

COMPLIANCE WITH THE PRELIMINARY DESIGN GUIDANCE

The MRC’s Preliminary Design Guidance for the proposed mainstream dams in the Lower Mekong basin (PDG) indicates that;

“The design guidance recommended in this document is preliminary and advisory in nature. The intention is to provide developers of proposed dams on the Lower Mekong mainstream with an overview of the issues that the MRC will be considering during the process of prior consultation under the 1995 Mekong Agreement. Responsibility for ensuring compliance with national standards and provisions of the 1995 Mekong Agreement remains with the project developers. MRC may commission an international expert group to assist in the interpretation of such requirements.”

This Annex provides this assessment in tabular form.

Fish and fish passage

PDG chapter 3 - Fish Passage on Mainstream Dams	Is paragraph relevant		Does the project conform to PDG			Remark
	No	Yes	Yes	Not enough info to assess	No	
3.1 Background						
53-58.				Needs additional information		<ul style="list-style-type: none"> ▪ Does not provide background information on species diversity, migration guilds or strategies, migration behavior of long-lived and short-lived species, the scale of fisheries in the affected region, specific contribution of Khone Falls fishery, migratory fishes that are at risk upstream and hence populations downstream, livelihoods fishing activities. ▪ DSHPP is a development on one of 14 main channels on the falls. Options analysis of possible development on other channels has very limited assessment. ▪ It will not have a fish passage solution on the dammed channel but relies mainly on modifying one adjacent channel (Hou Xangphueak) and a smaller channel (Hou Sadam near Hou Phapheng) for mitigating fish migration issues throughout the year. ▪ EIA states that there will be no “reservoir effect” i.e. lotic to lentic habitat. This is true compared to dams with large reservoirs, but water velocity is reduced to 0.3 m/s near dam

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						<p>which may trap larvae and other large life stages.</p> <ul style="list-style-type: none"> Hou Sahong channel would take more flow for DSHP; 50% of Mekong flow in dry season down to 7% in wet season
3.2 Guidance on fish passage design and operation. General:						
60. Fish passage facilities for both upstream and downstream passage must be incorporated into all dams on the mainstream.		YES		Needs additional design information		<ul style="list-style-type: none"> General outline for upstream - downstream (u/s) passage considered in design, but needs much more technical details. Presently these are considered unlikely to mitigate the migration issues identified. Upstream passage restricted to two channels that do not have the dimensions and capacity of the lost channel. Downstream passage only presented as optional solution but has to be mandatory, general design provides little information on screening solutions or how downstream drifting larvae will be accommodated (especially in dry season and early wet season when increase spawning occurs).
61. The developer should provide effective fish passage upstream and downstream; "95% of the target species under all flow conditions"		Yes		Clarification needed		<ul style="list-style-type: none"> Review and details of design of fish passage facilities inadequate and does not relate to species or guilds. No appraisal of effectiveness of u/s passage or likelihood of and survival during d/s passage. Developer is committed to 95% passage in EIA but no methodology provided for measurement.
62. Where fish passage rates are unlikely to be adequate to maintain viable populations, the developers must develop and propose mitigation options as one element of compensation programs for lost fisheries resources.		Yes			No	<ul style="list-style-type: none"> No assessment of likelihood or scale of loss of fisheries to determine compensation programmes. No true mitigation or compensation measures proposed. There will be no possibility of developing a reservoir fishery or aquaculture units because of the nature of the impoundment and operating regime. No budget for any significant mitigation compensation measures, if required.
63. Consideration should be given to multiple systems at each site to cater for the large number of species and high biomass, especially given the variable flow regime and lack of biological knowledge on behaviour of migrating species.		Yes		Clarification needed.		<ul style="list-style-type: none"> Upstream fish passage solution relies on one major adjacent channels (Hou Xangphueak) and a minor channel (Hou Sadam) for mitigating fish migration issues throughout the year. These solutions are not considered technically adequate to compensate for loss of migration through Hou Sahong channel. No channel morphology or hydraulic modelling carried out to optimise solutions. No consideration given to other solutions using alternative channels.

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Planning and design phase						
64. The planning and design of the fishways should be fully integrated into the dam design concept from the earliest stages of planning.		Yes			NO	<ul style="list-style-type: none"> ▪ The dam location and alignment has been designed to optimise construction. No options analysis of dam location to consider optimal solution to protect fisheries or provide fish passage. ▪ Fish are attracted to flow from a dam and hence, effective fish passage is completely dependent on integrating the dam and fishway design; if fish cannot locate the fishway they cannot use it. ▪ Planning and design of fish bypass solutions not integrated at present, particularly the entrance of Hou Xang Phueak and the dam. This will be less of an issue in the peak wet season as more flow comes from HXP. ▪ Options beyond the two channels chosen are not considered and no evidence that criteria outline in Para 64 have been considered. The proposed solutions are modifications of existing channels but few details of the modifications are given. In-channel works have not been planned and no hydraulic modeling of channels or attraction flows to entrances provided. It is unlikely that a high biomass or many species of Mekong fish will be attracted to the Hou Sadam channel ▪ No evidence of physical or hydraulic modelling to assess these characteristics. Physical modelling (common practice in dam design) is likely to be essential to optimise entrance attraction. ▪ Downstream passage design characteristics limited. No criteria to show larval and drifting juveniles considered from older life stages and large sized fish. ▪ No account of impounding effect or how deepening of Hou Sahong upper channel will effect downstream fish migration/passage.
65. Developers are encouraged to utilise best international practice in fish passage design and be aware of the outputs of the MRC Fisheries Programme and ensure that a “core expert group” is retained.		Yes		Most information concerns fisheries monitoring with little input to channel design		<ul style="list-style-type: none"> • Developers have engaged with several international consultancy groups for advice, but first evidence suggests this expertise needs widening to provide optimal design solutions for both upstream and downstream passage

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Biological/ecological:						
66. Facilities should be designed to cater for the upstream and downstream movement of the most important species at any site, under the seasonal flow conditions during the periods when the species migrate.		Yes		Further information needed	No	<ul style="list-style-type: none"> The Fish passage designs have considered all species in all seasons but little information of the channel hydraulics under different flow conditions and whether suitable to account for seasonal variability in species and sizes of fish. Issue for both upstream and downstream migration
67. The maximum standard length of the target species moving upstream will vary from around 20cm to more than 100cm. For downstream migration, the size will vary from eggs and larvae a few millimetres long, to adult fish.		Yes			No	<ul style="list-style-type: none"> Limited consideration of swimming capacities and behaviour of various and size and species against hydraulics of bypass channels. No design criteria or plans for modifications to proposed bypass channels given. Downstream facilities do not consider life history stages and assume most fish will pass over the falls in other channels. No consideration of the entrainment aspects associated with modification (deepening upstream entrance) of Hou Sahong channel.
68. The preferences, tolerances and biological attributes of the target fish species relevant to successful movement through the facilities should be clearly established.		Yes			No	<ul style="list-style-type: none"> Basic information on the biology of a few target species provided in SEA report but not carried through to EIA. No further biological information provided, although some information is available, especially from MRC reports, and reasonable assumptions could be made for this aspect. No information relating to ecology of downstream movements.
69. The peak biomass likely to be using the facilities must be determined and the appropriate structure sizing of fishways, cycle time of fish locks and/or lifts, and water availability established.		Yes			No	<ul style="list-style-type: none"> Peak biomass data in both upstream and downstream migration not presented. DSHPP need to make assumptions to establish monitoring procedures. MRC fisher monitoring data would provide species and seasonal pattern.
70. Predation within the fish passages should be minimised.		Yes			No	<ul style="list-style-type: none"> Predation within fish pass not considered, but likely to be no greater than existing situation. Residence time in pass not considered but key issue given length of passes and design.

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71. Fish exiting fishways both upstream and downstream should be sufficiently healthy to continue their natural patterns and migration routes.		Yes		Need further information		<ul style="list-style-type: none"> No information on direct or indirect mortality during movement upstream and downstream, just statement that fish-friendly turbines will keep it to the minimum. This has not been proven for Mekong fishes and design of turbine is critical. High mortalities are also expected for large fish passing through proposed fish-friendly turbines Downstream passage - most fish assumed to pass through other routes, however no consideration given to entrainment into Hou Sahong channels as a result of channel modifications.
Hydrology						
72. The fishways should cater for the largest operational ranges practical, within the biological and hydrological requirements of the fish species concerned.		Yes			No	<ul style="list-style-type: none"> Hydrological modelling (2009-2014) pre- and post-dam is coarse with only discharge in each of the four main channels. No information on how changing flow scenarios in different seasons will change the hydraulics of the channels. Pages 5-29 and 5-30 of EIA shows that DSHPP will affect minimum, mean and maximum flows of Phapheng in every month; and will likely be the largest hydrological impact of the project.
73. Particular attention must be given to ensuring that the entrances to fishways effectively attract fish.		Yes			No	<ul style="list-style-type: none"> At present the bypasses have very poor attraction during dry season compared with Hou Sahong, which represents the standard to maintain. No information on entrance designs of the alternative fish pathways is available as part of the submitted documents. In addition, (i) assessment regarding flow attractions and access to proposed bypass channels, (ii) fish behavioural studies and (iii) physical or CFD model study of tailwater are lacking.
74. Dam and fish passage design should minimise fish injury or entrapment. Spillway design, aprons, stilling basins and dissipater design should seek to minimise fish injury, mortality and entrapment.		Yes		Needs further information		<ul style="list-style-type: none"> Evaluation of downstream passage and the likely impacts on fisheries have not been thoroughly investigated or reported. Inadequate information on downstream passage mitigation facilities. No information about fish injury and mortality, impingement, entrapment.
Hydraulic environment						
75. Fishway entrances should be: <ul style="list-style-type: none"> Sited to take maximum advantage of the hydraulic conditions created by spillways, outlets and channel 		Yes			No	<ul style="list-style-type: none"> Problems finding pass entrances likely when most flow is through DSHPP. Hou Sadam channel remote from DSHPP and likely overridden by flows from Khone Phapheng.

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<p>structures.</p> <ul style="list-style-type: none"> Suitably located to be accessed by fish over the full operational range of the fishway. Located where the morphology of the river, as well as the substrate and cover, promote fish attraction to the facility. 						<ul style="list-style-type: none"> Little consideration of morphology and hydraulics of the river, apart from rock wall proposed to divert Hou XangPheuak flows toward DSHP. No evidence of 2-d or 3-d computer modelling or physical modelling of velocity and turbulence conditions at entrances to alternative channels Hou Sadam and Hou Xangphueak under different flow and water level conditions to estimate accessibility and attraction for fish.
76. Spillways should be designed so that extra flows initiate and terminate adjacent to the fishway entrance(s) to maximise attraction to the fishways.		Yes	Yes			<ul style="list-style-type: none"> The spillway is only for emergency situations, as normally the floods will spill through the other channels in the wet season. The embankment is lowered in one section for extreme events and flows into the Hou Xang Pheuak.
77. Fish attracted to the spillway need to be able to access the fishway entrance without needing to double back to find the entrance.	No				No	<ul style="list-style-type: none"> Dam located two hundred metres up Hou Sahong channel; fish need to double back. Modelling in the EIA shows that Hou Xang Pheuak will have less flow than Don Sahong Dam from late wet, dry and early wet season. Fish will primarily be attracted to the dam and not Hou Xang Pheuak in these periods. The extent that fish move back downstream and try another route is likely to be species-specific but no data are presented by the proposal.
78. Fish exiting upstream fishways should not be drawn back over the spillway during overtopping. Exit conditions should be sufficient to provide stimulus for fish to exit the fishway. The combination of suitable attractive water flows, substrate and protection from predators is important.		Yes			No	<ul style="list-style-type: none"> Spillway at dam rarely operational (emergency only) Fish will not be drawn back over this spillway Exit condition: no information on upstream exit design of modified channels for fish included. Varying water levels of reservoir impacts inflow depth at channel exits. Upstream exit out of Hou Xangphueak is likely to require enlargement, as proposed by developer, so as to ensure passage of large-bodied fish species at lowest water level in dry season, as well as flow down fishway.
79. Barrier screens should be designed to guide downstream moving fish away from turbines and towards the fish passage facilities.		Yes			No	<ul style="list-style-type: none"> Minimal information on design of downstream passage – minimal review of screens made available. Needs more information on hydraulic conditions, approach velocities, screen/deflector designs. Adaptive management is quoted, but the way this will be implemented needs clarification.
80. The use of fish friendly turbines should be investigated and adopted where feasible.		Yes		Further research is		<ul style="list-style-type: none"> Standard bulb turbines are used because of their lower overall project cost and slightly greater efficiency and generation. These have slow rotation and few blades are suggested but specific designs and operating

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				needed		<p>regimes are not included.</p> <ul style="list-style-type: none"> EIA states “there is a reasonable likelihood [of] 95% safe passage” but provides no evidence and assumes data from salmonids (in Northern hemisphere) is transferrable to Mekong fisheries conditions. Low mortality quoted for “Fish friendly turbines” is misleading. It refers to blade strike and not pressure. This figure would be under the best circumstances for physostomous fish (swim bladder open to the throat) such as salmon, herring, cyprinids but would be much higher for physoclistous fish (swim bladder closed).
Operation						
81. The period of captivity and interruption to the normal movements of the fish should be as short as possible.		Yes		Clarification needed		<ul style="list-style-type: none"> The design of the passage facility allows for fish movements at all times if adequate flows done bypass channels provided. Potential issue hydropeaking has been missed. This could affect fish attraction and the stimulus for migration.
82. Water quality should be maintained within any holding enclosures to ensure fish health. Oxygen levels should be maintained within the fishways at >5 ppm.		Yes	Yes			<ul style="list-style-type: none"> Water quality in fishway– no information. Assume from flows and baseline data that this would not be a problem, although this needs to be checked against sediment dynamics and when flows through fishway are low.
83. Where an environmental flow downstream of the dam is required, the appropriate volumes should be directed through the fishway as a first priority, thereby ensuring fish are attracted to the fishway entrance as well as maximising operating time.		Yes		Clarification needed		<ul style="list-style-type: none"> Flows diverted through bypass channels by lowering sill but no details on hydraulics and impact of dam operational procedures. No estimates of attraction flow (% of Mekong river flow) provided. Assurance is needed that sufficient flows will be allowed down the fish passage channels.
84. Entrance slot velocities should be adjustable, such that feedback from monitoring and observation of fish behaviour can lead to optimisation of the fishway operation.		Yes		Further information needed		<ul style="list-style-type: none"> No plans of entrance design but nature-like channels so slot velocities not required. Entrance localities very poor, especially as problems with attraction flows highlighted earlier. Unclear how fish behaviour is monitored at entry and exits.
Monitoring and evaluation						
85. Provisions for monitoring facilities at fishways are to be incorporated into the design and operation phase of environment management and monitoring programmes.		Yes		Need full specification of monitoring		<ul style="list-style-type: none"> Monitoring of fisheries proposed but not of fish passage efficacy. Fisheries monitoring may not be best design. Water turbidity will limit any direct observation. Need to plan for a DIDSON acoustic system.

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						<ul style="list-style-type: none"> Tracking studies for a range of species and sizes of fish required. This would also provide insight to whether fish find entrance and proportions of fish that ascend is designed appropriately. Also downstream passage has to be monitored.
86. Monitoring programmes should be established to quantify the effectiveness of the fishways.		Yes		Requires monitoring protocol		<ul style="list-style-type: none"> Monitoring of fish passes is allowed for in EIA –through FishMap, but it is appears inadequate and more details are needed of how the monitoring will be carried out and the information used to adapt the design of the fish bypass channels.
87. The monitoring programme should be funded by the developer for the duration of the concession period.		Yes	Yes			<ul style="list-style-type: none"> Monitoring funded by developer for only 10 years (not for the duration of the concession period) –but funds limited given scale of programme needed.
88. Developers should utilise a core group of international experts to assist with the design and implementation of the monitoring programme, with all expenses covered by the developer.		Yes	Yes			<ul style="list-style-type: none"> Monitoring assisted by international experts, although details not provided and adding external peer review would improve experimental design and collection of appropriate data.
89. Developers should set aside contingency funds for modification of the fishway facilities, which may be identified as necessary based on the results of the monitoring programme as well as new information from other Mekong fishway programmes.		Yes		Clarification needed		<ul style="list-style-type: none"> No data from preconstruction monitoring provided or summary of outputs reported. Contingency funds for fishway modification suggested if remedial action required but no indication how output of FishMap will feed into this procedure to flag issues to which developer will respond. No information.

Water quality and Aquatic Ecosystems

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	No	Yes	Yes	Not Enough Information to assess	No	
Water Quality and Aquatic Ecology						
141-159	Background information					<ul style="list-style-type: none"> The scope of the EIA covers water quality and aquatic ecology. However, no justification or methodology has been described for initial assessment of impacts (ref. EIA report, Figure 2-8).
160	Yes (intro-text)					
161		Yes	Yes			<ul style="list-style-type: none"> It is probable that with the measures put in place for managing water pollution during construction and the nature of the reservoir and its residence time during operation that the DSHPP will be able to conform to this guidance.
162		Yes	Yes			<ul style="list-style-type: none"> The EIA and the subsequent hydraulic documents show that water levels are affected marginally in distribution of water across the channels on each side of the Hou Sahong. The biggest change in water levels will be in the channel leading to the Khone Phapheng Falls which will be artificially lowered by the excavation of bed rock at the entrance to the Hou Sahong. The water levels are also marginally affected in the downstream channels in Cambodia, with small increases in the western channels and corresponding decrease in the eastern channels. Once these channels merge, these differences are no longer relevant. The DSHPP can consequently be considered to meet these requirements.
163		Yes		Yes		<ul style="list-style-type: none"> The DSHPP is a run of river project and would not operate in a peaking mode, and as such would have negligible impacts on the natural variability in flow.

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						<ul style="list-style-type: none"> ▪ However, a minimum flow requirement of 800 m³/sec is applied to the flows over the Khone Phapheng Falls as an 'environmental flow'. This reflects the minimum recorded flow. This minimum flow will be maintained for about 6 months of the year during a normal year. ▪ Modelling has been carried out to demonstrate the flows in different channels throughout the year, but no environmental flow assessment has been carried out to assess the impacts of these changed flows in the different channels. ▪ Whilst environmental flows have often been taken to cover the wider distribution of flows across the year, this consideration of the flows over the Khone Phapheng Falls is a specific but very important interpretation of Para 163. ▪ Little justification is provided for the selected value of the EF over Khone Phapheng.
164		Yes		Yes		<ul style="list-style-type: none"> ▪ Whilst there is a considerable focus on the hydrological, hydrodynamic and hydraulic aspects of the DSHPP, there has been no assessment of the localised impacts of these changes on river morphology in each of the channels, or aquatic habitats or ecosystem functions of the different channels affected, apart from their importance for fish migration. ▪ There is no baseline description or analysis of the different aquatic habitats in each of the channels affected, or identification of their ecological importance. ▪ Although generally applicable to hydropower schemes working in a peaking mode, it is suggested that because of the changes in flows in these different channels, an EFA should be carried out to assess the

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						impacts of these changes in these channels especially the Hou Phapheng channel.
165		Yes		Yes		<ul style="list-style-type: none"> The water quality monitoring programme is indicated in the EMMP with numbers and frequencies of sampling and numbers of sampling stations, and associated costs. This has not been further developed, and there is no adequate baseline for water quality established.
166		Yes		Yes		<ul style="list-style-type: none"> Use has been made of the MRC's water quality monitoring network, with summarised results from the results from Pakse but the more recent guidance, procedures, standards and report cards have not been referred to The MRC's water quality data on Stung Treng could have been used to develop a baseline downstream of the proposed DSHPP, but these have not been described The water quality monitoring programme proposed does target the locations around the construction site, within the reservoir and downstream.
167		Yes		Yes		<ul style="list-style-type: none"> The monitoring programme proposed in the EMMP would be undertaken and funded by the developer, however as shown above the baseline and extent of the water quality monitoring have not been fully described. The duration of the monitoring programme is not fully described in the EMMP.
168		Yes			Yes	<ul style="list-style-type: none"> The DSHPP have carried out a detailed modelling of the changes in flow both through the different channels and downstream throughout each month of the year. However they have not carried out an environmental flow assessment at the EIA stage, as required by the

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						<p>PDG, to assess the impacts of these changes in flow upon the geomorphology or aquatic habitats of the river, especially in the various channels and in the immediate cross border area of the Mekong.</p> <ul style="list-style-type: none"> However, due to the small storage capacity and strict run-of-river operation of the dam, the potential impacts on downstream dams are negligible.
169		Yes		Yes		<ul style="list-style-type: none"> Whilst the minimum flow releases over the Khone Phapheng Falls has been established at 800 m³/sec, the developers have indicated that the flows over the Falls will be monitored, and when they are approaching 800 m³/sec, the flows through the turbines will be automatically reduced, raising headpond levels and creating a backwater effect, thereby allowing more water to pass over the Falls. The detailed design stage would be used to provide further details on this. However, the PNPCA's hydrological review has indicated the need for some sort of flow regulating weir at the mouth of the Hou Sahong, which would indicate concerns about maintaining this flow. Additional provision should also be made for dry years to ensure that this minimum flow release is complied with, and it is suggested that a flow gauge be maintained on the Khone Phapheng Falls channel so that this may be monitored.
170		Yes	Yes			<ul style="list-style-type: none"> Not relevant to DSHPP because no peaking operation will occur
171		Yes	Yes			<ul style="list-style-type: none"> Not relevant to DSHPP because no peaking operation will occur
172		Yes			Yes	<ul style="list-style-type: none"> The EMMP for DSHPP makes no mention of flow management or monitoring of flows apart from the need to ensure that Mekong flows

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						and water quality are essentially unchanged in the dolphin areas. The developers have confirmed that the flows over the Falls will be monitored, and indicate that flow regulation will be done through the management of the turbines.
173		Yes	Yes			<ul style="list-style-type: none"> Whilst the EMMP does not mention flow management or monitoring, other project documents indicate that the inflow to the headpond will be managed through the speed of the turbines as described above
174		Yes			Yes	<ul style="list-style-type: none"> Within the EMMP there are no descriptions for measures for monitoring flows or impacts on wetlands, and river morphology. However, the developer has indicated that flows over the Khone Phapheng Falls will be monitored and when reduced below 800 m³/sec, flows through the turbines will be adjusted to maintain those flows Sediment monitoring programmes are mentioned in the detailed study on hydrology and hydraulics. Impacts on fisheries habitats are monitored in terms of fish migration channels, but not for feeding or spawning habitats within the overall Siphandone area. Water quality monitoring is covered by specifying the number and frequency of sampling, but not integrated with flow monitoring.
175		Yes			Yes	<ul style="list-style-type: none"> No such provision has been made for an independent review of environmental flows or impacts upon the natural aquatic environment. Because of the significant changes in flow in several of the main channels parallel to the Hou Sahong, including down the Hou Sadam and Hou YESang Pheuak, which essentially act as “fish ladders” and

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						downstream, it is suggested that there is a comprehensive flow monitoring over all the major channels during operation, in order to demonstrate the reliability of the flow model findings..

Sediment and river morphology

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	No	Yes	Yes	Not Enough Information to assess	No	
Sediments						
90-98		Yes				<ul style="list-style-type: none"> ▪ The developer recognises this and has modelled sediment deposition with the 3D Telemac model. This result conducted over a 5 year modelling period suggests that a sediment equilibrium will be reached after 3-4 years. ▪ They have therefore not considered further measures in detail.
99-135	Possibly			Yes		<ul style="list-style-type: none"> ▪ As above the developer has not considered these measures given the results of their modelling studies. However, this TRR suggests that a 5 year modelling period is insufficient. ▪ These paragraphs will have to be considered should sediment flushing of the headpond ever be required.