

Appendix 2

Gap Analysis Matrix with References

Draft

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A) Dam Engineering

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Sub-component	Inception Report Section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Dam design life	3.2.1	Civil structure/fixed items	No design life or standards referenced within the feasibility or the proposed cross sections. There is a direct relationship between dam safety and its lifespan, i.e., if the dam is unsafe its lifespan has expired	High	The service life of a major asset like Kalpasar dam the design life should be at least 100 years. All fixed, cast-in, or non-replaceable components should be capable of service for the full dam design life. A design life is to be agreed on project leadership scale and requirements included in the brief for the subsequent design phases of the project.
Dam design life	3.2.1	M&E structures/components	No design life or standards referenced within the feasibility or the proposed M&E structures components, such as spillway gates draw off pipes or pumps for lifting irrigation of water. There is a direct relationship between dam safety and its lifespan, i.e., if the dam is unsafe its lifespan has expired	High	A design life for the M&E equipment is to be agreed on project leadership scale and requirements included in the brief for the subsequent design phases of the project. Where mechanical and electrical components with a shorter design life are used the design must consider how they may be safely refurbished or replaced. Where a range of options for equipment with differing design life exists the whole life cycle cost should be assessed including differing maintenance and replacement/refurbishment intervals. The design life for replaceable M&E components should be at least 25years.
Dam design life	3.2.1	O&M manuals and plan	Instruction manuals describing operation and maintenance should be provided for all equipment and included in the Operations and Maintenance Plan (O&M Plan). Emphasis should be drawn on the tidal regime effect on O&M to ensure minimal saline water intrusion in the reservoir.	Medium	To follow as design develops though needs consideration with spillway operations (feeds into reservoir flood study) and regular consultation with stakeholders
Dam Hazard Categorisation	3.2.2	Hazard categorisation	The currently proposed dam geometry would classify as a large dam in accordance with ICOLD (Bulletin 157). The dam should be categorised based on its hazard potential. While the dam is constructed in an open estuary, there are coastal communities and infrastructure both upstream and downstream of the dam, and therefore the risk of loss of life, economic losses and environmental impact should be considered should the dam fail.	High	Conduct a dam breach study on the proposed dam alignment and construction, identifying potential failure modes including breaches from sea and reservoir, risk of occurrence and inundation potential. Assess the potential loss of life, economic damages from the inundation and environmental impacts. Classify the dam in accordance with USACE dam hazard classification.
Dam Hazard Categorisation	3.2.2	Dam Breach assessment	Breach analysis carried out but not representative of worst-case water levels and no hazard analysis carried out. See dam hazard categorisation. Considered medium risk as dam appears to have been designed as high hazard	Medium	See dam hazard categorisation.
Design and Safety Check Floods	3.2.3	Safety check flood	PMF selected as Safety check flood however, a simplification of the coincidence of peaks has been made. Earlier pre-feasibility study (1998) suggested not enough data for statistical analysis and following feasibility partly utilised the earlier study. Suggest update to new dam alignment and update to include additional 20 years of data, statistically analysis of coincidence of storm peaks from different catchments may now be possible. Check if 2018 report does this	Medium	
Design and Safety Check Floods	3.2.3	Design flood	Unclear about the return period of the design flood. PMF used for design of the spillway. Consideration could be given to use of both a design and safety check flood.	Low	Provide return periods for storms. Considered low risk as PMF used for design.

Surveys	3.2.4	Topography	Topographical survey provided in scanned paper format and in tiles. It is difficult to assess completeness without joining the pieces together. Survey origin 2003 to 2004. Survey scale is 1:15,000, and contour spacing is 0.5m. No detailed levels provided along the proposed level of the embankment. No survey report provided and so methods, coordinates system and benchmarks used are unclear. Scale is too coarse for detailed design.	Medium	Provide a digital copy of the terrain information for subsequent design stages to enable detailed evaluation of the terrain and flood inundation levels. If not up to date survey is available, conduct a new survey of the estuary, including the dam footprint, estuary rim, Narmada dam and Narmada canal. Benchmarks should be established and retained to ensure consistency for following surveys and construction work. Due to the large area of survey needed, it is possible to deploy LIDAR scanner for the wider basin and limit the extents of the conventional topographical survey close to the footprint of the proposed embankment and dam associated structures. If LIDAR survey is used, it is recommended that a high frequency (high resolution) scanner is used to improve the accuracy of the survey. Ground stations should be established to ground truth the LiDAR survey and relate the survey to permanent benchmarks retained for conventional surveys and construction setting out. Survey needs to be consistent benchmark and coordinate system with the bathymetric survey.
Surveys	3.2.4	Bathymetry	Only bathymetry survey report provided, not the survey data itself. Not possible to assess completeness and suitability for design. Only a single survey was reported (2018).	Medium	Provide a digital copy of the bathymetric information for subsequent design stages to enable detailed evaluation of the terrain, construction foundation details. Bathymetry and topography should have the same spatial reference point and datum, so a complete terrain surface is generated for the subsequent design stages. Consideration should be given to water level at time of survey for both bathymetry and bank in topographic survey to ensure no gaps in coverage. Multiple surveys should be carried out, spread over time or older surveys referenced to allow variation of bed levels over time to be assessed.
Hydrology and Hydraulic Modelling	3.2.5	Hydrology	PMF estimated but no other flood events, a range of flood events combined with tidal variation should be considered. PMF assumes no contribution from Narmada - it is not clear how the contribution from the Narmada will be managed during floods. Hydrological study is dated 2011; PMP estimated does not appear significantly greater than max observed event; no/little evidence of model calibration or event testing. Hydrological assessment assumes that the existing dams regulate the catchment contribution to the estuary- we need to ensure that there are supporting legislation in place to ensure this is practice. No allowances made for climate change.	High	As there have been several big events in the region in the last decade it is recommended that the hydrological study is updated to include recent data; it is recommended that the use of the radar network is explored to bolster the rainfall analysis which in the previous study was limited to a small number of rainfall gauges.
Hydrology and Hydraulic Modelling	3.2.5	Hydraulic modelling	Reservoir routing analysis has been carried out however, consideration of different storm durations and patterns could be made. Study will require update for new dam alignment and to reflect any changes to gate operation philosophy.	Low	Carrying out flood study with flood routing considering different storm events, hydrograph shapes and storm durations
Water Demand and Supply Reliability	3.2.6	Flow requirements	Refer to Water Availability in Section B of this matrix.	High	
Water Demand and Supply Reliability	3.2.6	Reliability	Unclear where reliability targets have been set and agreed with client	High	Reliability targets to be agreed
Climate change impact	3.2.7	Extreme heat and drought		Medium	
Climate change impact	3.2.7	Future flow capacity		Medium	
Climate change impact	3.2.7	Sea Level Rise - spillway	This does not appear as a consideration in the hydrological assessment	Medium	
Climate change impact	3.2.7	Sea Level Rise - saline seepage	This does not appear as a consideration in the hydrological/climate assessment	Medium	
Climate change impact	3.2.7	Sea Level Rise - freeboard and overtopping	This does not appear as a consideration in the hydrological assessment	Medium	
Climate change impact	3.2.7	Sea Level Rise - soil erosion and sedimentation	This does not appear as a consideration in the hydrological assessment	Medium	
Climate change impact	3.2.7	Sea Level Rise - extreme winds	This does not appear as a consideration in the hydrological assessment	Medium	
Climate change impact	3.2.7	Sea Level Rise - rainfall induced landslides	This does not appear as a consideration in the hydrological assessment	Medium	

Dam key design considerations	3.2.8.1	Choice of Dam Type	The dam will have three sections: Dam body, closure section and spillway. These were discussed in the 1998 Pre-feasibility Report and further discussed in the Feasibility Report from 2009. More recent documents do not appear to refer to the design of the closure section, which will be a large and critical part of the project. The dam body is planned to be an embankment, which is to be expected. The closure section and the spillway section are distinct sections and are each discussed separately.	High	Mitigation discussed separately for each section of the dam; below.
Dam key design considerations	3.2.8.2	Selection of dam alignment	The revised alignment of the Kalpasar dam, following the deletion of tidal power and navigation locks is appropriate for design at this stage. The diversion of flows from the Narmada River and the related separate dam alignment is broadly outlined, but there is a considerable lack of detail regarding the preferred alignment and construction type. Refer to Narmada Dam and Canal Sections below.	Medium	Amendments might be required at the detailed design stage, for example when more detailed geotechnical data is available.
Dam Body key design considerations	3.2.8.3	Standard design units and reference datum	All designs are in metric units. Horizontal datums are not critical at this early planning stage of the project but need confirmation before detailed design. Vertical datums are a frequent source of confusion, particularly on large maritime projects where Chart Datum might vary across the project area, but the Kalpasar project is using the Indian National Datum which approximates to Mean Sea level and will be constant across the area.	Low	Ensure any future surveys make consistent use of datums.
Dam Body key design considerations	3.2.8.3	Design life for dam and for replaceable elements (see section 3.1.4)	See earlier comment on design life	High	
Dam Body key design considerations	3.2.8.4	Design geometry	The detailed design of the cross section of the dam body is complicated and it is not clear how it could be constructed in the prevailing depths and tidal conditions. The cross section, which will vary along the length of the dam with varying depth, exposure, and geotechnical conditions, will need further optimisation but in addition this will optimisation need to focus on constructability. There was no design report accompanying the cross sections, lacking clarity on how the sections were developed.	High	Simplify the cross-section design as far as possible. Provide a design report stating the standards and the governing criteria for the design.
Dam Body key design considerations	3.2.8.6	Stability analysis	As well as the geotechnical stability of the dam and its foundations, there are many other factors to be considered, such as wave action, seismic events, floods, and impacts of climate change. Although the stability of the completed dam has been assessed, it will be vulnerable to damage during the construction process. Risks of damage are also affected by the duration of the construction process and an understanding of the proposed construction method should be an integral part of the design process.	High	Review stability at all stages of construction.

Closure section design considerations		Design geometry	The closure method and the design of the closure sections are discussed in the 1998 Pre-feasibility Study and Six Specific Reports Volume V which refer to the earlier project plan with a larger impounded area, and in the Techno Economic Feasibility Report (2009?). In the earlier reports a closure section 10km long is suggested. This would comprise caissons (for sudden closure) or a rock embankment placed from a bridge (for gradual vertical closure) At that time it was estimated that these two options had very similar costs. For the revised alignment a shorter closure section is proposed but it would still be a substantial proportion of the total length of the dam. In the 2009 report a gradual closure (horizontal and then vertical embankment construction, without caissons) is described. This is based on a simplified calculation showing that currents would be about 4.37 m/s, i.e., within the limit of 6 m/s considered as the practical limit for gradual closure. However, this calculation appears to consider only average velocities in the closure gap, and more rigorous calculations are presented in the Dam Impact Model Studies report (2018). These show currents of at least 5.84m/s during closure, which would require very substantial scour prevention measures that are close to the limits of practicable construction. No further details of designs or modelling were provided for the closure section in the subsequent drawings of the proposed dam cross-sections. The criticality of the closure design cannot be over emphasised. This tidal closure will present issues of an order of magnitude greater than any tidal closures on previous projects around the world and requires very careful planning and design to ensure that scour near the dam is managed and contained at acceptable levels.	high	This will need a detailed approach to the design, including a focus on constructability, taking into consideration the rates at which construction materials can be placed.
Spillway section design considerations	3.2.12	Design geometry	Includes large vertical lift gates. These would need to be designed to be capable of opening and closing with a head of water in either direction. Construction of the concrete spillway structures will need to be done in the dry, and cofferdam works to achieve this will be very substantial. If a construction method involving the use of float-in caissons was to be adopted, issues would include selection of a suitable construction site, feasibility of towing caissons in the existing tidal flow conditions, and preparation of adequate foundations. Access for lifting or removing the gates for maintenance will also be needed. There is very little detail regarding constructability of the slipway and gates. In 1999 it was reported that low level sluices (-14 to -19m MSL) would be required to discharge saline water and allow degradable and non-degradable pollutants that tend to settle to the bottom of the reservoir to be flushed out. These low-level sluices do not appear to be part of the present design.	high	The constructability of the spillway section will have a major impact on the selection of the optimum design and the design should be reviewed taking this into consideration, if such a review has not already been done. The cost of temporary works such as cofferdams will be a significant part of the total cost of the spillway. The impact of the spillway design on water quality in the reservoir requires careful study, also including the impact of the closure method and the design of the closure section.
Dam Body key design considerations	3.2.8.7	Seepage analysis	See comment on Basin Leakage in C Geotechnics. Risk of seepage through dam, foundation, abutment and at interfaces with structures requires consideration. Risks include internal erosion, negative impact of seepage on stability, loss of fresh water and potential for saline intrusion. Seepage analysis needs to be integrated to wider design of embankment geometry and materials	Medium	Seepage analysis needs to be undertaken considering all potential impacts of seepage
Dam Body key design considerations	3.2.8.3	Topographical and bathymetric data	See earlier comment on surveys. It should be noted that the bathymetry of the area constantly changes as a result of erosion and deposition. Reports on the bathymetric survey have been provided but not the actual bathymetric survey charts.	Medium	Provide copies of the actual bathymetric survey charts.
Dam key design considerations	3.2.8.3	Metocean data for various return periods	It appears that extreme events with a return period of 50 years have commonly been adopted for design, but the probability of these values being exceed during the design life of the project is very high. The design life of the project is considerably longer than the length of time for which metocean data is available, and extrapolation is therefore necessary to evaluate extreme events, and in addition allowance for the effects of climate change is necessary.	Medium	For the permanent structure design, the return periods of typical events adopted for design should substantially exceed the design life of the structure. Designers should identify and use responses for a range of events including conditions above any nominal design level, and not simply use a single design event. Designs for temporary conditions during the construction period can be based on less extreme events because the shorter duration of the construction period leads to a lower risk of failure. See comments elsewhere on effects of climate change.

Dam key design considerations	3.2.8.3	Tidal Data	See Section B on consideration on extreme tides and tidal surges and associated comments on freeboard and overtopping.	Low	Need to consider combination of fluvial and tidal events.
Dam key design considerations	3.2.8.3	Water Levels	A key objective of the project is to fill the reservoir with fresh water by storing river flows. By August and September, the reservoir levels will be high, but river flood flows can occur in these months with the potential of causing flooding. The 1998 and 1999 studies considered the impact of fluvial flows, dominated by the effect of the Narmada River. It appears that similar studies have not been carried out in detail for the revised layout which is upstream of the Narmada River. It is expected to be necessary to lower the reservoir level in advance of forecast floods, but unnecessary lowering will result in not achieving a full reservoir for the following dry season. Water levels adopted for design of the reservoir side of the dam are based on the intended operating policy for water levels in the reservoir, with an allowance for the effects of fluvial floods affecting the level in an already partly full reservoir. Water levels on the seaside include allowance for extreme tides, storm surges and future sea level rise.	High	A decision support system will be needed, making use of forecast fluvial flows and with a knowledge of the response of the water levels in the reservoir to the inflows and the spillway management response times. The reliability of such systems, as well as the reliability of the mechanical and electrical systems controlling the spillway gates, will be critical to the safe operation of the reservoir and the avoidance of flooding. [See comments on spillway design.] Water levels adopted for dam design should be updated to allow for the effects of climate change on sea level, river flows, and frequency and intensity of cyclones.
Dam key design considerations	3.2.8.3	Design Return Periods	See comments above on Metocean data for various return periods		
Dam key design considerations	3.2.8.3	Risk levels	See comments above on Metocean data for various return periods		
Dam key design considerations	3.2.8.3	Materials	Sources of the required large quantities of materials have not been described. For example, 8 quarries each producing 25,000 tonnes/week are proposed. The logistics of transporting and placing such quantities requires study. Placing scour protection cannot take place during spring tides or during the monsoon season, and towing caissons will have similar constraints.	High	Identifying the sources of construction materials and the locations of any offsite construction locations will be necessary to plan the construction method and duration.
Geometry	3.2.8.4	Crest width	Newest dam cross-sections (2015) show 6 lane road on berm with 18m wide crest, earlier studies recommended 8+2 lanes on crest. Unclear how latest berm and crest widths have been determined	High	Dam width including crest and berm should consider all the contributing factors such as transport corridor requirements (traffic forecasts), seepage (internal erosion and saline intrusion risks) and stability and demonstrate that the most economical solution has been selected. An optioneering report should be carried out identifying the optimum solution.
Geometry	3.2.8.4	Crest Height	The crest height of the dam should take into consideration overtopping in extreme wave and sea level conditions, allowance for sea level rise, and settlement. Overtopping will impact upon the stability of the dam and operational conditions for road and rail traffic along the dam and influence the salinity of the freshwater reservoir. Waves from the north should be evaluated and allowed for in design. The level of the road is shown as 2m above the reservoir flood level and the possibility that wave action could affect traffic using the road should be checked. We have not seen any overtopping calculations carried out to date.	High	Check the frequency and significance of overtopping from north and south affecting the road and railway. Evaluation of overtopping on this large and complex structure will require numerical and physical modelling at the detailed design stage. All the factors which influence the crest height should be considered and the dam crest height determined, including tidal range, sea level rise, reservoir water level range and flood rise, settlement, wave run-up/overtopping limits (operational and safety to both reservoir and sea sides), potential for tsunami action.
Geometry	3.2.8.4	Road/Railway alignment	Road and spillway bridge design not provided.	Medium	Develop the design of the road alignment, details of the bridges and connecting infrastructure in the future design stages.

Geometry	3.2.8.4	Downstream slope	The downstream (seaward) slope, with a vertical height of up to about 44m, is planned to be protected by a layer of concrete Xbloc armour units of 8t to 48t weight, on a base layer of rock of 1.3 to 2.4m thickness. The unit weight of the armour units appears to be appropriate in relation to possible design wave heights although smaller armour units could be used in those parts of the dam in shallower water with depth-limited waves. The presence of berms at several levels on the armoured slope will affect the amount of overtopping. No information has been seen regarding the selection of the type of armour unit, which will be affected by construction conditions and overall cost. The method of construction is not clear, and construction of relatively thin base layers in conditions exposed to waves and variations in tide height, in depths of more than 20m, might not be practicable with the accuracy implied by the complex cross-section. The dam will be vulnerable to damage from waves until the protection is in place. The seabed and the dam will be vulnerable to scour damage from tidal flows as construction progresses along the length of the dam and scour protection along the length of the dam will be required in advance of the main dam construction.	High	Planning the method and sequence of construction, including the number of fronts along which dam construction will proceed, requires assessment at different stages of construction to confirm stability.
Geometry	3.2.8.4	Upstream slope	The upstream slope is shown as a riprap layer 60cm thick overlying a 30cm inverse filter and a geotextile fabric layer. The fetch to the north of the dam is about 50km. No information has been seen regarding extreme winds and waves that could occur from the north, but cyclones could cause substantial wave action. The basis for selecting the riprap layer has not been seen, but a layer of the described size is suitable only for very small waves. Construction of the described layers and geotextiles will be very difficult in the prevailing depths and tidal conditions.	High	The design of the upstream slope needs to be clarified, taking into account appropriate design wave heights from the north. Planning the method and sequence of construction, including the number of fronts along which dam construction will proceed, requires assessment at different stages of construction to confirm stability.
Geometry	8.2.8.4	Rock armour thickness/diameter	See comments above on downstream and upstream slopes.		
Geometry	3.2.8.4	Settlement allowance	Settlement of the foundations can be expected, and allowance must be made for this. Settlement of the material in the dam cross section should be relatively rapid and can be expected to occur during the construction period.	Low	Settlement allowances should be checked during the detailed design of the project.
Geometry	3.2.8.4	Freeboard allowance	See comments above on crest height	High	
Loading	3.3.7.5	Wave loading	Wave loading on structures requires consideration	Medium	Assessment of wave loading and structural response
Loading	3.2.8.5	Ship Impact	No consideration of debris and ship impacts has been identified, these should be considered in the design of the dam and appurtenant structures.	Medium	Provision of aids to navigation, and availability of a tugs should a vessel be drifting towards the spillway gates, should be considered. Design of structures for debris and ship impact.
Stability Analysis	3.2.8.6	Critical Failure modes - End of Construction, Rapid Draw down, Steady state seepage, Earthquake	No stability analysis has been identified and these issues listed should be considered in the analysis: Critical Failure modes - End of Construction, Rapid Draw down, Steady state seepage, Earthquake	Medium	Stability analysis to be undertaken including these considerations: Critical Failure modes - End of Construction, Rapid Draw down, Steady state seepage, Earthquake
Stability Analysis	3.2.8.6	Static and dynamic analysis - 2D and 3D finite element, soil structure interaction, stresses in structural elements	No stability analysis has been identified and these issues listed should be considered in the analysis: Static and dynamic analysis - 2D and 3D finite element, soil structure interaction, stresses in structural elements	Medium	Stability analysis to be undertaken including these considerations: Static and dynamic analysis - 2D and 3D finite element, soil structure interaction, stresses in structural elements
Stability Analysis	3.2.8.6	Loads - dead loads, water load (reservoir and tail water), silt, earth, earthquake, traffic surcharge	No stability analysis has been identified and these issues listed should be considered in the analysis: Loads - dead loads, water load (reservoir and tail water), silt, earth, earthquake, traffic surcharge	Medium	Stability analysis to be undertaken including these considerations: Loads - dead loads, water load (reservoir and tail water), silt, earth, earthquake, traffic surcharge
Seepage Analysis	3.2.8.7	Safety, flooding, and saline contamination	No stability analysis has been identified and these issues listed should be considered in the analysis: Safety, flooding, and saline contamination	Medium	Stability analysis to be undertaken including these considerations: Safety, flooding, and saline contamination
Rock armour design	3.2.8.8	Failure methods: Slope instability, Sliding of structure, Movement of rock cover, Migration of sub-layers, Piping, Liquefaction, Erosion of foreshore	No stability analysis has been identified and these issues listed should be considered in the analysis: Failure methods: Slope instability, Sliding of structure, Movement of rock cover, Migration of sub-layers, Piping, Liquefaction, Erosion of foreshore	Medium	Stability analysis to be undertaken including these considerations: Failure methods: Slope instability, Sliding of structure, Movement of rock cover, Migration of sub-layers, Piping, Liquefaction, Erosion of foreshore

Scour protection	3.2.8.9	Analysis and modelling	The seabed and the dam will be vulnerable to scour damage from tidal flows as construction progresses along the length of the dam and particularly in those areas affected by the closure. Scour protection along the length of the dam and upstream and downstream of the closure section and the spillway will be required in advance of the main dam construction. Some of this will have a permanent function while other parts may become buried as construction proceeds.	High	Adequate planning of the sequence of construction to mitigate excessive scour
Freeboard and overtopping	3.2.9	Protection of vehicles	See comment on crest height above, acceptable serviceability limits should be set, and the berm (reservoir waves) and crest heights (sea waves) set accordingly	Medium	
Freeboard and overtopping	3.2.9	Protection of railway	See comment on crest height above, acceptable serviceability limits should be set, and the berm (reservoir waves) and crest heights (sea waves) set accordingly	Medium	
Freeboard and overtopping	3.2.9	Pedestrian access during storms	See comment on crest height above, acceptable serviceability limits should be set, and the berm (reservoir waves) and crest heights (sea waves) set accordingly	Medium	
Freeboard and overtopping	3.2.9	Maintenance access during storms	See comment on crest height above, acceptable serviceability limits should be set, and the berm (reservoir waves) and crest heights (sea waves) set accordingly	Medium	
Freeboard and overtopping	3.2.9	Salinity of the reservoir	See comment on crest height above	Low	
Sedimentation	3.2.10.1	Catchment Sedimentation load	Sediment yields have been estimated however, additional sediment gauging would be beneficial	Medium	Additional sediment gauging at a range of flows to inform estimates
Sedimentation	3.2.10.2	Sediment management	A high proportion of sediment flushing is assumed. Additional consideration of distribution of siltation is required particularly around offtakes, draw offs and spillways.	Medium	Consider risk of sedimentation in design of hydraulic structures. Assess movement of silt within reservoir at differing stages of operation
Dam Access for inspection and maintenance	3.2.11	Construction, maintenance, and surveillance access	The proposed draw off facility is at -4mSL. The dam embankment is to extend to the maximum depth of the estuary at approximately -25mSL. The remainder of the lake side dam will only be exposed at low lake levels (about once a year) with no option to dewater reservoir below low tide and the seaside of the dam will be exposed in a pattern related to the estuary tides. There are currently no proposals for surveillance, operation and maintenance of the dam structures and the O&M plans need to be developed. No access route designs have been provided and need to provide sufficient maintenance and inspection access to the dam and structures.	High	A plan for the operation, surveillance and maintenance is to be prepared during the design process. Provisions for executing the plan without compromising the health and safety of the operatives are to be incorporated in the detailed design of the project. Design for access routes to be developed.
Spillway structures	3.2.12	Modelling of discharge with tide levels	Current design of spillway only considers discharges during PMF in combination with tides. No other return periods considered.	Medium	The design of the spillway is to consider normal operational conditions and lower return periods other than PMF conditions combined with varying tide levels
Spillway structures	3.2.12	Freeboard requirements	It is not clear how the freeboard allowance has been determined and incorporated in the dam design crest level, only seaside wave run up has been considered not reservoir wave run-up, unclear how the different studies have been used and whether settlement has been considered	High	Determine minimum freeboard requirements and assess performance of design
Spillway structures	3.2.12	Form and design of spillways	The proposed spillway is of gross width of 2086m, having 95 spans of 18m wide gates and 4m thick piers.	Medium	Consider range of flow and tide cases
Spillway structures	3.2.12	Location of spillways	The location of the spillway has been considered but will require review for the new alignment	Medium	Study to review location to ensure still valid with new alignment
Spillway structures	3.2.12	Gates and controls	Spillway option of gated or uncontrolled spillways has not been determined. Physical or mathematical modelling would be required to determine which options are feasible and then cost analysis would be required to refine options.	Medium	CFD or physical modelling to be carried out when design sufficiently developed
Spillway structures	3.2.12	Load cases with tides	Load cases not provided	Medium	To be provided
Spillway structures	3.2.12	Crest level	It is not clear how the freeboard allowance has been determined and incorporated in the dam design crest level, see freeboard above	High	
Spillway structures	3.2.12	Performance modelling (physical/CFD)	No physical or CFD modelling carried out for spillway structures, should be undertaken	Medium	CFD or physical modelling to be carried out when design sufficiently developed
Spillway structures	3.2.12	Discharge rating curve	Provided	Low	

Spillway structures	3.2.12	Flow velocity and depth profile	Only tentative design of the spillway and stilling basin provided. The design of spillway report suggests further model studies upon finalising location and design flows for the spillway.	Medium	CFD or physical modelling to be carried out when design sufficiently developed
Spillway structures	3.2.12	Stilling basin	Consideration has been given to a range of flows and tidal conditions however, confirmation of design through model studies is required	Medium	
Spillway structures	3.2.12	Structural details	Not yet provided	Medium	To be developed
Highway Design	3.2.13	Indian Road standards, links to overtopping limits, traffic loading	The road design and standards applied is not clear (alignment, road construction). Similarly, permissible overtopping limits (sea or reservoir) related to road remaining safe for use have not been set.	Medium	Standards to be proposed and design developed
Railway Design	3.2.14	Indian rail standards, links to overtopping limits, railway loading, routing of utilities regarding waterproof dam elements	The railway design and standards applied is not clear (alignment, track construction). Similarly, permissible overtopping limits (sea or reservoir) related to remaining safe for use have not been set.	Medium	Standards to be proposed and design developed
Access for fishing and shipping	3.2.15	Fish passage, locks	As noted in Section D fish passage and impact on fish has not been properly addressed	High	Refer to Section D. Design of mitigation measures will need to follow the recommended studies.
Mechanical equipment	3.2.16	Gates	There are two proposed designs for gate layout identified which comprise 105no 18m x 7.5m or 95 18m x 5m vertical lift gates. Mathematical and physical modelling required to determine preferred arrangement.	Medium	CFD or physical modelling to be carried out when design sufficiently developed
Mechanical equipment	3.2.16	Sluices/pumps	Selection of sluicing or pumping has not been identified for optimum operation. Durations required for removal of saline water need to be refined, currently estimated at 1-2 years by using the freshwater pumps.	Medium	Modelling to determine if sluices are suitable for removal of saline water. Establish required timescales for removing saline water to inform requirements.
Mechanical equipment	3.2.16	Monitoring, instrumentation, and controls	There are little proposals on the instrumentation and controls required.	Medium	Once design layout and initial control philosophy are determined, Layer of Protection Analysis (LOPA), and Hazard & operability study (HazOp) should be undertaken.
Construction sequence and methods	3.2.17	During construction, closure, emergency access	For closure works and construction sequence see comment above, no up to date construction sequence or methods available	Medium	To be developed for latest design cross-sections and alignment
Instrumentation plan	3.2.18	Water levels	No dam instrumentation plan identified	Medium	A draft document should be prepared and developed as the design progresses
Instrumentation plan	3.2.18	Seepage and leakage	No dam instrumentation plan identified	Medium	A draft document should be prepared and developed as the design progresses
Instrumentation plan	3.2.18	Water pressure in embankment/foundations	No dam instrumentation plan identified	Medium	A draft document should be prepared and developed as the design progresses
Instrumentation plan	3.2.18	Deformation monitoring	No dam instrumentation plan identified	Medium	A draft document should be prepared and developed as the design progresses
Instrumentation plan	3.2.18	Seismic monitoring	No dam instrumentation plan identified	Medium	A draft document should be prepared and developed as the design progresses
Operations and maintenance manual	3.2.19	Operations and instrumentation	No draft O&M identified	Medium	A draft document should be prepared and developed as the design progresses
Operations and maintenance manual	3.2.19	Surveillance/inspections	No draft O&M identified	Medium	A draft document should be prepared and developed as the design progresses
Emergency preparedness plan	3.2.20	Prepared prior to construction and agreed with stakeholders. Contents as per best practice, such as US Federal Dam Safety Commission	No EPP identified	Medium	A draft document should be prepared and developed as the design progresses; stakeholders should be continuously involved in development
Narmada Dam		Alignment	Only preliminary concept design on barrage alignment with approximate location has been presented in the Feasibility Report. The design has not been developed further, there is no optioneering report/statement or constraints plan considering the possible alignments for the proposed barrage. The preliminary concept design suggests 1.3km river barrage, with connected to 7km embankment for tidal protection of low-lying land, and 18km of flood protection embankment. It is unclear where the flood protection embankment is located. It is unclear the extents of the lake formed by the barrage in normal operation and flood conditions.	High	Develop an optioneering report assessing the possible locations for the Narmada barrage, including constructability, environmental and socio-economic impact of the construction of the barrage. Consider the water availability impact on Kalpasar with and without the water from Narmada River

Narmada Dam		Crest Height	The preliminary design alignment suggests that the barrage will be located in the tidal zone of the Narmada River and that the approach embankment will serve as a protection of low-lying land from saline intrusion. Therefore the embankment of the dam will be subject to the same tidal and wave actions from the estuary experienced by the Kalpasar dam. There is no analysis on tide and wave action from both estuary and lake side, settlement, tsunami and mean sea level rise to determine the required dam crest elevation. Nominally the dam crest is set at +10mSL, however, this is lower than Kalpasar Dam.	Medium	Check the frequency and significance of overtopping from the river and from the sea affecting the road proposed on the crest of the dam. Evaluation of overtopping on this large and complex structure will require numerical and physical modelling at the detailed design stage. All of the factors which influence the crest height should be considered and the dam crest height determined, including tidal range, sea level rise, reservoir water level range and flood rise, settlement, wave run-up/overtopping limits (operational and safety to both reservoir and sea sides), potential for tsunami action.
Narmada Dam		Crest Width	The preliminary design in the Feasibility Report suggests crest width of 30m to accommodate 6 lane road.	Medium	Provide updated traffic survey and forecast for the need of the new coastal path including the latest local infrastructure in development (e.g. New Narmada bridge), coupled with a cost benefit analysis for the proposed barrage and embankment cross sections.
Narmada Dam		Cross Sections	Not provided	Medium	Cross sections to be developed.
Narmada Dam		Surveys	Not provided. A list of proposed surveys to be undertaken listed in feasibility report.	Medium	Surveys to be carried out as proposal enable further refinement of options for the Narmada dam design.
Narmada Dam		Water Availability	The Narmada dam project is at an earlier stage e of development compared to Kalpasar dam. Kalpasar water security heavily depends on the flows from the Narmada barrage. No assessment of the Kalpasar project viability was provided without the Narmada Dam.	High	Water availability analysis to be carried out evaluating the viability of the Kalpasar project in case of delays of the Narmada dam and canal project.
Narmada Dam		Operations and instrumentation	No dam instrumentation plan identified; no draft O&M plan provided.	Medium	A draft document should be prepared and developed as the design progresses
Narmada Dam		Spillway	Spillway capacity required 100,000m ³ /s. Brief description of how it can work presented in Feasibility Report. Spillway width required is wider than the river at that location. No analysis provided on operation of the spillway working with the tidal range. As there is no storage curve for the Narmada reservoir, it is unclear if the reservoir will have enough storage capacity for the part time operation of the spillway.	Medium	Design to be developed further to prove the viability of the dam.
Narmada Canal		Alignment	No alignment provided, only a preliminary possible route proposal described in the Feasibility Report. Route and alignment description demonstrates that the canal will be operating under minimum available head, increasing the risk of siltation for the canal.	High	Possible routes options and impact assessment to be considered as design progresses. Consideration to be given to the possibility of the benefits of widening the existing Narmada Canal.
Narmada Canal		Dimensions	Minimal consideration for the proposed canal dimensions provided. No proposed cross sections provided.	Medium	As design develops, consideration to be given to the relationship between the water availability and flood storage capacity in the proposed new Narmada Dam, which is to govern the dimensions required for the canal.
Narmada Canal		Operations and instrumentation	No canal instrumentation plan identified; no draft O&M plan provided.	Medium	As design is developed further, a detail instrumentational and O&M plan to be developed. The canal O&M plan has to be linked with the O&M for the proposed Narmada Dam, Existing Narmada Dam, and Kalpasar Dam.
Narmada Canal		Surveys	No accompanying studies provided to support alignment	High	Conduct topographical and GI surveys, conduct socio-economic and environmental impact studies to enable the further development of the Narmada canal.

B) Estuary Water Management & Quality

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Tidal Flood Risk	3.4.2	Tidal model including proposed dam	Extent of model. Noting the processes that generate the macro tide range it is not clear that the model domain can encapsulate the whole of the effect of the barrage. It may also lead to overprediction of the magnitude of effect on tide at the barrage line. The cyclone model area used elsewhere is close to what I would expect.	High	Sensitivity testing for larger model domains
Tidal Flood Risk	3.4.2	Extreme tidal surges, sea level rise (consideration of RCPs), strategy for management/adaptation for protection of the dam and surrounding area.	There is no return period attached to the extreme water level study based on cyclones. It targets a probable maximum storm surge based on the historical record. This is then added to the highest astronomical tide level and modelling of wind waves. The validation of the model or tide alone or surges is vague. The best is that the predicted Surge was 2.2 m compared to an observation of 2 m. A 10% difference is quite large in this context.	High	Improved statement on model validation. Sensitivity testing to investigate uncertainties. Intercomparison of various models reported
Tidal Flood Risk	3.3.2	Dam breach scenarios	Dam breach scenarios have been considered from both reservoir side and seaside in the hydrodynamic and sedimentation report. However, the loss of life, damages of the breach wave on flood risk are not developed. This is tightly linked to the Dam Hazard Categorisation. See also A Dam Engineering	Medium	Map flood risk receptors within the estuary, assess risk to life and property and prepare a draft Emergency Preparedness Plan.
Tidal Flood Risk	3.3.2	Overtopping of the dam	Refer to Section A Dam Engineering	Medium	Refer to Section A Dam Engineering
Tidal Flood Risk	3.4.2	Consideration of dam design levels with regard to the above	Refer to Section A Dam Engineering note comments on surge and tidal modelling for seaward issue on dam height.	Medium	Refer to Section A Dam Engineering
Fluvial Flood Risk	3.3.3	Baseline hydraulic model including upstream catchment, seasonal aspects, use of gauged data, 2D modelling, survey data, link to tidal model, calibration	The Dam Impact Study hydrodynamic model's extents stop at the confluences of the rivers. Only annual averages considered. No long-term interaction between the reservoir and the rivers considered.	Medium	Review model domain and extend to include the low river reaches that would impact by the tidal range and Kalpasar reservoir.
Fluvial Flood Risk	3.3.3	Upstream fluvial impact of removing the tidal influence and implementing the Kalpasar Dam scheme	In the Six Specific Studies it is advised to consider the effect of the reservoir to the low-lying lands near the confluences of the river. The Dam Impact Study extents stop at the confluences of the rivers. The reservoir will have a high tailwater effect on the rivers directly discharging in the reservoir basin, reducing the discharge capacity of the rivers and increasing the probability of flooding to those lands. There has not been a study looking at the Kalpasar's impact on the fluvial flood risks in the upstream catchment.	Medium	Prepare a study on the impacts of fluvial flood risk as a result of the dam. Identify flood receptors and potential consequences such loss of life and property damages

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Fluvial Flood Risk	3.3.3	Flood risk to reclaimed land due to lower water levels on the reservoir side, assessed for monsoon flooding and potential breach scenarios of the Kalpasar Dam	No model of storms of different return periods was found of the Kalpasar reservoir. Different flood scenarios need to be considered to establish the impact on flood risk (positive or negative) by the construction and operation of Kalpasar study needs to review both the upstream and the downstream flood risks, assess the combined probability of flood scenarios happening simultaneously (such as a monsoon flooding and spring tide and a storm surges, high waves etc)	High	After revising the extents of the dam impact model, establish and run sufficient scenarios to determine the impact on flood risk at the reservoir rim, upstream catchment reaches and the downstream coastal areas. Determine the flood extents and identify the flood receptors.
Fluvial Flood Risk	3.4.3	Use of hydraulic models in dam design levels	Refer to Section A Dam Engineering note comments on surge and tidal modelling for seaward issue on dam height.	Medium	
Fluvial Flood Risk	3.4.3	Climate change consideration	The assessment for sea level change is dated 2011 and needs to be updated in line with present predictions.	Medium	Update sea level change predictions
Fluvial Flood Risk	3.4.3	Environmental Damages	There has been no assessment of potential environmental impacts reservoir and the estuary, as a result of increased risk of flooding. For example, there has been no assessment of potential sources of pollution, such as Nirma Point chemical plant, and how increased risk of fluvial flooding and lack of tidal flushing would impact on the reservoir water quality.	High	Carry out an assessment on the risk for economic and environmental damages, such as triggering water pollution incidents or closure of vital local infrastructure due to changes of the risk of flooding.
Catchment water management (quality/supply)	3.3.4	Drinking water	Data from the reports [1 – Prefeasibility vol.1&3], which were written in 1998, is outdated and include future projections of population growth (2010, 2035 and 2060, assuming the dam would be in service by 2010). It is necessary to update the projected population growth and water demand forecasts as these are likely to have changed over time.	High	Obtain latest information on the population expected to have access to water for drinking purposes and future prediction of population growth in the next 30-50 years.
Catchment water management (quality/supply)	3.3.4	Irrigation water	Data from the reports is outdated and does not include future projections of land use/crops. Climate change forecasts are not taken into account either. Report: 22. - Study of taluka-wise Irrigation planning and Agro-economic impact of Kalpasar project. In this report, the land use pattern described dates back from 2003-4 to assess water needs for irrigation purposes. The land use and crop patterns are likely to have changed since this study was carried out. More recent data is needed to understand water usage requirements for irrigation purposes.	High	Obtain the latest information on the crop type, surface area of each crop type, associated water usage and future prediction of agricultural land use in the next 30-50 years
Catchment water management (quality/supply)	3.3.4	Industrial water	No information available in the reports provided about the current and future water demand for industrial and other commercial purposes in the region.	High	Obtain the latest information available on the industrial and other commercial current water demand and future forecasts (30-50 years horizon)

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Catchment water management (quality/supply)	3.3.4	Pollution	The water quality data provided in the reports is not very recent; seasonal analysis of water quality trends would be beneficial. Report 8 - Water quality report. The water quality data is displayed as a annual average over 5 years (July 2009-December 2014). The data is outdated to fully understand the most recent status of the water quality in the catchment. Obtaining water quality data at a finer resolution (e.g. monthly) would allow to monitor the trends of the parameters during different seasons.	High	Obtain more recent water quality data in the estuary (e.g. turbidity, BOD, COD, TSS, Nitrogen, Phosphorus, heavy metals)
Catchment water management (quality/supply)	3.3.4	Water availability	There is no recent information on water availability in the catchment or analysis that takes into account seasonality of the inflow. Report: 1 - Techno economic feasibility report states calculations making use of the monthly inflow series for the period from 1901 to 2006 to deduct the water availability in the catchment area. Another study in this report has refined the assessment of the water availability which was done by the C.D.O. (2009) considering a greater number of rain gauge stations, establishing modified rainfall runoff relationship for each of the river basins, future planning in the basin up to 2025, and demand assessment as per pattern in the command area. Again, more recent data is required as well as water availability forecasts based on climate change projections.	High	Obtain recent monthly rainfall data and revise water availability projections taking into account climate change predictions
Catchment water management (quality/supply)	3.3.4	Water availability	Target water supply reliability and how this has informed design are unclear. Short record period used to determine availability and so may not be representative of long-term performance.	High	Target availability should be agreed and design set to achieve this. Study should be carried out using longer record period should be used in simulation of reservoir water level including inflows, outflows (spills, various supplies), losses (e.g., seepage, evaporations). Sensitivity and climate change impacts should also be assessed.
Catchment water management (quality/supply)	4.1.2	Salinity	Impact of salinity on crops is not fully considered, only seems to consider a short time period rather than long-term effects	High	Study required into long-term risk of salinity to crops

C) Geotechnics/Geology and Seismology

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Geotechnical - Ground Investigation, dam site and construction materials	3.5.1.1	Spacing of investigation locations	<p>The current coverage of the favoured alignment will need supplementing by further phases of ground investigation and should be informed by a detailed desk study and the development of a preliminary ground model. Currently perhaps only some 10% to 15% of the required detail has been undertaken and the subsequent work is likely to include amongst other things:</p> <ol style="list-style-type: none"> 1. Line of route geophysics to characterise the superficial geology along the route; 2. CPTU/SCPT to provide detail (CPT and Seismic cone); 3. Boreholes for correlation with the above indirect methods; <p>The above will be supplemented by detailed laboratory testing on the samples recovered.</p> <p>Supplementary information is also required including periodical monitoring of changes in the bed level (regular bathymetric survey or other monitoring).</p>	Medium	<p>Assuming the viability of the project and alignment is confirmed and as the design stages develop there will quickly become a need for more detailed ground investigation. This is likely to be undertaken in stages and the very hostile environment of much of the alignment means that significant forward planning will be required to facilitate this work and is likely to include:</p> <p>Line of route geophysics to characterise</p> <p>CPTU/SCPT to provide detail (CPT and Seismic cone)</p> <p>Boreholes for correlation with the above indirect methods</p> <p>Later investigation of sources of materials will be required</p>
Geotechnical - Ground Investigation, dam site and construction materials	3.4.1.1	COMACOE zones and data	The COMACOE Geo Technical Investigation Report (Reported April 2021) although called final appears to require further review. For example, the report is divided into 7 Zones but appears to be missing all of the borehole and insitu test data (Appendix B and C have information from a different zone) from Zone 1.	High	COMACOE reports to be finalised
Geotechnical - Ground Investigation, dam site and construction materials	3.5.1.1	Lack of comment on high to very high carbonate content of many of the underlying soils	One aspect of the COMACOE investigation that does not appear to have been commented on by other is the apparent high to very high carbonate content of many of the underlying soils. These results need some clarification as it is not clear whether this is expected in this area as it does not appear to have been noted by published information for the geology of the area. However, if confirmed, this may have a positive effect in relation to liquefaction potential (see Seismic Assessment Section).	Medium	Suggest to be confirmed by COMACOE in the finalisation of their draft report
Referencing system to be used by all parties	3.4.1.1	The site seems to be split into different zones by different authors which could cause confusion	The report by COMACOE is divided into 7 Zones. We would note that IITM's assessment of the data reduces this to 6 Zones.	High	Suggest that a clear referencing system needs to be put in place to avoid confusion.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Geotechnical - Ground Investigation, dam site and construction materials	3.4.1.1	Dynamic nature of seabed levels	It is clear from the 'as built' levels of investigation locations in the COMACOE investigation that the bed of the inner as well as the outer gulf is a very active environment with constantly changing levels and differences over a few years of up to 30m appear to be a characteristic result from successive bathymetry and borehole location surveys. This means that geotechnical investigation of the soils within 30m of mean sea level provides only a 'snapshot in time'. Sand ridge and bar migration will result in variable bed level, density and strength development in the shallow foundation soils until construction is complete. The proposed earthfill dam will have a potentially huge volume of material below MSL. This means that the normally simple calculation of dam material volumes is going to be difficult to predict with certainty, due to the shifting nature of the seafloor. Consequently, dam construction cost and programme are going to unpredictable. Further study of this aspect is likely to be required.	High	A study of seafloor morphology /scour study to understand how the sea bed changes with time. This may well include on site monitoring work
Geotechnical - Ground Investigation, dam site and construction materials	3.4.1.1	Desk study to place geotechnical data in a coherent soil model recognising the transient seabed levels	Whilst various investigations have taken place these have not been reviewed together to provide a combined soil model recognising the transient seabed levels. NIOT (Jan 2013) have noted for example that the 'Area has been investigated by several reputed organizations who have also identified some active faults in the area. The earlier work carried out by NIOT in 1999 and 2004 in the GoK to the south, picked up possible neo tectonically active faults which have affected the seabed itself. '	High	An overarching Desk Study is required to bring together all the available information regarding the existing ground conditions and to identify ground issues and risks. The development of the Geodatabase should facilitate this.
Geotechnical - Ground Investigation, dam site and construction materials	3.4.1.1	ground model based on all the available information	We understand that the Client body propose to develop a project Geodatabase which would be available to all collaborators. This is regarded as being the essential first step in enabling a conceptual 'ground model' for the dam site to be prepared. This would, amongst other things, include the ground levels and seal levels (various tides) and potentially the variation of these - i.e. including bathymetry data, and interpretation of the superficial deposits and geological sequence beneath the site (as partly identified in the Camocoe reports) , and an interpretation of the structural geology as interpreted from the geophysical survey works undertaken.	High	Based on the desk study a conceptual ground model/geological model should be prepared so that the various findings to date can be collated and interpreted
Geotechnical - Ground Investigation, dam site and construction materials	3.4.1.1	material sources	Currently it is envisaged that the dam structure will be constructed largely of rock fill and sands (potentially dredged) but there are no further details of the sources of such material, the means of transport to site or of the environmental impact of such activities. It is understood that such work is to be instructed shortly but at this point we have no further information.	High	A preliminary sources study should be undertaken to identify sources of material for use in construction.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Geotechnical - Ground Investigation, dam site and construction materials	3.5.1.1	Developing geotechnical design	<p>Further details of the developing geotechnical design will need to be reviewed as information becomes available. It is apparent that some preliminary work is underway including in the following areas:</p> <p>Development of a Geological Model for the site</p> <p>Assessment of Geohazards</p> <p>Seismic engineering including liquefaction assessment</p> <p>Soil structure interaction aspects</p> <p>Study of construction options</p>	Medium	It is suggested that a comprehensive geotechnical scope is developed to ensure all relevant aspects are covered going forward including the issues mentioned
Geotechnical - Reservoir Basin	3.4.1.2	Rim stability/Landslides	The potential for mass movement hazard needs to be assessed in relation to the reservoir basin. Risks of mass movements in the reservoir rim area must be evaluated and mitigation measures may be needed. The stability and structural integrity of the reservoir rim upstream of the structure must be evaluated for all potential loading conditions whether hydrologic, earthquake, or other hazards, man-made or natural. Reservoir rim instability may lead to poor water quality, blockage of channels and structures and waves which may threaten reservoir users and the dam structure.	High	<p>Risks of mass movements in the reservoir rim area must be evaluated and mitigation measures may be needed.</p> <p>The stability and structural integrity of the reservoir rim upstream of the structure must be evaluated for all potential loading conditions whether hydrologic, earthquake, or other hazards, man-made or natural</p>
Geotechnical - Reservoir Basin	3.4.1.2	Basin Leakage	Basin leakage during impoundment occurs when infiltration of reservoir water is occurring through the surrounding and underlying soils, which is problematic if seepage occurs beneath the dam retention structures and can cause other erosional issues for the reservoir area. The permeability, hydraulic conductivity, and porosity of the soils supporting the reservoir volume should be evaluated. Erosion potential and corrosivity of the foundation soils should be evaluated.	High	The permeability, hydraulic conductivity, and porosity of the soils supporting the reservoir volume should be evaluated. Erosion potential and corrosivity of the foundation soils should be evaluated.
Construction assumptions	4.4.1	A study of alternative construction options should be undertaken and compared to the currently identified method of mass filling.	Alternative construction methods (other than mass filling) for part of the structure may well be appropriate, for example the use caissons of known geometry that can be floated out and ballasted into position on a seafloor prepared by suction dredger or similar. Such options could significantly reduce the quantity of mass fill required and will no doubt be considered as the design develops.	High	Review alternative construction options - these could significantly reduce the quantity of mass fill required and will no doubt be considered as the design develops.
Design basis	4.4.1	Design Basis	A Design Basis Report should be established at the earliest opportunity and agreed by all stakeholders to inform all designers going forward. We note that development of this has now been initiated.	High	A Design Basis Report should be established at the earliest opportunity and agreed by all stakeholders to inform all designers going forward.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Seismic Design Considerations	3.4.2.2	Performance criteria	No seismic performance criteria have been defined relating to the operational and safety requirements of the Kalpasar dam and the linear infrastructure (rail, highway, communication, etc) that it will carry. The seismic security and the operational resilience of the various installations require evaluation and stakeholder agreement. Please note that due to the nature of the project, there is no current Indian or international codes which adequately define these requirements. The performance criteria should be both qualitative and quantitative (e.g. acceptable settlement and/or displacement limits). See Tables 3-1 & 3-2 in the Inception report for some suggested high level seismic criteria.	High	Define Performance requirements for both operational (serviceability) and safety (ultimate) requirements which must consider the multi-functional aspects of the project.
Seismic Design Considerations	3.4.2.2	Site specific seismic assessment	No site-specific seismic hazard assessment has been carried out to define the design criteria. It is expected that this should be a site specific probabilistic seismic hazard assessment (PSHA). This should define the Safety Evaluation Earthquake (SEE), the Operating Basis Earthquake (OBE) and a earthquake to be considered during the construction phase (CLE). The potential of Reservoir Triggered Earthquakes (RTE) should also be considered.	High	A site-specific seismic hazard assessment is required. This seismic hazard study must be consistent with the performance requirements.
Seismic Design Considerations	3.4.2.2	Site response analyses	No site-specific site response analyses have been carried out. These studies model the influence of the near-surface layers on earthquake ground motions. The near-surface layers act as a filter that amplify/de-amplify the seismic waves coming from the earthquake source. The site responses studies should account for the variation in geology along the length of the dam, the impact of scour, the presence of mobile soils and the impact of the dam on the in-situ stresses.	High	A series of site response analyses should be carried out along the length of the dam at regular intervals. Intervals should be selected based on the variation of the underlying geology.
Seismic Design Considerations	3.5.2 & 4.4.2	Seiche	No assessment of the reservoir seiches has been undertaken.	Medium	A study of seiche potential and impact within the newly impounded area must be carried out.
Seismic Design Considerations	3.4.2.3 & 3.4.2.4	Design Basis	Local seismic design standards need to be enhanced based on best international practice.	High	Appropriate local and international design standards related to seismic design need to be confirmed in the Design Basis.
Seismic Design Considerations	3.4.2.2 & 3.4.2.5	Liquefaction	The current liquefaction assessment should be repeated once the site specific seismic hazard assessment has been completed.	High	Update the liquefaction assessment for SSE, OBE, CLE and RTE.
Seismic Design Considerations	3.4.2	Faulting	All regional and local faults and the evidence of their seismic activity identified.	High	Undertake regional and local fault mapping exercise to feed into seismic hazard assessment collating evidence for fault activity. New geophysical studies should examine whether there are any unknown faults under the proposed alignment.
Seismic Design Considerations	3.4.2	Overtopping	Risk of overtopping of the dam due to seismic effects has not been considered	High	An assessment should be made of seismic displacement of the dam, liquefaction, seismically induced waves in the reservoir (in addition to Tsunami listed elsewhere) and earthquake induced landslides into reservoir resulting in overtopping of the dam with the design including an allowance for these effects
Seismic Design Considerations	3.4.2	Overtopping	Consequence of earthquakes on condition, safety and operation of road and railway has not been considered	Medium	Effect of earthquakes on multi-functional installations should be considered in design

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Tsunami Hazard Assessment		Tsunami	<p>The tsunami hazard assessment report by NGRI must be updated to consider other tsunami sources (volcanoes, landslides, meteorological etc.). Furthermore, the proposed model should be verified. Based on an initial review it does not appear to match observed events such as the 1945 Makran tsunami which had a maximum water height of 17m at Pasni, Pakistan. Additionally, the NOAA tsunami database indicates 2m water height in Mumbai for the 1945 event, which is much higher than the values calculated for Scenario 1 in the NGRI report.</p>	High	Update the tsunami hazard assessment.

Draft

D) Environmental Review

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Baseline and evidence - Land	There is limited baseline understanding of the soil conditions both in the terrestrial and sub-tidal areas. Limited sampling data for the terrestrial and marine soils has been undertaken that will need to be enhanced to give a full dataset. Sampling has concentrated at a number of built-up areas and will need to also look at other land/intertidal areas to determine likely impact during and following the dam works. This is needed to inform the assessment of the interactions with water quality following barrage enclosure, especially salinisation and eutrophication effects. Will need a good delineation of what areas are going to be 'reclaimed' or if areas are going to undergo land use alteration.	Medium	Comprehensive sampling programme of the Gulf of Khambat and adjacent land areas. This should consider physical and chemical quality of the soils. Can use sampling to date to guide new sampling programme.
Technical coverage of environmental risks	3.5.2	Baseline and evidence - Water	There is insufficient baseline understanding of the water quality conditions and inputs from feeder rivers. Sampling data for input rivers is available for 2009-2014, but seemingly limited to one year for the Gulf beyond some physical parameter measurements. This is essential to inform the assessment of the water quality changes arising from barrage enclosure. There is mention of the use of dredging within the project however, there is no indication of where this dredging is to occur. Detailed sampling of sediments to be dredged and used in either dam construction or land reclamation will be required as there is a high probability of the resuspension of contained contaminants within any dredged sediments.	Medium	Comprehensive sampling programme of the Gulf of Khambat and, to a lesser extent, feeder rivers is needed. This should consider physical and chemical quality and take into account seasonal variability.
Technical coverage of environmental risks	3.5.2	Baseline and evidence - Vegetation	The prefeasibility reports suggest that the areas of mangrove affected by the barrage are already substantially degraded. However, subsequent survey report that appears reasonably comprehensive does not support this assertion. There seems to have been an increase in mangrove cover over time, and this is at least partially due to agencies efforts in reforestation. Satellite images used in mapping do not seem to tally with the ground-truth assessment of density assessment. This has a very important bearing on the impact assessment and compensation requirement and so inconsistencies need to be addressed. The reports note the presence of areas of halo-tolerant and saline plants such as <i>Salicornia brachiata</i> , which is a saltmarsh species. Assessment should be made of the presence and density of saltmarsh, as well as the presence of mangrove.	high	Detailed habitats survey is needed for all potentially affected areas (including areas outside the barrage affected by sea level changes), including assessment of the type, condition and extent of habitats. It is recommended that data is collected in such a way that the value of baseline habitats (terrestrial and aquatic) can be assessed according to international Lender's standards for biodiversity (i.e. the determination of modified, natural or critical habitat, as defined by ADB / IFC biodiversity standards, as part of formal Critical Habitat Assessment). This baseline habitat analysis will inform the mitigation requirements (i.e. "no net loss" or "net gain" requirement). Surveys can build on previous surveys. Will require most recent satellite images with a repeat of some of the more detailed ground-based surveys and QA of the remote sensing land-cover assessment. There is some assessment of the potential areas for mangrove planting as mitigation. However, the project needs full analysis of how successful attempts have been to reforest mangroves in areas close to the project site. Updating the mangrove data should also include mapping and assessment of saltmarsh in the direct and indirect impact zones.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Baseline and evidence - Fauna	A detailed description of the terrestrial and aquatic fauna is largely lacking, other than a high-level review of the fisheries of the Gulf. There is for example only cursory information on avifauna which is mostly derived from secondary data and some bird data form around the 11 survey sites, which will not represent the majority of the impacted area. There is some but limited sampling of marine benthos. There is some survey data on classes of fauna found in rivers as well as information on planktonic species. However, there is insufficient baseline for a full assessment of likely change in community composition following the closure of the dam and the resulting alterations to communities present. Impacts on marine fauna will be a pivotal issue for the project and needs a detailed baseline. Reason for high-risk status is the driven mostly by the use of the intertidal areas as foraging and stop-over areas for internationally important bird species. Some assessment of the intertidal areas as a feeding resource will be required and assessment of increased flight times for some migratory birds. There is a lack of information on marine turtle nesting areas and the use of the gulf area and surrounding area for marine mammals. The reports mention the presence of dunes and associated dune flora, however, this is not surveyed or mapped.	High	Detailed faunal surveys are needed for all potentially affected areas, including assessment of the abundance and diversity of fauna present. This should include consideration of seasonal variability. Surveys will need to include seasonal avifauna survey of intertidal areas within closed dam area and use of intertidal in adjacent and further afield areas that will be affected by sea level changes post dam closure. This should link in with assessment of the intertidal area as a food resource for birds. There is a need to show baseline for turtle nesting areas as well as use of the gulf for marine mammals. Survey and mapping of dune systems and associated fauna. It is recommended that faunal surveys are undertaken in such a way that allows the value of faunal species / assemblages (terrestrial and aquatic) to be assessed according international Lender's standards for biodiversity (i.e. the determination of potential Critical Habitat trigger species and subsequent assessment, as part of a formal Critical Habitat Assessment). This baseline analysis will inform the mitigation requirements (i.e. "no net loss" or "net gain" requirements).
Technical coverage of environmental risks	3.5.2	Scoping - Land	The effects of displacement of people engaged in the saltpan, agriculture and fishery sectors need to be properly scoped and displacement effects fully assessed and resolved. Other than for the saltpan sector, these effects are only discussed in general terms. The work will need to include an assessment of the effect of land alteration, and/or conversion from what is described as 'wasteland' into either agricultural, industrial, housing or other and its knock-on effect on sedimentation, water quality issues as well as human use. This should also include assessment of the effect of large increases in human population as a result of the dam closure and associated works.	High	Confirm what studies have been undertaken since 2008. Update the scoping for the latest project design, and ensure that effects on directly and indirectly affected people are fully considered and addressed. Also address the secondary effects of population growth stimulated by the barrage.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Scoping - Water	The scoping report identifies the water quality impacts as a key area of investigation and resolution. Detailed scoping recommendations are made. This scoping needs to be updated with the latest project design and the required studies confirmed. The work will need to include assessment of the impact of land-cover change as well as population increases and associated growth/development/construction that is predicted to happen as a result of the dam closure. Current calculations of land cover (including water) seem to massively underrepresent areas of open sea. This is possibly due to the satellite tiles that were used for the analysis which do not cover the full open water area.	High	Confirm what studies have been undertaken since 2008. Update the scoping of water issues with the latest project design, including sea level changes outside the dam. There will be a requirement to obtain sediment sample results from any areas that are identified for dredging. This will include sampling throughout the dredge depth. Re-check the current land use (including water) from satellite images analysis. Will need to obtain up-to-date satellite images as current sets are not suitable. Scoping should encompass cumulative effects from other projects in the area, and also secondary effects from the population growth stimulated by this scheme.
Technical coverage of environmental risks	3.5.2	Scoping - Vegetation	The scoping report also identifies the impacts on flora, especially mangroves, as a key area of investigation and resolution. Further work on mangrove extent is summarised in the GES Synopsis report. Nonetheless, detailed scoping recommendations are made. This scoping needs to be updated with the latest project design and the required studies confirmed, including the impacts of water level changes outside the dam. The scope should include an assessment of the recent efforts to reforest mangrove areas by agencies with a view to determining the uncertainties associated with the planned mangrove mitigation. This includes an assessment of use by humans (fodder for cattle, building material, heating/cooking) as a result of increases in populations as a result of the project. Vegetation scope should consider also the loss of saltmarsh, and the impact of potentially changing what is currently likely to be saltmarsh into compensatory mangrove habitat, and conversion to sub-tidal as a result of sea level changes.	High	Confirm what studies have been undertaken since 2008, especially the recommended estimates of type, quantity and quality of mangrove areas affected. Update the scoping of flora issues with the latest project design, and consider other key receptors such as saltmarsh. Assessment of any land/fauna/flora clearance that may be required for the quarrying of rock that will be required for the project. Scoping should encompass cumulative effects from other projects in the area, and also secondary effects from the population growth stimulated by this scheme.
Technical coverage of environmental risks	3.5.2	Scoping - Fauna	The scoping report also identifies the impacts on a wide range of fauna as a key area of investigation and resolution. Detailed scoping recommendations are made. This scoping needs to be updated with the latest project design and the required studies confirmed, and must include receptors such as sea mammals, turtles, avifauna, and intertidal benthos.	High	Confirm what studies have been undertaken since 2008. Update the scoping of fauna issues with the latest project design. Scoping should encompass cumulative effects from other projects in the area, and also secondary effects from the population growth stimulated by this scheme.
Technical coverage of environmental risks	3.5.2	Analysis - Land	It is not clear how the recommendations of the Scoping Report (2008) have been taken forward since 2008, noting the reservations of the MoEF expressed in 2010. Full examination is needed, supported by validated modelling of the effects on estuary water levels and morphology outside the barrage.	High	See scoping issues above.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Analysis - Water	It is not clear how the recommendations of the Scoping Report (2008) have been taken forward since 2008, noting the reservations of the MoEF expressed in 2010. The GES report indicates that baseline survey has continued but detailed examination of effects and mitigation planning is lacking. Current calculations of land cover (including water) seem to massively underrepresent areas of open sea. This is possibly due to the satellite tiles that were used for the analysis which do not cover the full open water area.	High	See scoping issues above.
Technical coverage of environmental risks	3.5.2	Analysis - Vegetation	The mangrove study quantifies the areas at risk and is updated in the GES synopsis report. This appears to be based on the scheme as foreseen in c. 2010 and needs to be updated. There is no consideration of saltmarsh effects.	High	Full update of mangrove and other flora impact studies to quantify the area and quality of habitat lost.
Technical coverage of environmental risks	3.5.2	Analysis - Fauna	The fisheries impact analysis is high-level and needs to be comprehensively updated and expanded. It needs to consider the latest proposed scheme, including the implications of the Narmada River diversion for Hilsa (and other migratory fish/invertebrates) and their migration routes. Likewise, other faunal effects such as upon marine mammals, avifauna and marine benthos are still not fully assessed, taking into account the (as yet not completed) effects on the estuary physical regime.	High	Full assessment needed using the latest baseline of the faunal impacts including fish but also avifauna, marine benthos etc.
Technical coverage of environmental risks	3.5.2	Mitigation and Compensation - Land	It is not clear how the recommendations of the Scoping Report (2008) have been taken forward since 2008, noting the reservations of the MoEF expressed in 2010. The GES Synopsis report indicates that baseline survey has continued but detailed examination of effects and mitigation planning is lacking. There is the need for detailed delineation of areas that are expected to change. This includes areas that are currently denoted as 'wasteland' and the areas that are going to be 'reclaimed' or where there is identified land-use alteration. There is a need to develop better mitigation for the likely effects on the Asiatic lion, which would also need to consider effects of land use change and increased population expected as a result of the project. See cells H4 and H5 which cover baseline habitat and species assessment requirements to meet international biodiversity standards for Lenders.	High	See scoping issues above.
Technical coverage of environmental risks	3.5.2	Mitigation and Compensation - Water	It is critical that plans are in place to improve the river water discharges behind the barrage, to mitigate the water quality effects. There is no clear evidence of this. In addition, where it is indicated that water/waste discharge will just be moved seaward of the dam, there will need to be other assessment of this impact 'at sea' and further mitigation put in place. Mitigation will need to consider the effects of increased population as a result of the project, as well as increases in project and post-project construction and its knock-on effect on water quality. Mitigation will be required to address increasing demand for waste/water/materials. GES synopsis report does not indicate any progress on mitigation planning.	High	Full mitigation plans for water quality effects are required.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Mitigation and Compensation - Vegetation	Thought has already been given to mangrove restoration and compensation. These plans need to be updated in view of the latest proposed project. The potential areas for mitigation of mangrove will need to be assessed against a climate change model and assessed against alterations to coastal processes as a result of having the dam in-place. This could alter conditions outside the dam closure area (e.g. water levels) that may indirectly affect further areas on mangrove. Mitigation areas will need to ensure areas are suitable at present, and for the medium-term future. Vegetation impacts should consider also the loss of saltmarsh, and the impact of potentially changing what is currently likely to be saltmarsh into compensatory mangrove habitat.	High	Updated mangrove restoration plan required, including more evidence of effectiveness, and including assessment of indirect impacts on mangroves and possible mitigation areas from project as well as project and climate change effects on sea level rise. There will also need to be mitigation for the increased need for wood (building material and fuel) as a result of the increased populations that are expected as a result of the project.
Technical coverage of environmental risks	3.5.2	Mitigation and Compensation - Fauna	The measures to mitigate the impacts on fisheries, avifauna, marine benthos etc are largely missing. This will need to include the increased pressure on these resources (especially those used as food or fuel) as a result of the increased populations as a result of the project.	High	Full fish resources and fishing activity mitigation plans are needed. Likewise, for other ecological effects. This will need to include mitigation as a result of increased demand following population increases as a result of the project and other cumulative effects.
Technical coverage of environmental risks	3.5.2	Residual risk - Land	It is not clear how the recommendations of the Scoping Report (2008) have been taken forward since 2008, noting the reservations of the MoEF expressed in 2010.	High	See scoping issues above.
Technical coverage of environmental risks	3.5.2	Residual risk - Water	The 2016 study on the impacts of the project on water levels at nearby ports identifies effects on water levels, currents and bedload sediment. However, these are not evaluated in terms of impacts for the port operations. A separate study in 2018 appears to reach contradictory findings that need to be reconciled. Neither report considers the water quality effects within the barrage (except for salinity), with respect to eutrophication effects for example. There is a residual risk concerning the likely increased salinity of water sources to the south of the dam as a result to alterations in flow and sea level height. There will need to be further assessment of this knock-on water levels and water quality issue for those outside the dam area. The cumulative impact assessment will need to consider the in-combination effect of the project on water, alongside a number of other large-scale projects that are in the planning process and within the same likely impact area.	High	As above, full impact and mitigation study needed.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Technical coverage of environmental risks	3.5.2	Residual risk - Vegetation	Whilst work has already been done to develop a mitigation plan for mangrove loss, this needs to be much more developed and detailed in order for the residual impact assessment to be credible, which will need to consider indirect project impacts as well as sea level increase and increased storminess. The cumulative impact assessment will need to consider the in-combination effect of the project on vegetation, alongside a number of other large-scale projects that are in the planning process and within the same likely impact area.	High	As above, full impact and mitigation study needed.
Technical coverage of environmental risks	3.5.2	Residual risk - Fauna	The impact analysis for fisheries and other fauna is high level and not based on comprehensive survey data. There is one year of marine benthos sampling. It is also not clear that it relates to the latest project option. The cumulative impact assessment will need to consider the in-combination effect of the project on fauna, alongside a number of other large-scale projects that are in the planning process and within the same likely impact area.	High	As above, full impact and mitigation study needed.
Compliance with international standards and good practice	3.5.3	ADB Environmental Safeguards Objectives	The major impacts of the project need to be assessed and addressed, including estuary physical regime, water quality, ecological impacts, waterborne disease and loss of livelihoods.	High	Comprehensive assessment to be undertaken.
Compliance with international standards and good practice	3.5.3	ADB Involuntary Resettlement Safeguards Objectives	There are major potential resettlement issues related to direct and economic displacement of people currently engaged in the ports sector, agriculture, salt production and marine fishing. There is insufficient evidence that this is being addressed, even if in the case of fishing it is recognised as an issue for the affected communities.	High	Comprehensive assessment to be undertaken and RAP developed.
Compliance with international standards and good practice	3.5.3	ADB Indigenous Peoples Safeguards Objectives	The GES Synopsis report refers to the scheduled tribes in the study area, especially Bharuch District. However, these effects are not assessed so significance is unknown.	High	Comprehensive assessment to be undertaken.

E) Socio-economic Impact

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Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Technical Coverage of Social Risks and Impacts	3.5.	Social Impact Assessment	Comprehensive Social Impact Assessment (SIA) hasn't been carried out. The available information related to baseline data and risks is scattered throughout many reports and not aligned to the common goal. Impoverishment risks & impacts and livelihood restoration measures are not available in the reports, though some indications of loss of employment for salt workers.	High	SIA should be conducted. Past, present, and future impacts & risks should be identified. Risks and impacts should be correspondent to the Project phases (construction, transition, operation). Temporary and permanent impacts should be differentiated.
Technical Coverage of Social Risks and Impacts	3.5.	Mitigation hierarchy	The Reports are silent on what measures have been taken (or will be taken) to avoid, minimize and mitigate (also compensate) adverse social impacts	Medium	Social Impact Assessment should specify what measures have been taken into account to avoid adverse social impacts, similarly minimization, mitigation, compensation/offset efforts should be explained.
Technical Coverage of Social Risks and Impacts	3.5.	Gender Assessment	Gender assessment hasn't been carried out. Potential adverse impacts of the Project on gender issues, as well as the opportunities to mainstream gender benefits haven't been discussed. Moreover, there is no indication of gender involvement in the public consultations held so far.	Medium	Gender assessment should be carried out. Depending on the results of the assessment, probably there might be a need for the preparation of Gender Action Plan.
Technical Coverage of Social Risks and Impacts	3.5.	Labour Impacts	Assessment of labour impacts hasn't been done. For example, impacts of forecasted labour influx due to Project activities, mitigation measures to avoid use of child labour, forced labour, measures to be implemented to restore potential loss of employment (such as salt workers, fishermen) etc.	High	Labour Assessment should be conducted, and appropriate mitigation measures should be defined as per mitigation hierarchy. Key risks on expected direct employees, key suppliers should be assessed. Also, major risks (child labour, forced labour, minimum working conditions) for Contracted workers and Community workers should be investigated.
Technical Coverage of Social Risks and Impacts	3.2.22	Cultural Heritage	The Reports are silent about the risks & impacts on cultural heritage.	Medium	Potential impacts on cultural heritage should be carefully assessed and relevant measures should be taken into account. Good international practice recognizes that cultural heritage provides continuity in tangible and intangible forms between the past, present and future.
Technical Coverage of Social Risks and Impacts	3.5.	Indigenous People	The Reports are silent about the risks & impacts on indigenous people.	High	Potential impacts on Indigenous People should be assessed. If any impact will be identified, Indigenous People Action Plan (or Development Plan) would be necessary. If the project proposes to use the cultural heritage including knowledge, innovations, or practices of Indigenous Peoples for commercial purposes, the Client has to inform the Affected Communities of Indigenous Peoples of (i) their rights under national law; (ii) the scope and nature of the proposed commercial development; (iii) the potential consequences of such development; and (iv) obtain their FPIC (Free, Prior, and Informed Consent).
Technical Coverage of Social Risks and Impacts	3.2.22	Loss of access to natural resources and Impoverishment risks	The impact of loss of access to natural resources and livelihood sources are not discussed comprehensively. Impoverishment risks on fishermen and fishing industry, especially during construction stage and transition stages are not discussed. Although some reports mentions this issue, but doesn't provide the scale and magnitude of the potential impact. On the contrary benefits of the Project is presented widely.	Medium	SIA should also consider loss of access to natural resources and income sources. Consequent action plan(s) should include appropriate measures relevant to the significance of potential risks.
Technical Coverage of Social Risks and Impacts	3.5.	Stakeholder Engagement	The reports do not include necessary Stakeholder Engagement activities which should be implemented during various phases of the Project	Medium	Stakeholder mapping should be conducted and appropriate measures to be defined to deal with Primary and Secondary Stakeholders throughout the Project.
Technical Coverage of Social Risks and Impacts	3.2.21	Land Acquisition & Resettlement	Land Acquisition and Resettlement Plan is missing.	High	Land Acquisition and Resettlement Plan (and/or Livelihood Restoration Plan, depending on the results of SIA) should be prepared.

Technical Coverage of Social Risks and Impacts	3.5.	Social Monitoring and Reporting	As the Project is complex, its adverse impacts may arise during different phases, therefore continuous (semi-annual for some aspects, annual for some issues) monitoring will be necessary.	Medium	Monitoring arrangements (nature, frequency, coverage, responsibilities, timeframe, indicators) to be identified and included in each relevant action plan (such as LARP, IPDP, GAP etc).
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F) Transport

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Transport report	6.2.1	<p>No Transport Report has been put forward. Only a Traffic Assessment.</p> <p>A comprehensive Multi Modal Transport Assessment is required to set out the baseline and Transport Business Case for Investment</p>	No analysis of multi-modal transport baseline, forecast flows, opportunities and impacts	High	Develop a Comprehensive Multi Modal Transport Assessment and baseline

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Transport Costs	6.2.2			High	<p>Develop a Transport Business Case for Investment Report - utilising the following headings:</p> <p>Strategic Case: Strategic Context Organisational overview Business strategy and aims Other relevant strategies The Case for Change Spending objectives Existing arrangements Business needs – current and future Potential scope and service requirements Main benefits and risks Constraints and dependencies</p> <p>Economic Case: Critical Success factors Long-listed options Preferred Way Forward Shortlisted options (including the “Business As Usual (BAU)” and ‘do minimum’) NPSC/NPSV findings Benefits appraisal Risk assessment Sensitivity analysis</p> <p>Integrate the above into the wider scheme Financial, Commercial and Management for the scheme as a whole</p>
Transport report		Traffic Assessment was undertaken in October 2013. Data, references and guidance used may no longer be relevant.	Outdated Datasets	High	Traffic Assessment to be updated, ideally to a 2019 baseline - representing the latest pre COVID 19 travel patterns
Transport report		The Traffic Assessment does not make reference to the proposed rail corridor and any potential associated impacts.	Transport Assessment not comprehensive as not multi-modal	High	Comprehensive Transport Multi Modal Assessment to be undertaken to a 2019 baseline - representing the latest pre COVID 19 travel patterns
Traffic survey data		Traffic surveys used to inform the TA were undertaken in 2010. Traffic surveys >3 years old are typically considered to be outdated. The changes in travel patterns due to Covid-19 have not been considered. This will need to be revised and brought up to date	Outdated Datasets	High	Undertake new traffic surveys (albeit may not be representative until pre-covid movement patterns return). Alternatively, use of appropriate growth factors could be considered.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Trip generation surveys		Surveys have been carried out at 50 industrial units to understand trip generation rates of various industries. The number of sites surveyed for each type of industry is considered to be relatively small.	Outdated Datasets	Medium	Suggest undertaking additional trip generation surveys or supplementing with data from another source to validate.
Traffic survey data		Average daily traffic for surveyed roads has been considered for roads where 7-day and 3-day surveys were undertaken. It is unclear whether the 3-day surveys were undertaken on weekdays or across a weekend. The potential differences in travel behaviour on weekdays / weekends does not seem to have been considered.	Outdated Datasets	Medium	Examine if any significant differences in weekday / weekend traffic is observed. Consider use of factors to apply to 3-day surveys, to align with 7-day surveys
Toll revenue data		Toll revenue data collected in 2008/09 has been used to derive seasonal correction factors.	Outdated Datasets	Medium	More recent toll revenue data should be analysed to understand any notable changes to seasonal patterns. This would ideally be 2019 data, representing the latest pre-covid trip rates
Willingness to pay survey		Willingness to pay survey undertaken in 2010 based on proposed toll rates at time. Multiple factors could have altered people's willingness to pay, as well as the proposed toll rate, since the original survey was undertaken. This will need to be revised and brought up to date	Outdated Datasets	High	Consider impact of any significant changes in proposed toll rates and people's willingness to pay on viability of project. E.g., Scenario testing?
Toll rate		Toll rates have been derived based on NHAI Toll Policy 2008, amended in 2011. This will need to be revised and brought up to date	Outdated Datasets	High	Check if policy has been amended / superseded since 2011. If so, update toll rates and consider impact on willingness to pay, revenue etc.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Socio-Economic Profile and Estimation of Growth Rates		Chapter 3 considers a range of data including demography, net state domestic product, per capita income, industrial output, agricultural output, tourism and examines growth trends. Most of this data covers 2000-2009. More recent growth trends have not been considered, in particular any adverse growth impacts arising from the Covid-19 pandemic. This will need to be revised and brought up to date	Outdated Datasets	High	Examine growth trends using more recent data and consider adverse impacts of pandemic. Produce a comprehensive baseline and forecasting report
Major Infrastructure Projects in the influence Area		Section 3.6 considers the potential impacts of several major infrastructure projects on the proposed Kalpasar Dam. Since the production of the 2013 transport report, a number of these projects (or phases of these projects) have become operational. These projects may also have changed in scale, detail etc. since production of the transport report. This will need to be revised and brought up to date	Outdated Datasets		Consider ongoing impacts of major infrastructure projects and identify any additional major infrastructure projects that have emerged since production of 2013 transport report. This should be a chapter of a comprehensive baseline and forecasting report
Estimation of traffic growth rates		'Past Traffic Data' method uses traffic data from 1996-2010. This is considered to be outdated and not representative of present-day traffic patterns.	Outdated Datasets		Undertake new surveys (once post-Covid 19 traffic levels return) to validate findings. Would be delivered as a chapter of a comprehensive baseline and forecasting report
Estimation of traffic growth rates		Growth trends of registered vehicles in Gujarat - data from 1996-2010 considered.	Outdated Datasets	High	Obtain and analyse more recent registered vehicles data, as well as comparing growth rates against other regions, to see whether Gujarat is representative of wider society trends across the country
Estimation of traffic growth rates		Recommended growth rates.		Medium	Revise growth rates based on any changes to above items.
Review of Feasibility Study for Kalpasar		Section 4.1 reviews a feasibility study undertaken in 1998 based on traffic survey data collected in 1996. This will need to be revised and brought up to date	Outdated Datasets	High	Undertake updated feasibility study.

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
Chapter 4	4	Unclear if whole of section 4 is a review of the feasibility study, or new analysis		High	
Chapter 4	4	No assessment undertaken of construction traffic, its impacts or mitigating travel plans	No Construction Traffic and Impact Assessment undertaken	High	Develop a Construction Transport Impacts Assessment and associated
Chapter 4	4	No analysis undertaken on the traffic generated / emissions released by the linked schemes, such as the ports development etc.	No assessment of impacts of linked developments, facilitated by the scheme	High	As part of the recommended Comprehensive Transport Multi Modal Assessment - a full environmental baseline analysis should be undertaken to explore the direct and indirect impacts of the scheme and linked ventures
Chapter 5 -Economic Viability Analysis		No benefit analysis undertaken on wider society benefits, such as increases attributed to access to labour / employment, skills / training, healthcare environment etc	No wider benefit or societal benefit analysis undertaken	High	Full Transport Economic Baseline and Assessment required, as set out above
Chapter 5 -Economic Viability Analysis		No Economic analysis undertaken on toll free Economic		High	Full Transport Economic Baseline and Assessment required, as set out above
Chapter 5 -Economic Viability Analysis		No Economic analysis undertaken on changes to growth factors such as population, car ownership, policy drivers		High	Full Transport Economic Baseline and Assessment required, as set out above
Chapter 5 -Economic Viability Analysis		No scenario tests undertaken on environmental grounds - including incentives towards zero-emission vehicles		High	Full Transport Economic Baseline and Assessment required, as set out above
Chapter 5 -Economic Viability Analysis		No strategic alternative case examined, such as a do nothing, or development of strategic alternatives (i.e., a bridge etc)		Medium	Full Transport Economic Baseline and Assessment required, as set out above
Chapter 5 -Economic Viability Analysis		No Value for Money statement provided best on transport impact		Medium	Full Transport Economic Baseline and Assessment required, as set out above
Appendices		Appendices referenced in report have not been provided, so cannot be reviewed		High	
MISSING COMPONENTS		No risk analysis undertaken - across traffic data analysis or economic value		High	Undertake a full Risk Assessment - covering Transport, rather than just traffic

Sub-component	Inception Report section	Topic	Gap/Issue identified	Risk/ Importance (High/ Medium/ Low)	Mitigation/ Recommendation
MISSING COMPONENTS		As titled, the report is a Traffic, rather than a Transport Assessment, and as such does not pick up on the full connectivity benefits, impacts and risks a full Transport Assessment would cover		High	Undertake a comprehensive Transport Baseline, Impacts, Risks and Benefits Assessment be undertaken

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