

Greater Beirut Water Supply Project (P103063)
Study of Project Cost Estimates, Financial and Economic Analyses

I. Introduction and Summary of Conclusions

By terms of reference dated March 14, 2011, the consultant¹ was asked to assess whether the project cost estimates and the financial and economic analyses for the Greater Beirut Water Supply Project (GBWSP) comply with the requirements of Operational Manual Statement (OMS) 2.20 (Project Appraisal) and Operational Policy (OP) 10.04 (Economic Evaluation of Investment Operations). The assessment was based on documents in the project file, other World Bank documents, and discussions with the project team.

Project costing, financial analysis, and economic analysis have overlapping but somewhat different demands under the OMS and OP. Each is addressed in this paper in turn.

Conclusions

- **The overall review concludes that, in general, the Bank team responded appropriately to the requirements of the OMS and the OP.** Gaps do exist, but they do not affect the conclusion of the project appraisal document (PAD) that **the project**, as structured against the constraint of available resources, **provides the least-cost solution for increasing potable public water supply to residents in the project area within Greater Beirut.**
- **The review confirms the team’s decision to support the Awali option.** However, the team could have more systematically documented their work. For example, they supplied this reviewer with all of the background material they had used to determine which of the available raw water supply options met the project development objective (PDO) at least cost. The analysis would have been simpler if the team had written up their options analysis and it had been available in the project files.
- **The project has less room for cost overruns or benefit delays than originally envisioned.** The project costing assessment found that the financial analysis significantly overstated the project’s incremental energy costs, so utility net revenues are likely to be much stronger than originally estimated. On the other hand, after the reclassification of some investment, operations and maintenance (O&M), and rehabilitation costs, the economic analysis was found to have overestimated the project’s expected net present value (NPV), which is closer to \$40 million than to the \$100 million originally estimated.

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II. Project Cost

The review finds that the appraisal team established the adequacy of the investment cost estimates, as required by OMS 2.20. However, operating costs were significantly overestimated at appraisal.

In assessing whether project costs conform to the requirements of OMS 2.20, particularly those in section B, “Technical Aspects,” the assessment relied on the PAD, mission aide-memoires, discussions with the project team, and Bank- and client-commissioned consultant reports.

The OMS (paras. 18, 20) requires that the project appraisal “render a judgment...on the adequacy of the cost estimates,” for both investment and operating costs; and also “ascertain whether sufficient allowance has been included for physical contingencies, for changes in the general level of costs during the implementation period, for working capital, etc.” The OMS also requires that the project appraisal determine whether costs have been broken down to allow identification of the main physical elements. The OMS notes that preparation should be sufficiently advanced by the date of Board presentation so that “implementation can start shortly after loan approval.”

- In accordance with the OMS (para. 21), staff undertook the project cost analysis on the basis of engineering cost studies and related work by the Government of Lebanon and its international engineering consultant, Montgomery Watson Harza (MWH).² Although MWH is responsible, as part of its broader work program, for the feasibility study and costing of the proposed tunneling as part of the GBWSP, Bank staff judged this to be the riskiest element of project design and implementation. To complement and evaluate the MWH study, therefore, the Bank team contracted an independent tunneling consulting firm, Arup, to undertake an onsite technical and costing review of this component.³

The MWH report disaggregated the estimated investment costs to a level well below that of the main physical elements, which allowed for a detailed cost review. The Bank’s tunneling consultant did not attempt an item-by-item review of those costs. Rather, the firm identified a recent tunneling contract in the UK to use as a comparator. The UK contract had several features that increased costs significantly above those that could be expected in the Beirut work, but it nonetheless provided the basis for the Bank’s engineer to challenge the MWH costing. Utilizing the Bank consultant’s study, the Bank’s engineer met several times with MWH and Government officials to undertake a detailed review of the proposed engineering approach and related costing. Based on that review, the Bank engineer was satisfied that the MWH costing appropriately reflects market prices for similar work in Lebanon.⁴

² Initial MWH results were first reported in Council for Development and Reconstruction, “Awali-Beirut Conveyor Project: Feasibility Study Update,” April 2010 (draft). Final versions of the feasibility studies were provided to the Bank team for review during the pre-appraisal mission, and can be found in the project files.

³ Appraisal mission aide-mémoire (para. 12), under cover letter to the Government dated August 31, 2010, discusses this assignment, which was carried out during the appraisal mission. The consultant’s final report was conveyed to the Bank on October 13, 2010 and can be found in the project files.

⁴ Interview with the Bank’s engineer, who has placed her analysis in the project files.

The Bank team paid particular attention to the issue of physical and price contingencies for the project's capital costs. The approach agreed upon with the client to minimize related risks was to procure both the tunneling and water treatment plant on a design-build basis. However, given the geological risk associated with tunneling, the tunneling contract—which accounts for nearly half of capital costs—will be bid on the basis of a 95 percent final design.⁵ Industry and Bank experience has shown the design-build approach to be effective in delivering efficient construction and, in particular, controlling cost overruns. Based on the agreement to use that approach, the project financing plan includes a quite optimistic cost contingency factor (physical plus inflation) of 8 percent of the total expected contract values for works and goods. The chosen contingency level is low considering the geological risk inherent in the extensive tunneling operation. Although the benign global cost environment at appraisal was supportive of a lower inflation element in the contingency, that environment has become much less benign in the ensuing 6 months.

The financial analysis does not directly address the question of whether the client has the resources to finance a cost overrun above the chosen 8 percent contingency. However, it does show that by the end of 2011, the client is expected to have on its balance sheet \$90 million in cash above its scheduled project capital contribution of \$140 million, and will therefore have the ability to finance up to a 40 percent overrun on total project costs.⁶ The impact of such a significant overrun, however, would be to force the utility to delay the next stage of its capital investment plan.

The economic analysis signals that the expected NPV will remain positive for any level of cost overrun up to 18 percent, providing a significant cushion above the appraisal estimate. This is discussed in more detail in the economic analysis section, below. To meet OMS requirements on inflation contingencies for project operations and maintenance costs, the team's financial analysis incorporated inflation adjustments based on projections provided by the Bank's country economics team. Working capital estimates were incorporated into the utility's financial forecasts, as discussed in the financial analysis section of this review.

The review of operating cost estimates found that the team had substantially overestimated the project's net energy costs in the financial analysis. The overestimation had two sources. First, the analysis assumed that the additional energy costs would apply to the entire service area, instead of just to the area benefiting from the project. Second, the analysis did not recognize the energy cost savings to be realized with the reduced operation of wells once the new water became available. The net effect of these two changes is an expected annual incremental energy cost of \$4.4 million, or less than half of the

⁵ While the water treatment plant will be bid on the basis of preliminary design, the tunneling contract will be bid on the basis of a 95 percent final design, since early design stage tunnels represent much more uncertainty for bidders than do water treatment plants. Due to the geological risk associated with tunneling, the client elected to undertake extensive geological testing ahead of contracting to minimize perceived geological risk and elicit bids that did not include costs for large geological uncertainties. As laid out by the Bank's independent consultant, the tunneling will require a sophisticated contractor with appropriate experience in tunneling through karstic formations. The Bank and client agreed on pre-qualification requirements designed to ensure that the contractor has the necessary experience.

⁶ The PAD, Figure 1, p. 37 shows net cash flows.

\$10.86 million estimated in the appraisal financial analysis.⁷ Thus the utility will have significantly higher annual free cash flow than anticipated at appraisal.

The financial analysis incorporated routine maintenance costs for the new investments, but did not appropriately allow for periodic rehabilitation costs. The project engineer subsequently developed a profile of expected rehabilitation costs, which can be found in the project file. These costs total about \$13.6 million over the 20-year project life, and will partially offset the benefit from the lower incremental energy costs. The net impact of the lower energy costs but higher rehabilitation costs is, in net present value terms, a gain to project finances of \$50.5 million over 20 years.

The team has worked with the client to advance preparation of and provide clearances on procurement documentation, to meet the implementation timetable set out in the PAD, Annex III. In this respect, project preparation meets the expectations of OMS 2.20.

Conclusion

Based on the consultant's work and discussions with the client, as described above, the appraisal team established the adequacy of the investment cost estimates, as required by OMS 2.20. The operating cost was substantially overestimated, as described above. The tunneling contract, one of the first contracts bid under the project, will reveal whether the project contingency level is appropriate. If the winning bid comes in significantly above the client's estimate, the client will have the opportunity to reassess project finances and economics before making a final commitment to the investment.

⁷ The Beirut Mount Lebanon Water Establishment (BMLWE) Business Plan uses an estimate of \$3 million in incremental energy costs, and the client's engineers continue to anticipate that outcome. However, the Bank team is comfortable with the higher estimate ahead of final system design.

III. Financial Analysis

The review finds that, in general, the team addressed the financial aspects of the project appropriately, either directly in the appraisal or by reference to the 2009 Social Impact Assessment (SIA)⁸ and the 2010 Public Expenditure Review (PER).⁹

The review of the financial analysis is based on the requirements of OMS 2.20, particularly those in section D, “Financial Aspects,” and section E, “Commercial Aspects.”

- **Implementing agency financial management**

The OMS (paras. 38, 45) requires appraisal of the implementing agency’s financial management capability, including its accounting and auditing arrangements and supporting financial systems. The financial assessment adequately addressed these issues, as described in Annex III of the PAD. Based on that assessment, the utility has agreed to specific measures to improve its practices; these measures are supported by Component 3 of the project and have been incorporated in the Legal Agreement.

- **Project financial effect on the intended beneficiaries**

The OMS (para 38, 43) requires that “An examination should be made of the ability of the final beneficiaries to pay for goods and services...,” and more generally, that appraisal assess the project’s financial impact on the intended beneficiaries.

The appraisal team based its beneficiary financial impact assessment on the SIA results, modified for Beirut’s market conditions.¹⁰ The analysis shows a strongly positive project financial impact on the intended beneficiaries, who currently face not only a fixed water bill based on house or apartment size, but also substantial additional expense when the utility is unable to supply adequate water volumes, particularly in the dry season. The additional water to be supplied by the project will not affect monthly household water bills, but will reduce coping costs.

The project finances expanded consumer metering, which will facilitate an eventual shift to charging for actual consumption rather than on a house or apartment basis.¹¹ Even if a volumetric tariff is designed to be revenue neutral for the utility (hence in aggregate having no financial impact on water users), consumers using relatively more water will face larger water bills. The team discussed the shift to metered billing with the Government and was informed that the shift would take place only as part of a national policy change affecting all citizens using utility water. The Government has not reached a decision on the timing for such a shift.

⁸ World Bank, LEBANON: Social Impact Analysis—Electricity and Water Sectors, Report No. 48993-LB, June 18, 2009.

⁹ World Bank, Republic of Lebanon: Water Sector: Public Expenditure Review, Report No. 52024-LB, May 17, 2010.

¹⁰ PAD, Annex VII and project files.

¹¹ The PER (para. 86) stresses the importance of such a shift as a means to improve water use efficiency and utility management. It does not recommend tariff adjustments ahead of this change.

- **Feasibility of project's and utility's financial objectives**

The OMS (paras. 38-44) addresses the issue of financial performance on a number of interrelated dimensions: (i) entity financial performance, (ii) revenue adequacy, (iii) financial forecasts, (iv) reliability of financing plan, and (v) commercial viability.

Entity financial performance. The financial analysis, undertaken in compliance with OMS 2.20 (para. 40), requires a “comprehensive analysis of the entity’s historical and forecast financial performance...,” and asks for “summary measures of creditworthiness and expected profitability...” The analysis was based on financial accounts for all activities since the utility was created 2005. The project files include summary financial measures, including the working ratio, and projections of the debt service coverage ratio under different debt assumption scenarios.

The financial analysis focused on the soundness of the implementing agency’s overall operation.¹² The appraisal found that neither current nor projected revenues would fully cover depreciation and debt service requirements.¹³ The financial model showed that maintaining the utility’s financial viability under the project would therefore necessitate either a tariff increase or a government capital injection. The team discussed this with the Government, which agreed to make a capital injection an explicit element of project financing.¹⁴

The OMS (para. 39) states that whenever possible for revenue-earning projects, a financial rate of return (FRR) will be calculated. The Government’s decision to continue with connection-based rather than volumetric billing left the appraisal team unable to calculate an FRR.

Revenue adequacy. The OMS (para. 39) requires analysis “of the adequacy of revenues resulting from the project to cover the project’s operating and maintenance costs, provisions for depreciation, and debt service requirements.” But in some circumstances, “the appraisal should ... focus on the soundness of the implementing agency’s overall operation.”

Since the utility operates on a cash flow basis,¹⁵ the appraisal focused on the soundness of the utility’s overall operation. On this basis, the analysis demonstrates that the utility will have adequate revenue to cover the operating and maintenance costs of the improved services during project implementation. As detailed in the project cost review, the energy component of operating costs was significantly overestimated at appraisal, and rehabilitation costs were underestimated. The net impact of adjusting for these two factors is an increase in the utility’s free cash flow as compared with the appraisal estimates.

¹² PAD, Annex VII and project files.

¹³ This finding is consistent with the PER’s analysis (para. 36) of the Beirut utility.

¹⁴ Although not anticipated by the OMS, this situation is common among water utilities, even in OECD countries. See, for example, Organization for Economic Co-operation and Development, “Pricing water resources and water and sanitation services,” Paris, 2010.

¹⁵ This is typical, globally, of government departments supplying utility services.

The analysis demonstrates that the utility will not, under the current tariff regime, have the ability to fully cover depreciation or service debt associated with the investment. Over the project period, and with support from the project, the utility anticipates moving to the corporate accounting standards mandated by national law.

The Bank's financial analysis shows that with the system in place and if the full cost of capital were introduced as a cost of water production, the utility will not generate sufficient revenue to show a net profit. However, cash flows will continue to be adequate over the medium term to sustain operations without an operational subsidy.

Financial forecasts. The OMS (para. 41) requires that the appraisal team "assess: (i) the reasonableness of the financial forecasts; (ii) the appropriateness of pricing policies/tariff levels; and (iii) the possibilities for reducing costs and improving performance...." Further, it asks for a "judgment on working capital, debt service capability, and [the utility's ability] to meet other commitments"; and also for the use of risk and sensitivity analysis where appropriate.

The discussion above already responds to the appraisal findings on the reasonableness of financial forecasts and the judgment on debt service and other capabilities. The team did not take an explicit view on the appropriateness of tariff levels, a topic dealt with at length in the 2010 PER. The team did establish that current tariff levels are sufficient, when combined with the agreed-upon capital injection into the project, to sustain utility operations with the new investment in place.

Financing plan reliability. The OMS (para. 38) requires that the team review the reliability of the project's financing plan.

The appraisal team reviewed the financing plan, which relies on three components: a cash contribution from the utility, Bank loan proceeds, and a government contribution. The utility already has its contribution, in cash, on its balance sheet. Furthermore, it has consistently generated surplus cash in recent years and is projected to continue to do so under conservative assumptions. The government contribution (\$30 million immediately, plus an undertaking to service the IBRD loan) is small relative to the government budget and has been agreed. As discussed above, the team also tested the reliability of incremental O&M financing for the new investment.

The risk and sensitivity analysis was undertaken by the team in the context of identifying the size of a government capital injection that would be needed to support sustainable project implementation. This was done on the basis of the 8 percent contingency; the impact of cost overruns above that level was not assessed. This is a shortcoming, given the nature of project risks, as discussed in the review of project costs. Ideally, the team would have explicitly addressed the utility's capacity to absorb cost overruns beyond the 8 percent level without further reliance on government. The financial analysis allows that question to be immediately answered, however, as it shows that the utility could absorb a 40 percent overrun on total investment costs, at the expense of delaying its prospective investment program for the post-project period. Moreover, and particularly considering the adjustments to

operating costs and free cash flow, the utility's finances are robust to operating and maintenance cost changes beyond those already incorporated in the analysis. Therefore, although it did not do so, the appraisal analysis can be used to demonstrate that the investment and operations financing is in place with a high degree of reliability.

Commercial viability. OMS 2.20 (para. 53) states that for certain types of projects, including utilities, "Appraisal requires...a determination...that the project is commercially viable." The appraisal determined that the utility, when evaluated against full commercial accounting norms, is not commercially viable in that it generates no financial return to its owner's equity. The project, through improved financial management and accounting systems, will help move the utility toward commercial operations. However, full commercial viability remains a long-run goal across the water sector in Lebanon, and will not be attained solely through this project.¹⁶

Conclusion

The project appraisal of financial aspects covered the "Financial Aspects" requirements of OMS 2.20. The team provided the analysis needed for sensitivity tests on the reliability of the financing plan and adequacy of project revenues, but did not document such tests. The appraisal demonstrated that the investment is financially sustainable on an operating basis and will, with high probability, generate significant financial benefits for the utility's customers. Although the project will not meet the test of full commercial viability, the team was explicit in describing that result and ensuring that the Government will provide the capital support necessary for a sustainable investment. As noted above, in taking this approach, Lebanon echoes a water utility financing practice common in OECD countries.

¹⁶ The PER analyzes this issue in depth.

IV. Economic Analysis

The review shows that the economic analysis fundamentally meets the requirements of OP 10.00, OP 10.04, and OMS 2.20. The team drew on deep Bank experience and analytical work in the sector, and on work the Government had undertaken in partnership with the European Union Water Initiative (EUWI), in accepting the Government’s judgment that the Awali Conveyor option for bulk water supply is the least-cost alternative available at this time.

Background and context

This evaluation of the project’s economic analysis is based on OP 10.04, “Economic Evaluation of Investment Operations”; the relevant sections of OMS 2.20, “Project Appraisal”; the project appraisal document; documents in the project file; World Bank publications that summarize Bank experience in the water sector; and discussions with the project team.

OP 10.04 provides a number of tests to determine whether a project is acceptable. First, “a project must meet two conditions: (i) the expected present value of the project's net benefits must not be negative; and (ii) the expected present value of the project's net benefits must be higher than or equal to the expected net present value of mutually exclusive project alternatives” (para. 2). Second, sustainability must be demonstrated in a number of dimensions. Third, risks must be assessed and mitigated. Fourth, “the economic analysis [must examine] the project's consistency with the Bank's poverty reduction strategy” (para. 7).

OMS 2.20 lays out a number of expected or required elements of appraisal. Many are different ways of stating those found in OP 10.04 (i.e., the OMS 2.20, para. 14 requirement that the analysis show “whether the project is the least cost alternative”). Others require a broader strategic view (i.e., the OMS 2.20, para. 11 requirement that the project “adequately reflects the recommended sectoral strategy,” in contrast with the OP 10.04 focus on the poverty reduction strategy alone).

The following sections address how (or extent to which) the appraisal responded to the requirements of OP 10.04 and OMS 2.20 with respect to project economics.

▪ **Project consistency with the Bank’s poverty reduction and sector strategies**

The Country Partnership Strategy (CPS),¹⁷ as well as the 2009 Social Impact Analysis and the 2010 water sector PER, establish that a Beirut water supply project is consistent with Lebanon’s and the Bank’s poverty reduction and sectoral strategies. The PAD (para. 11 and elsewhere), documents the consistency of the project design with these strategies.

¹⁷ Lebanon Country Partnership Strategy for the Period FY11–FY14, Report No. 54690-LB, dated July 28, 2010, and endorsed by the Board on August 31, 2010.

Project preparation overlapped with preparation of the CPS, which identified improvement of water supply to Beirut as a major Government goal (para. 39) and validated this goal through discussions with civil society (para. 54). Both the CPS and project preparation were informed by the SIA and PER, which included elements of a water sector strategy.

The SIA, based on surveys conducted in 2008, noted that if households could rely entirely on network water, households in the bottom quintile of those connected could cut their water bills in half (SIA, para. 89). The SIA was based on an 1,800 household sample representative at the regional level. It highlighted the intermittent nature of current public water supply and the negative financial impact on households being forced to purchase expensive vendor-supplied water to fill gaps in public supply.

The SIA found that in Beirut, public network water is equally available across income classes, suggesting that the high connection rate of 96 percent benefits the poor and wealthy equally.¹⁸ Moreover, the intermittent nature of the water supply affects all income groups. Only 10 percent of households receive water every day, 52 percent every other day, and 37 percent every third day (SIA, Table 3.3). Based on the SIA calculations for costs of coping with the lack of daily water, Beirut residents pay about \$106 million annually for private water (SIA, Table 3.8).

The SIA cost of coping estimate provides a measure of the financial benefit from bringing Beirut network water up to full supply and, by implication, of the annual cost of delaying implementation of an investment that would lead to full closure of the supply gap. The project will not fully close that gap and the appraisal team estimates \$49.7 million as the annual net project benefits.¹⁹ While the project would benefit all income groups, those in the lowest quintile enjoy the largest proportional benefit, as the water bill is invariant to income group.²⁰

The 2010 Water Sector Public Expenditure Review concluded that “Improving continuity of water supply to achieve 24/7 provision across the country is the priority for the water sector” (PER, para. 80). It highlights the need to improve efficiency, particularly by reducing unaccounted for water and improving collection rates. It asks for a broad range of actions to “support investment prioritization, implementation of Law 221, utility management and information management” (PER, para. 83). The project’s main focus is on improving supply continuity through a number of measures, including additional treated water, better water loss and utility management, and support for studies to provide the basis for investment prioritization.

¹⁸ SIA, paras. 73, 75, 76. Note, however, that the SIA sample survey findings do not discriminate between legal and illegal connections. The 96 percent connection rate must include a substantial proportion of the illegal connections in Beirut, which the water company estimates at 5 to 20 percent of total connections, depending on the area of the city (Business Plan, Table IV-5b).

¹⁹ Calculated from the project benefit analysis, in the project files and revalued cost stream.

²⁰ This result is driven by the fact that households are charged a fixed amount, not billed on actual consumption.

- **Selecting the best alternative**

OP 10.04 focuses on the requirement to establish which project maximizes expected net present value among “mutually exclusive options for the use of the resources in question.” With a Beirut water supply project identified, this is equivalent to establishing the least-cost option for attaining the investment goals—in this case, “to increase the provision of potable water to the residents in the project areas within the Greater Beirut area ... and to strengthen the capacity of the Beirut Mount Lebanon Water Establishment in utility operations” (PAD, para. 15). OP 10.04 requires that in comparing alternative designs, a number of aspects must be reviewed, including sustainability and risks. It also requires a comparison with the “no project” alternative.

The “no project” alternative would result in continued water shortages, reliance on more expensive private water supply, and continued degradation of ground water resources in the Greater Beirut area due to excessive abstraction. The “no project” alternative also implies continued large system losses through unaccounted-for-water, which ranges up to 40 percent (PER, para. 38), as well as the continuation of intermittent water supply and the coping costs identified in the SIA.²¹

At the time of the pre-appraisal mission, the Government and Bank team agreed on the basic project approach to the water supply challenge. The selected approach has three components: (i) bulk water supply infrastructure; (ii) supply reservoirs, distribution networks, and metering; and (iii) project management, utility strengthening, and studies.²² These components have continued unchanged through further preparation, as documented in the appraisal aide-memoire²³ and subsequently in the PAD.²⁴

The PAD established, and this review confirms, that all three project components will be needed to meet the project development objectives of increasing the provision of potable water to the residents of the project area, and strengthening the operational capacity of the utility. The project components are interrelated, but different approaches could potentially meet the needs addressed by each. These are considered in turn, below.

²¹ As stated in the report of the Lebanese Republic Council for Development and Reconstruction (CDR), “The current potable water demand in Beirut is estimated at 780 Ml/d. In the driest month (October) of an average year, there is a predicted deficit of 368 Ml/d. Consequently, the water supply in many parts of Beirut is intermittent. Furthermore, reliance on wells, coupled with the effects of salinity ingress, has resulted in many homes being supplied unpalatable water in coastal areas. “Awali-Beirut Conveyor Project: Feasibility Study Update,” April 2010, p. 8 (draft). Note that the supply gap refers to the entire service area of the utility. The project seeks to fill the gap for only part of Beirut.

²² Greater Beirut Water Supply Project Pre-Appraisal Mission Aide-Memoire, conveyed to Government under a cover letter from the Country Director, Hedi Larbi, dated May 25, 2010.

²³ Greater Beirut Water Supply Project Appraisal Mission Aide-Memoire, conveyed to Government under a cover letter from the Country Director, Hedi Larbi, dated August 31, 2010.

²⁴ Project Appraisal Document for the Greater Beirut Water Supply Project (Report No: 56341-LB, dated October 13, 2010). The components were unchanged from those anticipated in the concept stage project information document (PID), dated February 1, 2010.

Economic evaluation of Component 1: Bulk water supply infrastructure

Beirut water supply alternatives matrix

Early in project identification, the Bank team was presented with a Government-endorsed matrix (Annex 1) of bulk water supply alternatives that could potentially meet Beirut's needs.²⁵

The Government's matrix of possible bulk water supply alternatives must be understood in the context of the EU Water Initiative (EUWI)-supported master planning work (Box 1). The matrix includes four water supply options, of which three are mutually exclusive in the OP 10.04 sense that the available resources permit them to be considered for the current investment. The Awali Conveyor and Bisri options are not mutually exclusive, as the Awali Conveyor would be necessary to deliver water that would be impounded by the proposed Bisri dam; however, the expected total cost would exceed currently available resources. Therefore, for the purposes of project appraisal, the three options considered were Awali, Damour, and Jannah.

A comparison of the Government's matrix with the EUWI report's list of potential water supply investments shows that all potential investments in the vicinity of Beirut were included. All other potential water sources would require pumping over such great distances that the combination of investment and O&M costs immediately eliminates them from consideration.

Box 1. The National Water Resource Master Plan and the EU Water Initiative

Ideally, a country would have a carefully considered national water resource utilization and development plan. With such a plan in place, a project to address any given need, such as additional raw water for Beirut public water supply, would simply refer to the plan for the best available alternative bulk water source. In Lebanon, the 2005 National Physical Master Plan for the Lebanese Territory (NPMPLT) highlighted the challenges of the water sector, in particular the dual problem of generating additional, environmentally sound sources of water for urban use, while significantly improving the management of water in urban distribution systems (NPMPLT, pp. 11-21).^a The NPMPLT also reported on the state of planning for water resource utilization and development, and noted the priority to be given domestic supply (NPMPLT, pp. IV-69 to IV-74). It also conveyed the then-current water resource development plan, listing potential water sources and the stage of feasibility study development for each. In addition, the NPMPLT acknowledged the long-term nature of overall management and resource development in the sector, and stated that "this [plan] should be perceived more as a development scheme, rather than a finalized and scheduled program." At the time of NPMPLT publication, Lebanon also joined the EUWI's MED Country Dialogue program. The EUWI engagement was quite ambitious, seeking to develop "detailed analyses of the current expenditures and needed financing to meet MDG/WSSD [Millennium Development Goals/World Summit on Sustainable Development] targets for WSS [water supply and sanitation] and IWRM [Integrated Water Resources Management]," as well as "prioritised interventions and framework programmes...financial strategies to bridge financial deficits and gaps as well as terms for monitoring and reporting progress achieved in the future."^b The terms of engagement also aimed to guide donor planning. The dialogue and associated activities resulted in a

²⁵ An e-mail to Mohammed Benouahi (previous Project Task Team Leader) from Randa Nemer (Lebanese Government advisor), dated January 19, 2010, conveyed the options matrix. In project files.

series of EUWI-sponsored studies, published in 2009, which updated and elaborated aspects of the NPMPLT.^c The report on “Domestic and Industrial Water Needs and Management” plays a particularly important role in assessing alternatives for Beirut.^d

The EUWI-sponsored work resulted in more detailed articulation of the water resources development plan than did the NPMPLT. Nevertheless, the Bank’s 2010 PER concluded that: “The lack of a consolidated WSS sectoral investment plan, and the limited coordination across agencies, greatly diminishes the ability to identify and select projects with the highest economic rates of return based on rigorous technical and economic criteria” (PER, para. 68).

Faced with incomplete information, the Government prioritized investments in dams and lakes (EUWI, tables 2 and 3) based on the likely benefit stream and on available feasibility studies. Domestic water was given first priority (conditioned on the current per capita water availability in the likely site of use), then irrigation, and, finally, other uses. Given the expense and time required to develop the deeper information needed for a comprehensive investment plan, these criteria appear sensible and were incorporated in the EUWI work.^e

^a Lebanese Republic Council for Development and Reconstruction, December 2005, with printing financed by the European Union. The Master Plan was intended to be the basis for urban planning, and also to aid in “national and land use development” (Foreword to Master Plan, p. vii).

^b See http://www.minenv.gr/medeuwi/dialogues/country.dialogue.lebanon.16-11-05_en/conclusion.lebanon.16-11-05_en.html for the conclusions of the inaugural meeting.

^c See <http://www.gwpmmed.org/node/59> for links to all of the reports.

^d See http://www.gwpmmed.org/files/090320_MEDEUWI_Rapport_GK-EEPI.pdf.

^e Component 3 of the project supports studies needed for elaboration of the National Water Sector Strategy.

Beirut’s water supply deficit²⁶ is highly seasonal, with high quality raw water supply from existing sources adequate to meet the needs of the population for six months of the year. Considering their available resources, the Government and BMLWE proposed a project that would close 250,000 m³/day of the supply gap over the remaining six months—a volume adequate to extend full supply over the entire year to approximately 1.2 million Beirut residents.²⁷ The raw water supply needs for a 250,000 m³/day water treatment plant over six months total just under 46 million m³. The matrix reports reliable dry season supply to BMLWE from the Awali Conveyor at 50 million m³, from Damour at 27 million m³, and from Jannah at 20 - 30 million m³.²⁸

Although the options matrix was one element in the Bank’s decision to support the Awali option and the related treatment plant sizing, the team did not document, in the PAD or elsewhere, the analysis that

²⁶ The best estimate of the current peak water supply deficit across the entire service area of BMLWE (which includes but is not limited to the project area) derives from the dry season water deficit of 368,000 m³/day. The current supply sources have a decade of documented highly variable supply, as shown in the EUWI report (EUWI, Table 5).

²⁷ The treatment plant would operate for only six months of the year. Once the project is implemented, the water loss reduction financed under components 2 and 3 would increase delivery of potable water to consumers throughout the year without the need for additional raw water supply.

²⁸ The analysis in this report does not simply accept the matrix estimate of Damour volumes, but considers the possibility of the higher volumes claimed by Damour project proponents.

led to the selection of this option.²⁹ Based on detailed discussions with the team, this review concludes that the team accepted the Awali option, pending a positive appraisal, based on a combination of factors: (i) Bank team members participated in the later stages of the EUWI-sponsored dialogue, and the EUWI report itself takes it as given that the Awali source is the best next investment for Greater Beirut water supply;³⁰ (ii) Awali had been the preferred option in the analysis done at the time of the 1999 decision to support the Awali Conveyor;³¹ and (iii) the options matrix itself included one alternative, Jannah, at an advanced planning stage but clearly inferior in terms of cost per m³ delivered; and another, Damour, that was competitive on a cost-per-m³-delivered basis, but offered significantly lower annual deliveries and would need substantially more development work to reach full feasibility stage.³²

In the absence of a documented Bank options analysis, this evaluation reviews the available information and analysis on each of the three options and asks whether there was a case for further development of either of the two alternatives to Awali before making a final decision to fully appraise only the Awali option for Component 1. The evaluation concludes that the team made the right decision in proceeding immediately to an Awali appraisal.

Economic evaluation of the Awali option

Benefit evaluation

The evaluation of benefits from the bulk water supply option would apply to any large source of new water supply delivered to the sections of the BMLWE service area covered by the project. In that sense, it can be used to value benefits from the Awali, Jannah or Damour options.

The project economist measured the benefits from additional supply by estimating the financial savings project beneficiaries could enjoy by substituting this new source of water for purchased water or other coping mechanisms. The 2009 SIA had already provided a quantitative estimate of the average annual coping cost to households in the bottom income quintile that are connected to the water supply system: “as much as...US\$147” It also noted that “savings could be even larger for the upper quintiles.”³³ During appraisal, the team validated these findings for the project area, but acknowledged that the planned investments would not completely close the supply gap and settled on a lower benefit figure of \$28 per person (or \$112 for the average household size of 4).³⁴ As stated in the PAD, no effort was made to evaluate avoided costs from any health improvements that might result from improved water quality,

²⁹ While the evidence provides clear support for that judgment, best practice would have the team provide more thorough documentation, in some areas, of the reasoning and information that supported its judgments.

³⁰ The EUWI report, when discussing potential new water sources for Beirut, simply lists the Awali project and states that there are plans to implement phase 1 (EUWI, p. 21).

³¹ Council for Development And Reconstruction; Project No. 1026 - Contract No. 6682; Awali-Beirut Water Conveyor Project (on build-operate-transfer basis); Phase I Interim Environmental Assessment (EA) Report, April 1998.

³² Note that the matrix shows Damour annual volumes at “around 30 million m³/year,” while the pre-feasibility study reviewed by the team shows sustainable annual deliveries at 27 million m³/year.

³³ SIA, p. v., based on 2008 costs.

³⁴ Average household size based on a 2007 CAS survey, reported in BMLWE, “Business Plan 2010- 2014,” p. 14.

nor of the environmental benefit to reduced abstraction of well water. The possibility of such benefits was noted, but either one would be costly to estimate with any precision and would not change the decision to proceed with a water supply project.

Cost evaluation

The economic evaluation of costs comes directly from the engineering and financial evaluation of the Awali Conveyor, and from the calculation of associated water treatment investment and operations and maintenance costs. Those costs were estimated at \$130 million for the conveyor, and \$106 million for the water treatment plant and associated transmission lines and reservoirs. The appropriateness of those cost estimates is established in the PAD, drawing from the consultant's feasibility study update.³⁵ However, the original economic analysis did not include the \$41 million investment in the distribution system and distribution reservoirs in calculation of the project's NPV, as the economist saw these as critical to system management but not to the expansion to new customers. However, discussion with the project engineer confirmed that these investments are necessary to deliver the improved service against which the benefits are measured. As part of this review, therefore, the NPV has been recalculated to include these capital costs. The original economic cost calculation did not include incremental O&M and rehabilitation costs over the service life of the project.³⁶ Again, the NPV has been recalculated taking these into account.

The economist chose not to adjust financial prices to derive economic prices. Given the open nature of the Lebanese economy and its freely traded currency, this assumption is robust.

The PAD analysis addressed the question of potential negative externalities from augmentation of the public water supply, in the form of potentially greater volumes of wastewater and the need to treat and dispose of sludge created during the treatment process. The economic analysis did not assign a value to either externality. In the case of wastewater volumes, because the additional public water supply will substitute for private alternatives, the assumption is that total water use (hence wastewater volumes) would increase very little, if at all. Based on the very large documented gap in the driest month, this assumption likely holds for that period. Insufficient information is available to judge likely outcomes at either end of the dry season. The team did confirm with the Government that existing sewers can handle any additional flow that might result from the project, and that the wastewater treatment plants now being constructed have been designed to handle the larger flows.³⁷ The sludge issue was analyzed in depth in the feasibility study, and the needed sludge treatment regime will be incorporated into the water treatment plant. A safe disposal option (to land) has been identified and the disposal costs incorporated into the O&M estimates.³⁸ For sludge, therefore, potential negative externalities have been mitigated.

³⁵ Council for Development and Reconstruction, "Awali-Beirut Conveyor Project: Feasibility Study Update."

³⁶ The incremental O&M costs were reflected in the financial analysis, as discussed in that section; however, the rehabilitation costs had not been included.

³⁷ Interview with Bank's project engineer

³⁸ Council for Development and Reconstruction, "Awali-Beirut Conveyor Project: Feasibility Study Update," pp. 35-38. The financial analysis included these costs.

Net present value

The Awali option meets the OP 10.04 requirement of a positive expected net present value. The economic analysis reported an estimated NPV of US\$100 million (based on the standard 10 percent cost of capital for investments in Lebanon), and an economic rate of return (ERR) of 18 percent (PAD, para. 38). After making the cost adjustments reported above, and extending the evaluation period to a more appropriate 20 years from the original 10-year period chosen by the economist, the revised NPV falls to \$39.5 million and the ERR to 12.0 percent. However, this analysis does not assign a value to the improvement in potable water quality that comes with switching from the high-salinity well water extracted by private suppliers, nor to the averted further damage to Beirut's aquifer by reducing or ending drawdown from those wells.

Sustainability

OP 10.04 (para. 5) requires a sustainability assessment that ranges broadly across legal and institutional issues, including "the project's financial impact on the implementing/sponsoring institution." The sustainability assessment documented in the PAD and in project files covers all of the elements asked for in the OP.³⁹ Taken together, these sources support the conclusion that the Awali Conveyor option would be sustainable when implemented in combination with the other project components.

Risk

The risk section of the PAD addresses engineering and institutional risks, with the former mitigated in part through contracting strategies and the latter in part through the institutional strengthening component of the project. Other risks include environmental and social impacts, which are addressed through an environmental management plan (EMP) and a resettlement action plan (RAP). The risk of failure to access the planned volumes of raw water is mitigated by the fact that the allocation of water rights from the watershed was established through a Presidential Decree,⁴⁰ which specifies the 50 million m³ annual allocation during the dry season to Beirut and, in periods of overall water shortage, gives drinking water for Beirut priority over irrigation.

For the sensitivity analysis, the economist selected two risks to evaluate: those of a project implementation delay and a substantial increase in project costs. The two risks are appropriately selected, as experience with complex engineering works shows these to be the two principal sources of risk. Instead of taking OP 10.04 advice to calculate switching values for these variables, the economist selected a specific level of delay (2 years) and cost overrun (25 percent) to test. The selected delay and overrun values approximate the Bank experience in high dam projects, which are a more difficult implementation challenge than the current project design, hence constitute a strong stress test.

In the PAD (Annex VII), the economist reported that even with a combined two year delay and 25 percent cost overrun, the project still yielded a positive NPV. However, as noted above, the original NPV

³⁹ The PER provides up-to-date analysis on sector institutions, including information not repeated in detail in the PAD.

⁴⁰ Ministry of Hydraulic and Electric Resources Presidential Decree No. 14522: "Distributing the Water of the Litani River and other Sources of Water in the Area between the Road of Beirut-Damascus and the Springs of Anjar-Chemsine and Underground Water in Terbol Area North of this Road in the Central Beqaa for Irrigation Purposes." Dated May 16, 1970.

calculation failed to incorporate two important cost elements. A recalculation of the sensitivity analysis against the revised cost and benefit stream shows that a 25 percent cost overrun would reduce the ERR to 9.3 percent, a two year delay to 9.7 percent, and with both factors taken together, the ERR would fall to 7.7 percent. Testing for switching values shows that a benefit delay of about 21 months would drive the NPV to zero and a cost overrun of 18 percent would do the same. A combination of a one year delay and a 7 percent overrun would also reduce the NPV to zero. These switching values highlight the importance of timely implementation and the accuracy of the appraisal investment cost estimates if the project is to have a positive NPV at completion. The ERR remains strongly positive under both stress scenarios.

Economic analysis of the Jannah and Damour options

Economic analysis of equivalent rigor to Awali was not performed on the Jannah and Damour options because of the team's determination that neither option came close enough to being a viable alternative, based on the information presented to the Bank in the matrix, feasibility or pre-feasibility studies on the two options, and the NPMPLT and EUWI assessments.⁴¹

The Jannah option

Of the two non-Awali mutually exclusive options, assessment of Jannah benefited from the fact that a feasibility study and environmental assessment had been completed and the expropriation decree for the dam site was in place. As with any proposed project, those steps substantially narrowed the uncertainty around the project's benefits and costs and provided a good basis for evaluation. The feasibility work established a lower capacity for the proposed reservoir than is available through Awali, while yielding an indicative cost of dam construction and associated transmission that was approximately the same as for Awali.⁴² Given the much greater volumes available through Awali and, in the operating phase, the ability to rely on gravity to convey the water, the Awali option clearly dominated the Jannah option. For this reason, it was appropriate to eliminate Jannah by inspection when tested against Awali.

⁴¹ Although the review substantiates their judgment, only the Jannah option can be eliminated by inspection, while the Damour option required a more considered review, and the team would have been well advised to include documentation of their judgment in the project files.

⁴² See Government matrix, Annex 1.

The Damour option

This option has been developed only to the pre-feasibility level, with the first such study from in the 1950s and the most recent in 2009. The findings of the studies were mixed, with the differences relating to differences in dam siting and dam height⁴³ and to geological risks.⁴⁴ The variability in findings across studies, in terms of feasibility, location, and cost is entirely consistent with World Bank experience in large dams (Box 2).

Box 2. Bank Experience with Large Dam Feasibility

A 1985 Bank review of experience with large dam construction noted the importance of thorough geological surveys and site investigations during the feasibility stage, especially in karsitic areas and prior to making any investment decision. “The important determination is whether the probability of cost or time overruns [due to geological risk] is sufficiently high that the project would no longer be a part of the least-cost development program. No project should be allowed to go forward if this risk is high.”^a

Even for projects with full feasibility work and successful Bank appraisal, a 1996 analysis of Bank-financed large dam projects found an average cost overrun of 27 percent and time overrun of 28 percent, *after* excluding nine projects with exceptionally large overruns that were judged to be outliers. Those overruns were against cost and time estimates at appraisal, and therefore based on information from the outcome of full feasibility studies that themselves had already incorporated cost contingencies.^b

^a World Bank, Energy Department Note No. 61, Geological Complications and Cost Overruns: A Survey of Bank-Financed Hydroelectric Projects, July 1985.

^b Robert W Bacon, John E. Besant-Jones, and Jamshid Heidarian, “Estimating Construction Costs and Schedules: Experience with Power Generation Projects in Developing Countries,” World Bank Technical Paper No. 325.

In addition to engineering uncertainties, the lack environmental, resettlement, and water rights studies for the Damour site created additional uncertainties about the benefits and costs of that option.⁴⁵ For purposes of selecting alternatives, a full feasibility and associated studies would be needed to adequately appraise Damour as an alternative to Awali. The time and cost needed for this set of studies was not broken out in the matrix, but the EUWI report estimated it at 20 months and a cost of \$2 million. The 20-month time estimate is consistent with Bank expectations for an efficient process and, after including four months for procurement of the needed services, implies a two-year appraisal delay.

Three factors support the Bank team’s decision not to delay appraisal during a two-year wait for a full set of Damour studies: (i) the 2009 SIA had already quantified the significant ongoing costs to project

⁴³ These differences were significant. One study indicated a storage capacity of 100 million m³, based on a dam height of 150 meters

⁴⁴ However, Damour is included in the national water resource development master plan (NPMPLT, and in both the master plan’s and the EUWI’s list of dams that could help meet Lebanon’s domestic and industrial water needs.

⁴⁵ With regard to environmental issues, for example, the Damour River is highly seasonal, with almost all of its flow during the winter season. While not a problem for water storage, this means that the riverine ecosystem developed around spate flows. The environmental impact of the changes to these flows that would come with the dam need to be assessed and are likely non-trivial.

beneficiaries due to the shortfall in Beirut public water supply; (ii) the outcome of a full Damour feasibility study was unknown, and Bank experience with high dams in karstic environments signaled significant geological risks and a high risk that the pre-feasibility cost estimates would need significant upward revision⁴⁶; and (iii) additional raw water sources were known to be needed in a second stage project, and moving forward with the Awali option did not foreclose later development of the Damour.

OP 10.04 asks that Bank teams, when considering alternatives, take starting dates into account (para. 3). It highlights the importance of risk and recognizes that the analysis “is necessarily based on uncertain future events and inexact data and, therefore inevitably involves probability judgments” (para 6). OP 10.00, among project criteria, requires that projects “reflect lessons learned from the Bank’s experience” (para. 3 (a)). The Bank team’s conclusion that it would not delay appraisal draws from and is consistent with Bank lessons of experience.

Economic evaluation of Component 2: Distribution system expansion and metering

Component 2 comprises two distinct activities: civil works to expand and upgrade the potable water distribution system (\$41 million base cost), and a program of bulk and customer metering (\$20 million base cost).

The first of these activities, expansion and upgrading of the distribution system, is motivated by the current inequality in access to water across the system (BMLWE Business Plan, p. 22). The Business Plan and the SIA both note the differences in hours and quality of supply across zones within the BMLWE service area, arising from the current lack of integration across the system. That integration will be possible only with the construction of additional reservoirs and transmission mains. The engineering studies, which look at the same investment from an engineering optimization perspective, see the additional works as providing more control over and adding resiliency to the water supply system. The engineering analysis demonstrates that the investments will efficiently meet these distributional goals.⁴⁷ The costs and benefits from this activity were incorporated into the revised overall economic analysis for the Awali component and reflected in the revised NPV.

The second activity, the metering component, was not subject to an economic analysis, although it could have been as an essential input to a program to reduce unaccounted for water. Water losses are known to be high (the PER estimates up to 40 percent, the EUWI report says >30 percent).⁴⁸ Intermittent supply

⁴⁶ Further, environmental risks remained to be evaluated, resettlement needs had not been explored, and water rights had not been established.

⁴⁷ ACE Engineering Report – 2001 - From an economic perspective, given the year-round shortage of water in the system, this investment represents a reallocation of an already insufficient supply of water from areas that are relatively water abundant to those that are relatively water scarce. Given the already low rates of consumption among users, if information were available to test whether this redistribution increases consumer surplus, it would very likely show very small net gains by that measure. The economic analysis did not attempt to quantify the benefits of the redistribution.

⁴⁸ Unaccounted-for water is quite high in the BMLWE service area, reaching 40 percent by some estimates (PAD, para. 6). Reducing losses to 20 percent, a level consistent with good performance in systems of this size, would provide an increment of about 80 million liters/day of delivered water in the driest month, making up just over 20 percent of the shortfall. The Government and the appraisal team both recognize the potential returns from this type of investment. However, as an

typically leads to high physical leakage, the sources of which project-procured bulk system meters will help identify. Illegal connections are a second problem. BMLWE has estimated that 5 to 20 percent of the connections in its service area are illegal, which suggests a total served population just over 10 percent of the population with registered connections.⁴⁹ Like many utilities committed to improving services, BMLWE has made the regularization of illegal connections a key element of its business plan.

The 2010 PER for the water sector directly addresses the costs and benefits of metering in relation to water loss reduction. The PER recognizes the uncertainty of cost reduction via metering and management programs, but based on documented international experience in developing countries, it estimates costs in the range of \$215 to \$500 to reduce losses by one cubic meter per day (PER, Box 3, p. 48). This can be contrasted with the cost of new bulk water supply for Beirut through the Awali Conveyor. Accepting the investment cost estimate of \$235 million to supply 250,000 m³/day for 6 months of the year, the capital cost will be more than \$1,800 to augment supply by one cubic meter per day. Even at the high end of the cost range, a loss reduction program promises comparatively high returns.⁵⁰ From a social perspective, the argument is equally strong. Indeed, the 2009 Social Impact Analysis concludes that “A rapid rollout of metering is needed if wastage and equity issues are to be addressed” (SIA, p. vii).⁵¹

The economic and social gains to household-level metering will be captured only if meter installation comes after the additional water supplies become available and is closely aligned with the Government’s contemplated switch to volumetric tariffs. Meters are expensive to install and read, and they tend to have short service lives under intermittent supply. Households use the information that meters provide only if they face volumetric tariffs.

Sustainability

The sustainability of both the distribution system improvements and the metering program depends on the overall performance of O&M services by BMLWE. Neither is technically demanding, but they both require systematic maintenance programs. Component 3 investments are designed in part to meet this need; and the sustainability of and ability to realize the gains inherent in Component 2 will depend on satisfactory implementation of Component 3.

intensified loss reduction program will not, by itself, come close to filling the supply gap, the need for additional raw water sources remains.

⁴⁹ Table IV-5b in BMLWE Business Plan 2010-2014, May 2010.

⁵⁰ Note that the unit cost of loss reduction grows as the system loss rate falls, as each additional source of loss becomes more difficult to detect and is responsible for less water lost per unit of time. For either bulk water supply or loss reduction efforts, ongoing O&M costs also come into play if gains are to be maintained. However, this will not change the relationship shown in the PER.

⁵¹ It is worth noting that one antecedent for the Beirut metering program comes from experience under an African Development Bank (AfDB)-funded management contract for Tripoli, executed by Ondeo Lebanon. Under that contract, substantial improvements were made in system management, utilizing newly installed production meters and complementary management improvements such as those to be funded under Component 3. Even with those improvements in place, however, Ondeo concluded that estimates of physical losses remained a theoretical exercise in the absence of consumer metering (EUWI, p. 42).

Risk

Component 2 risk arises from the possibility that the utility will not take advantage of its new infrastructure to identify and remedy sources of system water loss. The same conclusion on risk holds as it did with sustainability—the utility strengthening activity in Component 3 must be successfully executed.

Economic evaluation of Component 3:

Component 3 includes support for three different activities, each with a base budget of \$5 million: (i) the project management unit (PMU); (ii) utility strengthening; and (iii) studies needed for the National Water Sector Strategy. These activities, while not explicitly addressed in the economic analysis, are either standard for major construction works, essential to the utility management upgrading program, or (in the case of the studies) responsive to the need for better national water resource planning, as noted in the PER. Further, the allocations for utility management upgrading and water resource planning activities will have benefits well beyond project life.

Sustainability and risk

The PAD draws on the thorough discussion in the PER of the challenges facing water sector development in Lebanon. The PER highlights the fact that much room for improvement remains, but also that among water utilities in Lebanon, Beirut's is by far the best performer.

Conclusion

The review shows that the economic analysis fundamentally meets the requirements of OP 10.00, OP 10.04, and OMS 2.20. The team drew on deep Bank experience and analytical work in the sector, and on work the Government had undertaken in partnership with EUWI, in accepting the Government's judgment that the Awali Conveyor option for bulk water supply is the least-cost alternative available at this time. While the evidence provides clear support for that judgment, good practice would have the Bank appraisal team document for the files the reasoning that supported its conclusions.

Annex 1

Water Supply for Greater Beirut

Current population: 1.7 to 2.1 million (ref. water establishment and CDR)
 Water deficit: 45 to 50 million m³/year in Dec. 2008 (ref. water establishment and CDR)
 100 million m³/year in 2025 (water establishment – CDR estimates are higher)
 Additional water resources: Awali, Bisri, Damour, and/or Jannah

	Awali Conveyor	Bisri	Damour	Jannah
Total Capacity (million m³)	50	130	40	30 to 40
Allocated quantity for Greater Beirut Water Supply (million m ³)	50	120	Unknown, but part of the water will go for irrigation, especially as there are considerable agricultural areas downstream and farmers have water rights.	20 to 30
Description of the water scheme associated with the water source	Presidential Decree No. 14522 (May 1970) allocated water from the Litani and Awali (Bisri) River catchments to different regions of Lebanon. The Greater Beirut area was allocated 50 million m ³ for mid-April through the end of October, which is typically the dry season in Lebanon. Water will be transmitted by gravity through the Awali Conveyor (around 24 km) to Khalde, and then through pipelines (9.5 km) from Khalde to storage reservoirs in Hadath, Telat el Khayat, and Hazmieh.	The dam will provide an additional 120 million m ³ , which will be transmitted through the Awali Conveyor to Greater Beirut.	The water scheme to feed Greater Beirut (transmission from dam, storage, distribution) is still not defined.	Water will be transmitted by gravity from Jannah to Dbaye (around 30 km), and from there pumped to Beirut. The option of transmitting water from Jannah to Dbaye through a tunnel or pipelines, and the exact route of the transmission line, have not yet been evaluated. The capacity of the Dbaye pumping station to pump additional water, and the cost of pumping, require further study.

	From there, water will be distributed by gravity to Greater Beirut.			
Estimated cost (\$ million), excluding cost of expropriation and distribution within Greater Beirut Cost of expropriation cannot be covered by donors and should be covered from government resources.	\$200 including: - 24 km tunnel from Awali to Khalde with 150 million m ³ capacity - Water treatment plant for 150 million m ³ /year (pipelines from Khalde to reservoirs) - 3 reservoirs of 30,000 m ³ , 50,000 m ³ , and 20,000 m ³ .	\$200 for dam, all other associated costs included in Awali Conveyor	\$140 – although costs of transmission line (around 10 km) and required storage are not yet known.	\$312 – of which \$158 for dam and the remaining for power plant, transmission, treatment, etc. (ref. Khatib and Alami) \$170 (ref. water establishment)
Status of expropriation	No expropriation required for tunnel Expropriation for the pipelines from Khalde to the reservoirs, the 3 reservoirs and the treatment plant are in advanced stages of preparation.	Expropriation decree for dam available	No expropriation decree for the dam. Expropriation for transmission (around 10 km) and storage are not available	Expropriation decree for dam available Expropriation for transmission (30 km) from Jannah to Dbaye is not available.
Available design documents	Final designs have been updated and are ready to be tendered. Environmental and Social Impact Assessment has also been updated and finalized.	Feasibility and environmental assessment	Pre-feasibility study available, feasibility study under preparation	Feasibility and environmental assessment
Time required to complete tender documents	Final design and tender documents are currently in final stages of review	2 years to finalize design and prepare tender documents for dam	5 years to complete feasibility studies, hydrological and geological studies, final designs, environmental assessment and tender documents for dam and transmission	12 to 18 months to complement dam hydrological and geological studies and finalize feasibility studies 2 year to finalize design and prepare tender documents At least 3 years to prepare and finalize

				conveyor studies
Availability of funds for construction	World Bank	\$70 million from Islamic Bank Donors for \$130 million to be identified (World Bank could contribute and would assist identifying other donors)	No funding available so far; donors to be identified once feasibility study is completed and cost of transmission and dam are known	\$170 million available at water establishment Arab Fund will not contribute Other donors to be identified
Estimated date to initiate construction	March 2011	December 2012	December 2015	December 2013
Estimated date to complete works and supply additional water to Beirut	December 2014 (50 million m ³ /year)	December 2017 (100 million m ³ /year)	December 2020, if funds available) (around 30 million m ³ /year)	December 2018, if funds available (around 20 to 30 million m ³ /year)