a commonly used grouping of invertebrates used as indicators for good water or habitat quality that tend to respond in a similar manner to changes in discharge and/or sediment supply.
	EPT diversity	
Fish	The fish indicators were chosen on the basis of survey results and stakeholder consultations.	
	Alwan Snow Trout	The fish has is vulnerable status and its population is decreasing due to introduction of exotics, damming of the rivers and overfishing. It is migrates to different parts of the Neelum, Jhelum and Kunhar rivers during winter and summer seasons depending upon the seasonal temperature changes and is therefore prone to impacts as a result of any change in temperature regime, flow patterns and damming. It is common fish and any change in population due to environmental factors, can be easily assessed. It is the main large-sized economically important fish that is also marketed in the area during the summer season. It is listed as Vulnerable in the IUCN Red Data List.
	Kashmir Hillstream Loach	It is an endemic fish only found in the Neelum, Jhelum and Kunhar rivers. It is mainly a cold-water fish and a carnivore.
	Nalbant Loach	A carnivore, the feeds on aquatic insect larvae and its eggs and young ones are preyed upon by other carnivorous fishes. It is an endemic fish. It is socially-important as an aquarium fish.
	Rainbow Trout	The rainbow trout is an introduced species which has commercial importance. It is bred in fish farms and stocked into the river.
Management	Details for the following management indicators are presented in **Section 3.2**: ▶ Fishing pressure – selective ▶ Fishing pressure – non selective ▶ Mining – sand and gravel ▶ Mining – boulders and cobbles ▶ Nutrient enrichment ▶ Tree cutting	

4.2 Hydrology Data

51 year daily baseline hydrology was established through gauging data from Garhi Habibullah and Talhata gauging stations. The record is based on measured data from

1960 to 2010. The hydrological modelling underlying the generation of flow scenarios is explained in the Reservoir Operations Modelling report in **Appendix B**.

4.3 Hydraulic Data

Topographic cross section survey data of at the EF Sites were used to model the hydraulics of the sites and the fish hydraulic habitat available over a range of flows. The hydraulic modelling enabled hydraulic indicators to be inserted into the DSS, and which were used to estimate changes in habitat. The data used to calculate the hydraulic indicators are presented in the hydraulics specialist report in **Appendix C**.

4.4 Response Curves

DRIFT predictions are driven by Response Curves that are constructed between every indicator and its linked indicators. The index of response curves used in the DSS and their explanations are provided in **Appendices D**.

4.4.1 Scoring Methodology

The values entered into the Response Curves are known as severity ratings; and are on a continuous scale from -5 (large decrease) to +5 (large increase). These ratings are converted to percentages using the relationships provided in **Exhibit 4.2**. The scale accommodates uncertainty, as each rating encompasses a range of percentages.

For each year of the hydrological record, and for each ecosystem indicator, the severity rating corresponding to the value of a driving indicator is read off its Response Curve and converted to a percentage change. The severity ratings for each driving indicator are then combined to produce an overall change in abundance for each season, which combined provide an indication of how abundance, area or concentration of an indicator is expected to change under the given flow conditions over time, relative to the changes that would have been expected under baseline conditions in the catchment.

Exhibit 4.2: DRIFT Severity Ratings and their Associated Abundance Change

A negative score means a loss in abundance relative to baseline, a positive means a gain

Severity rating	*Severity*	*% Abundance Change*
+5	Critically severe	501% gain up to pest proportions
+4	Severe	251-500% gain
+3	Moderate	68-250% gain
+2	Low	26-67% gain
+1	Negligible	1-25% gain
0	None	no change
-1	Negligible	80-100% retained
-2	Low	60-79% retained
-3	Moderate	40-59% retained
-4	Severe	20-39% retained
-5	Critically severe	0-19% retained includes local extinction

4.4.2 Uncertainty

As discussed briefly in the previous section, there is automatic and fixed level of uncertainty to the DRIFT predictions[9], particularly where these predictions concern a condition that is far removed from the baseline. This reflects uncertainty around the response of the indicators to the flow regime under discussion, uncertainty of their response to the proposed protection measures and inherent difficulties in predicting the future in dynamic systems.

The 90% confidence range is calculated using Hozo *et al.*'s (2005) [10] estimation of sample variance (see formula below). As the difference from the mean in the original full range is not symmetrical about the mean, the 90% confidence range is apportioned according to the original portion of the full range that the upper and lower bounds were, so as to keep the skewness in the 90% confidence limits. This gives the estimated lower and upper 90% confidence limits around the mean and is illustrated in

$$S^2 = \frac{1}{12}\left(\frac{(1 - 2m + b)^2}{4} + (b - a)^2\right)$$

Where

m = median

a = the smallest value (minimum)

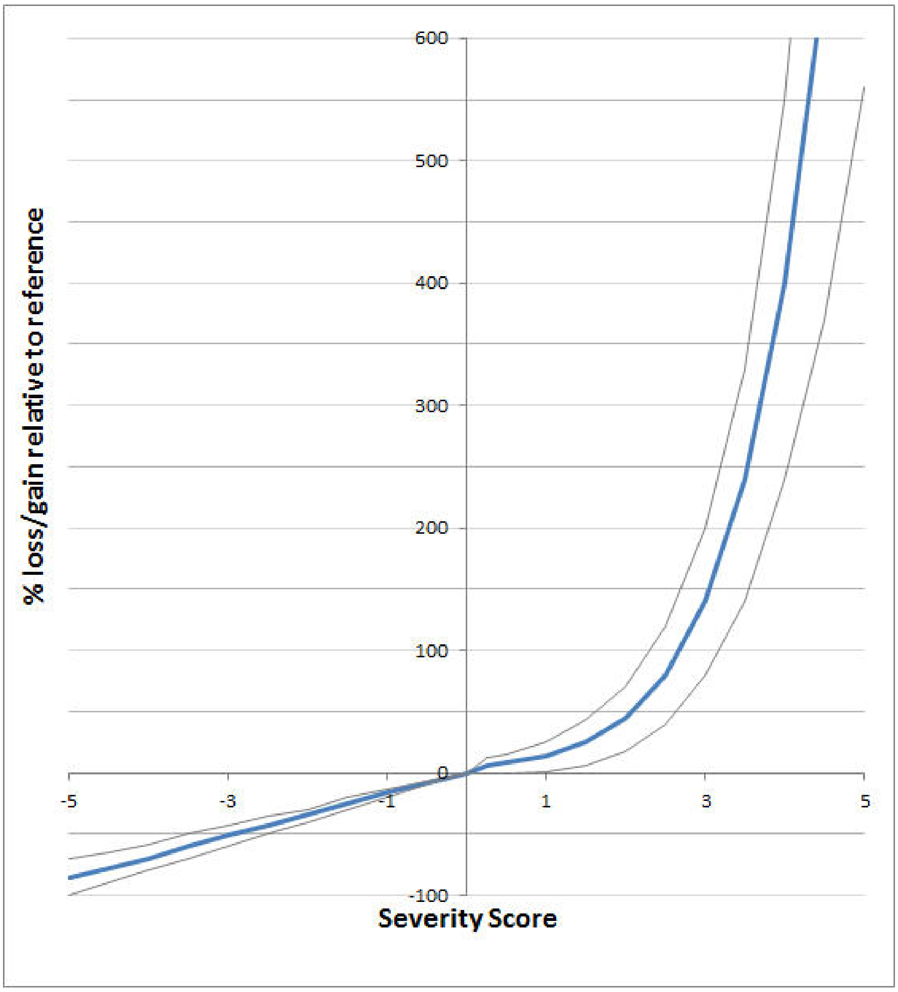
b = the largest value (maximum)

---

[9] There is an option in DRIFT for specialists to increase e the uncertainty above that automatically applied by DRIFT, but this was not used /needed in this assessment.

[10] Hozo, S.P., Djulbegovic, B. and Hozo, I: 2005. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol, 5:13.

Exhibit 4.3: DRIFT Uncertainty Margins



4.5 Barrier Effects

At 78 m, the Project dam and resultant 4.5 km reservoir will present considerable barriers to in-channel movement of abiotic and biotic components of the river ecosystem. The abiotic components, as well as water, include sediments of different sizes (boulders, cobbles, gravel, sand, mud and silt). The biotic components include migrating fish, drifting macroinvertebrates and floating plant seeds. Of these, the following barrier effects were incorporated into the scenarios:

- trapping of bedload and suspended sediments moving down the river (see **Section 4.5.1**); and
- barriers to fish movement between over-wintering areas in the lower parts of the Kunhar River and summering areas in the upper parts of the river and tributaries (e.g., Alwan Snow Trout; see **Section 4.5.2**),

4.5.1 Sediment Trapping and Flushing

Sediment trapping was estimated based on the methodology used in the consolidated DRIFT DSS for the Jhelum Basin (Pakistan)[11] Changes in sediment supply were incorporated using the connectivity function in the DSS. Thus, bedload inflows and suspended-sediment inflows were set at 100% for baseline, and at 75% reduction and 40% reduction respectively in the site downstream of Project (EF Site 2) after the construction of the dam. These values are based on the following assumptions:

- Bedload moving down the Kunhar River will be trapped by the dam, so bed sediment concentration downstream will be reduced. It is likely that with distance downstream of a weir, bed sediment concentration will gradually recover, at least in the short term.
- Suspended sediment will also be trapped by the dam, but to a lesser extent than bed sediments, as the particles are smaller and some will travel through the impoundment and over the dam in flood conditions.

The current operation rules for Project are to flush once or twice a year in flood season, or not at all if sediment inflow is low. The DRIFT DSS as configured for this assessment assumes that sediment flushed in flood season will be carried down and dispersed and will not embed downstream habitat. This is particularly true if sediment is flushed twice in the flood season, as the build-up of sediment will be lower than in situations where sediment is flushed once every few years.

4.5.2 Barrier to Fish Movement

The influence of the Project dam and reservoir on fish populations at the various sites is partially attributable to the barrier effects created by the HPP on the movement of fish between breeding and feeding areas, or between over-wintering and over-summering areas.

For this assessment, migration success was set at 0% for upstream movement and at 5% of downstream movement. This is based on the current understanding that:

- As discussed in the BAP (see **Volume 2C** of the **EIA**), it is not feasible to provide fish passages on the proposed dam. If this situation changes in the future then the migration success in the DSS would need to be adjusted and the scenario rerun.
- Downstream migration of adults and young-of-year will be limited by:
  - the Project impoundment, which will be difficult if not impossible for young-of-year to cross as they rely a current to transport them downstream; and
  - the diversion to the tunnel and powerhouse, which will attract adult fish.

The Alwan Snow Trout is the sole migratory fish to be effected by the Project. The Rainbow Trout, although migratory as well is present upstream of the dam and migrates

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[11] Progress Report, October 2016 *The consolidated DRIFT DSS for the Jhelum Basin,* International Finance Corporation, Hagler Bailly Pakistan and Southern Waters.

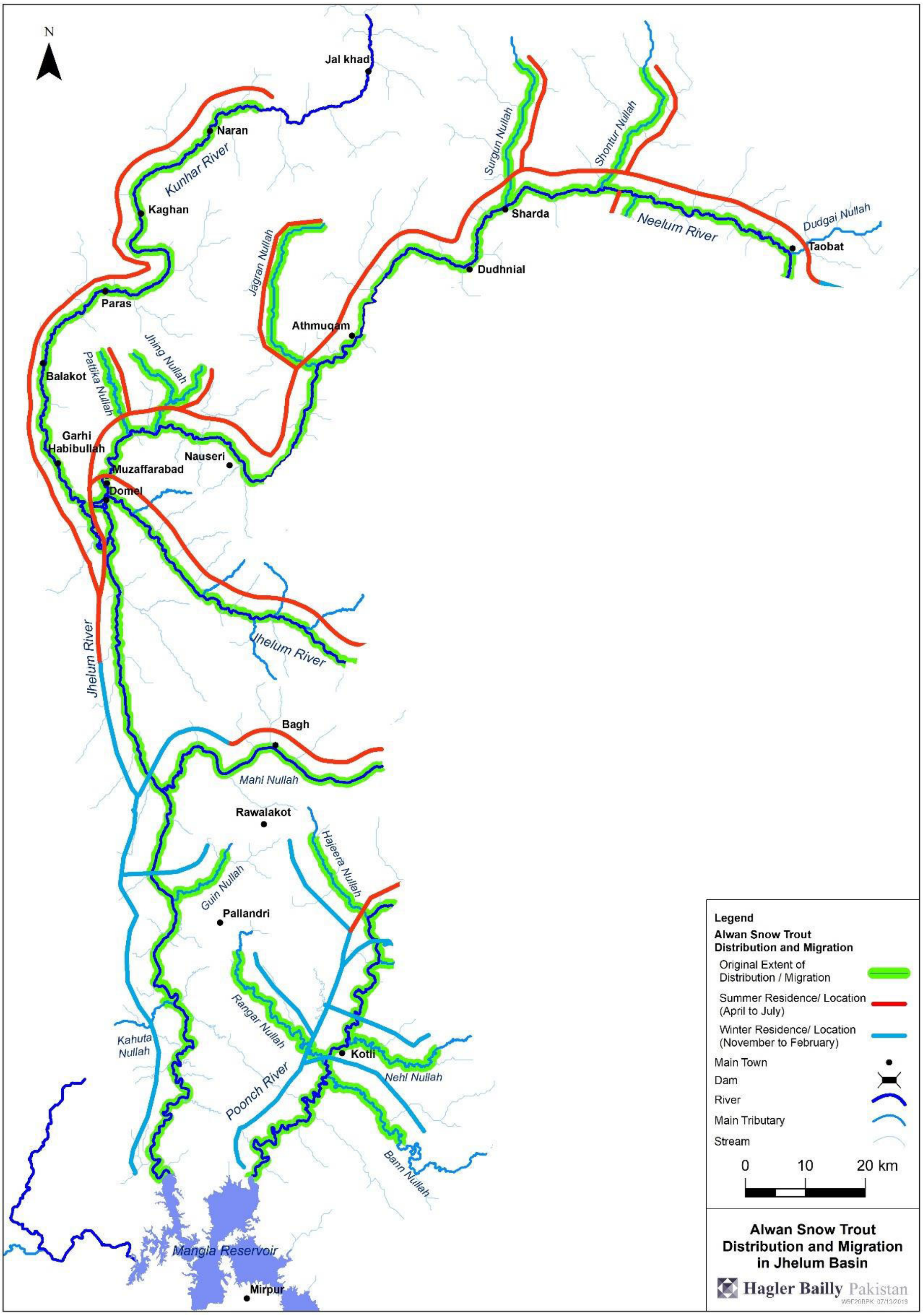
further upstream and therefore its migration will not be effected by the dam. The migratory patterns of the Alwan Snow Trout are discussed further below.

The actual impact on the fish populations is dictated by a combination of migration success and dependence on migration. The Alwan Snow Trout is a cold-water fish with a wide range of temperature tolerances (10-25°C), but a narrower temperature tolerance for breeding (12-18 °C). It migrates up and downstream in the river to avoid temperatures that are either too warm or too cool. They can breed in the main river or in the tributaries but breeding will only occur when temperatures are sufficiently warm. If the fish cannot reach warm enough waters they will not breed. The summer temperature regime for the Kunhar River is provided in **Chapter 4** of the EIA Report. The main breeding areas are in the Kunhar River and in the Lower Neelum River. The migration pathways of the Alwan Snow Trout are presented in **Exhibit 4.4**. As can be seen the Kunhar River is preferred for breeding and not the ideal over wintering location for the Alwan Snow Trout. However, the PHPP has isolated its populations in the Kunhar River.

The estimated current breeding dependence (based on expert opinion, supported by fish and habitat surveys, and temperature measurement) of the Alwan Snow Trout on the three distinct reaches created post the construction of the Project are:

- 5% upstream of SKHPP
- 20% from SKHPP Dam to Project Dam
- 75% from Project Dam to PHPP reservoir

Exhibit 4.4: Alwan Snow Trout Migration Pattern



Source: Hagler Bailly Pakistan, 2017, Draft Report of the Environmental Impact Assessment of Balakot Hydropower Development Project for the Asian Development Bank (ADB)

4.6 Values for Non-Flow Related Indicators

The predicted effects of non-flow related pressures are reflected as Response Curves under each linked indicator. Selective fishing, for instance, will appear as a Response Curve under each fish indicator, its shape reflecting current understanding of the original abundance of the indicator, its present abundance and its expected abundance in 51 years under different protection measures (i.e., predicted end values). The predicted end values are provided in **Exhibit 4.5**.

These values were decided in team consultations, and some explanation of them is provided in **Exhibit 4.6**. Essentially, the relevant experts were asked how the abundance of each indicator has changed (if at all) from its known or predicted condition 51 years ago (considered as the historic baseline) and what have been the main drivers of change. They were also asked what abundance level they would expect it to reach in the future under the protection scenarios (BAU, LP, and MP).

Thus, in **Exhibit 4.5**, the Alwan Snow Trout for instance, is shown as 30% more abundant 51 years ago than at present; and is expected to drop to 20% of its present abundance in 31 years if future trends reflect past trends (protection level BAU). Enhancing protection to LP, however, would see its abundances decline more slowly over the 51 years to 40% of present, while protection at MP would increase abundances to 110% of present.

The values provided are targets only, as the eventual values predicted by the DSS for these indicators depend on the interaction of a multitude of factors, protection level being just one.

To ensure that the DSS results approximate the targets shown in **Exhibit 4.5**, the Response Curves for each non-flow indicator were set at the following values:

BAU = A gradual increase in 2017 pressures from 100% in 2015 to 200% over 30 years and then stable at that level for the next 21 years.

LP = 2017 pressures fixed for the next 51 years.

MP = 2017 pressures halved over the next 5 years and then stable at that level for the next 46 years.

HP = 2017 pressures reduced by 90% over the next 5 years and then stable at that level for the next 46 years[12].

All other indicators were switched on and the DSS calibrated to achieve the target values.

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[12] Experience in neighboring rivers has shown that it is easier to impose a complete ban on activities such as illegal fishing and mining than it is to reduce these activities by half.

Exhibit 4.5: Predicted End Values of Selected Indicators under the Management Options

Business as Usual (BAU), Low Protection (LP), Moderate Protection (MP). High Protection is taken as the values 51 years ago. Present Day is 100%
Black: direct impacts, Grey: affected by knock on effects

Indicator		*Present Ecological State at EF sites*	*51 years ago*	*Predicted Change in 51 years under Management Option*			*Link to Pressures*					
				BAU	*LP*	*MP*	*Fishing Pressure Selective*	*Fishing Pressure Non-selective*	*Mining Sand and Gravel*	*Mining Cobble and Boulder*	*Eutrophication*	*Tree Cutting*
Geomorphology	Active channel width	A	100	110	105	100			■	■		
	Area of silt/mixed deposits	A	100	90	95	100			■	■		
	Area of cobble bars	A	100	80	90	100				■		
	Median bed sediment size (armouring)	A	100	90	93	98			■	■		
	Depth of pools	A	100	95	97	100			■	■		
	Area of 2^{o} channels and backwaters	A	100	85	95	100			■	■		
Water quality	Nutrients in dry season	B	50	200	140	120					■	
	Conductivity	A	100	105	104	102					■	
	Temperature	A	100	100	100	100						
Algae	% Filamentous Algae	A	100	120	110	105				■	▨	
	Chl a biomass	A	100	120	110	105				■	■	
Riparian vegetation	Width of marginal zone	A	100	100	100	100						
	Recruitment of marginal zone vegetation	C	120	100	100	110						■

Indicator		*Present Ecological State at EF sites*	*51 years ago*	*Predicted Change in 51 years under Management Option*			*Link to Pressures*					
				BAU	*LP*	*MP*	*Fishing Pressure Selective*	*Fishing Pressure Non-selective*	*Mining Sand and Gravel*	*Mining Cobble and Boulder*	*Eutrophication*	*Tree Cutting*
Macro-invertebrates	EPT abundance	B	110	85	95	95			▨	▨	▨	
	EPT diversity	A	100	90	93	100			▨	▨	▨	
Fish	Alwan Snow Trout	C	130	20	40	110	■	■	▨	▨	▨	
	Kashmir Hillstream Loach	B	110	30	50	105		■	▨	▨	▨	
	Nalbant Loach	B	110	45	75	105		■	▨	▨	▨	
	Rainbow Trout	A	100	100	100	100						

Exhibit 4.6: Comments on Trends in Indicators Over time

	Indicator	*Explanation*
Geomorphology	Active channel width	There is a possibility that there may be some channel widening associated with cobble bar removal/mining downstream of Balakot.
	Area of silt/mixed deposits	Collection of sediments in Sukki Kinari Dam and other dams upstream in future which will lead to a decline in larger sediment fractions.
	Area of cobble bars	A decline of the bars started 200 years ago (associated with accelerated catchment development and increased mining).
	Median bed sediment size (armouring)	Erosion in the catchment and mining has changed the nature of the bed sediments, probably resulting in some infilling of interstitial spaces. However, this will be somewhat offset by the Sukki Kinari and other upstream HPPs.
	Depth of pools	Possibly a minor decrease in pool depth as a result of mining activities in the last 10-20 years downstream of Balakot town.
	Area of secondary channels and backwaters	Possibly a very minor decrease in secondary channels as a result of a reduction in channel width and loss of cobble bars.
Water quality	Nutrients in dry season	Nutrients form detergents, fertilizers and waste from a rapidly-growing population in the area. Nutrient concentrations are expected to increase above baseline rates even at half of today’s nutrient loading rates.
	Conductivity	There are no major sources of industrial effluent in the area. Nutrients loadings are not expected to be high enough to impact conductivity.
	Temperature	Management impacts are unlikely to affect temperature.
Algae	% Filamentous Algae	There is not a significant population of algae in the main river but there can be substantial stands in the nullahs. The quality of the algae will deteriorate due to an increase in turbidity and impacts due to cobble mining.
	Chl. a biomass	Chl a biomass follows trends in algae and so the same trends are predicted.
Riparian vegetation	Width of marginal zone	This may have changed slightly in line with channel widening but is unlikely to have been significant.
	Recruitment of marginal zone vegetation	There is significant protection of trees in KPK by government departments

	Indicator	*Explanation*
Macro-invertebrates	EPT abundance	Possible minor decreases related to increased nutrients in the river. But this is also negatively affected by non-selective fishing activities such as blasting and poisoning.
	EPT diversity	EPT diversity is not expected to change with this scale of impacts as diversity is relatively resilient.
Fish	Alwan snow trout	Alwan Snow Trout is the major food fish in the Himalayas. It is under severe fishing pressure in the region and is also being affected by other anthropogenic influences. Its distribution is estimated to have declined by more than 90% in some areas with an overall reduction of 50% over the last 5-10 years www.iucnredlist.org (as assessed in 2010). Main threats for the species include: ▶ Overfishing for commercial use in hotels/ restaurants: it is one of the most popular fish for eating. The Kunhar River is a popular tourist location with many established restaurants serving fresh fish to visitors/tourists. Use of gill nets is now a common practice in the Jhelum River. The fish is easily available from local poachers at nominal cost and fishing pressures are expanding with increasing population and joblessness in the area. ▶ Destruction of breeding and feeding habitat and nursery grounds due to sand, gravel and stone mining due to poor enforcement of existing conservation laws. ▶ Fish mortality due to non-selective fishing methods (e.g., use of dynamite, electric currents and poisons). ▶ Introduction of exotic fish species like Brown Trout and Rainbow Trout which feed on the eggs, fries and fingerlings of this species.
	Kashmir Hillstream loach	Kashmir Hillstream Loach has a limited range and is endemic to the Upper Jhelum Basin, which includes the Kunhar, Neelum and upper Jhelum rivers. Main threats for the species include: ▶ Destruction of breeding and feeding habitat and nursery grounds due to sand, gravel and stone mining. ▶ Lack of sand-mining regulations/laws/rules and poor enforcement of existing conservation laws. ▶ Fish mortality due to non-selective fishing methods like use of dynamite, electric currents and poisons. ▶ Introduction of exotic fish species like Brown Trout and Rainbow Trout which feed on the eggs, fries and fingerlings of this species.
	Nalbant loach	The impacts are similar to the Kashmir Hillstream Loach. However, this fish has a large population and is present in the tributaries. Furthermore, it has a small size and a high survivability. These factors combined result in less of an impact to the Nalbant's Loach than on the Kashmir Hillstream Loach.
	Rainbow Trout	This is a non-native fish stocked into the river each year and permits are issued for its fishing. As populations are determined by the level of stocking these can be maintained at present levels due to the high commercial demand.

5. Biophysical Outputs

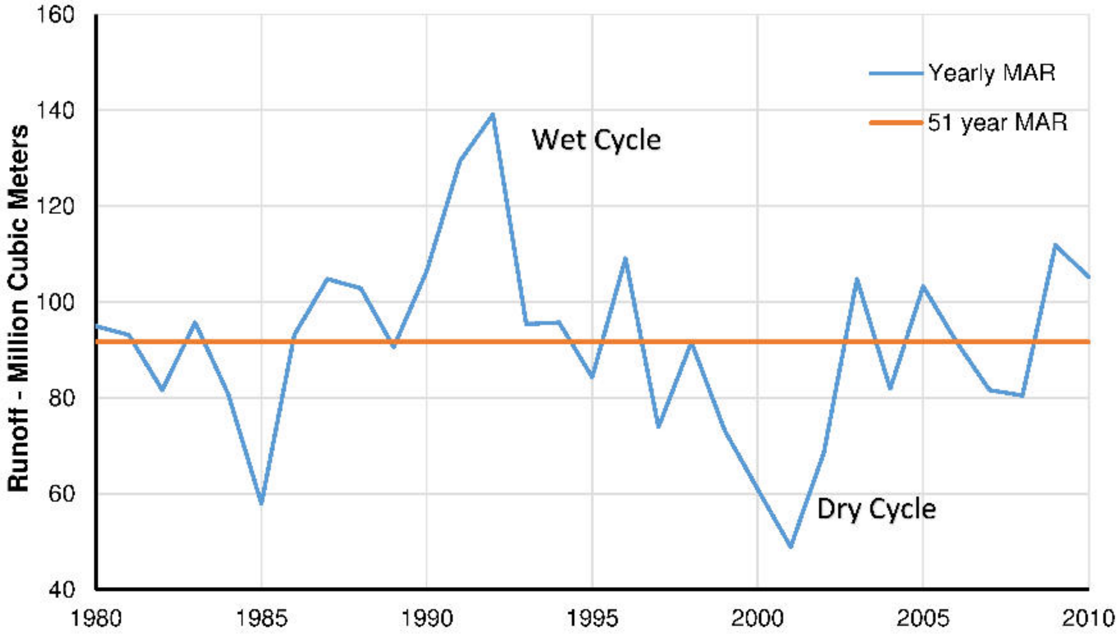
This section lists the biophysical results from the DRIFT model. Analysis of results are presented in the next section.

5.1 Reporting Methodology

For each scenario, the predicted changes in the river ecosystem are evaluated per site as the estimated mean percentage change from baseline in the abundance, area or concentration of key indicators.

These predictions for the estimated mean percentage change from baseline in the abundance are reported as an average for the last 20 years of the 51 year hydrological record. The 20-year period was selected it includes a wet and dry period in the record (see **Exhibit 5.1**), and a slight recovery towards the end of the record (2006-2010).

Exhibit 5.1: Mean Annual Runoff EF Site 2 (Downstream of Dam)



5.2 Biophysical Results

The main characteristics of the flow regimes associated with each of the scenarios are presented in **Exhibit 5.2** for EF Sites 1 and 2 and in **Exhibit 5.3** for EF Sites 3 and 4.

The biophysical results for each site are presented in **Exhibit 5.4** to **Exhibit 5.7**.

- **EF Site 1 Upstream of Dam**

The river section represented by EF Site 1 starts from the SKHPP tailrace and goes up till the Project dam. The reductions in fish populations are predicted mainly due to the barrier effect of Project as the modelled hydrology is assumed to be the same as before the Project.

▶ EF Site 2 Downstream of Dam

This site represents the low flow section between the dam and the tailrace of the Project. There will be large changes as a result of the Project to the hydrology of this site with large reductions in mean annual runoff, mean flood peak and mean flood volume due to the flow diversion. This change in flow also will result in a longer dry season and shorter wet season in this section.

There will be an increase in algae as the low flows result in less dilution of nutrients in this section. There will also be a corresponding decrease in macroinvertebrate abundance. The low flows also reduce the area of secondary channels and backwaters. Due to these impacts the Kashmir Hillstream Loach is most affected followed by the Nalbant’s Loach. The Alwan Snow Trout is further affected by the blockage of connectivity upstream and conditions downstream due to its migratory behavior. The Rainbow Trout is stocked by the Fisheries Department, KP and is fished using permits issued by the Fisheries Department, KP.

▶ EF Site 3 and 4 Downstream of Tailrace and Downstream of Balakot

The baseload scenario downstream of the tailrace and downstream of Balakot closely approximates the baseline hydrology. Therefore, increase in protection increases the fish abundance in these sections.

In the peaking scenario there are sharp changes to the hydrology. The dry season minimum flow goes down from 17 m^3/s to between 3 and 9 m^3/s depending on the environmental flow release. Furthermore the dry season max daily flow goes up to between 161 to 170 m^3/s for a large daily range in flows. These flows are very harmful to fish that are less active during the winter or are over wintering in pools and crevices and are flushed downstream. Therefore, large declines in fish abundance in the peaking scenarios are observed.

Exhibit 5.2: Hydrology Indicators EF Site 1 and 2

Red: greater than 70% change from baseline, Orange 40% to 70% change from the baseline. Where baseline values are 0 shading is based on expert judgement of severity

		EF Site 1	*EF Site 2*						
	Units	*All*	*Baseline*	*B1*	*B4.*	*B6*	*P1*	*P4*	*P6*
Mean Annual Runoff	m^3/s	82	92	22	26	28	22	24	26
Mean flood peak	m^3/s	296	330	174	175	175	174	175	175
Mean flood volume	Mm^3	1892	2135	346	344	344	346	344	344
Dry Season									
Dry season onset	calendar week	39	39	29	29	29	29	29	29
Dry season relative onset	weeks	0.00	0.00	-10	-10	-10	-10	-10	-10
Dry season duration	days	183	180	304	309	309	304	304	304

		EF Site 1	*EF Site 2*						
	Units	*All*	*Baseline*	*B1*	*B4.*	*B6*	*P1*	*P4*	*P6*
Dry season avg. daily volume	Mm^3/d	2.3	2.5	0.7	1.1	1.3	0.7	1.0	1.1
Min 5 day dry season flow	m^3/s	15.6	17.6	2.9	6.3	8.0	2.9	5.9	7.5
Min 5 day dry season velocity	m/s	1.3	1.5	1.3	1.2	1.2	1.3	1.2	1.2
Min 5 day dry season Hydraulic Habitat	m	18.3	14.9	6.3	8.1	10.6	6.3	7.6	9.9
Min 5 day dry season Stage	m	1.6	1.5	0.8	0.9	1.1	0.8	0.9	1.1
Dry season min instantaneous flow	m^3/s	14.9	16.7	2.8	6.2	7.9	2.8	5.8	7.4
Dry season max instantaneous flow	m^3/s	60	64	102	102	105	102	105	106
Dry season max rate of change	m^3/s/min	1	1	69	49	47	69	66	67
Dry season daily range in flow	m^3/s	0.00	0.00	0.11	0.18	0.24	0.11	0.11	0.11
Transition Season (T1)									
T1 avg. daily volume	Mm^3/d	5.6	6.0	6.2	6.8	6.8	6.2	6.6	6.6
T1 min instantaneous flow	m^3/s	47	51	34	56	56	34	51	51
T1 max instantaneous flow	m^3/s	98	105	130	130	130	130	130	130
T1 max rate of change	m^3/s/min	1	1	38	35	33	38	36	36
T1 daily range in flow	m^3/s	0	0	9.95	7.70	7.62	9.95	7.61	7.61
Wet Season									
Wet season onset	calendar week	16	16	22	22	22	22	22	22
Wet season relative onset	weeks	0	0	6.0	6.0	6.0	6.0	6.0	6.0
Wet season duration	days	130	134	31	30	30	31	30	30
Wet season avg daily volume	Mm^3/d	15	16	10	10	10	10	10	10
Flood volume	Mm^3	1953	2164	315	258	258	315	258	258
Max 5 day flood season flow	m^3/s	292	324	170	170	170	170	170	170
Max 5 day flood season velocity	m/s	3.5	3.0	2.6	2.6	2.6	2.6	2.6	2.6
Max 5 day flood season hydraulic habitat	m	35	57	46	46	46	46	46	46
Max 5 day flood season stage	m	4.1	4.4	3.5	3.5	3.5	3.5	3.5	3.5
Min 5 day flood season flow	m^3/s	84	91	77	77	77	77	77	77
Min 5 day flood season velocity	m/s	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1

		EF Site 1	*EF Site 2*						
	Units	*All*	*Baseline*	*B1*	*B4.*	*B6*	*P1*	*P4*	*P6*
Min 5 day flood season Hydraulic Habitat	m	29	33	32	32	32	32	32	32
Min 5 day flood season stage	m	2.6	2.8	2.7	2.7	2.7	2.7	2.7	2.7
Wet season min instantaneous flow	m^3/s	73	80	40	40	40	40	40	40
Wet season max instantaneous flow	m^3/s	331	374	203	198	198	203	198	198
Wet season max rate of change	$m^3/s/min$	3	3	60	60	60	60	58	60
Wet season daily range in flow	m^3/s	0	0	14	14	14	14	14	14
Transition Season (T2)									
T2 recession slope	$m^3/s/d$	-1.2	-1.3	-4.4	-4.1	-4.1	-4.4	-4.1	-4.1
T2 avg. daily volume	Mm^3/d	5.2	5.6	4.0	4.0	4.0	4.0	4.0	4.0
T2 min instantaneous flow	m^3/s	43	47	21	20	20	21	20	20
T2 max instantaneous flow	m^3/s	81	88	58	58	58	58	58	58
T2 max rate of change	$m^3/s/min$	1	0	22	22	22	22	23	22
T2 daily range in flow	m^3/s	0.0	0.0	8.1	8.0	7.9	8.1	8.0	7.9

Exhibit 5.3: Hydrology Indicators EF Site 3 and 4

Red: greater than 70% change from baseline, Orange 40% to 70% change from the baseline.
Where baseline values are 0 shading is based on expert judgement of severity
BX represents all baseload scenarios as they are the same

	Units	*EF Site 3*					*EF Site 4*				
		Base	*BX*	*P1*	*P4*	*P6*	*Base*	*BX*	*P1*	*P4*	*P6*
Mean Annual Runoff	m^3/s	94	94	94	94	94	101	101	101	101	101
Mean flood peak	m^3/s	337	337	337	337	337	363	363	363	363	363
Mean flood volume	Mm^3	2174	2174	2174	2174	2174	2336	2336	2336	2336	2336
Dry Season											
Dry season onset	calendar week	39	39	39	39	39	39	39	39	39	39
Dry season relative onset	weeks	0	0	0	0	0	0	0	0	0	0
Dry season duration	days	181	181	181	182	181	181	181	181	182	181
Dry season avg. daily volume	Mm^3/d	2.6	2.6	2.5	2.6	2.5	2.7	2.7	2.7	2.8	2.7
Min 5 day dry season flow	m^3/s	17.9	17.9	18.0	18.0	18.0	19.3	19.3	19.3	19.3	19.3
Min 5 day dry season velocity	m/s	0.9	0.9	0.9	0.9	0.9	1.3	1.3	1.3	1.3	1.3

	Units	*EF Site 3*					*EF Site 4*				
		Base	*BX*	*P1*	*P4*	*P6*	*Base*	*BX*	*P1*	*P4*	*P6*
Min 5 day dry season Hydraulic Habitat	m	42.9	42.9	42.9	42.9	42.9	21.5	21.5	21.5	21.5	21.5
Min 5 day dry season Stage	m	1.2	1.2	1.2	1.2	1.2	0.9	0.9	0.9	0.9	0.9
Dry season min instantaneous flow	m^3/s	17.0	17.0	3.2	6.2	7.8	18.3	18.3	4.4	7.4	9.0
Dry season max instantaneous flow	m^3/s	67	67	161	164	166	71	71	166	169	170
Dry season max rate of change	$m^3/s/min$	1	1	155	155	155	1	1	155	155	155
Dry season daily range in flow	m^3/s	0	0	88	74	66	0	0	88	74	66
Transition Season (T1)											
T1 avg. daily volume	Mm^3/d	6.3	6.3	6.3	6.3	6.4	6.8	6.8	6.8	6.8	6.9
T1 min instantaneous flow	m^3/s	52	52	8	11	13	56	56	12	16	17
T1 max instantaneous flow	m^3/s	109	109	161	164	166	117	117	166	169	170
T1 max rate of change	m^3/s /min	1	1	154	154	154	1	1	155	155	155
T1 daily range in flow	m^3/s	0.00	0.00	8.79	8.79	8.01	0.00	0.00	9.44	9.44	8.60
Wet Season											
Wet season onset	calendar week	16	16	16	16	16	16	16	16	16	16
Wet season relative onset	weeks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wet season duration	days	133	133	133	133	133	133	133	133	133	133
Wet season avg. daily volume	Mm^3/d	17	17	17	17	17	18	18	18	18	18
Flood volume	Mm^3	2212	2212	2211	2211	2211	2377	2377	2376	2376	2377
Max 5 day flood season flow	m^3/s	331	331	331	331	331	355	355	355	355	355
Max 5 day flood season velocity	m/s	2.6	2.6	2.6	2.6	2.6	2.0	2.0	2.0	2.0	2.0
Max 5 day flood season hydraulic habitat	m	77	77	77	77	77	156	156	156	156	156
Max 5 day flood season stage	m	2.8	2.8	2.8	2.8	2.8	2.6	2.6	2.6	2.6	2.6
Min 5 day flood season flow	m^3/s	94	94	94	94	94	101	101	101	101	101
Min 5 day flood season velocity	m/s	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Min 5 day flood season Hydraulic Habitat	m	69	69	69	69	69	80	80	80	80	80
Min 5 day flood season stage	m	1.9	1.9	1.9	1.9	1.9	1.6	1.6	1.6	1.6	1.6
Wet season min instantaneous flow	m^3/s	82	82	79	79	79	88	88	85	85	85

	Units	*EF Site 3*					*EF Site 4*				
		Base	*BX*	*P1*	*P4*	*P6*	*Base*	*BX*	*P1*	*P4*	*P6*
Wet season max instantaneous flow	m^3/s	382	382	382	382	382	411	411	411	411	411
Wet season max rate of change	m^3/s /min	4	4	91	91	91	4	4	94	97	97
Wet season daily range in flow	m^3/s	0	0	9	9	9	0	0	10	9	9
Transition Season (T2)											
T2 recession slope	$m^3/s/d$	-1.4	-1.4	-1.4	-1.4	-1.4	-1.5	-1.5	-1.5	-1.5	-1.5
T2 avg. daily volume	Mm^3/d	5.8	5.8	5.8	5.8	5.8	6.2	6.2	6.2	6.2	6.2
T2 min instantaneous flow	m^3/s	49	49	47	47	47	52	52	51	51	51
T2 max instantaneous flow	m^3/s	90	90	91	91	91	97	97	98	98	98
T2 max rate of change	$m^3/s/min$	0	0	16	16	16	1	1	18	18	18
T2 daily range in flow	m^3/s	0.0	0.0	2.1	2.1	2.1	0.0	0.0	2.3	2.3	2.3

Exhibit 5.4: Biophysical Results for EF Site 1 (Upstream of Dam)

All figures are predicted percentage changes in population compared to Present Day over a 51 year period
Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Fish														
Alwan Snow Trout	-79.2	-59.8	22.7	44.3	-100.0	-99.7	-75.5	-64.1	-64.1	-64.1	-64.1	-64.1	-64.1	-64.1
Nalbant Loach	-56.2	-26.9	3.7	11.0	-56.8	-27.5	3.0	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Rainbow Trout	-2.2	-1.5	-0.8	0.7	-3.3	-2.6	-2.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Kashmir Hillstream Loach	-73.5	-55.5	1.2	13.7	-75.9	-59.2	-2.4	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Macroinvertebrates														
EPT abundance	-16.7	-7.9	-1.7	7.6	-18.3	-9.6	-3.4	6.0	6.0	6.0	6.0	6.0	6.0	6.0
EPT diversity	-19.1	-5.6	-2.1	5.6	-19.3	-5.8	-2.3	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Marginal Vegetation														
Width of marginal zone	-4.7	-2.6	-0.8	-0.8	-4.5	-2.4	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7
Recruitment of marginal vegetation	-3.6	-1.5	10.6	19.3	-4.5	-2.5	9.6	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Algae														
% Filamentous taxa	24.4	12.4	5.9	-1.6	25.8	13.6	7.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Chl a biomass	18.4	8.6	1.6	-3.4	19.1	9.2	2.2	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
Water Quality														
Conductivity	6.4	5.0	2.3	1.3	7.1	5.8	3.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Nutrient concentration (DRY Season)	99.2	38.6	15.1	-52.7	100.6	39.9	16.5	-51.3	-51.3	-51.3	-51.3	-51.3	-51.3	-51.3
Water temperature	0.9	0.9	0.9	0.9	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Geomorphology														
Active channel width	12.2	6.0	-0.3	-0.3	11.7	5.5	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7	-0.7
Exposed sand and gravel bars	-9.6	-4.2	0.3	0.8	-7.9	-2.5	2.0	2.5	2.5	2.5	2.5	2.5	2.5	2.5

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Median bed sediment size (armouring)	-9.9	-6.4	-0.2	1.3	-10.0	-6.4	-0.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Exposed cobble and boulder bars	-18.9	-10.0	0.7	0.7	-18.3	-9.4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Depth of pools	-5.0	-2.5	-0.6	-0.6	-6.1	-3.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Area of secondary channels, backwaters	-6.9	-4.3	-0.6	-0.6	-8.2	-5.6	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9	-1.9

Exhibit 5.5: Biophysical Results for EF Site 2 (Downstream of Dam)

All figures are predicted percentage changes in population compared to Present Day over a 51 year period
Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Fish														
Alwan Snow Trout	-68.8	-50.2	23.9	41.9	-100.0	-100.0	-78.0	-66.9	-64.8	-62.9	-58.8	-92.2	-89.4	-86.8
Nalbant Loach	-57.6	-26.9	3.8	9.1	-100.0	-94.6	-70.4	-74.7	-64.0	-58.8	-47.5	-75.0	-62.7	-55.5
Kashmir Hillstream Loach	-75.9	-54.8	1.8	11.0	-100.0	-100.0	-97.8	-97.9	-96.0	-94.6	-91.3	-97.8	-95.0	-92.4
Macroinvertebrates														
EPT abundance	-16.1	-7.5	-1.5	7.2	-81.3	-80.0	-77.8	-81.4	-76.4	-73.6	-67.0	-81.5	-75.7	-71.9
EPT diversity	-18.5	-5.6	-2.1	5.2	-37.5	-35.4	-32.8	-32.9	-30.4	-28.3	-22.4	-32.8	-30.6	-28.5
Marginal Vegetation														
Width of marginal zone	-5.0	-2.8	-0.9	-0.9	2.1	2.7	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Recruitment of marginal vegetation	-3.7	-1.5	10.8	20.7	-28.1	-27.5	-16.5	-6.5	-6.5	-6.9	-6.9	-6.5	-6.9	-6.9
Algae														
% Filamentous taxa	20.8	12.0	5.5	-1.4	91.4	87.9	83.3	83.8	81.0	79.2	72.2	83.7	81.2	78.9
Chl a biomass	18.2	8.4	1.4	-3.2	43.9	41.7	37.6	37.4	36.5	35.7	32.7	37.4	36.9	35.9

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Water Quality														
Conductivity	6.1	4.8	2.1	0.8	9.9	8.5	5.8	8.1	4.6	2.6	0.2	8.6	4.8	2.9
Nutrient concentration (DRY Season)	99.0	38.3	15.1	-49.5	314.9	254.2	230.9	209.0	166.4	146.1	116.6	215.2	172.1	148.7
Water temperature	1.4	1.4	1.4	1.4	32.4	32.4	32.4	31.8	32.4	33.0	33.5	31.6	32.4	32.7
Geomorphology														
Active channel width	6.3	12.9	-0.1	-0.1	-17.2	-23.4	-29.7	-29.7	-29.7	-29.7	-29.6	-29.7	-29.7	-29.6
Exposed sand and gravel bars	-3.0	-9.9	0.0	0.5	-1.3	5.1	8.6	14.4	9.1	6.5	2.3	14.8	7.5	3.5
Median bed sediment size (armouring)	-4.9	-7.4	-0.3	-0.3	7.8	10.2	14.9	13.9	14.9	15.4	16.1	13.7	14.8	15.3
Exposed cobble and boulder bars	-10.1	-20.1	0.4	0.4	0.4	10.2	20.9	25.6	20.9	18.6	15.3	26.3	21.5	18.9
Depth of pools	-2.6	-3.9	-0.4	-0.4	-26.0	-24.5	-22.5	-23.0	-22.5	-22.4	-22.1	-23.0	-22.6	-22.4
Area of secondary channels, backwaters	-5.2	-5.9	0.4	0.4	-83.1	-81.7	-76.8	-87.5	-76.8	-71.1	-62.4	-88.2	-73.2	-64.9

Exhibit 5.6: Biophysical Results for EF Site 3 (Downstream of Tailrace)

All figures are predicted percentage changes in population compared to Present Day over a 51 year period
Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Fish														
Alwan Snow Trout	-68.7	-54.0	20.7	42.1	-75.6	-64.9	-1.4	18.6	19.0	19.5	20.4	-73.0	-65.8	-62.1
Nalbant Loach	-56.8	-27.1	3.7	10.0	-55.6	-25.9	5.7	12.0	12.0	12.0	12.0	-31.7	-30.3	-29.6
Kashmir Hillstream Loach	-72.8	-55.0	1.7	11.0	-72.3	-54.4	2.5	11.9	11.9	11.9	11.9	-51.8	-48.5	-47.0
Macroinvertebrates														
EPT abundance	-16.4	-7.8	-1.7	7.2	-14.5	-5.8	1.0	10.0	10.0	10.0	10.0	15.4	15.3	15.3
EPT diversity	-18.8	-5.5	-2.2	5.1	-17.7	-4.4	-1.1	6.3	6.3	6.3	6.3	6.3	6.3	6.3

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Marginal Vegetation														
Width of marginal zone	-4.7	-2.6	-0.8	-0.8	-1.4	-0.2	0.5	0.5	0.5	0.5	0.5	-1.5	-1.5	-1.5
Recruitment of marginal vegetation	-3.6	-1.6	10.6	19.2	-0.3	0.8	11.9	20.5	20.5	20.5	20.5	18.4	18.4	18.4
Algae														
% Filamentous taxa	22.4	11.5	5.9	-0.9	25.5	14.6	8.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Chl a biomass	18.4	8.6	1.6	-3.0	21.4	11.5	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Water Quality														
Conductivity	6.4	5.0	2.3	1.1	1.9	0.5	-2.2	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4
Nutrient concentration (DRY Season)	99.5	38.9	15.6	-49.0	99.5	38.9	15.6	-49.0	-49.0	-49.0	-49.0	-48.8	-48.9	-49.1
Water temperature	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7
Geomorphology														
Active channel width	12.2	6.1	-0.2	-0.2	2.4	-3.8	-10.1	-10.1	-10.1	-10.1	-10.1	2.7	2.6	2.5
Exposed sand and gravel bars	-9.6	-4.2	1.9	0.8	-25.3	-19.9	-13.8	-14.9	-14.9	-14.9	-14.9	-14.8	-14.8	-14.8
Median bed sediment size (armouring)	-7.0	-6.1	0.2	1.6	5.7	6.6	12.8	14.3	14.3	14.3	14.3	38.5	38.4	38.4
Exposed cobble and boulder bars	-18.7	-10.3	0.4	0.4	-22.3	-13.9	-3.2	-3.2	-3.2	-3.2	-3.2	-3.1	-3.1	-3.2
Depth of pools	-4.3	-2.2	-0.2	-0.2	0.8	3.0	4.9	4.9	4.9	4.9	4.9	10.3	10.2	10.2
Area of secondary channels, backwaters	-3.9	-2.5	2.4	2.4	-13.2	-11.8	-6.9	-6.9	-6.9	-6.9	-6.9	10.2	10.0	9.9

Exhibit 5.7: Biophysical Results for EF Site 4 (Downstream of Balakot)

All figures are predicted percentage changes in population compared to Present Day over a 51 year period
Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	BaseBAU	*BaseLP*	*BaseMP*	*BaseHP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Fish														
Alwan Snow Trout	-71.2	-51.6	22.8	42.3	-73.0	-54.4	17.7	36.9	37.0	37.1	37.3	-53.5	-46.7	-43.2
Nalbant Loach	-56.9	-27.3	3.5	9.9	-56.1	-26.3	5.2	11.7	11.7	11.7	11.7	-31.8	-30.3	-29.7
Kashmir Hillstream Loach	-73.9	-56.1	0.0	5.9	-73.3	-55.5	0.8	6.8	6.8	6.8	6.8	-58.4	-55.2	-53.6
Macroinvertebrates														
EPT abundance	-16.3	-7.8	-1.6	7.3	-14.8	-6.1	0.6	9.6	9.6	9.6	9.6	15.0	15.0	14.9
EPT diversity	-18.6	-5.5	-2.2	5.1	-17.9	-4.8	-1.4	5.9	5.9	5.9	5.9	5.9	5.9	6.0
Marginal Vegetation														
Width of marginal zone	-3.9	-2.0	-0.5	-0.5	-2.1	-0.6	0.3	0.3	0.3	0.3	0.3	-2.3	-2.2	-2.2
Recruitment of marginal vegetation	-2.9	-1.0	10.9	19.5	-1.1	0.4	11.7	20.3	20.3	20.3	20.3	17.6	17.7	17.7
Algae														
% Filamentous taxa	21.2	11.5	5.9	-1.0	23.1	13.5	7.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chl a biomass	18.3	8.4	1.4	-3.1	20.2	10.3	3.4	-1.2	-1.2	-1.2	-1.2	-1.1	-1.1	-0.9
Water quality														
Conductivity	6.2	4.9	2.2	0.9	3.2	1.9	-0.8	-2.0	-2.0	-2.0	-2.0	-2.1	-2.1	-2.1
Nutrient concentration (Dry Season)	99.4	38.7	15.5	-49.1	99.4	38.7	15.5	-49.1	-49.1	-49.1	-49.1	-49.3	-49.4	-49.5
Water temperature	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0
Geomorphology														
Active channel width	10.1	3.9	-2.4	-2.4	4.5	-1.7	-8.0	-8.0	-8.0	-8.0	-8.0	4.7	4.6	4.6
Exposed sand and gravel bars	-11.1	-3.5	1.0	1.5	-22.9	-15.2	-10.8	-10.2	-10.2	-10.2	-10.2	-10.1	-10.1	-10.1
Median bed sediment size (armouring)	-6.9	-6.0	0.3	1.7	3.9	4.8	11.0	12.5	12.5	12.5	12.5	36.7	36.6	36.6
Exposed cobble and boulder bars	-18.5	-10.1	0.6	0.6	-21.2	-12.8	-2.1	-2.1	-2.1	-2.1	-2.1	-2.1	-2.2	-2.2
Depth of pools	-4.4	-2.2	-0.3	-0.3	-0.5	1.7	3.6	3.6	3.6	3.6	3.6	9.0	8.9	9.0
Area of secondary channels, backwaters	-7.1	-5.7	-0.8	-0.8	-13.4	-12.0	-7.1	-7.1	-7.1	-7.1	-7.1	-7.0	-7.0	-7.0

6. Analysis of Results

This section presents Net Gain calculations that are used in the BAP (see **Volume 2C** of the **EIA**) to develop biodiversity offsets. It also presents an analysis of impacts of varying management and operational options. A discussion on the impact to power generation, and the overall change to the ecosystem integrity is also discussed.

6.1 Impact of Various Management and Operational Alternatives on Fish Abundance

The impacts on fish species will vary with their habitat requirements, migratory behavior and current pressures on the ecosystem.

6.1.1 Impact of Increasing Protection Levels

Exhibit 6.1 shows the impact of variations in protection levels on fish populations. For illustrative purposes, the impacts are shown for the segment downstream of the tailrace under baseload operation where variations in flow will be minimal, in comparison to the baseline. The barrier effect of the dam on the migratory fish, however, will apply. The following is a summary of observations:

- Under the Business as usual (BAU) Scenario, without the dam in place, the decline in fish populations will average at 66% of present day populations due to pressures related to unregulated fishing and sediment mining whereas the decline is predicted at 45% under the Moderate Protection (MP) baseline.
- After the Project is put in place with Moderate Protection (MP), fish populations will improve by an average of about 70% compared to the BAU baseline and 48% compared to the MP baseline. The increase is expected to be highest for the non-migratory Kashmir Hillstream Loach.
- With High Protection (HP), fish populations are predicted to improve by an average of 80% compared to the BAU Scenario. The increase is expected to be highest for the Alwan Snow Trout at close to an 88% increase over the baseline
- Increasing protection from Moderate Protection to High Protection results in an increase in population by an average of 12%, irrespective of the baseline scenario chosen for comparison.

Exhibit 6.1: Impact of Variation in Protection on Fish Population, Downstream of Tailrace (Baseload Generation with EFlow of 3.5 m^3/s)

Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	Projected Change in Population					
	(% change from Present Day Populations)					
Fish	*Baseline*		*With Project*			
	BAU	*LP*	*B3BAU*	*B3LP*	*B3MP*	*B3HP*
Biophysical Results						
Alwan Snow Trout	-68.7	-54	-75.6	-64.9	-1.4	19.0
Nalbant Loach	-56.8	-27.1	-55.6	-25.9	5.7	12.0
Kashmir Hillstream Loach	-72.8	-55	-72.3	-54.4	2.5	11.9
Average	**-66.1**	**-45.4**	**-67.8**	**-48.4**	**2.3**	**14.3**
Incremental Gain compared to Business as Usual Baseline, %						
Alwan Snow Trout			-6.9	3.8	67.3	87.7
Nalbant Loach			1.2	30.9	62.5	68.8
Kashmir Hillstream Loach			0.5	18.4	75.3	84.7
Average			**-1.7**	**17.7**	**68.4**	**80.4**
Incremental Gain compared to Low Protection Baseline, %						
Alwan Snow Trout			-21.6	-10.9	52.6	73.0
Nalbant Loach			-28.5	1.2	32.8	39.1
Kashmir Hillstream Loach			-17.3	0.6	57.5	66.9
Average			**-22.5**	**-3.0**	**47.6**	**59.7**

6.1.2 Impact of Increasing EFlow

Exhibit 6.2 shows the impact of increasing EFlow on fish species immediately Downstream of the Dam where the impact of lower releases from the dam will be significant. Given the high anthropogenic pressures on the fish, the benefit of EFlow can be realized only if the river is protected. Under Business as Usual the gains due to increasing EFlow are close to 0%. For example, with EFlow of 3.5 m^3/s under BAU all fish indicators show a 100% decline (not shown below, see previous section for BAU results). Therefore, figures in **Exhibit 6.2** are presented for the High Protection scenario in other words, EFlow releases can be considered of little consequence in absence of protection of the river. The following is a summary of observations:

- The Kashmir Hillstream Loach is most affected by the lower flows in the reach downstream of the dam, and decline is predicted at over 90% for the range of EFlows considered. Increasing EFlow also benefits this fish the least.

- The Alwan Snow Trout benefits from the increased EFlow, however, impact of increasing EFlow on the population of this fish are limited as they are overshadowed by the impact of the barrier to its migration created by the dam.
- The Nalbant's Loach is least affected by lower flows. However, increasing EFlows benefits this fish the most, with loss in population declining aby about 27% as EFlow is increased from 1.5 to 6.1 m^{3}s/.

Exhibit 6.2: Impact of Variation in Flow on Fish Population, Downstream of Dam with High Protection

Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

Fish	*Change in Population, %*				*Incremental gain, % by increasing Environmental Flow*		
Flow Scenario	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*1.5 to 3.5 m^3/s*	*3.5 to 4.5 m^3/s*	*4.5 to 6.1 m^3/s*
EFlow, m^3/s	1.5	3.5	4.5	6.1			
Alwan Snow Trout	-66.9	-64.8	-62.9	-58.8	2.1	1.9	4.1
Nalbant Loach	-74.7	-64	-58.8	-47.5	10.7	5.2	11.3
Kashmir Hillstream Loach	-97.9	-96	-94.6	-91.3	1.9	1.4	3.3

6.1.3 Impact of Baseload vs Peaking Generation

Shifting from peaking to baseload operation has a large positive effect on fish populations as shown in **Exhibit 6.3**. In case of baseload operation, the hydrology of the river downstream of the tailrace largely remains close to natural. Comparison is provided for an EFlow of 4.5 m^3/s for illustrative purposes. With High Protection, fish populations can be restored to above present day levels.

Exhibit 6.3: Impact of Baseload vs. Peaking Operation on Fish Population, Downstream of Tailrace

Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day

	Change in Population, %		*Incremental gain, %*
Fish	*P4HP*	*B4HP*	*Peaking to baseload*
Alwan Snow Trout	-46.7	37.1	84
Nalbant Loach	-30.3	11.7	42
Kashmir Hillstream Loach	-55.2	6.8	62

6.2 Net Gain Calculations

Net gain was calculated based on the length of the reach represented by the EFlow site multiplied by the predicted changed in abundance at that particular EFlow site. Distribution of fish populations between the main river and the tributaries was also taken into account, as both the main river and tributaries will benefit from protection (see **Exhibit 6.4**).

Exhibit 6.4: Current Distribution of Fish between River and Tributaries

Fish	*Main River*	*Tributary*
Alwan Snow Trout	70%	30%
Nalbant's Loach	30%	70%
Kashmir Hillstream Loach	100%	0%

As the hydrology of the tributaries will be unchanged, the tributaries will gain from protection only. The estimated impact of protection at EF Site 4 under baseload operation where flows remain unaffected was used as a proxy for impact of protection in tributaries.

The segment of the river upstream of the dam will be impacted by peaking releases from the SKHPP prior to construction of the Project, and fish populations will suffer a high losses in this reach of the river. Following the construction of the Project, the fish that are adapted to a flowing river will not be able to adjust to the non-flow reservoir conditions with a greater depth of water, and will practically be eliminated from the reservoir. Net Gain was therefore calculated for the reaches downstream of the dam represented by EF Sites 2, 3 and 4.

The predicted abundances were compared against baselines with two different levels of protection (Business as Usual Protection and Low Protection). These dynamic baselines represent the expected fish abundances in the absence of the Project. Lastly, Net Gain against Present Day (i.e. static baseline) is also presented.

Predictions of DRIFT model are subject to an uncertainty of the order of 15% above and below the predicted mean[13].

The resultant Net Gain under each scenario is summarized in **Exhibit 6.5** and detailed in **Exhibit 6.6**.

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[13] Based on results from Kohala Hydropower Plant Environmental Flow Assessment, Technical Report. Southern Waters in Association with Hagler Bailly Pakistan, November 2016

Exhibit 6.5: Summary of Net Gain Calculations for Selected Scenarios

Red: loss over baseline, White: 0% to 15% increase over baseline, Green: greater than 15% increase over baseline.

Operation	*Baseload*				*Peaking*		
Environmental Flow (m^3/s)	*1.5*	*3.5*	*4.5*	*6.1*	*1.5*	*4.5*	*6.1*
Scenario ID	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Against Business as Usual Baseline							
Alwan Snow Trout	78.3	78.9	79.5	80.7	32.0	35.8	38.0
Nalbant Loach	59.1	60.4	60.9	62.2	51.0	52.6	53.5
Kashmir Hillstream Loach	42.6	43.3	43.8	45.0	2.1	5.2	7.1
Against Low Protection Baseline							
Alwan Snow Trout	59.6	60.2	60.8	62.0	13.3	17.1	19.3
Nalbant Loach	29.1	30.3	30.9	32.2	20.9	22.6	23.5
Kashmir Hillstream Loach	23.5	24.2	24.8	26.0	-17.0	-13.9	-11.9
Against Present Day							
Alwan Snow Trout	8.3	8.9	9.5	10.7	-38.0	-34.2	-32.0
Nalbant Loach	2.0	3.2	3.8	5.0	-6.2	-4.6	-3.6
Kashmir Hillstream Loach	-32.0	-31.2	-30.7	-29.5	-72.5	-69.4	-67.4

Exhibit 6.6: Details of Net Gain Calculations

	Baselines		*Project Operational Scenarios*									
	BaseBAU	*BaseLP*	*B3BAU*	*B3LP*	*B3MP*	*B1HP*	*B3HP*	*B4HP*	*B6HP*	*P1HP*	*P4HP*	*P6HP*
Biophysical Results (Red: greater than 70% reduction from Present Day, Orange: 40% to 70% reduction from Present Day, and Green: increase over Present Day)												
River Weighted Average Change in Abundance												
Alwan Snow Trout	-70.0	-51.4	-83.4	-72.7	-20.4	-4.2	-3.3	-2.5	-0.7	-70.3	-64.9	-61.8
Nalbant Loach	-57.2	-27.1	-72.5	-51.9	-23.1	-20.7	-16.7	-14.7	-10.5	-48.0	-42.5	-39.4
Kashmir Hillstream Loach	-74.5	-55.5	-83.2	-72.1	-36.1	-32.0	-31.2	-30.7	-29.5	-72.5	-69.4	-67.4
Tributary Average Change in Abundance												
Alwan Snow Trout	-70.0	-51.4	-71.2	-51.6	22.8	37.3	37.3	37.3	37.3	37.3	37.3	37.3
Nalbant Loach	-57.2	-27.1	-56.9	-27.3	3.5	11.7	11.7	11.7	11.7	11.7	11.7	11.7
Kashmir Hillstream Loach	-	-	-	-	-	-	-	-	-	-	-	-
Net Gain (Red: Net Loss, Black: Net Gain Between 0 and 15%, Green: Net Gain Greater than 15%)												
Against BAU Baseline												
Alwan Snow Trout			-9.8	3.6	62.5	78.3	78.9	79.5	80.7	32.0	35.8	38.0
Nalbant Loach			-4.4	22.5	52.7	59.1	60.4	60.9	62.2	51.0	52.6	53.5
Kashmir Hillstream Loach			-8.7	2.4	38.5	42.6	43.3	43.8	45.0	2.1	5.2	7.1
Against LP Baseline												
Alwan Snow Trout			-28.4	-15.0	43.9	59.6	60.2	60.8	62.0	13.3	17.1	19.3
Nalbant Loach			-34.5	-7.6	22.6	29.1	30.3	30.9	32.2	20.9	22.6	23.5
Kashmir Hillstream Loach			-27.7	-16.6	19.4	23.5	24.2	24.8	26.0	-17.0	-13.9	-11.9
Against Present Day												
Alwan Snow Trout			-79.8	-66.4	-7.5	8.3	8.9	9.5	10.7	-38.0	-34.2	-32.0
Nalbant Loach			-61.6	-34.7	-4.5	2.0	3.2	3.8	5.0	-6.2	-4.6	-3.6
Kashmir Hillstream Loach			-83.2	-72.1	-36.1	-32.0	-31.2	-30.7	-29.5	-72.5	-69.4	-67.4

6.3 Impact to Power Generation

The following key assumptions are incorporated into the calculation of power loss under the different operational scenarios: (see **Exhibit 6.7**)

- Impact to power generation was calculated based on the water diverted through the turbines and did not take into account the turbine efficiency at varying flows.
- The operating rules of the Project are detailed in **Appendix B**, for which the power generation is calculated.
- Baseline power generation (i.e. 0% power loss) is taken as the peaking scenario with EFlow of 1.5 m^3/s as designed
- The Project is designed to produce 1,187 GWh per year in the baseline scenario (see point above) and the price of power is taken as 0.11 $.kWh. No premium is assigned to peaking power generation.
- Recovery from the EFlow turbine is estimated at 20% of the main power house turbine for the same flow of water through the turbine.

Exhibit 6.7: Power Loss Under EFlow Scenarios

Operation	*EFlow (m^3/s)*	*Scenario ID*	*Power Loss*	*Monetary Loss per year, USD Million*
Peaking	1.5	P1	0.0%	-
	4.5	P4	2.1%	$2.78
	6.1	P6	3.5%	$4.59
Baseload	1.5	B1	0.2%	$0.31
	3.5	B3	2.5%	$3.28
	4.5	B4	3.8%	$4,94
	6.1	B6	5.7%	$7.42

7. Conclusions

Two operational scenarios are recommended for consideration of the stakeholders:

- Preferred Case: Baseload operation with an EFlow of 1.5 m^3/s and High Protection (corresponding to scenario B1HP)
- Alternate Case: Peaking operation with an EFlow of 6.1 m^3/s and High Protection (corresponding to scenario P6HP)

With a baseload operation it will be possible to meet the requirement of Net Gain in population of fish species that trigger Critical Habitat, with a margin for uncertainties in predictions of EFlow modeling of the order of 15% above and below the predicted mean change in populations, and a more conservative baseline of LP level of protection against which Net Gain is calculated.

With a peaking operation and EFlow release of 6.1 cumec, there will be a loss in power generation of the order of 3.5% compared to the loss under a baseload operation with an EFlow release of 1.5 cumec. While the basic requirement of Net Gain will be met assuming a Business as Usual Baseline, there will be limited margin for accommodating uncertainties in EFlow modeling predictions. Net Gain requirement will not be met assuming a conservative baseline with a Low Protection level of protection.

A peaking operation will produce power to meet the demand on the national power grid during evening peaking hours. Peaking power is presently priced at a premium of about 30% for high end residential and commercial customers with three phase connections. However, power purchase tariff for the generation companies remains at a flat rate, and no premium for peaking power is available to the power producer. This notwithstanding, the power purchaser, Central Power Purchase Agency Guarantee Ltd. (CPPA-G) and system operator, National Power Control Centre (NPCC) of national transmission and Dispatch Co. Ltd. (NTDCL) under the current framework of Power Purchase Agreement (PPA) retain the right to ask the hydropower producers to operate in peaking mode when technically feasible. Operation on a baseload will therefore require appropriate amendments in the PPA.

Following the approval of EIA and BAP (see **Volume 2C** of the **EIA**) by KP EPA, a baseload operation, if opted for will become a legally binding requirement for the Project. Amendments in the PPA will therefore have a policy and legal basis, which will be binding on the power purchaser as well as the electricity regulator, the National Electric Power Regulatory Authority (NEPRA). Further technical studies may be required to design the Project to operate on baseload in view of peaking releases from the SKHPP located upstream of the Project. Obviously, no amendment in standard PPA will be required if a peaking operation is opted for.

The operational configuration selected and agreed upon by the stakeholders, project owner, and the lenders will be presented in the final version of the EIA, along with the justification for the decision.

Appendix A: Overview of DRIFT Model for Environmental Flow Assessment

A.1 DRIFT Decision Support System

The DRIFT Decision Support System (DSS) is programmed using Delphi XE and uses a NexusDB v3 database. The software is designed for use in all computers running Windows XP and upwards, and the DSS supports both single-user and multi-user modes.

The DSS makes use of Google Earth (standard version) and Google kml files.

The DRIFT DSS is divided into three sections, each dealing with a different stage in the EF determination process. These are (Brown *et al*. 2013):

1. Set-up,
2. Knowledge Capture, and
3. Analysis.

The first two sections deal with the population of the DSS and the calibration of the relationships that will be used to predict the ecosystem response to changes in flows. The third section is used to generate results once the first two sections have been populated, and to produce the reports and graphics detailing the predictions for the scenarios under consideration.

All hydrological modelling is done outside of the DSS. The DSS is dependent on the outputs of two external models, namely:

- an Hydrological Model used to provide baseline basin hydrology; and
- a Water Resource Model used to predict the changes in the flow regime associated with the existing and proposed water-resource developments under the various scenarios.

Additional detail on the DSS, including a User Manual, is available in Brown *et al.* (2013).

A.2 Summary of DRIFT Process

DRIFT (Downstream Response to Imposed Flow Transformations; King *et al.* 2003) was used to evaluate different water management scenarios for the Jhelum River for, *inter alia*, the following reasons:

1. It is a holistic interactive method, which provides the biophysical consequences for the downstream river for various scenarios of flow change. These scenarios can then be used to determine the impact of proposed operating rules for the dam, and possible mitigation thereof.

Appendix B: Reservoir Operations Modelling

The purpose of the hydrological component of the work was to simulate hydrological flow sequences that could result from operations of the HPP under varying environmental flows.

To cater for the requirement of DRIFT DSS input requirements, a reservoir operations model was created in the GoldSim® software package. GoldSim® is the premier Monte Carlo simulation software solution for dynamically modeling complex systems in engineering, science and business. GoldSim® is particularly suited for mass balances, including water balances. For the current model the Monte Carlo capabilities of GoldSim® were not utilized as these were not necessary.

The simulated flow sequences were analyzed to produce ecologically relevant flow indicators that serve as driving variables for the biophysical socio-economic response curves that form the core of the DRIFT approach (see **Environmental Flow Assessment Report**)

This report provides a summary of the reservoir operations modelling

B.1 Approach

The specific simulated output derived from GoldSim® Version 12, which is required for DRIFT DSS includes the following:

- Possible range of daily flows at different locations, including upstream of the dam, immediately downstream of dam and immediately downstream of the tailrace, immediately downstream of the Balakot Town with reservoir operations
- Flows at the EFlow site using multiple EFlow scenarios

B.2 Data

The Key Project components proposed for the BAHPP and the baseline hydrological input data is provided below.

B.2.1 Dam Design

Key dam design parameters utilized in the reservoir operations model are provided in **Exhibit B.1** below.

Appendix C: Hydraulics

This appendix provides hydraulic information to support the Environmental Flow (EF) assessment along reaches of the Kunhar River impacted by the 'Balakot Hydropower Project' (BAHPP) or the 'Balakot Hydropower Development Project'. Hydraulic characteristics of the EFlow sites are presented which are incorporated into the DRIFT (Downstream Response to Imposed Flow Transformation) DSS (Decision Support System).

C.1.1 EFlow Sites

Hydraulic parameters at the following EF sites on the Kunhar River were calculated in this assessment:

- EF Site 1 Upstream Reservoir,
- EF Site 2 Downstream Dam,
- EF Site 3 Downstream Tailrace, and
- EF Site 4 Downstream Balakot

C.2 Methodology

The topographic river surveys were conducted from April 11 to 14, 2017. The survey locations, dates, are provided in **Exhibit C.1** for the four BAHP EFlow sites. Cross section data is also available from the Feasibility Study at locations also listed in the exhibit.

The above water-level channel topography (at the time of data collection) was surveyed by standard land surveying methods (see **Exhibit C.2**). For non-wadable conditions, the channel bed was surveyed using the Deeper Smart Sonar Pro+. Depth sounding either took place from a boat, or by mounting the sonar equipment on a float and attaching to a tag line. For wadable sections a measurement staff was used. Lastly, depth was also verified by using a plumb line which was dropped into the Kunhar River from various bridges. These methods are illustrated in **Exhibit C.3**.

Aerial and site photographs of the cross sections for each site are presented in **Exhibit C.4** to **Exhibit C.11**.

Exhibit C.1: Locations of Cross Section Measurements

Eflow Site	*Cross Section ID*	*Survey dates**
Upstream of Dam (EF Site 1)	1-1	April 13, 2017
	1-2	April 11, 2017
	1-3	April 13, 2017
	1-4	April 13, 2017

Appendix D: Response-Curve Library

This appendix contains the response curves used in the DRIFT DSS and their explanations. The response curves of the multiple disciplines in DRIFT are arranged as follows:

D.1 Geomorphology Response-Curves

D.2 Water Quality Response-curve Explanations

D.3 Algae Response-curve Explanations

D.4 Riparian Vegetation Response-curve Explanations

D.5 Macroinvertebrate Response-curve Explanations

D.6 Fish Response-curve Explanations

D.1 Geomorphology Response-Curves

The explanations of the Response Curves are tabulated as follows:

Exhibit D.1: Suspended Sediment Load

Exhibit D.2: Active Channel Width

Exhibit D.3: Exposed Sand and Gravel Bars

Exhibit D.4: Median Bed Sediment Size (Armouring)

Exhibit D.5: Exposed Cobble and Boulder Bars

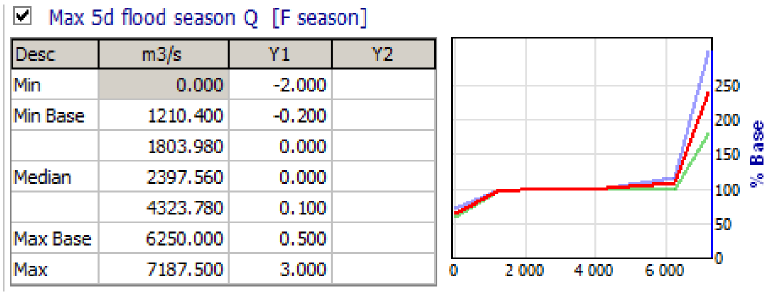
Exhibit D.6: Depth of Pools

Exhibit D.7: Area of Secondary Channels and Backwaters

Exhibit D.1: Suspended Sediment Load

Suspended Sediment Load

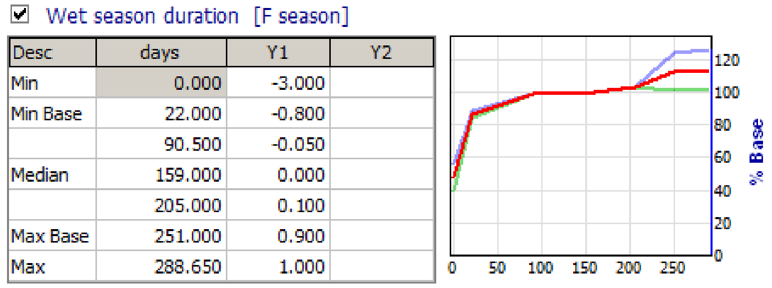
Response curve *Explanation*



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y1	Y2
Min	0.000	-2.000	
Min Base	1210.400	-0.200	
	1803.980	0.000	
Median	2397.560	0.000	
	4323.780	0.100	
Max Base	6250.000	0.500	
Max	7187.500	3.000	

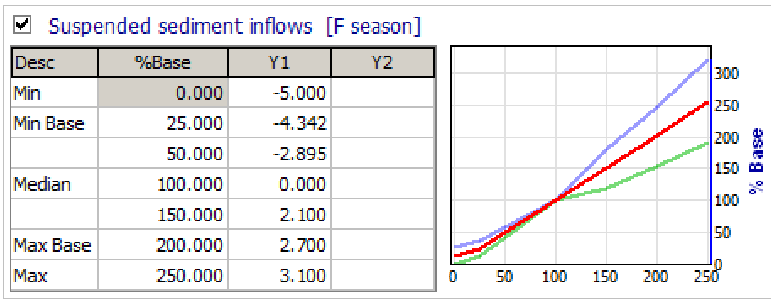
Larger floods are generally associated with higher suspended sediment loads.



☑ Wet season duration [F season]

Desc	days	Y1	Y2
Min	0.000	-3.000	
Min Base	22.000	-0.800	
	90.500	-0.050	
Median	159.000	0.000	
	205.000	0.100	
Max Base	251.000	0.900	
Max	288.650	1.000	

The longer the wet season, the greater the concentration of sediment that is likely to occur.



☑ Suspended sediment inflows [F season]

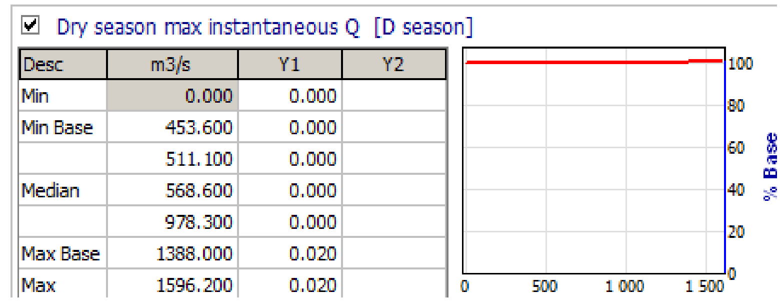
Desc	%Base	Y1	Y2
Min	0.000	-5.000	
Min Base	25.000	-4.342	
	50.000	-2.895	
Median	100.000	0.000	
	150.000	2.100	
Max Base	200.000	2.700	
Max	250.000	3.100	

Upon closure of the dam, some suspended sediments will be trapped in the reservoir. This will result in a reduced concentration downstream.

Exhibit D.2: Active Channel Width

Active channel width

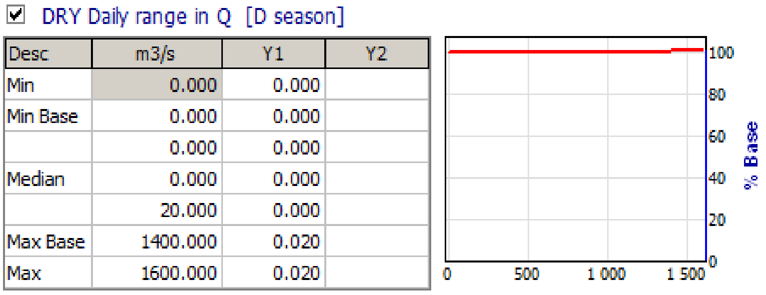
Response curve | *Explanation*



☑ Dry season max instantaneous Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	453.600	0.000	
	511.100	0.000	
Median	568.600	0.000	
	978.300	0.000	
Max Base	1388.000	0.020	
Max	1596.200	0.020	

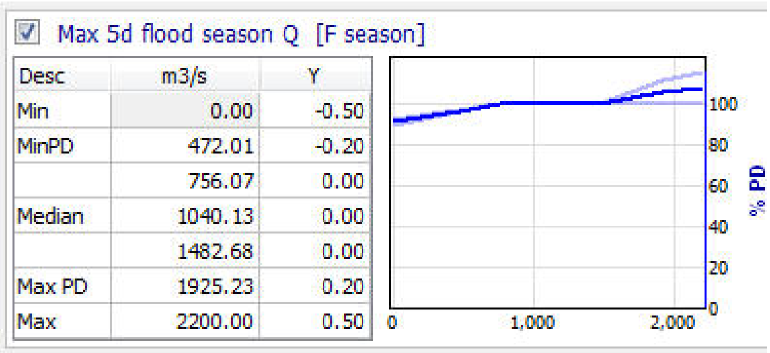
The greater the variation in flows (indicative of intra-daily peaking), the larger the channel that is likely to develop (peaking will promote erosion and widening of the main channel).



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	20.000	0.000	
Max Base	1400.000	0.020	
Max	1600.000	0.020	

A widely fluctuating daily range of discharges will create a zone of high disturbance between the low and peak flows. When this water level fluctuation is very high, of up to a few metres per day, this would create a highly disturbed, scoured and fast velocity (associated with the rise and fall of the peaks) zone, effectively rendering the backwater refugia unavailable for most instream biota, and a slightly wider active channel. With a more moderate fluctuation, some of the habitat can be expected to still be available.

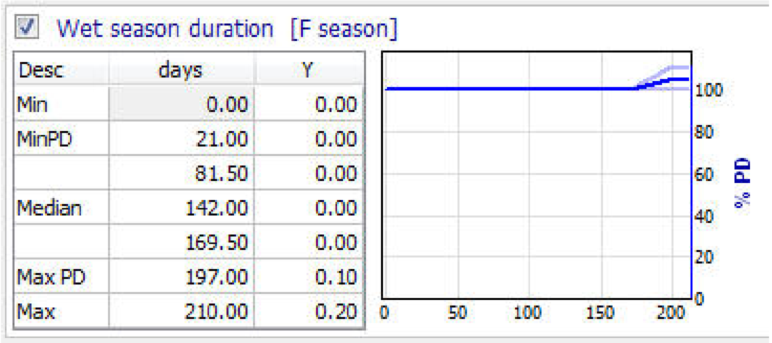
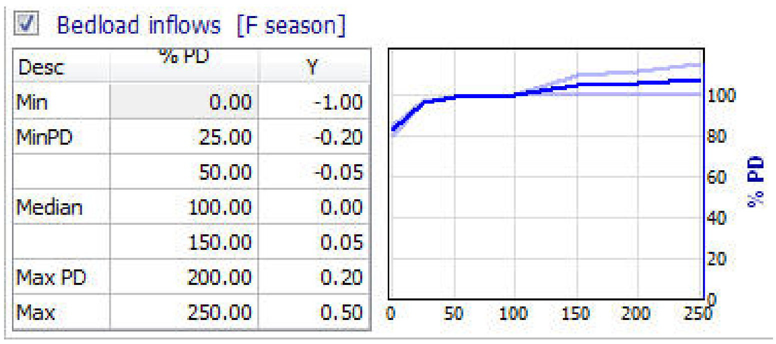
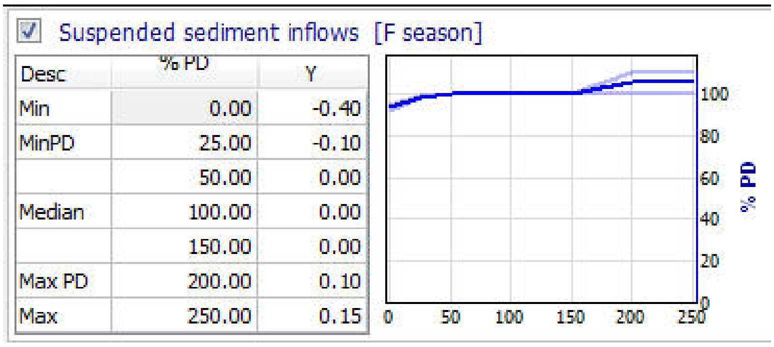


☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-0.50
MinPD	472.01	-0.20
	756.07	0.00
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	0.20
Max	2200.00	0.50

Large floods widen the active channel, eroding the marginal areas and increasing the channel width. A series of small floods will cause the active channel to narrow as the channel reduces to adjust to a smaller effective discharge.

Active channel width

Response curve	*Explanation*
 ☑ Wet season duration [F season]	Longer wet seasons mean a longer period of high flows with relatively lower sediment loads (in this river observed data suggest that the peak sediment loads generally occur early in the wet season, prior to peak discharge). Thus erosion of the channel is easier later in the season, and this may cause some increase in width when the flood season is extended.
 ☑ Bedload inflows [F season]	Reduced bedloads will promote channel incision and a reduction in width. A large increase in bedloads will cause channel instability and an increase in the channel width.
 ☑ Suspended sediment inflows [F season]	Although suspended sediment plays a smaller role than bedload, increased sand flows can aggrade the bed and increase channel width slightly.

☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	0.00
MinPD	21.00	0.00
	81.50	0.00
Median	142.00	0.00
	169.50	0.00
Max PD	197.00	0.10
Max	210.00	0.20

☑ Bedload inflows [F season]

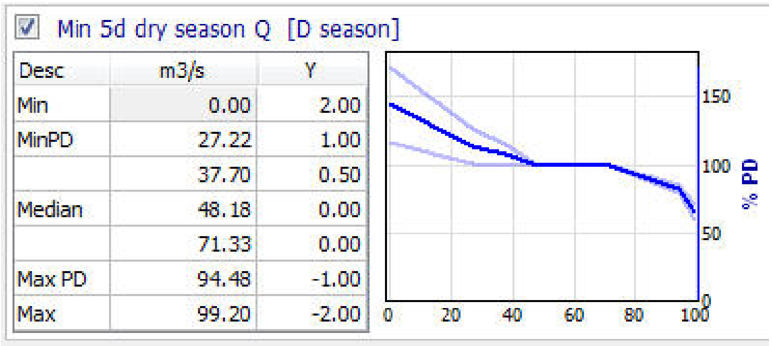
Desc	% PD	Y
Min	0.00	-1.00
MinPD	25.00	-0.20
	50.00	-0.05
Median	100.00	0.00
	150.00	0.05
Max PD	200.00	0.20
Max	250.00	0.50

☑ Suspended sediment inflows [F season]

Desc	% PD	Y
Min	0.00	-0.40
MinPD	25.00	-0.10
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	0.10
Max	250.00	0.15

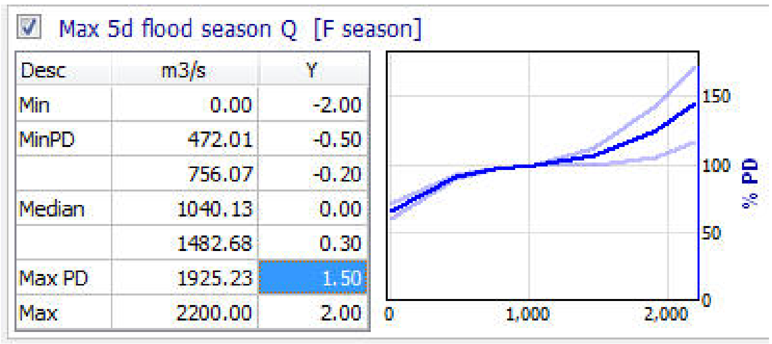
Exhibit D.3: Exposed Sand and Gravel Bars

Exposed Sand and Gravel Bars

Response curve	*Explanation*
	The lower the dry season flows, the more sand bars will be exposed. Higher dry season discharges will erode more sand/gravel bars, and inundate more of them also.

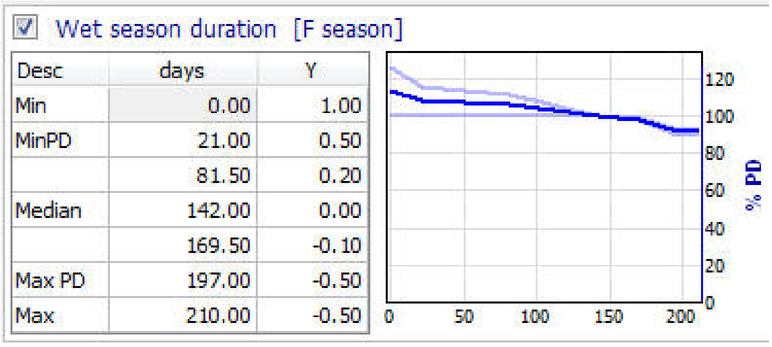
☑ Min 5d dry season Q [D season]

Desc	m3/s	Y
Min	0.00	2.00
MinPD	27.22	1.00
	37.70	0.50
Median	48.18	0.00
	71.33	0.00
Max PD	94.48	-1.00
Max	99.20	-2.00

Response curve	*Explanation*
	Larger floods are associated with higher sediment loads, and with widespread channel instability and reworking of the channel bed and banks. Large floods will thus introduce more sediment and create more sand/gravel bars during the flood season (which can be exposed as sand/gravel bars during the dry season).

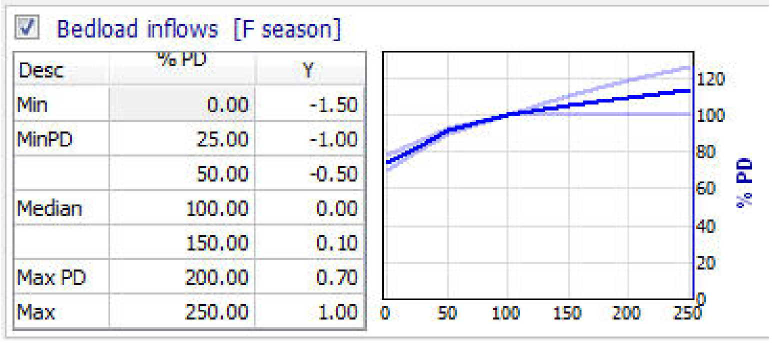
☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-2.00
MinPD	472.01	-0.50
	756.07	-0.20
Median	1040.13	0.00
	1482.68	0.30
Max PD	1925.23	1.50
Max	2200.00	2.00

Response curve	*Explanation*
	Longer wet seasons mean a longer period of high flows with relatively lower sediment loads. In this river observed data suggest that the peak sediment loads generally occur early in the wet season, prior to peak discharge. Thus longer wet seasons may mean greater erosion (widening/deepening) in the main channel, causing some reduction of sand/gravel.

☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	1.00
MinPD	21.00	0.50
	81.50	0.20
Median	142.00	0.00
	169.50	-0.10
Max PD	197.00	-0.50
Max	210.00	-0.50

Response curve	*Explanation*
	More bedload inflows will create more aggradation and lead to more exposed bars. Reduced bedload will promote channel incision and erosion (or incorporation of the bars within the banks) and thus fewer sand/gravel mid-channel bars.

☑ Bedload inflows [F season]

Desc	% PD	Y
Min	0.00	-1.50
MinPD	25.00	-1.00
	50.00	-0.50
Median	100.00	0.00
	150.00	0.10
Max PD	200.00	0.70
Max	250.00	1.00

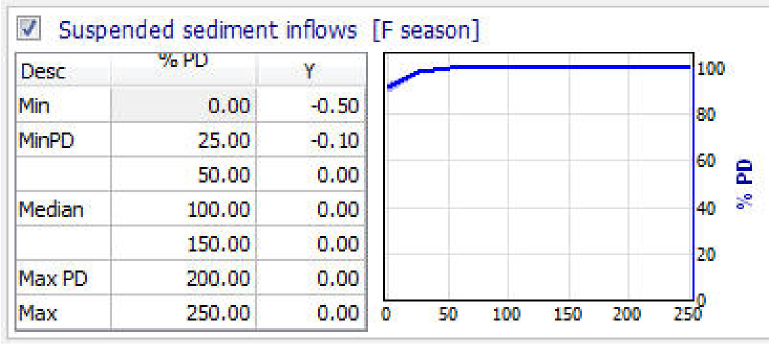
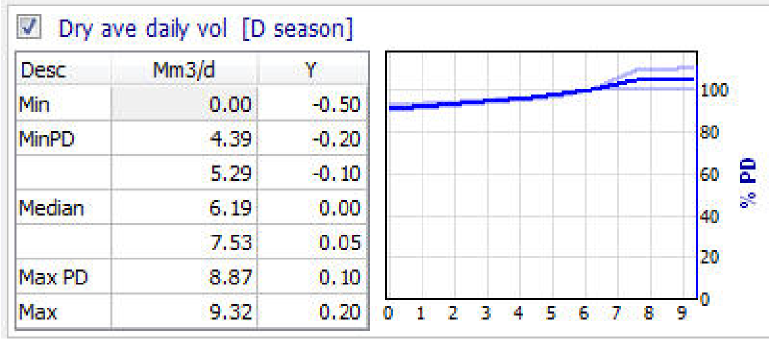
<table>
<tr><th colspan="2"><i>Exposed Sand and Gravel Bars</i></th></tr>
<tr><th><i>Response curve</i></th><th><i>Explanation</i></th></tr>
<tr><td>
☑ Suspended sediment inflows [F season]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-0.50</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>-0.10</td></tr>
<tr><td></td><td>50.00</td><td>0.00</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>0.00</td></tr>
<tr><td>Max</td><td>250.00</td><td>0.00</td></tr>
</table>
</td><td>Upon closure of the dams, some suspended sediments will be trapped in the reservoir. This will result in erosion of downstream sediments (eating away of gravel and sand bars and abandonment of secondary channels due to active channel incision). These impacts will be ameliorated downstream by inputs of sediment from tributaries and increased loads derived from the banks and river bed due to enhanced scour.</td></tr>
</table>

Exhibit D.4: Median Bed Sediment Size (Armouring)

Median Bed Sediment Size (Armouring)

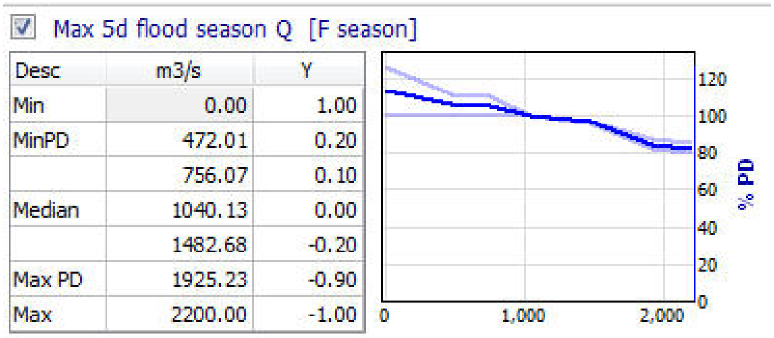
Response curve | *Explanation*



☑ Dry ave daily vol [D season]

Desc	Mm3/d	Y
Min	0.00	-0.50
MinPD	4.39	-0.20
	5.29	-0.10
Median	6.19	0.00
	7.53	0.05
Max PD	8.87	0.10
Max	9.32	0.20

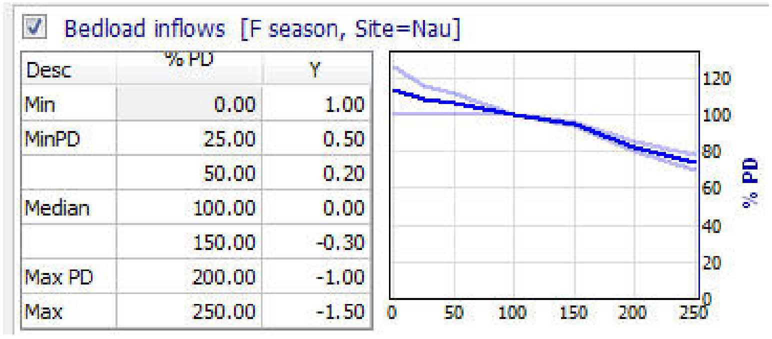
The lower the dry season discharge, the more fines that can deposited on the channel bed and thus the smaller the mean bed sediment size will become. The higher the dry season discharge the more fines that will be removed and the coarser the (now armoured) channel bed will become.



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	1.00
MinPD	472.01	0.20
	756.07	0.10
Median	1040.13	0.00
	1482.68	-0.20
Max PD	1925.23	-0.90
Max	2200.00	-1.00

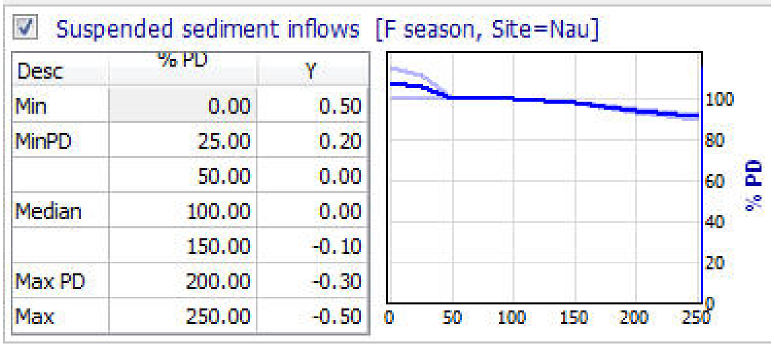
Larger floods are associated with higher sediment loads, and with widespread channel instability and reworking of the channel bed and banks. Large floods will thus reset the channel sediments, resulting in overall finer average bed sediment conditions.



☑ Bedload inflows [F season, Site=Nau]

Desc	% PD	Y
Min	0.00	1.00
MinPD	25.00	0.50
	50.00	0.20
Median	100.00	0.00
	150.00	-0.30
Max PD	200.00	-1.00
Max	250.00	-1.50

Negatively correlated (Buffington and Montgomery 1999): more bedload inflows will reduce the average bed sediment size. Reduced bedload inflows will promote channel incision/erosion and the progressive loss of smaller sediments, resulting in an overall increase of the average bed sediment size.



☑ Suspended sediment inflows [F season, Site=Nau]

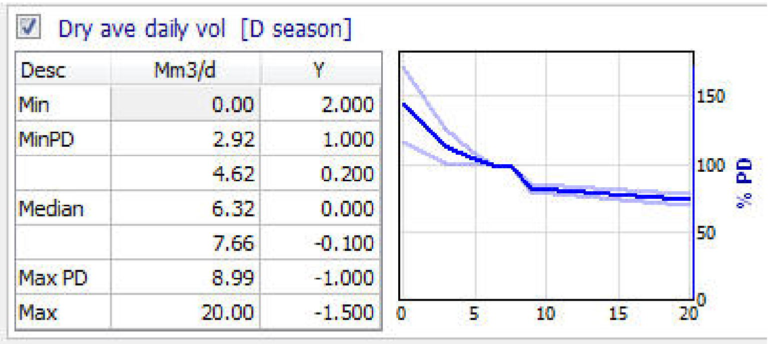
Desc	% PD	Y
Min	0.00	0.50
MinPD	25.00	0.20
	50.00	0.00
Median	100.00	0.00
	150.00	-0.10
Max PD	200.00	-0.30
Max	250.00	-0.50

Although suspended sediment plays a smaller role than bedload in overall bed sediment size, increased suspended sediment (e.g., sand) supply can reduce the average bed sediment size. Similarly whereas reduced inflows will mean that fines washed from the bed will not be replaced and would result in an increase of the average bed sediment size (Buffington and Montgomery 1999).

Exhibit D.5: Exposed Cobble and Boulder Bars

Exposed Cobble and Boulder Bars

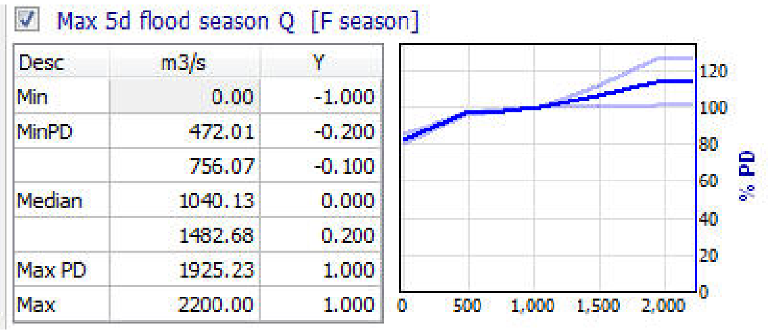
Response curve	*Explanation*



☑ Dry ave daily vol [D season]

Desc	Mm3/d	Y
Min	0.00	2.000
MinPD	2.92	1.000
	4.62	0.200
Median	6.32	0.000
	7.66	-0.100
Max PD	8.99	-1.000
Max	20.00	-1.500

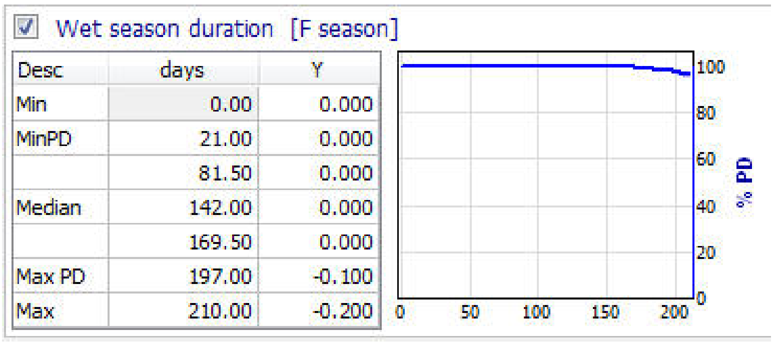
Lower dry season flows will expose more cobble bars whereas higher dry season flows will cause more bars to remain inundated.



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-1.000
MinPD	472.01	-0.200
	756.07	-0.100
Median	1040.13	0.000
	1482.68	0.200
Max PD	1925.23	1.000
Max	2200.00	1.000

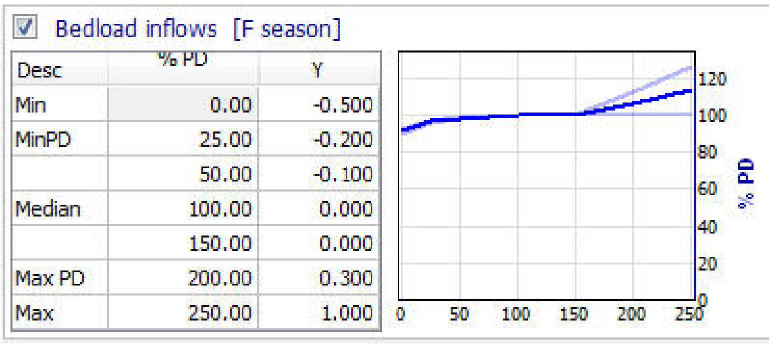
Very large floods tend to redistribute sediments across the channel, and in rivers with a cobble matrix these events should enlarge existing and create additional bars. Very small floods may not overcome thresholds to redistribute bed sediments across the valley floor, allowing bars to over time be incorporated into the bank.



☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	0.000
MinPD	21.00	0.000
	81.50	0.000
Median	142.00	0.000
	169.50	0.000
Max PD	197.00	-0.100
Max	210.00	-0.200

Longer wet seasons mean a longer period of high flows with relatively lower sediment loads. In this river observed data suggest that the peak sediment loads generally occur early in the wet season, prior to peak discharge. Thus longer wet seasons may mean greater erosion (widening/deepening) in the main channel, with some potential loss of cobble bars.



☑ Bedload inflows [F season]

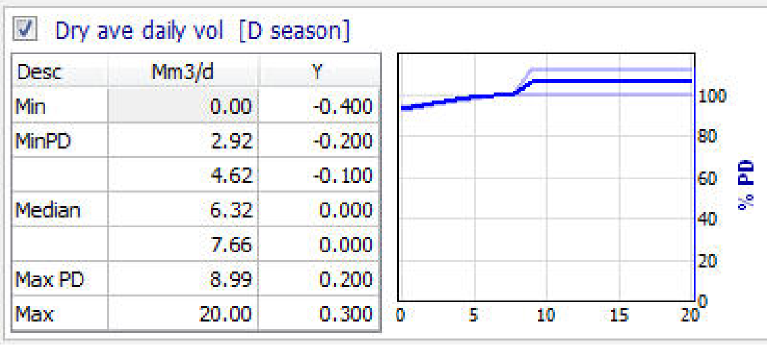
Desc	% PD	Y
Min	0.00	-0.500
MinPD	25.00	-0.200
	50.00	-0.100
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	0.300
Max	250.00	1.000

Reduced bedload would promote channel incision and probably promote the slow loss of gravel bars (as these become bank attached).

Exhibit D.6: Depth of Pools

Depth of pools

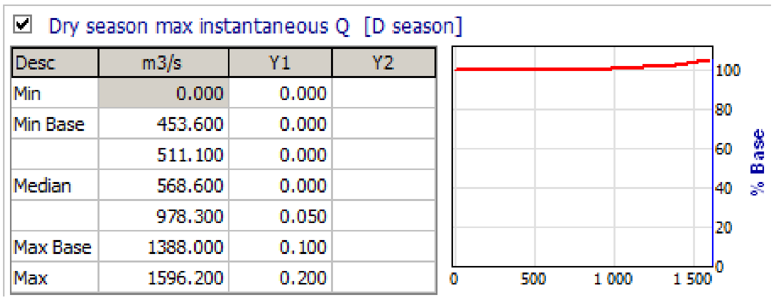
Response curve	*Explanation*



☑ Dry ave daily vol [D season]

Desc	Mm3/d	Y
Min	0.00	-0.400
MinPD	2.92	-0.200
	4.62	-0.100
Median	6.32	0.000
	7.66	0.000
Max PD	8.99	0.200
Max	20.00	0.300

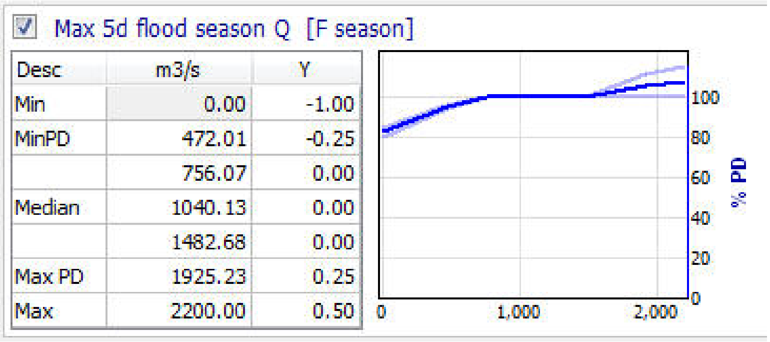
Lower dry season discharges will have lower velocities, allowing for more sediment to settle in the pools during dry season periods than in dry seasons where the average discharge remains high.



☑ Dry season max instantaneous Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	453.600	0.000	
	511.100	0.000	
Median	568.600	0.000	
	978.300	0.050	
Max Base	1388.000	0.100	
Max	1596.200	0.200	

High variations in water levels would initially result in increased bank erosion and infilling of pools as the marginal sediments are eroded and introduced into the main channel. However, this would only be a temporary impact, since the twice-daily flood peaks would increase sediment transport capacity of the channel and result in overall enhanced flushing of sediments and deeper pools.



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-1.00
MinPD	472.01	-0.25
	756.07	0.00
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	0.25
Max	2200.00	0.50

Flood peaks scour steep channels and pools. A reduced flood peak may cause the pools to become shallower. The hysteresis of stage-discharge curves associated with large flood pulse systems indicates the build-up of the bed (from flood sediments) and subsequent incision of channel beds during the late wet and dry seasons. Pool beds in the main channel must therefore aggrade (build-up), with increasing aggradation[1] in larger flood

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[1] Aggradation is the increase in land elevation, typically in a river system, due to the deposition of sediment. Aggradation occurs in areas in which the supply of sediment is greater than the amount of material that the system is able to transport.

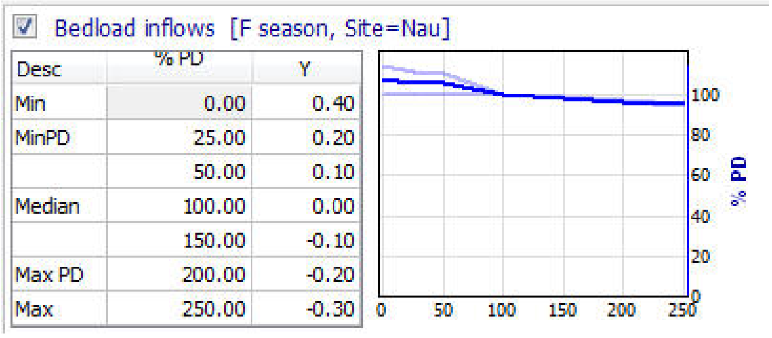
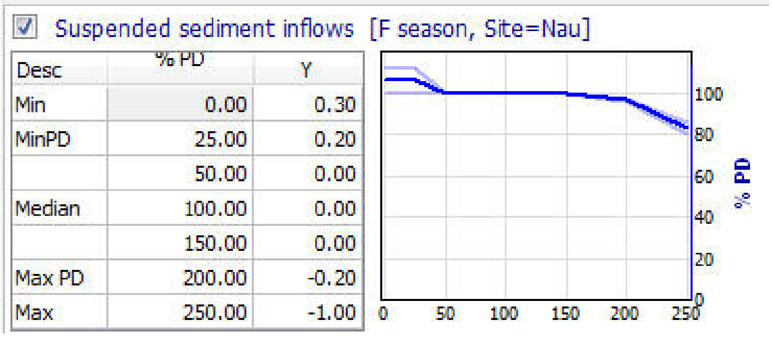
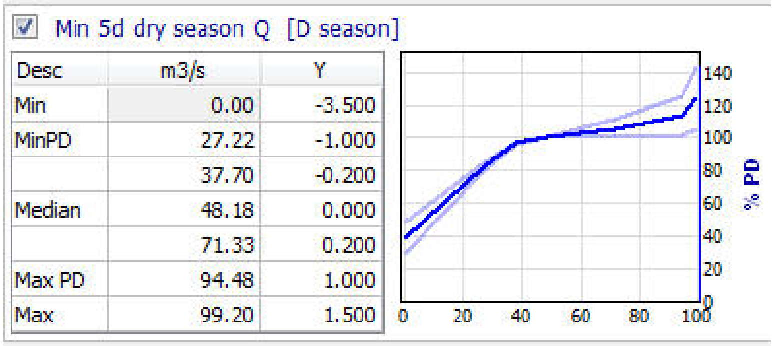
<table>
<tr><th colspan="2"><i>Depth of pools</i></th></tr>
<tr><th><i>Response curve</i></th><th><i>Explanation</i></th></tr>
<tr><td></td><td>seasons due to higher sediment loads. Very small flood seasons could result in pool aggradation due to low velocities and lack of scour.</td></tr>
<tr><td>
☑ Bedload inflows [F season, Site=Nau]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>0.40</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>0.20</td></tr>
<tr><td></td><td>50.00</td><td>0.10</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>-0.10</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>-0.20</td></tr>
<tr><td>Max</td><td>250.00</td><td>-0.30</td></tr>
</table>
</td><td>Reduced bedloads should reduce the potential for pool infilling, but may increase the risk of pools eroding away (as the river planform shifts to a single incised channel). This will not occur if the pools are bedrock-controlled, and the risk decreases quickly downstream of the dam.</td></tr>
<tr><td>
☑ Suspended sediment inflows [F season, Site=Nau]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>0.30</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>0.20</td></tr>
<tr><td></td><td>50.00</td><td>0.00</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>-0.20</td></tr>
<tr><td>Max</td><td>250.00</td><td>-1.00</td></tr>
</table>
</td><td>Reduced sand inflows should reduce the risk of infilling of the pools, whereas very high suspended sand load could infill pools more rapidly.</td></tr>
</table>

Exhibit D.7: Area of Secondary Channels and Backwaters

Area of Secondary Channels and Backwaters

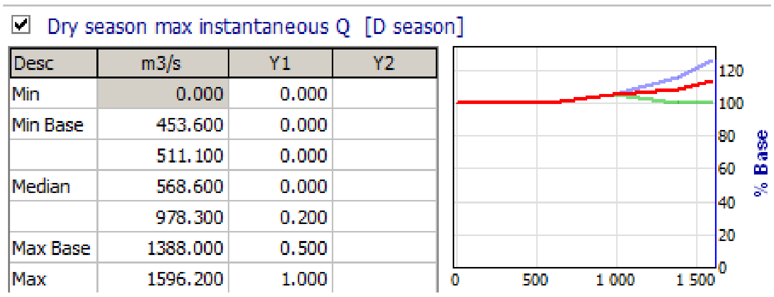
Response curve	*Explanation*



☑ Min 5d dry season Q [D season]

Desc	m3/s	Y
Min	0.00	-3.500
MinPD	27.22	-1.000
	37.70	-0.200
Median	48.18	0.000
	71.33	0.200
Max PD	94.48	1.000
Max	99.20	1.500

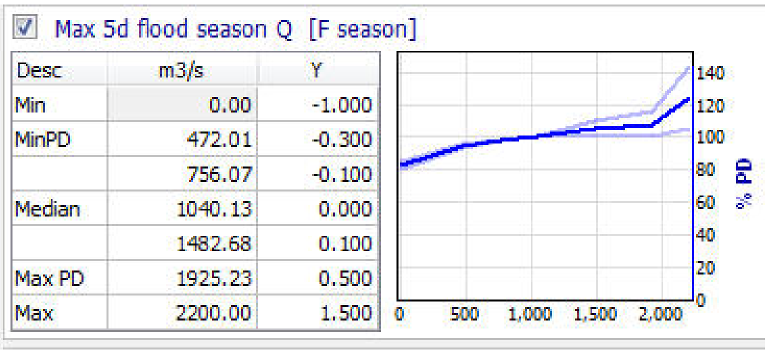
The higher the average dry season flows, the more secondary channels will remain active during the low flow season (and thus available for instream biota)



☑ Dry season max instantaneous Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	453.600	0.000	
	511.100	0.000	
Median	568.600	0.000	
	978.300	0.200	
Max Base	1388.000	0.500	
Max	1596.200	1.000	

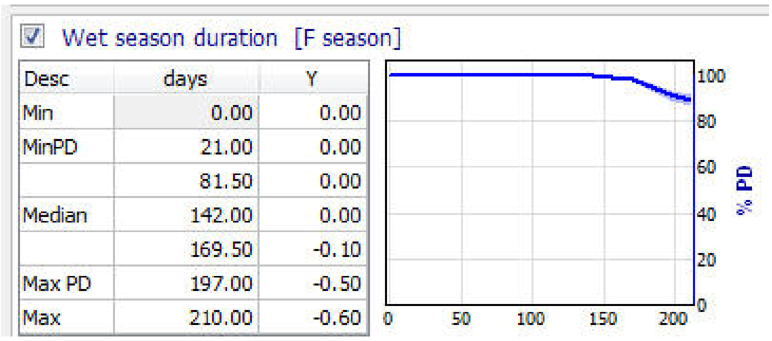
A widely fluctuating daily range of discharges will create a zone of high disturbance between the low and peak flows. When this water level fluctuation is very high, of up to a few metres per day, this would create a highly disturbed, scoured and fast velocity (associated with the rise and fall of the peaks) zone, effectively rendering the backwater refugia unavailable for most instream biota. With a more moderate fluctuation, some of the habitat can be expected to remain.

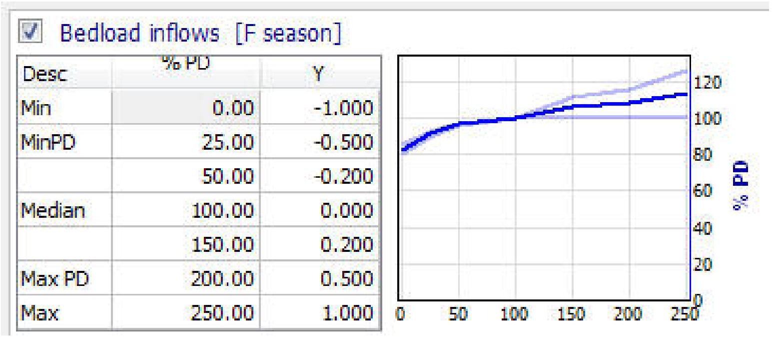


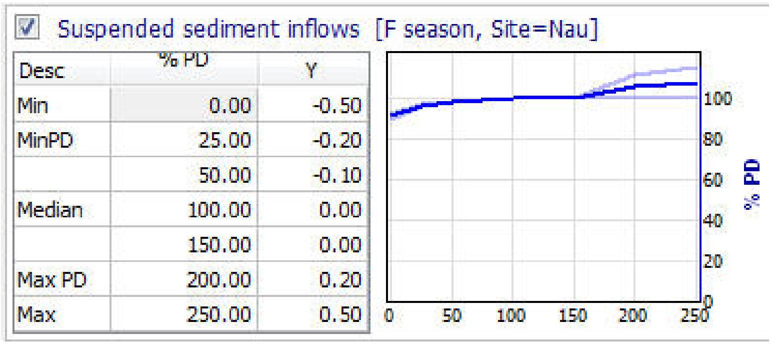
☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-1.000
MinPD	472.01	-0.300
	756.07	-0.100
Median	1040.13	0.000
	1482.68	0.100
Max PD	1925.23	0.500
Max	2200.00	1.500

Very large floods will widen the channel and erode areas for secondary channels to form. Very small/failed floods may not be able to counteract channel narrowing of the low flow season.

<table>
<tr><th colspan="2">Area of Secondary Channels and Backwaters</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>

☑ Wet season duration [F season]
<table>
<tr><th>Desc</th><th>days</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>0.00</td></tr>
<tr><td>MinPD</td><td>21.00</td><td>0.00</td></tr>
<tr><td></td><td>81.50</td><td>0.00</td></tr>
<tr><td>Median</td><td>142.00</td><td>0.00</td></tr>
<tr><td></td><td>169.50</td><td>-0.10</td></tr>
<tr><td>Max PD</td><td>197.00</td><td>-0.50</td></tr>
<tr><td>Max</td><td>210.00</td><td>-0.60</td></tr>
</table>

</td><td>Longer wet seasons mean a longer period of high flows with relatively lower sediment loads. In this river observed data suggest that the peak sediment loads generally occur early in the wet season, prior to peak discharge. Thus longer wet seasons may mean greater erosion (widening/deepening) in the main channel, causing some loss of secondary channels.</td></tr>
<tr><td>

☑ Bedload inflows [F season]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-1.000</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>-0.500</td></tr>
<tr><td></td><td>50.00</td><td>-0.200</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.000</td></tr>
<tr><td></td><td>150.00</td><td>0.200</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>0.500</td></tr>
<tr><td>Max</td><td>250.00</td><td>1.000</td></tr>
</table>

</td><td>Higher bedload inflows will infill the channel, creating more channel instability and the formation of more sand bars and secondary channels. Lower sediment inflows will promote incision and the abandonment of secondary channels.</td></tr>
<tr><td>

☑ Suspended sediment inflows [F season, Site=Nau]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-0.50</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>-0.20</td></tr>
<tr><td></td><td>50.00</td><td>-0.10</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>0.20</td></tr>
<tr><td>Max</td><td>250.00</td><td>0.50</td></tr>
</table>

</td><td>Higher sand inflows will infill the channel, creating more channel instability and the formation of more sand bars and secondary channels. Lower sand inflows will promote scouring of fines and more channel instability, leading to slow incision of the main channel (increased capacity) and gradual abandonment of secondary channels.</td></tr>
</table>

D.2 Water Quality Response-curve Explanations

The explanations of the Response Curves are tabulated as follows:

Exhibit D.8: Nutrient concentration in the river in the dry season

Exhibit D.9: Conductivity

Exhibit D.10: Water Temperature.

Exhibit D.8: Nutrient concentration in the river in the dry season

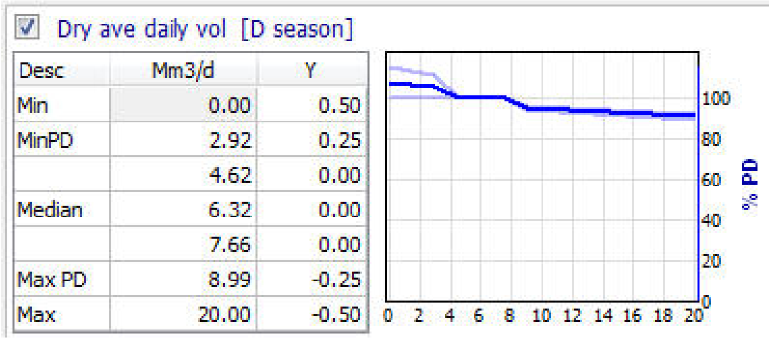
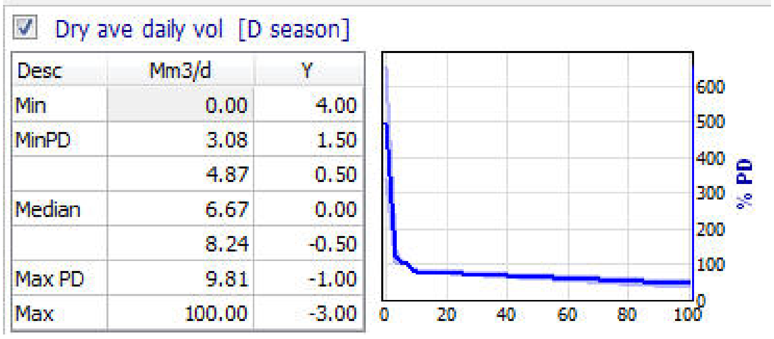
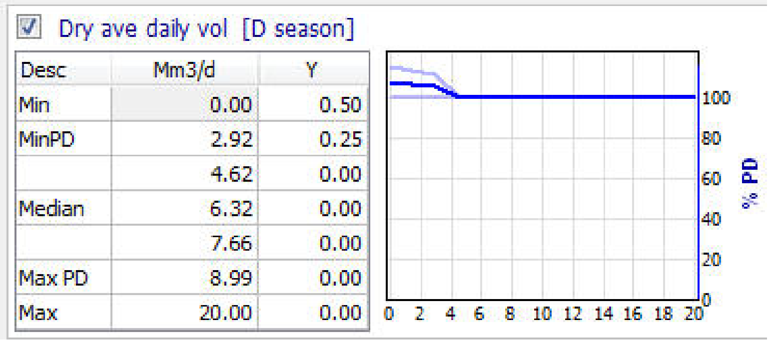
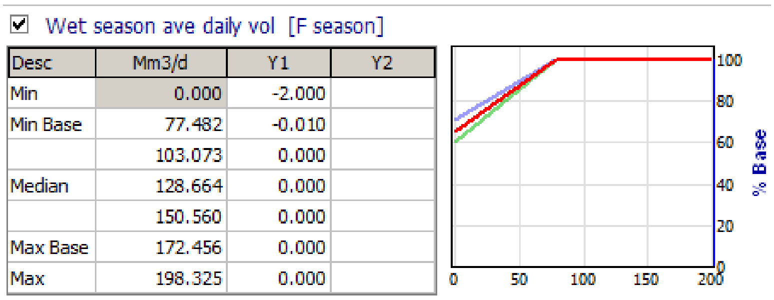
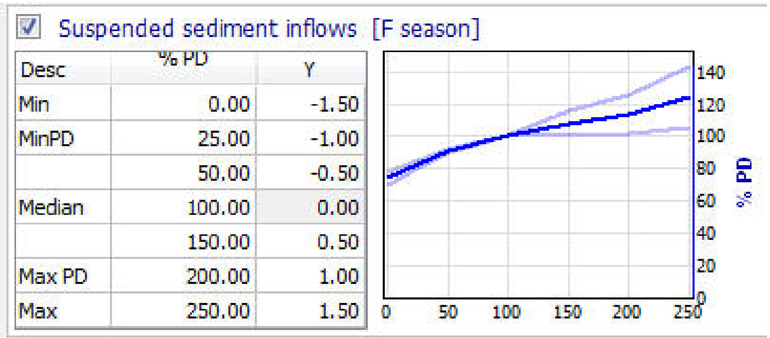
<table>
<tr><th colspan="2">Nutrient Concentration in the River in the Dry Season</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>Site 1</td><td>Assumption: Very little inflow of sewage</td></tr>
<tr><td>
☑ Dry ave daily vol [D season]
<table>
<tr><th>Desc</th><th>Mm3/d</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>0.50</td></tr>
<tr><td>MinPD</td><td>2.92</td><td>0.25</td></tr>
<tr><td></td><td>4.62</td><td>0.00</td></tr>
<tr><td>Median</td><td>6.32</td><td>0.00</td></tr>
<tr><td></td><td>7.66</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>8.99</td><td>-0.25</td></tr>
<tr><td>Max</td><td>20.00</td><td>-0.50</td></tr>
</table>
</td><td>This Response Curve is for Site 1, where assuming inflows of sewage into the river remain at 2012 levels, less discharge would mean only slightly higher concentration of sewage in the river as sewage inflows in the reach represented by site 1 are very low.
The situation is different for some other reaches such as those represented by Site 3.</td></tr>
<tr><td>Site 3</td><td>Assumption: Considerable inflow of sewage</td></tr>
<tr><td>
☑ Dry ave daily vol [D season]
<table>
<tr><th>Desc</th><th>Mm3/d</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>4.00</td></tr>
<tr><td>MinPD</td><td>3.08</td><td>1.50</td></tr>
<tr><td></td><td>4.87</td><td>0.50</td></tr>
<tr><td>Median</td><td>6.67</td><td>0.00</td></tr>
<tr><td></td><td>8.24</td><td>-0.50</td></tr>
<tr><td>Max PD</td><td>9.81</td><td>-1.00</td></tr>
<tr><td>Max</td><td>100.00</td><td>-3.00</td></tr>
</table>
</td><td>Assuming inflows of sewage into the river remain at 2012 levels, less discharge would mean a higher concentration of sewage in the river. This is particularly relevant for Site 3 in Muzaffarabad, but also at sites downstream of this.</td></tr>
</table>

Exhibit D.9: Conductivity

Conductivity

Response Curve	*Explanation*
	Catchment variable: conductivity increases with reduced volumes, however this site is directly downstream of a major dam, so it is expected water quality will be affected mostly by dam water quality, and not by inflow from the surrounding catchment. The relationship provided assumes good dam water quality.
	Catchment variable: if wet season fails - conductivity will decrease.
	Reduced suspended solids loads will result in reduced conductivity.

☑ Dry ave daily vol [D season]

Desc	Mm3/d	Y
Min	0.00	0.50
MinPD	2.92	0.25
	4.62	0.00
Median	6.32	0.00
	7.66	0.00
Max PD	8.99	0.00
Max	20.00	0.00

☑ Wet season ave daily vol [F season]

Desc	Mm3/d	Y1	Y2
Min	0.000	-2.000	
Min Base	77.482	-0.010	
	103.073	0.000	
Median	128.664	0.000	
	150.560	0.000	
Max Base	172.456	0.000	
Max	198.325	0.000	

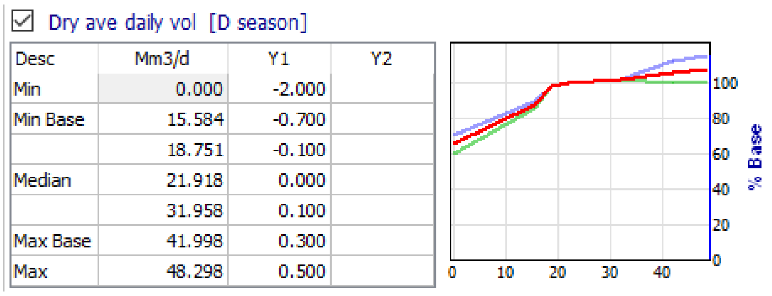
☑ Suspended sediment inflows [F season]

Desc	% PD	Y
Min	0.00	-1.50
MinPD	25.00	-1.00
	50.00	-0.50
Median	100.00	0.00
	150.00	0.50
Max PD	200.00	1.00
Max	250.00	1.50

Exhibit D.10: Water Temperature

Water Temperature

Response curve	*Explanation*

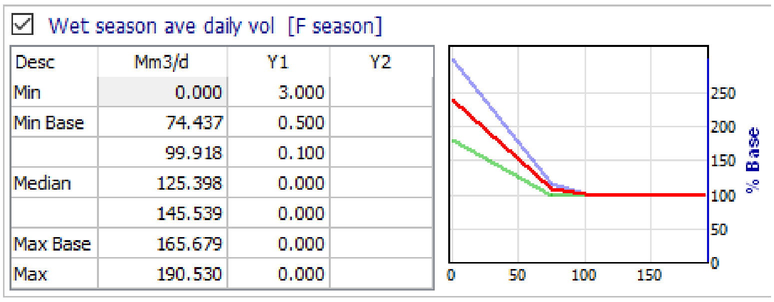


☑ Dry ave daily vol [D season]

Desc	Mm3/d	Y1	Y2
Min	0.000	-2.000	
Min Base	15.584	-0.700	
	18.751	-0.100	
Median	21.918	0.000	
	31.958	0.100	
Max Base	41.998	0.300	
Max	48.298	0.500	

Water volume buffers the river from ambient temperatures. The less the volume, the closer stream temperature will track ambient temperature. This is why small streams freeze in winter more readily than do large rivers.

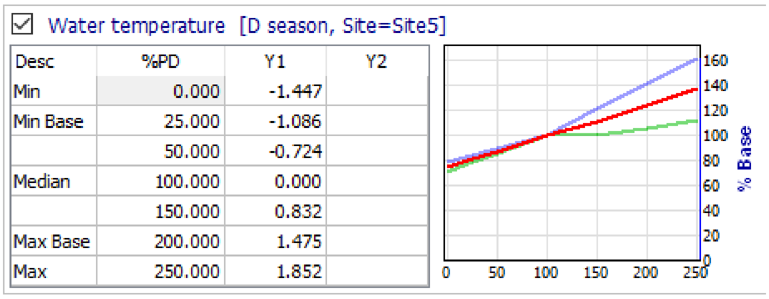
As an aside: For water to freeze and change into ice, it must be cooled to its freezing point, which implies heat loss. That heat loss occurs when the ambient temperature of the air is lower than the temperature of the water. The freezing point of fresh water is 0°C; however, its maximum density is reached at 4°C. From an ecological perspective, the latter point is extremely important, since the deeper water, which is located under the ice – except in some small lakes or ponds - does not freeze, which means that the creatures living there can survive winter under the ice (www.fishingvermont.net/How_Ice_Is_Made.htm). However, if there is little or no depth, this liquid layer is either non-existent or too confined to provide water habitat.



☑ Wet season ave daily vol [F season]

Desc	Mm3/d	Y1	Y2
Min	0.000	3.000	
Min Base	74.437	0.500	
	99.918	0.100	
Median	125.398	0.000	
	145.539	0.000	
Max Base	165.679	0.000	
Max	190.530	0.000	

Volume (and shade) buffers the river from high ambient temperatures in the summer months. The less the volume the closer stream temperature will track ambient temperature.

<table>
<tr><th colspan="2">Water Temperature</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>

☑ Water temperature [D season, Site=Site5]

<table>
<tr><th>Desc</th><th>%PD</th><th>Y1</th><th>Y2</th></tr>
<tr><td>Min</td><td>0.000</td><td>-1.447</td><td></td></tr>
<tr><td>Min Base</td><td>25.000</td><td>-1.086</td><td></td></tr>
<tr><td></td><td>50.000</td><td>-0.724</td><td></td></tr>
<tr><td>Median</td><td>100.000</td><td>0.000</td><td></td></tr>
<tr><td></td><td>150.000</td><td>0.832</td><td></td></tr>
<tr><td>Max Base</td><td>200.000</td><td>1.475</td><td></td></tr>
<tr><td>Max</td><td>250.000</td><td>1.852</td><td></td></tr>
</table></td><td>This link (from Site 6 to Site 5 in the example shown) is provided to cater for the anticipated temperature effect of cooler water entering the river from the NJHEP tailrace. Given that this water originates upstream of Nauseri, high in the Neelum River, and is then transported below ground to the Jhelum upstream of Site 6, it is likely to be significantly cooler than baseline wet season temperatures in the Lower Jhelum River. Given the volume of water released relative to the volume remaining in the Jhelum, it is expected that there will be a nett drop in temperature of the water entering site 6 and 7 relative to baseline.</td></tr>
</table>

D.3 Algae Response-curve Explanations

The explanations of the Response Curves are tabulated as follows:

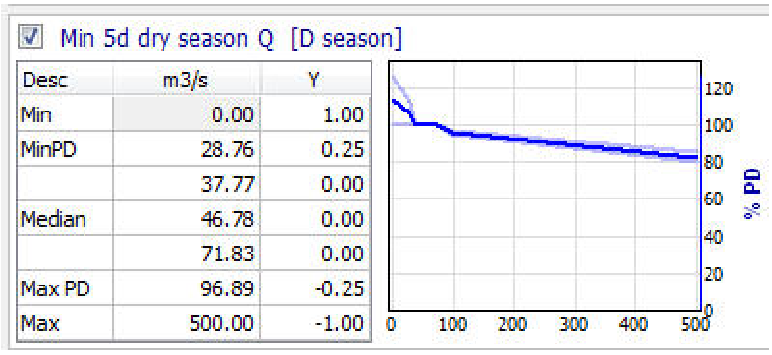
Exhibit D.11: % Filamentous Algae

Exhibit D.12: Chl a Biomass

Exhibit D.11: % Filamentous Algae

% Filamentous Algae

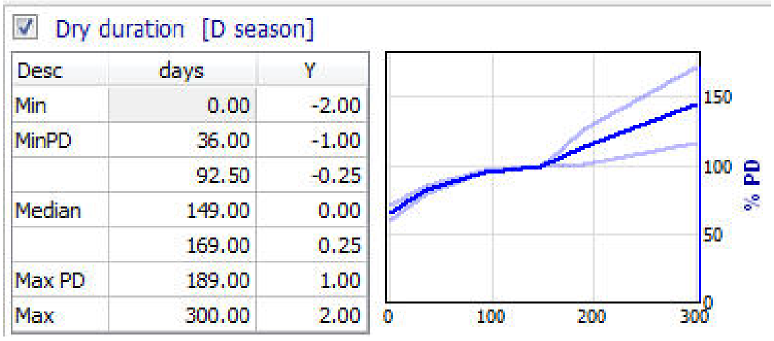
Response curve | *Explanation*



☑ Min 5d dry season Q [D season]

Desc	m3/s	Y
Min	0.00	1.00
MinPD	28.76	0.25
	37.77	0.00
Median	46.78	0.00
	71.83	0.00
Max PD	96.89	-0.25
Max	500.00	-1.00

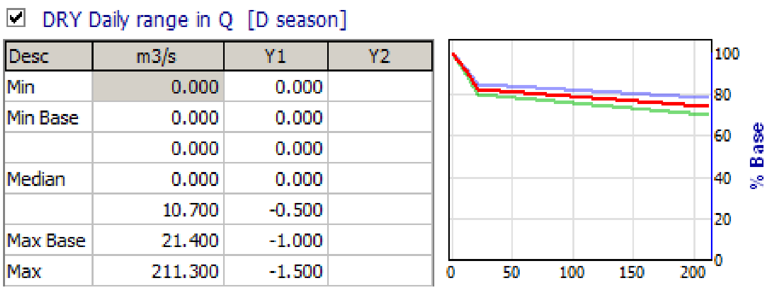
The higher the discharge in the dry season, the more the community is maintained in a state of early succession with low % filamentous algae. A decrease in discharge would reduce velocities and therefore shear stress on the river bed would be less and this would result in an increase in the proportion of filamentous algae.



☑ Dry duration [D season]

Desc	days	Y
Min	0.00	-2.00
MinPD	36.00	-1.00
	92.50	-0.25
Median	149.00	0.00
	169.00	0.25
Max PD	189.00	1.00
Max	300.00	2.00

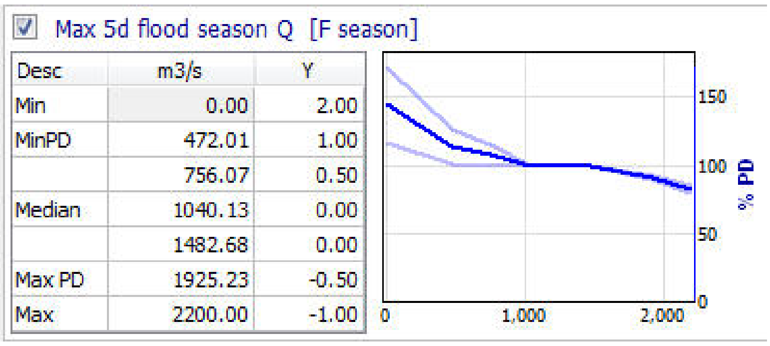
The longer the duration of stable conditions the greater the complexity of the community structure, with filamentous algae forms dominating in late succession. Under cool conditions, it is likely that filamentous diatoms rather than green algae will dominate regardless of nutrient availability.



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	10.700	-0.500	
Max Base	21.400	-1.000	
Max	211.300	-1.500	

The longer the duration of stable conditions the greater the complexity of the community structure, with filamentous algae forms dominating in late succession. Thus, with daily fluctuations it is expected that the algae will be held in an early successional state, and filamentous algae will not dominate.

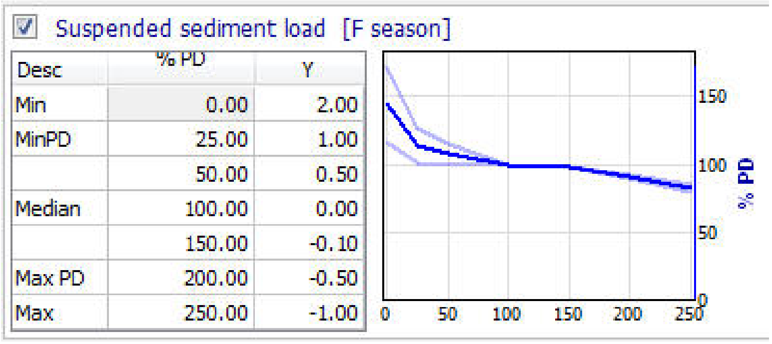
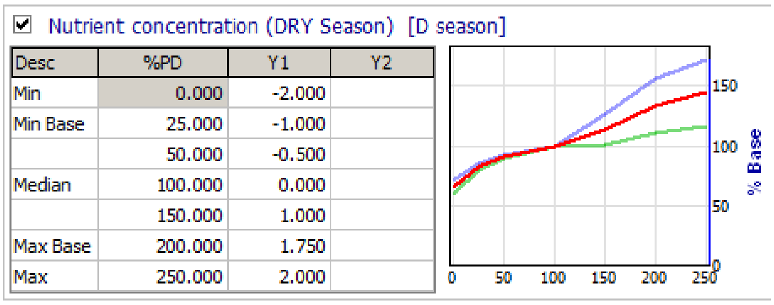


☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	2.00
MinPD	472.01	1.00
	756.07	0.50
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	-0.50
Max	2200.00	-1.00

A reduction in floods in the wet season would result in an increase in the proportion of filamentous taxa as the community is no longer 'reset' by disturbance events.

Floods scour algae from the benthic rocks upon which they grow (Biggs and Thomsen 1995). The period

% Filamentous Algae	
Response curve	*Explanation*
	over which flood scour exerts an influence is minimised over a short wet season and maximised over a longer wet season. Growth of green algae is favoured by shorter wet seasons.
	Suspended sediments affect light penetration, which the algae need for growth. Lower loads mean more light, and more algae.
	An increase in nutrients will favour algal growth (Larned *et al.* 2004; Larned 2010). A reduction in nutrients will reduce the abundance of green algae.

☑ Suspended sediment load [F season]

Desc	% PD	Y
Min	0.00	2.00
MinPD	25.00	1.00
	50.00	0.50
Median	100.00	0.00
	150.00	-0.10
Max PD	200.00	-0.50
Max	250.00	-1.00

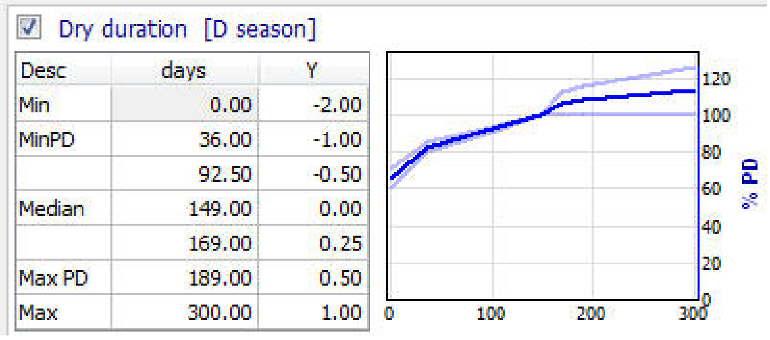
☑ Nutrient concentration (DRY Season) [D season]

Desc	%PD	Y1	Y2
Min	0.000	-2.000	
Min Base	25.000	-1.000	
	50.000	-0.500	
Median	100.000	0.000	
	150.000	1.000	
Max Base	200.000	1.750	
Max	250.000	2.000	

Exhibit D.12: Chl a Biomass

Chl a Biomass

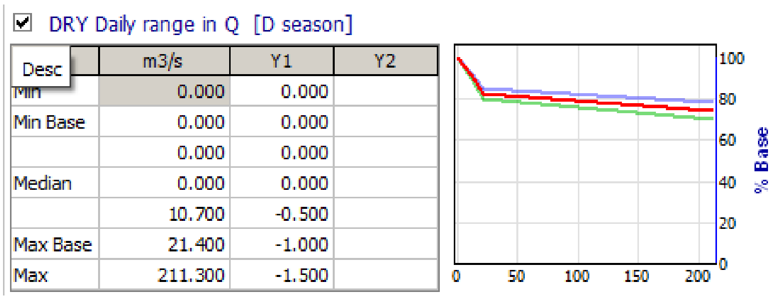
Response curve	*Explanation*



☑ Dry duration [D season]

Desc	days	Y
Min	0.00	-2.00
MinPD	36.00	-1.00
	92.50	-0.50
Median	149.00	0.00
	169.00	0.25
Max PD	189.00	0.50
Max	300.00	1.00

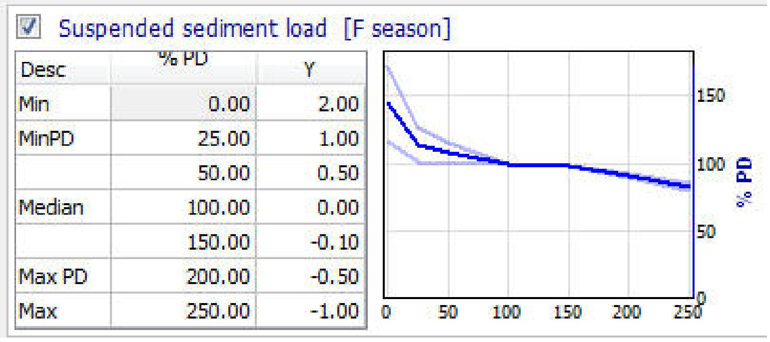
Because of cold conditions, Chl a will increase only to a point with low flows. After that it will maintain a constant biomass.



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	10.700	-0.500	
Max Base	21.400	-1.000	
Max	211.300	-1.500	

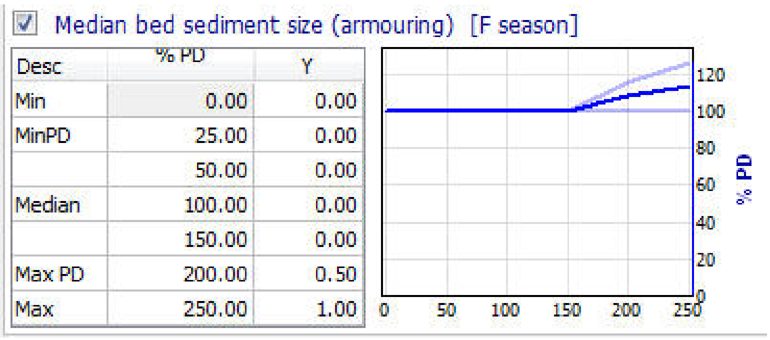
Chl a would normally be expected to increase with a long dry season because temperature would optimal and nutrients are not limiting. However, a considerable portion of the river bed is currently sandy and thus relatively mobile which means that algal build-up would be limited by the fluctuation in flows.



☑ Suspended sediment load [F season]

Desc	% PD	Y
Min	0.00	2.00
MinPD	25.00	1.00
	50.00	0.50
Median	100.00	0.00
	150.00	-0.10
Max PD	200.00	-0.50
Max	250.00	-1.00

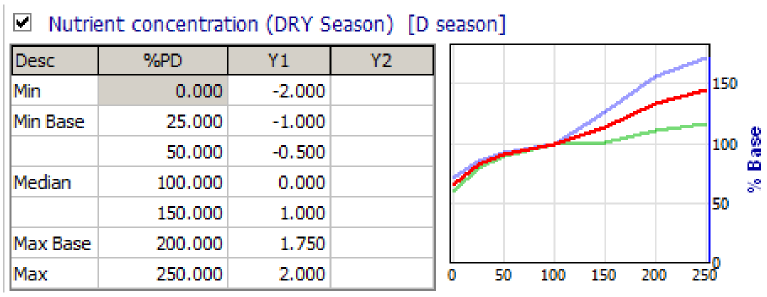
Suspended sediments affect light penetration, which the algae need for growth. Lower loads mean more light, and more algae.



☑ Median bed sediment size (armouring) [F season]

Desc	% PD	Y
Min	0.00	0.00
MinPD	25.00	0.00
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	0.50
Max	250.00	1.00

The more stable (armoured) the bed, the greater the flows necessary to remove algae.

Chl a Biomass	
Response curve	*Explanation*
	Assuming that the pollutants are dominated by nutrients, as their concentrations decline, then so will algal productivity (Chl a).

☑ Nutrient concentration (DRY Season) [D season]

Desc	%PD	Y1	Y2
Min	0.000	-2.000	
Min Base	25.000	-1.000	
	50.000	-0.500	
Median	100.000	0.000	
	150.000	1.000	
Max Base	200.000	1.750	
Max	250.000	2.000	

D.4 Riparian Vegetation Response-curve Explanations

The explanations of the Response Curves are tabulated as follows:

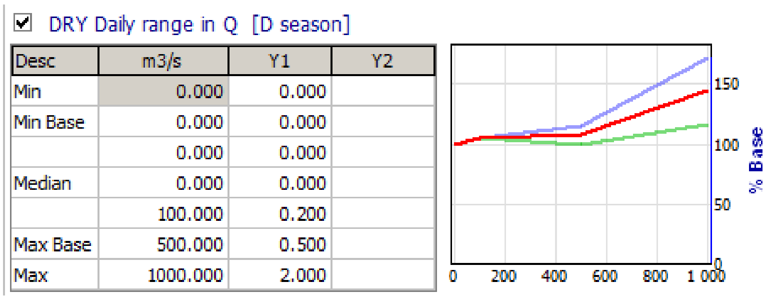
Exhibit D.13: Width of Marginal Zone

Exhibit D.14: Recruitment of Marginal Zone Vegetation

Exhibit D.13: Width of Marginal Zone

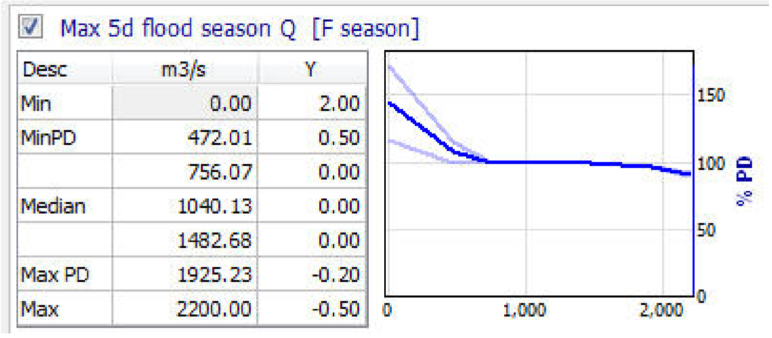
Marginal Vegetation

Response curve | *Explanation*


☑ DRY Daily range in Q [D season]

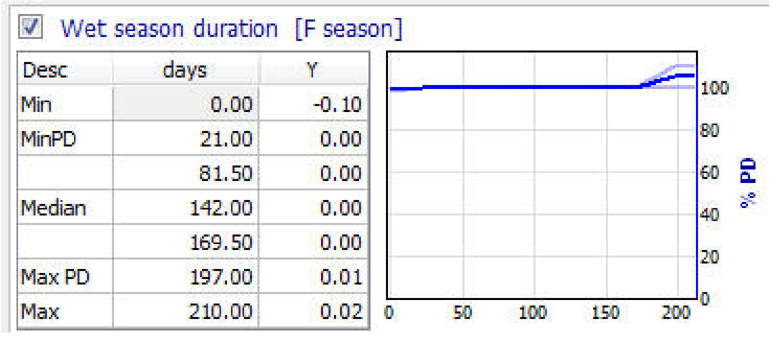
Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	100.000	0.200	
Max Base	500.000	0.500	
Max	1000.000	2.000	

Fluctuating water levels will increase the width of the marginal zone. Frequent wetting favours growth (Parson *et al.* 2005).


☑ Max 5d flood season Q [F season]

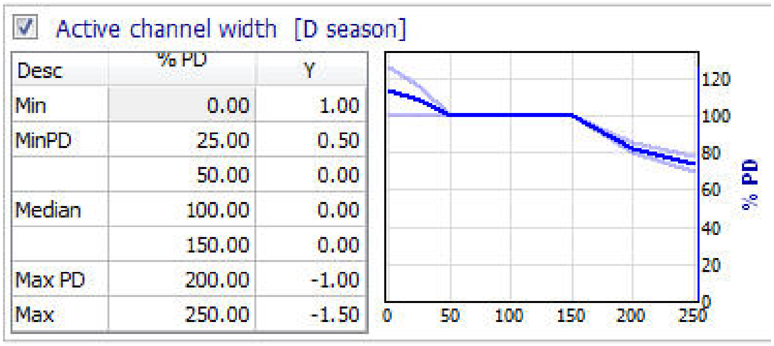
Desc	m3/s	Y
Min	0.00	2.00
MinPD	472.01	0.50
	756.07	0.00
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	-0.20
Max	2200.00	-0.50

Large floods may clear adults and smaller floods may clear saplings; both contribute towards the creation of riparian vegetation nursery sites that promote recruitment.


☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	-0.10
MinPD	21.00	0.00
	81.50	0.00
Median	142.00	0.00
	169.50	0.00
Max PD	197.00	0.01
Max	210.00	0.02

Increased water availability favours growth of saplings and adults, a few saplings may perish during extreme drought but adults should persist.


☑ Active channel width [D season]

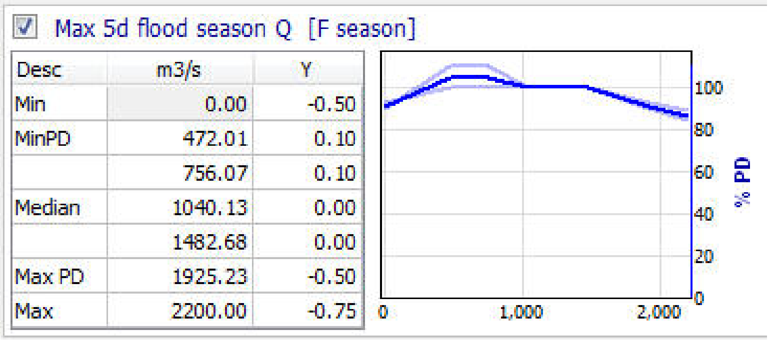
Desc	% PD	Y
Min	0.00	1.00
MinPD	25.00	0.50
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	-1.00
Max	250.00	-1.50

Active channel narrowing increases the marginal surface area available over the old active channel bed for colonisation of vegetation. Active channel widening decreases the colonisable surface due to bank steepening IF channel widening results in near vertical banks that 'eat' outwards.

Exhibit D.14: Recruitment of Marginal Zone Vegetation

Recruitment of Marginal Zone Vegetation

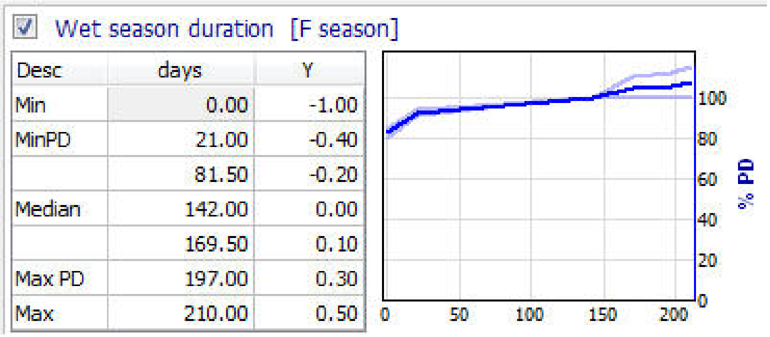
Response curve	*Explanation*



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-0.50
MinPD	472.01	0.10
	756.07	0.10
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	-0.50
Max	2200.00	-0.75

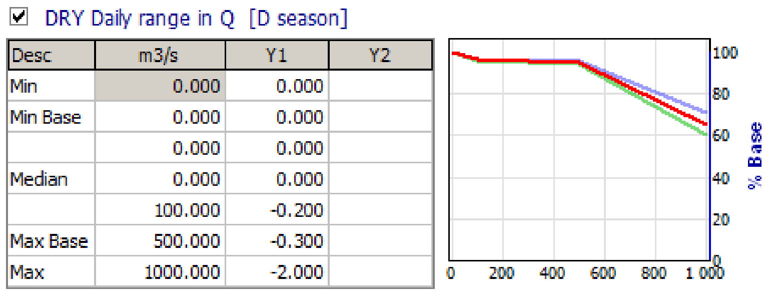
Reduced water availability decreases abundance of seedling establishment.



☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	-1.00
MinPD	21.00	-0.40
	81.50	-0.20
Median	142.00	0.00
	169.50	0.10
Max PD	197.00	0.30
Max	210.00	0.50

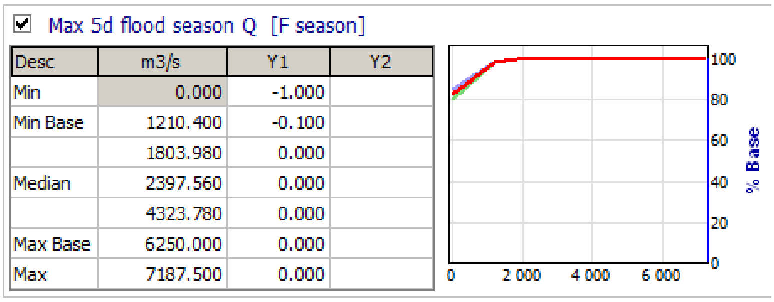
Increased duration of the wet seasons favours seedling establishment and growth and also increases opportunities for seed dispersal.



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	100.000	-0.200	
Max Base	500.000	-0.300	
Max	1000.000	-2.000	

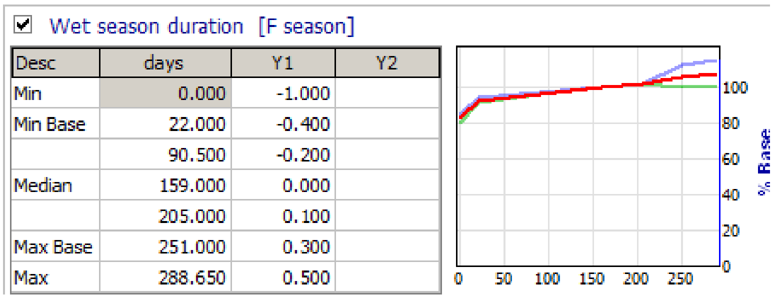
Large fluctuations in daily discharge will disrupt recruitment of marginal vegetation.



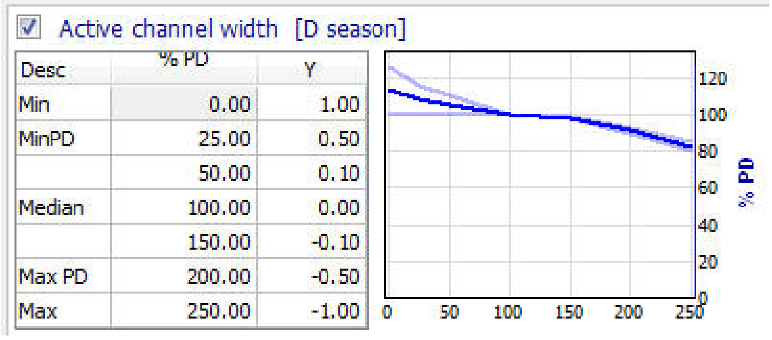
☑ Max 5d flood season Q [F season]

Desc	m3/s	Y1	Y2
Min	0.000	-1.000	
Min Base	1210.400	-0.100	
	1803.980	0.000	
Median	2397.560	0.000	
	4323.780	0.000	
Max Base	6250.000	0.000	
Max	7187.500	0.000	

Reduced water availability decreases abundance of seedling establishment.

<table>
<tr><th colspan="2">Recruitment of Marginal Zone Vegetation</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>


☑ Wet season duration [F season]

<table>
<tr><th>Desc</th><th>days</th><th>Y1</th><th>Y2</th></tr>
<tr><td>Min</td><td>0.000</td><td>-1.000</td><td></td></tr>
<tr><td>Min Base</td><td>22.000</td><td>-0.400</td><td></td></tr>
<tr><td></td><td>90.500</td><td>-0.200</td><td></td></tr>
<tr><td>Median</td><td>159.000</td><td>0.000</td><td></td></tr>
<tr><td></td><td>205.000</td><td>0.100</td><td></td></tr>
<tr><td>Max Base</td><td>251.000</td><td>0.300</td><td></td></tr>
<tr><td>Max</td><td>288.650</td><td>0.500</td><td></td></tr>
</table>
</td><td>Increased duration of the wet seasons favours seedling establishment and growth and also increases opportunities for seed dispersal.</td></tr>
<tr><td>


☑ Active channel width [D season]

<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>1.00</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>0.50</td></tr>
<tr><td></td><td>50.00</td><td>0.10</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>-0.10</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>-0.50</td></tr>
<tr><td>Max</td><td>250.00</td><td>-1.00</td></tr>
</table>
</td><td>Active channel narrowing increases the marginal surface area available over the old active channel bed for colonisation by vegetation. Active channel widening decreases the colonisable surface due to bank steepening IF channel widening results in near vertical banks that erode outwards.</td></tr>
</table>

D.5 Macroinvertebrate Response-curve Explanations

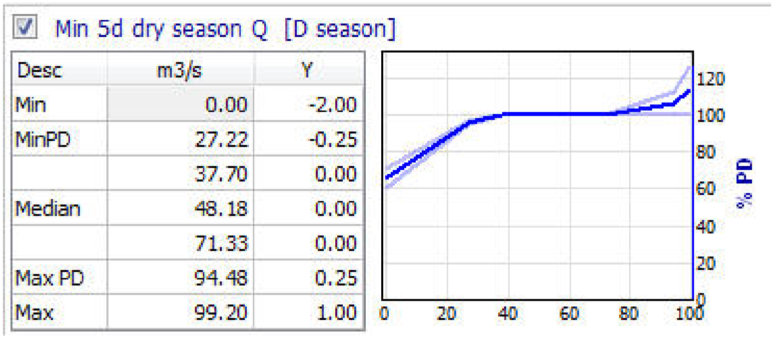
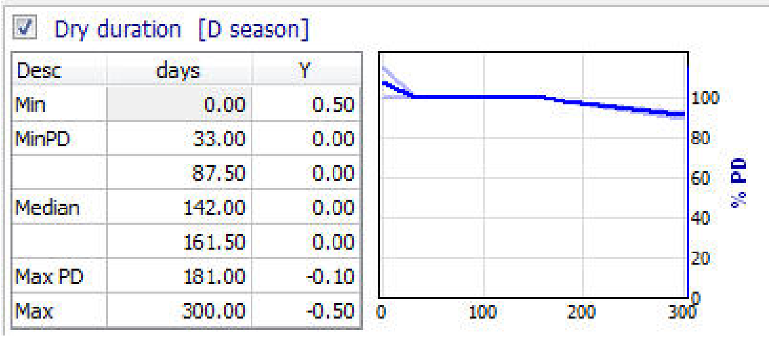
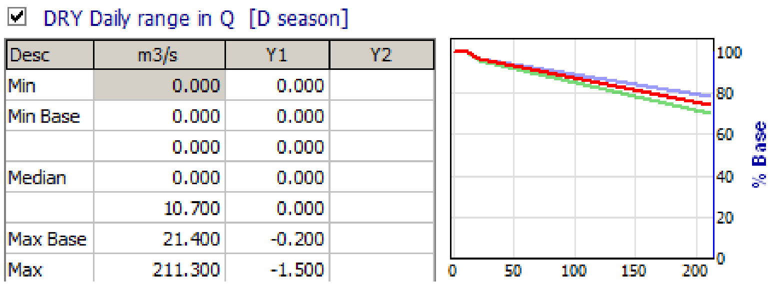
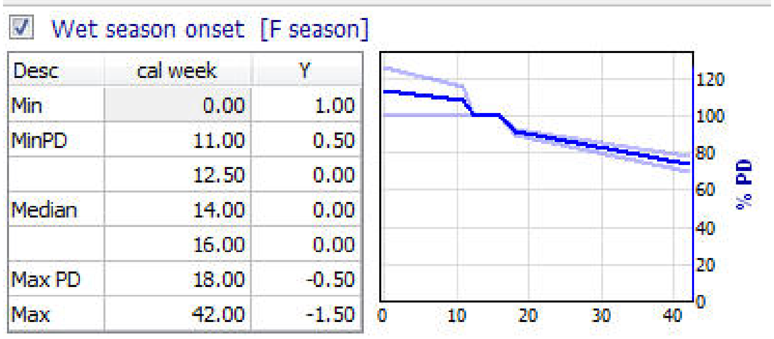
The explanations of the Response Curves are tabulated as follows:

Exhibit D.15: EPT Abundance

Exhibit D.16: EPT Diversity

Exhibit D.15: EPT Abundance

EPT Abundance

Response curve	*Explanation*
	With less discharge there will be less wetted area and so less macroinvertebrate habitat and an expected decrease in abundance of EPT invertebrates. This would become more pronounced at very low flows as the river shrinks across its bed. In years with low flows above the median, habitat availability will improve so abundances should increase.
	Aquatic invertebrates have life-histories that are adapted to wide variations in seasonal flows, but populations are likely to drop slightly if the low-flow period is too long. A longer period of low flows is also likely to increase the risks of mortality as a result of high water temperature once the seasons change.
	The physical disturbance associated with fluctuating water levels and velocities will negatively affect EPT abundance.
	A delayed onset of the flood season could affect cues for various stages of the insect's life-cycles, perhaps delaying emergence of the adults, mating and laying eggs (Suren and Jowett, 2006).

☑ Min 5d dry season Q [D season]

Desc	m3/s	Y
Min	0.00	-2.00
MinPD	27.22	-0.25
	37.70	0.00
Median	48.18	0.00
	71.33	0.00
Max PD	94.48	0.25
Max	99.20	1.00

☑ Dry duration [D season]

Desc	days	Y
Min	0.00	0.50
MinPD	33.00	0.00
	87.50	0.00
Median	142.00	0.00
	161.50	0.00
Max PD	181.00	-0.10
Max	300.00	-0.50

☑ DRY Daily range in Q [D season]

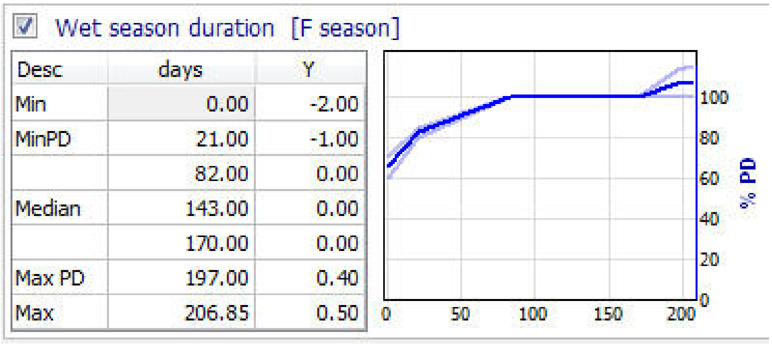
Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	10.700	0.000	
Max Base	21.400	-0.200	
Max	211.300	-1.500	

☑ Wet season onset [F season]

Desc	cal week	Y
Min	0.00	1.00
MinPD	11.00	0.50
	12.50	0.00
Median	14.00	0.00
	16.00	0.00
Max PD	18.00	-0.50
Max	42.00	-1.50

EPT Abundance

Response curve	*Explanation*

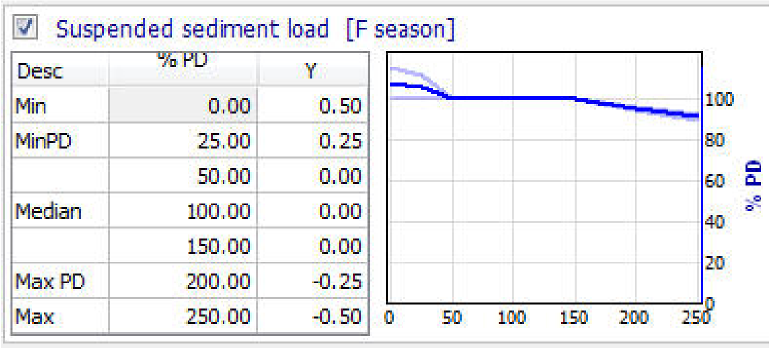


☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	-2.00
MinPD	21.00	-1.00
	82.00	0.00
Median	143.00	0.00
	170.00	0.00
Max PD	197.00	0.40
Max	206.85	0.50

The normal length of the wet season provides time for eggs to be laid, and the aquatic nymphs/larvae to mature and emerge as adults (Bispo *et al*. 2006). Slightly longer wet seasons may enhance the success of slow maturing individuals.

The absence of a wet period will not provide the cues needed for hatching of eggs (Cobb *et al*. 1992; De Jalon *et al*. 1994).

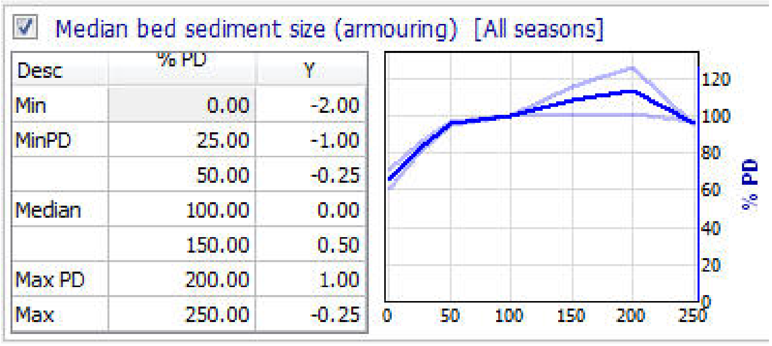


☑ Suspended sediment load [F season]

Desc	% PD	Y
Min	0.00	0.50
MinPD	25.00	0.25
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	-0.25
Max	250.00	-0.50

A reduction in the mean sediments suspended in the water column, and thus in turbidity, in the warm summer season could increase primary production of aquatic plants. This would provide more food for invertebrates (Huggins *et al*. 2007; and many others).

A concomitant drop in suspended sand will also reduce abrasion, and thus favour higher populations of invertebrates.



☑ Median bed sediment size (armouring) [All seasons]

Desc	% PD	Y
Min	0.00	-2.00
MinPD	25.00	-1.00
	50.00	-0.25
Median	100.00	0.00
	150.00	0.50
Max PD	200.00	1.00
Max	250.00	-0.25

Macroinvertebrates have a positive relationship with large substrate sizes, including gravel and cobbles. In particular, cobble form the ideal habitat for macroinvertebrates, especially the EPT (Matthaei *et al*. 2000). The invertebrates mainly favour areas with gravel and cobbles, which provide habitat for breeding and growth - it avoids areas of fine sediments (Nikora *et al.* 1998). Armouring of the river bed would increase the productivity of EPT while fine sediment in the bed would reduce the area available for breeding, growth and development by choking the interstitial spaces of the sediment which form the micro-habitat for macro-invertebrates

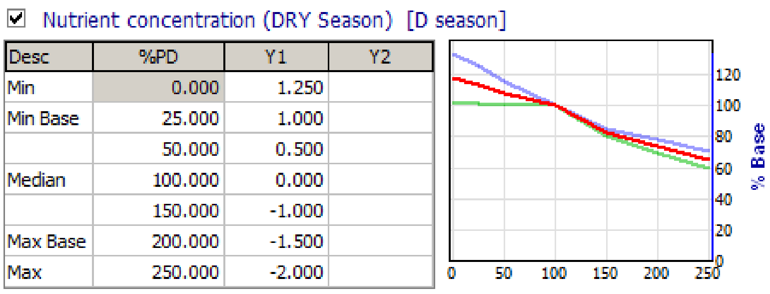
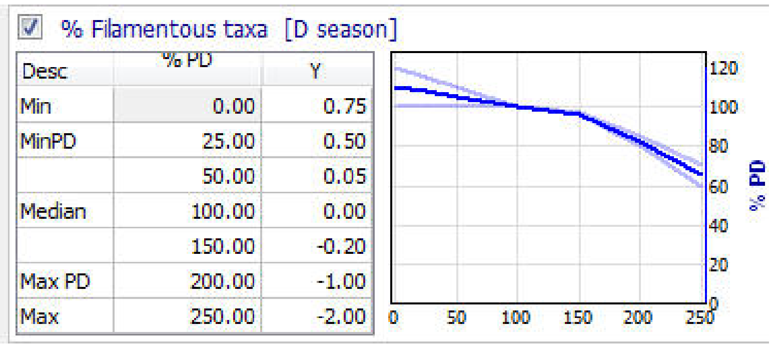
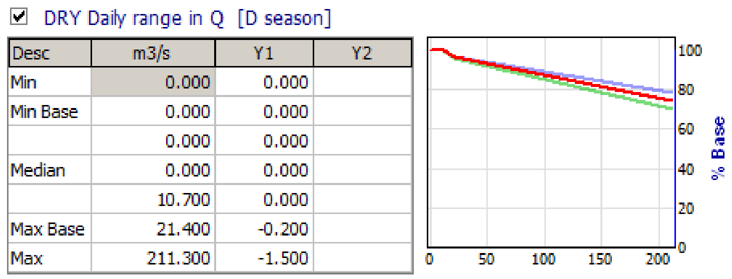
<table>
<tr><th colspan="2"><i>EPT Abundance</i></th></tr>
<tr><th><i>Response curve</i></th><th><i>Explanation</i></th></tr>
<tr><td></td><td>like EPT (Quinn <i>et al</i>, 1992). Fine sediments are difficult habitats to survive on as they provide little to attach to. The EPT species thrive on river beds with coarser substrata as they can hold position in strong flows and find some hydraulic cover behind cobbles and boulders. If these bed elements become scarcer due to further armouring, they decline in abundance due to lack of hydraulic cover (Berry <i>et al.</i> 2003).</td></tr>
<tr><td>
☑ Nutrient concentration (DRY Season) [D season]
<table>
<tr><th>Desc</th><th>%PD</th><th>Y1</th><th>Y2</th></tr>
<tr><td>Min</td><td>0.000</td><td>1.250</td><td></td></tr>
<tr><td>Min Base</td><td>25.000</td><td>1.000</td><td></td></tr>
<tr><td></td><td>50.000</td><td>0.500</td><td></td></tr>
<tr><td>Median</td><td>100.000</td><td>0.000</td><td></td></tr>
<tr><td></td><td>150.000</td><td>-1.000</td><td></td></tr>
<tr><td>Max Base</td><td>200.000</td><td>-1.500</td><td></td></tr>
<tr><td>Max</td><td>250.000</td><td>-2.000</td><td></td></tr>
</table>
</td><td>Although most EPT taxa are sensitive to pollution, some taxa, such as baetids and hydropsychids, can tolerate an increase in pollutant concentrations and may even increase in abundance as more sensitive EPT taxa are lost. Therefore the balance of a loss of some EPT taxa and an increase in the abundance of the more hardy taxa will result in a zero change in abundance with a moderate increase in pollution. But as pollution increases further, there will be some loss of even these less sensitive and other taxa such as chironomids eventually out-complete them</td></tr>
<tr><td>
☑ % Filamentous taxa [D season]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>0.75</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>0.50</td></tr>
<tr><td></td><td>50.00</td><td>0.05</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>-0.20</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>-1.00</td></tr>
<tr><td>Max</td><td>250.00</td><td>-2.00</td></tr>
</table>
</td><td>Many of the EPT taxa are sensitive to a reduction in habitat quality. As the % of filamentous algal taxa increase, so habitat quality decreases and more hardy taxa such as chironomids proliferate resulting in a lower EPT. However, the reduction is not so severe because currently there is very low abundance of filamentous taxa at this site (Site 1).</td></tr>
</table>

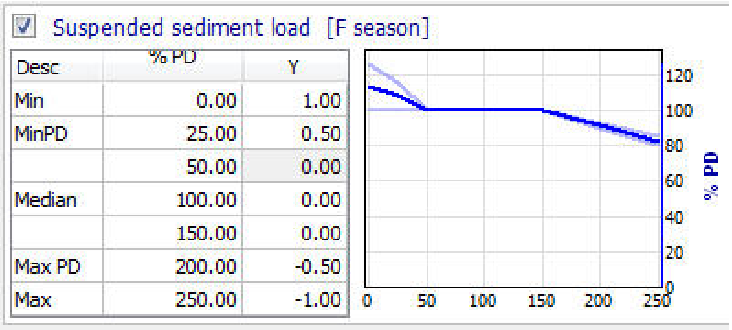
Exhibit D.16: EPT Diversity

EPT Diversity

Response Curve	*Explanation*
	The physical disturbance associated with fluctuating water levels and velocities will negatively affect EPT abundance.

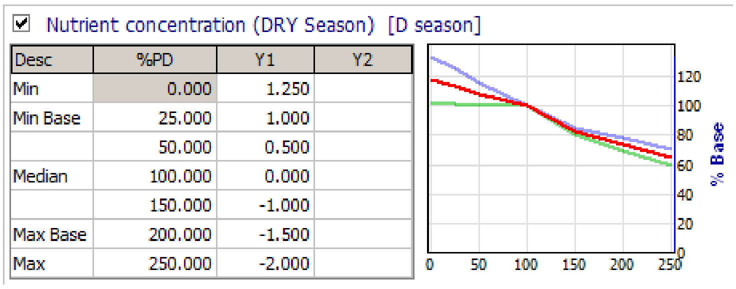
☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	10.700	0.000	
Max Base	21.400	-0.200	
Max	211.300	-1.500	

Response Curve	*Explanation*
	Reduced turbidity will increase light penetration and improve primary production. This should enhance EPT diversity.

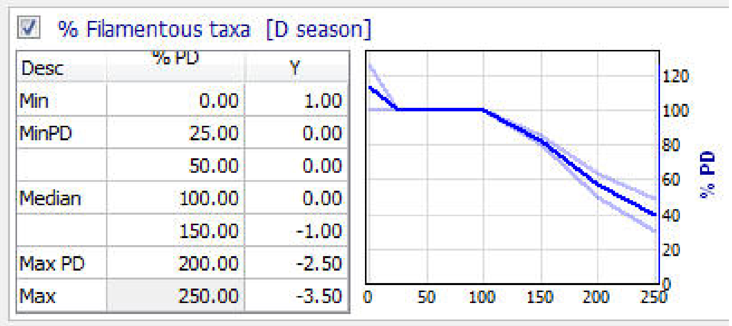
☑ Suspended sediment load [F season]

Desc	% PD	Y
Min	0.00	1.00
MinPD	25.00	0.50
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	-0.50
Max	250.00	-1.00

Response Curve	*Explanation*
	11 of the 15 EPT taxa found at Site 1 are sensitive to pollution and therefore, doubling the concentration of sewerage is likely to result is about a 70-80% reduction in the diversity of EPT taxa.

☑ Nutrient concentration (DRY Season) [D season]

Desc	%PD	Y1	Y2
Min	0.000	1.250	
Min Base	25.000	1.000	
	50.000	0.500	
Median	100.000	0.000	
	150.000	-1.000	
Max Base	200.000	-1.500	
Max	250.000	-2.000	

Response Curve	*Explanation*
	An increase in the filamentous algal taxa would result in a loss of taxa that are sensitive to habitat availability.

☑ % Filamentous taxa [D season]

Desc	% PD	Y
Min	0.00	1.00
MinPD	25.00	0.00
	50.00	0.00
Median	100.00	0.00
	150.00	-1.00
Max PD	200.00	-2.50
Max	250.00	-3.50

D.6 Fish Response-curve Explanations

The explanations of the Response Curves are tabulated as follows:

Exhibit D.17: Alwan Snow Trout

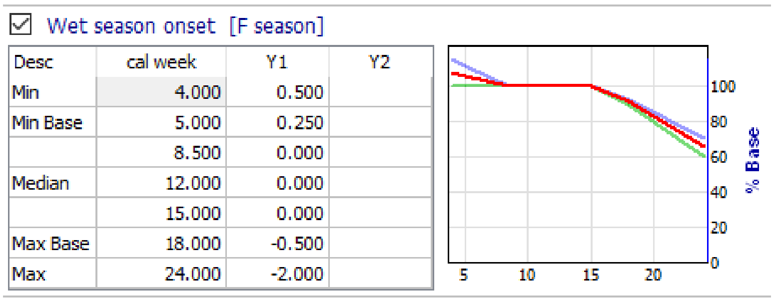
Exhibit D.18: Kashmir Hillstream Loach

Exhibit D.19: Nalbant's Loach

Exhibit D.17: Alwan Snow Trout

Alwan Snow Trout

Response curve



☑ Wet season onset [F season]

Desc	cal week	Y1	Y2
Min	4.000	0.500	
Min Base	5.000	0.250	
	8.500	0.000	
Median	12.000	0.000	
	15.000	0.000	
Max Base	18.000	-0.500	
Max	24.000	-2.000	

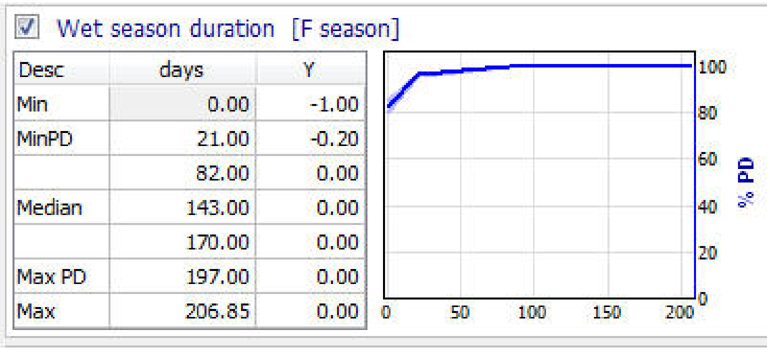
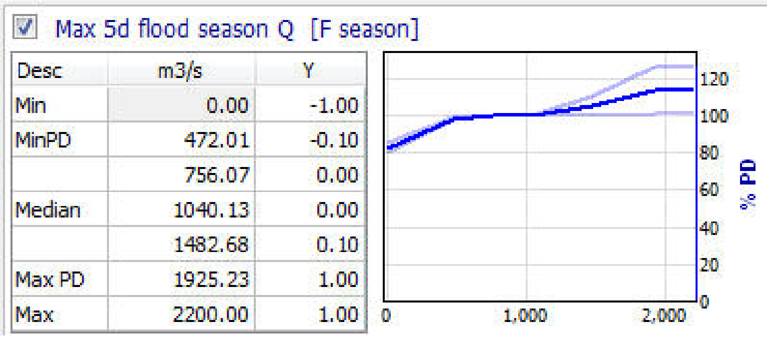
Explanation

The Alwan Snow Trout breeds during the summer season from May to August (Negi 1994). By this time of the year, the fish eggs reach their final stage of maturity provided there is sufficient food for proper development of eggs. Once the eggs reach their final stage of maturity, the fish can spawn under various triggers such as snowmelt, rise in water temperature, comparatively higher turbidity level, swelling of rivers, creation of side channels etc. These triggers are mainly linked with the monsoon rains and snowmelt in the upper reaches of the Himalayan rivers (Rafique and Qureshi 1997). These triggers for successful spawning need to coincide with the maturity of eggs in the ovary of fish.

An early onset of the flood season (a month before the median) is predicted to lead to increased availability of food for the fish early in the season, which allows proper development of eggs and improved breeding.

Delayed onset of the flood season is predicted to result in failure of fish with mature eggs to spawn if they miss the necessary triggers for breeding. Eggs could perish within the fish and be reabsorbed. Much reduced volumes in the flood season would mean that breeding habitats in the side channels are not replenished and are not available for breeding.

Alwan Snow Trout

Response curve	*Explanation*
	The flood season must be long enough for spawning and hatching to occur and for fry to grow. In very long or short flood seasons, maturity of eggs in both early and late spawning fish would not coincide with spawning cues (Sunder 1997). In years when the flood season is shorter than normal, there is likely to be an adverse impact on the fish, similar to that for delayed onset of flood season, as the maturity of eggs in the fish would not coincide with the spawning cues resulting in reduced breeding success. Abnormally short flood seasons could result in a complete failure of the breeding season. A longer flood season in a particular year is predicted to enhance the survival rate for the fry and fingerlings due to higher temperatures and better availability of food.
	Higher flows in flood season flush the habitat, removing debris, silt and sediments. Flood peaks scour pools, which are overwintering and feeding habitat for the fish (Reiser *et al.* 1987). In years when there are lower peak flows in the flood season there is likely to be a reduction in breeding habitat, which would negatively impact breeding success (McKinney *et al.* 1999), although this is minor. With a reduction in wet peaks, pools would become shallower. Reduced flood season flows would

☑ Wet season duration [F season]

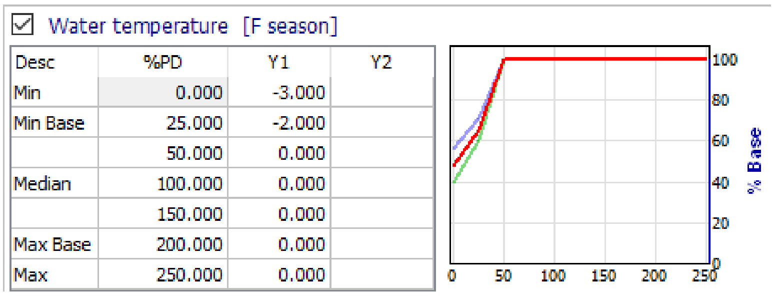
Desc	days	Y
Min	0.00	-1.00
MinPD	21.00	-0.20
	82.00	0.00
Median	143.00	0.00
	170.00	0.00
Max PD	197.00	0.00
Max	206.85	0.00

☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-1.00
MinPD	472.01	-0.10
	756.07	0.00
Median	1040.13	0.00
	1482.68	0.10
Max PD	1925.23	1.00
Max	2200.00	1.00

Alwan Snow Trout

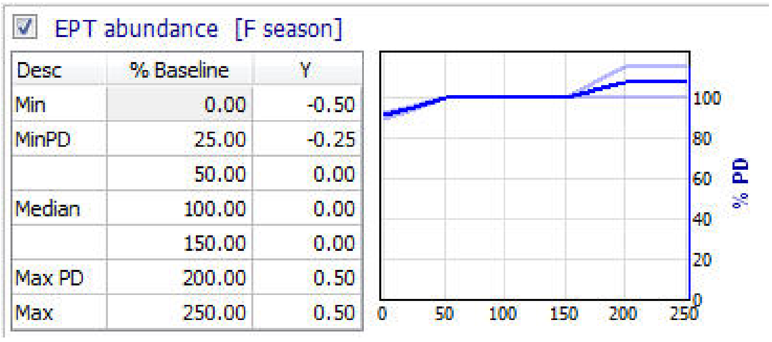
Response curve	*Explanation*
	also affect spawning success and water temperatures (through less buffering of higher temperatures). In years when there are higher peak flows, as long as they remain within natural limits, the habitat and productivity is maintained resulting in higher survival rates for fish fry and fingerlings.



☑ Water temperature [F season]

Desc	%PD	Y1	Y2
Min	0.000	-3.000	
Min Base	25.000	-2.000	
	50.000	0.000	
Median	100.000	0.000	
	150.000	0.000	
Max Base	200.000	0.000	
Max	250.000	0.000	

Alwan Snow Trout are sensitive to very cold temperatures and will tend to migrate away from these areas. Very cold temperatures also reduce the chances of breeding and breeding success. There is however some evidence that the fish can adapt morphologically to lower temperatures (Rajput *et al.* 2013), with fish in low temperature areas being smaller and more cylindrical.



☑ EPT abundance [F season]

Desc	% Baseline	Y
Min	0.00	-0.50
MinPD	25.00	-0.25
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	0.50
Max	250.00	0.50

Alwan Snow Trout are omnivorous and feed on benthic plants and aquatic invertebrates (mainly EPT; Raina and Petr 1999). They are opportunist feeders and their dependence on invertebrates varies depending on the season and stage of maturity.

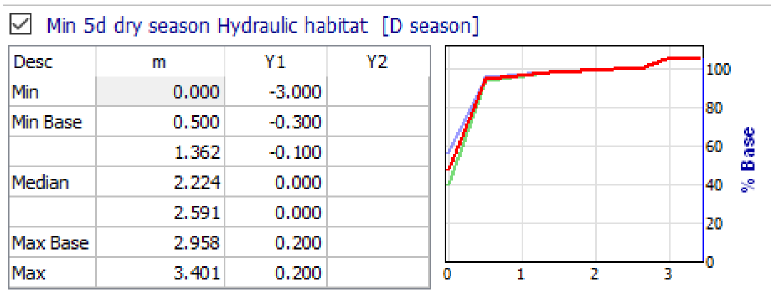
In years with low EPT productivity, the fish would have less invertebrate food and the population would be compromised (Jhingran 1991).

In years with high EPT productivity, all age classes of fish would have better growth and fattening for overwintering and a high fecundity rate, which would

Alwan Snow Trout

Response curve | *Explanation*

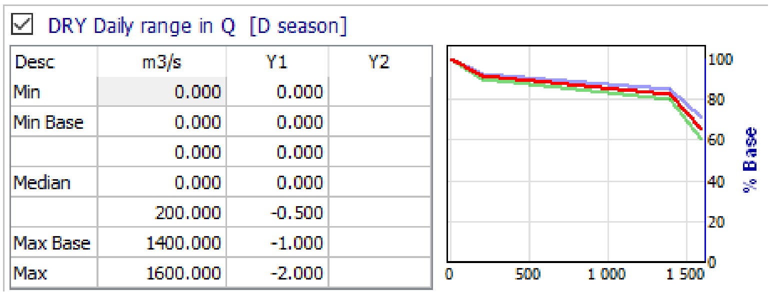
lead to overall higher numbers.



☑ Min 5d dry season Hydraulic habitat [D season]

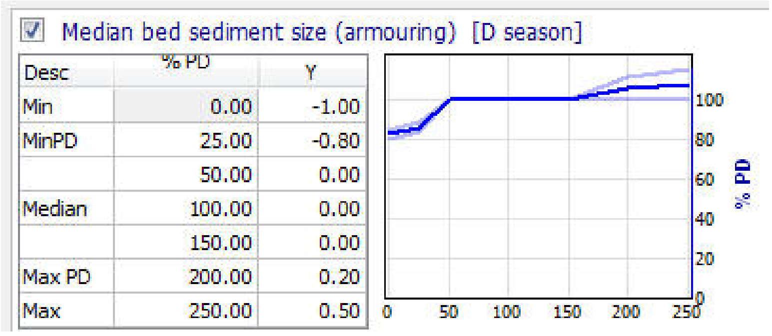
Desc	m	Y1	Y2
Min	0.000	-3.000	
Min Base	0.500	-0.300	
	1.362	-0.100	
Median	2.224	0.000	
	2.591	0.000	
Max Base	2.958	0.200	
Max	3.401	0.200	

These fish are adapted to low temperatures, and overwinter in pools and rock crevices in the main river rather than migrating to side streams.



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	200.000	-0.500	
Max Base	1400.000	-1.000	
Max	1600.000	-2.000	

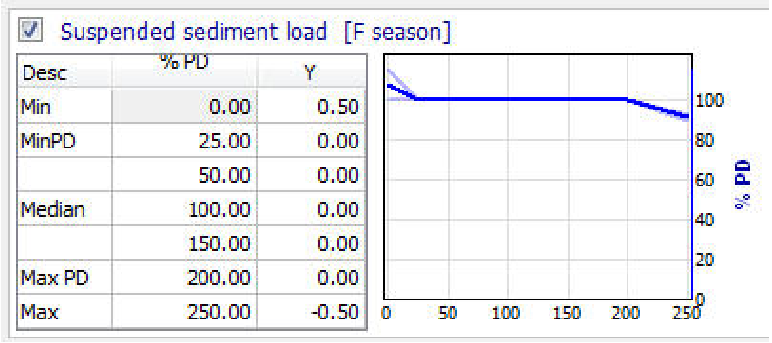
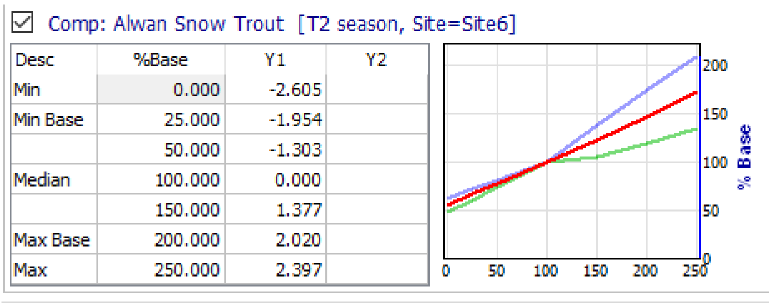


☑ Median bed sediment size (armouring) [D season]

Desc	% PD	Y
Min	0.00	-1.00
MinPD	25.00	-0.80
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	0.20
Max	250.00	0.50

The fish favour areas with gravel and algae. Gravel beds, free of fine sediment, provide habitat for attached algae and are the feeding and breeding grounds for Alwan Snow Trout. Armouring would increase the availability of food for this fish, while fine sediment in the bed would reduce the area available for algal growth (Talwar and Jhingran 1991; Raina and Petr 1999).

With decreasing particles size, there would be a higher chance of embeddedness of the spawning areas. The smaller particles fill the interstitial spaces and make it hard for attached algae to grow on the gravely and cobble bed resulting into productivity of less food for fish and hence result in a considerable decrease in fish population.

Alwan Snow Trout	
Response curve	*Explanation*
	Accumulation of larger particles in the river bed (armouring) result in a growth of attached algae which is food for the fish. It also becomes the breeding habitat for fish as it prefers the gravelly and cobble beds for breeding. Consequently, the armouring of the bed results in a modest increase in fish population.
	Alwan Snow Trout are able to cope with high turbidity loads. There are no Brown Trout in this reach, and so reduced turbidity should not present much of a problem - but will affect habitat (see median bed size).
	Alwan Snow Trout breeds during May and June in the upper reaches of the Jhelum River even in the areas upstream of line of control. Breeding potential gradually decreases as we move downstream in the Jhelum River. It breeds in the area of Jhelum River upstream of Kohala Weir (25%), Jhelum River between confluence with Neelum and Kohala Weir (25%), Neelum River between NJHEP and confluence with the Jhelum River (15%), Jhelum River between confluence with Neelum and NJHEP /Kohala tailraces (15%), Kunnar River (15%), and to some extent in the areas Jhelum River between NJHEP /Kohala tailraces and Karot (5%).

☑ Suspended sediment load [F season]

Desc	% PD	Y
Min	0.00	0.50
MinPD	25.00	0.00
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	0.00
Max	250.00	-0.50

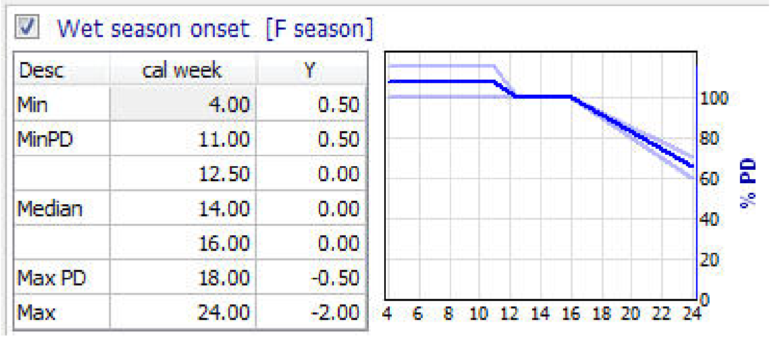
☑ Comp: Alwan Snow Trout [T2 season, Site=Site6]

Desc	%Base	Y1	Y2
Min	0.000	-2.605	
Min Base	25.000	-1.954	
	50.000	-1.303	
Median	100.000	0.000	
	150.000	1.377	
Max Base	200.000	2.020	
Max	250.000	2.397	

Exhibit D.18: Kashmir Hillstream Loach

Kashmir Hillstream Loach

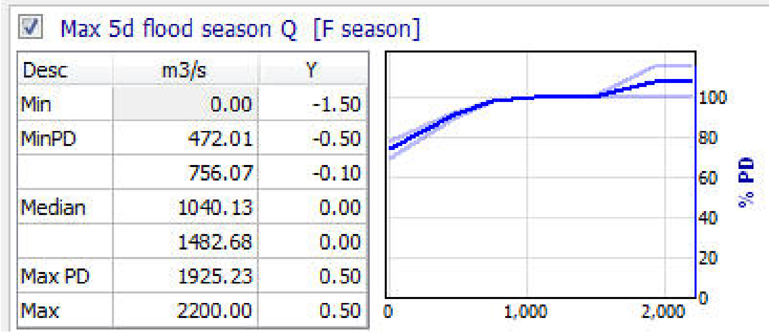
Response curve	*Explanation*



☑ Wet season onset [F season]

Desc	cal week	Y
Min	4.00	0.50
MinPD	11.00	0.50
	12.50	0.00
Median	14.00	0.00
	16.00	0.00
Max PD	18.00	-0.50
Max	24.00	-2.00

Delayed onset of the wet season means missing spawning cues (May to August).



☑ Max 5d flood season Q [F season]

Desc	m3/s	Y
Min	0.00	-1.50
MinPD	472.01	-0.50
	756.07	-0.10
Median	1040.13	0.00
	1482.68	0.00
Max PD	1925.23	0.50
Max	2200.00	0.50

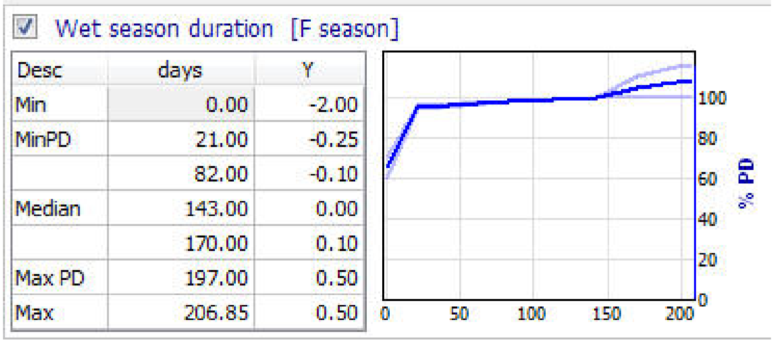
Higher flows in flood season flush the habitat by removing debris, silt and sediments in the river bed. Flood peaks scour pools, which are overwintering and feeding habitat for the fish (Reiser *et al*. 1987).

In years when there are lower peak flows in the flood season, there is likely to be a reduction in suitable breeding habitat, which would negatively impact breeding success (McKinney *et a*l. 1999). Reduced flood season would also affect the spawning triggers negatively affecting the breeding process.

In years when there are higher peak flows, as long as they remain within natural limits, the habitat and productivity is maintained, resulting in higher survival rates for fish fry and fingerlings. Deeper pools developed by higher flood flows would improve survival of the fish in the dry season.

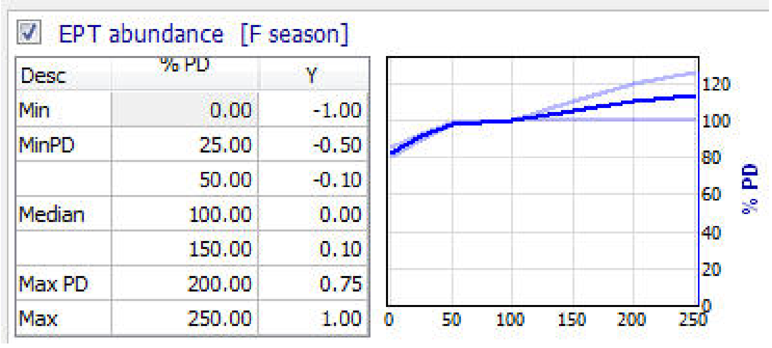
Kashmir Hillstream Loach

Response curve	*Explanation*
See below (Wet season duration)	The flood season must be long enough for breeding and for fry to grow. In very long or short flood seasons, maturity of eggs in both early and late spawning fish would not coincide with spawning cues (Amanov 1985). In years when the flood season is shorter than normal, there is likely to be an adverse impact on the fish similar to that for delayed onset of flood season as the maturity of eggs in the fish would not coincide with the spawning cues, resulting in reduced breeding success. Abnormally short flood seasons could result in failure of the breeding season. A longer flood season in a particular year is predicted to enhance the survival rate for the fry and fingerlings due to higher temperatures and better availability of food.
See below (EPT abundance)	Kashmir Hillstream Loach are strictly carnivorous and feed on aquatic invertebrates mainly EPT (Hora 1936). The fish eat only invertebrates irrespective of the season and stage of maturity. In years with low productivity of EPT, the fish would have less food and the population of fish would be compromised (Jhingran 1991). In years with high EPT productivity, all age classes of fish would have plenty of food, which would promote growth and fattening for overwintering and higher fecundity rates, leading to an



☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	-2.00
MinPD	21.00	-0.25
	82.00	-0.10
Median	143.00	0.00
	170.00	0.10
Max PD	197.00	0.50
Max	206.85	0.50

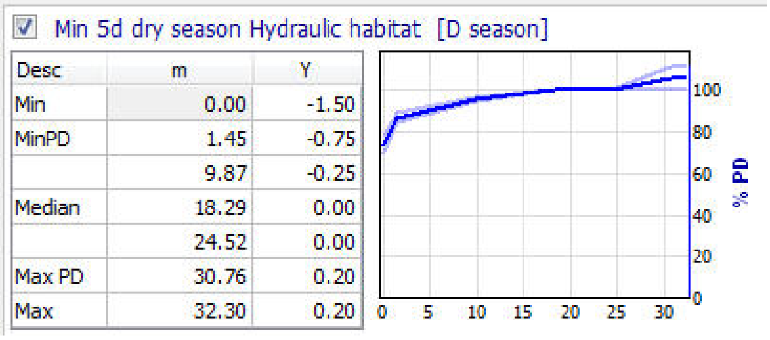


☑ EPT abundance [F season]

Desc	% PD	Y
Min	0.00	-1.00
MinPD	25.00	-0.50
	50.00	-0.10
Median	100.00	0.00
	150.00	0.10
Max PD	200.00	0.75
Max	250.00	1.00

Kashmir Hillstream Loach

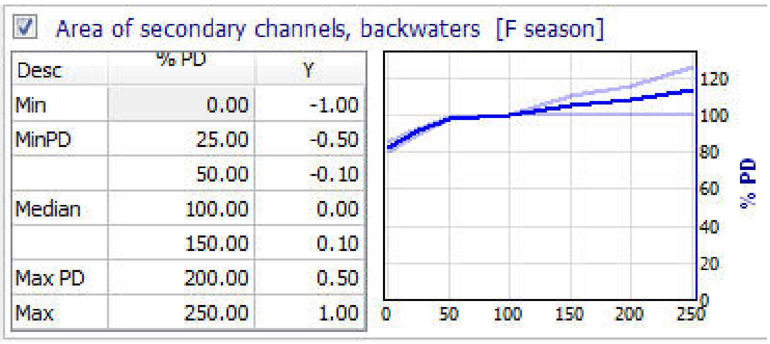
Response curve	*Explanation*
	overall increase in the population.



☑ Min 5d dry season Hydraulic habitat [D season]

Desc	m	Y
Min	0.00	-1.50
MinPD	1.45	-0.75
	9.87	-0.25
Median	18.29	0.00
	24.52	0.00
Max PD	30.76	0.20
Max	32.30	0.20

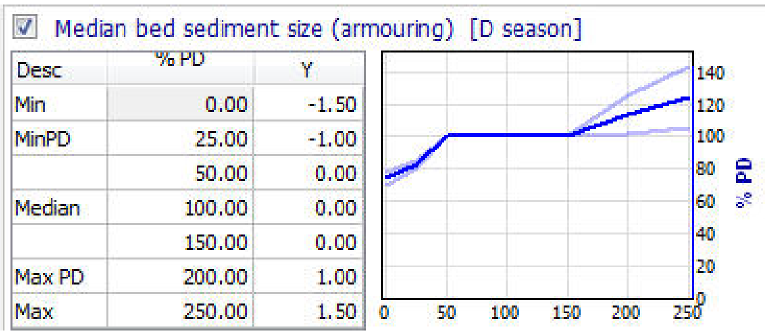
A small-sized cool-water fish inhabiting both turbid and clear water. It survives in the dry season in crevices and under the boulders protected from the main current. Low dry season hydraulic habitat will mean reduced wintering area and restricted fish movement. Some fish will survive in deeper waters with some flow, but they will be under stress.



☑ Area of secondary channels, backwaters [F season]

Desc	% PD	Y
Min	0.00	-1.00
MinPD	25.00	-0.50
	50.00	-0.10
Median	100.00	0.00
	150.00	0.10
Max PD	200.00	0.50
Max	250.00	1.00

Breeds in shallow side pools and channels with cobble beds. Avoids floods and strong flow and moves to slow side-channels and spaces between boulders closer to the banks in the flood season.



☑ Median bed sediment size (armouring) [D season]

Desc	% PD	Y
Min	0.00	-1.50
MinPD	25.00	-1.00
	50.00	0.00
Median	100.00	0.00
	150.00	0.00
Max PD	200.00	1.00
Max	250.00	1.50

The diet of smaller fish (e.g., *Triplophysa stoliczkai*) consists of small aquatic insects which are mainly produced in the interstitial spaces of the boulders and cobbles (Rosgen 1996). The habitat complexity in the form of boulders and cobbles provide refugia from predation, sites for breeding and feeding and other biotic interactions. Naturally-occurring cobble-boulder and gravel substrates are, therefore, considered excellent fish habitats (Byron 1989; Nelson and Franzin 2000).

The fish favours areas with gravel and cobbles. The gravely bed provide habitat for growth of invertebrate food and is also a feeding

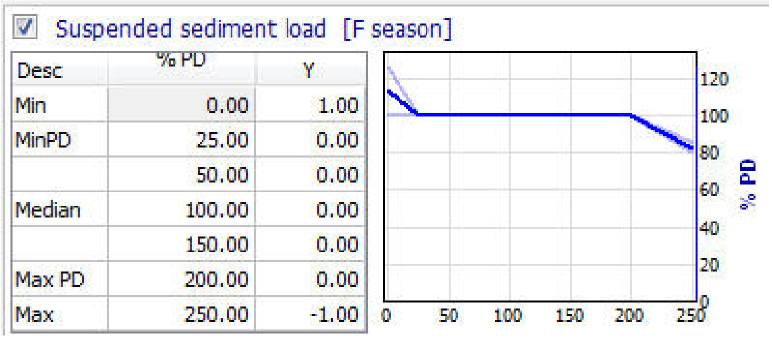
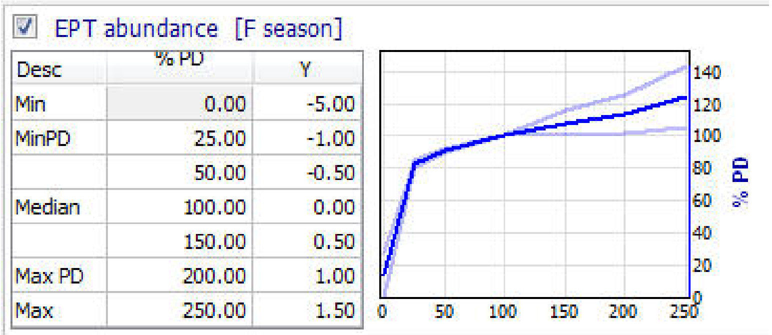
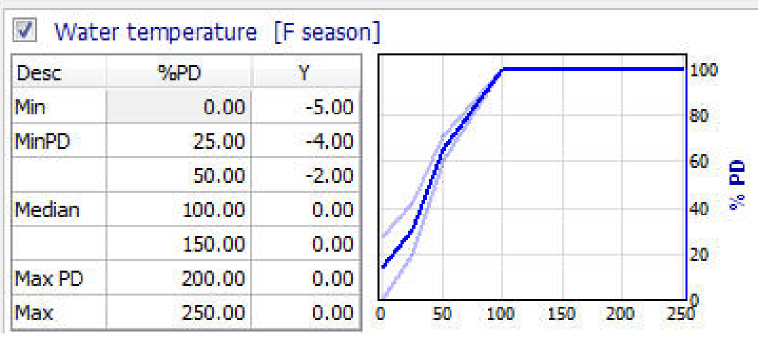
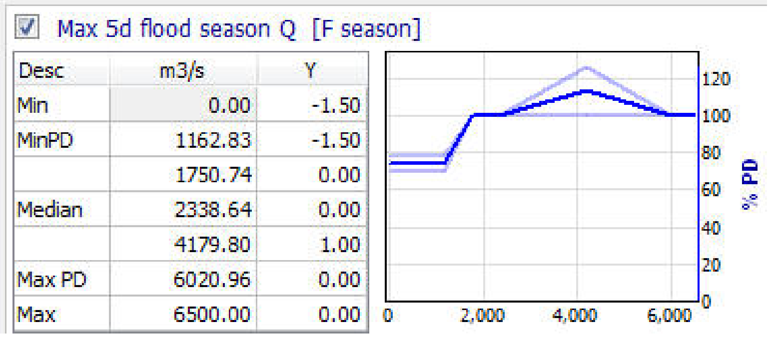
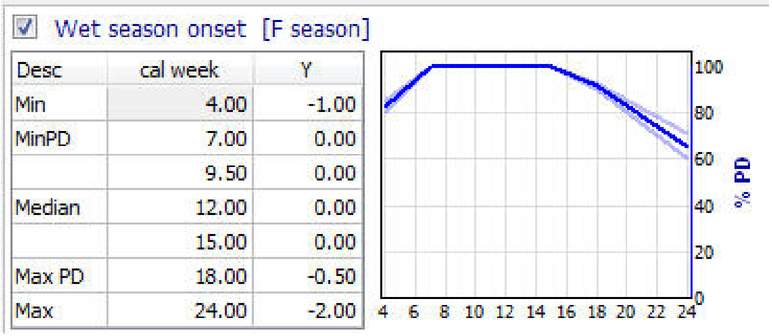
<table>
<tr><th colspan="2">Kashmir Hillstream Loach</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td></td><td>ground for fish as it avoids the areas of fine sediments. Armouring would increase the availability of food for this fish, while fine sediment in the river bed would reduce the area available for food productivity and breeding (Talwar and Jhingran 1991; Raina and Petr 1999).
With decreasing particles size, the concentration of fine particles increases cause embeddedness of the spawning areas. The smaller particles fill the interstitial spaces and make it hard for the invertebrates to grow on the gravely and cobble bed resulting into productivity of less food for fish and hence result in a considerable decrease in fish population.
Accumulation of larger particles in the river bed (armouring) result in increased abundance of invertebrates which is food for the fish. It also improves the breeding habitat for fish as it prefers the gravely and cobble beds for breeding. Consequently, the armouring of the bed results in a modest increase in fish population.</td></tr>
<tr><td>
☑ Suspended sediment load [F season]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>1.00</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>0.00</td></tr>
<tr><td></td><td>50.00</td><td>0.00</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>0.00</td></tr>
<tr><td>Max</td><td>250.00</td><td>-1.00</td></tr>
</table>
</td><td>It is unlikely that KHL will respond much over the range of sediments expected in baseline. However, if sediments are very low it will improve primary productivity and thus food sources. If they are very high, it will affect productivity (light penetration), fish condition, e.g., through clogging gills.</td></tr>
</table>

Exhibit D.19: Nalbant's Loach

<table>
<tr><th colspan="2"><i>Nalbant's Loach</i></th></tr>
<tr><th><i>Response curve</i></th><th><i>Explanation</i></th></tr>
<tr><td>

☑ EPT abundance [F season]
<table>
<tr><th>Desc</th><th>% PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-5.00</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>-1.00</td></tr>
<tr><td></td><td>50.00</td><td>-0.50</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.50</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>1.00</td></tr>
<tr><td>Max</td><td>250.00</td><td>1.50</td></tr>
</table>

</td><td>Nalbant's Loach feeds on EPT only.</td></tr>
<tr><td>

☑ Water temperature [F season]
<table>
<tr><th>Desc</th><th>%PD</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-5.00</td></tr>
<tr><td>MinPD</td><td>25.00</td><td>-4.00</td></tr>
<tr><td></td><td>50.00</td><td>-2.00</td></tr>
<tr><td>Median</td><td>100.00</td><td>0.00</td></tr>
<tr><td></td><td>150.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>200.00</td><td>0.00</td></tr>
<tr><td>Max</td><td>250.00</td><td>0.00</td></tr>
</table>

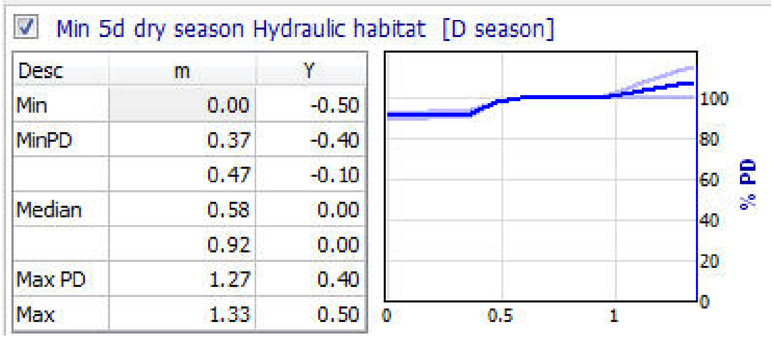
</td><td>Nalbant's Loach does not tolerate water that is less than ~15ºC.</td></tr>
<tr><td>

☑ Max 5d flood season Q [F season]
<table>
<tr><th>Desc</th><th>m3/s</th><th>Y</th></tr>
<tr><td>Min</td><td>0.00</td><td>-1.50</td></tr>
<tr><td>MinPD</td><td>1162.83</td><td>-1.50</td></tr>
<tr><td></td><td>1750.74</td><td>0.00</td></tr>
<tr><td>Median</td><td>2338.64</td><td>0.00</td></tr>
<tr><td></td><td>4179.80</td><td>1.00</td></tr>
<tr><td>Max PD</td><td>6020.96</td><td>0.00</td></tr>
<tr><td>Max</td><td>6500.00</td><td>0.00</td></tr>
</table>

</td><td>Less rejuvenation of the habitat, with lower floods.</td></tr>
<tr><td>

☑ Wet season onset [F season]
<table>
<tr><th>Desc</th><th>cal week</th><th>Y</th></tr>
<tr><td>Min</td><td>4.00</td><td>-1.00</td></tr>
<tr><td>MinPD</td><td>7.00</td><td>0.00</td></tr>
<tr><td></td><td>9.50</td><td>0.00</td></tr>
<tr><td>Median</td><td>12.00</td><td>0.00</td></tr>
<tr><td></td><td>15.00</td><td>0.00</td></tr>
<tr><td>Max PD</td><td>18.00</td><td>-0.50</td></tr>
<tr><td>Max</td><td>24.00</td><td>-2.00</td></tr>
</table>

</td><td>If the wet season comes early, fish will be triggered to spawn but the eggs in the ovary will not have reached full maturation for the ovulation stage. So early breeders will be unsuccessful. If the wet season comes very late then the eggs are mature in the ovaries but there no triggers for spawning. If slightly delayed, food availability is reduced, which may affect egg development.</td></tr>
</table>

Nalbant’s Loach

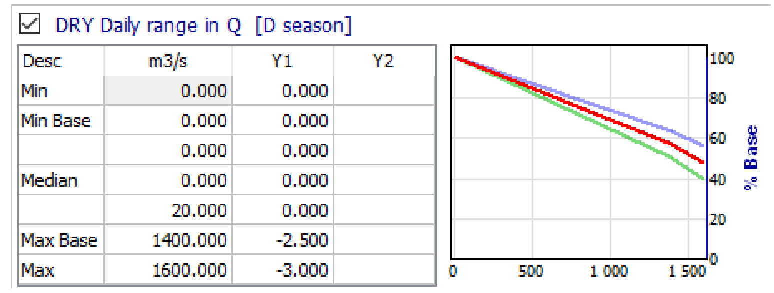
Response curve | *Explanation*



☑ Min 5d dry season Hydraulic habitat [D season]

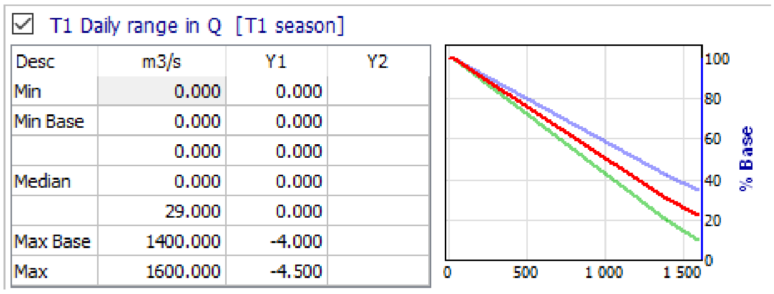
Desc	m	Y
Min	0.00	-0.50
MinPD	0.37	-0.40
	0.47	-0.10
Median	0.58	0.00
	0.92	0.00
Max PD	1.27	0.40
Max	1.33	0.50

Nalbant’s Loach breeds in side channels or in riffle areas with slow moving water with some vegetation. This hydraulic habitat matches these sorts of areas.



☑ DRY Daily range in Q [D season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	20.000	0.000	
Max Base	1400.000	-2.500	
Max	1600.000	-3.000	



☑ T1 Daily range in Q [T1 season]

Desc	m3/s	Y1	Y2
Min	0.000	0.000	
Min Base	0.000	0.000	
	0.000	0.000	
Median	0.000	0.000	
	29.000	0.000	
Max Base	1400.000	-4.000	
Max	1600.000	-4.500	

Nalbant’s Loach prefers gravel bars on the river edge. Peaking releases may dislodge this fish and remove it from its preferred habitat. This may expose it to increased predation and reduce the abundance that may return to the gravel bars during low flows. Peaking will effectively drastically reduce its available habitat to zero.

Eflow Site	*Cross Section ID*	*Survey dates**
	1-5	FS (BKTU1-A)
	1-6	FS (BKT-G1-A)
	1-7	FS (BKT-D1-A)
Downstream of Dam EF Site 2	2-1	FS (BKT-D-U1)
	2-2	FS (BKT-D-U2)
	2-3	FS (BKT-D-D1)
	2-4	FS (BKT-D-D2)
	2-5	April 12, 2017
	2-6	April 12, 2017
	2-7	April 12, 2017
Downstream of Tailrace EF Site 3	3-1	FS (BKT-P-U1)
	3-2	FS (BKT-P-U2)
	3-3	FS (BKT-P-D1)
	3-4	FS (BKT-P-D2)
	3-5	April 14, 2017
	3-6	April 14, 2017
Downstream of Balakot EF Site 4	4-1	April 14, 2017
	4-2	April 14, 2017

* FS indicates cross sectional data from the Feasibility Study

Exhibit C.2: Survey Level for Measurement of Dry Sections

Exhibit C.3: Multiple Methods Employed for Measurement of Wet Sections


Rope with 1 meter graduation


Sonar attached to graduated rope


Cross section measurement at EF site 1-1


Depth measurements in wadable areas


Verification of depths by using a rock and plumb line


Sonar measurements from boat

Exhibit C.4: Cross Section Locations – EF Site 1: Upstream of Dam

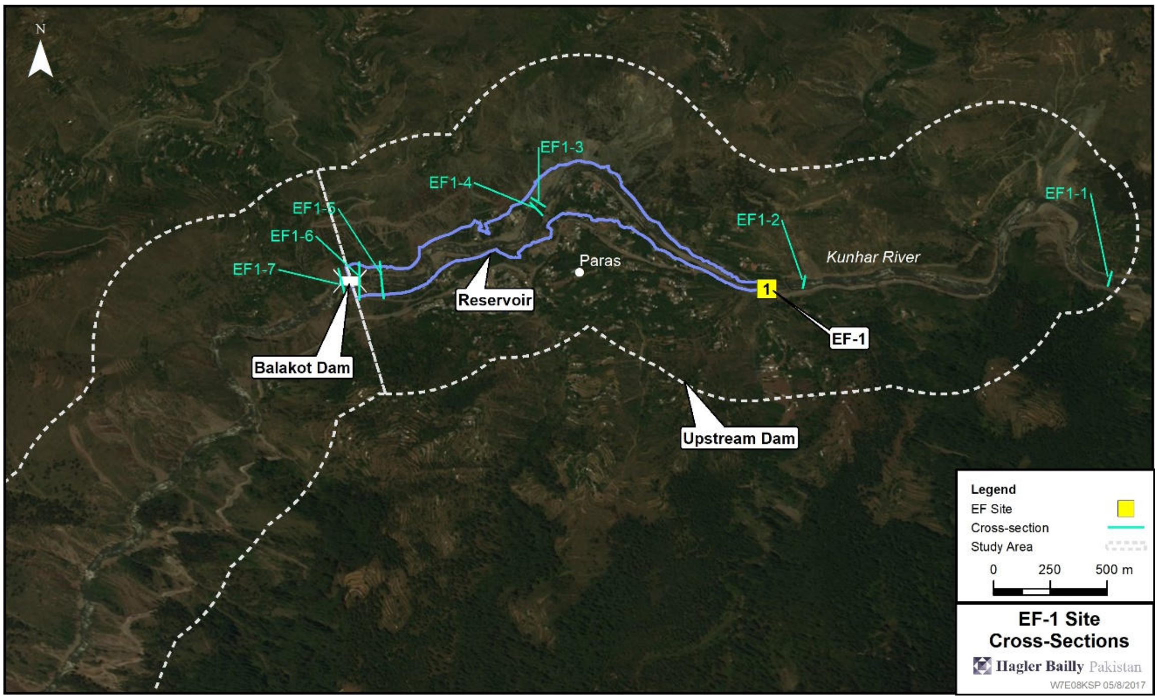


Exhibit C.5: Cross Section Photographs – EF Site 1: Upstream of Dam

Cross Section 1-1

Cross section 1-2

Cross section 1-3 and 1-4

Exhibit C.6: Cross Section Locations – EF Site 2: Downstream of Dam 2

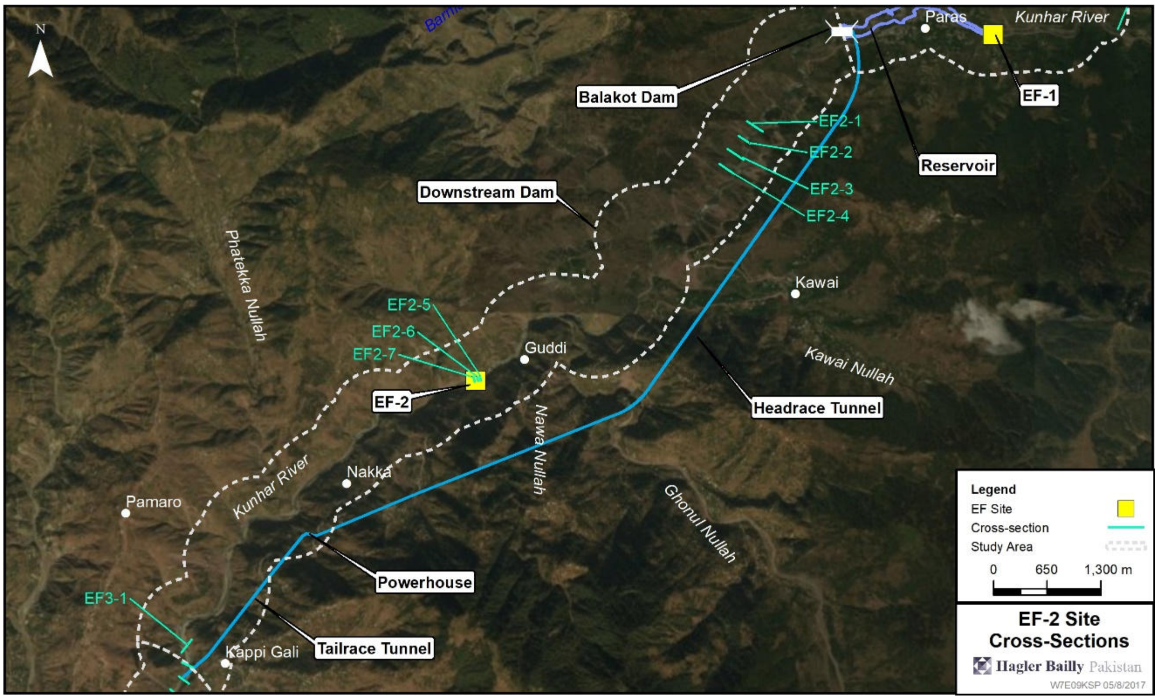


Exhibit C.7: Cross Section Photographs – EF Site 2: Downstream of Dam

Cross Section 2-5, 2-6 and 2-7

Close up of bridge near cross sections at EF Site 2

Exhibit C.8: Cross Section Locations – EF Site 3: Downstream of Tailrace

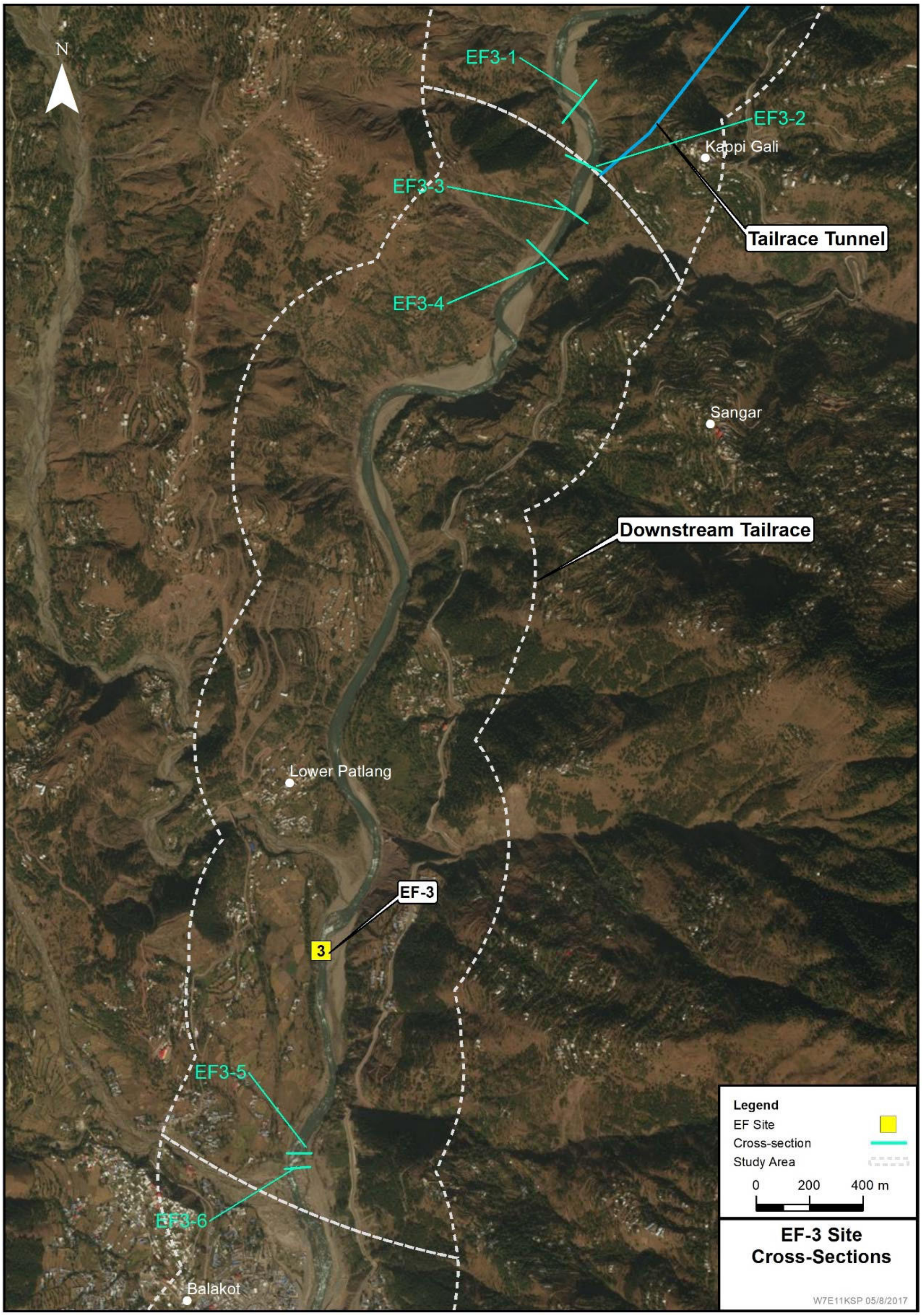


Exhibit C.9: Cross Section Photographs – EF Site 3: Downstream of Tailrace

Cross Section 3-5 and 3-6

Exhibit C.10: Cross Section Locations – EF Site 4: Downstream of Balakot

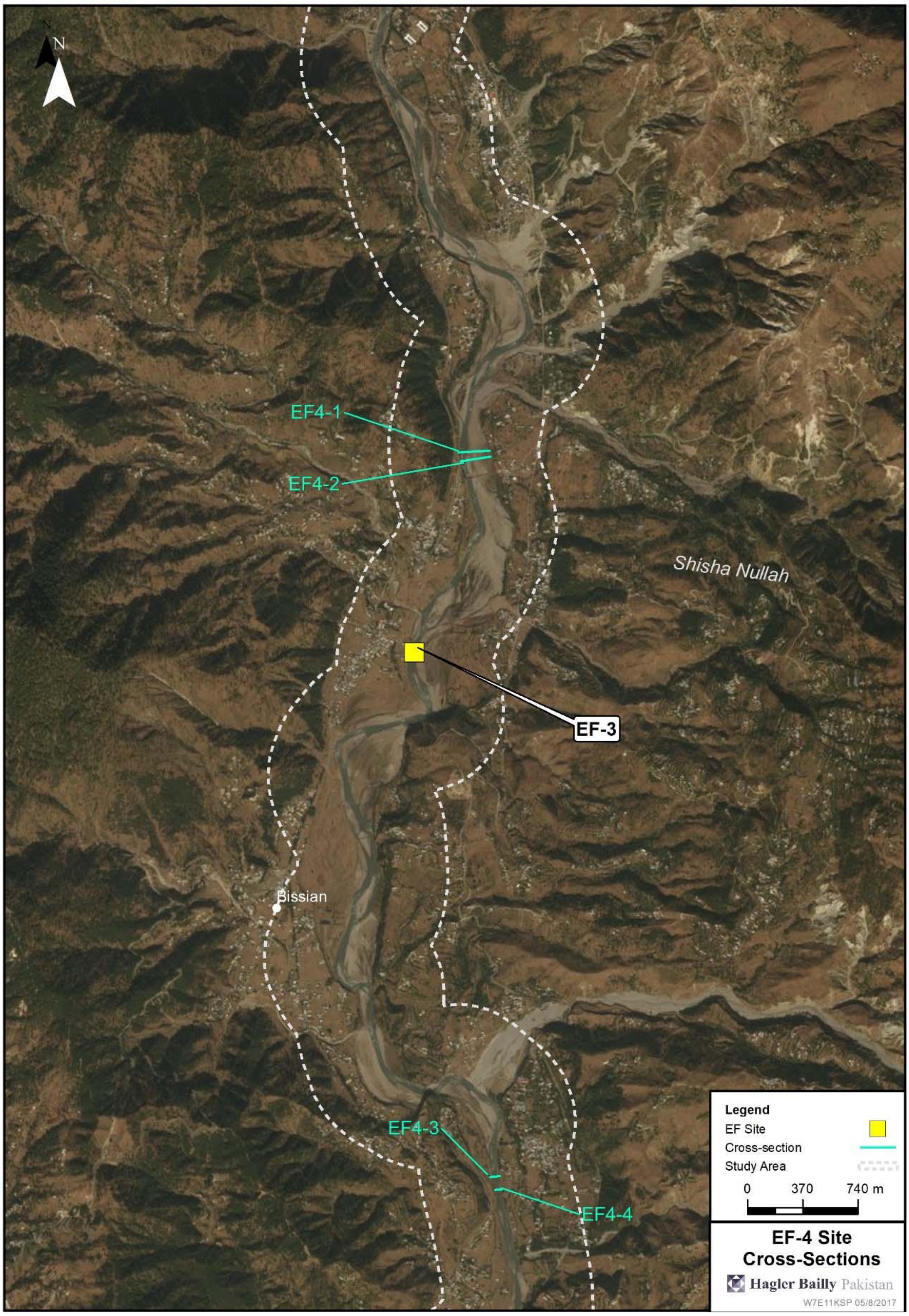


Exhibit C.11: Cross Section Photographs – EF Site 4: Downstream of Balakot

Cross Section 4-1 and 4-2

C.2.1 Analysis and Hydraulic Modelling

Data on gauging station locations and flow calculations for each EF site is presented in **Appendix B**.

The hydraulic modelling software, HECRAS[1] was used for steady-state[2] non-uniform[3] computations at the EFlow sites. Manning's value was taken as 0.05 for the channel (representing cobble and boulders) and 0.035 (for short grasses) for the overbanks.

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[1] Version 5.0.3, available at http://www.hec.usace.army.mil/software/hec-ras/

[2] Flow characteristics do not change over time at a location

[3] Flow characteristics vary with distance along the river

C.2.2 Hydraulic Characterization for use in the DRIFT DSS

The flow preference for juveniles and for spawning requirements is defined by a velocity-depth class with velocities in the range 0.1 - 2.0 m^3 s^{-1}, and depths in the range 0.3 - 0.75 m. DRIFT was provided a hydraulic lookup table (see **Exhibit C.12**) and calculated the abundance of the hydraulic habitat for each hydrology scenario.

C.3 Results

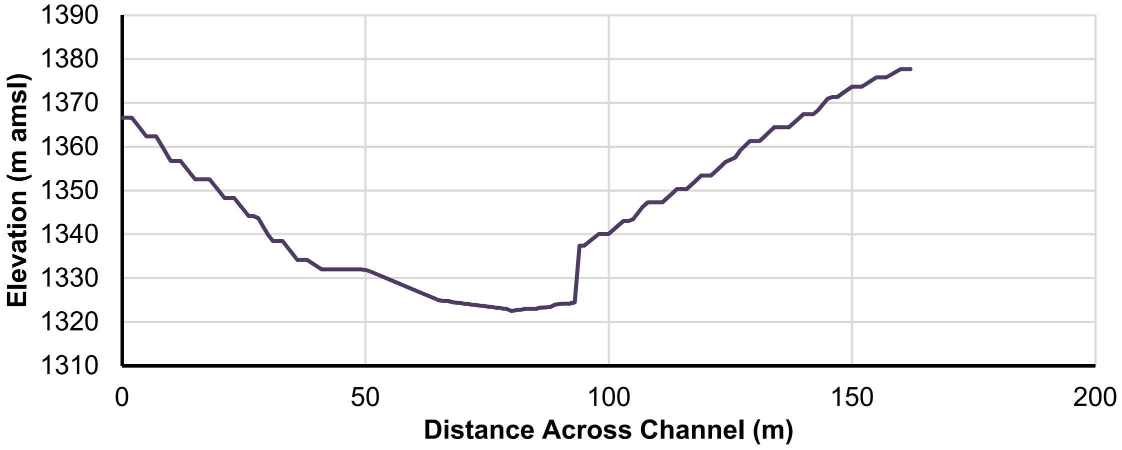
The cross section measurements and the hydraulic variables calculated for each site are presented in this section. **Exhibit C.12** presents the outputs from HEC-RAS as a hydraulic lookup table that is imported into DRIFT and **Exhibit C.13** presents selected topographic cross sections from the survey and literature.

Exhibit C.12: Hydraulic Lookup Table for DRIFT

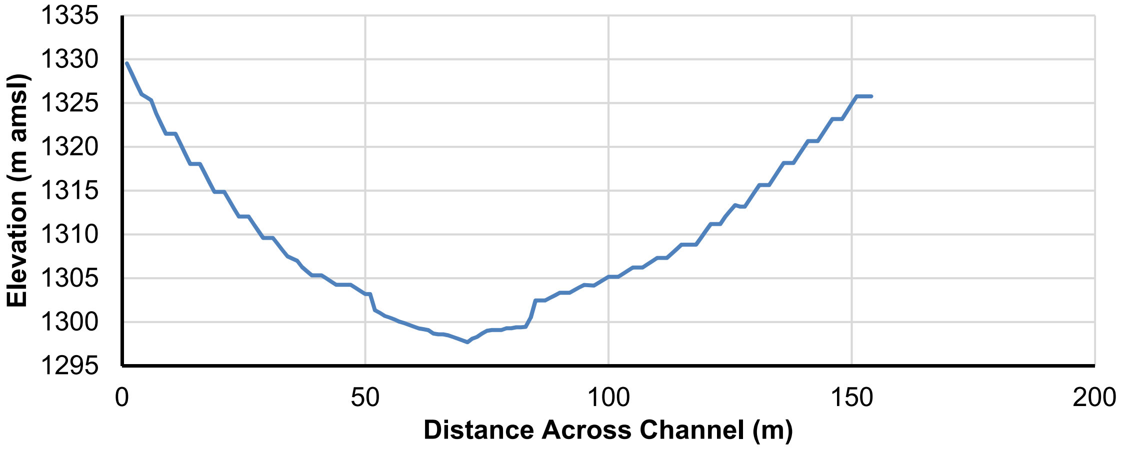
Discharge (m^3/s)	*Top Width (m)*	*Velocity (m/s)*	*Depth (m)*	*Wetted Perimeter (m)*
EFlow Site 1				
5	10.54	0.97	1.09	10.83
10	12.31	1.26	1.34	12.68
20	22.27	1.37	1.73	22.7
50	25.83	1.85	2.24	26.53
75	28.2	2.14	2.53	29.09
100	28.93	2.37	2.78	29.99
150	30.76	2.75	3.19	32.12
200	32.08	3.05	3.55	33.71
300	32.95	3.53	4.14	35.27
500	36.6	4.2	5.11	40.32
1000	54.83	4.58	7.21	60.47
2000	77.42	5.35	9.51	84.95
EFlow Site 2				
5	5.66	1.25	0.83	6.34
10	12.13	1.21	1.28	13.42
20	13.5	1.58	1.63	15.37
50	27.61	1.74	2.4	30.76
75	28.7	2.06	2.68	32.31
100	29.65	2.3	2.91	33.65
150	40.96	2.48	3.36	45.35
200	41.87	2.68	3.7	46.49
300	51.41	2.95	4.28	56.44

Discharge (m^3/s)	*Top Width (m)*	*Velocity (m/s)*	*Depth (m)*	*Wetted Perimeter (m)*
500	55.56	3.47	5.09	61.15
1000	59.05	4.36	6.57	65.77
2000	62.88	5.6	8.66	71.45
EFlow Site 3				
5	24.37	0.67	0.83	25.2
10	33.84	0.79	1	34.9
20	43.63	0.98	1.21	44.94
50	53.25	1.36	1.55	54.88
75	60.9	1.52	1.77	62.76
100	69.35	1.61	1.96	71.32
150	71.92	1.89	2.21	74.11
200	72.64	2.13	2.41	74.63
300	73.85	2.52	2.75	76.42
500	75.85	3.11	3.31	78.83
1000	79.79	4.07	4.4	83.56
2000	85.94	5.22	6.06	90.92
EFlow Site 4				
5	16.19	0.78	0.47	16.41
10	18.28	1.03	0.66	18.59
20	21.24	1.33	0.93	21.67
50	75.8	1.14	1.37	76.58
75	77.26	1.36	1.52	78.18
100	78.52	1.55	1.64	79.53
150	80.72	1.83	1.85	81.92
200	82.19	2.14	2	83.52
300	153.98	1.76	2.5	155.79
500	154.96	2.34	2.78	157.05
1000	157.33	3.14	3.45	160.06
2000	161.03	4.12	4.5	164.78

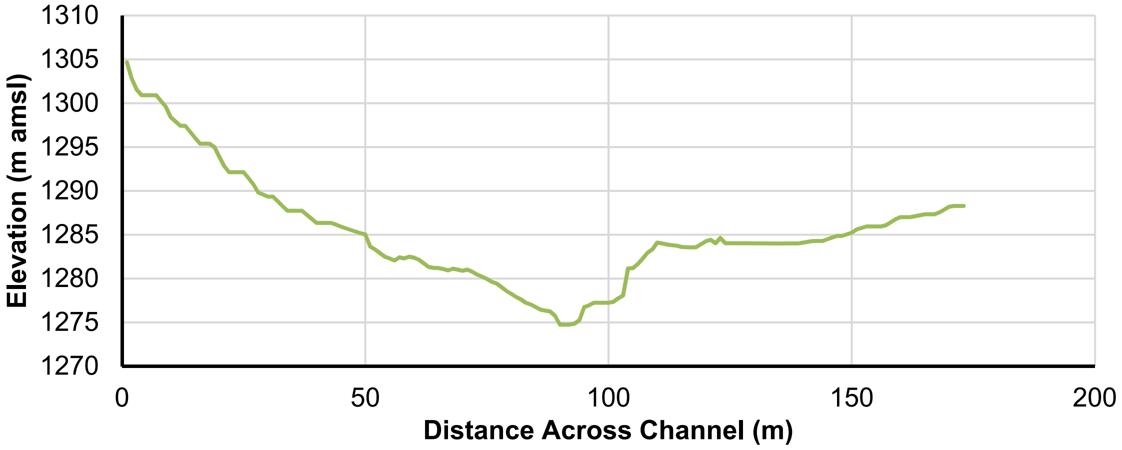
Exhibit C.13: Topographic Cross Sections at EF 1



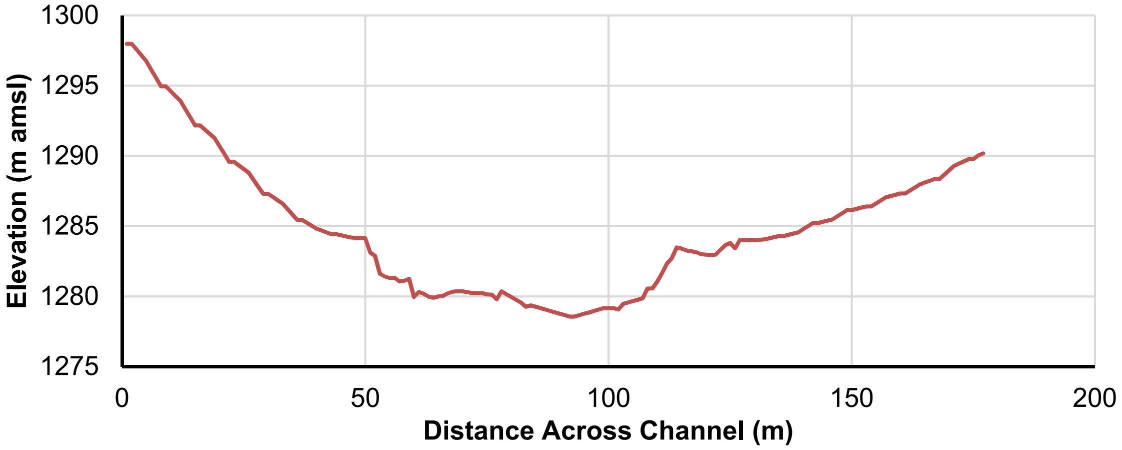
Cross Section 1-1



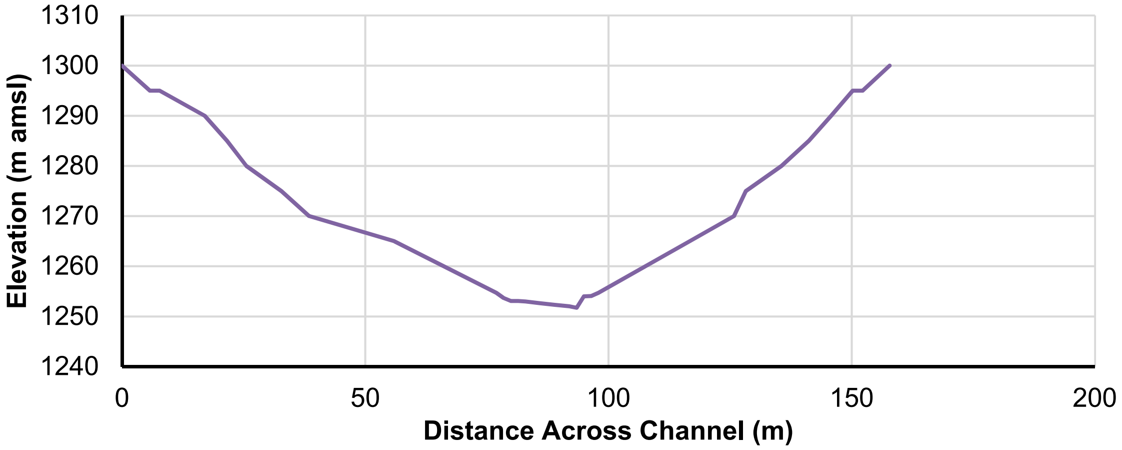
Cross Section 1-2



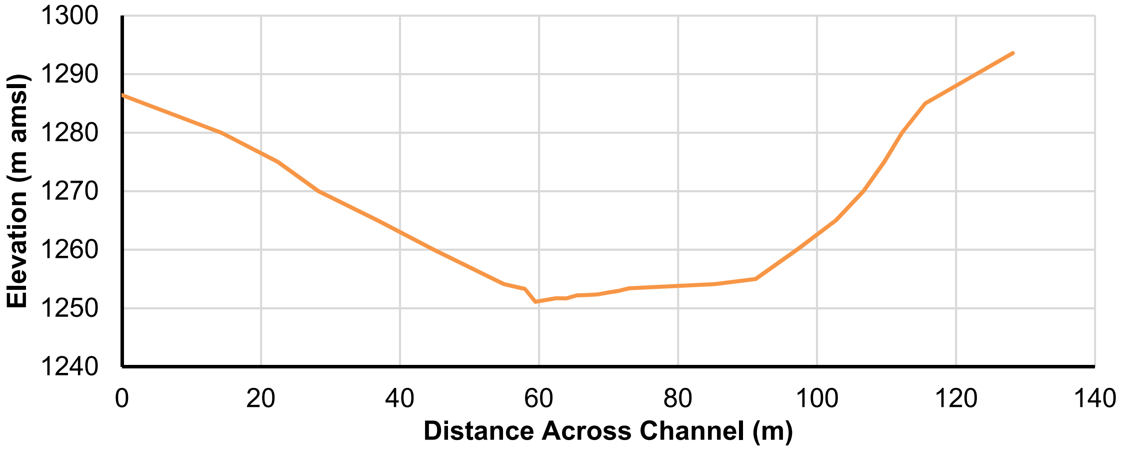
Cross Section 1-3



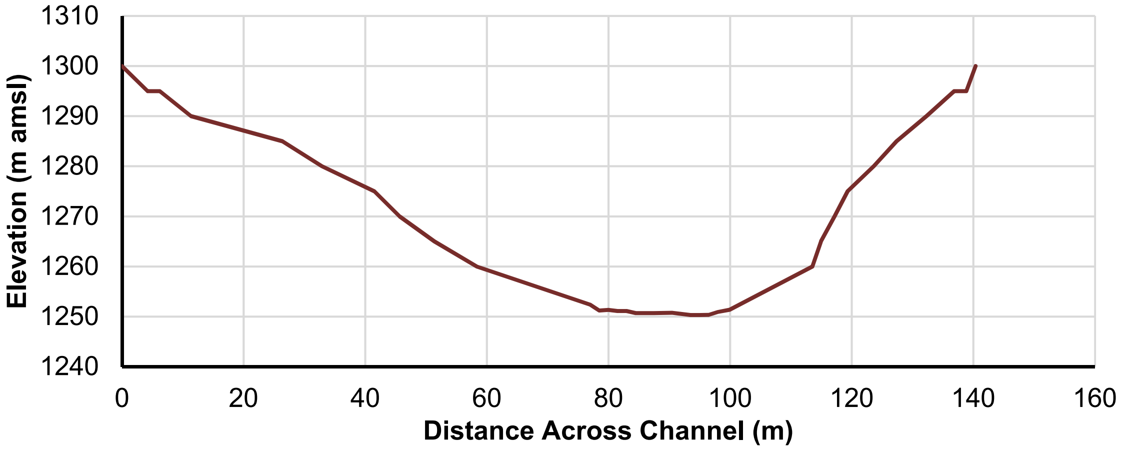
Cross Section 1-4



Cross Section 1-5

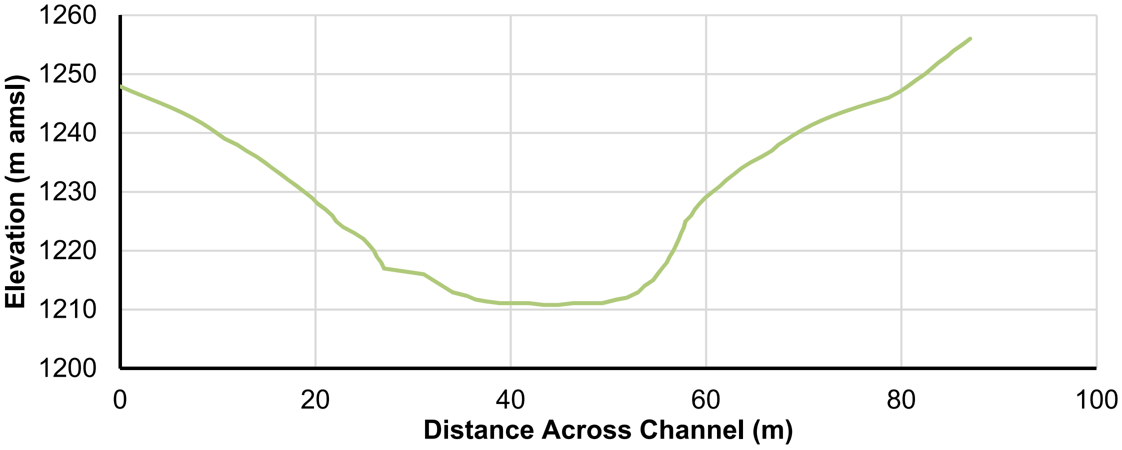


Cross Section 1-6

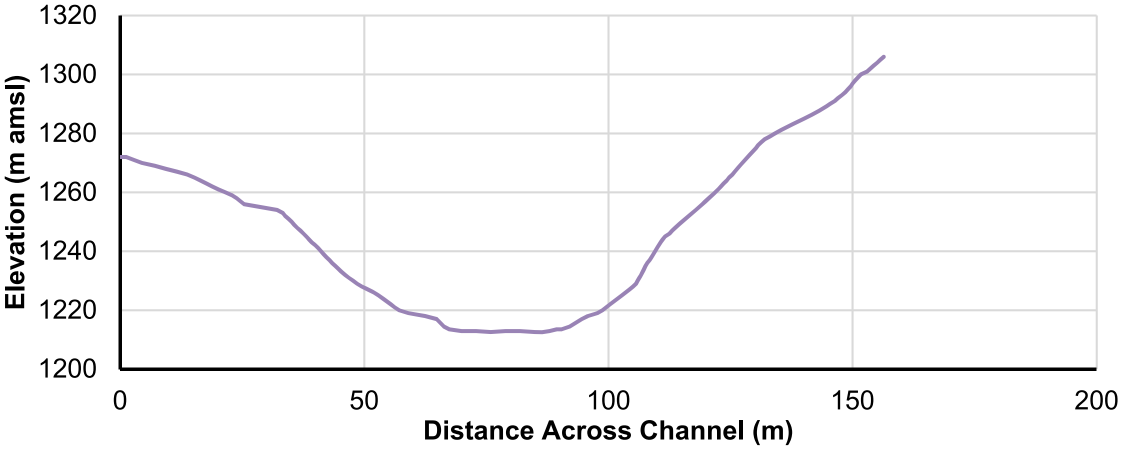


Cross Section 1-7

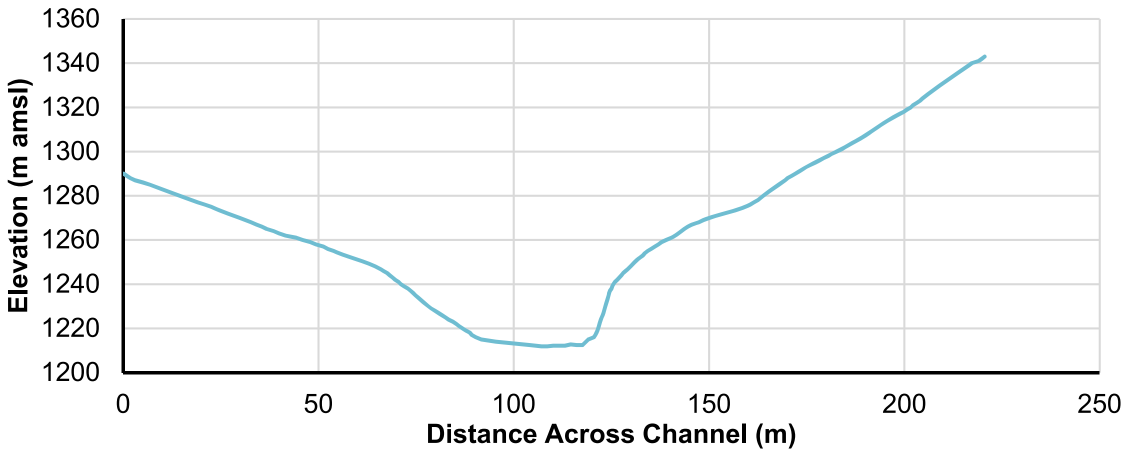
Exhibit C.14: Topographic Cross Sections at EF 2



Cross Section 2-1



Cross Section 2-2



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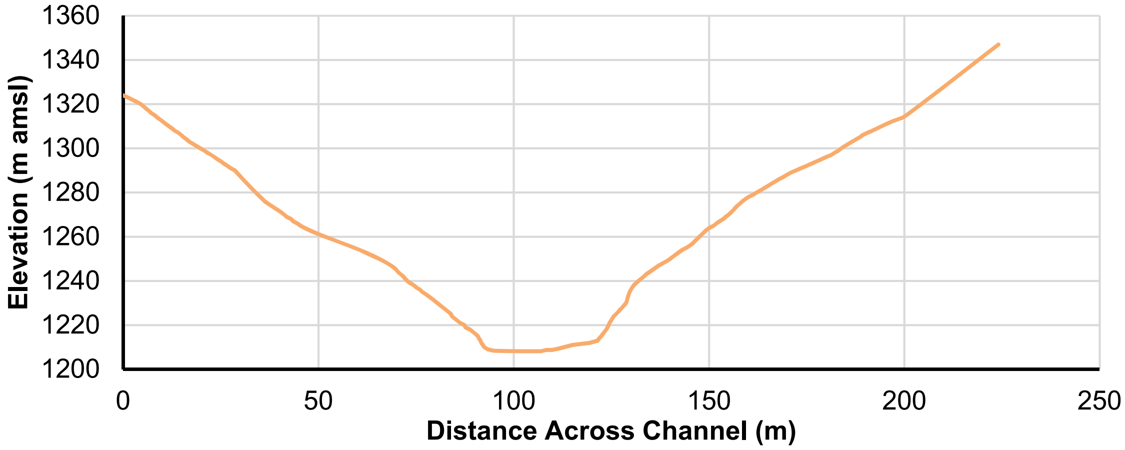

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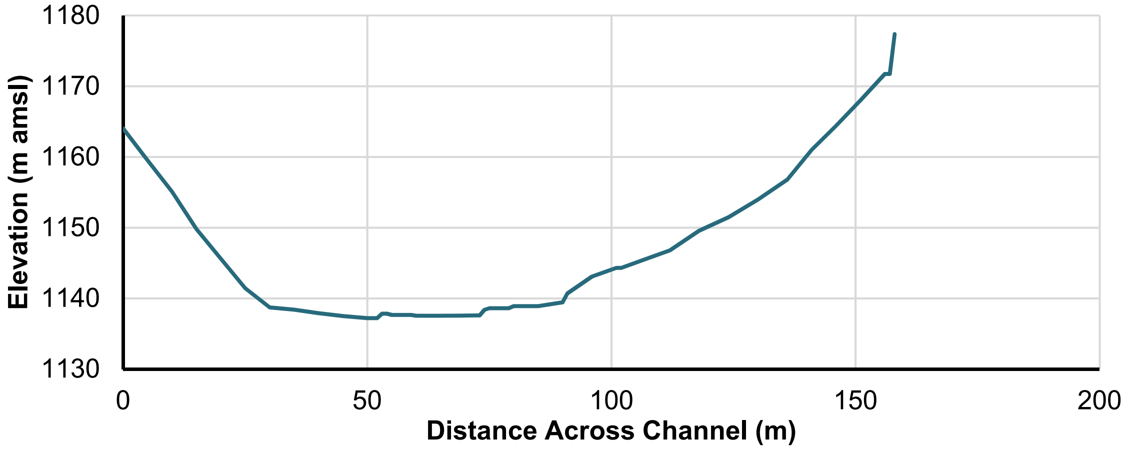
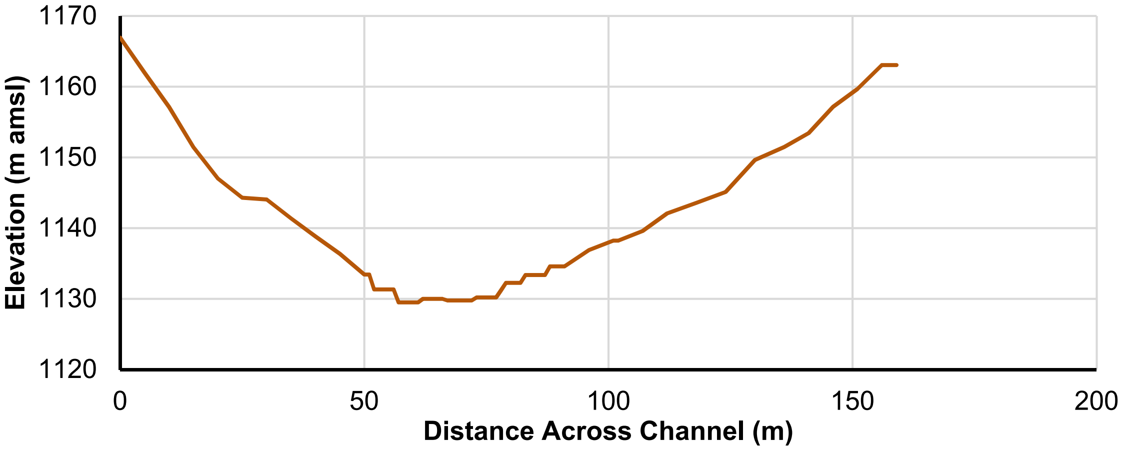
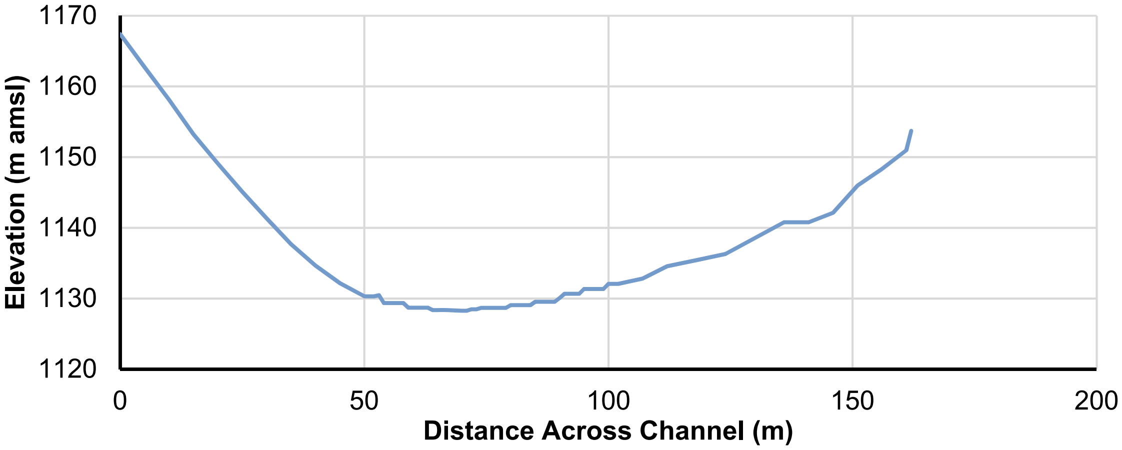


Cross Section 2-5

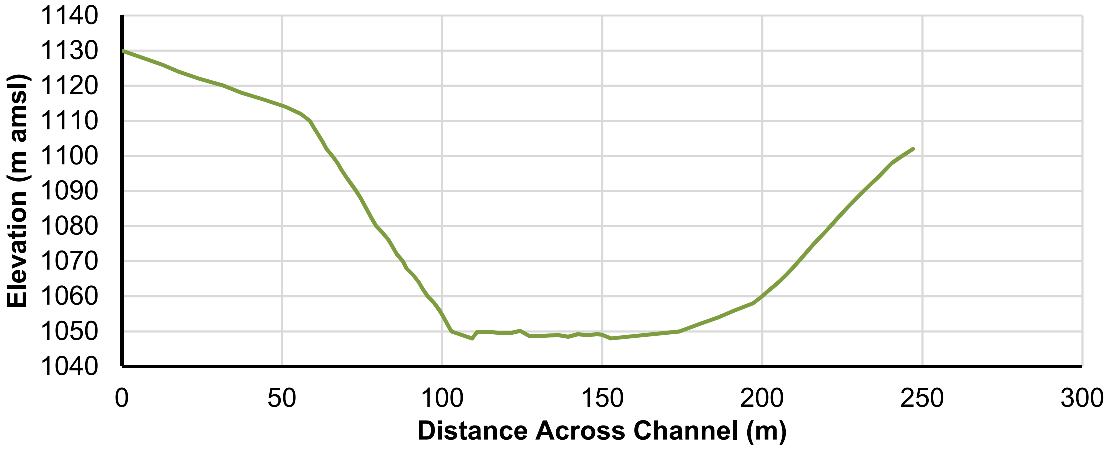


Cross Section 2-6

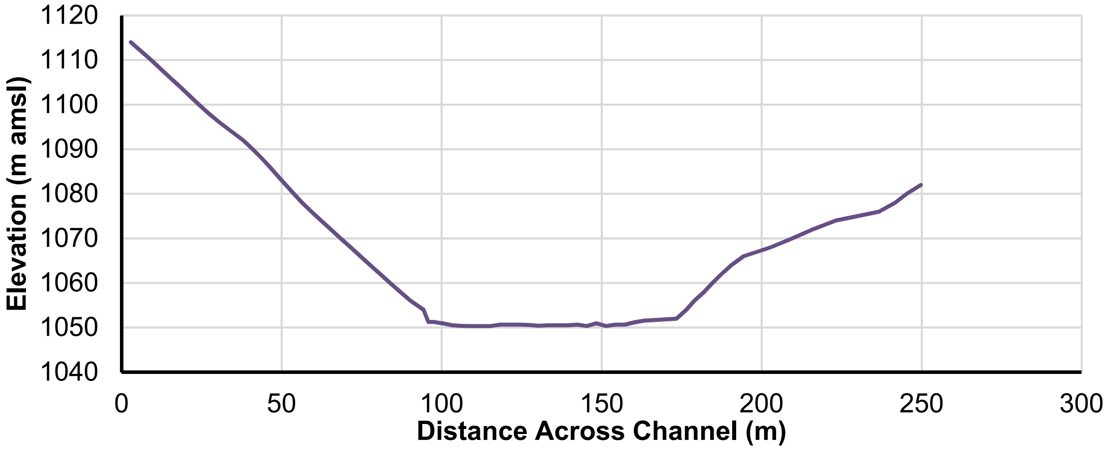


Cross Section 2-7

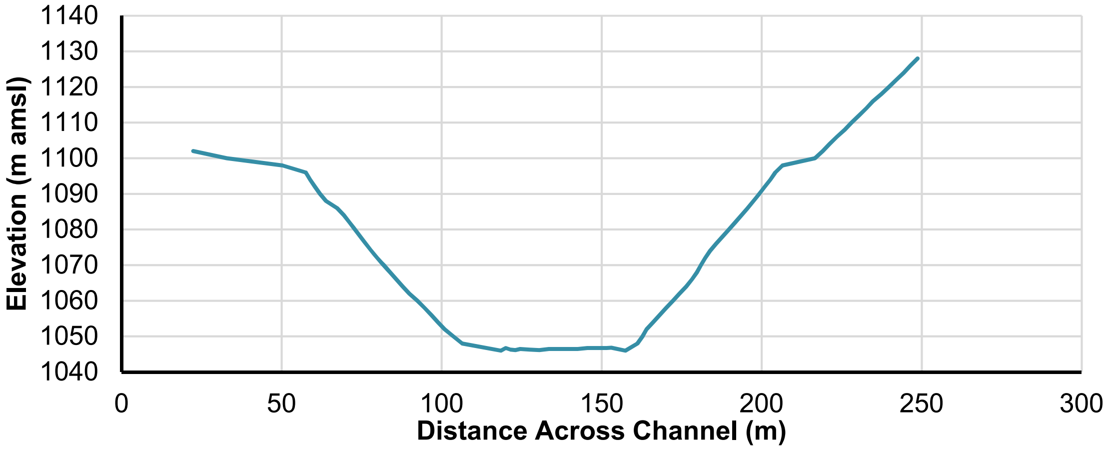
Exhibit C.15: Topographic Cross Sections at EF 3



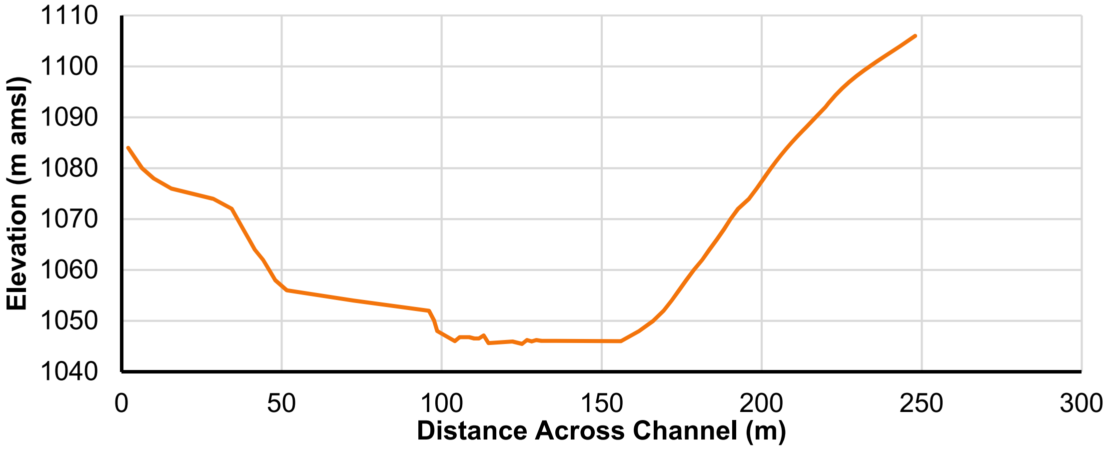
Cross Section 3-1



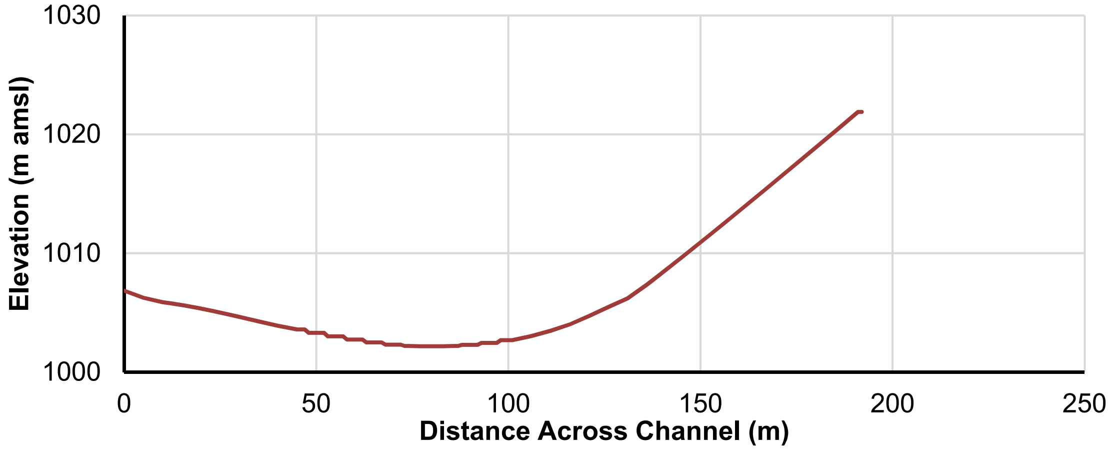
Cross Section 3-2



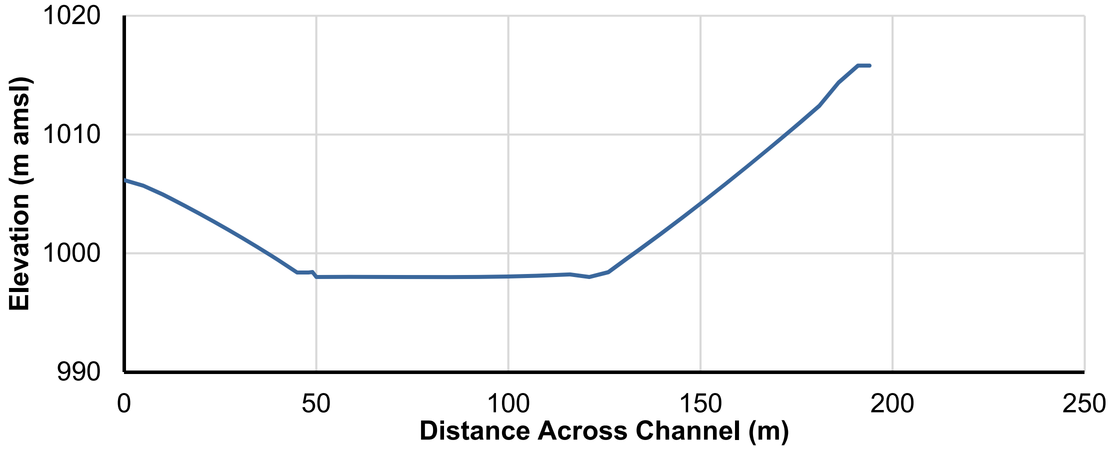
Cross Section 3-3



Cross Section 3-4

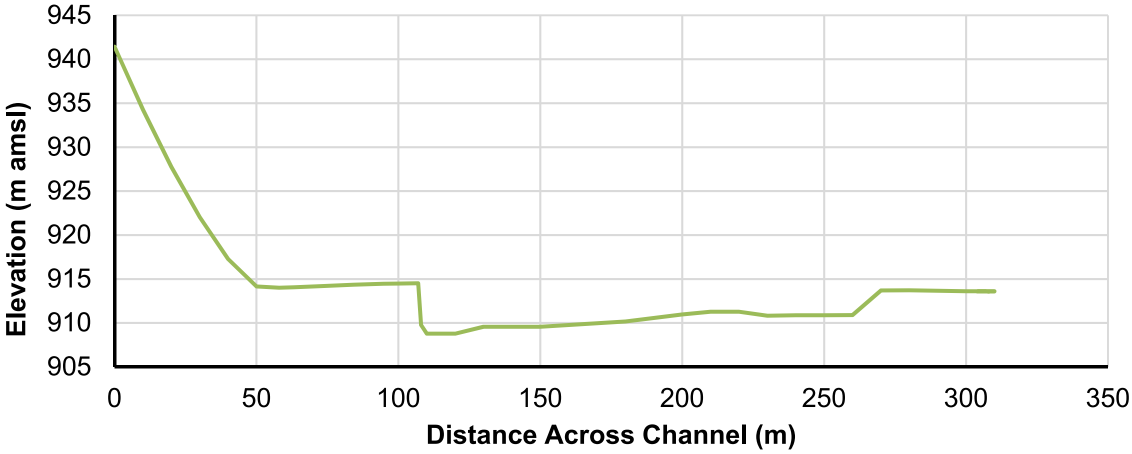


Cross Section 3-5

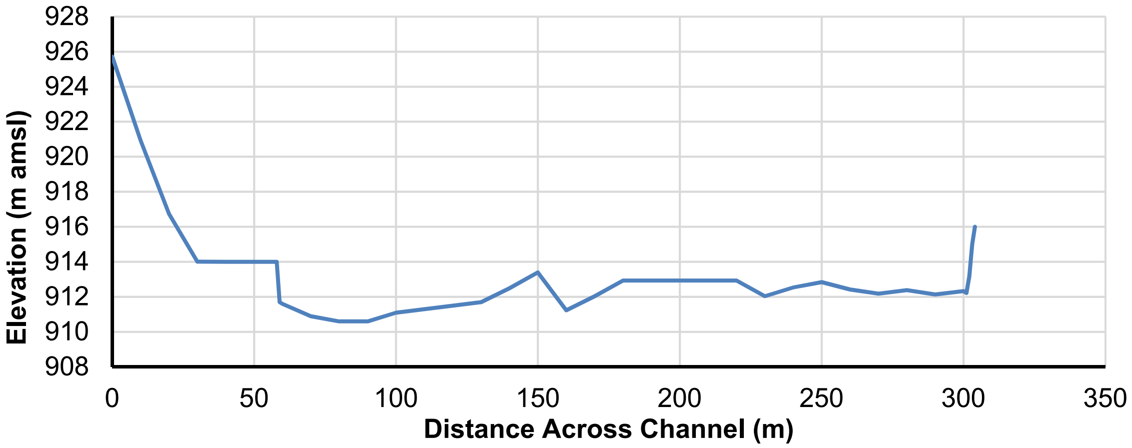


Cross Section 3-6

Exhibit C.16: Topographic Cross Sections at EF 3



Cross Section 4-1



Cross Section 4-2

Exhibit B.1: Dam Design parameters

Parameter	*Unit*	*Value*
Full Reservoir Level	m amsl	1290
Volume of reservoir (as reported) up to FRL	MCM	13.7
Minimum Draw Down level (MDDL)	m amsl	1283
Volume of reservoir (as reported) up to MDDL	MCM	10
EFlow Discharge Level	m amsl	1276
Main powerhouse turbine capacity	MW	300
Main powerhouse rated unit discharge	m^3/s	154
Number of turbines in main powerhouse	no	4
Minimum turbine flow of main powerhouse	m^3/s	15.4

B.2.2 Hydrological Baseline

The Surface Water Hydrology Project (SWHP), of the Water and Power Development Authority Pakistan (WAPDA) had established gauge and discharge (G&D) stations in the Kunhar basin (see **Exhibit B.2).** Data from the Gari Habibullah gauging station was selected as the primary source of data due to its location and long term data availability. In 1995, Gari Habibullah G&D station was closed and moved 2 km upstream to Talhata. Flow data available at this station was appended to the Gari Habibullah data by adopting a catchment ratio approach shown below to create a 51 year record of gauging data-from 1960 to 2010 (see **Section 5** of the main EIA report).

Exhibit B.2: Gauging Stations in the Kunhar Basin

Location Name	*Latitude*	*Longitude*	*Catchment Area (km^2)*	*Period*
Gari Habibullah	73.357091°	34.447679°	2,356	1960-1994
Talhatta	73.347018°	34.465495°	2,336	1995-2010

The mean monthly flows for Gari Habiullah and Talhata are displayed in **Exhibit B.3** and **Exhibit B.4** respectively**.**

Exhibit B.3: Mean Monthly Flow at Gari Habibullah (1960-1994)

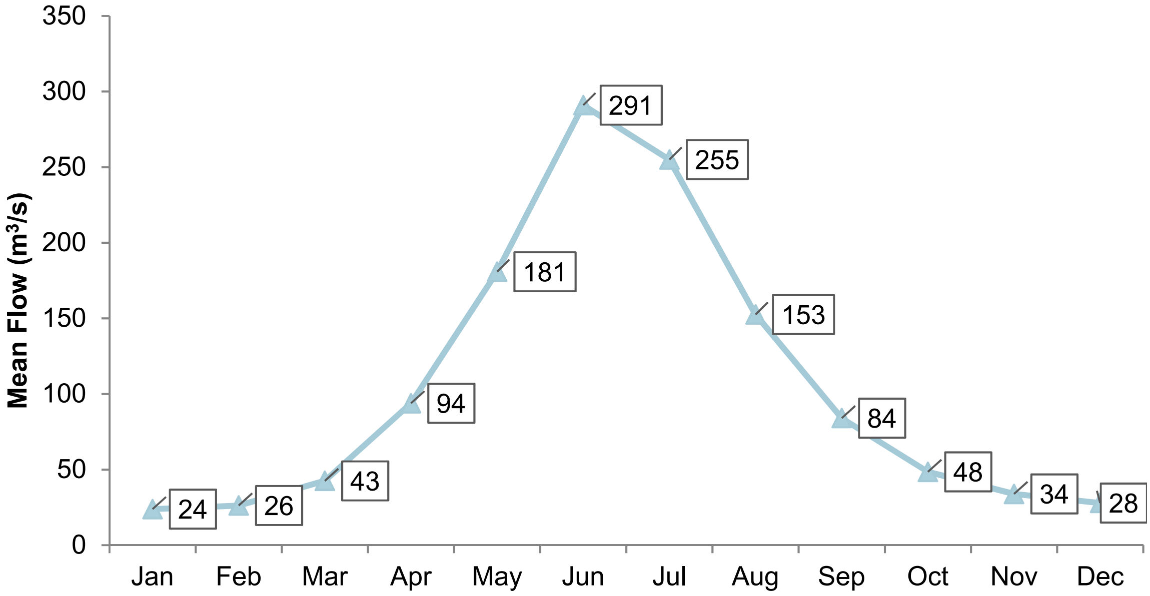
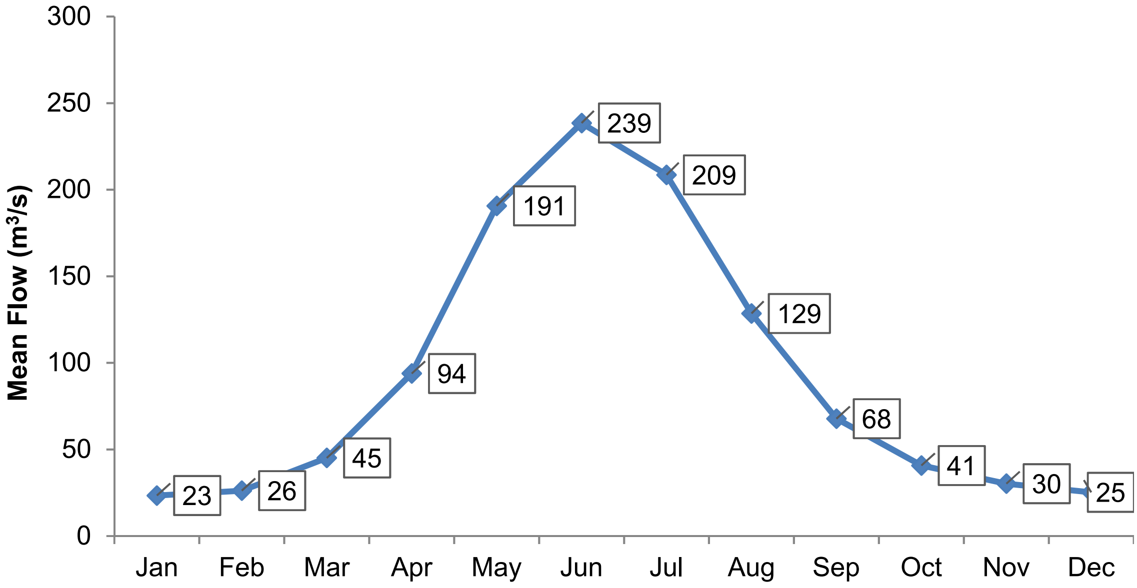


Exhibit B.4: Mean Monthly Flow at Talhata (1995-2010)



Raster mapping of stream flow records provide a visual representation of annual, seasonal and daily patterns of discharge that can be used (prior to statistical analysis) to develop a broad characterization of differences in flow regimes in sub-systems. This technique was first developed by Keim and Kriegel (1996) and later by Koehler (2004)[1]. It is based on the plotting of an entire stream flow record on a two-dimensional (2-D)

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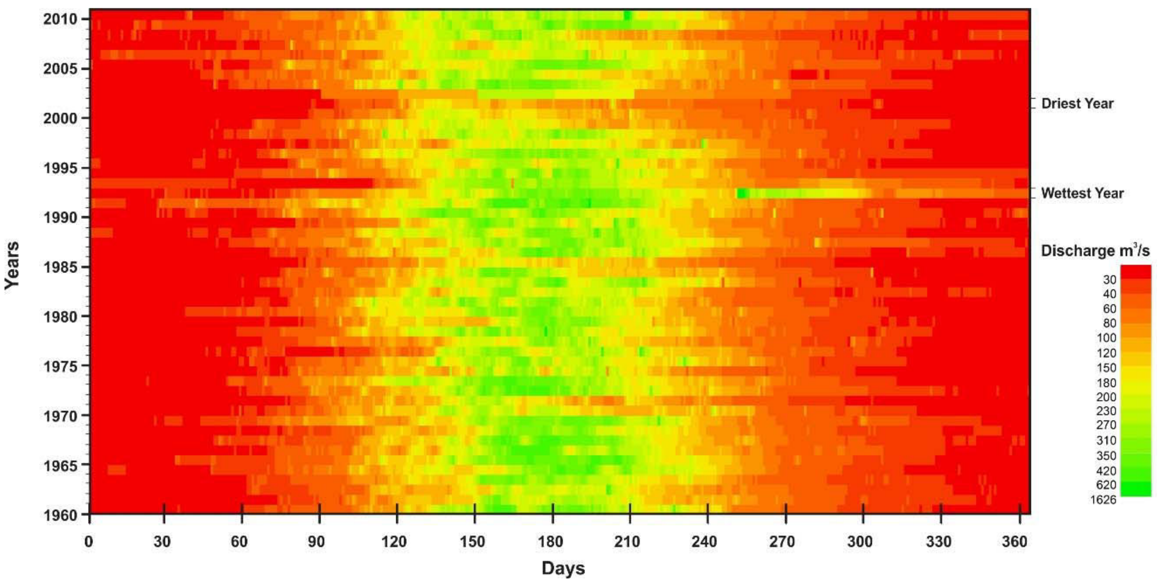
[1] Moog O. (1993). Quantification of daily hydropower effects on aquatic fauna and management to minimize environmental impacts. Regulated Rivers: Research & Management, 8, 5-14.

map. Each map pixel represents a single daily discharge value. Y coordinate represents hydrological year and X coordinate represents the day of the year. The gauging data is shown in **Exhibit B.5** as a raster diagram. The raster diagram clearly shows the flood-pulse nature and well-defined ecological seasons of the Kunhar River system. A high flood occurred in 1992 and severe drought occurred in 2001 which is indicated in the exhibit.

Exhibit B.5: Raster Map of Baseline Gari Habibullah Gauging Station flow data



B.2.3 Flow Simulation Sites (EFlow Sites)

The EFlow assessment for the Project (BAHPP) utilizes four sites, called Eflow (EF sites) for assessment. **Exhibit B.6** provides a list of the EF sites. Flows are calculated these sites were calculated for the baseline conditions and simulated using GoldSim® for the various operational scenarios (**Section B3**).

Exhibit B.6: EFlow sites for BAHPP EF Assessment

ID	*Site Description*	*Coordinates*	*Reach Length*	*Description*
EF Site 1	Upstream Reservoir	73° 28' 13.561" E 34° 39' 36.338" N	From Sukki Kinari Tailrace to Project Reservoir	This site is upstream of reservoir. Flow regime is not affected by BAHPP. The Sukki Kinari HPP will alter flows at this site, however, this is not incorporated quantitatively into the results.
EF Site 2	Upstream Dam	73° 24' 09.705" E 34° 37' 16.960" N	From Project Dam to Tailrace	This is downstream of the dam. It is drained by the selected environmental flows and the spillway. The streams and nullahs draining into this section is calculated using the catchment area ratio approach (as described

ID	*Site Description*	*Coordinates*	*Reach Length*	*Description*
				in section 1.1.2) using the catchment area from the dam site to the tailrace tunnel.
EF Site 3	Downstream Tailrace	73° 21' 18.015" E 34° 33' 46.565" N	From Tailrace to Balakot Town	This is downstream of the tailrace. The flows in this section are the inflows coming from the EF site 2 and the streams and nullahs draining into this section (calculated using the catchment area ratio approach -as described in section 1.1.2-using the catchment area from the tailrace tunnel to the Balakot town)
EF Site 4	Downstream Balakot	73° 21' 06.992" E 34° 28' 35.723" N	From Balakot Town to Patrind Reservoir.	This is downstream of Balakot. The flows in this section are the inflows coming from the EF site 3 and the streams and nullahs draining into this section (calculated using the catchment area ratio approach -as described in section 1.1.2-using the catchment area from the Balakot town to Patrind hydropower reservoir

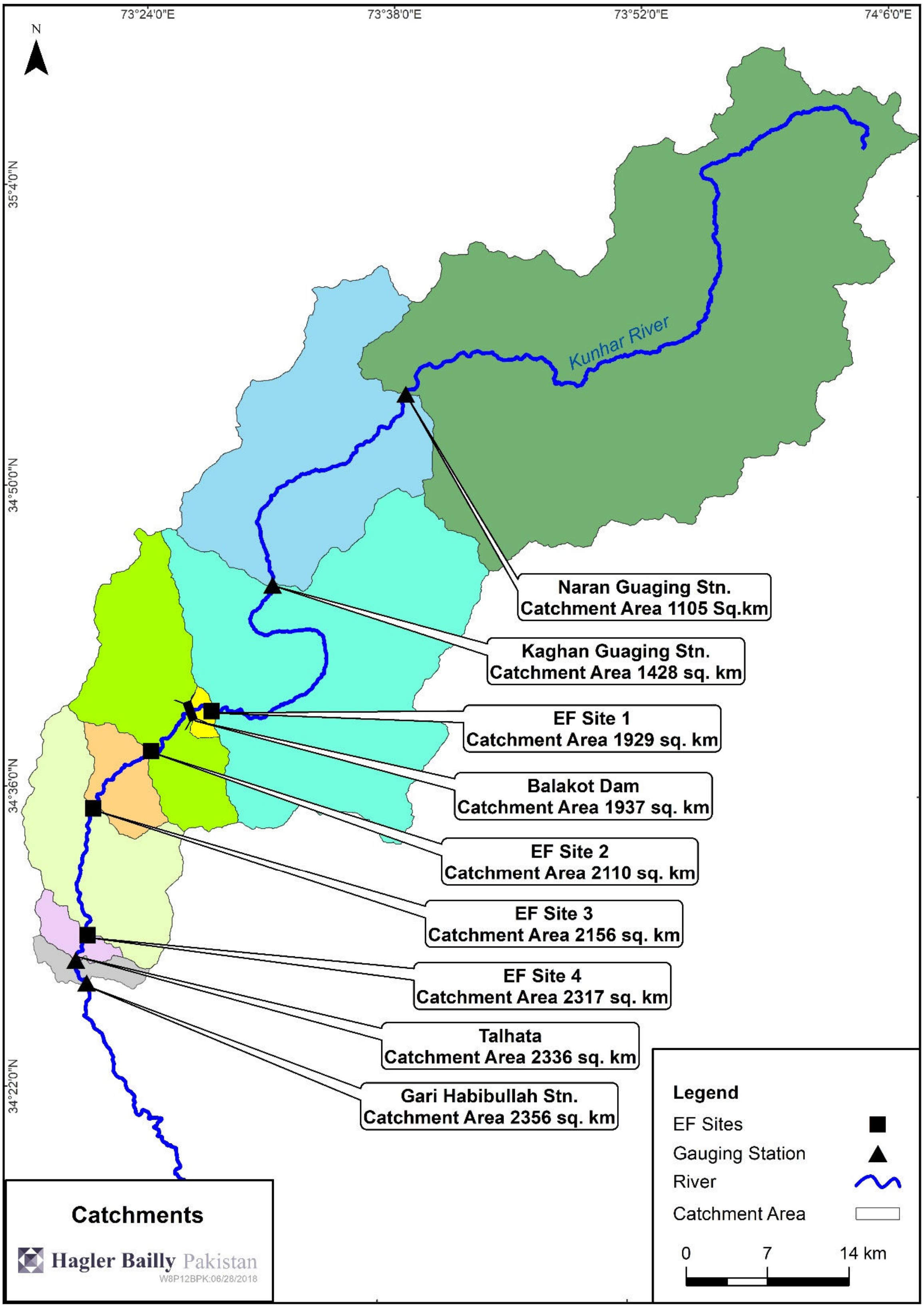
B.2.4 Baseline Calculations for EFlow Sites and Catchment Contributions

To calculate baseline (i.e. without Project) flows at the EFlow sites, the catchment area ratio method was utilized. Catchment ratios for the designated sites are presented in **Exhibit B**.7 and catchment sizes shown in **Exhibit B.8.** The inflows to the dam which were used in calculating diversions were also calculated using this method.

Exhibit B.7: Catchment Ratios for Calculating Flows at EFlow Sites

Location	*Fraction of Catchment with reference to the Catchment size of Gari Habibullah*
EF Site 1	0.819
EF Site 2	0.896
EF Site 3	0.915
EF Site 4	0.983
Dam Site	0.826

Exhibit B.8: Gauging Station and EFlow Locations and Catchment Size



B.2.5 Season Delineation

The baseline flow was simulated on an hourly time step using GoldSim® Monte Carlo simulation software which were then incorporated into DRIFT DSS. Ecologically-important flow indicators are calculated for ‘ecological seasons’ in DRIFT. In perennial flood-pulse systems, these are usually a dry season and a wet (flood) season, separated by two transition seasons. The seasonal divisions chosen for the EF assessment were:

- Dry season
- Transitional season 1(Dry to Flood))
- Flood season
- Transitional season 2 (Flood to Dry).

Owing to the varying nature of the seasons, starting and ending dates are defined for each year of the hydrological time-series. The rules for defining the seasons are provided in **Exhibit B.9**, while the threshold values for season delineation are given in **Exhibit B.10**. A sample hydrograph of a single year, which displays the threshold values and season delineation, is presented in **Exhibit B.11**.

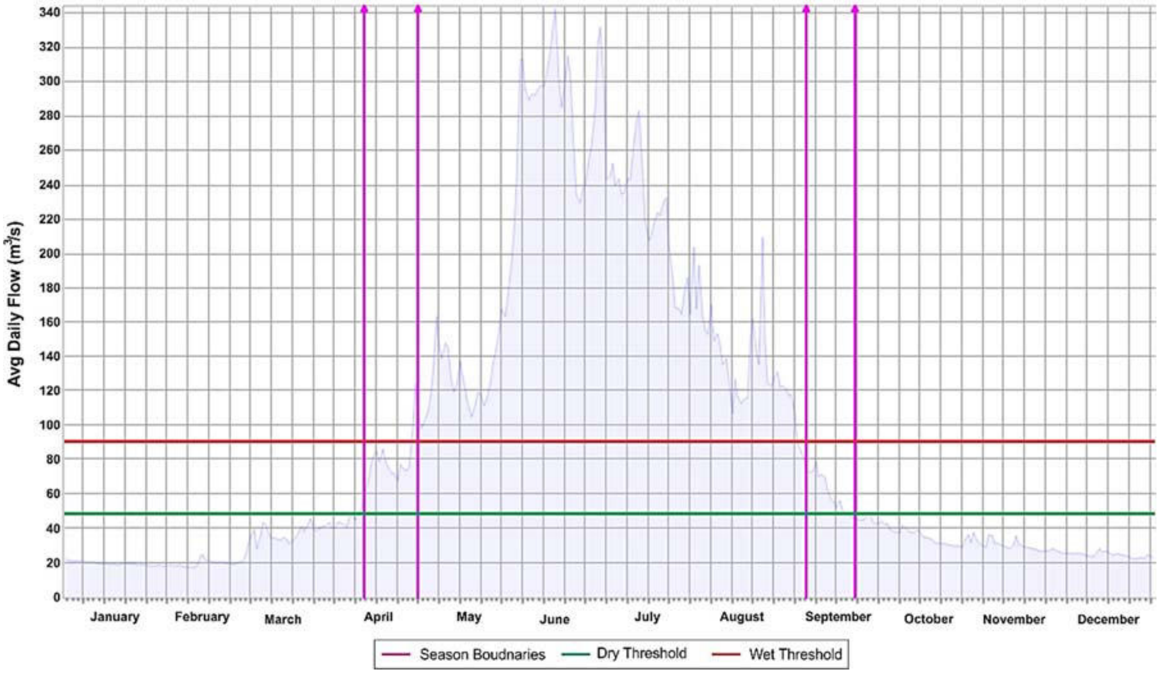
Exhibit B.9: Rules for Defining the End of the Four Ecological Seasons

Season	*Definition*
Dry Season	4 x minimum 5-day dry-season discharge
Transition 1	First up-crossing of the mean annual discharge
Flood Season	Last down-crossing of mean annual discharge
Transition 2	Average recession rate over 15 days < 0.7 $m^3 s^{-1} d^{-1}$ OR down-crossing of 4 x minimum 5-day dry season discharge

Exhibit B.10: Seasonal Threshold Discharge Values ($m^3 s^{-1}$) at EFlow Sites

	EF1	*EF2*	*EF3*	*EF4*
End of Dry Season and End of Transition 2	45.46	49.72	50.81	54.60
End of Transition 1 and End of Flood Season	83.79	91.66	93.66	100.65

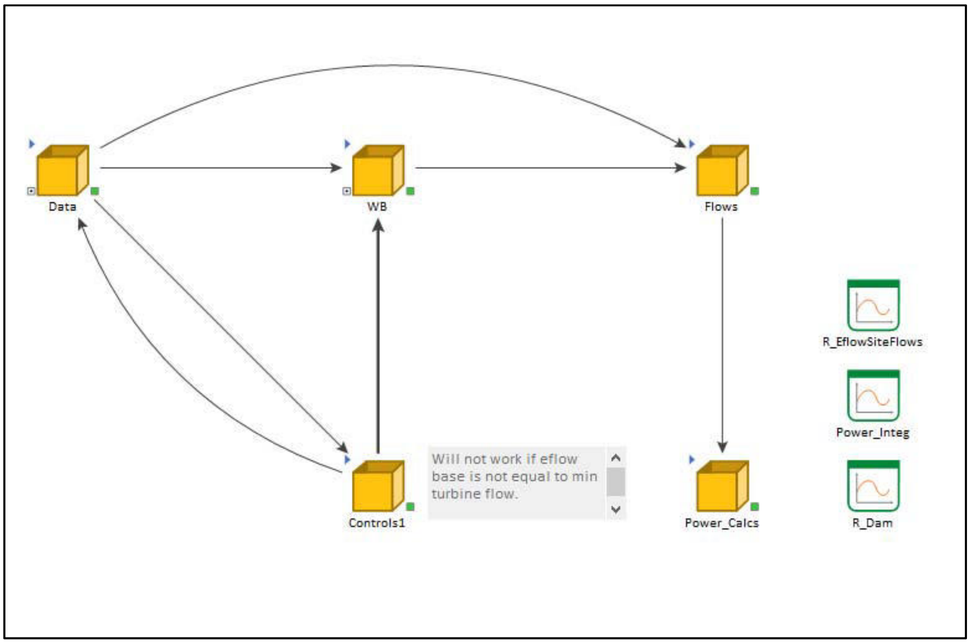
Exhibit B.11: Hydrograph with Season Delineation at EFlow Site 2 for Year 1963



B.3 GoldSim Operation Model

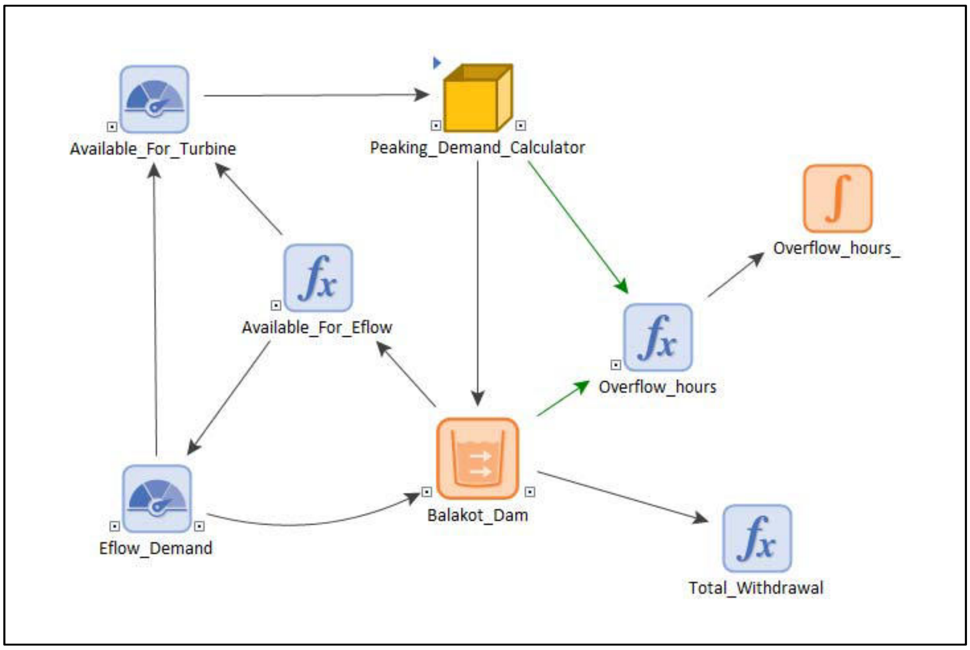
The Project design provides for a reservoir extending 4.5 km upstream. This only provides for just enough storage to cater for daily peaking flow variations. Apportionment of diversions to the power plant and releases into the river downstream of the headrace are configurable, and forms the basis for identification of operational scenarios at BAHPP. The impacts of these scenarios (essentially variations of the operation of the Project) are measured relative to the Baseline (no change from present) which represents the current situation, i.e. before construction of BAHPP. Part of the model set up in GoldSim® for the Project is depicted in **Exhibit B.12.**

Exhibit B.12: Screenshots Parts of GoldSim® Model

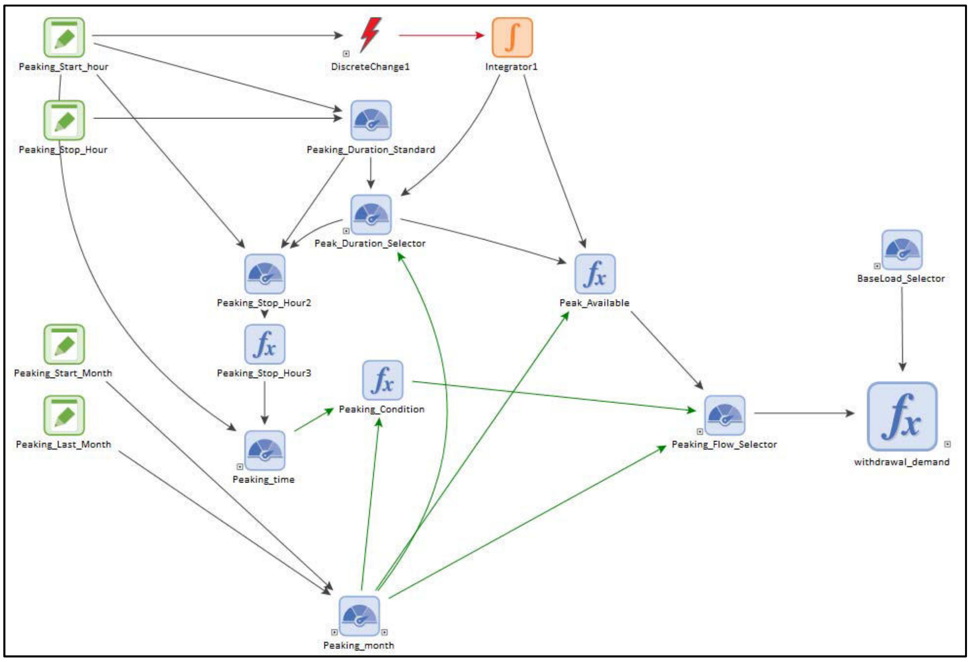


Will not work if eflow base is not equal to min turbine flow.

Main Model



Water Balance



B.3.1 Peaking Demand and Total Peaking Hour Calculations Constraints in Simulation Model

The following are the conditions and constraints govern the Reservoir Operations Model:

1. **Environmental Flow** is released from the dam at first priority. If inflows are less than the EFlow all of the inflow is released.
2. **Baseload Operation:** minimum required flow for powerhouse operation (i.e. one turbine operating at 40% design capacity) is 15.4 m^3/s. If incoming flow (after subtracting EFlow) is below this then incoming flows are released as EFlow downstream of the dam. Water is diverted through the headrace tunnels to the powerhouse once the minimum flow requirement is met for the powerhouse operation. Maximum diversion is 154 m^3/s and flows in excess to this are also released downstream of the dam via the spillway.
3. **Peaking Operation:** peaking months are from March through November other than which the dam operates at baseload. Diversion flows during peaking is calculated based on the dam volume at the start of peaking hours and expected river inflows. Peaking hours are from 5 pm to 10 pm, however if there is extra volume of water available peaking duration is extended until the dam reaches its minimum operating level.
4. **Dam storage** is taken from minimum operating level (1283 m amsl) to the flood volume (1290 m amsl), to minimize the loss through spillway when peaking.

B.4 Results

This section discusses the variation in hydrological flow profile of the simulated scenarios at the selected EF sites as a result of varying value of environmental release and operation mode. These results are compared to the Baseline Scenario to study the impacts associated with BAHPP.

B.4.1 Simulated Results: Flows

Operation of BAHPP will result in releases down the dam, and releases from the tailrace downstream of Sangar, affecting flow regimes at the EFlow sites in different ways:

- **EFlow Site 1** (Upstream Dam): Flow regime is not affected by BAHPP. The Sukki Kinari HPP will alter flows at this site, however, this is not incorporated quantitatively into the results.
- **EFlow Site 2** (Downstream Dam): Flow regime affected by flow diversions due to BAHPP.
- **EFlow Site 3** (Downstream Tailrace): Flow regime affected by releases from the powerhouse.
- **EFlow Site 4** (Downstream Balakot): Flow regime affected by releases from the powerhouse dampened by the inflow from additional streams and nullahs

A summary of simulated results is presented in this section. Detailed DRIFT indicators on the basis of this result are provided in the **Environmental Flow Assessment Report**.

- Examples graphs of flow regime at the EFlow sites for one year (1960) for the scenarios are shown in from **Exhibit B.13** through **Exhibit B.20**.
- Examples graphs out of the Dam outputs (Volumes, Inflows and Outflows) and the flow regimes at the designated EFlow sites for one year (1960) for the scenarios are shown in from **Exhibit B.21** through **Exhibit B.27.**

Exhibit B.13: Flow at EF Sites (baseline)

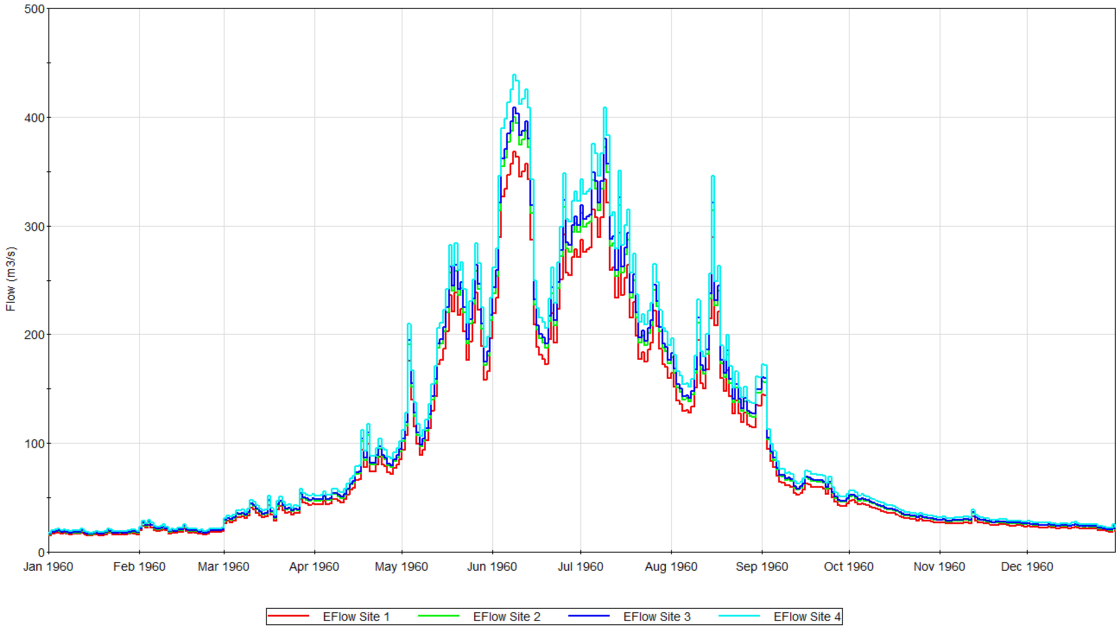


Exhibit B.14: Flow at EF Sites with Dam operation – B1 Scenario

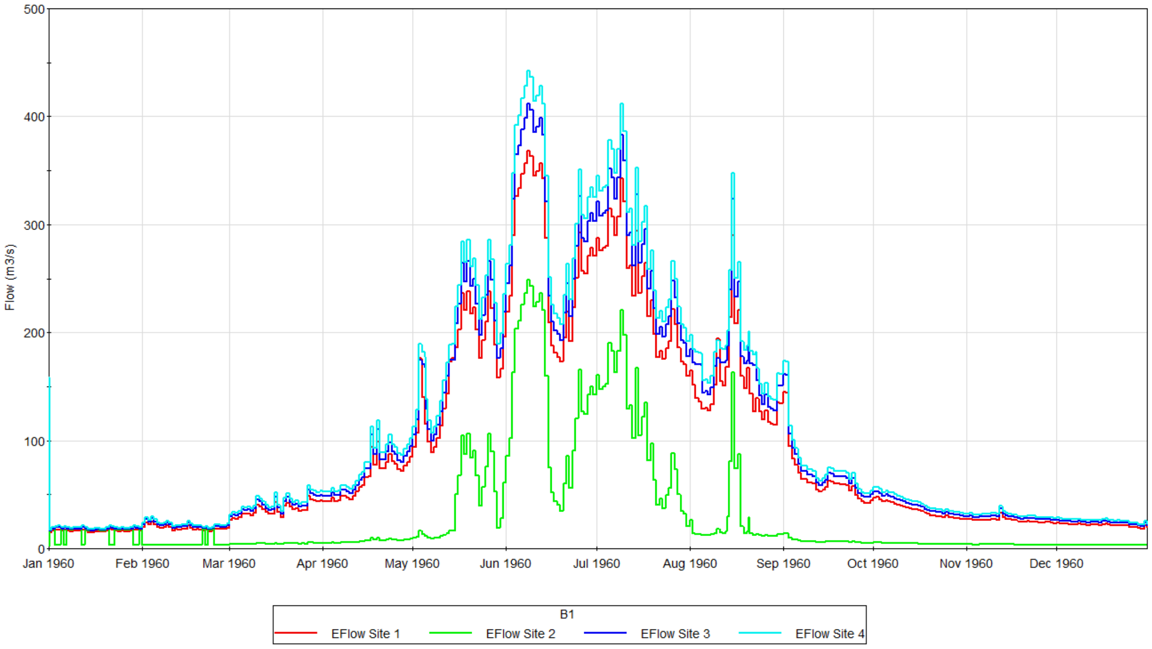


Exhibit B.15: Flow at EF Sites with Dam operation – B3 Scenario

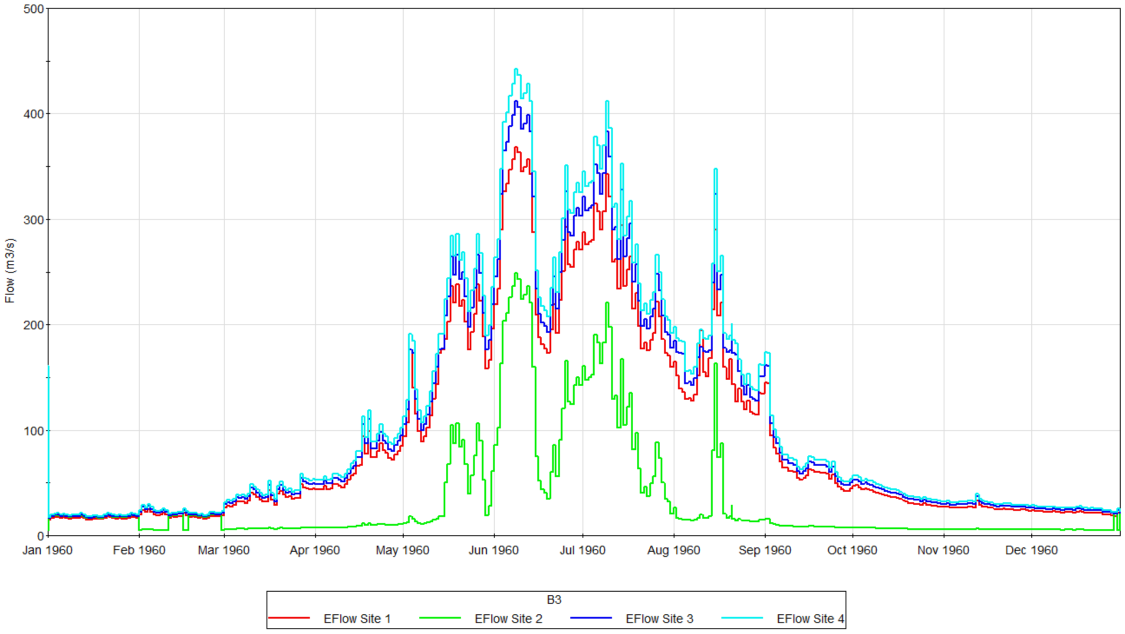


Exhibit B.16: Flow at EF Sites with Dam operation – B4 Scenario

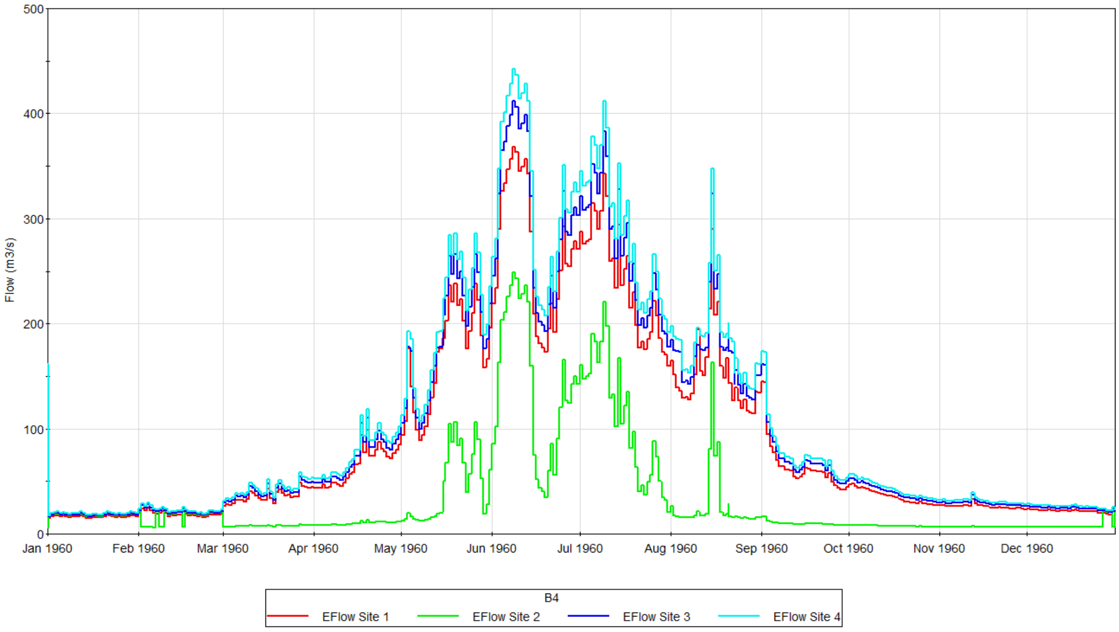


Exhibit B.17: Flow at EF Sites with Dam operation – B6 Scenario

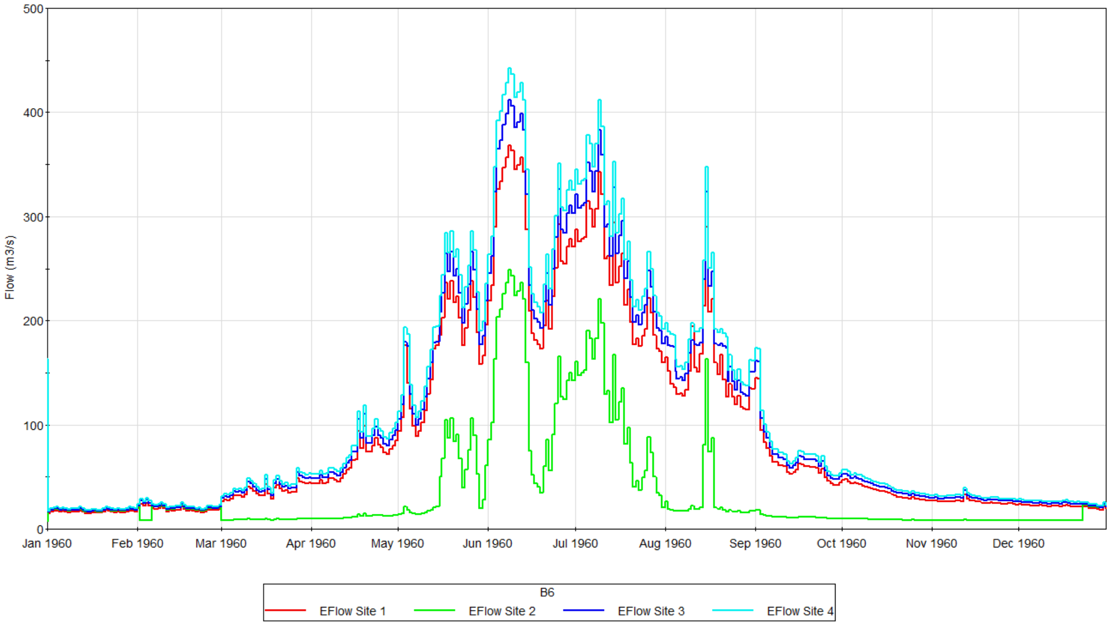


Exhibit B.18: Flow at EF Sites with Dam operation – P1 Scenario

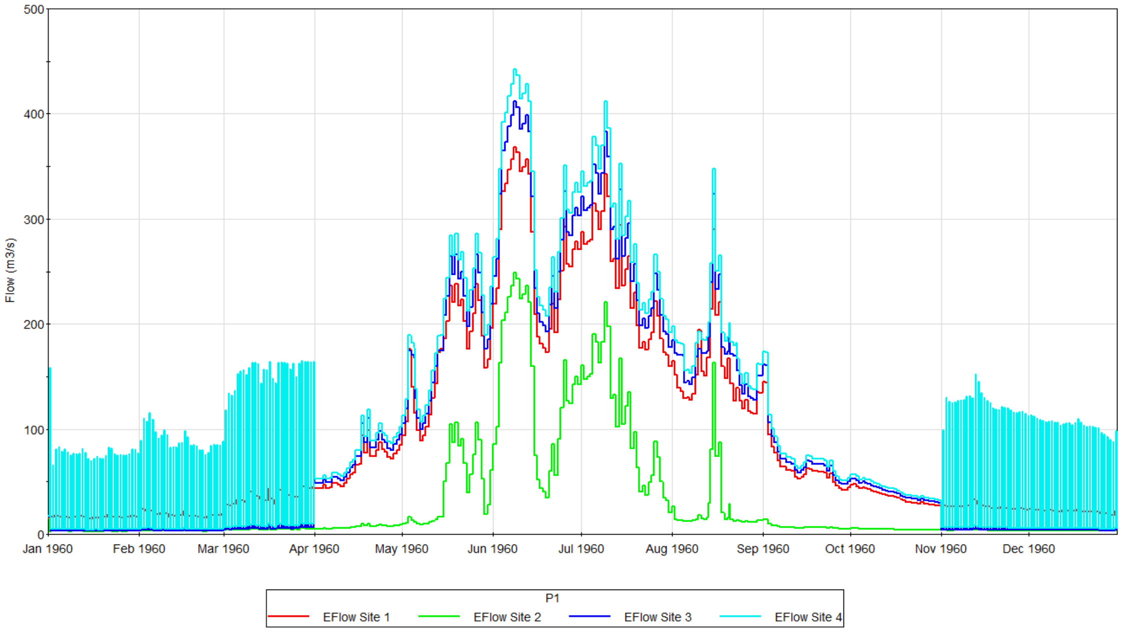


Exhibit B.19: Flow at EF Sites with Dam operation – P4 Scenario

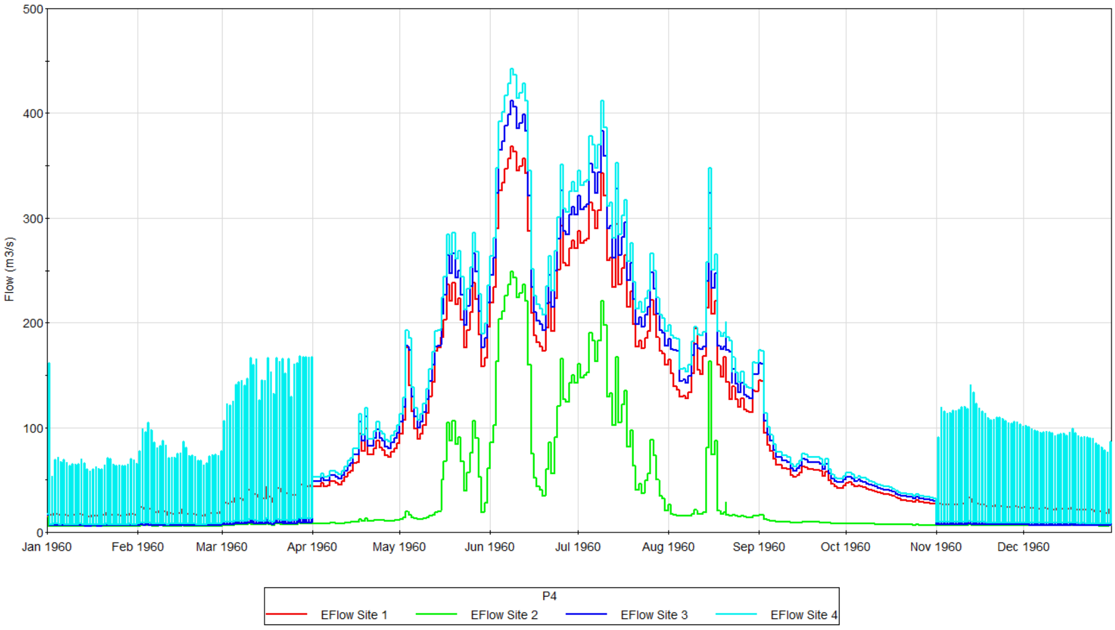


Exhibit B.20: Flow at EF Sites with Dam operation – P6 Scenario

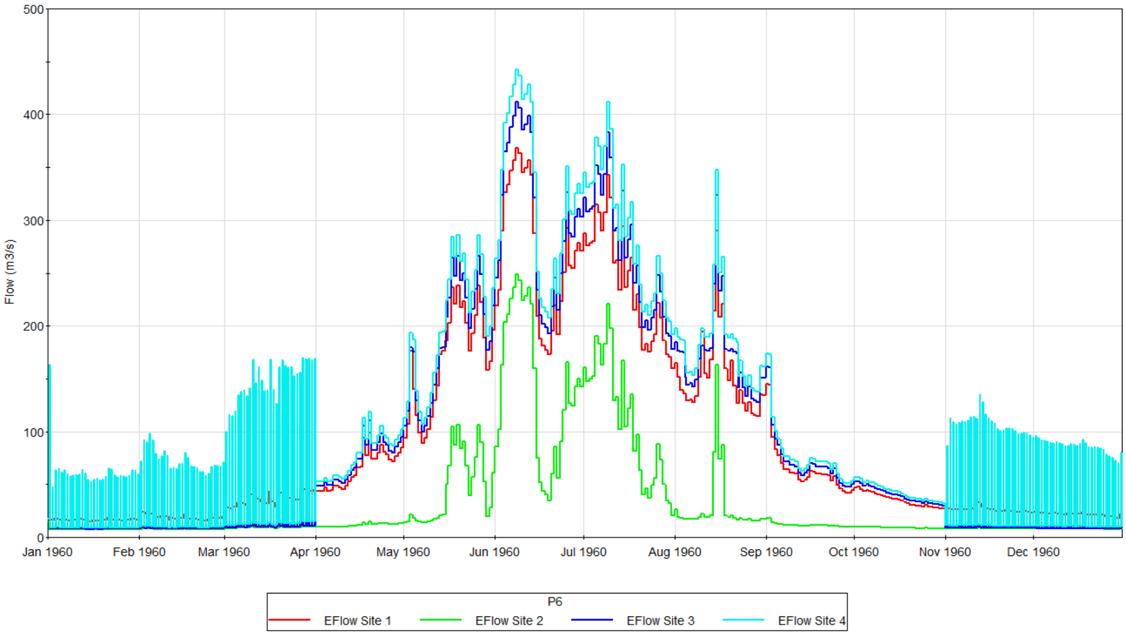


Exhibit B.21: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –B1 Scenario

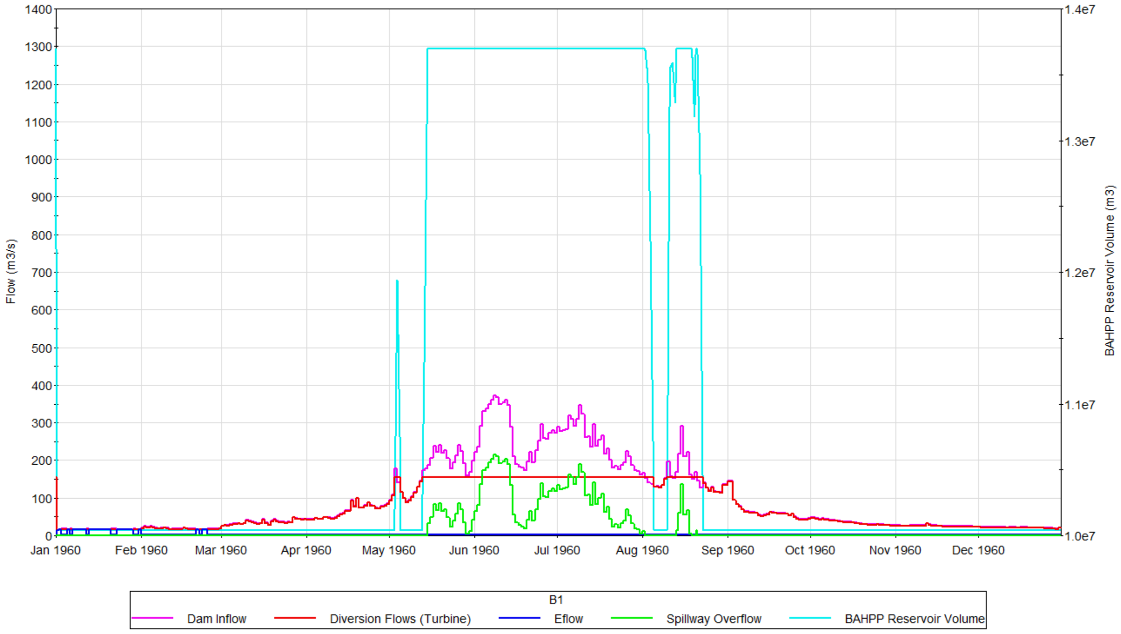


Exhibit B.22: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –B3 Scenario

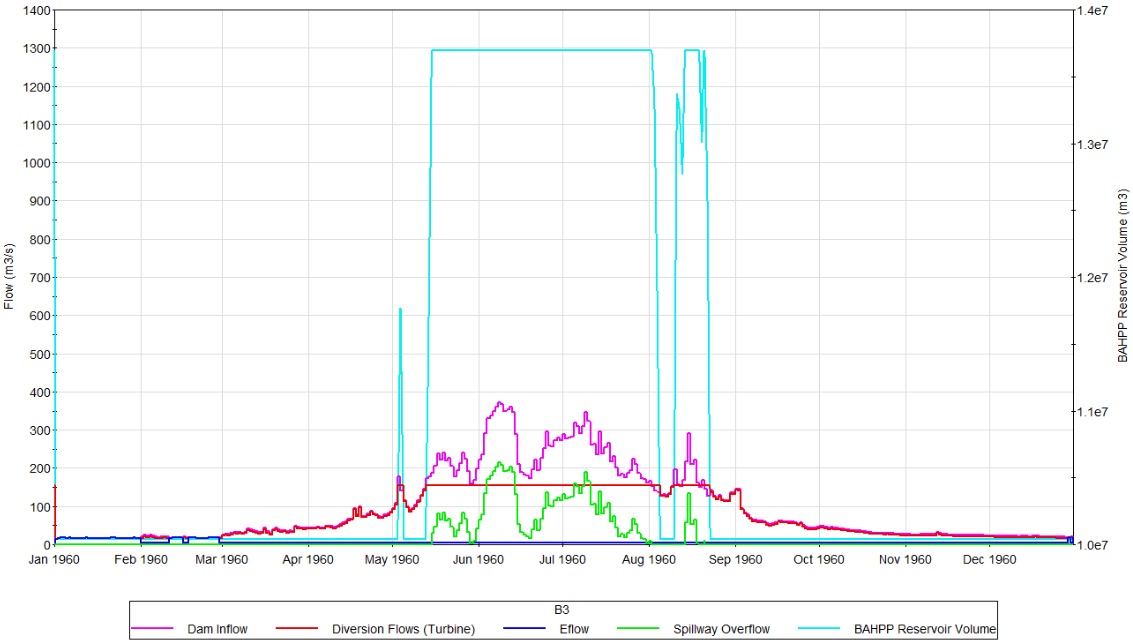


Exhibit B.23: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –B4 Scenario

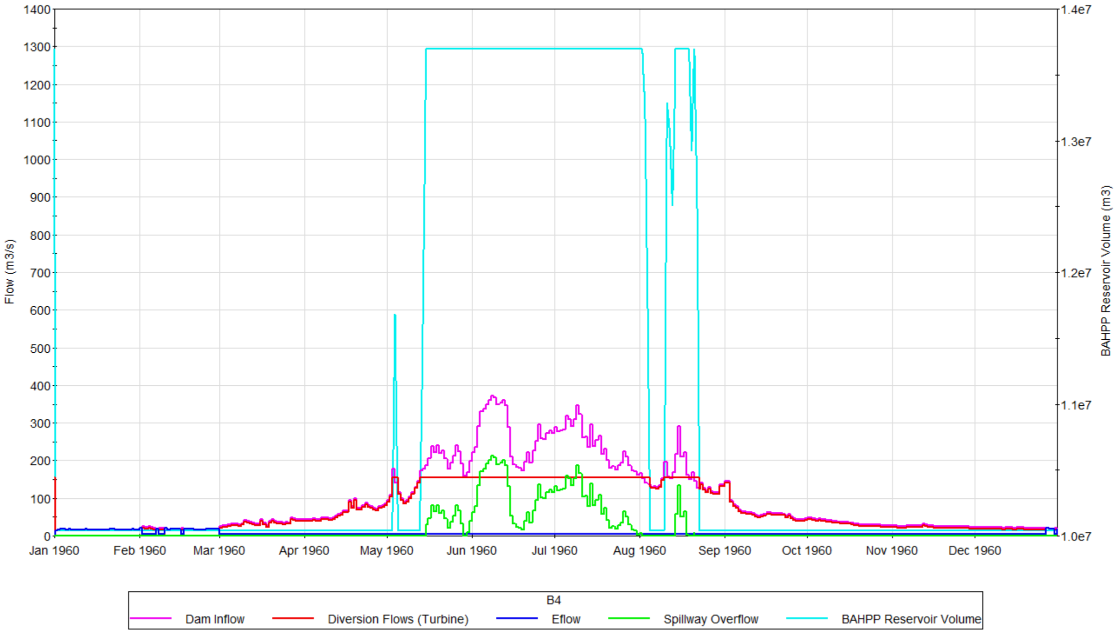


Exhibit B.24: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –B6 Scenario

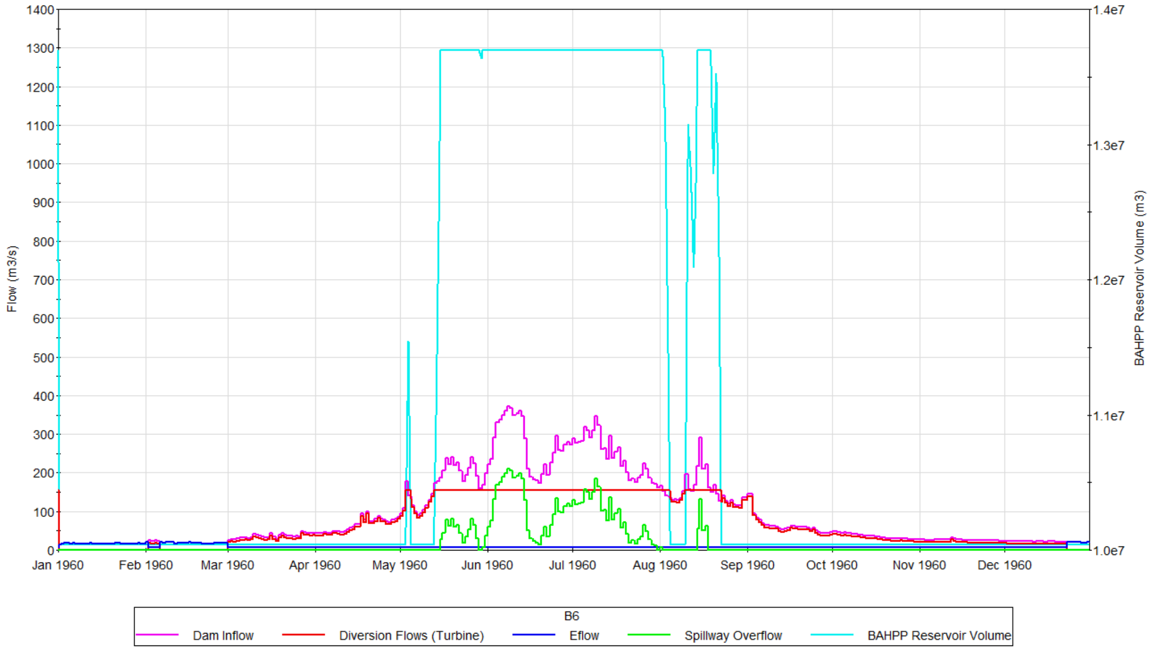


Exhibit B.25: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –P1 Scenario

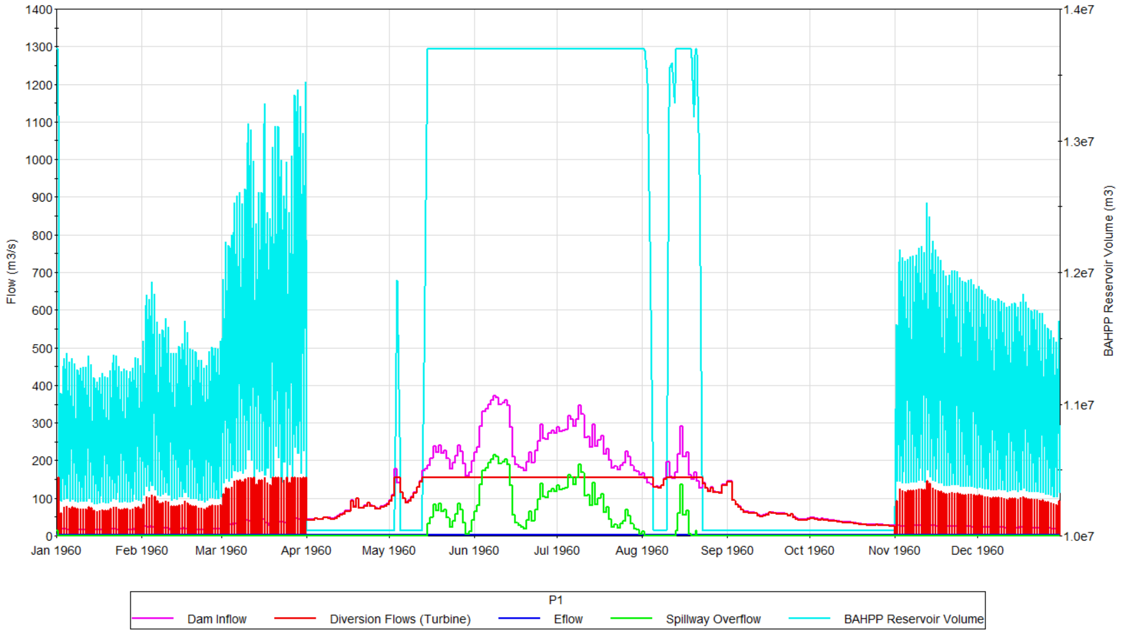


Exhibit B.26: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –P4 Scenario

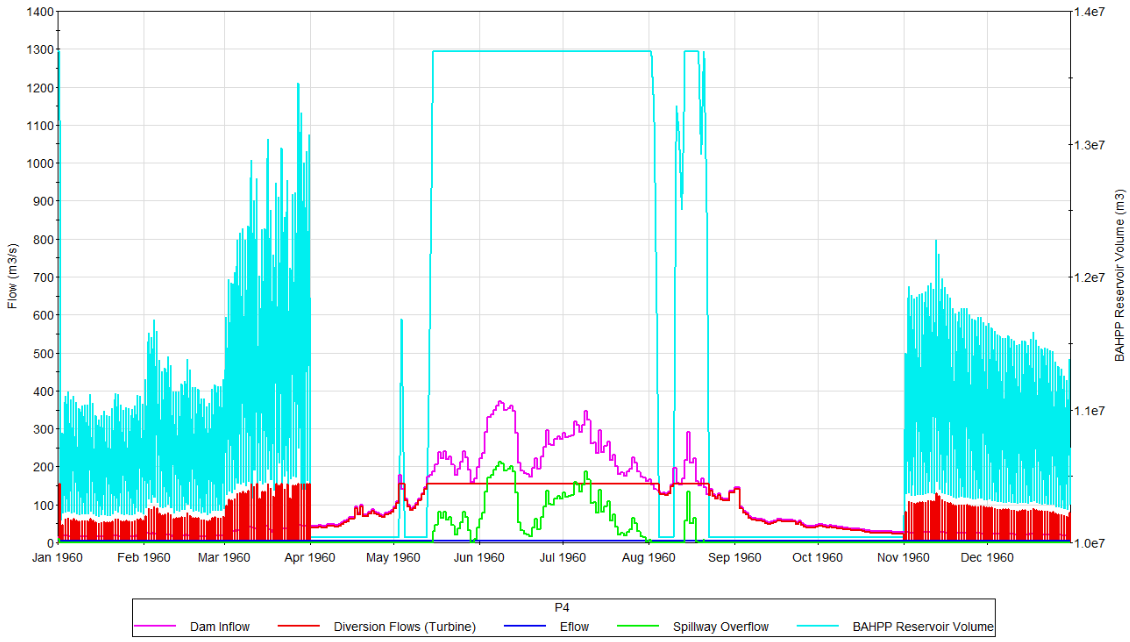
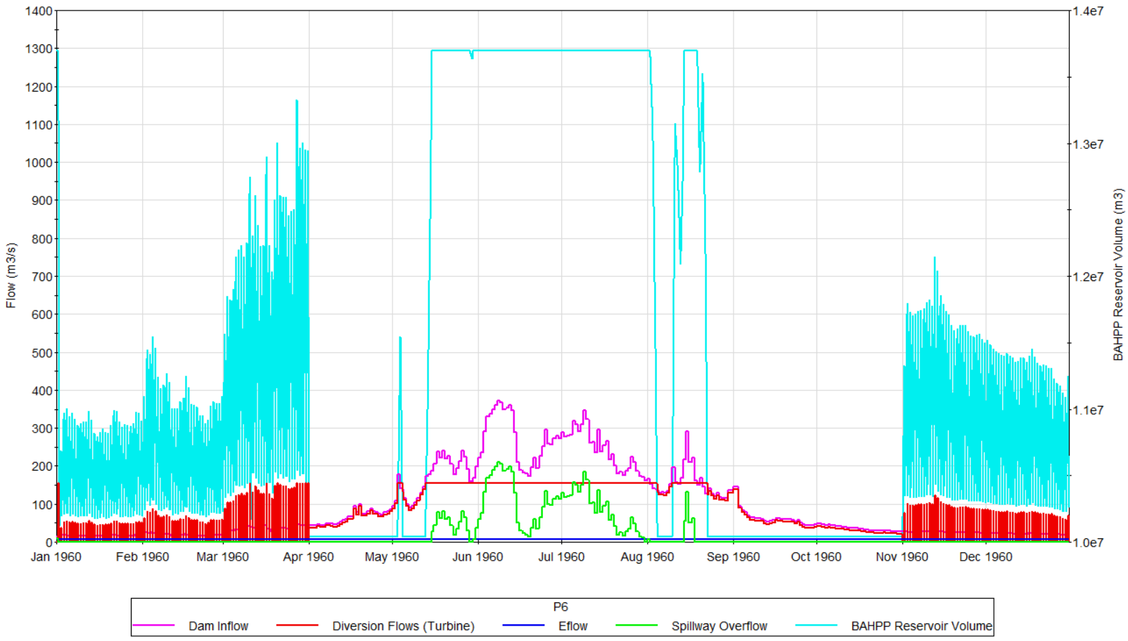


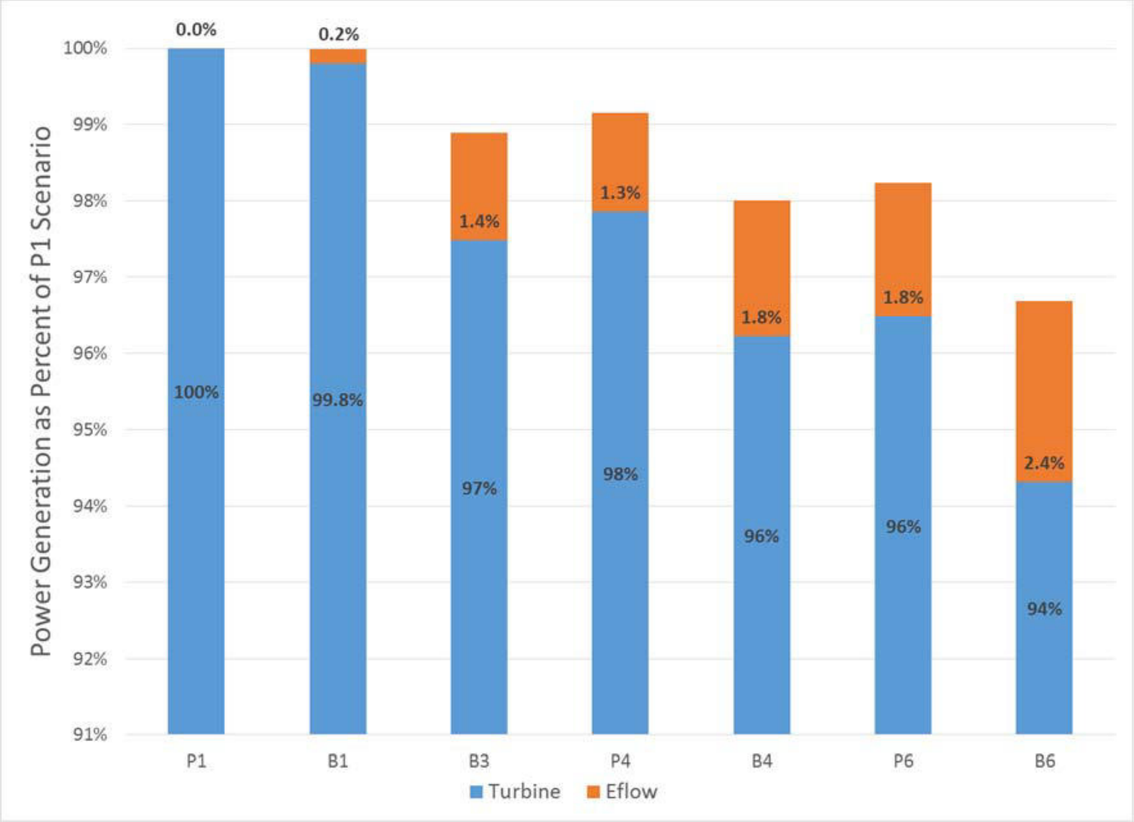
Exhibit B.27: Dam Volume, Inflows and Outflows Using 10-Day 90% Dependable Flows –P6 Scenario



B.4.2 Simulated Results: Power Generation

Impact to power generation for the simulated scenarios was calculated based on the water diverted through the turbines and did not take into account the turbine efficiency at varying flows. The Peaking operation scenario with environmental release of 1.5 m^3/s was taken as the base-case (i.e. producing 100% power) and percentage power generated for the others were calculated.(see **Exhibit B.28**) The current design[2] does not generate electricity from the environmental flow that is released. The potential of power generation from the EFlow is also indicated in the **Exhibit B.28**.

Exhibit B.28: Power Generation



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[2] As of May 2015

2. It is a published method (King *et al.* 2003), with a detailed User Manual (Brown *et al., 2*008), and as such is has been peer reviewed.
3. It has been widely applied in the Southern African Development Community, such as Lesotho (King *et al.* 2003), Mozambique (Beilfuss and Brown, 2010; Southern Waters 2011), Namibia (Southern Waters 2010), Peru (Norconsult and Southern Waters 2011), South Africa (e.g. Brown *et al*., 2006), Tanzania (PBWO/IUCN 2008), Zimbabwe (Brown 2007) and Sudan (Southern Waters 2009). It was used as the basis of a basin-wide EF assessment in the Okavango River Basin (Angola, Namibia and Botswana; King and Brown 2009), and has been used in Pakistan on the Neelum-Jhelum River (Southern Waters and Hagler-Bailly Pakistan 2013).
4. It is based on Response Curves constructed from any relevant knowledge including expert opinion and local wisdom and as such is suitable for use in regions where there are few biophysical data available for the flow-related aspects of the rivers, as was the case for the Jhelum River
5. It aims to provide an objective and transparent assessment of the effects of changes in flow on the downstream environment based solely on structured consideration of the biophysical aspects thereof.

DRIFT is a data-management tool, allowing data and knowledge to be used to their best advantage in a structured way. Within DRIFT, each specialist, to derive the links between river flow and river condition, uses discipline-specific methods. The central rationale of DRIFT is that different aspects of the flow regime of a river elicit different responses from the riverine ecosystem. Thus, removal of part or all of a particular element of the flow regime will affect the riverine ecosystem differently than will removal of some other element.

In DRIFT, the long-term daily-flow time-series is partitioned into parts of the flow regime that are thought to play different roles in sculpting and maintaining the river ecosystem, such as the onset of important flow seasons, which may affect breeding cycles, or the magnitude of the annual flood, which may inundate a floodplain. This makes it easier for ecologists to predict how changes in the flow regime could affect the ecosystem. The ‘parts’ of the flow regime used in DRIFT are called flow indicators.

- Seasonal/daily variations
  - Mean annual runoff
  - Dry season onset
  - Dry season minimum 5-day discharge
  - Dry season duration
  - Dry season average daily volume
  - Wet season onset
  - Wet season minimum 5-day discharge
  - Wet season duration

  - Wet season flood volume
  - Transition 1 average daily volume
  - Transition 2 average daily volume
  - Transition 2 recession shape
- Hourly variations (required for sites downstream of the tailrace, which releases flows resulting from peak power generation):
  - Dry season within day range in discharge
  - Dry season maximum instantaneous discharge
  - Dry season minimum instantaneous discharge
  - Wet season within day range in discharge
  - Wet season maximum instantaneous discharge
  - Wet season minimum instantaneous discharge
  - Transition 1 within day range in discharge
  - Transition 1 maximum instantaneous discharge
  - Transition 1 minimum instantaneous discharge
  - Transition 2 within day range in discharge
  - Transition 2 maximum instantaneous discharge
  - Transition 2 minimum instantaneous discharge.

The variability of the flow regime in timing and magnitude, both in its natural state and in any future scenario, was captured automatically through instructions within the hydrological module of the DSS that identify the flow indicators year-by-year. Thus, for the Jhelum River, the time-series are made up of annual time-series of each flow indicator for the 31 years of flow record. This means the specialists can consider a response to a condition for a particular time-step rather than thinking of an averaged response over several years. They can also use data from a particular year or season to calibrate time-series responses.

The study process was structured as follows:

1. The study focused on EF sites on the Jhelum Rivers. The flow changes that were evaluated encompass a mixture of:
   i. Changes in magnitude.
   ii. Changes in duration.
   iii. Changes in timing (e.g., delayed onset of wet season or range of hourly discharge fluctuations).
2. Specialists provided opinion on the consequences of these changes in the form of Response Curves. The disciplines represented were:
   i. Water quality

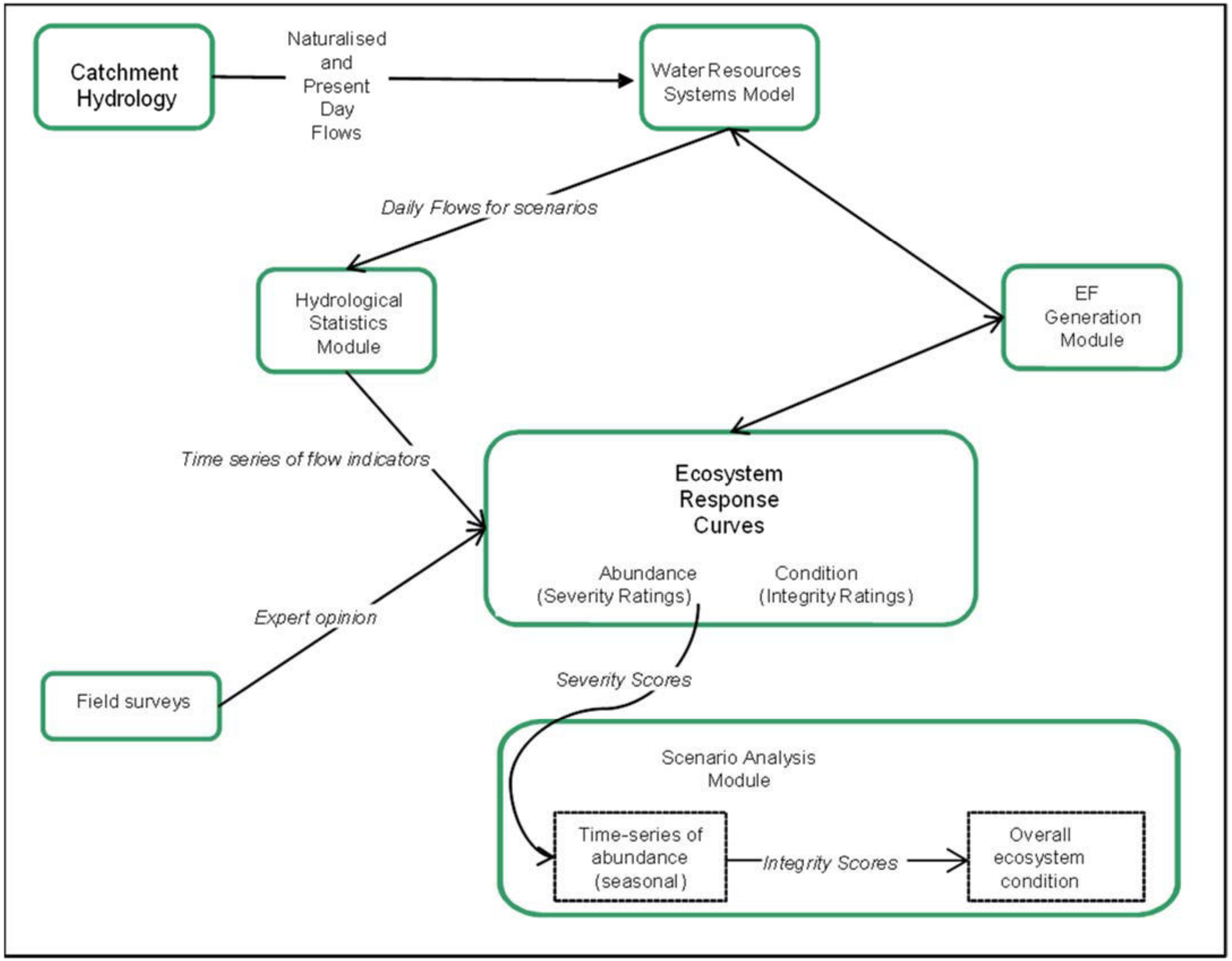
   ii. Hydraulics
   iii. Geomorphology
   iv. Algae
   v. Riparian vegetation
   vi. Invertebrates
   vii. Fish
   viii. Socioeconomics.

3. The database was used to evaluate
   i. changes in individual aspects of the ecosystem (e.g. fish, vegetation), for each site and scenario;
   ii. changes in the overall condition of the river, for each site and scenario.

The basic sequence of activities in the DRIFT DSS can be summarized as follows **Exhibit A.1**):

1. Collect data for the study at the river.
2. Augment with expert knowledge for similar river systems and a global understanding of river functioning.
3. Construct relationships for the expected response of individual ecosystem indicators to changes in aspects of the flow regime (Response Curves).
4. Use Response Curves to predict time-series of abundance changes.
5. Adjust the severity ratings to integrity ratings by assigning a negative sign for a move away from the natural ecosystem condition and a positive for a move towards natural.
6. Model future changes in catchment hydrology.
7. Calculate annual flow indicator time-series.
8. Use Response curves to calculate severity scores and develop time-series of change in abundance for ecosystem indicators.
9. Calculate average severity score for each indicator for entire hydrological time-series.
10. Convert severity scores to Integrity Scores to predict overall ecological condition.

Exhibit A.1: Flow chart of DRIFT process



A.3 Response Curves[1]

Response Curves depict the relationship between a biophysical or socio-economic indicator and a driving variable (e.g., flow). In this EF assessment, Response Curves linked an indicator to any other indicator deemed to be driving change. The aim is not to ensure that every conceivable link is captured but rather to restrict the linkages to those that are most meaningful and can be used to predict the bulk of the likely responses to a change in the flow or sediment regimes of the river.

The number of Response Curves constructed for an EF assessment depends on the level of detail at which a flow assessment is done. These were used to evaluate scenarios by taking the value of the flow indicator for any one scenario and reading off the resultant value for the biophysical indicators from their respective Response Curves. Once this had been done the database combined these values to predict the overall change in each biophysical indicator and in the overall ecosystem under each scenario.

A.3.1 Construction of the Response Curves

The Response Curves used in this project were constructed as follows:

- Draft curves constructed at a workshop in Islamabad attended by Southern Waters and Hagler-Bailly Pakistan team members.
- Draft curves re-evaluated by Southern Waters once the scenarios has been run, and adjusted where deemed necessary.
- Draft curves re-evaluated by Hagler-Bailly Pakistan using these scenarios as reference, and adjusted where deemed necessary.
- Final curves agreed on by Hagler-Bailly Pakistan and Southern Waters.

A.3.2 Response Curves and cumulative change

The time-series approach means that the Response Curves are used to predict the likely seasonal change in an ecosystem indicator in response to the flow/sediment conditions experienced in that, or possibly preceding, seasons. For instance, the kind of question typically asked to facilitate setting the dry season discharge Response Curve for Kashmir catfish are:

- “If the dry season discharge declines from baseline values, what will be the consequences for the abundance of Kashmir catfish?”:
  - Do Kashmir catfish use the main river in the dry season?
  - Do Kashmir catfish abundances change noticeably over the climatic range covered in the baseline, i.e., are they noticeably more abundant in wet years than in dry years, or vice versa?
  - What kinds of habitat do adult Kashmir catfish use in the main river?
  - Do Kashmir catfish breed in the dry season?

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[1] The bulk of this section is taken from Joubert *et al.*, 2009.

- ▷ Do they breed in the main river or in the tributaries?
- ▷ Where do Kashmir catfish lay their eggs?
- ▷ What sorts of habitat do fry, fingerlings and juvenile trout use in the main river?
- ▷ At what discharge(s) does the favoured habitat(s) disappear?
- ▷ What is the consequence of these habitats not being available for one season?
- ▷ If discharge reaches zero for one season, are there pools that the trout will be able to survive in?
- ▷ Can the Kashmir catfish survive for a dry season in pools?
- ▷ Is water temperature a concern, i.e., would winter temperature be an issue for Kashmir catfish if discharge dropped?
- ▷ What do Kashmir catfish adults/juveniles/fingerlings/fry eat?
- ▷ How will the food base be affected by changes in dry season low flows? Etc.

Often, a species (such as Kashmir catfish will be expected to survive even an extremely-dry dry season, with possibly only minor changes (5-10%) in overall abundance if dry season flows drop to zero. If, however, the flows drop to this level in the dry season year after year, then the cumulative effect on catfish populations is likely to be far greater. The time-series enable the DSS to capture this cumulative effect.

A.4 Scoring System Used

Into the foreseeable future, predictions of river change will be based on limited knowledge. Most river scientists, particularly when using sparse data, are thus reluctant to quantify predictions: it is relatively easy to predict the nature and direction of ecosystem change, but more difficult to predict its timing and intensity. To calculate the implications of loss of resources to subsistence and other users in order to facilitate discussion and tradeoffs, it is nevertheless necessary to quantify these predictions as accurately as possible.

Two types of information are generated for each biophysical indicator, *viz.*:

- ▶ Severity ratings, which describe increase/decreases for an indicator in response to changes in the flow indicators, and;
- ▶ Integrity ratings, which indicate whether the predicted change is a move towards or away from natural, i.e., how the change influences overall ecosystem condition.

The severity ratings are used to construct the Response Curves. The Integrity ratings are used to describe overall ecosystem condition/health.

A.5 Severity Ratings

The severity ratings comprise 11-point scale of -5 (large reduction) to +5 (very large change; Brown *et al.*, 2008; **Exhibit A.2**), where the + or – denotes a increase or decrease in abundance or extent. These ratings are converted to percentages using the relationships provided in **Exhibit A.2**. The scale accommodates uncertainty, as each rating encompasses a range of percentages; however, greater uncertainty can also be expressed through providing a range of severity ratings (i.e. a range of ranges) for any one predicted change (after King *et al.*, 2003).

Exhibit A.2: DRIFT severity ratings and their associated abundances and losses – a negative score means a loss in abundance relative to baseline, a positive means a gain.

Severity rating	*Severity*	*% abundance change*
5	Critically severe	501% gain to ∞ up to pest proportions
4	Severe	251-500% gain
3	Moderate	68-250% gain
2	Low	26-67% gain
1	Negligible	1-25% gain
0	None	no change
-1	Negligible	80-100% retained
-2	Low	60-79% retained
-3	Moderate	40-59% retained
-4	Severe	20-39% retained
-5	Critically severe	0-19% retained includes local extinction

Note that the percentages applied to severity ratings associated with gains in abundance are strongly non-linear[2] and that negative and positive percentage changes are not symmetrical (**Exhibit A.3**; King *et al.* 2003).

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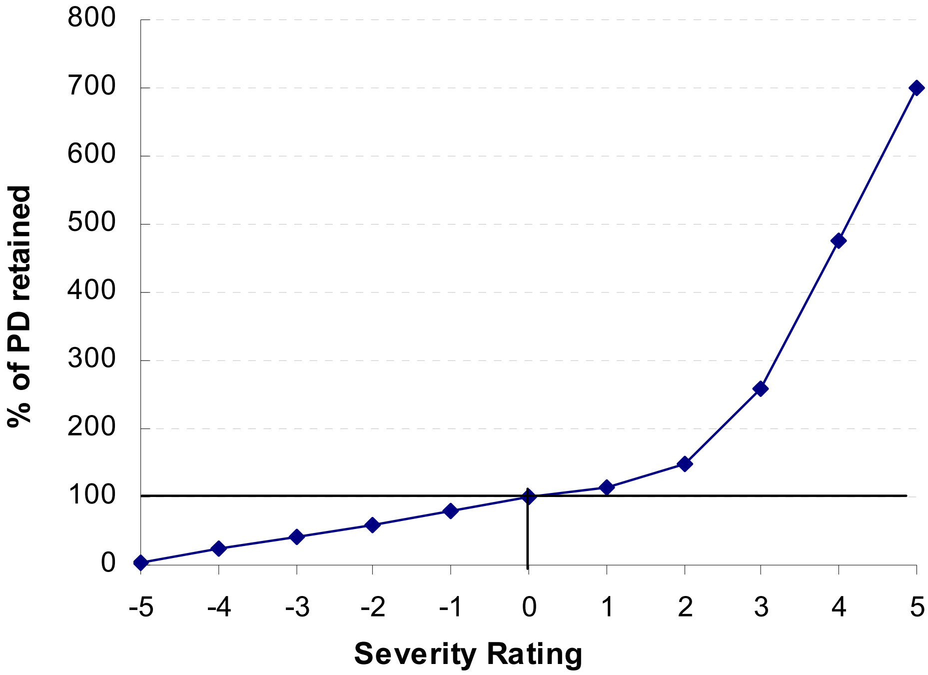
[2] The non-linearity is necessary because the scores have to be able to show that a critically-severe loss equates to local extinction whilst a critically severe gain equates to proliferation to pest proportions.

Exhibit A.3: The relationship between severity ratings (and severity scores) and percentage abundance lost or retained as used in DRIFT and adopted for the DSS. (PD=present day AND = 100%)



For each year of hydrological record, and for each ecosystem indicator, the severity rating corresponding to the value of a flow indicator is read off its Response Curve. The severity ratings for each flow indicator are then combined to produce a severity score, which provides an indication of how abundance, area or concentration of an indicator is expected to change under the given flow conditions in each year, relative to the changes that would have been expected under baseline conditions in the catchment.

A.6 Identification of Ecologically-relevant Elements of the Flow Regime

One of the main assumptions underlying the DRIFT EFs process is that it is possible to identify ecologically-relevant elements of the flow regime and isolate them within the historical hydrological record. Thus, one of the first steps in the DRIFT process is to identify the ecologically-important flow indicators, which are calculated per season for each year.

A.7 Major Limitations of DRIFT

Predicting the effect of flow changes on rivers is difficult because the actual trajectory and magnitude of the change is additionally dependent on so many other variables, such as climate, sediment supply and human use of the system. Thus, several assumptions underlie the predictions. Should any of these assumptions prove to be invalid, the actual changes may not match the predicted changes. This does not necessarily make the predictions themselves incorrect or invalid, but simply means that the surrounding set of circumstances that support the predictions has changed.

The main limitation is the paucity of data. This is a universal problem, as ecosystems are complex and we will probably never have complete certainty of their present and possible future characteristics. Instead it is essential to push ahead cautiously and aid decision-making, using best available information. The alternative is that water resource development decisions are made without consideration of the consequences for the supporting ecosystems, eventually probably making management of sustainability impossible. Data paucity is addressed in the DRIFT process by accessing every kind of knowledge available - general scientific understanding, international scientific literature, local wisdom and specific data from the river under consideration or from similar ones – and capturing these in a structured process that is transparent, with the DSS inputs and outputs checked and approved at every step. The Response Curves used (and the reasoning used to construct them) are available for scrutiny within the DSS and they, as well as the DRIFT DSS, can be updated as new information becomes available.

A second aspect of the paucity of data is that it is neither known what the river was like in its pristine condition nor exactly how abundant each ecosystem aspect (sand bars, fish, etc.) was then or is now. To address this, all DRIFT predictions are made relative to the baseline situation (there will be a little more, or a lot less, than today, and so on), as explained further below.

These inherent uncertainties also mean that the trends and relative position of the scenarios are more reliable predictors of the impacts of the scenarios than are their absolute values. Also, DRIFT is designed to predict overall condition, and focusing on one indicator to the exclusion of others is not recommended.

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