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Inception Report

Financial and Economic Viability of Kalpasar Project

Submitted by:
Grant Thornton Bharat LLP
&
G Tech Infrastructure Pvt. Ltd.

September 2022

Contents

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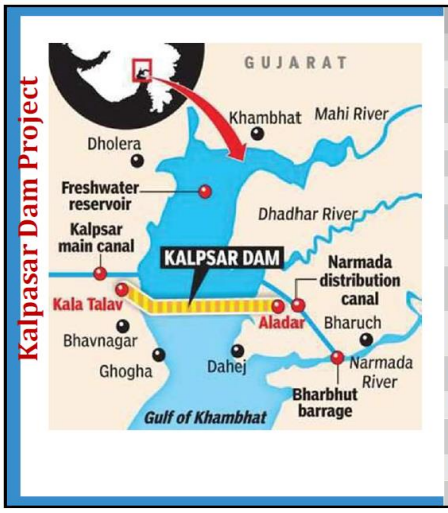
1 Introduction

1.1 Project Description

The Ministry of Earth Sciences (MoES) has taken up the task of preparing a Detailed Project Report (DPR) for the construction of a dyke across the Gulf of Khambhat, which is influenced by a higher tidal range (~9m) at the gulf's head. The project entails building a 30 km earthen dyke across the Gulf of Khambhat to create a freshwater coastal reservoir for irrigation, drinking, and industrial purposes, as well as a 2 km concrete spillway, to flush out saltwater or flood water. A 16-lane road and 4-lane rail network are planned to be built over the dyke, reducing travel distance from 350 Km to 50 Km. The project site is in the moderate seismic zone (Zone III) and about 700 km from the Makran fault. Kalpasar Project aims to create a freshwater coastal reservoir in the Gulf of Khambhat by construction of about 30 km dyke connecting the east and west banks of the gulf. It will be the world's largest freshwater lake in the marine environmentto create huge fresh water of about 10,000 Million cubic meters for irrigation, drinking and industrial purposes. It will be the world's largest freshwater lake in the marine environment.



Description	Details
Length of dam (in sea)	30 km
Top width of dam	100m, 10 lane
Reservoir :	
Full Reservoir Level (FRL)	(+) 3.0m
Maximum Water Level (MWL)	(+) 5.0m
Minimum Draw Down Level (MDDL)	(-) 4.0m
Irrigation command	
Water envisaged for irrigation	6500 mcm
Ground water improvement in periphery of reservoir	7.0 lakh ha
Extra land to be recovered (Availability of new fresh land)	1.2 lakh ha
Reduction in distance	
Bhavnagar – South Gujarat	136 km
Proposed Power Generation	
Wind Power	1470 MW
Solar Power	1000 MW

1.2 Project Benefits

The project is expected to create the world's largest man-made freshwater reservoir. The proposed project will generate resources pertaining to irrigation and drinking water for Saurashtra and Central Gujarat regions. The proposed reservoir will have the storage that is two times the storage of the Sardar Sarovar (Narmada Reservoir) capacity. It is expected that approximately 10.54-lakh hectare of land in 37 talukas of nine districts of Saurashtra region will get irrigation benefit facilities, including rejuvenation of rivers. More than 60 existing dams will get permanently filled up with water. Wind and solar energy will be generated, which can also be used for lifting fresh water from the reservoir to the canal. Bhavnagar port will get revived, resulting into the speedy development of the region. There will be large savings in travel time and fuel due to reduction in the distance by about 136 km between Bhavnagar to Surat/Mumbai. Saline ground water of coastal area of Saurashtra & Central Gujarat will get converted into freshwater with reduction in soil salinity. Substantial improvement in ground water quality as well as soil salinity of coastal area of Saurashtra & Central Gujarat. About 1.2 lakh hectare land along the periphery of the reservoir will be opened up for development towards value-based land utilization. An enhanced benefit of world-class industrial estates like Dahej and Dholera will be available to Bhavnagar/Saurashtra region.

1.3 Objectives of the Assignment

The objective of the current assignment is to conduct a Financial and Economic Viability Analysis of the Kalpasar Dyke project as per the Scope of Work set forth in the following section.

National Centre for Coastal Research (NCCR) vide File No. MoES/NCCR/47/Kalpasar/Financial/2022, dated: 12.07.2022 issued Letter of Acceptance (LOA) to Grant Thornton Bharat LLP (Lead Partner undertaking the Assignment in Association with G Tech Infrastructure Pvt. Ltd.), hereinafter referred to as 'GT or the Consultant'.

1.4 Data Collation

Collation of data would entail the collection of data from various existing reports to be shared by NCCR, secondary data (comparable benchmarks from similar projects) and literature review. Since primary data collection is outsider the purview of the Financial and Economic Analysts, no primary data collection will be undertaken. If however felt necessary, the team might undertake visits to the project site for a better understanding and appreciation of the complexities involved.

This data will be used in building the financial and economic model to assess the financial and economic feasibility of the project. To this end, a number of parameters will be analysed. A more detailed description of these parameters is provided in the relevant sections which follow. Given the scale and scope of the project, a number of direct and indirect benefits are expected to accrue to all the stakeholders of the project (Government, financiers and local population, among others). In particular, the lower strata of the society (e.g., daily wage earners, agricultural economy) is expected to particularly benefit from various aspects of this project. The proposed analysis aims to capture these financial and economic benefits, which will also comprise Social Cost Benefit Analysis.

1.5 Important Considerations

In conducting the Financial and Economic Viability Analysis, following considerations are important:

1 Cost phasing will be based on the Project Structure (Capital Budgeting structure) as suggested by the Authorities. Effort estimates do not include the same (project structuring except as already mentioned by the Authorities)

2 The Project Cost Estimate will be as per the Detailed Project Report. GT shall not prepare/revise the same.

3 Opex as mentioned in the DPR shall form the basis of calculating the Operational Cash Outflow. In case of any gross mismatch from established standards, GT shall discuss the same with the Authorities. The authorities in turn shall make necessary changes and share it with GT

4 For the purpose of conducting economic analysis, GT shall rely on data to be made available by the Authorities in the form of EIA and the SIA Reports. Apart from physical inspection of the project site and project-benefit area, GT shall not conduct any primary data collection activities. (Refer ***Note i*** below)

5 Unless due to reasons arising out of errors in calculation, the present assignment shall remain restricted to one-stage revision of the Analysis Model based on changes in Cost/Revenue/Benefit estimates. (Refer ***Note ii*** below)

6 Revisions in the model due to changes in the project structure / capital budgeting structure (except changes in ratios of Equity, Debt and/or Grant) / Implementation Scheduling (except postponement / preponement of the existing project phasing) / any other changes requiring complete overhaul of the analysis model are outside the purview of the current scope

Note i. GT shall rely on data provided by the Authorities (e.g. Demographic, Socio-Economic etc.). Basis the data/information provided, GT shall carry out further analysis and develop new quantifiable measures to be used in the Financial and Economic Analysis.

Note ii. At each deliverable stage, once the Draft Report has been submitted, GT shall make necessary revisions basis the inputs and observations received from the Authorities and submit the Report incorporating such inputs and observations.

However, basis the current effort estimates, once the Final Report has been submitted, GT agrees to carry out a maximum one revision of the Financial (and Economic) Analysis Model based on changes in Cost/Revenue/Benefit estimates.

2 Reports and Information Received

Reports	Status as on date of issue of Report
Detailed Project Report mentioning the following	
– Capex Cost components including domestic inputs and non-domestic inputs	Following Reports have been received – Broad project cost estimates (Sec 2.2 and 2.3) based on pre-feasibility reports (1996-2000) – Costing of the physical infrastructure (water supply management, wastewater management, solid waste management, lighting and power, and roads)
– Opex cost components during the economic life of the project	Yet to be received
– Economic Life of the various capex items	Received, refer Section 5.5 of the Report
Construction sequencing and Implementation Scheduling	Yet to be received; Indicative
Social Impact Analysis Report	Qualitatively discusses the Potential Socio-Economic impact; stratified demographic data yet to be received
Environmental Impact Analysis Report	Yet to be received; report on impact of the project on Air, Water, Noise quality, flora and fauna of the project affected area is required
Report on Willingness-to-pay for various services	Only possible toll based on GoG calculations available (as per Transportation Report presented yesterday) Net (negative) Carbon emission to be calculated from the Transportation Reports.
Report on Wind & Solar Hybrid Systems	Information as per the DPR of July 2022 been received. Partial reports on wind and solar energy generation, potential and potential capacity estimates for the period 2006-2010.
Transportation Report	Draft Report from L&T received; updated report with the proposed 130 m top width along with the assessment of toll plaza specific road and rail traffic (rail traffic for both passenger as well as freight) required
Tourism Studies	Limited information as available in the CEPT University Report of 2019
Ecological, Hydrological and Socio-Economic Studies	Yet to be received
Morphological Studies	Yet to be received
Any other report (Security Studies) considered pertinent to executing the assignment	Yet to be received

Please refer to Section 9.3 for necessary additional/updated information requirement to generate secondary data

3 Project highlights including project components

Kalpasar is a multi-purpose project consisting of various components such as the reservoir for storing freshwater, an Earthen Dyke for acting as barrier between seawater and reservoir, a flood regulator for regulation of water levels, a Transportation corridor for connecting Bharuch and Bhavnagar, an Irrigation system that utilises fresh water and renewable energy farms to produce energy for operation of the entire system.

Reservoir

The proposed reservoir has a water spread area of about 2,000 sq. km. Area-capacity table is developed based on the topography and bathymetry for the reservoir. Based on estimated inflow in to the reservoir and outflow for irrigation, drinking and industrial water, the Full Reservoir Level (FRL), Maximum Water level (MWL) and Minimum Draw-down Level (MDDL) are determined.

Flood Regulator

Unlike other cases, the flood regulator here satisfies two purposes. Not only will it let off the excess flood water into the sea, but it will also prevent the flow of sea water when water level rises during storm surge, thus preventing any increase in the salinity of the reservoir. The tidal variations on the seaside are estimated to be +6.5m and -6m MSL post-implementation. The volume available between levels + 3.0 m MSL (FRL) and + 5.0 m MSL (MWL) is 4104 Mm^3, which is the storage space available for flood absorption. Here, it is pointed out that the summation PMF of all the contributing rivers comes to 1,38,858 m^3/s. Considering channel routing up to Kalpasar reservoir, the net routed inflow for the reservoir will be 1,07,299 m^3/s. The flood inflow of 1,07,299 m^3/s is required to be absorbed for a duration of 6 hours which is the duration of the tidal event by which time the tide from its highest level (+4.40 m MSL) recedes to its lowest level (-4.40 m MSL), and the flood regulator comes in full operation. The volume of the possible maximum water quantum that will be required to be retained in the reservoir for 6-hour duration is 2318 Mm^3. Since the additional volume available is 4104 Mm^3, it is apparent that the maximum flood can be retained for about 10 hours to take care of the ever-likely maximum flood as the flood regulator comes to full operation after the tidal event of 6 hours. The flood regulator will be required to be closed whenever the downstream water levels, governed by tidal range, exceed the reservoir level.

The capacity of the flood regulator is therefore designed to have a larger discharge to compensate the deficiency in operation time. Based on the PMF study carried out excluding discharge from river Narmada, the inflow flood considered is 1,10,000 cumecs taking into consideration the allowance of water level to rise till +5m on the reservoir side during any event of flood. The capacity of flood regulator is designed to be 1,10,000 cumecs, with a gross width is 2,196 meters and net width is 1,800 meters having 100 spans of 18 meters width and 99 no. of 4 m thick piers. The levels of structural elements such as downstream apron level is -10.0 m MSL, upstream apron level is -7.1 m MSL, level of ogee crest is -3.5 m MSL.

Roadways

Construction of dyke road across the Gulf of Khambhat will fulfill the requirement of connecting the Saurashtra region with South Gujarat as a result of which transport distance will be reduced significantly thereby reducing the transport costs. At present one can reach Bhavnagar to Surat through Vataman-Vadodara-Bharuch-Surat network. Once the Gulf of Khambhat dyke (60 km long) is constructed, Bhavnagar will be directly connected to Dahej. There is extended length of road on both Bhavnagar side (22km) and Bharuch side (23 Km) for dispersal of traffic. On the Bhavnagar Side it starts from Sonegadh on NH-8E, passes through Ghangalia on SH-36 and Bhavnagar on NH-751. On the Dahej Side it passes through Panjadara/ Aladar on SH-6, Pipaliya / Pakhajan, Sadathala connecting NH-64 (under construction) Keshrol on SH-6.

On construction of the road, the distance between Saurashtra to South Gujarat would be reduced by about 150 km and time saving ranging from 6 hours to 1.5 hour.

Most of the heavy vehicles (goods movement) heading for Saurashtra and Kutch coming from South Gujarat will be able to utilize this route once the road is provided over the proposed dyke. Also, there is going to be significant development activities in the study area in view of the DMIC corridor, Dholera SIR Projects, Federa International Air Port, Port activities, Tourism Development, Agriculture activities, and other related activities.

Railways

Technically, it is envisaged to extend the Bhavnagar railway line onto the Kalpasar dyke, while on the east side, the Dahej-Bharuch broad gauge line is in operation. Hence, on top of dyke, the railway connectivity will be useful for goods as well as passenger traffic between Saurashtra and Surat/Mumbai. There will be a great reduction in distance between Saurashtra and Mumbai.

The prospects of regional development potential consequential to Kalpasar Project as well as the proposed DMIC, Dholera SIR, PCPIR, Fedra International Airport, etc. warrant a detailed study to assess the future railway traffic flow and pattern as well as the requirement for 10 m wide utility corridor on the dyke top.

The provision of a railway on the top of the dyke will, on the one hand, enhance the development potential of the Kalpasar Project due to saving in transport cost consequential to shortened route and on the other hand, it will be beneficial to railway also in terms of increased revenue from passenger and goods traffic. Being an attractive proposition both for the Kalpasar Project and the Railway Ministry, the development of the railway transport system on the Kalpasar dyke top can be explored for adopting it as a joint venture of the Government of Gujarat- Kalpasar Department and the Railway Ministry.

Earthen Dyke and Approach Embankment

The total length of the dyke including the intertidal regions is about 61.3 km. The total length of dyke is divided into three zones based on the bathymetry and soil profile in the project area. The three zones are (i) Intertidal zone at Bhavnagar, (ii) Gulf region and (iii) Intertidal zone at Dahej. The length of the intertidal zone at Bhavnagar is 19.83 km and the sea bed level in this zone is around +4.0 m to 4.5m MSL. The gulf region is about 26.7 km and extending till -27 m below MSL with predominantly silty sand. The length of intertidal zone at Dahej is 13.6 km and the sea bed level in this region is +3.0 to +5.0 m MSL. The water level in intertidal zone depth varies from 0.25 to 2.0m during high tides and mainly consist of clay.

The water level post-construction of dyke is estimated to be +6.5m MSL Highest Astronomical Tide (HAT) and -6 m MSL Lowest Low Tide Level (LLTL). Based on the study carried out by CWPRS, the significant wave height in the location is estimated to be 8.1m and the design water level is estimated to be 8.765m w.r.t. MSL. The dyke section on the seaside is designed as breakwater using the Hudson Formula and model studies.

The crest level of the breakwater is designed based on the allowable overtopping rate for safety and structural design as per the Specification given in Euro top manual. The entire design is based on the desk and wave flume studies carried out by CWPRS.

The crest level for sections below– 5.0 m seabed is +19.0m MSL. The crest levels in the shallow regions with seabed bed level at0 m, +2.0 m and +5.0 m are +16.5 m, +15.0 m and +12.0 m respectively. The crest levels of the breakwater in intertidal zones will be gradually reduced to connect the existing road at Bhavnagar and Dahej, which is at +10.0 m level.

The placement of the transportation corridor on the dyke is based on the storm surge and Sieches study by carried out by IIT Delhi. The results indicate that there will be an increase in water level of 2.5m in the reservoir during a hypothetical cyclone track. Therefore, the transportation corridor is located on the

crest of sand fill embankment on the reservoir side at an elevation of +9.0 m MSL elevation (4m above MWL). The sand fill embankment on the reservoir side is protected by providing the rock toe protection and filter layer.

Geotechnical Investigations carried out indicate that the analyses for both static and pseudo-static conditions for the cross-section is sufficient for stability, settlement, bearing capacity and prevention of seepage. The liquefaction assessment carried out indicates the liquefiable layers where ground improvement is proposed.

Irrigation System

The water stored in the Kalpasar reservoir will be used to irrigate the Saurashtra region, which is at an elevation of about 100 m. Unlike conventional irrigation project which works on the principle of variation in the elevations, in this project, water is required to be first lifted by providing pumps near the reservoir and the water is to be conveyed to an appropriate balancing reservoir from where irrigation water can be provided by gravity canals. The existing reservoirs namely Shetrunji dam, Malan Dam, Moj Dam, Puna Dam, Ranjit Dam, Ruparaj Dam and Macchu Dam shall be used as balancing reservoirs. The pumping stations will be placed at different locations to lift the water into balancing reservoirs.

In the first phase, the total water required for irrigation shall be transferred from Kalpasar reservoir to Shetrunji reservoir by pumping to reach from elevation - 4.0 m to +55.0 m. To link the Kalpasar reservoir to Shetrunji reservoir two pumping stations are used at Narbad and Charmadi ganguly.

In the second phase, to convey water further from Shethrunji reservoir, three canal systems are planned in the Saurashtra region by connecting existing reservoirs to distribute the water for drinking and agriculture. The canals are provided at 50.0 m FSL, 80.0 m FSL and 100.0 m FSL. The three canals are named as Lower Garland canal (50m FSL), Middle Garland canal (80m FSL) and Upper Garland Canal (100m FSL). A total of 7 pumping stations are required to lift 6,500 Mm^3 of water into balancing reservoirs.

Renewable Energy

The power required for pumping 6,500 Mm3 of water from the Kalpasar reservoir to the Saurashtra region, which is at higher elevation, requires about 2500 Million Units/year. To meet this power requirement, about 1,470 MW capacity wind turbine generators are proposed in three locations. These wind farms consist of 700 wind turbine generators (WTGs) of 2.1 MW capacity. Out of 700 wind turbine generators, 341 WTGs will be placed in Wind Farm 1 (Vadgam I), 186 WTGs will be placed in Wind Farm 2 (Vadgam II) and 173 WTGs will be placed in Wind Farm 3 (Jambusar Nada). The proposed windfarms require about 4500 ha land; 3000 ha land area (without shadow effect) will be available for development of solar power. Solar isolation in this area is 5.8 KWh/m^2/day and this can yield about 174 Million units and a capacity of about 1000 MW.

4 Project Financing

4.1 Financing options

An indicative list of the possible financing options is given in the table below.

Equity	Debt
Domestic • State Government / Public Utilities • Central Government • Private Corporates • Other institutional investors • Viability Gap Funding by Govt. • Revenue from real estate development rights	**Domestic** • Banks / FIs • Government bonds • Specialized infrastructure financing institutions
Foreign • International developers • Equipment suppliers • Dedicated infrastructure funds • Other international equity investors • Multilateral agencies	**Foreign** • International commercial banks • Export Credit Agencies • International Bond markets • Multilateral agencies • Bilateral aid agencies

Key Considerations for Government

- Such projects are highly capital intensive with long gestation periods
- Construction period is generally 5-8 years and much longer periods of the order of 30-50 years, for debt servicing
- Such projects are undertaken by governments in view its social responsibility to provide sustainable infrastructure and returns are not the prime drivers
- Other drivers for government supported such projects are reduction of emissions, economic development of the area, reduction in traffic etc. which can not be monetised
- Government subsidies and support in the form of equity and viability gap funding are an important part of project during construction as well as during operation of the project

Equity Financing and Sponsor Support

- Government of Gujarat (GoG)/ Government of India (GoI) as Co-sponsors may jointly contribute to the equity of the project
- Both GoG and GoI may allow certain tax (Custom duty, excise duty and Sales tax) rebates during the construction and concession period
- GoG may facilitate the acquisition of land at subsidised rates or free of cost
- GoG/ GoI may provide equity support through Viability Gap Funding if necessary for Initial cash losses
- GoG would ensure that electric power is made available to the project on a no profit-no-loss basis
- GoG may have to provide guarantee for refinancing domestic loans for the bullet portion to be paid at the end of 15th year
- Sale of property development rights will also form a source of funding for the project

- GoI may also provide guarantee for raising funds through bonds

Key Considerations for Debt Financing

- Project would require debt funding spread over at least 30 - 50 years
- Quantum of debt and repayment profile will depend upon the projected revenues over 30-50 year period
- Debt would be funded through various instruments i.e. External Credit Agency (ECA)/Multilateral funds, Govt. guaranteed bonds and domestic Rupee loan
- Funding from ECA/Multilateral institutions will provide cheap and long term source of funds spread over 30 years and hence it is to be maximized depending upon their comfort and import level from their countries
- Raising of funds through bonds will require Government guarantee as the project SPV will not get desired rating on standalone basis
- Part of funds can be raised from domestic lenders for tenor up to 15 - 25 years with structured repayment keeping a portion as bullet repayment at the end of tenor to be refinanced later
- Being long gestation and capital intensive project there may be cash losses in the initial years and government may have to fund the same by way of viability gap funding

Debt Financing options

Funding from ECAs / International Cooperative Agency

- ECAs like JICA, Korean Exim, KFW etc. can provide cheap long term funding i.e. 30 – 50 years plus for such projects
- Repayment would be spread over 30 - 50 years after construction and moratorium period of 5 to 8 years
- Low interest rate during construction which will increase after moratorium to match with cash flow projections. Similarly principal repayment can also be structured as per the cash flow projections.

Funding from Multilateral / Development Agencies

- ADB and World Bank can provide long term funding at attractive rates
- Repayment would be spread over 15 - 20 years after construction and moratorium period of 10 years
- Generally provide fixed rate loans

Government Guaranteed Bonds

- The SPV can raise 10-15 years funds by issue of government guaranteed bonds
- Tax free features can make them more attractive
- SPV can repay these bonds by raising fresh debt once operations are stabilised

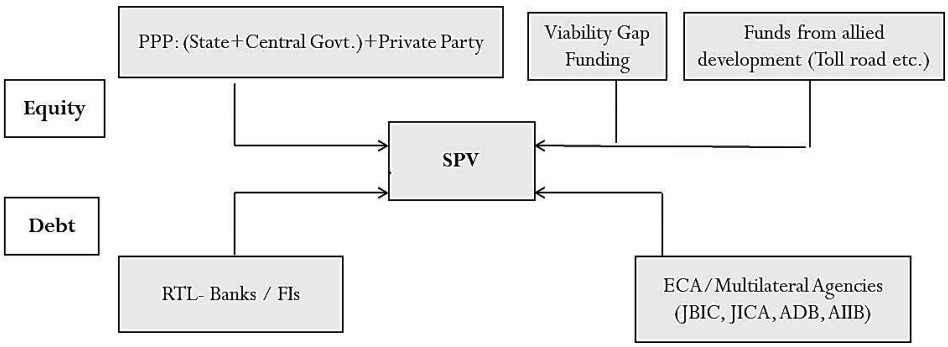
Rupee Term Loans

- Indian banks can provide debt up to 15 years with 6 to 8 years of construction and moratorium period, 8-9 years of repayment
- Repayment will be step-up to match the cash flows
- Step up repayment with full amortisation of Rupee loan at the end of 15 years; or
- 30%-40% of loan repayment over 15 years and balance bullet repayment at the end of tenor to be refinanced by fresh debt

4.2 Project Structuring

We understand that the modalities of project structuring are yet to be finalised. We propose to discuss with the Authorities about the modes which have been thought of while preparing the DPR and proceed further with the analysis. Presented below is a schematic representation of one possible structure which can be considered.

Indicative Financing Structure



4.3 Summary of Funding Options

Funding Option	Description
Revenue from Property Development Rights	Part funding of project cost from such revenues
Equity	Part of the project cost to be funded by equity from GoG/GoI and multilaterals
Grant by Government	Initial year cash losses supported through viability gap funding by Govt.
ECA debt	Maximum debt to be funded through ECA / Multilateral Lenders for tenor of 30-50 years
Bonds	10-15% of the project cost can be funded by way of issue of 15-years bonds to be raised in tranches and their repayment through refinance
Rupee Term Loan (RTL)	Residual funding by domestic loan for 15 years where part payment during the tenor and the balance refinance on maturity

4.4 Key Financing Attributes

The equity portion (~30% of total project cost) is expected to be partly contributed by state/central governments and private entities. The project SPV is expected to be provided a sovereign guarantee by central government, which will provide additional comfort to the lender consortium. The debt financing (70% of the project cost) is expected to be provided by a consortium of banks led by ADB, AIIB, other multilaterals, or SBI. Currently, India is rated as Baa3 (Stable) by Moody's, BBB- by S&P and Fitch. That is an investment grade rating. Such entities are customarily able to avail of dollar funding from ADB/AIIB at all-in-cost of LIBOR+3% – LIBOR+5%. That is all-in-cost of 5.3%-7.3%. As per IMF forecasts, India is expected to witness GDP growth rates of 8.5%-9.5% over the next 2-3 years. Given these growth rates, the rating is expected to witness upwards movement. Also, given the sovereign guarantee by the central government, the rupee term loans are expected to cost 7%-9%. Thus, depending upon the Rupee-Dollar funding mix, the borrowing costs are expected to range from 7%-8%.

Loan Tenor

The project is expected to be a very long-gestation project (30-50 years) with ballooning revenues during the last 15 years of the project. The debt component may carry a 5-year moratorium during which interest may be capitalized [interest during construction (IDC)] with a 25-year (Approximate that could be further extended) repayment period. That is an overall door-to-door tenor of 30 - 50 years. A ballooning repayment structure is proposed that matches the project cash flow profile. As the construction period is over, the execution risk will decrease considerably, and the debt may be refinanced at a lower cost and larger tenors (from ADB/ECA/Multilateral funds). This would require cash-flow securitization of project cash flows from allied sources such as toll revenues, wind & solar power generation, industrial and domestic water connections, revenues from state tourism, etc., through TRA/Escrow mechanism. Additionally, long-term tax-free bond options can be explored to refinance the loans.

5 Indicative Methodology for Conducting Financial Analysis

5.1 Objectives of the Financial Analysis

1 Phasing of costs as per the Detailed Project Report

2 Phasing of operational expenses as per the implementation schedule proposed in the DPR

3 Identify the various sources of revenue accruing to the project

4 Quantification of the revenue as per Industry standards

5 Prepare a Cash Inflow – Outflow statement based on accounting principles

6 Prepare a functional Financial Model for necessary Financial Analysis to arrive at the Project NPV, Project IRR under different scenarios

7 Identify the critical parameters affecting the Financial returns from the project and conduct a Sensitivity Analysis.

8 GT will suggest a few (at least two) project financing structures based on experience, market intelligence and other relevant information.

- A project financing structure shall lay out all the components of the capital to be raised for the project with specific details on the amount, timing, interest rates, moratorium, indicative repayment schedules and any other commercial terms likely to affect the financial viability under the relevant financing structure . However, in detailing such commercial terms, GT is not expected to approach any of the Funding Agencies.
- GT will analyse the feasibility of each financing structure suggested. The feasibility analysis should incorporate
  - i Viability of the financing structure from a cash flow perspective under various economic scenarios being considered in the financial model. To the extent possible, the Consultant shall consider the possibility of cost and time escalations, as well. Specific focus on the ability to service debt and ensure adherence to various financial covenants likely to be in place (e.g. DSCR, EBITDA ratios etc.)
  - ii Viability of the financing structure from a commercial perspective. To the extent possible, highlight precedents of projects having similar structures / components.
  - iii Pros and cons of each structure beyond items covered in (i) and (ii)
- For each financing structure, identify the optimal mix of the components taking into account the intended social outcomes from the project as well as maximisation of revenue potential from the various sub-components.

5.2 Cash Flow Analysis

This will include cash flow projections over the potential life cycle of the project. The cash flows (inflows and outflows) will be projected considering inflows and outflows that are tangible (occurring directly on account of the project) and those that are intangible (social economic cost and benefits). These are discussed in detail in the subsequent sections. The cash flow projections will be employed for the computation of various profitability measures and indicators of project financial and economic viability. The cash flow project will also entail project cost estimates and schedule of principal and interest repayment.

Capitalization and Coverage indicators

It is customary for such projects to be supported by debt. Therefore, the ability of projected cash flows and other benefits to support the debt servicing ability is important. This will be examined through various capitalization and coverage indicators such as Debt-to-Equity ratio, EBITDA/Interest, EBITDA/(Interest+Principal), Debt-to-EBITDA, NCA/Debt, among others.

5.3 Analysis of Financial Feasibility

Fundamentals of Financial Feasibility Analysis

Present values are often expressed in current dollar (Rs.) terms. That means they can be very simply added up. Let us consider a stream of cash flows $C_i's$ spread over 't' years as shown here, $for\ i = 1\ to\ T\ years$. Also assume a discount rate 'r'. The present value of this set of cash flows can be simply represented as shown here.

$$PV = \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_T}{(1+r)^T} = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} \quad (1)$$

This is a powerful result, often called discounted cash flow (DCF) formula for present value calculation. This is converted into NPV formula by simply subtracting the initial investment C_0 (C_0 is a negative term as it is a cash outflow).

$$NPV = C_0 + PV = C_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} \quad (2)$$

The appropriate rate of interest here, that reflects the risk of project, is called opportunity cost of capital or weighted average cost of capital (WACC). The expected rate of return is just a weighted average of the cost of debt (r_D) and the cost of equity (r_E). The weights are the relative market values of the firm's debt and equity, that is, D / V and E / V . Also, if the marginal corporate tax rate $T_C = 35\%$, then after-tax Weighted Average Cost of Capital (WACC) or company cost of capital is computed as shown here.

WACC =$\boldsymbol{r_D * (1 - T_c) * \frac{D}{V} + r_E * \frac{E}{V}}$

This blended measure of the cost of capital is called the weighted-average cost of capital or WACC.

Internal rate of return (IRR)

Internal rate of return (IRR) is one of the often-used measures as a project evaluation criteria. The ancestry of IRR rule comes from the simple return measure shown here. For a one period project, the return can be simply computed as shown here. $Project\ return = \frac{Profit}{Investment} = \frac{Payoff}{Investment} - 1$.

If we carefully notice this formula, we can rearrange it slightly to obtain the expression shown here.

$-Investment + \frac{Payoff}{1+Project\ Return} = 0$. It should not be very difficult to see here that the NPV of the project is zero at this return. This can be generalized to a multiperiod project to define a more generic IRR formula. That is, IRR is the return or discount rate at which NPV=0. It is a very useful measure, though it sometimes contradicts inferences from NPV rule. With this definition, the IRR rule can be expressed as shown here.

$$NPV = C_0 + \frac{C_1}{(1+IRR)} + \frac{C_2}{(1+IRR)^2} + \cdots + \frac{C_T}{(1+IRR)^T} = 0 \quad (3)$$

Project IRR

In this spirit we compute the Project IRRs using the cash flows of a project.

In order to compute the project IRR, we employee free cash flows to project (FCFP) as shown here.

$FCFP = PAT + Interest * (1 - Tax) + Depreciation\ and\ amortization\ expense - Capital\ Expenditure - \Delta Net\ WC (or\ Changes\ in\ Net\ working\ capital)$

These are the cash flows to project after meeting all the expenses.

Equity IRR

In order to compute the equity IRR, we employ free cash flows to equity (FCFE) as shown here.

$$FCFP = PAT + Depreciation\ and\ amortization\ expense - Capital\ Expenditure - \Delta Net\ WC(or\ Changes\ in\ Net\ working\ capital) + Net\ Borrowing$$

These are cash flows to equity investors after meeting all the expenses and debt obligations to lenders.

Net Present Value (NPV) Analysis

The first and one of the most important indicators to examine the viability of the project is NPV analysis. We propose to compute NPV of the project at different rates of opportunity costs (or weighted average cost of capital) that reflect the risk of the project. This would account for the fact that project investors should be able to earn commensurate returns; sensitivity analysis at different opportunity costs will highlight the value of the project, and also accounts for differing risk-perceptions.

Project and Equity IRR

The project financial analysis will involve project and equity IRRs for the project. Project IRR is the Internal Rate of Return for the project at which the discounted NPV of cash inflows is equal to cash outflows. In addition, we also propose to estimate Equity IRRs that will examine the returns specifically to equity providers. Projects that involve debt have Equity IRRs that are different from project IRRs. Thus it is important to examine the returns from equity investors perspective. This is so because returns from debt holders' perspective are specifically mentioned in the form of the interest cost.

Project Viability Gap Funding (VGF)

Kalpasar project is expected to make a sizable contribution to the local region in the form of agri-economy, employment generation, connectivity to metro cities, tourism, and fisheries, socio-economic development and welfare (education, per capital availability of drinking water, etc.). A sizable component of such benefits do not directly accrue to government. To make such projects financially feasible, government support is required in the initial stages, in the form of viability gap funding. The NPV analysis and IRR analysis is expected to highlight the VGF support which might be necessary to be provided to the project by the government to make it sustainable.

5.4 Indicative Methodology pertinent to the Kalpasar Project

Provision for Toll Road Construction

For toll road construction two main components of cost need to be suitably accounted: CAPEX and OPEX.

These are long-gestation projects (e.g., 40 years). Assuming a 10-year construction period, the capital expenditure can be phased at 10% for each of the years (Typically though, Capex Projects follow a S Curve). Given the useful economic life of the project, the project costs need to be depreciated over the long gestation period. Through appropriate securitisation structure, the revenues from toll can be used to service debt. The proposed financing may include 70:30 of debt equity ratio. Debt may come with a moratorium period of 5-8 years.

First phase of debt financing may be costly, however, once the construction period is over and toll revenues start, cheaper debt can be obtained through refinancing as most of the project construction and execution risk will be over.

The financial costs such as taxes, interests, and depreciation charges can be considered as transfer payments and adjusted in the financial costs to convert into economic costs.

The main operating and maintenance (O&M) costs include regular costs at 1% p.a. of project cost and periodic (O&M) include 5% of the project cost to be incurred every 5 years. [Latest block estimate of road and rail costs are provided in Table 28 CEPT].

Revenue Estimation

Under the broad umbrella rules of Govt of Gujarat toll policy, the following factors can be considered to estimate the toll revenues. Willingness to pay will be a factor of time and fuel cost savings depending upon vehicle milage (commercial light and heavy vehicles, private transport, etc.). This aspect will help in establishing the toll tax. Toll tax, coupled with traffic volume and composition, will help in estimating the average revenue profile. For example, TAS report offers two scenarios (Table 2-26 and 2-27) with distance savings, perceived travel cost savings, and accordingly, the proposed toll rates for bus, car, truck, LCV, and MAVs. The resulting number needs to be multiplied by expected annual/5-year/or 10-year traffic growth rates (TAS Table 3-24). Revenue forecasts to be obtained from TAS (Refer Table 4-19), these can be suitably revised to reflect the present conditions.

Provision for Generation of Renewable Energy

Wind Power Generation

The area where a number of Wind Turbine Generators are installed is called as Wind Farm. The essential requirements for establishing a wind farm for optimal exploitation of wind are as under

- Wind resource at site
- Adequate open land availability
- Suitable Terrain and Topography
- Proper Approach to the site
- Suitable power evacuation Facility
- Micro siting Layout

All the above written parameters are easily met at Kalpasar.

The governing feature of the wind climatology in India is the monsoon circulations. Winds in India are influenced by the strong South-West summer monsoon winds which start in May-June and weaker North-East winter winds in December-January. Wind energy is intermittent and highly site specific; therefore an extensive wind resource assessment is essential for deciding potential sites. The locations having annual mean power density greater than 200Watts/m^2 at 50 meter height are considered suitable for commercial wind power development.

On the basis of Annual mean power density, Vadgam and Jambusar Nada have been selected for the erection of Wind Farm. These areas are at the periphery of proposed reservoir and near to the power evacuation facility.

It is proposed to have 700 turbines of S120, 2100 kW capacity with a hub height of 105 Meter along the coast of Gulf of Khambhat. Hence total of 1470 MW is proposed.

Total 1470 MW will be installed in three clusters of Vadgam1, Vadgam2, and Jambusar region.

716.1 MW, 390.6 MW, 363.30 MW respectively will remain the installed capacity of the three clusters.

Wind power output for Kalpasar project is presented below:

Site Location	Total Wind Turbine No	Capacity MW	Total Installed Capacity	Estimated Output KWH/WTG/YEAR	Total Annual output KWH in Lacs.
VADGAM I	341	2.1 MW	716.1 MW	39.25 Lacs	13384.25 Units
VADGAM II	186	2.1 MW	390.6 MW	39.25 Lacs	7300.50 Units
JAMBUSAR	173	2.1 MW	363.30 MW	47.50 Lacs	8217.50 Units

TOTAL	700		1470 MW		28902.25 Lacs Units
Grid Level Availability		0.97*28902.25 Lacs Units		=28035.18 Lacs Units	
Power availability to Kalpasar Project Per Year (After 10% Wheeling Charges)				0.90*28035.18=2523.15 Million Units	
Power Required for Irrigation Water Pumping/Year				2500 Million Units	

Total Cost of the Project

As per the prefeasibility study and six specific studies of Kalpasar Project, for pumping of 6,500 Mm^3 water from the reservoir at elevation at 70 metre (660 km long canal), required annually is 2500 million units. Considering this much power requirement for the project, and also the availability of huge land area as well as positive parameters of wind energy, it is proposed to install 1470 MW capacity wind turbines which will generate net annual 2523 million units. Hence total cost of 700 Wind turbine generators is given in the Table below

Total No of Wind Turbine Generators	Cost of One WTG (In Rs. Crore)	Total Cost(In Crore)
700	17	11900

Note :(Above cost has been given in account for surge in steel and iron ore prices in recent past.)

The useful life of the WTG is 25 Years.

Operation and Maintenance

Per MW Operation and Maintenance cost will be Rs. 1,000,000 at an Annual Escalation of 5.72%.(As per CERC Norms)

Power generated through this plant will be used for captive purpose.

Solar Power Plant

A pre Feasibility study has been done in Vadgam and Jambusar region wherein it has been found average solar radiation at 5.8 Kw-hr/m^2/day.

Parameters which are required to commission a solar power plant are available in this area as given below:

- Solar insulation in this area is 5.8 kWh/m^2/day
- 3 Hectare land is required to install 1MW of Solar Project
- 3000 Hectare of land is available in this area without shadow effect wherein 1000 MW of Solar Power plant can be installed.
- Easy supply of adequate fresh water from Kalpasar reservoir for cleaning of solar panels.
- Distribution Network/Infrastructure available for wind can be used for solar power.

Power Generation from the plant

We know that at the given solar insulation level, 1.5 Million Units of electricity can be generated from 1 MW Solar plant in a year. Therefore 1000MW of solar will generate 1500 Million Units of electricity in a year.

Components of Solar Power Plant

The main components of solar power plant are as under:

- Solar Panel
- Solar Inverter
- Combiners & Junction Box
- Land Bank
- Erection of Project
- SCADA and Data Logger System
- Robotic Cleaning

The overall project cost will be the summation of individual cost of the above written components. The overall project cost is given in the Table below:

S.No.	Component Name	Cost in Crore
1	Solar Panel(Mono Crystalline Perk Half Cut)540watt Peak	2800
2	Solar Inverter(1MW,10MPPT)	225
3	Combiners and Junction Box	200
4	Protective Gears Arrangement	100
5	Erection	500
6	SCADA and data logger system	70
7	Robotic Cleaning	500
8	Total cost	4395

Note: Here we have assumed that land for the project will be provided by state authorities therefore we have not accounted the land cost.

Operation and Maintenance

Operation and Maintenance will be done with the help of Robotic Cleaning which has been accounted for in the Capital Cost. For O&M we are taking Rs.2.5Lacs/MW as O&M cost with 5.72% escalation(As per CERC Norms) on annual basis.

Other necessary assumptions

Given the capacity of wind and solar power projects, assumptions (or estimates) can be obtained for comparable projects across India. These include project cost estimates based on plant capacity. Opex related estimates as a percentage of plant capacity. Competitive tariff rates for power can be employed to estimate the revenues.

Such projects are usually 70: 30 or 75:25 debt equity financed. Thus, financial projections can be obtained using these line items. Indicative broad project and financing assumptions are provided in Sec 20 (DPR).

5.5 Design Life of various Components

S.No.	Component	Design Life
1	Structural Components	Minimum 100 Years
2	All fixed, cast-in, or non-replaceable components	Minimum 100 Years
3	Replaceable Mechanical and Electrical components	Minimum 25 Years
4	Hydromechanical Steel Structures (Gates and Valves)	Minimum 40 Years

Source: DPR, Version June 2022 Table 14.1

6 Preliminary estimate of expected benefits

Understanding the Socio-Economic Impact of The Project

Given the scale of the project, we understand that substantial socio-economic benefits, both tangible (revenue generation, income from assets likely to be generated, increase in Gross Domestic Product i.e. GDP, improvement in groundwater quality etc.) and intangible (improved quality of life, improvement in flora and fauna etc.) are expected to accrue to the project. In order to carry out the economic feasibility analysis, we shall strive to understand these and categorise them in to tangible and intangible benefits. ***The tangible benefits shall then be quantified to conduct the feasibility analysis and the intangible benefits shall be mentioned separately.***

Following are some of the likely benefits expected to accrue, divided into two broad categories-

- Direct benefits, and
- Indirect benefits

Direct Benefits	Reduction in passenger transport and freight haulage cost
	Generation of Sustainable Energy
	Land Reclamation and Development
	Water availability for industry, agriculture (irrigation), and domestic/municipal applications
	Tourism and recreation
Indirect Benefits	Increase in Agri Gross Regional Product
	Reduction in siltation along the coastal shipping route
	Reduction in air pollution and Consequent Carbon Credit
	Additional Employment Generation
	Improved navigation for coastal shipping
	Negative Impact on Fauna

Most of these benefits are briefly discussed below. Few of the indirect benefits have been directly covered in the Section on Methodology for Estimation of the respective benefits

Reduction in passenger transport cost and freight haulage cost

Direct connectivity between the Saurashtra region and South Gujarat (Bharuch, Surat) has been a long-felt requirement of Gujarat. Construction of dyke road across the Gulf of Khambhat will fulfill that requirement by connecting the Saurashtra region with South Gujarat; thus, transport distance will be reduced significantly, thereby reducing the transport costs. The road transport benefits will accrue largely through the diverted and generated traffic. While the traffic will be diverted to the dyke road from other modes of transport or other routes in view of the differences between the transport costs incurred in the dyke; the generated traffic will be consequential to the new road connection and the reduced costs between the Saurashtra region and South Gujarat, and to the demand of transport on account of various projects in the region, viz Petrochemical and Petroleum Investment Region (PCPIR), Delhi-Mumbai Industrial Corridor (DMIC), Dholera Special Investment Region (Dholera SIR), Fedra (Dholera) International Airport, Port activities, etc. Moreover the transport component within the project will stimulate the regional economic development.

Presently, we have estimates of major district connectivity with and without dyke (details in TAS Table 1) and therefore savings in distances. For example, savings in distance from Bhavnagar to Bharuch is

137 km. As per the savings matrix Table, across different districts, the savings range from 50-150 kms. Moreover, the expected travel time savings is estimated to be between 30-minutes to more than 6 hours. Estimates of traffic volumes and traffic composition for different vehicle movements in the project influence area (heavy and light commercial vehicles, passenger cars, auto rickshaws etc.,) are similar to those provided in TAS (Oct, 2013). [The corresponding train traffic volume details are provided in Table 5&6 (CEPT)]. These estimates of cost and time (road user benefits) are categorized as Savings in Vehicle Operation Costs (VOC) and Savings in Value of Passenger Time (VOT) and are provided in Table 5-6 (TAS).

The overall benefits (both quantifiable and non quantifiable) can be summarised as under

- Reduction in operating expenses, both for the users of the new highway on the dyke, but equally for traffic that continues to use the existing routes, which may become less congested
- Time savings for both passengers and freight
- Reduction in accidents
- Increased comfort and convenience
- Secondary benefits like savings in foreign exchange as consequence of reduction in transport timing of fuel imports

Generation of Sustainable Energy

Owing to environmental concerns and rapidly depleting fossil fuel reserves, renewable sources of energy like Wind, Solar etc. have been the preferred option. Wind power is non polluting and causes no ecological imbalance, no throughput fuel. It has low gestation periods and is having rapid technological advancements.

One of the objectives of Gulf of Khambhat Development Project is to explore the possibility of power generation through renewable energy sources like Wind and Solar to meet the power requirement for pumping of water into canals.

Under the ambit of the Gulf of Khambhat Development Project, the power requirement for pumping of water from the proposed freshwater reservoir is planned to be achieved through renewable energy sources by setting up wind power farms along the periphery of the reservoir.

The annual power requirement for water pumping of the project would be approximately 2500 Million Units (TEFR). As per TEFR and Suzlon study (pre-feasibility survey), the wind energy potential is the estimated energy assessment of 700 turbines each of 2.1 MW capacity, aggregating to a total of 1470 MW capacity.

Along with wind power, solar power is planned to be developed collaterally. Basic parameters for the feasibility of solar power development are aligned to wind-farm are provided as follows: 4500 ha land area is proposed to be made available for wind park, of which 3000 ha land area (without any shadow effect) can be available for solar power development.

Land Reclamation and Development

Consequent to the construction of the dyke across the Gulf and creation of the fresh water reservoir, the presently tidal affected land between EL + 5.0 m MSL and EL + 8.0 m MSL in the periphery of the proposed reservoir will open up for reclamation and development. Based on a reconnaissance field survey of the peripheral areas reinforced with computer-based estimation, such land areas are 2,38,464 ha, which are mostly governmental lands. Because of the project-induced development in the region as well as several upcoming developments in the neighboring areas, like Dholera Special Investment Region (SIR), Petrochemical Petroleum Investment Region (PCPIR), etc., there is a high value-additive setting for these lands to be appropriately reclaimed and developed towards value-based land utilisation.

Water availability for industry, agriculture (irrigation), and domestic/municipal applications

Total water available for storage in Kalpasar reservoir is 10,000 MCM at 50% dependability, of which 6568 MCM water is proposed to be allocated for irrigation in Saurashtra region covering 39 talukas in six coastal districts viz. Bhavnagar (7 talukas), Amreli (3 talukas), Junagadh (12 talukas), Porbandar (3 talukas), Jamnagar (10 talukas) and Rajkot (4 talukas). Details of net-water availability (after accounting for losses) for these three major causes (industry, agriculture, and domestic) are provided in Table 9.2 (DPR). For drinking water a reservation of 1000 MCM from proposed Kalpasar Reservoir has been planned. It will be provided to Water Supply Department of GoG to cover deficit of drinking water in the entire Kalpasar command area. Also, 100 Mm3 of water for industrial use from the freshwater Kalpasar lake. A good part of this can be reused for irrigation after proper treatment. Appropriate water tariffs can be employed to value the additional water resource generated by the project. Moreover, surface irrigation would recharge the ground water in the command area, as a result of which the additional irrigation has been planned using the groundwater.

Tourism and Recreation

Tourism will be one of the relatively new economic activities in the region. The Kalpasar lake will offer avenues of recreation along the waterfront. Hence recreation has been proposed as a separate land use zone in the Final Structure Plan of the Gulf of Khambat Development Project Report prepared by CEPT University in January 2019, which includes tourism and recreation-based activities depending on the location and environmental sensitivity. To promote tourism activities, riverfront is proposed at strategic locations to create Entertainment for heterogeneous group of people, it will also increase the degree of tourism development in the area

Apart from revenue generation potential, this will also create new jobs in the form of hotel management, guides, drivers, hotel staff, craftsmen, agents, trade and commerce, transport and logistics, locals etc. This includes a mix of skilled, semi-skilled, and daily wage earners.

Increase in Agri Gross Regional Product

It is expected that the reservoir developed in Kalpasar Project will irrigate approximately 10.50 lakh hectare land, benefiting 9 to 10 districts of Gujarat where the present agriculture is dependent solely on monsoon. With an increase in water supply for irrigation due to the development of dyke, the Agricultural output of the state would likely increase, thus, increasing the Agri Gross Regional Product.

As per the DPR (June 2022 Section 2.7.20), the gross value of crops proposed to be grown under irrigation at current prices works out at Rs.10,366.9 Crore as against the present realization of Rs, 2,110.7 Crore, thereby implying an additional gross value of Rs.8,256.2 Crore per year. Among the proposed crops/crop groups, groundnut turns out to be the main crop with a share of 23% of irrigated area and providing highest return of additional production worth Rs.2,338.2 Crore. Though wheat accounts for 30.8% and cotton 6.4% of irrigated area, the returns from wheat is just 50% of that from cotton. The highest return after groundnut is from onion and wheat. These two cash crops taken together constitute the major source of income to the farming community of Saurashtra region. An increase of 8.38 million tonnes is envisaged in the overall production of crops due to the proposed Kalpasar Project.

From available information, it seems that due to dependency on monsoon mostly single crops are roped. With creation of irrigation facilities the farmers will be able to harvest two to three crops in a year. The availability of water will help in reclamation of degraded soils due to which more land will be converted from barren to fertile. This will bring prosperity to rural households depending mainly on agriculture. The farmers of the area need to be guided to adopt integrated farming through which they can generate more income even from small holdings. With respect to hydrological properties, majority of the soils in the Kalpasar Command Area have high available water capacity suggesting that crops like cotton, sugarcane and paddy, can be safely grown.

Insofar as the fisheries sector is concerned, the proposed Kalpasar Project may not bring in any appreciable loss of fisheries yield (DPR Section 2.7.19). On the contrary, the proposed Kalpasar reservoir would add at least 2,000 tonnes of reservoir fish, valued about Rs.15 Crore through its 2,000 km^2 reservoir. Thus the creation of fresh-water reservoir is likely to result in excess reservoir fish yield. Apart from value realisation from the fish yield, the working population ratio is also expected to increase significantly with a substantial number getting involved in pisciculture.

The fishing in the Ghogha area of the Bhavnagar district may profit from the rise in water level. Additionally, prospects for aquaculture near the villages of Ghogha and Kuda may arise due to the rising sea level. Many Ghogha families rely on marine fishing for their livelihood. The years-long decline in fish catches was one of the main complaints. The increase in saltwater could help the local fishing industry.

Families from the SC and ST communities in the Bharuch district, particularly in the Dahej area, have historically relied heavily on fishing as a source of income. But the extensive industrialization in the Dahej region has had a negative impact on the quality of the seawater, which has decreased the availability of fish and other aquatic life.

The projected Kalpasar dyke is expected to raise the water level, which should help to flush away or diluted the level of pollutants in the sea water in this area. This would have a favourable effect since it would make it easier for fish and other aquatic animals to move about, which would be extremely beneficial for households in the underprivileged groups of society in the villages of Dahej, Luvara, Ambetha, Koliyad, Vengni, Suva, and Mahegam.

With the rise in water level, fishing—another important occupation for the locals in the Hansot-Ankleswar region might benefit. The majority of the households from the Rathore and Vasava villages depend on fishing and day labour in agricultural areas for a living. According to preliminary findings, these communities' way of life will remain mostly untouched or enhanced. Due to the scarcity of Narmada water following the Sardar Sarovar Dam and the incursion of tidal saline water deep into the river, the yield of hilsa fish has decreased in the Bharbhut region near Bharuch. Freshwater fishing may flourish close to Bharbhut while seawater fishing may flourish in the villages of Katpor and Vamleswar further downstream as a result of the construction of the dyke.

Improvement in Groundwater

Due to availability of fresh water from canal system around 10 Lakh ha of area would be under irrigation. With the availability of 4500 MCM/year for irrigation, pressure on groundwater will reduce. Considering infiltration rate of 30 to 35% there would be additional ground water recharge between 1400-1600 MCM/year. This will improve the ground water condition both in terms of increase in water table and reduction in salinity. There are plans to promote drip and sprinkler irrigation to reduce overuse of water in the region, with arid conditions and prevent sodicity of soils. The canals will also firm up existing reservoir in the command area and in turn benefit in prevention of salinity ingress along the sea coast of Saurashtra region. Amreli, Jamnagar, Junagadh, Bhavnagar and Porbandar districts would benefit from the salinity projects already in operation from the Kalpasar canals. This in turn would benefit the ground water resources of the region.

Reduction in siltation along coastal shipping route

The region towards the east of the Gulf of Khambat around Dahej is exposed to siltation due to the discharge of water from Sardar Sarovar Dam which brings a huge volume of silt, impacting the ferry route in the region. With the development of the Kalpasar Dyke the siltation would likely reduce, thus, reviving the ferry route and reducing the cost of dredging along the route.

Reduction in Air Pollution and Consequent Carbon Credits

Emission estimates depending on vehicle types are provided in Table 5 (TAS). Reduction in emissions due to distance savings via the Kalpasar Project road will result in Carbon Credits accruing due to the project. Trading of Carbon Credits is therefore, another benefit that is likely to accrue due to the project.

A carbon credit is a generic term for any tradable certificate or permits representing the right to emit one tonne of carbon dioxide or carbon dioxide equivalent. Carbon Credit is maintained in the form of an Electronic Certificate, similar to that of a De-Materialized (Demat) Share Certificate. One carbon credit is equal to one ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases. Emission trading (also known as cap and trade) is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

7 Indicative Methodology for Conducting Economic Analysis

7.1 Objectives of the Economic Analysis

1. Conversion of Financial Project Cost Estimates into economic costs
2. Conversion of Opex estimates into economic costs
3. Identification of tangible economic benefits accruing due to the project (Economic benefits as already identified in the DPR shall be considered as the base; however, in case any other benefits have not been identified, the Consultant shall propose the same, subject to final acceptance of the Authorities)
4. Review of population projection as per accepted standards and identification of beneficiary population out of the same (based on population projection and demographics as mentioned in the Social Impact Analysis)
5. Quantification of the tangible economic benefits based on sound economic principles – To the extent possible, the quantifications shall be based on benefits accrued due to similar projects implemented nationally or globally.
6. Conducting an economic analysis of the Present Value of Economic Benefits and Economic Return from the project

Note iii. Sequencing of economic benefits which are likely to accrue – GT will make an informed estimate of commencement of the economic benefits aligned with the Construction and Implementation Schedules

7.2 Fundamentals of Economic Analysis

The socio-economic impact of the project can be classified into tangible and intangible benefits. The tangible benefits (or tangible outputs) can be further classified as Traded and Non Traded Outputs in the nature of Incremental and Nonincremental outputs. Similarly, inputs or project (and associated) costs can be classified as Traded/Non Traded, further classified into Incremental and Nonincremental inputs.

Economic cost-benefit analysis establishes the overall economic merit of the project. Economic assessment includes monetizing benefits, such as time savings, decongestion benefits, environmental impact, accident cost savings, etc. This analysis is the central tool for measuring the net economic gain that can be achieved through the development of the project.

Economic valuation of project benefits and costs involves converting their financial values into economic values, also known as “shadow pricing.” This conversion requires economic prices of project outputs and inputs to be estimated. Economic prices reflect values of goods, services, and other project effects on the national economy. The basis for estimating economic prices differs between internationally traded and nontraded goods and services, between project outputs and inputs, and between incremental and non-incremental outputs and inputs.

Based on the above principles, input costs and outputs shall be converted into shadow prices. Further analysis and calculation of EIRR / ENPV follows the same method as is used for the calculation of FIRR.

7.3 Calculation of Economic Feasibility

Economic Internal Rate of Return (EIRR) will be computed based on sound economic principles and globally accepted norms of conducting Economic Analysis of the Project (also known as Social Cost Benefit Analysis) to arrive at the economic feasibility of the project. The EIRR indicates the rate of return at which the present value of the economic costs and benefits of the project are equal. In other words, it

is the discount rate for which the net present value of the net effect on the economy (ENPV) is zero. The EIRR should be compared with the socially required rate of return. Projects that are found to have an EIRR that is higher than the socially required rate of return would be said to be feasible economic investments. These may then proceed for a detailed analysis of their viability as PPPs.

FIRR and EIRR give different sorts of information about a project. FIRR provides a decision criterion on whether the project generates enough return to cover the cost of funds (or in other words generates a positive Net Present Value of Net Cash Flow during the project period) On the other hand, the EIRR is better suited to being a decision criterion from the socially beneficial purpose. By allowing a project to be compared against a required rate of return it gives a yes or no answer about whether it is economically feasible. EIRR includes aspects such as socio-economic perspective and positive and negative externalities of the project to society.

7.4 Indicative Methodology pertinent to the Kalpasar Project

Net Economic Benefit

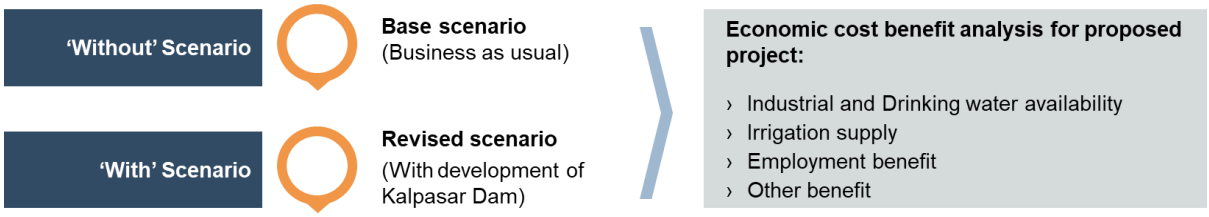
Economic appraisal is done by estimating net project gains by comparing the 'With Kalpasar' scenario and 'Without Kalpasar' scenario. Stream of costs and benefits, as estimated in market values are then converted into economic values by using appropriate shadow cost factors.

The annual stream of project costs and benefits are compared over the entire analysis period for estimating the net benefit and economic viability of the project. These benefits are presented in terms of the Economic Internal Rate of Return (EIRR).

EIRR represents the discount rate at which ENPV of the project is equal to zero; in other terms where the Net Present Value of all economic cash flows is equal to zero. The higher the value of EIRR, the greater the net economic returns from the project.

Economic assessment – Approach and framework

As highlighted, economic cost-benefit analysis analyses overall costs and benefits from the development of the Kalpasar Dyke. The assessment includes monetizing non-market benefits from the development of the dyke, such as availability of water drinking, industrial, and irrigational purposes, hydropower generation, employment generation, travel time savings, decongestion benefits, environmental impact savings, etc.



Economic appraisal of this project evaluates social cost-benefit and compares project benefit and costs under "With" and "Without" project cases.

"With" case considers the possible benefits achieved with the development of Kalpasar Dyke whereas "Without project" case considers the existing base case. The Economic Internal Rate of Return (EIRR) would be calculated as-

EIRR = Private Returns + Cost Gains

Where, Private Returns = Actual Revenues – Actual Costs

Cost Gains = Actual Cost – Opportunity Cost

All taxes and subsidies are excluded from the computation of EIRR

The financial analysis only looks at the project from the perspective of the implementing agency. Also, financial analysis is only concerned with line items that entail monetary outlays. Economic analysis, on the other hand, considers cost and associated benefits to the economy.

Economic analysis requires quantification of various costs and benefits converted to 'economic equivalent' terms. EIRR also requires identification of 'externalities and valuation of inputs and outputs at their true economic prices, or the 'opportunity costs'. These externalities would be estimated as the Shadow Cost Factor, as explained in the section ahead.

Shadow Cost Factor Estimation

In order to estimate the economic benefits of the Kalpasar Dyke, the actual financial value of construction and operational costs would be estimated including the Shadow Cost Factor. The Shadow Prices are adjusted financial prices, which discount the effects of government taxation and subsidies, the opportunity cost of resources, environmental externalities, and market distortions.

The Shadow Exchange Rate Factor determines the domestic currency value converted at the official exchange rate, and as per the Asian Development Bank's (ADB) guidelines it is determined as per the formula below.

SERF = RER / OER * (1 + T – S)

Where, SERF = Shadow Cost Factor,

RER = Long-run Real Exchange Rate for the Economy,

OER = Original Exchange Rate (Actual) of the economy,

T = Average rate of tax on infrastructure investment, and

S = Average rate of subsidy on infrastructure investment

Shadow Wage Rate Factor (SWRF) determines the opportunity cost of labour. For skilled labour, SWRF is considered equal to 1, whereas, for unskilled labour, SWRF varies between 0-0.75 implying a loss of output.

The relevant shadow factors for the economic assessment of Kalpasar Dyke would be derived using the ADB or similar Guidelines.

Benchmark EIRR

For all investment projects such as transportation, energy, urban development, and agriculture, Multilateral Funding Agencies use a discount rate of between 9% to 12% as the minimum required EIRR to accept or reject a project and to choose the least-cost (or most efficient) project choice. This rate serves as a rationing rate to maintain resource efficiency and as a stand-in for the opportunity cost of capital in each of the member countries that are developing (DMCs). However, lower discount rates of about 6% can be used as the minimum required EIRR for social sector projects, specific poverty-targeting projects (like rural roads and rural electrification), and projects that primarily generate environmental benefits (like pollution control, ecosystem protection, flood control, control of deforestation, and disaster risk management).

These projects can be justified by using a lower social discount rate for the following reasons: Numerous environmental protection and conservation initiatives have very long-term effects that justify a

lower discount rate, and many social sector and poverty-targeting projects frequently have many advantages that cannot be quantified.

Estimation of Various Benefits

This section explains various direct and indirect benefits to be considered for the assessment.

Estimation of Direct Benefits

The approach for estimating the indirect benefits has been highlighted in the table below.

Reduction in passenger transport and freight haulage cost

Estimates of traffic volumes and traffic composition for different vehicle movements in the project influence area (heavy and light commercial vehicles, passenger cars, auto rickshaws etc.,) are similar to those provided in TAS (Oct, 2013). [The corresponding train traffic volume details are provided in Table 5&6 (CEPT)]. These estimates of cost and time (road user benefits) are categorized as Savings in Vehicle Operation Costs (VOC) and Savings in Value of Passenger Time (VOT) and are provided in Table 5-6 (TAS).

Sources for Calculation: *Conceptual Report for Road, Rail, and Bridge Designs, L&T Infra Engineering, June 2022; Stakeholders' consultations*

Generation of Sustainable Energy

As per the Narmada, Water Resources, Water Supply, and Kalpasar Department, the Kalpasar Dyke is proposed to generate 1,470 MW of Wind Energy and 1,000 MW of Solar Energy.

A 25 MW Solar Grid-connected power plant at Sardar Sarovar Dam generated ~183.8 Million units of electricity in May 2022. GT shall estimate the economic benefit due to sustainable energy generation based on benchmarking of unit cost/MW of energy generated in similar projects.

While it may not directly be related to the present project, the benefit of increased consumption resulting from a generation project will also depend on the presence of transmission and distribution surplus capacity. Additional investment in transmission and distribution will be needed if there is insufficient capacity to support increased usage. When this occurs, a system approach should be used to combine the transmission and distribution components with the generation project such that their investment and operation costs are added to the project cost to derive net gain.

Sources for Calculation: *Benchmarking from similar projects/studies*

Land Reclamation and Development

A maximum water level (MWL) of about 5.0 m in the reservoir will result in recovery of land between 5.0 m to 8.0 m surrounding the reservoir. As per the DPR and the CEPT University reports, it is expected that approximately 1 lakh hectare of land will be reclaimed upon implementation of the project.

GT shall estimate the additional revenue generated from the reclaimed land through market estimates of land based on the proposed land use pattern. Alternately, since multiple projects are planned for the development of this land, an intuitive approach would be to obtain market valuation of the land based on a comparable approach. Similar locations can be identified, and their private/commercial valuations can be used as the benefit/value accrued to the government.

Sources for Calculation: *Benchmarking from prevalent land rates in the areas surrounding the project area*

Increase in availability of Industrial and Drinking water

Total water available for storage in Kalpasar reservoir is 10,000 MCM at 50% dependability, of which 6568 MCM water is proposed to be allocated for irrigation in the Saurashtra region covering 39 talukas in six coastal districts viz. Bhavnagar (7 talukas), Amreli (3 talukas), Junagadh (12 talukas), Porbandar (3 talukas), Jamnagar (10 talukas) and Rajkot (4 talukas). Details of net-water availability (after accounting for losses) for these three major causes (industry, agriculture, and domestic) are provided in the reports. GT shall estimate the economic benefit generated due to the provision of water for domestic and industrial purposes based on benchmarking of unit cost/MCM of water supply in similar projects.

Sources for Calculation: *Benchmarking from similar projects/studies*

Increase in revenue due to tourism and recreation

Estimation of revenue generation from tourism and recreation would be based on assessment of and benchmarking against similar development work in Gujarat (Statue of Unity etc.) and elsewhere.

The computation of employment generation potential would require an estimate of full capacity employment at steady state and annual incremental phasing of the same. Assuming three categories of employment, skilled ($wage = w_1$), semi-skilled ($wage = w_2$), and daily wage earners ($wage = w_3$). Moreover, these comprise x_1%, x_2%, x_3% of the overall employment generation. Here, $w = w_1 * x_1 + w_2 x_2 + w_3 * x_3$. If 'N' jobs are created in a phase-wise manner over 'n' years, and after that steady state is achieved. Also, the increase in average wage rate to be 'y%' per year. Again the risk of tourism related employment generation can be take as the risk of the project (discount rate of 'r%'). The value created in terms of tourism employment generation can be obtained as follows.

$$PV_{tourism} = N * w[\frac{1}{n} * \frac{(1+y)}{1+r} + \frac{2}{n} * \frac{(1+y)^2}{(1+r)^2} + \cdots + \frac{(1+y)^n}{(1+r)^n} + \frac{(1+y)^n}{(1+r)^n * (r-y)}]$$

The above method is developed based on the inputs from CEPT report (Sec 5).

Any other source of job creation (e.g., industrial and urban development or proposed special investment region) can be suitably considered as per the respective development plans. The discounted cash flow valuation method can be suitably adopted thereafter.

Sources for Calculation: *Benchmarking from similar projects/studies*

Estimation of Indirect Benefits

The approach for estimating the indirect benefits is highlighted below.

Increase in Agri Gross Regional Product (including Fisheries)

The Agri Gross Regional Product would be estimated by benchmarking the unit yield per Hectare in the state and the nation. As per the Social Economic Review of Gujarat 2019-20, the average yield of foodgrains in 2019-20 was ~2.2 tonnes/hectare.

Depending on information obtained on the current yield, variance from mean yield mentioned above and other necessary limiting factors, the same yield with suitable variations would likely be used to estimate the output of the single-yield Agricultural activities.

Output from multi crop yield would be based on market estimates of the proposed (less water intensive) crops to be introduced, adjusted for local conditions.

Sources for Calculation: *Social Economic Review of Gujarat 2021-22; Socio-Economic Survey Report of India 2021-22*

The following assumptions are required to value the incremental cash flow benefits from fishing activity.

The creation of fresh-water reservoir may result in excess reservoir fish yield. (a) The max-yield full development scenario and the number of years in which this full capacity scenario is obtained. (b) Yearly

incremental phasing of increase in reservoir fish. For example, assume total reservoir fish capacity to be 'C' tonnes. This is to be achieved in 'n' years with C/n incremental phasing. After n year onwards the capacity will achieve its steady state value C. (c) Assume per tone reservoir value of fish to be 'R' and a steady growth of g_R year on year in this rate. Again the risk of reservoir fishing can be taken as the risk of the dyke project. Then the present value (PV) of reservoir fish at the end of the year can be computed as

$$PV_{fish} = \frac{C}{n} * \frac{R*(1+g_R)}{1+r} + \frac{2C}{n} * \frac{R*(1+g_R)^2}{(1+r)^2} + \cdots + \frac{C}{1} * \frac{R*(1+g_R)^n}{(1+r)^n} + \frac{C}{1} * \frac{R*(1+g_R)^n}{(1+r)^n*(R-G)}$$; or

$$PV_{fish} = C * R\left(\frac{1}{n} * \frac{(1+g_R)}{1+r} + \frac{2}{n} * \frac{(1+g_R)^2}{(1+r)^2} + \cdots + \frac{(1+g_R)^n}{(1+r)^n} + \frac{(1+g_R)^n}{(1+r)^n*(R-G)}\right) \quad (1)$$

1. Also, assuming direct and indirect employment generation of 'N' and 'N*x' man-days per year per tonne of reservoir fish at wage rate 'w'. Similarly, the increase in wage rate to be 'y%' per year. The value created in terms of employment generation can be obtained as follows.

$$PV_{fishemp} = \frac{C}{n} * \frac{N*(1+x)*w*(1+y)}{1+r} + \frac{2C}{n} * \frac{N*(1+x)*w*(1+y)^2}{(1+r)^2} + \cdots + \frac{C}{1} * \frac{N*(1+x)*w*(1+y)^n}{(1+r)^n} + \frac{C}{1} * \frac{N*(1+x)*w*(1+y)^n}{(1+r)^n*(r-y)}$$; or

$$PV_{fishemp} = C * N * (1+x) * w[\frac{1}{n} * \frac{(1+y)}{1+r} + \frac{2}{n} * \frac{(1+y)^2}{(1+r)^2} + \cdots + \frac{(1+y)^n}{(1+r)^n} + \frac{(1+y)^n}{(1+r)^n*(r-y)}]$$

$$\boldsymbol{Total\ value\ addition = PV_{fish} + PV_{fishemp}}$$

Reduction in siltation along coastal shipping route

As per the approved rates by Superintendent Engineer, Port and Inland Water Department, vide letter dated 01/08/2019, the rate for dredging all types of soils, pebbles, soft rocks, etc. is INR 234 per cum. The same would be considered for the estimation of saving in dredging cost.

Sources for Calculation: *Approved rates by Superintendent Engineer, Port, and Inland Water Department, vide letter dated 01/08/2019 (S. No. 4)*

Reduction in air pollution and Consequent Carbon Credit

Emissions from the transport sector depend mainly on type of transport and fuel apart from type of combustion engine, emission mitigation techniques, maintenance procedures, and vehicle age. The major pollutants emitted from transport are Carbon dioxide (CO_2), Methane (CH_4), Carbon monoxide (CO), Nitrogen oxides (NO_x), Nitrous oxide (N_2O), Sulphur dioxide (SO_2), Non-methane volatile organic compounds (NMVOC), Particulate matter (PM) and Hydrocarbon (HC). Diesel is used in public passenger and cargo vehicles, while private two-wheelers, light motor vehicles (passenger), cars, and jeeps use gasoline. Emission estimates depending on vehicle types are provided in Table 5 (TAS). Reduction in emissions due to distance savings via the Kalpasar Project road are quantified based on the number of vehicles and distance saved in a year per different vehicle type, as follows

$$E_i = 365 * \left(\sum_{j=1}^{J} Veh_{j,wihout\ GKDP} - \sum_{j=1}^{J} Veh_{j,wih\ GKDP}\right) * E_{ijkm}$$

Here, E_i= emission of GHG (i) in tons;

E_{ijkm} = emission of GHG(i) in tons from vehicle type (j) per driven kilometer. Estimates for the project are provided in Table 5-5 (TAS).

As per the research paper on Freight Transportation and Value Chains by Rodrigue J. in 2020, a conventional truck carrying 35 tonnes emits ~0.1 kg/tonne-km of CO_2. The average cost of CO_2 per tonne-km is ~INR 6.7/kg. The same may be used to estimate the reduction in CO_2 emissions in the region.

Sources for Calculation: *Rodrigue, J. P., & Slack, B. (n.d.). Freight Transportation and Value Chains. Retrieved January 2021, from The Geography of Transport Systems*

Additional Employment Generation

The development of the Kalpasar Dyke would likely induce direct employment opportunities. As per the Annual Report of Bhakra Beas Management Board, 2020-21, the Bhakra Dam employs 12,072 people, of which 696 are technical employees (Class-A) whereas others are non-technical employees.

Similar benchmarking would be conducted to estimate the employment generation at the Kalpasar Dyke and the likely cost of their salaries, as per the class-wise benchmarked salaries. This would further factor in SWRF.

Sources for Calculation: *Benchmarking from similar projects/studies*

Improved navigation for coastal shipping

The development of the Kalpasar Dyke would likely provide efficient navigational lights and sound signals for Ro-PAX movements between Ghogha and Hazira during the night. This would lead to increased revenue due to a longer navigation period. The consultant would review the available information to understand the possibility of night navigation for the Ro-PAX movement between Ghogha and Hazira and estimate the additional revenue generated due to the extended service time of the ferries. Quantification of the benefit is possible once the proposed investment (CAPEX and OPEX) and mode (including frequency) of operations are known and it would be limited to the likely impact of incremental coastal shipping due to the proposed development.

Sources for Calculation: *Review of available information*

Negative Impact on Fauna

The development of the Kalpasar Dyke would likely change the composition of the water and negatively transform the ecosystem. According to the National Oceanic and Atmospheric Administration, rising temperatures in dammed waters limit the ability of species of cold-water fish to inhabit them.

During the year 2018-19, total fish production in the Gujarat State was estimated at 8.42 lakh tonnes (6.99 lakh tonnes of Marine fish production and 1.43 lakh tonne of Inland fish production), accounting for a revenue of INR 7,005.14 crore. Marine fish production contributes about 83.03% of the total fish production of the state. During the year 2018-19, through the export of 0.31 MTPA of fish and fish products, the state received foreign exchange earnings of INR 5,202.30 crore.

In a similar case, in Columbia, the construction of the Grand Coulee Dam eliminated a fishery worth USD 0.25 million annually. Almost 30-50% of the anadromous fish habitat in the Columbia basin has submerged due to reservoirs and blocked by dams.

The consultant would benchmark the likely reduction in the marine fishery in similar projects through secondary research to understand to loss of revenue due to fishing.

Sources for Calculation: *Secondary Research*

8 Indicative Methodology for Identifying Non Quantifiable Externalities

Large infrastructure projects generally have numerous benefits, both direct and indirect. That apart, some of these direct / indirect projects can be quantified and others cannot, or, are not quantified.

Generally, quantifiable benefits are those where:

- Investments are required to be made to reap the eventual benefits
- The benedits, so identified, can be quantified in terms of market estimates, or close economic approximations and the net of benefits less the required investments are considered for economic analysis.

For the other benefits, it might be challenging to quantify the financial value. These are considered as externalities that can create both positive benefits as well as have negative consequences. Cost-effectiveness analysis should be used in these situations. It is also likely that some benefits, especially external consequences, may not be measurable outside of the social sectors. Where such effects are significant but impossible to quantify, they should be noted and a qualitative explanation offered.

In so far as the Kalpasar Project is concerned, preliminary analysis outlines the following as externalities that are unlikely to be quantified:

8.1 Projects under the Conceptual Structure Planning of Kalpasar Project

A Conceptual Structure Plan For Gulf of Khambhat Development Project has been submitted by the CEPT University in 2019.

The proposed Structure Plan for Kalpasar Region has the following objectives

- To delineate the area under the influence of Kalpasar Project for the purpose of the comprehensive development
- About 122386 ha (public land between 5-6 and 6-7 contour intervals) of area is likely to be created through the Kalpasar Project, by stabilizing the difference between high and low tide. Suitable utilization of these new/reclaimed/created lands is crucial.
- To induce optimum development for the improvement of regional economy as well as environmental protection
- Region as a Global Hub of Eco Centric development
- To create balanced physical and social infrastructure for sustainable development
- Capitalize on the proposed investments in the study area, through the development of suitable forward and backward linkages
- To enhance the infrastructure facilities for better connectivity of the region in order to achieve faster growth of the study area
- Propose for an institutional structure and legal backing for the Structure Plan

The concept development bases on structuring growth, linking the growth centres, economic development and environmental protection. A detailed analysis of existing trends of growth, infrastructure levels, development hotspots, environmental hotspots were used to understand and design the future growth trends in the region.

- Lakefront zone detailing
- Health city
- Waterfront real estate

- Logistic hub
- Education city
- Green energy research and development center
- Riverfront and tourism development
- Ghogha port redevelopment

We understand that, while these are part of the overall development plans, these projects would entail CAPEX for each of the sub components mentioned above. Therefore, considering economic benefits accruing due to these projects would not be a true and fair representation of quantifiable benefits. Much of the benefits may eventually have to be classified as non quantifiable externalities.

8.2 Impact on Social & Cultural Practices

It's possible that social and cultural behaviours in some of the villages in the Bhavnagar district won't alter significantly. However, due to changes in road connectivity and future industrialization, a significant influx of migrant workers may occur in the villages. Barwada Mosque, Jain Derasars in Ghogha, and Nishkalank Mahadev in Koliyad, among others, could be impacted. A significant part in the social and cultural lives of the villagers is represented by the numerous temples and ashrams found in some villages of the Bhavnagar district. These religious sites are not anticipated to be negatively impacted by the project.

The Barwada Mosque, a mosque built in the seventh century, is in poor shape. The Mosque may need protection measures in the unlikely event of seawater intrusion to preserve this important historical relic. Similar to this, the neighbouring villagers have religious significance for the Nishkalank Mahadev temple, which is submerged in the water near Koliyad beach. To prevent full submersion, the place that is submerged during high tide may need protection.

Similar to this, there are numerous ashrams and temples situated along the Narmada River in the villages on the Bharuch side. The majority of these temples and ashrams are part of the Narmada Parikrama, an annual pilgrimage that includes Ambetha, Jageswar, Luvara, and Vamleswar. The Narmada River's diversion may have an impact on Narmada Parikrama. Religious and cultural customs may shift in the nearby villages of Ambetha and Vamleswar, which are strongly linked to the Parikrama. Depending on how much of an impact these proposed changes would have on religious monuments and cultural customs, alternative alternatives might be taken into consideration.

8.3 Impact on Water Bodies

From the initial analysis, it is expected that there would be certain unquantifiable externalities arising out of the following:

- River Boundaries will change, presently rivers in catchment area are not perennial rivers.
- High Tide Lines and Low Tide Lines (HTL & LTL) will change, the demarcation of CRZ Boundaries and permissible activities under various CRZ Zones requires to be confirmed by GCZMA.
- Red and Blue Line demarcation of Rivers in catchment area required to be redefined.
- Total Water disposal through rivers in catchment area (including monthly pattern thereof) is required to be estimated.
- Total Sewage Generation in Catchment area, Quantity of Treated Sewage (with quality of Treated Sewage) and Quantity of untreated Sewage disposal in catchment area is required to be compiled. Presently all treated and untreated Sewage leading to Bay of Khambhat/Cambay get diluted through Esturine / Marine Disposal system, after the project becomes operational the treated/untreated sewage will get dissipated in the reservoir.

- Total Trade Effluent (Industrial Wastewater) Generation in Catchment area, Quantity of Treated Effluent (with quality of Treated Effluent) and Quantity of untreated Effluent, if any and its disposal in the catchment area is required to be compiled.
- This aspect is also required to be looked into in the context of Final Orders passed by Hon'ble NGT in the case of 673/2018 (AKA Polluted Rivers of India).

8.4 Impact on Institutions & Sociology

- **CSMCRI**: A CSIR Institute having excellent infrastructure, research capabilities and Naval Vessels might become irrelevant on implementation of the proposed project. Its relocation is required to be looked into. Details on similar institutions working on marine and other research and the impact of the proposed project is required to be assessed.
- **Businesses**: Dahej and Vadodara, two of the biggest Industrial hubs of Gujarat thrives on Chlor-Alkali Production by Industries such as GACL (GoG PSU), Reliance, Nirma etc. are dependent on Salt production from the coastal region spread from north of Dahej to Bhavnagar. The industries producing Chlor-Alkali Products, which are essential for Chemicals and other industries, might face short supplies and find challenges to continue their industrial production activities (contributing substantially to GDP).

In order to further analyse the effects, both positive and negative, the following information would be required:

- List of industries currently operating in the region and for whom Consent to Operate was conditional upon the Kalpasar Project. (Since it might not be possible to collate their contingency plans, the effect of possible relocation might be difficult to quantify.)
- List of Ecological (Bird Parks, National Parks etc.), Archaeological and other sensitive areas within 10 KM of project boundary are required to be delineated for appropriate actions there upon.
- The Project will need huge quantities of Construction Materials (Such as Sand, Stone & Aggregates etc.) which will be procured from parts of Gujarat, leading to management of Natural Resources.

9 Deliverables, Timelines and Way Forward

9.1 Deliverables and Timelines

S. No.	Deliverable	Timelines For Submission
1	Submission of Inception report	T + 1 Month
2	Collection of secondary data necessary for conducting the analysis and site visit	T1 + 1 Month
3	Collation and presentation of secondary data to the Authorities; approval from concerned Authorities for further developing financial model	T2 + 1 Month
4	Development of Financial Model	T3 + 1 Month
5	Submission of Draft Report	T4 + 15 Days
6	Submission of Final Report	T5 + 15 Days
	Total	**5 Months**

9.2 Note on Deliverables and Timelines

Note iv. T = 1st August, 2022

Note v. At the Final Phase, GT shall submit a Detailed Report comprising of the complete analysis, observations and recommendations and a short Comprehensive report not more than 20 pages comprising of the major highlights from the Report.

Note vi. In order to maintain the above mentioned timelines, it is expected that the Authorities shall share their inputs and observations with GT within a week of submission of the Reports. In case there is any delay in sharing the same, the timelines are likely to get extended by the extended period.

While the first set of information has been received in two tranches, August 9th, 2022 and August, 17th 2022, GT has made every possible effort to submit the Inception Report reasonably within the Timeline.

9.3 Way Forward

In the next stage, team GT shall review the reports received, interact with other Consultants and conduct necessary site visits to collate information on the following:

- Broad estimates on Project Cost (including sub components e.g. transportation, renewable energy, irrigation, tourism development etc.) and the likely variation
- Project Cost phasing (including sub components mentioned above)
- Opex cost (Skilled, Semi skilled, Unskilled and Administrative Manpower required for maintenance of dyke and associated components, Repair and maintenance costs assumed, Spares, Insurance; similarly for the other components)
- Electricity requirement for operations of the various components forming part of the Project; assessment of sufficiency of the renewable energy for operations of all the sub components
- Updated informaiton on Renewable Energy generation, captive and other uses as discussed in the PMC meeting held on 26th and 27th August, 2022
- Detailed GoG Policy and Action Plan for ensuring conformance of effluent discharge to the rivers, effluent disposal channels, marine disposal facilities and other estuarian discharges in the catchment area which will ultimately feed the fresh water reservoir

- GoG Action Plan, if any, envisaged for introduction of improved irrigation and better cropping systems in the project affected area
- Proposed investment (CAPEX and OPEX) and mode (including frequency) of operations for Ro-PAX movements between Ghogha and Hazira
- Rehabilitation and Resettlement Cost and Plan
- Information, Education and Communications Plan and Cost
- Toll Plaza Based Road Traffic since there are multiple Toll Plazas
- Cost of replanation/ compensatory plantation against the likely loss of flora
- Climate / Air quality
- Geology, Geomorphology and Lithology of the Area
- Topographical information
- Drainage system in the affected area
- Hydrogeology / Hydrology
- Discharge and depth
- Water Availability
- Surface Water Quality
- Groundwater quality
- Hydrobiology
- Soils/Vegetation/Biodiversity including existing benthic biodiversity, floral and faunal endimicity
- Disposal and management mechanism for dredged soil/sediments
- Affected Settlements
- Population/Age
- Ethnic/Religious Compositions
- Housing Pattern
- Means of communication
- Occupational Pattern
- Health Care Facilities and Services
- Housing/Household Energy
- Waste Disposal
- Disease prevalence
- Morbidity/Mortality pattern
- Satellite datasets of Topography, Hydrometeorology, Geomorphology, Soil, Land use Land cover
- List of industries currently operating in the region and for whom Consent to Operate was conditional upon the Kalpasar Project

- List of Ecological (Bird Parks, National Parks etc.), Archaeological and other sensitive areas within 10 Km of project boundary along with shapefiles and/or coordinates of the locations for proper GIS mapping
- Documents related to clearances under the umbrella EPA Act 1986 – such as CRZ Clearance, Forest Clearance, Biodiversity Clearance etc. and status/action plan to understand the cost implications

Basis the information mentioned above, secondary datasets would be generated for eventual use in conducting both the Financial as well as Economic Analysis of the project.