Council for Development and Reconstruction

Greater Beirut Water Supply Augmentation Project Environmental and Social Impact Assessment

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ABBREVIATIONS AND ACRONYMS

AWWA	American Water Works Association
AWW	Arab Water World magazine
BMLWE	Beirut and Mount Lebanon Water Establishment
c.	circa
^{O}C	Degree Celcius
CAS	Central Administration of Statistics
CBO	Community Based Owner
CH_4	Methane
CDR	Council of Development and Reconstruction
CLO	Community Liaison Officer
CO_2	Carbon Dioxide
CoM	Council of Ministers
CN	Curve Number
DBA	Dam Break Analysis
DBO	Design Build Operate
DBOO	Design Build Own Operate
DGA	Directorate General of Antiquities
DO	Dissolved Oxygen
DoA	Directorate of Antiquities
ERP	Emergency Response Procedures
ESIA	Environmental and Social Impact Assessment
EIA	Environmental Impact Assessment
ESMP	Environmental and Social Management Plan
FS	Feasibility Study
GBA	Greater Beirut Area
GBWSAP	Greater Beirut Water Supply Augmentation Project
GBWSP	Greater Beirut Water Supply Project
GHG	Greenhouse Gas
GIS	Geographic Information System
GoL	Government of Lebanon
ha	hectares
IEE	Initial Environmental Examination
ILO	International Labour Organisation
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
IWA	International Water Association
IWRD	Integrated Water Resources Development
km	kilometer
km^2	Square kilometer

LCWMC	Lebanon Centre for Water Management and Conservation
LRA	Litani River Authority
m.a.s.l	meter Above Sea Level
m	meter
m^3	cubic meter
MCE	Maximum Credible Earthquake
MEW	Ministry of Energy and Water
MoE	Ministry of Environment
MoF	Ministry of Finance
MoSA	Ministry of Social Affairs
MPWT	Ministry of Public Works and Transport
MSF	Multi-Stage Flash
N_2O	Nitrous Oxide
NE	North East
NERP	National Emergency Recovery Programme
NGO	Non-Governmental Organisation
NPV	Net Present Value
NWC	National Water Council
NWFP	Non-Wood Forest Product
NWSS	National Water Sector Strategy
OP	Operating Policy
O&M	Operation and Maintenance
PAP	Project Affected Person
PDESIA	Preliminary Draft ESIA
PIC	Project Information Center
PMF	Probable Maximum Flood
PMT	Project Management Team
POE	Panel of Experts
RAP	Resettlement Action Plan
RCC	Roller Compacter Concrete
RO	Reverse Osmosis
RPF	Resettlement Policy Framework
RWE	Regional Water Establishment
RWH	Rainwater Harvesting
s	second
SCS	Soil Conservation Service
SE	South East
SOW	Scope of Work
t	ton
TDS	Total Dissolved Solids
UFW	Unaccounted for Water
USBR	United States Bureau of Reclamation
WB	World Bank
WFP	Wood Forest Product

EXECUTIVE SUMMARY

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Background

To overcome increasing severe shortages in public water supply, the Government of Lebanon (GoL) through the Council for Development and Reconstruction (CDR), the Ministry of Energy and Water (MEW), and the Beirut and Mount Lebanon Water Establishment (BMLWE), has initiated the Greater Beirut Water Supply Augmentation Project (GBWSAP) to identify the most significant environmentally and socially acceptable, technically viable and economically efficient solutions to the medium and long term provision of potable quality water throughout the Greater Beirut Area..

The GBWSAP ESIA has been implemented in two phases. Phase 1 compared dam and non-dam options for water supply augmentation to the Greater Beirut and Mount Lebanon area in the long term and recommended Bisri dam as the Priority Scheme, while in Phase 2 a full Category A ESIA for Bisri dam has been prepared. This report reflects the changes to dam design and area to be expropriated of January 2014. The report has been discussed with stakeholders and has been endorsed by CDR and other agencies involved in implementation of various portions of the ESMP. A draft ESIA was disclosed in country and at the World bank Infoshop on May 30, 2014.

ESIA Process

An environmental and social assessment process is in place to avoid, mitigate and/or compensate those identified potential negative environmental and social impacts.

The environmental and social analytical work and recommendations, all designed in a transparent and collaborative manner has been packaged into two sets of documents:

- The ESA documentation consisting of:

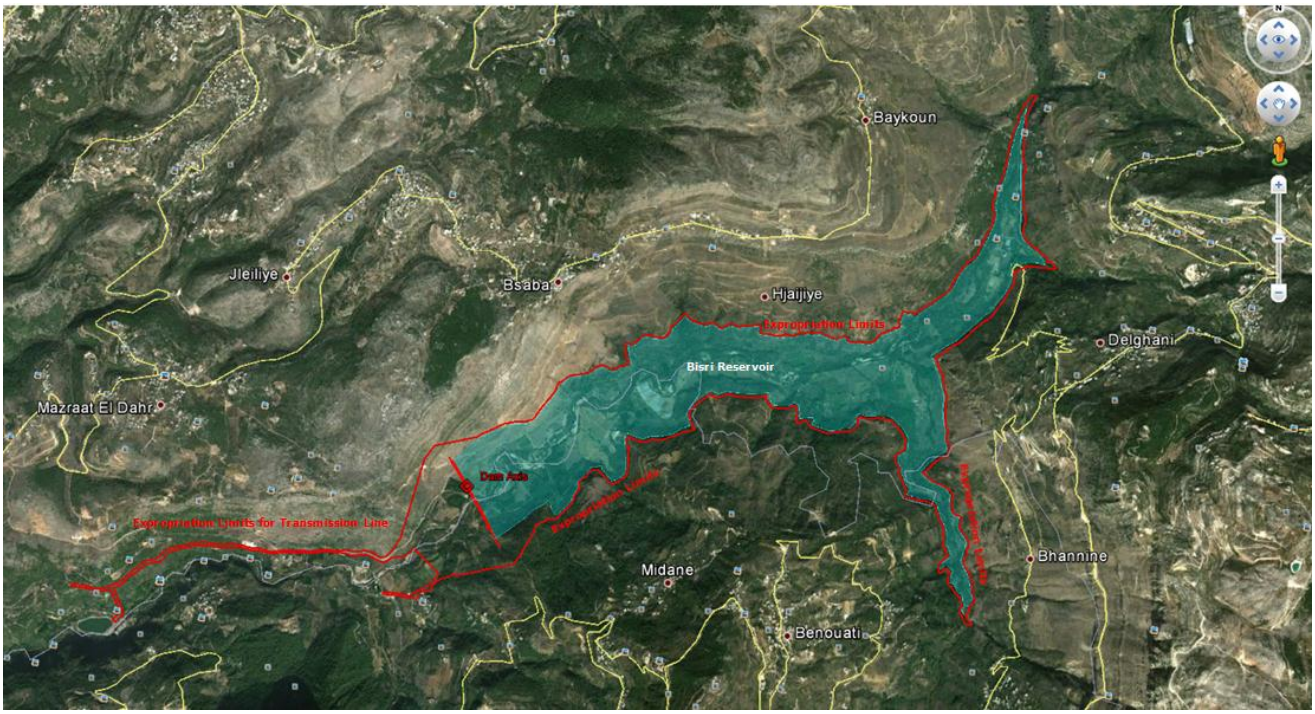
1. Environmental and social impact assessment (ESIA) report – i.e. the present report
2. Its accompanying appendices
    - Appendix A: Bibliography and List of References
    - Appendix B: Dam Design
    - Appendix C: Unofficial translation of Law No 8633 of August 2012, Fundamentals of Environmental Impact Assessment
    - Appendix D: 'Chance Finds' procedure
    - Appendix E: Geological and Geoechnical review report
    - Appendix F: Water quality
    - Appendix G: Ecological Assessment Report
    - Appendix H: Preliminary report of Polish-Lebanese Expedition to the Eshmoun Valley (Wadi Bisri)
    - Appendix I: Benefit Sharing
    - Appendix J: Dam Breach report construction, supervision and quality assurance plan
    - Appendix K: ToR for consultancy services to monitor water quality entering Bisri Reservoir

- Appendix L: Records of Public Consultations

- The Resettlement Action Plan (RAP) for the dam, reservoir, transmission line, and access roads – a separate report

Project Description

The proposed Bisri Dam site on Nahr Bisri is about 15 km inland from the Mediterranean coastline at Saida and 35 km south of central Beirut, at an elevation of c.395 masl. The reservoir extends for about 4 km upstream of the dam axis on Nahr Bisri, as illustrated in the following Figure. The two easterly lobes of Bisri Reservoir formed by Nahr Barouk from the north and Wadi Bhannine where Aari'ye River runs from the south merge at Marj Bisri to form Nahr Bisri, which after a further 5 km merges with Wadi Khallet west of Bisri Village to become Nahr Awali, thereafter continuing to the sea. Above the dam site on Nahr Bisri the surface water catchment area extends to some 215 km^2. At maximum water level 467 masl, the total storage volume of the reservoir is estimated at 116 Mm^3 and the area expected to be inundated at 434 ha.



Bisri Dam, Reservoir and Expropriation Limits

GBWSAP involves the construction and operation of a series of infrastructure, notably:

- The dam and its 256 ha reservoir (excluding the dam footprint),
- A 4 km transmission line connecting the dam to the Awali HEP, and,
- The construction and improvement of several access roads.

While land take will be extensive within the proposed area to be expropriated, some 570 ha, residential properties are few and there are no commercial or industrial premises and no significant public infrastructure or community facilities within the impoundment area. The occupied residential accommodations house seasonal farm workers, mostly non-Lebanese, that will need to be relocated.

Land to be expropriated and inundated on the completion of Bisri Dam is primarily agricultural estimated at 150 ha in addition to pine woodland (82 ha) and natural vegetation (131 ha).

Estimated Costs

The updated design report 2014 estimated the total cost of the dam and associated facilities to be some US$300 million, comprising $220 million contractors' costs, $66 million contingencies, and $10 million for engineering. The construction of the transmission line is estimated at $20 million. The construction cost of the hydropower plant is estimated at $15 million.

Specifically excluded from these costs are the cost of the expansion of the Ouardaniyeh water treatment plant (currently under construction), and onward conveyance for distribution to Greater Beirut, which will be provided under the independent Greater Beirut Water Supply project (GBWSP), currently under implementation The estimated cost of land acquisition, to be covered by GoL, was estimated at $150,228,686 for around 570 ha of land (including inundation area, dam footprint and a 15 m buffer).

Legal, regulatory and institutional framework

Existing Lebanese Legislation

Following Lebanon's reconstruction and development drive after fifteen years of civil unrest and invasion, Lebanon had no alternative but to rely upon external funds granted by international donors such as the European Commission, World Bank and unilateral donors for whom projects had to be environmentally assessed as a prerequisite for funding.

Subsequently, Draft Decree No. 444 of 2002 defined the binding principles to which all public and private projects are subject in evaluating the impacts projects have on the environment. In accordance with Article 23, all projects are required to undergo an Environmental Assessment, for which the regulatory authority is the Ministry of Environment (MoE). The Draft Decree was eventually passed in August 2012, during the currency of the present project, becoming Decree No 8633, Fundamentals of Environmental Impact Assessment.

Triggered World Bank Safeguard Policies

In accordance with CDR policy, the Assessment complies with the structure and guidelines of World Bank Operating Policy 4.01 Environmental Impact Assessment for a Category A Project, as well as with the requirements of the Lebanese Ministry of Environment, as

recently formalized in Decree No. 8633 of August 2012. Five of the WB Safeguard Policies are triggered by GBWSAP, these are: Environmental Assessment, Natural Habitats, Physical Cultural Resources, Involuntary Resettlement and Safety of Dams:

Environmental Assessment (OP/BP 4.01): The project will have significant and irreversible environmental impacts. Phase I of the ESIA has thus been prepared as a comparative study between the different alternatives considered to identify the priority option based on an environmental, social, economic and technical assessment. Based on the findings of the alternatives analysis, Bisri Dam was selected as the Priority Scheme for long term water supply augmentation to the Greater Beirut area. An ESIA and an ESMP have subsequently been prepared, following OP/BP 4.01 guidance for category A projects.

Natural Habitats (OP/BP 4.04): The project will have significant impacts on natural habitats, both during construction and operation of the dam. A detailed assessment has been carried out to draw the ecological profile of the area, assess flora and fauna diversity, and to identify those species endangered or IUCN-listed that are at added risk from the Project. In line with OP/BP 4.04, a Biodiversity Management Action Plan has subsequently been proposed, building on the results of the detailed ecological survey.

The construction of Bisri dam and its associated structures, in addition to the creation of the reservoir, will cause both loss and alteration of natural habitats, with resulting impacts on ecology and biodiversity. The presence of the reservoir will transform riparian riverine habitats into lacustrine habitats with both adverse and beneficial effects. The reservoir will reduce habitats for wildlife species that require flowing water but attract those adapted to still or slower-moving waters such as waterfowl.

Beneficial effects will also arise from the habitats presented by the reservoir and new biological communities will establish themselves over time.

Physical Cultural Resources (OP/BP 4.11): The significance and extent of archaeological, historic and recent cultural heritage throughout the Bisri project area is a crucial issue. While there is much overlap between the archaeological and cultural, measures to be undertaken to rescue and preserve the various cultural heritage components, each of these have been addressed separately, with the Directorate General of Antiquities (DGA) and the Maronite Diocese of Saida respectively.

The DGA will carry out archaeological investigations and rescue excavation in accordance with their policies and procedures and in collaboration with the University of Warsaw. These mitigation measures shall be funded by the project as required by OP/BP 4.01 and are included in the cost estimates of dam construction. A detailed Cultural Heritage Plan (including a Chance find Procedure to be adopted during construction and maintenance of the main infrastructure works as a sub-component of the ESMP) is further detailed in the draft ESIA.

Heritage preservation, as distinct from archaeological rescue, is primarily concerned with the relocation of Mar Moussa Church, St. Sophia's Monastery and architectural salvage from some of the old ruined houses throughout the valley. Meetings have been held with the Bishop of the Maronite Archdiocese of Saida, the Church's architectural advisors, the head of Mazraat El Dahr municipality and the priest responsible for Mar Moussa. Repeated walkovers have identified four potential Mar Moussa relocation sites four potential sites. The most appropriate site has been agreed with stakeholders (including the Maronite Church) and arrangements made for the full expropriation of the land as detailed in the RAP. Present responsibilities must, however, extend to provision of a storage area within which to retain excavated material from Marj Bisri and elsewhere pending its re-erection as and when DGA determine.

Similarly, the DGA has agreed the need for rescue archaeology and the time frame proposed in the ESIA. In accordance with its normal internal procedures, it will review the situation and make arrangements to implement its responsibilities under Lebanese law once the Loan Agreement and Project Appraisal Document have been ratified by a Decree of the Council of Ministers. CDR and DGA have agreed that DGA will appoint a team of qualified archaeology specialists to undertake the rescue archaeology, with costs of hiring these appointed experts to be borne by the project. The cost of rescue works are included in the dam works contract. A Physical Cultural Resources Plan is provided in the appendix.

Involuntary Resettlement (OP/BP 4.12): GBWSAP is expected to have direct and indirect social impacts in its area of influence and beyond. Consistent with WB safeguards policies, OP/BP 4.12 was triggered and social mitigation plans identified. A Resettlement Action Plan by broad categories of works (dam and reservoir, power plant and transmission line, access roads) was prepared to mitigate, offset, reduce negative impacts and strengthen positive impacts on the communities in the Project area. The resettlement recommendations are discussed in the RAP, which is a separate document.

Safety of Dams (OP/BP 4.37): A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. The dam breach report includes an Emergency Action Plan with details of implementation. Dam Safety Plans either issued to date or under preparation include:

- Construction Supervision and Quality Assurance Plan;
- Instrumentation Plan;
- Operation and Maintenance Plan; and,
- Emergency Preparedness Plan.

ANALYSIS OF ALTERNATIVES

A comprehensive comparative analysis of the economic, social, technical and environmental aspects of potential solutions to the augmentation of Greater Beirut's long-term water supply has been carried out, the full details of which were presented in the Preliminary Draft ESIA. The GBWSAP ESIA has investigated a range of alternatives; non-dam alternatives, dam alternatives, in addition to the 'Do Nothing' or 'Without Project' alternative. Non-dam alternatives that have been considered are desalination, ground water, rainwater harvesting, wastewater reuse and reduction in 'Unaccounted for Water'. The Table below summarizes the major advantages and/or setbacks that may facilitate or deter these solutions from being realistically achieved for the long-term supply of potable water to Greater Beirut.

Summary of Potential Non-Dam Alternative Sources

Source	Advantages	Disadvantages	Conclusion
Desalination	• Plentiful and sustainable resources; • Could supply whole GBA demand; • Technically reliable; • Independent of Climate.	• Utilises an Industrial process; • Only 40% of intake to supply; • High construction cost; • Substantial coastal land take; • High energy and O&M costs; • Marine environment damaged by brine;	Highly feasible, but very expensive. For current consideration, the 'Source of Last Resort'
Ground Water	• Most discharge to supply; • Suitable for conjunctive-use; • Better quality than surface water; • Diverse source locations; • Modest carbon footprint.	• Limited future use due to over-exploitation • Resources currently ill-defined; • Probably insufficient to supply GBA alone; • Recharge climate-dependent; • Substantial energy costs.	Resources remain to be quantified but at minimum will significantly contribute to conjunctive use with a dam alternative alternative but with limited volumes to be used in the future
Rainwater Harvesting	• Basic technology; • Local sources; • Low carbon footprint.	• Short wet season; • Ill-suited to high-rise urban areas; • Climate dependent; • Poor public perception.	At best, it will contribute to household or compound non-potable water use.
Wastewater Reuse	• Source origin within GBA; • Source generally sustainable; • Majority of technology already required for best management practice.	• High treatment costs; • Lack of technical expertise; • Insufficient resources to meet GBA demand; • Very poor public perception and confessional objection.	Strong cultural objections. At best can supply substantial quantities of non-potable water for landscape irrigation, etc.
Reduction in UfW	• Optimises existing system efficiency and cost-recovery; • Promotes Best Management Practice.	• Requires political will, legal reform and judicial support; • Requires public cooperation; • Leakage unlikely to be <25%.	Should be pursued as is economically viable. Will not reduce the need for new source development.

Based on the above, desalination, albeit it technically, economically and politically the 'Source of Last Resort', is the only non-dam alternative capable of sustaining long term water supplies to Greater Beirut, but at the highest cost. The significant limitations in the Lebanese energy sector currently also impede the development of desalination as an economically feasible alternative.

The ESIA also considered three dam sites other than Bisri dam, all of which are included in the Ministry of Energy and Water's National Surface Storage Strategy; these are dam sites at Damour on Nahr Damour (two sites) and at Janneh on Nahr Ibrahim. Based on the comparative analysis, CDR has opted for Bisri dam being the priority scheme. The advantages and disadvantages of each are summarised in the following Table.

Summary of Potential Dam Alternatives

Scheme	Advantages	Disadvantages	Conclusion
Bisri	• High storage volume that meets GBA demands to 2030 or longer; • Utilises GBWSP transmission, treatment and storage facilities at limited additional cost; • Reservoir floor underlain by low permeability deposits; • Little or no pumping costs; • Lowest cost per unit volume delivered to GBA;	• Most land take is productive land; • Historic and cultural remains at risk; • High sedimentation risks to be mitigated; • High seismic risk to be mitigated.	Bisri dam is the only site that will supply GBA demand over an appreciable period of time with cost effective investment. Nevertheless; additional studies into reservoir geology, water tightness, seismic and sedimentation risks are needed prior to detailed design. Preference for the present dam axis location should be confirmed. These studies have been completed as part of the finalization of the detailed design of Bisri dam.
Damour West	• Land take mostly non-productive; • Favorable dam-site morphology in V shape; • Might utilise some GBWSP facilities.	• Small storage capacity; • Unlikely to sustain significant hydropower; • New treatment plant required otherwise additional conveyances costs; • Significant pumping costs.	Water storage is substantially less than at Bisri or Damour East, and dam site geology is less favoured. Any dam here should have a reduced water level to limit lateral leakage and/or be part of a conjunctive use scheme with ground water.

Scheme	Advantages	Disadvantages	Conclusion
Damour East	• Dam site geology better than at Damour West; • Favorable dam-site morphology in V shape; • High storage volume that meets GBA demands to 2030 or longer.	• High lateral leakage; • New treatment plant required, otherwise additional conveyance costs; • Significant costs to treat the J6 permeable strata; • Significant pumping costs; • Subject to block collapse from reservoir cliffs.	Notwithstanding; the high storage volume and the relatively better site-dam geology than Damour West, this scheme raises serious concerns about the potential excessive lateral leakage.
Janneh	• High flow rates, reservoir readily replenished each spring. • Favorable dam-site morphology in V shape; • High Potential of hydropower generation.	• Most land take is natural landscape; • Located on highly permeable strata, hence leakage likely to be substantial; • New treatment plant and transmission line required; • Highest cost per unit volume delivered to GBA.	As a stand-alone dam Janneh will only meet GBA short term needs. Janneh dam is thus best suited to serve the northern areas of the Greater Beirut and Mount Lebanon region. Futher investigations need to be carried out to address the concerns about dam and reservoir geology and water tightness.

Based on the above, the following conclusions can be drawn:

- Given its size, cost effectiveness, and all combined favorable geological settings, Bisri Dam is considered the priority option.
- Janneh Dam could be constructed in phases, catering on short term for Jbeil and Kesrwane needs.
- The first years of construction of Bisri and Janneh Dams will allow for a more in depth study about the feasibility of Damour West Dam, the outcome of which should indicate the way forward either to proceed with Damour West Dam or to advance with the Damour East from a feasibility study into a detailed design. In all cases Damour proposed Dams with their reduced volumes could be compensated by possible conjunctive use with ground water from underlying aquifers.

Environmental and Social Baseline Conditions

Climate

Air temperature combined with relative humidity and wind are the major determinants of how much water will evaporate from the surface of the reservoir. Being topographically part of the region that lies between the coastal strip and the western mountains, the Bisri project area site affords all the climatic features of a transitional microclimate that unfolds for hot and humid summers at the proposed location for the dam axis to less humid and mild

summers at the extremities of the proposed impoundment. The five winter months are generally characterized by abundant rains with cool temperatures at the dam site, and severe winters with more precipitation in form of snow, which contributes over time to the replenishment of the mountains springs, with their water heads, extending between the Barouk and Jezzine mountains.

The highest evaporative demands occur during the six dry months from April to August, with a peak in July, when the reservoir is expected to reach its full storage capacity and start delivering water to GBA.

Landscape

The landscape consists mainly of wild plantations, cedar trees in Barouk Mountain, oak and pine forests in Jezzine, Bkassine, and the Upper Chouf, in addition to woodland varieties, farmland and natural scrubby bush vegetation. The plant cover is important for controlling erosion and landslip, promotes aquifer recharge and boosts carbon sequestration.

Landuse

Land to be expropriated and inundated on the completion of Bisri Dam is presently utilised as shown in the Table below.

Current Land Use within Expropriated Area

Landuse	Approximate Area - ha	% of Total Expropriation
Open Field/Fallow	148	26%
Natural Vegetation	131	23%
River Bed and Bankside Vegetation	105	18%
Open Land	99	17%
Pine Woodland	82	14%
Polytunnels	4	0.7%
Built-up Area	1	0.2%

Geology

The Bisri Dam catchment area encompasses a geological sequence extending from the Jurassic Kesrouane Limestone (J4) in the higher mountainous areas through the intervening formations to the Cretaceous Sannine Limestone (C4) and the recent Quaternary alluvial and fluvial deposits exposed along the course of the Bisri river and continuing downstream of the dam site.

Cultural Heritage

From the available records of the 2004 and 2005 field seasons carried out by a Polish-Lebanese mission, a total of 78 sites were identified, of which 27 fall within the area of expropriation for the Bisri project and a further 10 sites are within 100 m of the expropriation boundary. The sites identified at Bisri represent almost the full span of human history, from Paleolithic times prior to 8,300 years BCE through to the present day.

Close to the confluence between Nahr Barouk and 'Aariye', now more commonly known as Wadi Bhannine, lies the temple of Marj Bisri believed to be connected with the Temple of Ashmoun, also known as Bustan El Sheikh, in the Lower Awali Valley, dating back to the 7th Century BC.

Today, the visible remains of Marj Bisri are limited to four black granite columns, perhaps the entrance to the main temple, and several large dressed stone blocks exposed in the nearby river bank, believed to be the wall of the Temenos, the sacred area surrounding the temple. Pottery sherds of both Roman and Persian origin have been found in the vicinity and it is assumed the buried remains of other buildings and at least a small village will also be present. No comprehensive archaeological surveys of Marj Bisri, neither of another suspected temple site downstream, have been completed, although very preliminary investigations without excavation have been undertaken by the Polish Centre for Mediterranean Archaeology at the University of Warsaw working in conjunction with the University of Balamand.

Of particular significance as witnesses to the relatively recent cultural heritage of the area are the sites of mar Moussa El Habchi Church and the remains of St. Sophia's Monastery, located very close to each other a short distance upstream of the proposed dam axis. The future of the church is an emotive issue for many Mazraat El Dahr residents. Because access is limited to an unmetalled track that is rough and untended, services are no longer held other than on Mar Moussa Day, 28th August, each year. As a result of these critical issues pertaining to cultural heritage, a detailed Cultural Heritage Management Plan, provided in Appendix I and the ESMP reflects arrangements to address these structures, as agreed with relevant GoL counterparts.

Surface Water Quality

Water quality analyses from Nahr Bisri and its tributaries show that the level of treatment required to bring water into compliance with Lebanese and international drinking water standards is afforded by a conventional treatment stream. However, of the organophosphorous pesticides, minute quantities of Lindane and Dieldrin in concentrations marginally above the limit of detection were present in two samples. Since both these substances are banned by the 2001 Stockholm Convention on Persistent Organic Pollutants (POPs), to which Lebanon is a signatory, the source is not immediately obvious. It is therefore recommended that the projectoversees a programme of monitoring to confirm the continued presence of pesticide residues and check for any additional substances

detrimental to health that may arise. This aspect will be sub-contracted to a qualified consulting firm which will report to MoE, the objective of which will be to monitor the presence of polluting substances present in surface water courses draining to the reservoir area and to investigate their sources of origin.

ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

GBWSAP area of influence is defined at two levels: the immediate surroundings of the project's infrastructure works for direct, indirect and induced impacts on the one hand and a substantial area, that extends beyond the direct vicinity of the Project itself. The critical area of influence is the reservoir area and the lower catchment whereby it is impacted by the construction activities as well as the changes that will occur resulting from dam operation, direct or indirect impacts upon which affected communities' livelihoods are dependent. The upper catchment will impact the environment mainly by what it discharges into the reservoir basin. The critical GBWSAP area of influence extends from the sources of Barouk and Aariye Rivers till the outlet of the Awali River on the coast, covering the agricultural plains downstream of the dam and the villages residing in this area.

GBSWAP area of influence also follows the life cycle of the dam construction material which will be sourced from quarries within the reservoir area. The final suitability of all borrow areas will be determined by the appointed contractor. Wastes will be disposed of at licensed sites. The location of construction camps for workers is more likely to be within the valley subject to areas to be protected such as Marj Bisri. GBWSAP area of influence also encompasses Mar Moussa Church relocation, migration routes for wildlife, and induced development, to finally reaching water supply for GBA users.

Main Environmental Impacts

Erosion and Sedimentation

A major significance of erosion and sedimentation is that it imparts a progressive decrease in reservoir storage, albeit this reduction is primarily in dead storage rather than operational storage. The reservoir has been designed to accommodate 9 million m^3 of sediment within 50 years operation. This will be provided for by 'dead storage' capacity, the volume that can fill with sediment without impacting the normal operation of the dam.

To minimize sedimentation and the loss of capacity and sediment build-up at the dam, it is important to promote reforestation and soil conservation in the upper catchment and around the periphery of the reservoir, and also to monitor reservoir depth to assess sedimentation. The development of wetland on the main contributing watercourses as well as a reforestation scheme in the upper catchment will reduce sediment load.

Biodiversity and Habitats

Dam construction will result in the direct loss of riparian habitats and natural vegetation within recognised fragile and vulnerable ecological zones. This however, must be balanced

against the new shoreline habitats that favour the colonization of tree species on the banks of the reservoir.

For native fish fauna, artificial barriers across rivers constitute one of the major factors threatening their population in the Mediterranean region, blocking or delaying upstream fish migration. Impacts on fish are considered to be moderate to minor at Bisri dam site, but some mitigation measures should be taken to maintain fish populations downstream of the dam and to allow the passage for migratory fish so to protect spawning grounds. The construction of Bisri dam will significantly reduce water flow downstream, which will definitely affect the freshwater blenny population surviving in the lower course of the river.

Bisri dam will have direct impacts on reptile and amphibian habitats, both upstream and downstream of the dam, which will include disruption to habitats and/or breeding sites, reducing sources of food, and increasing vulnerability to predators.

Species with poor swimming ability may become stranded and prevented from interacting with mainland populations, particularly for breeding, and make them more vulnerable to illegal hunting. Other species may be positively affected by newly created habitats.

The upper level of the reservoir approaches the lower reaches of the Moukhtara River where there are populations of rare *Bufo cf bufo*, whose habitat appears to consist mostly of rocky terrain and riparian trees, some of which will be inundated.

The presence of a large body of standing water may disrupt the flyways of migratory soaring raptor species, as they will be deprived of thermal air currents necessary for soaring and saving energy during migration.

Mammals will adapt and adjust their behaviour, despite any permanent obstructions to their previous dispersal routes, after dam construction is completed. The reservoir may attract species such as bats and otters. Smaller mammals such as shrews and squirrels will tend to have smaller home ranges, and will therefore be susceptible to both habitat loss and fragmentation. Larger or more mobile species are less likely to experience significant habitat loss, albeit habitat fragmentation.

A preliminary Biodiversity Management Plan has been proposed in the draft ESIA and describes the mitigating measures, costs and responsibilities of the impacts described above. The biodiversity baseline, conservation management actions and mitigation have been generally identified and reflected in the Biodiversity Management Plan. The biodiversity specialist team described in the Biodiversity Management Plan section will develop a biodiversity monitoring plan to monitor biodiversity and habitat management, the results of which will inform the project on the level of degradation to the sensitive habitats and the presence of any direct or indirect activities/actions potentially degrading these habitats especially as it relates to the identified endangered species of fish (namely the blenny freshwater fish). To supplement the management/mitigation measures, the biodiversity monitoring plan will include surveys that will take place during pre-construction,

construction and operational phases of the project. These surveys will measure indicators that include but are not limited to: water quality, environmental flow volume and quality, number of target species as well as numbers of indicator species, and cumulative impacts within the upstream watershed. Supplemental details to the biodiversity management plan will be included in a revised version of the ESIA.

Consumption of Materials

The consumption of materials for construction will be significant and is estimated at approximately 6 million $m^{3.}$ However all granular materials and rock products are expected to be sourced from within the reservoir site. The exception may be riprap, which because of block size and rock quality specifications may need to be sourced externally. All water consumed on site is likely to be taken from the river and given appropriate treatment prior to use.

Nearly 6 million m^3 of earth materials are expected to be consumed in the construction of Bisri Dam. The majority of these materials – building aggregate, sand and clay, are expected to be taken from temporary borrow areas within and adjacent to the area of inundation, as near as is practically possible to the construction site, thereby significantly reducing reliance on quarries.

Water and Power Supplies

Based on discussions with the designer, the proposed Bisri dam water releases will be allocated securing 5.1 m^3/s or 5.8 m^3/s for the domestic needs to Greater Beirut and 0.3 m^3/s and 0.45 m^3/s for the environmental flow to be maintained downstream the dam, in summer and winter respectively.

The production of approximately 11.2 MW hydroelectric power, is considered a "by-product" of the dam releases and as such will not be considered as consumptive usage.

Reservoir Stratification

The anticipated conditions at Bisri – cold high-volume inflows from spring snow melt and warm low-volume inflows throughout the summer and autumn – are likely to result in the stratification of the reservoir. Failure to identify and control it frequently poses major problems for water service companies and may compromise the effectiveness of water treatment streams, the meeting of water quality standards and consumer expectation, and the adequacy of environmental flow releases.

Typically, and to be expected at Bisri, stratification becomes more severe during the summer months when the intensity and duration of sunlight increases and mixing due to reservoir inflow decreases; thus coinciding with the main period of Bisri operations. Hence a greater proportion of the reservoir turns anaerobic and in consequence minerals such as manganese, iron, sulphides and arsenic are released from bottom sediments, phosphorous and ammonia may be released. The downstream water treatment plant at Ouardaniyeh

(currently under implementation under the parallel and independent Greater Beirut Water Supply Project), has been designed to take these issues into consideration.

Dam Safety

A major contribution to dam safety is the formulation of Dam Safety Plans based on Dam Breach modelling and inundation analysis undertaken by the dam designer. Often referred to as Dam Break Analysis or DBA, this primarily hydrological modelling exercise is standard procedure in dam design and provides for (i) the evaluation of design performance, including the sizing of emergency spillways, and (ii) the development of regional and community Emergency Preparedness Plans.

Because of the steep V-shaped configuration of the valley in its middle sections between the dam and the coast, the most affected villages in the path of a dam breach flood by either seismic loading or flood failures are Bisri and Khirbet Bisri a short distance downstream of the dam, and Aalmane and Quastani a short distance inland from the coast.

Detailed dam safety plans are in an advanced stage of preparation. The Quality Assurance and Construction Supervision (CSQA) plan will be finalized by appraisal as required by OP/BP 4.37.

Advisory Panel

The Advisory Panel is composed of two panels: the Dam Safety Panel and the Environmental and Social Panel.

The role of the Dam Safety Panel is to advise on all critical aspects of the dam; its appurtenant structures, its catchment areas, the surrounding and downstream areas. It is also usually in charge with oversight of project formulation, technical design, construction procedures, and associated works such as power facilities, river diversion during construction, fish ladders, etc. The Dam Safety Panel was appointed in early October 2013 and will remain under contract to CDR until the first fill of the reservoir.

The Environmental and Social Panel will provide independent review of, and guidance on the environmental and social issues associated with the planning, design, construction and operation of Bisri Dam and its appurtenant structures. The Panel will assess the extent to which the Bisri project complies with World Bank safeguards procedures.

Main Social Impacts

Construction will result in the loss of productive land estimated to extend to some 150 ha, about 25% of the area to be taken. The braided river bed and natural bankside vegetation occupies 105 ha, with built-up areas; farm buildings, housing and heritage, making up less than 1%. The remaining area is primarily uncultivated natural vegetation on the bottomlands away from the river and generally open land and scrub on the lower valley slopes. The number of built-up structures to be inundated is estimated at 135 over a total number of 88 plots with a total area of around 1.0 ha. The majority are already abandoned (some derelict) or only provide seasonal accommodation for agricultural labourers.

Land take will also occur for other project activities and associated infrastructure like the distribution lines and access roads leading to the conveyor. These have been incorporated into the final plans for expropriation.

The total number of individual plots of land, identified from available cadastral mapping, is currently identified to be about 966, split between the various cadastral regions as shown in the Table below.

Extent of Land Take within the Reservoir Area

Casa	Cadastral Region	No. of Plots	No. of plots totally expropriated	No. of plots partially expropriated	Expropriated Area (ha)	% Area Expropriated
CHOUF	Bsaba	9	5	4	6.8	1.3%
	Mazraat El Chouf	277	225	52	120	23%
	Mazraat El Dahr	55	36	19	42	8%
	Aamatour	310	279	31	160	31%
	Bater	14	6	8	8.8	2%
	Sub-Total	665	551	114	338	65%
JEZZINE	Bisri	74	62	12	44	9%
	Bkassine	2	0	2	0.3	0.1%
	Benouati	27	19	8	4	0.8%
	Ghbatiyeh	4	1	3	6	1.2%
	Harf	69	64	5	46	9%
	Aariye	1	0	1	0.95	0.2%
	Bhannine	28	15	13	10	2%
	Midane	80	70	10	48	9%
	Deir-el-Mkhaless	3	0	3	2	0.4%
	Khirbit Bisri	13	4	9	18	3%
	Sub-Total	301	235	66	179	35%
Expropriation Grand Total		966	786	180	517	100%
Domaine Publique (river + roads)					53	
Total Land take					**570**	

Benefit Sharing Program

To ensure an equitable distribution of Project benefits, the project will establish a Benefit Sharing Program to provide the means to improve community services on the surrounding hills and throughout the dam catchment and the local environment. This shall be carried out initially through the capital funds available for the project (as reflected in the RAP budget), later through continued revenue from primary beneficiaries which are the GBA consumers. Capacity building will be ongoing to mitigate the project's environmental and social risks and to ensure inclusive communication with all project stakeholders.

Induced Development

Given the relative uniqueness of the Bisri scheme and its proximity to urban centres such as Beirut and Saida, visitor attraction may be expected will commence soon after the start of construction. The precursor to induced development may therefore be coffee vans and refreshment trucks, with existing cafés, petrol stations and other services in Bisri and villages en-route from the highway catering for the influx.

On the overlooking hillsides the demand for land on which to construct villas, apartment blocks, hotels, hill resorts and restaurants, all with access roads and public infrastructure will be extensive. While these may also occupy shoreline plots, waterside land is more likely to induce smaller water sport focused accommodation, camping and picnic sites, bathing areas, shoreline walkways and cycle tracks, boat rental and repair yards, yacht and canoe clubs. In addition to visitor and recreational activities, the reservoir will also afford the opportunity to expand local irrigated agriculture and develop water-based commercial enterprises.

Induced development will only impart positive environmental and social impacts if it complies with a well formulated and agreed Master Plan. If development is not planned and piecemeal, or certain political and/or commercial interests are allowed to violate the Plan, the results may be entirely negative.

GBSWAP *Cumulative Impacts*

The cumulative impacts assessment focuses on the interaction of the Project and developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could directly impact on the project area of influence. The Table below is a matrix showing those incremental impacts with some existing developments and others proposed.

Cumulative Impacts on Selected VECs

		Existing and Proposed Projects			
VECs	**Parameters**	**GBWSP**	**HEPs (Joun, Awali, and Anan)**	**Sewerage Treatment Schemes**	**Reforestation Scheme**
Water	*Water Abstraction*	0	0	0	0
	Water Quality	+	0	+	+
	Flow Rate	+	0	0	+
	Domestic Water Supply	+	0	0	0
Air	*Greenhouse Gases*	0	-	+	+
Power	*Power Supply*	0	+	0	0
Land Use	*Land Cover*	0	0	0	+
	Reservoir Sedimentation	0	0	0	+
Habitats and Wildlife	*Species Diversity*	0	0	0	+
	Species Population	0	0	0	+
Public Health	*Health Costs*	+	+	+	+

+ Positive Cumulative Impact
- Negative Cumulative Impact
0 No Cumulative Impact

The Table below summarises the impacts that might accrue from Bisri dam and the mitigation measures proposed for each impact, while the table that follows summarizes the estimated costs. The total cost of implementing the ESMP is about 137 million USD: comprising 132 million USD for mitigation measures, 2.2 million USD for monitoring, 2.6 million USD for monitoring reporting and 192,000 USD for capacity building. A significant portion of the ESMP costs are included in the anticipated works contract.

Summary of Potential Impacts Arising from the Bisri Scheme

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
Land Take	Land taken for dam and reservoir, access roads	Unavoidable	Major	Locate reservoir to minimize land take and loss of natural landscape per unit volume impoundment.	Designer
	Loss of natural landscape	Expected	Moderate		
	Land take for `resettlement and/or relocation of PAPs	Unavoidable	Minor	Locate reservoir to minimize land take per unit volume impoundment. Provide adequate resettlement and compensation in accordance with RPF and RAP compliant with Lebanese Law.	Designer, RAP Developer and Project Proponent
	Loss of existing communities	Not Expected	n/a		
	Loss of individual homes	Unavoidable	Moderate		
	Loss of non-agricultural business premises	Not Expected	n/a		
	Loss of productive land	Unavoidable	Major		
	Loss of temporary employment	Unavoidable	Major		
	Loss of permanent employment	Expected	Moderate		
	Loss of historic and cultural heritage	Unavoidable	Major	Salvage cultural property and reconstruct within existing communities. Avoid inundation of immoveable sites such as burial grounds. Undertake rescue archaeology.	Project Proponent
Impoundment	Additional loss and severance of access	Expected	Moderate	Create alternative access roads around the reservoir;	Project Proponent
	Increased risk of seismicity	Expected	Major	Analyze hydraulic loading to assess seismic potential and avoid areas of high risk. Design to minimise seismic loading.	Designer
	Loss of natural vegetation	Unavoidable	Moderate	Increase planting around reservoir;	Designer
	Impaired water quality from uncleared vegetation	Unavoidable	Major	Vegetation and soil to be cleared prior to inundation. Treatment plant will provide suitable process stream to ensure water delivered to GBA of potable quality.	Contractor

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	GHGs from uncleared vegetation	Expected	Major	Vegetation and soil to be cleared prior to inundation.	Contractor
	Soil erosion along new foreshores	Expected	Major	Construct shoreline protection. Increase planting around reservoir.	Designer and Contractor
	Reservoir stratification	Expected	Major	Install provision for mechanical mixing where natural circulation insufficient.	Designer
Sedimentation	Creation of backwaters on tributary streams	Expected	Moderate	Promote development of wetlands. Promote reforestation of upper catchment slopes. Monitor reservoir depth to assess sedimentation. Operate reservoir to minimize sediment build-up. Allow for sediment loading in structural design.	Designer and Operator
	Loss of capacity and sediment build-up at dam	Expected	Moderate		
Upper Watershed Management	Road construction opens area to non-residents	Expected	Minor	Ban land clearance for new agriculture. Restrict access to previously remote areas.	Project Proponent
	Soil Erosion and Sedimentation	Expected	Moderate	Promote reforestation of upper catchment slopes and the expansion of existing forests.	Project Proponent
	Social unrest due to the restriction of human activity	Not Expected	n/a	Ensure new developments prioritize local employment.	Project Proponent and Contractor
	Loss of water quality due to evaporation	Unavoidable	Major	Promote shoreline planting and reforestation.	Operator
	Impaired water quality due to discharges above dam	Expected	Moderate	Adopt an integrated planning framework and a strict ESMP, and provide effective enforcement. Developing sewerage and solid wastes systems for villages throughout the upper watershed in accordance to GoL master Plans.	Project Proponent
Lower Watershed Management	Reduced non-agricultural surface water resources	Unavoidable	Moderate	Provide agricultural extension and other services to promote low water-use crops and irrigation practices. Ensure resettled communities are adequately resourced without detriment to existing communities.	Project Proponent
	Reduced water resources for existing agriculture	Unavoidable	Moderate		
	Water-use conflict	Expected	Moderate		
	Loss of stock watering points	Not Expected	n/a	None required	

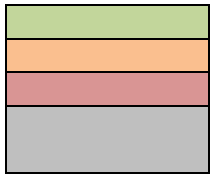
Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Salinization of downstream floodplain	Expected	Moderate	Provide adequate compensatory flows to leach salt build-up.	Project Proponent
	Reduced dilution of chemical residues, sewage	Expected	Moderate		
	Reduced Dissolved Oxygen downstream	Expected	Moderate	Provide for multi-level releases to avoid the discharge of anoxic water. Design for aeration downstream of dam site;	Designer
	Scour by water released under increased head	Expected	Minor	Provide for energy dissipation from dam outflow; Provide for sediment trap and its orderly release.	Designer
Ground Water	Reverse ground water flow upstream of the dam	Expected	Moderate	Undertake hydrogeological study and modelling to assess impact on ground water levels and flow;	Designer
	Change in water table	Expected	Moderate		
	Reduced downstream aquifer recharge	Expected	Moderate	Provide adequate releases to maintain recharge; Provide downstream structures to induce shallow recharge.	Designer and Operator
	Deterioration in ground water quality	Expected	Major	Promote ground water resources management.	Project Proponent
Biodiversity and Habitats	Loss of indigenous flora	Unavoidable	Moderate	Promote the colonization of shoreline trees. Provide for species rescue and relocation. Minimize disturbance of non-inundated vegetation.	Operator
	Loss of terrestrial habitats	Unavoidable	Moderate	Provide mammal-resistant fencing. Provide for species rescue and relocation. Provision safe crossing points to enable dispersal and links between fragmented populations.	Operator and Project Proponent
	Reduced downstream biodiversity	Expected	Moderate	Provide compensatory discharges to maintain downstream biodiversity.	Operator
	Build-up of weed and algal mats around spillways, etc.	Expected	Moderate	Control algal blooms by using appropriate additives (e.g. 22 kg/ha $CuSO_4$). Harvest weed and algal growth for compost, fodder or biogas.	Operator

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Disruption of flyways	Expected	Minor	Planting trees to create habitat corridors; National hunting ban to be enforced as per Law 580/04.	Operator
	Reduced aquatic habitats	Expected	Major	Provide fish leats, ladders and other by-passes. Protect spawning grounds; Incorporate sensitive design, i.e. allow shallow areas for spawning, etc.	Designer
	Barrier to fish migration and loss of spawning areas	Expected	Moderate		Designer
	New habitats for migratory bird species	Expected	Positive	Promote reforestation and areas of dense shrub.	Operator
	New farming fish species	Expected	Positive	Ban the introduction of exotic species such as trout, bass, tilapias, and mosquito fish. Promote the user of native species.	Operator
Agriculture	Inundation of agricultural land	Unavoidable	Major	Consider stripping highly fertile soils from reservoir area and spreading on adjacent less fertile land.	Project Proponent and Contractor
	Loss of fertile soils	Unavoidable	Major		
	Loss of yet-to-be-harvested crops	Unavoidable	Major	Consider relocating the poly-tunnels and their content with no actual loss, or move when fallow.	Project Proponent
	Derogation of downstream irrigation	Unavoidable	Major	Use agricultural extension to promote low water-use crops species and irrigation practices.	Operator
	Fertilizer use upstream increases nutrient load	Expected	Moderate		
	Increased soil salinity downstream	Expected	Major	Provide compensatory discharge to leach soil salts.	Operator
Settlement and Resettlement	All residents in the inundated area will be displaced	Unavoidable	Moderate	Provide adequate compensation in accordance with RAP.	Project Proponent
	Disaggregation of communities	Not Expected	n/a	No significant communities to disaggregate. Resettlement unlikely to result in conflict as resident Lebanese PAPs will keep within their previous communities.	
	Impact on indigenous groups/lifestyles	n/a	n/a		
	Social conflict between existing residents and PAPs	Not Expected	n/a		
	Competition for resources between residents & PAPs	Not Expected	n/a	None required.	

Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Particular impacts on vulnerable groups	Expected	Moderate	Provide social support to vulnerable groups. Use resettlement to aid poverty alleviation.	Project Proponent
Public Health	Increase in water-related diseases	Major	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Maintain water free of algae. Develop and implement an Emergency Response Procedures.	Operator
	Increase in mosquito breeding sites	Major	Moderate	Implement health awareness campaigns and provide adequate health care facilities. Spray mosquito breeding sites if necessary.	Operator
	Climatic changes such as increased humidity & fogs	Expected	Moderate	None.	
	HV transmission lines in proximity to housing	Not Expected	n/a	Power generated at dam to be used at dam. New turbines for network distribution to be located at existing plant will utilise existing cableways.	
Indirect Issues	Negative impacts from increased urban development	Expected	Moderate	Adherence to coordinated sustainable development via Shoreline Development Master Plan.	Project Proponent
	Upper catchment activities limit dam efficiency	Expected	Moderate	Restrict activities on the upper watershed to those that have minimal environmental and social impact.	Project Proponent
Construction Issues	Construction site unsightliness	Expected	Moderate	Construction contractors to offer priority employment to PAPs and other local residents; Contractor to develop and implement a comprehensive Construction Environmental and Social Management Plan.	Contractor
	Increase traffic generation and exhaust emissions	Expected	Moderate		
	Noise and dust from site clearance and excavation	Expected	Moderate		
	Temporary works such as drainage diversion	Unavoidable	Moderate		
	Camp working area sewage and solid waste disposal	Expected	Moderate		
	Emissions from batching plants & power generators	Expected	Moderate		
	Increased hunting, egg collecting, live capture	Expected	Moderate		
	Social conflict between workers and residents	Expected	Minor		Contractor

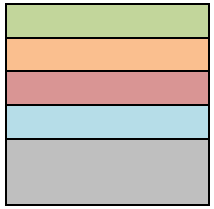
Issue	Potential Impact	Likelihood	Likely Severity	Mitigation Measures	Responsible Party
	Importation of contagious diseases	Expected	Minor		
	Fuel spillage and waste oil disposal	Expected	Moderate		

Likelihood



Not Expected
Expected
Unavoidable
Not Applicable

Likely Severity



Minor
Moderate
Major
Positive
Not Applicable

Summary of Proposed Environmental and Social Impact Mitigation Measures Costs

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
Land Take and Resettlement	Archaeological rescue and safe storage of artifacts	DGA and Project Proponent	Consultant's estimates with storage site acquisition, clearance, fencing and buildings	$0.5
	Relocation of Mar Moussa Church, St. Sophia's Monastery, and architectural salvage	Maronite Diocese of Saida and Project Proponent	Deconstruction and reassembly of main walls, demolition and replacement of church interior vaulting. Included in construction costs.	$2.0
Impoundment	Increase planting around reservoir.	Operator and MoA	Tree band 12 m wide, planted on a 3 m grid, over half the reservoir periphery	$3.0
	Design and install provision for mechanical mixing where natural circulation insufficient.	Designer and Contractor	Included in construction costs	n/a
Sedimentation	Promote development of wetlands.	Operator	Promotion budget only	$0.1
	Promote reforestation of upper catchment slopes	MoA and Municipalities	Promotion budget only	Included above
Upper Watershed Management	Promote reforestation of upper catchment slopes and the expansion of existing forests.	As above	Promotion budget only	Included above
	Adopt integrated planning, a strict ESMP, and effective enforcement.	GOL, DGUP, Project Proponent & Municipalities	Of wider benefit that GBWSAP and should come from GOL budget	n/a
	Develop sewerage and solid wastes systems for villages throughout the upper watershed.	Project Proponent, MEW, and Municipalities	various documents supplied by CDR	$23
Lower Watershed Management	Design and provide for multi-level releases to avoid the discharge of anoxic water, and for downstream aeration.	Designer and Contractor	Included in construction costs.	n/a
	Design and provide for energy dissipation from dam outflow and sediment trap	Designer and Contractor	Included in construction costs.	n/a
Biodiversity and Habitats	Biodiversity Management Plan	Mitigation Activities and specialist staff.	Biodiversity specialist and species specialist part-time for pre-construction, construction and reservoir filling.	$0.7
Agriculture	Provide agricultural extension to promote low water-use crops species and irrigation practices.	MoA and MEW	Extension office for 2 years, with vehicle, admin support, etc.	$0.5
	Provide compensatory discharge to leach soil salts.	Operator	Included in construction costs	n/a
Public Health and Safety	Implement health awareness and water safety campaigns.	MoH and Operator	Awareness and safety campaigns	$0.2

Issue	Mitigation Measures	Responsible Party	Basis of Cost	Estimated Cost (million $)
	Spray mosquito breeding sites if necessary.	Operator	Operator, protective clothing, water-safe chemicals, labour, 3 applications/year	$2.0
	Provide for Public Safety at dam site	Designer, Contractor and Operator	Fencing and signage (Included in construction costs)	n/a
	Develop and implement an Emergency Response Procedures.	Designer, Operator, Civil Defense and Municipalities	Included in GOL costs	$1.0
Construction Issues	Contractor to develop and execute a comprehensive Construction Environmental and Social Management.	Project Proponent, Contractor and Construction Manager	Included in construction costs. 'Best Practice' construction only.	n/a
Total Costs of Mitigation beyond normal Design, Construction and Operation				c. $34.5

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The proposed programme of environmental and social monitoring is summarized in the Table below.

Environmental Quality Monitoring Requirements

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
Pre-Construction Environmental Quality Monitoring										
Surface Water Quality	Lebanese Potable Water Standards	4 locations; Nahr Barouk and Wadi Bhannine at extremities of reservoir, two other seasonal inflows	Water sampling and full laboratory analysis	Ongoing until completion of construction and throughtout operations	Quarterly, varied to include high and low flows	To confirm background conditions for comparison in operational monitoring	Experienced surface water sampler	BMLWE	US$1,500 per sample	US$330,000 (including staff costs)
Rate of Sedimentation	Volume and size of sediment captured	Nahr Barouk and Wadi Bhannine at extremities of reservoir	Sediment capture behind a small weir or sediment capture pit	Ongoing	Quarterly, varied to include high and low flows	To confirm design assumption	Hydrologist	BMLWE	US$15,000 per site	US$600,000
Biodiversity Management	Observation and rate of capture. Adaption to relocation	Reservoir area and site of relocation	Visual observation	Ongoing until completion of construction	Seasonally	To determine extent of rescue and make sure implementation strategy is implemented	Ecological surveyor	CDR	US$667,000	US$667,000
Rescue Archeology and Heritage Relocation	Archaeological finds unearthed and documented	Marj Bisri	Excavation, observation and documentation	Ongoing until completion of construction	Seasonally	To make sure implementation strategy is implemented	Archaeologist	DGA	US$ 500,000	US$ 500,000
	Structures removed and reconstruction	Mar Moussa	Dismantling and reassembling	Prior to construction	Monthly	To address community concern for heritage	Building conservationist	DGA	US$ 2,000,000	US$ 2,000,000
Land Expropriation and Resettlement	Progress of expropriation execution. PAP satisfaction	All lands to be acquired under the project	Expropriation and resettlement reporting	Throughout expropriation	Monthly for 6-months, then bi-annually.	To monitor progress and ensure transparency	Community Liaison Office	CDR	Included in Expropriation costs	-
Construction Environmental Quality Monitoring										
Site Inspection	General construction activity	All sites associated with the Bisri construction	Visual and descriptive, against check list	Ongoing throughout period of construction	Daily	To ensure compliance with good construction practice and EMP	Environmentalist with construction site experience	Construction Manager	US$ 200,000	US$ 200,000
Complaint Investigation	Any parameter relevant to the nature of the complaint	At or in the vicinity of sites for which complaints are received	As appropriate for the parameter being monitored	As necessary	As necessary	To investigate complaints and provide a basis for redress	Environmentalist with experience of field monitoring and analysis	Contractor and Construction Manager	Depends on complaints received	-

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
Health and Safety	Absence of unauthorized public. Injuries and work days lost among workers.	All sites of construction and project related activity	Primarily visual and descriptive, against a check list. Time card records	Ongoing throughout period of construction	Monthly	To protect the public and workers in accordance with H&S BMPs	Experienced H&S site supervisor	Contractor and Construction Manager	Included in construction costs	-
Air Quality	Lebanese atmospheric emissions standards, fixed and mobile	Contractors' work sites and selected sensitive receptors	Visual assessment and portable air quality equipment	Dependent on source	On suspicion of non-compliance	To prevent air pollution	Site inspector	Contractor	Included in construction costs	-
Noise	Lebanese ambient noise standards	At selected sensitive receptors	Ambient noise monitoring equipment of approved manufacture	Over 1 hour during the working day	On suspicion of non-compliance	To prevent noise nuisance	Site inspector	Contractor	Included in construction costs	-
Cultural Heritage	Documented Chance Finds	Any unknown remains unearthed during construction	DGA standard procedures	As necessary	Every find DGA deem worthy of recording	To improve understanding of Lebanese and optimise relic recovery	DGA Inspector	Contractor and DGA	Depends on number of finds and delay caused	-
Post-Construction Environmental Quality Monitoring										
Air Quality	Stack emissions from stand-by generators	At stacks and sensitive receptors	Portable stack insertion monitors and other monitors	Over 12 hours	Every 3 months during the operating season	To prevent air pollution	Plant Engineer	BMLWE	US$ 500 per sample	US$ 5,000
Workers Health and Safety	No. of accidents and working days lost	On the dam and reservoir sites	H&S records	Ongoing	Ongoing	To monitor compliance with Operator's H&S Manual.	Operator's Health and Safety Inspector	BMLWE	Included in ongoing O&M	-
Public Health and Safety	No. of accidents and injuries.	Dam, reservoir and environs	Accident reports	Ongoing	Ongoing	Promote security and safety, and adequacy of signage.	Compliance with Operator's H&S Manual and EMP.	Compliance with Operator's H&S Manual and EMP.	Included in ongoing O&M	-
Dam Safety	Dam Safety Panel inspection reports	Dam site	Visual inspection and review of Dam Safety File	Ongoing	Throughout construction and every 3-5 years, post construction	To identify early warning signs of potential failure	Dam Safety Inspection Panel	BMLWE/CDR	US$ 25,000 per inspection	US$ 25,000
Reservoir water	To check development of stratification	2 fixed sampling points within reservoir	Multiple depth sampling and on-site analyses	Seasonal	Monthly from May to October	To confirm adequacy of mixing to limit stratification	Experienced water sampler and boatman	BMLWE	US$1,000 per sample	US$ 30,000
Groundwater	Groundwater flow and water quality	Selected springs and wells	- Flow gauging, water level monitoring and sampling	Ongoing	Bi-annual	To identify changes in groundwater regime	Hydrogeologist	BMLWE	US$ 3,000 per sample	US$ 30,000
Biodiversity	Diversity of species and habitats	Dam, reservoir and environs	Visual observation and survey	Seasonal	Annually for 3 years, then every 5 years	To assess fish migration and reduced biodiversity	Ecological team	BMLWE	US$ 20,000	US$ 20,000
Downstream abstraction	Adequacy of environmental flows	Downstream abstraction sites	Survey of abstractors	During Autumn	Annually	Optimise abstraction management	Agriculture extension officer	MoA/MEW	US$ 10,000	US$ 50,000
Reservoir Sedimentation	Sediment build up	Reservoir	Depth or Echo sounding	Ongoing	Annually, in May or June	To check loss of dead storage and protect	Mechanical Engineer and Boatman	BMLWE	US$ 10,000	US$ 50,000

Category	Indicators	Location	Method	Duration	Frequency	Purpose	Expertise Required	Responsibility	Estimated Cost	Total Estimated Costs
						intakes				
Induced Development	Adherence to Shoreline Master Plan	Surrounding lands	Enforcement of planning regulation	Ongoing	Ongoing	Safeguard investment in dam and protect water resources	Development inspector	Planning Authorities and Municipalities	No cost to project	-
Total Monitoring Costs										**US$ 4,507,000**

Note: Total Costs are calculated for 5 years of operation

Summary of Environmental Monitoring Reporting and Costs

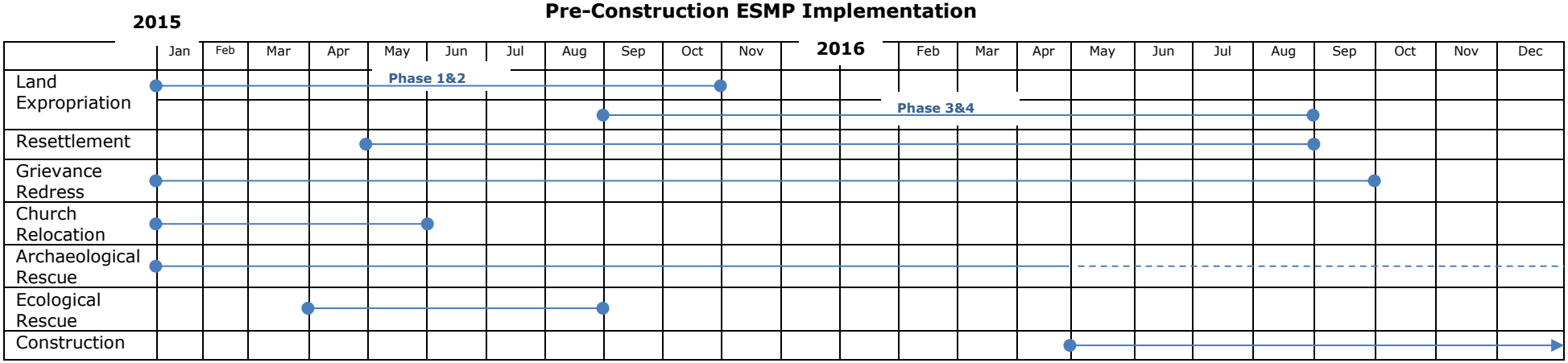
Activity	Reports	Implementation Structure	Estimated Costs	Total Estimated Costs	Budget Assignment
Site Inspections	Individual Visit Reports Summary Reports every 6 months	CM reporting to CDR	150,000$	150,000$	CM budget
Environmental Quality Monitoring	Quarterly Reports	CM reporting to CDR,and MOE	Pre-Construction 50,000$/year Construction 50,000$/year Post-Construction 30,000$/year	Pre-Construction 400,000$ Construction 1,000,000$/year Post-Construction 500,000$/year	CM EMP Budget
Monitoring by Construction Manager	Included in Monthly Construction Progress Reports	CM to CDR	Included in contract supervision	-	CM Budget
Bi-Annual Environmental Reporting	Bi-Annual Reports during construction	CM reporting to CDR and MoE	30,000$/year	300,000$	To CM EMP budget
Land Acquisition Monitoring	In accordance with RAP implementation requirements	CDR and Independent Monitor reporting to GOL and FA	Included in RAP implementation costs		To CDR RAP budget
Operational Reporting	Internal BMLWE Reports	BMLWE reporting to MEW	20,000$/ year	100,000$	To BMLWE Budget
Environmental Auditing	Annual Audit of operational EMP implementation	MOE reporting to MEW and BMLWE	20,000$/year	100,000$	To MOE budget in agreement with CDR
Total Monitoring Reporting Costs				2,650,000$	

Note: Total costs are calculated for 5 years of operation

ESMP Planned Implementation

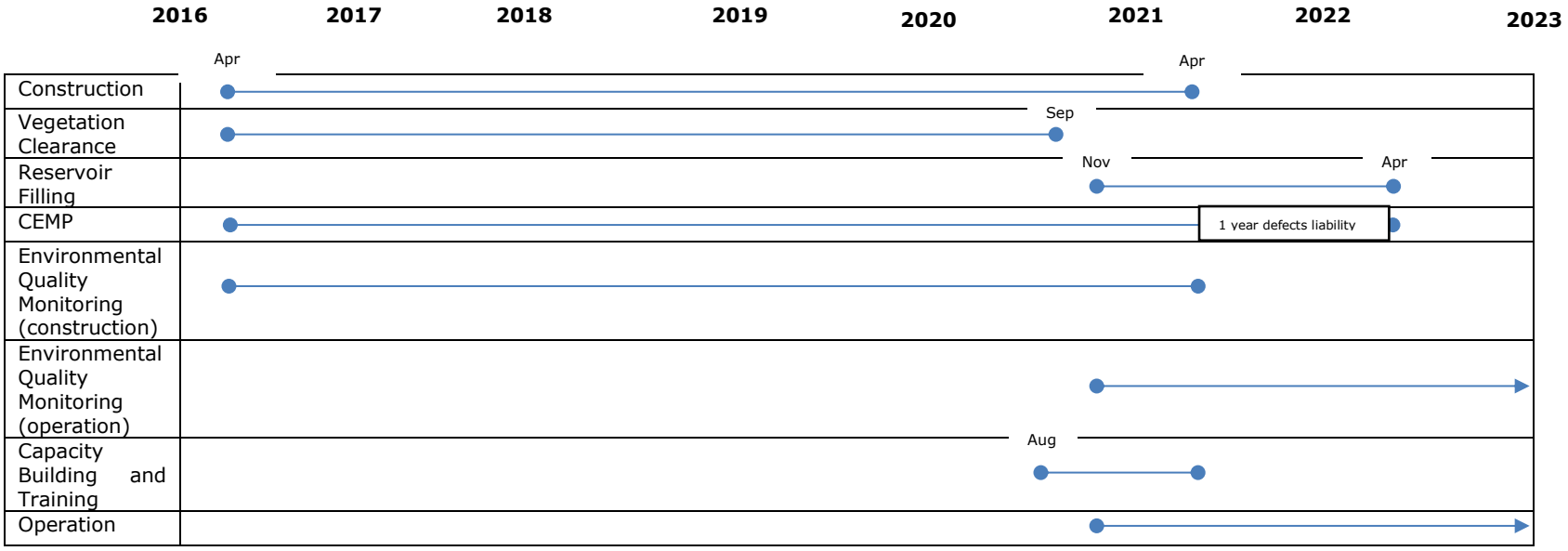
The following Tables show the proposed schedule for the implementation of the ESMP pre-construction, during construction, and during operation.

Pre-Construction ESMP Implementation



*Final Project Approval (Day Zero)

Construction and Operation ESMP Implementation



Institutional Structure and Responsibilities

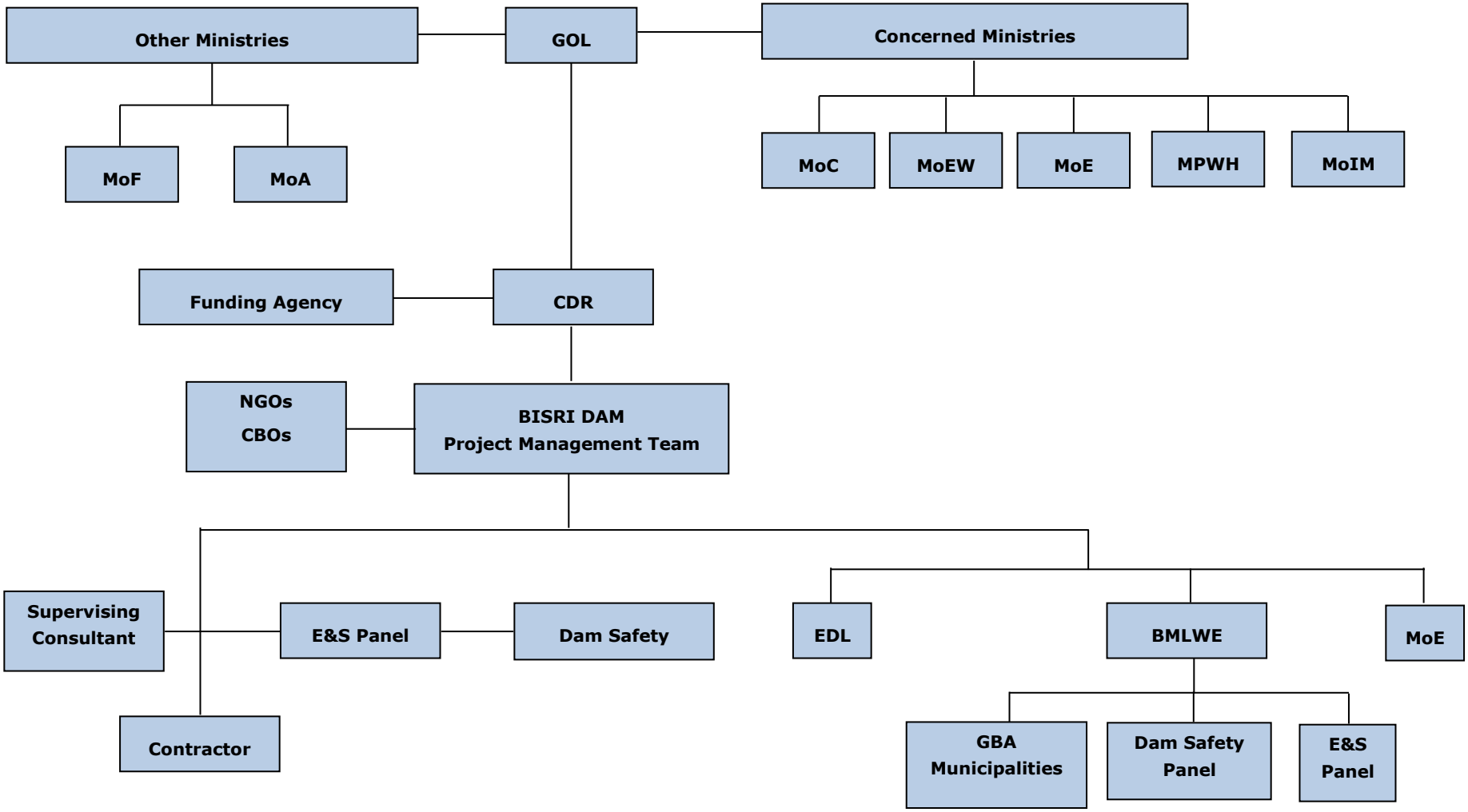
The prime institutional stakeholders in respect of expected management structure and responsibilities are shown in the Figure and Table below, respectively.

Prime Institutional Stakeholders for Bisri Dam Management

Institution	Prime Responsibilities
CDR	In its planning role, commissions specialist studies and dam design, secures funding, pre-qualifies contractors and manages the tender process through to award, executes land acquisition, and on behalf of GoL acts as the contract administrator.
MOEW	The effective dam owner; establishes operational policy including determining available yields and environmental releases. Ensures formal Dam Safety Panel inspections are undertaken according to pre-agreed schedules, in coordination with CDR.
BMLWE	Day-to-day operational management of the dam and its appurtenances, implements MEW policy, ensures environmental yields are delivered to riparian owners. Maintains the dam, the reservoir shoreline and operational monitoring. Facilitates dam safety and E&S panel inspection visits. Responsible for public safety including the maintenance of warning signage. Manages structures and water resources downstream of the offtake upstream of the Joun power plant to the Awali Conveyor, the treatment plant, post-treatment distribution, leakage reduction, cost billing, etc.
MoE	Setting and monitoring the adequacy of environmental flow releases to cater for non-abstraction requirements. A *statutory consultee* for the Dam Safety Panel. As existing laws, shoreline development environmental permitting.
EDL	Purchase the hydropower output and sell it on customers at a rate that at least ensures cost recovery.
MPWT	Implements the Bisri Reservoir Shoreline Development Master Plan.
MoA	Puts in place agricultural extension services to maximise the efficiency of downstream irrigation practices for minimum water use. Advises MEW on the adequacy of releases to maintain legal abstractions. Advises the dam operators on the permitting of commercial fish farming within the reservoir.
LRA	Manages the two hydropower plants ancitipated through the Bisri project to offset lost hydropower at the Charles Helou power plant.

Institution	Prime Responsibilities
DGA	Collection of pottery shards, glass and other artifacts from surface soils and shallow excavations at previously identified sites; Trial pitting and/or geophysical surveying at selected sites where buried structures may be present; Major excavation and the removal of material at Marg Bisri Roman temple; Excavations in the vicinity of Mar Moussa Church and the remains of St. Sophia's monastery. Archaeological finds unearthed and documented during construction
Diocese of Saida	Deconstruction, removal and reconstruction of Mar Moussa Church and of St. Sophia's Monastery; and, Scavenging old building materials from the ruins of 19-20th century houses to provide for new construction adjoining the relocated Mar Moussa Church.
Concerned Municipalities	Implementation of Land Expropriation Procedure
MoSA	Implementation of the RAP especially regarding refugees registered at the UNHCR
UNHCR	Assist the 79 registered UN refugees (as per the date of the project cut off date on March 20, 2014 – see RAP for details) with resettlement to UNHCR designated refugees camps if they are willing to. Facilitate the other 23 non-registered refugees to get registered with the UNHCR and eventually assist them with their resettlement to refugees' camps.

Institutional Structure for Bisri Dam Management



CAPACITY BUILDING AND TRAINING

Bisri dam will require a substantial programme of capacity building, provided through (i) the new employment of suitably qualified managers and maintenance staff, (ii) training schemes for selected existing staff, and (iii) the subcontracting of selected services, or indeed the overall management of the dam and reservoir pending the building of in-house capacity.

As part of the construction contract, it will be important for MEW and BMLWE staff to be seconded to the teams of both the contractor and construction manager to receive hands-on knowledge and experience of the equipment and apparatus installed. Selected operations staff proposed for supervisory positions should be given the opportunity to visit and receive detailed briefing, including hands-on training, at dams of similar size and purpose outside Lebanon.

While the Ministry of Agriculture (MOA) already provides extension services, the consensus among agriculturalists is that it does not provide the level of expertise required to optimise farming efficiencies. Capacity building of staff in respect of modern low water-use crop species and irrigation equipment and practices is therefore likely to be required.

It is important to note that the ESMP in this document incorporating all sub-components including mitigation and monitoring measures reflects the final design. The Church relocation will be undertaken by the contractor and capacity building for chance finds will be included in general HSE briefings to staff.

Total cost of capacity building and training is estimated at $ 192,000.

Total Costs of the ESMP Implementation

The Table below summarizes the total costs of the ESMP implementation assigned for mitigation measures, monitoring, monitoring reporting, and capacity building.

Table Error! No text of specified style in document**.1: Total Costs of ESMP Implementation**

Mitigation Measures	$34,500,000
Monitoring	$ 4,507,000
Monitoring Reporting	$2,650,000
Capacity Building	$ 192,000
Total Costs of ESMP Implementation	**$ 41,849,000**

CONSULTATION AND COMMUNICATIONS

In accordance with CDR policy on public participation, which generally follows that of the World Bank and other international funding agencies, a Consultations and Communications

Programme (C&CP) detailing the steps that are to be followed throughout the project, from site selection through to commissioning has been drafted.

From the beginning of the Project and throughout the ESIA process, institutional stakeholders have been consulted at scoping and briefing levels as described below. Additional discussions have been carried out with MoE, DGA and Maronite Diocese of Saida to reach agreement on specific issues including water quality monitoring, Mar Moussa church relocation, and archaeological recue, described in the ESIA.

At the outset of the EIA process, a series of Scoping sessions then followed by collaborative and information meetings during April and May 2012, commencing with an institutional stakeholders session at the CDR offices in Central Beirut to which stakeholder ministries, government agencies and NGOs were invited. This was followed by a consultation session held at Mazraat El Dahr Municipality in the vicinity of Bisri dam. Finally, two separate sessions were held for Beirut residents, the prime GBWSAP beneficiaries.

The safeguards (ESIA and RAP) consultant presented the results and recommendations of the ESIA study in different venues for institutional stakeholders, for local PAPs in the villages in the vicinity of the proposed Bisri dam, and for Greater Beirut residents. The date and timing of all meetings were agreed with individual municipalities. The village sessions were scheduled at weekends and early evening's week-day for Beirut Water Consumers to allow the maximum number of concerned people to attend.

Following revisions to the ESIA and RAP consequential upon changes to Dam design, land expropriations requirements, completion of the household survey and the establishment of indicative costs, further sessions of public consultation were in April 2014. The following table summarizes all public consultations carried since the beginning of the Project.

Date	Location	Time	Venue	Attendees
2012				
3 April 2012	Beirut	10am	CDR	Institutional Stakeholders
10 April	Mazraat El Dahr	10am	Mazraat El Dahr Municipality	PAPs
24 April	Hadat	10 am	Hadat Municipality	Water consumers of Greater Beirut Area
5 May	Beirut	10am	Beirut Municipality	Water Consumers of Central Beirut
2013				
30 January	Beirut	10am	CDR	Institutional

				Stakeholders
2 February	Midane	10am	Midane Municipality	PAPs
2 February	Mazraat El Dahr	3.30pm	Mazraat El Dahr Municipality	PAPs
6 February	Hadat	5pm	Hadat Municipality	Water consumers of Greater Beirut Area
9 February	Ammatour	10am	Ammatour Municipality	PAPs
9 February	Mazraat El Chouf	2:30pm	Mazraat El Chouf Municipality	PAPs
2014				
Friday 25 April	Ammatour	10.00am	Dar Ammatour	PAPs
	Mazraat El Chouf	3.00 pm	Municipality Hall	PAPs
Saturday 26 April	Bisri	10.00am	Church Hall	PAPs
	Mazraat El Dahr	3.00 pm	Municipality Hall	PAPs

The objectives and benefits of the Project including induced development in the area and the possibility of establishing a Benefit Sharing Program have been presented and explained to the audience. Main environmental and social impacts and mitigation measures were highlighted. The details of expropriation procedure along with compensation entitlements have also been explained. The overall attitude of all four audiences was strongly opposed to the construction of Bisri Dam. As was always anticipated, the majority of comments raised from the floor concerned land expropriation and asset compensation.

Main issues raised by PAPs in the four villages included: (i) need to allocate water and power generated by Bisri dam to neighboring villages and account for irrigation needs, (ii) benefit of project should go to villagers not GBA residents to encourage them to stay in their villages, (iii) loss of productive land and biodiversity, (iv) cash compensation is not enough especially that land has an inheritance value to landowners, (v) PAPs want to get involved in property valuation, (vi) municipalities should benefit from Bisri dam revenues and get yearly compensation to invest in development in neighboring villages, (vii) need for access roads to villages, (viii) need to relocate historical and archaeological remains, (ix) study desalination as an alternative, (x) need to study risk of seismicity, (xi) need for wastewater treatment schemes in villages in the upper catchment, (xii) surface water quality, (xiii) pesticide residues in water, (xix) vector-borne diseases and bad odors in the Project area, (xx) increased water salinity and impact on agriculture and residents, (xxi)

possibility of creating several ponds instead of a large dam, (xxii) possibility of passing a law for the establishment of a company for Bisri dam similar to Solidere where landowners are shareholders, (xxiii) relocate the proposed dam axis.

CDR will continue consultations throughout the period of land expropriation and beyond from a Project Information Centre (PIC). The ESIA and the RAP will be disclosed in and will be followed by disclosure at the World Bank's *Infoshop.*