Downstream Flow Regimes

This guideline expands on what is expected by the criteria statements in the Hydropower Sustainability Tools for the Downstream Flow Regimes topic, relating to assessment, management, conformance/compliance, stakeholder engagement and outcomes. The good practice criteria are expressed for different life cycle stages.

In the Hydropower Sustainability Assessment Protocol (HSAP), this topic is addressed in P-23 for the preparation stage, I-20 for the implementation stage and O-19 for the operation stage. In the Hydropower Sustainability ESG Gap Analysis Tool (HESG), this topic is addressed in Section 3.

Good practice requires that flow regimes downstream of hydropower project infrastructure should be planned and delivered with an awareness of and measures incorporated to address environmental, social and economic objectives affected by those flows. Objectives should reflect important river uses, values and services. All affected river reaches downstream of hydropower infrastructure should be considered and there should be evidence that the flow regimes meet publicly disclosed objectives and commitments.

A river's flow naturally varies and has a characteristic pattern. The flow regime can be characterised according to many aspects, such as flow magnitude, duration, frequency, timing, rates of change, and predictability. The flow regime sustains the ecology of rivers and where relevant their associated floodplains, wetlands, groundwater dependent ecosystems, and estuaries. The flow regime supports the ecological processes and associated values that rivers provide to communities and the environment, including: flood attenuation; water purification; sediment flushing; channel and habitat maintenance; nutrient dispersion; water supply; wastewater dilution; electricity generation; and the production of fish and other foods and marketable goods.

Hydropower developments result in changes to various aspects of the flow regime depending on the project design and operational patterns. These changes relative to the pre-project hydrological regime can be, for example, seasonally reduced flows, seasonally increased flows, rapid (i.e. hourly) increases and decreases in flows due to hydropeaking, loss of or changes to flood events, and large flow events due to spill. For base load stations, discharges can be at a consistent flow for long periods; for peaking

stations, flows can fluctuate rapidly on timescales of hours. Where diversions have occurred from one river basin into another, power stations can deliver prolonged periods of higher than natural flows while dewatering or reducing flows in the river system downstream of the diversion point or diversion structure.

The most common mitigation measure to minimise the impacts of altered flow regimes resulting from hydropower developments has been through the design of rules governing the downstream flow releases. These rules are commonly known as 'environmental flows', although in some regions terms such as 'minimum flows', 'riparian flows', or 'compensation flows' might be used.

Assessment

Assessment criterion - Preparation Stage: An assessment of flow regimes downstream of project infrastructure over all potentially affected river reaches, including identification of the flow ranges and variability to achieve different environmental, social and economic objectives, has been undertaken based on relevant scientific and other information with no significant gaps.

For hydropower projects at the preparation stage, good practice requires that the effects on flow regimes downstream of project infrastructure have been evaluated, as well as mitigation measures to address impacts. Ideally this process starts early to inform the evaluation of project alternatives. The results of these evaluations should be within the Environmental and Social Impact Assessment (ESIA) and informed by many specific study areas within the ESIA. This assessment should be information-based and consider environmental and social aspects in addition to economic factors. Options for flow ranges and variabilities should be considered in terms of their implications for diverse objectives and issues identified by the studies and by stakeholders.

Of importance is that all potentially affected river reaches are considered as often attention is only given to the dewatered reach between the dam and power station. For hydropower projects with water storage capabilities, the releases out of the power house may have seasonal or even daily patterns that differ from the pre-project river flows. For hydropower projects involving diversion of water out of one river into another, the effects on flow regimes both out of the diversion river and into the receiving river should be carefully evaluated as they will result in the diversion river having lower than pre-project average flows and the receiving river having higher than pre-project average flows. In all cases, the evaluation of downstream flows should be for the downstream river distance for which flow changes can be attributed to the project, informed by hydrological modelling (see the Hydrological Resource topic guideline).

There is no specific methodology that must be used in reaching a downstream flow regime commitment. Traditionally, there have been four broad categories of "environmental flow" determination methodologies. In order of increasing sophistication, time and cost, these are: hydrological index, hydraulic rating, habitat simulation and holistic methods. International good practice requires that scientific approaches are embedded within interactive frameworks that are objectives-oriented and involve stakeholder engagement. These use scientific analyses as necessary to match elements of the flow regime to identified objectives that reflect important river uses, values and services.

Downstream flow regime studies should focus on trade-offs among competing ecological, social and economic objectives, and seek to optimise the outcomes for the lowest impact and highest benefit. Examples of ecological flow objectives include: increasing habitat availability for nominated species, e.g. critical spawning areas for fish species; enhancing the population of a threatened species; or providing flows to trigger biological responses such as fish migration. Examples of social flow objectives include: ensuring water user safety; managing flood risks; supporting navigation needs; or maintaining water levels for irrigation pumps. Examples of economic flow objectives include: providing sufficient water availability to maintain local industries (e.g. irrigation, aquaculture, sport-fishing, rafting); and maximising electricity generation.

The approach taken needs to be proportional to the significance of the flow changes and the sensitivity of the flow-dependent aspects of

the downstream river system. Of importance is that a methodological and defensible process is followed to determine the link between flows and objectives. Regardless of the exact method used, a logical 12-step approach with the steps grouped into four stages is reflective of good practice, as follows.

Stage 1: Characterising the Downstream Flows and Associated Values

1. Review of available maps, aerial photos and satellite images of the river system, catchment areas, major tributaries, and confluences downstream of the project to characterise the flow network and significant features (other projects, land-uses, townships, protected areas)
2. Review of climate, meteorological data and hydrological data to form a view regarding the major pre-project flow characteristics in the catchment and downstream river
3. Review of the storage and operational characteristics of the project to identify the implications for downstream flows
4. Definition of significant reaches (i.e. river sections) downstream of the project from a hydrological perspective (e.g. one reach is likely to be between the dam and tailrace, or more than one reach if a major tributary comes into this section of the river or there are other significant influences on flows; another reach between the tailrace and the next major tributary; another reach between the first and second major tributary downstream of the tailrace)
5. Identification of important river uses, values and services in each of the downstream river reaches based on analysis of existing data, plus consultations with project affected people and other stakeholders based on stakeholder mapping

Stage 2: Defining Project Impacts

6. Design and implementation of more focussed data collection to evaluate the sensitivity of existing uses, values and services to flow changes expected by the project
7. Development of pre-project and post-project flow relationship analyses for important river uses, values and services on a reach-by-reach basis, identifying the characteristics of the flow regimes that are most significant to maintenance of negatively affected aspects

Stage 3: Cost-Benefit Analysis of Impact Mitigation Options

8. Identification of the mitigation options that could address those affected aspects based on data analysis, research and consultations, and including water management, infrastructure, or other management actions
9. Cost-benefit analyses of mitigation options following the mitigation hierarchy (avoid, minimise, mitigate, compensate), and including compensation options for significant residual downstream impacts that cannot be mitigated
10. Stakeholder discussions on priority approaches

Stage 4: Mitigation Commitments

11. Downstream flow commitments are designed on a reach-impact basis
12. Supplementary commitments are defined to further address downstream impacts that are not resolved through flow management measures, such as bank erosion protection works or the creation of off-stream watering areas for stock

Assessment

Assessment criterion - Implementation Stage: Issues in relation to flow regimes downstream of project infrastructure during the project implementation stage have been identified and assessed; and monitoring is undertaken to assess effectiveness of flow management measures or any emerging issues during project implementation.

Assessment criterion - Operation Stage: Ongoing or emerging issues relating to the operating hydropower facility's downstream flow regimes have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

For hydropower projects at the implementation or operation stage, a permit or licence to operate has been issued which may or may not require dedicated releases to meet non-generational objectives (i.e. objectives other than for electricity

generation). The implementation stage may need particular consideration if for example a river will be dewatered for a long period while the newly created reservoir fills.

Mechanisms by which ongoing or emerging issues with the downstream flow regimes could be raised might include stakeholder engagement processes, grievance mechanisms, or follow-up monitoring programmes. Of importance is that the developer or owner/operator has processes in place that enable identification and evaluation of issues arising with regards to the downstream flows, and that these areas are not ignored or dismissed. Hydropower facilities are long-lived assets and over time the downstream community and the river values and other uses evolve, the science improves, and expectations of and demands for more water for social or environmental needs can increase. Cumulative impacts through later developments may also raise the need to consider downstream flow regimes from the hydropower facility. The experience of changed flow regimes may also draw attention to issues or concerns that had not previously been considered.

If there are issues and concerns with downstream flow regimes below hydropower infrastructure, the owner/operator should show that options to address these issues have been fully considered. It is not essential that all issues raised must be addressed through dedicated flow releases. There may be ways that the owner/operator can help meet the needs of other users or values without unduly impacting on the generation needs, and this should be explored. Non-flow related solutions to downstream flow issues have been exhibited in many places around the world. Examples of built solutions include: artificial spawning channels; off-river water storages; riverbank protection works; and habitat enhancement measures.

If commitments are made to delivery of specific downstream flow regimes, monitoring should be undertaken to verify delivery of commitments and that the objectives are being met. The methods, frequency and location for this monitoring process should provide information that enables a determination on delivery and effectiveness of downstream flow commitments and whether the objectives are being realised. Monitoring should be periodically reviewed to confirm that the data is meaningful and the monitoring programme is effective.

Management

Management criterion - Preparation Stage: Plans and processes for delivery of downstream flow regimes have been developed that include the flow objectives; the magnitude, range and variability of the flow regimes; the locations at which flows will be verified; and ongoing monitoring; and where formal commitments have been made, these are publicly disclosed.

Management criterion - Implementation Stage: In the case that a need to address downstream flow regimes has been identified, measures are in place to manage identified downstream flow issues; and where formal commitments have been made, these are publicly disclosed.

Management criterion - Operation Stage: In the case of a need to address downstream flow regimes, measures are in place to address identified downstream flow issues; and where formal commitments have been made, these are publicly disclosed.

Management plans for downstream flow regimes should be incorporated into the Environmental and Social Management Plan (ESMP). Where commitments are made for dedicated downstream flow release regimes below hydropower infrastructure, these should be well-documented with respect to a number of aspects (e.g. objectives, flow magnitude, timing, seasonal variations, where measured, follow-up monitoring) and be publicly disclosed. Ideally, management plans will allow for later adaptations to be made based on findings from the monitoring programme and determinations on whether the flow regime is meeting the objectives.

Determinations on downstream flow regimes can result in power station or dam operational rules. These may take various forms, such as: guaranteed minimum flows; caps on maximum flow releases; constraints on water level draw-down or ramp-up rates; provision of periodic flushing or flood flows; flood or drought management rules; and rules in relation to spill events. Operational rules may include some or all of these considerations and may be specified for year-round or be conditional, e.g. by season or to be met under certain natural inflow or climatic

conditions. The location at which delivery of committed flows is guaranteed should be clear and tied into the monitoring commitments.

It is important to consider the mechanism for delivery of the flow regime commitments from a design perspective. Measures include, for example, through turbines, a pipe in the dam, gates or valves, a dedicated ecological power house, or a re-regulation storage. Whatever mechanism is chosen, its design would ideally allow for later adaptations in flow release characteristics given that knowledge, values and needs are likely to change over time.

A commitment should be made in writing to recognise its formality and be within an appropriate document signed by a recognised representative of the party who will deliver on the commitment. Legal and/or administrative requirements and court decisions are considered formal commitments. The formality of a commitment can be demonstrated by how it has been recorded, documented, witnessed and publicised by the party responsible for its implementation.

Public disclosure is demonstrated if members of the public can access information on the commitment if they would like to do so. This may involve access to the actual document that records the commitment (either posted on a website, distributed, or made available on request to interested parties), or public notification via a media release or website about the main provisions of the commitment. If there was a one-off notification, information may later be hard to access. In this case, some effort should be made by the owner/operator to ensure awareness of and ease of accessibility of information by stakeholders over time on downstream flow regime commitments.

Stakeholder Engagement

Stakeholder Engagement criterion - Preparation Stage: The assessment and planning process for downstream flow regimes has involved appropriately timed, and often two-way, engagement with directly affected stakeholders; ongoing processes are in place for stakeholders to raise issues with downstream flow regimes and get feedback.

Good practice requires that a process of stakeholder engagement has been followed in the assessment and planning for downstream flow regimes.

During the project preparation, the social impact assessment and any stakeholder mapping should identify directly affected stakeholders for downstream flow regimes. Stakeholders who are directly affected might include riparian residents and land owners, irrigators, people who draw water for stock and domestic purposes, local government agencies (water suppliers), government regulators, fishermen, other recreational users, and tourism businesses.

'Appropriately timed' means that:

- engagement should be early and frequent enough so that the project can respond to the issues raised;
- stakeholders can respond before the project takes decisions; and
- engagement takes place at times that are suitable for people to participate (e.g. with respect to seasonality or time of day).

Stakeholders should be supportive of the timing of engagement activities. Communities need sufficient time to receive information, discuss it openly with the project representatives, and finally go through their own community dialogue processes before forming a consolidated community view to relay back into the evaluation processes.

'Two-way' means the stakeholders can give their views on considerations for downstream flow regimes rather than just being given information without any opportunity to respond. Examples of two-way processes include public meetings and hearings, public comments on studies and options assessment documents, interactive participation in workshops, negotiation, mediation, and focus groups.

Processes in place for stakeholders to raise issues could include, for example, a contact person and/or a "contact us" space on the company website, periodic public briefings or question/answer opportunities, or participation of company staff on stakeholder or catchment committees.

Feedback on stakeholder issues could be demonstrated by means such as emails, records of telephone conversations, written correspondence, meeting minutes, media releases, or provision of responses to frequently asked questions on the company website. Ideally a register is kept by the owner/operator of source, date and nature of issues raised, and how and when each was addressed and resolved.

Further and more detailed guidance relating to good international practice stakeholder engagement processes can be found in the Communications and Consultation guideline.

Conformance/Compliance

Conformance/Compliance criterion - Implementation and Operation Stages: In the case that a need to address downstream flow regimes has been identified, processes and objectives in place to manage downstream flows have been and are on track to be met with no significant non-compliances or non-conformances, and downstream flow related commitments have been or are on track to be met.

Good practice requires evidence that commitments to downstream flow regimes are met. These should be separately considered for the implementation versus operation stages given that different issues may be relevant.

Commitments may be expressed in regulatory requirements for addressing downstream flow regimes, in relevant policy requirements of the developer or owner/operator, or in any relevant commitments made either publicly or within management plans. Evidence of adherence to commitments could be provided through, for example, internal monitoring and reports, government inspections, or independent review. Variations to commitments should be well-justified and approved by relevant authorities, with appropriate stakeholder liaison.

The significance of not meeting a commitment is based on the magnitude and consequence of that omission. For example, a failure to demonstrate delivery of a downstream flow commitment may be a significant non-compliance, whereas a slight delay in delivery of a monitoring report could be a non-significant non-conformance.

Outcomes

Outcomes criterion - Preparation Stage: Plans for downstream flows take into account environmental, social and economic objectives, and where relevant, agreed transboundary objectives.

Outcomes criterion - Implementation and Operation Stages: In the case that a need to address downstream flow regimes has been identified and commitments to downstream flow regimes have been made, these take into account environmental, social and economic objectives, and where relevant, agreed transboundary objectives.

Of utmost importance is that the downstream flow releases are meeting objectives that reflect not just economic or financial interests but take into consideration environmental and social objectives important to stakeholders, as well as transboundary objectives if relevant. Objectives should be clear and data should demonstrate that these objectives are being met.

Transboundary objectives would be relevant if the downstream effects of the hydropower facility cross into a different jurisdiction than that in which the reservoir, dam and power station are found. If this is the case, then processes to assess and make determinations on downstream flow regimes should take into account transboundary stakeholder interests and objectives. There may be existing agreements in place establishing common objectives for management of the shared river system, or these may be developed alongside preparation of the project. Any existing transboundary river management agreements should be well-integrated into the assessment and decision-making on downstream flow regimes.