Report Number: ICRR0022166

1. Project Data

Project ID	Project Name
P127759	IRRIGATION SYSTEM ENHANCEMENT PROJECT
Country	**Practice Area(Lead)**
Armenia	Water

L/C/TF Number(s)	Closing Date (Original)	Total Project Cost (USD)
IBRD-82670,IBRD-87860	30-Jun-2017	31,030,974.87
Bank Approval Date	**Closing Date (Actual)**	
22-May-2013	31-Dec-2019	

	IBRD/IDA (USD)	Grants (USD)
Original Commitment	30,000,000.00	0.00
Revised Commitment	31,735,008.16	0.00
Actual	31,659,236.60	0.00

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2. Project Objectives and Components

a. Objectives

The Project Development Objectives (PDOs) for the Irrigation System Enhancement Project (ISEP) were (i) to reduce the amount of energy used and to improve the irrigation conveyance efficiency in targeted irrigation schemes; and (ii) to improve the availability and reliability of important sector data and information for decision-makers and other stakeholders.

The PDOs are the same in the legal agreement and the Project Appraisal Document (PAD).

For the ICR review, the PDOs are parsed out into four objectives:

1. to reduce the amount of energy used in targeted irrigation schemes,
2. to improve the irrigation conveyance efficiency in targeted irrigation schemes,
3. to improve the availability of important sector data and information for decision-makers and other stakeholders,
4. to improve the reliability of important sector data and information for decision-makers and other stakeholders.

b. Were the project objectives/key associated outcome targets revised during implementation?

No

c. Will a split evaluation be undertaken?

No

d. Components

Component 1. Irrigation System Enhancement (appraisal cost: US$33.1 million; actual cost: US$33.3 million). This component aimed to lower the operation and maintenance (O&M) needs of the conveyance section of selected irrigation schemes by supporting the following three activities. First, four pump-based irrigation schemes (Baghramyan-Norakert, Geghardalich, Kaghtsrashen, and Meghri) were to be converted to gravity-based irrigation schemes. Second, in 13 pump-based irrigation schemes different from the four above, outlet (and other) canals conveying the pumped water to secondary and tertiary canals were to be upgraded ('rehabilitated'). Third, in the Geghardalich scheme, the height of the reservoir's dam was to be raised.

Component 2. Management Information (appraisal cost: US$1.7 million; actual cost: US$0.9 million). This component aimed to improve the information available for decision making by supporting the following three activities. First, technical investigations would analyze the O&M and extraordinary maintenance (EM) needs of the irrigation systems. Second, a technical audit of different irrigation institutions supported by the project (see below) was conducted. Third, the project would install a supervisory control and data acquisition system (SCADA).

Component 3. Support to Project Management and Water User Associations (WUAs) (appraisal cost: US$2.7 million; actual cost: US$2.9 million). This component aimed to support project management and strengthen the capacity of the Support Group (SG), staff, and executive bodies of WUAs.

Note that the appraisal costs for each component above were derived from paragraph 32 in the PAD and included contingencies. The actual costs for each component were based on paragraph 15 of the ICR and not Annex 3 in the ICR.

e. Comments on Project Cost, Financing, Borrower Contribution, and Dates

Project Cost. The original total project cost estimate in the PAD was US$37.5 million. The estimated total actual cost as shown in the ICR Data Sheet was US$31.7 million.

Financing. The IBRD committed through a Loan Agreement to finance US$30 million of the project cost which was increased by US$2 million through Additional Financing (AF). The ICR (Data Sheet) reports that the actual IBRD disbursement totaled US$31.7 million.

Borrower Contribution. According to paragraph 33 in the PAD the Government of Armenia (GoA) committed to contribute US$7.5 million to the project, but the ICR (Data Sheet) reports, without explanation, that the GoA did not contribute.

Dates. The project was approved on May 22, 2013, and became effective on July 15, 2013. The Mid Term Review (MTR) was held on November 16, 2015. The original date of closure was June 30, 2018; but was changed several times as a result of several project restructurings. As a result, the actual closing date was December 31, 2019, i.e., two years after the original closing date.

Restructuring. During the second project restructuring in November 2017, the project accommodated the request of the GoA for an AF of US$2 million for the project to rehabilitate the tertiary irrigation infrastructure of the Baghramyan-Norakert scheme. It would also allow more time to finalize infrastructure work in the Geghardalich and Kaghtsrashen schemes after local communities raised their concerns about the social and environmental impacts of the infrastructure works (see section 8).

3. Relevance of Objectives

Rationale

The agricultural sector is the main livelihood provider for rural households in Armenia. As such, productivity growth in agriculture plays an important role in rural development and poverty reduction. Irrigated agriculture is the dominant agricultural production system but its full potential in terms of acreage has not been achieved. Moreover, the delivery of irrigated water by irrigation institutions from the intake water source to the end-users (farmers) is inefficient. First, the irrigation infrastructure dated from the Soviet Union period. The Water Supply Agency (WSA) managing the primary irrigation canals had low cost-recovery rates because of the high energy costs of pumping irrigation water into primary outlet canals and the high O&M costs of the irrigation canals. Second, the deteriorated state of the irrigation infrastructure also reduces the irrigation conveyance efficiency, thus limiting the amount of irrigated water available for end-users. Third, while Armenia had already introduced WUAs as legal entities to manage secondary and tertiary water canals, these groups require continued capacity-building and empowerment support. Finally, the different institutions responsible for water delivery – the Water Committee (WC but earlier referred to as State Committee for Water Management (SCWM)) of the Ministry of Territorial Administration and Infrastructures and the Ministry of Energy, Infrastructures and Natural Resources (MOEINR) – lacked information and accurate data on the financial sustainability needed for efficient and effective decision making in the management of irrigation schemes of Armenia.

The PDOs were relevant to the principles outlined by the Government of the Republic of Armenia (GoA) in its ‘5-year programme of the GoA for 2019 – 2023’. More specifically, the GoA aims to modernize the management of its irrigation systems and make irrigation water more widely available (‘as common as electricity’) by replacing mechanical irrigation systems with new gravity-based technologies. Such an upgrade of the irrigation infrastructure is complemented with efforts to introduce technologies that reduce

water losses (for example, drip irrigation), support for legislative and institutional reform in the management of irrigation systems, and collection of important data needed for improved water management.

The PDOs were also relevant to the engagement of the World Bank in Armenia, as reflected in the most recent Systematic Country Diagnostic (SCD, 2017) and the Country Partnership Framework (CPF, 2019 – 2025). The SCD identified the outdated and uneconomical irrigation system as one of the main constraints holding back the transformation of the agricultural sector towards a modern commercial sector and more broadly a structural transformation. As a result, the third focus area of the CPF (Sustainable Management of Environmental & Natural Resources) drew attention to improved management of water resources, enhanced water security and climate resilience, and more sustainable energy consumption in, among others, irrigation systems. The CPF (paras 50 and 83), moreover, noted a shift in the World Bank approach from supporting the supply of irrigation water to bolstering the cost recovery and financial sustainability of irrigation schemes partly driven by the crowding-in of other development partners which focused on water supply issues in the sector. As such, the PDOs of the ISEP were aligned with both the CPF objectives and those of the development partners.

The PDOs were also relevant to addressing the higher-level development challenge of the low productivity of the (irrigated) agricultural sector in Armenia. In particular, the project aimed to support different institutions responsible for the delivery of irrigation water by reducing their O&M costs and improving their access to information needed for decision making in irrigation management. As the focus was on water delivery, it addressed three of the four challenges in water delivery identified in the first paragraph of this section. However, while the activities under component 3 supported WUAs, institutional strengthening was not included in the PDOs. Hence, the ISEP did not explicitly address one of the main identified challenges to water delivery. According to the ICR (para 77), this decision was deliberate and requested by the GoA. The WUA-support activities were envisioned to improve data availability and reliability for decision-makers in the irrigation sector, but general capacity-building activities do not necessarily result in improved availability or reliability of important information. Nonetheless, the PDOs were clearly defined and had an appropriate level of ambition. Therefore, the Relevance of the ISEP's objectives is rated High.

Rating
High

4. Achievement of Objectives (Efficacy)

OBJECTIVE 1

Objective
Objective 1: To reduce the amount of energy used in targeted irrigation schemes

Rationale
Theory of change. By converting the existing pump-based irrigation schemes into gravity-based irrigation schemes, the project sought to reduce the high energy usage of the four targeted irrigation schemes. More precisely, the project aimed at reducing the electricity cost needed to pump the water from the water source

into the primary outlet canals. The use of gravity-based irrigation schemes that do not consume electricity was a logical solution to avoid this pumping cost, under the assumption that the gravity-based irrigation schemes have an equal water-supplying capacity compared to the existing pump-based schemes. The replacement of pump-based irrigation schemes by gravity irrigation schemes was expected to result in the shutdown of pumping stations, that would be removed or decommissioned. Thus, in the medium term, WSAs would be able to reduce their O&M cost by relying on gravity rather than electric power.

Outputs. The ICR reports one intermediate results indicator that is an output indicator relevant for the first objective of the project:

- One (1) pumping station shut down, far below the original target of four. According to Annex 1 (p43), only the Meghri gravity scheme was fully operational, and its shutting down of pumping stations can be attributed to the project.

Outcome. The outcome indicator reported in Annex 1 of the ICR related to the first objective is the following:

- 3.7 GWh of energy saved annually in operating the irrigation system, far below both the original target of 38 GWh and the revised target of 36.8 GWh for the four schemes. The project therefore achieved only 10 percent of the revised target for energy savings.

Discussion. At the time of the ICR, the project was unsuccessful in converting the four targeted pump-based irrigation schemes into gravity-based irrigation schemes. Only the conversion of the Meghri scheme was successful. However, this achievement was only partial, as the pumps were required to be maintained and functional during the drier moment of the production season. The construction works of the Geghardalich Scheme were not finalized because the project failed to formally settle the complaints by one of the communities in the upstream area of the irrigation scheme. The conversion in the Kaghtsrashen Scheme was finalized but not yet operatorial: the infrastructure failed several pressure tests caused by leakages in the cheaper but lower-quality construction material. The Baghramyan-Norakert scheme was also not operational. Its inclusion into the project was questionable because both the gravity pumps and the tertiary delivery system were dysfunctional for several years before the project started.

During the writing of the ICR review, the World Bank team provided an update on the status of the conversion of the three remaining pump-based irrigation schemes to gravity-based irrigation schemes. In a follow-up communication, the ICR team indicated that “the Kaghtsrashen irrigation scheme was declared operational [in May 2020]. It now generates energy savings as envisaged at project stage”. The other two schemes have not been finalized, but commitments have been made (see section 7). The saving of energy costs in the Kaghtsrashen scheme amounts to 8 GWh. This brings the total amount of energy saved in 2020 to 11.7 GWh, which is still only one third of the revised target.

The rating for the Efficacy with which objective 1 was achieved is therefore Negligible.

Rating
Negligible

OBJECTIVE 2

Objective

Objective 2: To improve the irrigation conveyance efficiency in targeted irrigation schemes

Rationale

Theory of change. The project sought to increase conveyance efficiency and reduce water losses by rehabilitating outlet (and other) canals conveying the pumped water from the water intake source to the secondary and tertiary irrigation network. The assumption was that if less of the total water pumped into the outlet canals was lost due to leakage of seeping, more water would become available for irrigation users. This would allow the size of irrigated land to increase, including land previously (but not currently) irrigated or land that previously could not access irrigated water. A smooth delivery of water from the main canal to end-users assumed that secondary and tertiary distribution canals were functional so that the water from the outlet canals would effectively reach the end-users.

Outputs. The ICR reports four intermediate results indicators that are relevant output indicators for the second objective of the project:

- 57 km of outlet canals receiving water from rehabilitated pumping stations, exceeding the target of 52 km. The label of this output indicator is confusing. In the 13 irrigation schemes where the outlets (and other) canals conveying the pumped water to the distribution canals were upgraded, the pumping stations themselves were not rehabilitated. Only the canals were rehabilitated (under component 1). An indicator with the label “km of rehabilitated distribution canals through an outlet” would have been clearer.
- 9,537 hectares provided with improved irrigation and drainage service, substantially below the original target of 12,932 hectares. The rehabilitated outlet canals contributed 8,851 ha and the Meghri gravity scheme contributed 686 ha.
- 8,286 water users provided with improved services, substantially below the original target of 12,336.
- 331 female water users provided with improved services, substantially below the original target of 493 km.

Outcome. The outcome indicator reported in Annex 1 of the ICR related to the second objective is:

- 21.44 Cubic Meter (m3) water losses reduced in rehabilitated canals, slightly below the revised target of 23.58 m3. Note that the original indicator was ‘lost liters per second per 100 meters in the targeted irrigation schemes’ with the original target of 0.71 liters per second per 100 meters. The indicator was simplified during the MTR and the measurement unit changed to million cubic meters. To measure this indicator, the ICR measured “the difference between the amount of water to be pumped before and after rehabilitation for irrigating the command area without changing the crops patterns or intensity.” It used data that were provided by the borrower, which were from 2018. Hence, the value reported in the ICR on what was actually achieved at completion in December 2019 was outdated by at least 12 months.

Discussion. The project nearly achieved the outcome of reducing the amount of water lost in the rehabilitated canals. At the same time, the project delivered more rehabilitated outlet canals as output than targeted. Hence, while more canals had been rehabilitated (output) than anticipated, less water was saved (outcome). In a follow-up communication, the ICR team explained that because the rehabilitated canals could

reach a larger command area (8,851 ha instead of 8,537 ha), more water has been pumped into the canals, resulting in higher absolute numbers of conveyance losses and lower savings in water.

It is also unclear why the ICR reports three output indicators related to improved service delivery. There are no project activities that support the improvement of irrigation and drainage services in the project. The ICR (para 11) explicitly mentions that the project "intently focused on reducing costs of water delivery […] and less directly on improving service delivery". Moreover, improved irrigation and drainage service delivery does not *lead* to improved efficiency, it is the result thereof. It is further unclear what the project considered to be improved services and how the improvement was measured. Finally, the project did not achieve improved service delivery, but even if it had done so, it cannot be attributed to the project and there was no impact on conveyance efficiency. This review concluded that the efficacy assessment of the second objective should not consider output indicators related to service delivery.

The rating for the Efficacy with which objective 2 was achieved is therefore Modest.

Rating
Modest

OBJECTIVE 3
Objective
Objective 3: To improve the availability of important sector data and information for decision-makers and other stakeholders

Rationale
Theory of change. The project sought to improve decision making in irrigation management by improving the availability of important sector data and information used by decision-makers and other stakeholders. The project was, however, not clear on what type of sector data was important and who the decision-makers were who would make use of the data.

Outputs. Annex 1 reports three PDO indicators and several intermediate results indicators related to the availability of sector data and information. However, this review did not consider all of these indicators in the assessment of the efficacy of the third objective. First, two of the original PDO indicators in the PAD ('Data about O&M and EM used by SCWM, WSAs and WUAs for decision making' and 'Technical audit of irrigation agencies used by MOEINR and SCWM for decision making') were later merged into one PDO indicator ([Data] *entered* into a data base to be used for budgetary and investment planning purposes). However, this indicator refers to an achievement on an output and not does not reflect an objective. The ICR review, therefore, considered this composite indicator as one output indicator. Second, not all of the seven intermediate results indicators listed in Annex 1 were directly related to the availability of data. Therefore, a selected overview of the achievements on this review's choice of relevant output results indicators is provided here:

- [Data] *entered* into data base to be used for budgetary and investment planning purposes, compared to the target of data *used* for budgetary and investment planning purposes. Since the results framework of the ISEP only reports on the entering and not effectively using the data, IEG could not verify the achievement concerning the original target. In footnote 27, the ICR acknowledges that

"evidence is lacking for [the technical assessments] having informed decision making". Similarly, the ICR (para 46) states that "because there have not been significant investment decisions by the irrigation sector institutions since the completion of these technical investigations in late 2018, the extent to which these indicator' targets were achieved remains inconclusive at the time of completing this ICR".

- 80 observation points have been equipped with installation of limnographs and water measurement devices for the SCADA system, achieving the target of 71 observation points. However, at the time of the ICR, only 50 devices were considered fully operational, and 30 devices were planned to be repaired (ICR footnote 29). Hence, while the project achieved the target of installing equipment, it did not achieve the target of *operational* equipment.
- The ICR also lists five output indicators that were related to the institutional strengthening of irrigation management institutions. As mentioned before, there was no separate PDO on institutional capacity-building and it is unclear how institutional capacity-building activities affected the availability of data. Attribution would also be difficult. As a consequence, any achievement of these indicators was not considered as evidence in this review on whether important irrigation information was more readily available to decision-makers and stakeholders.

Outcome. The outcome indicator reported in Annex 1 of the ICR to measure the third objective was:

- 93 percent of WUAs having water intakes tracked by SCWM in real-time, slightly below the target of 100 percent. The underachievement is related to the fact that one of the 15 WUAs did not install the SCADA system, because that irrigation system receives water from local sources and not the WSA.

The outcome indicator in the results framework and the ToC related to information activities measured achievement on the availability of water flow data. The project, thus, lacked outcome indicators to assess achievement on improved availability of the two other sources of information, i.e, the O&M and EM costs and a technical audit of irrigation institutions. There is, thus, inadequate evidence that the availability of important sector data for decision makers improved.

Discussion. The evidence presented in the ICR does not allow IEG to conclude that the project successfully achieved the objective to improve the availability of important sector data. The project reports slight underachievement on the availability of information on water intakes to decision-makers (i.e., WUAs) but more worrisome is that only 50 of the reported 80 observation points were operational devices to measure water flows. Moreover, the presented evidence is too weak to conclude that the availability of information on budgetary and investment to decision-makers improved. The fact that information is entered in a database is a necessary but not a sufficient condition for the information to be available to (and being used by) decision-makers and stakeholders. This is acknowledged by the ICR (ICR para 46). Moreover, evidence is only available on improved information on water flows, not other important data and information.

Conclusion. Because of inadequate evidence, the achievement of the third objective is rated Modest.

Rating
Modest

OBJECTIVE 4

Objective

Objective 4: To improve the reliability of important sector data and information for decision-makers and other stakeholders

Rationale

Theory of change. The fourth and last objective to improve the reliability of data feeds upon the third objective of data availability. Reliability, as defined in the Oxford Dictionary, is “the fact of being likely to be correct or true”. Hence, not only is it important to have data available, the data needs to be measured accurately (and frequently). But the same argumentation of why there is an unclear link between the availability of information and effective use of information applies to the reliability of data.

Outputs. The same output indicators listed under objective 3 on the availability of information also contribute to the reliability of the data.

Outcome. The same outcome indicators listed under objective 3 on the availability of information also contribute to the reliability of the data.

Discussion. The near achievement of the project on the share of WUAs having water intakes tracked by SCWM in real-time is of particular relevance to data reliability. According to the ICR (para 47 to 49), the real-time tracking of water flow volumes by the SCADA system is much more accurate than the traditional measurement system. This has contributed to resolving disputes and conflicts between (i) WSA and WUAs, (ii) WUAs and its members, and (iii) WUAs and up- or downstream water users. More accurate and timely measurement of water flows is stated to have improved decision making, suggested by the more accurate fee collection by WUAs and lower operational losses by the WSA. The ICR (para 50) also states that interviews with SWA staff indicated that the SCADA system “helped to advance their understanding of water balance in the irrigation system; thus, improving management and future investment decisions”.

However, there is a lack of quantitative data to conclude achievement claimed in the qualitative assessment. First, there is no evidence presented in the ICR that WUAs collected more accurate fees from users to close their budget gaps. Data on WUA collection fees and budget are the outcome of an effective M&E system in a project supporting WUAs. Second, the ICR shows a correlation between the aggregated water supply and the amount of water lost, to illustrate the effect of the introduction of the SCADA system (Figure 2 p20). While this correlation could be plausible, the ICR used data for the entire WSA network in Armenia, and not the specific schemes and canals supported in this project. Hence, attribution to the project is difficult. Finally, the above-mentioned qualitative assessment of ‘improving […] future investment decisions’ contradicts the ICR statement that “there have not been significant investment decisions by the irrigation sector institutions” (ICR para 46).

Conclusion. Because of insufficient evidence, the achievement of the third objective is rated Modest.

Rating

Modest

OVERALL EFFICACY

Rationale

The achievement of the project to reduce electricity costs from the conversion to gravity-based pumps was Negligible. Only one of the four schemes was (partly) converted before the project closed but another was converted and declared operational 5 months after the project closed. Nonetheless, the amount of electricity saved remains well below the project target. The project almost achieved the targets on improved conveyance efficiency (measured as reduced water losses) but the evidence is weak. There is also insufficient evidence to assess whether the third and fourth objectives on improved availability and reliability for decision making were achieved. These three objectives were therefore rated Modest. As a result, the overall efficacy is rated Modest, as, from a system perspective, little progress was made to enhance the effectiveness of the irrigation system in Armenia.

Overall Efficacy Rating	Primary Reason
Modest	Insufficient evidence

5. Efficiency

Economic and Financial efficiency

The ICR states that the project intentionally focused on reducing the O&M costs of water delivery and improving the information for decision making in irrigation. Thus, the direct project beneficiaries were the institutions responsible for water delivery institutions and not the end-users, that is, the farmers. The latter were expected to indirectly benefit in the medium term from the increased water availability that the WUA could distribute among its members. This is expected to increase agricultural productivity in the longer term (ICR para 11).

The project's short-term benefits thus accrue to the WUA with lower O&M costs and more water available for their users to irrigate the existing land or to incorporate new land into irrigation.

The economic analysis in the PAD is based on a with-and-without project comparison that assumed three types of benefits: (1) savings in electricity usage from the conversion from pump-based to gravity-based irrigation infrastructure, (2) increased intensity of production and the shift towards higher-value crops, and (3) water delivery to parts of the command area that could previously not be served. Combining both the benefits and costs of the project, the Internal Rate of Return (IRR) at the project appraisal was 25 percent.

The ICR updated the assumptions and unit costs in the IRR methodology used in the PAD. Most importantly, the assessment took into account delays in the finalization of irrigation schemes and applied an optimistic and conservative calculation approach. However, these approaches are not well explained in the ICR. The footnote on the conservative approach mentions 'Lessons learned from completed projects (Meghri and outlet canals) are reflected in the other water conversion schemes' while the footnote on the optimistic approach mentions 'Whole additional area considered will be irrigated.' However, using these two approaches, the ICR arrives at an optimistic IRR of 17 percent and a conservative IRR of 14 percent.

While it is applaudable that the ICR revised the methodology to account for the operational delays in the estimated IRR, there are some flaws in the (updated) methodology presented in the ICR. First, there is friction in the economic analysis between the expected achievement of the TOC (to reduced electricity costs and water loss of irrigation institutions) and the medium- or longer-run benefits to farmers included. The benefits are

measured at the level of the end-users, not the project beneficiaries. The medium-term benefits of increased productivity and higher-value crop production are also uncertain to accrue. Access to irrigation water is unlikely to automatically incentivize beneficiaries to upgrade their irrigation farming system. Because the project did not address farm-level constraints to irrigation systems, it would be difficult to attribute the yield benefits wholly to the project. Moreover, it unlikely that the project would have achieved these medium-term benefits during the course of the project given the implementation delays.

Second, several assumptions on the costs and benefits in the financial analysis require more discussion and justification. First, it is unclear how the 'water savings from rehabilitation of outlet canals' result in savings of electricity usage. Similarly, it is unclear what is meant when the optimistic approach assumes that "Whole additional area considered will be irrigated" and how that assumption is different in the conservative approach. Second, the estimation of the relative benefits of the increased irrigated area makes a strong assumption that no crops were cultivated on the lands without access to irrigation water (because no data were available). However, this assumption could have been verified with the project team on the ground, using government statistics, or using georeferenced data. Third, the analysis assumes O&M costs to be 2 percent of the investment costs for both the converted irrigation schemes and the rehabilitated outlet canals. Without more evidence, it is difficult to assess whether this is a realistic assumption.

Operational efficiency

The project exhibited many operational inefficiencies. Most of these examples were related to design issues (see Section 8). Most importantly, the design of the project failed to verify the existing field conditions of the irrigation infrastructure in the four targeted schemes. It also failed to notice the non-operational pumps and non-existent or highly-deteriorated state of the tertiary distribution network in the Baghramyan-Norakert scheme (ICR para 28). Insufficient involvement of and consultation with local communities at the design stage resulted in conflicts with local communities in two schemes (see section 9). It also overstretched the implementation agency (WSPIU) because it had to focus on resolving community issues (ICR para 80). The efficient implementation of the project was further constrained by some of the – according to the ICR – well-intended course changes that turned out to be less effective than the original design. Most notably, the decision to replace the metallic/steel pipes with locally produced glass-reinforced plastic (GRP) pipes was detrimental to the operational efficiency in the Kaghtsrashen scheme. While GRP is a cheaper material, it does not perform well in high elevations, slopes, and for long-distance pipes; and the local contractor was unaware of the construction requirements when installing these types of pipes (ICR para 82). After failure on the first pressure test, the contractor replaced the leaking pipeline joints at its own expenses, but the infrastructure failed the second pressure test as well. As mentioned in section 3, the Kaghtsrashen scheme became operational 6 months after the project closure (that is in May 2020).

Conclusion

The Economic and Financial efficiency analysis is based on the returns on investments to all four irrigation schemes. The ICR is optimistic that the GoA will finalize the construction works in the remaining three irrigation schemes (ICR para 53). On the contrary, the ICR also argues that it is uncertain that the GoA will complete the remaining infrastructure work (ICR para 41). Besides the confirmation from the follow-up communication that the Kaghtsrashen scheme is operational, it remains to be seen whether the project's objectives in the two unfinished irrigation schemes will be achieved within 2 years. This is crucial for the project to remain economically viable. Moreover, it is also uncertain whether the expected benefits in the Geghardalich and Baghramyan-Norakert Gravity Schemes will fully materialize, as the benefits as the actual amount of energy saved might be different from the current amount of energy used for water delivery. Most notably, the engagement and interest of local

communities in using the irrigation schemes might be uncertain. Therefore, the project's overall efficiency when it closed, or even 5 months thereafter – when the Kaghtsrashen scheme became operational – is rated Modest.

Efficiency Rating

Modest

a. If available, enter the Economic Rate of Return (ERR) and/or Financial Rate of Return (FRR) at appraisal and the re-estimated value at evaluation:

	Rate Available?	Point value (%)	*Coverage/Scope (%)
Appraisal	✓	25.00	100.00 ☐ Not Applicable
ICR Estimate	✓	14.00	100.00 ☐ Not Applicable

* Refers to percent of total project cost for which ERR/FRR was calculated.

6. Outcome

The relevance of the project was high to the government's objective to modernize the irrigation sector in Armenia and to the main elements of the World Bank's engagement with the country. The efficacy of the project was, however, rated modest because of conclusive evidence that the project failed to achieve the first objective to reduce energy costs and the inconclusive evidence that information was more available and reliable and that it was used for decision making. The evidence on improved conveyance efficiency was weak. While the analysis of the economic efficiency in the ICR arrived at an overall assessment that its internal rate of return was just above a discount rate of 10%, it remains uncertain whether the unfinished irrigation works would be finalized and operational in due time. Moreover, significant construction flaws resulted in operational inefficiencies in the Kaghtsrashen Gravity scheme that could have been avoided with the use of higher-quality material.

According to IEG's rating guidelines, a High rating for Relevance, a Modest rating for Efficacy, and a Modest rating of Efficiency indicates an overall Outcome rating of Moderately Unsatisfactory.

a. Outcome Rating

Moderately Unsatisfactory

7. Risk to Development Outcome

The risk to the development outcome is expected to be significant. At the time of the ICR, it remained uncertain whether the non-operational irrigation schemes would be finalized soon after project closure as further implementation delays were expected. The ICR (para 108) warns for the "limited success in the final year of the Project to effectively address the technical and community challenges that have hamstrung the

functionality and completion of the Kaghtsrashen and Geghardalitch Schemes". According to the efficiency analysis, if the infrastructure works are not finalized within two years, the project becomes economically not viable. The ICR (para 64) states that: "[…] it is noteworthy that further delays in Geghardalitch and Kaghtsrashen Schemes […] beyond a two-year delay […] would sufficiently place these schemes into the category of being economically not viable". Moreover, local communities have shown limited interest in the new technologies considered in the Baghramyan-Norakert Scheme. According to the ICR (para 65) "A delay in its implementation would only further decrease the expected net benefits below the 10 percent threshold". Hence, based on the lack of evidence that there is a strong commitment to finalize the conversion of the three schemes within the next two years, and that communities will make use of them, the ICR anticipated that the economic viability of the project could fall below a 10 percent discount rate.

In a follow-up communication to IEG, the ICR team expressed optimism regarding the completion of the Gegardalich and Baghramyan-Norakert Schemes. "First, the [GoA] agreed to mobilize funds for the completion of the Geghardalich gravity scheme [during the 2021 season]. There are 2.9 km of pipeline missing upstream to connect the system to the reservoir. Once done and the system has been tested satisfactorily, it will be declared operational and pumping will not be needed anymore. Second, the Baghramyan-Norakert Scheme has been converted from a previously pumped to a gravity-fed system. Additional financing was used to upgrade the entire system to a piped and naturally pressurized system which, delivers filtered water to over 85 hydrant stations. The system has been tested and declared functional. There are minor improvements needed to improve operability of the system. The problem is on the downstream side as [most land is bare and not cultivated]. [This] needs investment into the development of high value orchards and vineyards including drip irrigation systems. This component will be supported from fund of the European Union (EU) and the Agence Française de Développement (AFD)." While these commitments are indeed promising, the realization of these investments, and the full operationalization of these schemes two years after the projects closure, remains to be seen. Moreover, if the Geghardalich Gravity Scheme is rehabilitated by 2021, this is a considerable time after project closure in December 2019.

The ICR identifies the crucial necessity to solve the fundamental governance issues around water-user rights and the continued need for institutional, technical, and financial support for the project to achieve the expected outcomes. Regarding institutional support, the outlook is also not so promising. The WC and SG have undergone several changes in their structure and leadership, resulting in reduced resources and staff to provide technical assistance and support to WUAs. The decision to restructure and centralize the governance of the WUA system also reduced the trust between WUA members and management. As a result, the level of technical and institutional support has decreased over time and that is likely to put another constraint to the effective management of irrigation schemes.

This review assessed the risk to the project's development outcomes as Substantial.

8. Assessment of Bank Performance

a. Quality-at-Entry

While the solutions proposed by the project to reduce energy costs and water losses were simple and sound, the design and implementation of these solutions were not sufficiently prepared and finetuned to the local circumstances. Especially the design of the project component to convert pump-based irrigation schemes to gravity-based irrigation schemes was not adapted to the local socio-economic realities and

complex topography. Moreover, there was a lack of a comprehensive approach that would take into account the concerns, water needs, and expectations of the local communities in and around the irrigation schemes. The following design flaws significantly hampered the effective and efficient implementation of the project but could have been avoided if the project design would have paid sufficient attention to the preparation and feasibility of the infrastructure work.

First, the feasibility of the conversion to gravity-based schemes was not properly assessed during the design stage and lacked a comprehensive perspective taking into account seasonality and water-user rights of outside communities. At the time of project closing, only the Meghri scheme was operational. But even the operational Meghri scheme still relies on the use of several electric pumps during drier periods of the irrigation season. When the river contains insufficient water, the gravity system will not be able to deliver water to the lower-located fields of remote end-users (ICR para 41). When the Geghardalich scheme is finalized, it is envisioned that electric pumps need to remain in standby mode to assure that all communities (in and around the scheme) have access to sufficient water. In redesigning the Kaghtsrashen scheme to accommodate community concerns, the construction of additional electric pumps was needed for the scheme to become operational. Even though the need to rely on electric pumps is a consequence of departures from the design to accommodate the concerns of local communities, the continued dependency on electric pumps defeats the whole purpose of promoting the conversion away from pump-based water delivery. If further questions the feasibility of gravity-based irrigation schemes if seasonal effects and the needs of all water users in the landscape are considered.

Second and similarly, during project implementation, it was found that the pumps in the Baghramyan-Norakert scheme had been out of operation for between 5 to 20 years. It was also found that the tertiary distribution network (for the reliable delivery of irrigation water from the outlet canals to water users) in this scheme was non-existent or in a state of significant disrepair (ICR para 28). This implies that the design of the project did not assess (or verify) but rather assumed the adequate state of the irrigation pumps as well as the tertiary distribution network. This was an error that could easily have been verified in the field (by, for example, an appraisal team field visit at the time of site selection). The ICR (para 40 and 78) rightly questions the site selection in the design of the project.

Third, in the Kaghtsrashen scheme, the project design inaccurately assumed that steel pipes could be replaced by cheaper GRP pipes. The ICR (para 82) notes that “the decision to use GRP piping was made to accommodate higher than expected costs for the steel piping and to experiment with a more modern and innovative solution”. However, because GRP pipes are more sensitive to destruction due to topology and seismic activity, and local contractors lacked the knowledge and experience to use the materials during construction, quality issues (e.g. the in-field lamination of pipes joints and the lack of storm-water overflow structure) caused the scheme to fail on pressure tests at the time of completion. The implicit assumptions made by the project that construction material can be replaced and that local contractors are capable of doing so are another clear example of how the project design did not fully understand the impact of local conditions and capacity on the effectiveness of the solution the project introduced.

Fourth, the design of the project handed the control of the water flow upstream to operators who would regulate the delivery of irrigated water to irrigation farmers based on the water availability upstream of the river. This arrangement, however, could result in substantial water losses when water is supplied to the irrigation canals at times of low downstream water demand. The ICR (para 25) states that it is only because the completion of the irrigation infrastructure was delayed in two schemes, that the project had the opportunity to adjust the regulation of water streams by installing control valves along the irrigation canals that allowed downstream users to regulate water inlets into the tertiary canal system. While this

project adjustment to a demand-based water control is likely to reduce water losses, it illustrates that the aspect of water control was not fully thought through at the design stage.

Finally, the construction works in the Geghardalich and Kaghtsrashen schemes had to be halted because of conflicts with stakeholders in and around the local communities upstream of the irrigation schemes. These stakeholders raised concerns about the reduced availability of water for upstream use and the impacts on the environment and cultural heritage. This implies that the project lacked a more comprehensive approach to irrigation management that looks at the entire landscape and water users (upstream, downstream, members, and non-members) at each site. The project also did not discuss or formalize the water-user rights of the different stakeholders that rely on the same water source as the one used for irrigation by the schemes. Ex-ante consultation with the different stakeholders in the irrigation scheme could have avoided these complaints and delays easily.

Hence, most of these technical and social issues could have been anticipated or minimized during a detailed, field-based, comprehensive feasibility study, and a careful appraisal. Surprisingly, the ICR (para 76) states that the project "included selecting schemes already analyzed and considered for pump to gravity conversion under the MCC program". The project, however, suffered throughout its entire lifespan from the lack of a decent feasibility study or on-the-ground verification of the prospects for pump to gravity conversion. Nor did the project sufficiently involve local communities in the design despite safeguard impact assessments conducted (see section 10). Later in the document, the ICR reaches the same conclusion. When explaining the drop in economic efficiency, the ICR states (para 62) that this was due to "insufficient detail of the investigations/feasibility studies performed at the time of the appraisal. If the analysis had been performed in more detail at the earlier stages by corroborating the desk review with field visits, the appraisal design and economic analyses would have identified some of the challenges, most notably the lack of an existing reliable tertiary distribution network in Bagramyan-Norakert Scheme."

Overall there were major shortcomings on a range of issues facing the project at entry. The project's quality at entry is therefore rated Unsatisfactory.

Quality-at-Entry Rating
Unsatisfactory

b. Quality of supervision
While the above-mentioned design problems became apparent as of the first year of the project's implementation, many of them proved to be hard to overcome (e.g. inappropriate selection of sites and construction materials). Regarding supervision, the ICR notes that the World Bank team provided close support including several technical supervision missions, and regularly expressed concerns about safeguards and technical design issues.

Despite this stated close World Bank support, the supervision team failed to address some of the key issues that emerged during the implementation of the project. First, the weak results framework and its disconnect with the M&E system was not addressed, except for some minor changes during the project restructuring. During the second project restructuring, it was decided that the technical assessments of the O&M and EM data and the audit of irrigation agencies (used for the third and fourth PDO indicators,

respectively) were to be replaced by one indicator, reducing the scope and cost of the activity. Therefore, these technical assessments were not conducted early during the project implementation (as envisioned) but in 2018. As a consequence, the project failed to collect baseline data on O&M and institutional improvements (ICR para 22). Moreover, the results framework was updated to replace two earlier PDO indicators with a new indicator of "[Data] entered into database to be used for budgetary and investment planning purposes". As discussed in the efficacy section, this is not a relevant indicator and especially not for measuring achievement towards an objective.

Second, while the AF was requested to allow more time to finalize the infrastructure work in the Geghardalich and Kaghtsrashen schemes, it was mainly used as a pilot to introduce drip irrigation in the tertiary irrigation network in Baghramyan-Norakert. More specifically, the modernized tertiary irrigation network would provide pressurized and filtered water to individual plots suitable for drip irrigation. The ICR, however, states (para 84) that "[the AF] was a risky approach, in that there was no verifiable evidence that this modernization pilot was designed to meet expressed demand". This was especially worrisome given that farmers themselves would be responsible to invest in on-farm drip tubing to be connected to the main water supply system. Moreover, at the time most of the infrastructure was already finalized, the Ministry of Agriculture requested adjustments to the initial design that would facilitate a (potential) future process of land consolidations. Hence, the AF suffered from similar complexity issues and did not properly incorporate the needs of the end-users in its design.

Finally, the concerns of local communities in the Geghardalich and Kaghtsrashen schemes did not only delay the construction of irrigation infrastructure, they were also never formally settled.

This review found that there were significant shortcomings in the project's quality of supervision and it is therefore rated as Moderately Unsatisfactory.

Quality of Supervision Rating
Moderately Unsatisfactory

Overall Bank Performance Rating
Unsatisfactory

9. M&E Design, Implementation, & Utilization

a. M&E Design
The M&E design lacked clear indicators to measure and demonstrate the project's achievement to its PDOs. There were no indicators to measure the availability and reliability of important sector data and information for decision-makers and other stakeholders. Hence, the M&E design did not provide sufficient evidence to conclude that the third and fourth objectives were achieved. The indicators used for the first and second objectives were better, but as mentioned earlier in this review and by the ICR (para 86), there was no logical results chain from inputs, outputs, to outcomes in the results framework which posed difficulties for designing the M&E system. While five out of 12 output indicators reported on the delivery of institutional capacity-building, there was no PDO related to institutional capacity. Similarly, three output indicators reported on improved irrigation and drainage services, but the ICR explicitly mentions that this

was not the focus of the project. Moreover, the concept of 'improved irrigation services' is not defined. The ICR (para 85) correctly concludes that "the indicators had shortcomings in their ability to accurately capture progress toward achieving the PDO (even after restructuring), in that they were defined in a way that left them open to interpretation."

b. M&E Implementation

The WSPIU was responsible for the data collection for the M&E – using existing systems and databases – and reporting on the progress of project achievement. The project restructurings had to adjust definitions, measurements, and targets during implementation to address some of the issues in the initial results framework, but many issues remained (see also above). The ICR (para 89) mentions that reporting by the WSPIU focused on procurement and but barely discussed the project's implementation progress (using the M&E system). Moreover, the WSPIU adjusted indicator targets beyond what was agreed during the formal restructuring, resulting in inconsistent definitions and targets and a mismatch between the information collected in the M&E system of the WSPIU and the information needed to track and illustrate progress on indicators included in the official results framework of the project (ICR paragraph 88 and 90).

c. M&E Utilization

Due to the design issues and inconsistency between WSPIU's M&E system and the project's results framework, the information in the M&E was not used effectively to track implementation or inform decisions during project restructurings (ICR para 90). Hence, the M&E system failed to guide decision making in the project's implementation.

M&E Quality Rating

Modest

10. Other Issues

a. Safeguards

The project was classified under the environmental category B and triggered OP/BP 4.01 on Environmental Assessment, OP 4.09 on Pest Management, OP/BP 4.12 on Involuntary Resettlement, OP/BP 4.37 on Safety of Dams, and OP/BP 7.50 on Project on International Waterways. Accordingly, the borrower developed an Environmental Management Framework (EMF) and a Resettlement Policy Framework to guide site-specific environmental and social work for all sub-projects. The ICR (para 93) states that "Environmental and Social Impact Assessment (ESIA) was carried out for works on some irrigation schemes and Environmental Management Plans (EMPs) developed thereafter, or self-standing ESMPs were prepared for others" but it is unclear whether all irrigation sites targeted by the project received a social and environmental assessment.

The PAD (para 84) states that "because the detailed designs of the civil works have not been finalized and the exact footprints of the works are still not defined, as a precautionary measure, the World Bank's

Operational Policy on Involuntary Resettlement (OP4.12) was triggered and a Resettlement Policy Framework (RPF) was prepared." The ICR notes that the project did not cause any resettlement impacts and therefore Resettlement Action Plans were not prepared. However, the ICR also notes the unrecorded use of private land for the placement of water pipes in the Meghri scheme after the redesign, and that this issue was settled by voluntary use agreements between the SWPIU and the land-owners. This, however, downgraded the social safeguard performance to Moderately Satisfactory.

The ICR (para 93) states that the ISEP complied with all triggered safeguard policies at project closure. Nonetheless, there were significant issues with the design and reporting of safeguard implementation. The implementation of the Geghardalich and Kaghtsrashen schemes had to be halted because local communities in and around the water intake for the irrigation schemes voiced their concerns about the environmental, economic, political, and cultural damage of the construction works (see earlier references in this review). As a consequence, an inspection panel request was submitted to the World Bank in 2016 concerning both schemes. However, such social and environmental issues were only discovered during project implementation, which illustrates that these aspects were not properly taken into account when preparing the ESIAs. The borrower's comments to the ICR (para 10) state that for the Geghardalich scheme "the project had passed through all the procedures set by the Armenian legislation and the WB operation policies and all the required consultations", so it is unclear why local communities' protests emerged during project implementation if they were consulted during the project's preparation. Moreover, the ICR notes the low quality of the ESIA reports, which contributed to the delay of construction works. Finally, the ICR (para 96) states that the monitoring and reporting of environmental aspects as well as work-safety aspects "remained a relative weakness of the Project implementing entity throughout the Project implementation".

b. Fiduciary Compliance

Financial Management. The ICR reports an overall adequate and satisfactory quality of the financial management of the project. Unaudited financial reports were received by the World Bank on time and in acceptable quality. External audits of the financial statements issued unmodified (clean) opinions and were publicly disclosed. The ICR does not mention that audits were qualified.

Procurement. The financial procurement system of the project implemented the World Bank's STEP system and procurement specialists were properly trained. Despite this, the ICR notes that the complex structure and the later reorganization of the implementing agency caused insufficient proactivity and delays in procurement activities. In response, the World Bank supported the WSPIU by a 'contract monitoring activity' to improve their procurement administration and reporting.

c. Unintended impacts (Positive or Negative)

The ICR does not mention unintended impacts.

d. Other

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11. Ratings

Ratings	ICR	IEG	Reason for Disagreements/Comment
Outcome	Moderately Unsatisfactory	Moderately Unsatisfactory	
Bank Performance	Moderately Unsatisfactory	Unsatisfactory	The project suffered from several major design issues which were the result of an insufficient assessment and preparation of the feasibility of the irrigation works. The environmental, social, and water-use implications of communities outside the WUAs were not properly assessed. The additional financing during the supervision period failed to address the weak results framework, the M&E system continued to be weak, and the introduction of a complex drip-irrigation network was out of line with farmers' interests.
Quality of M&E	Modest	Modest	
Quality of ICR	---	Substantial	

12. Lessons

The ICR provides 4 detailed lessons, of which the following lessons are retained (with language adapted):

Support for the enhancement of irrigation systems needs to integrate water delivery with service delivery. In Armenia, where a minimum level of irrigation infrastructure is available, support to the irrigation sector has traditionally focused on improving water delivery. However, water delivery cannot be addressed without addressing service delivery or water rights governance at the same time. The development of the irrigation sector needs an integrated model that combines investments in infrastructure to improve water delivery with investments in improved service delivery and water-rights governance at different levels of water users. Moreover, irrigation development needs to incorporate institutional strengthening when the sector-wide institutional reform in the irrigation sector is still in a relatively early stage of development. In this project, however, there is no mention of the quality, uptake, and impact of service delivery, and therefore it provides no evidence on

whether the rehabilitation of the irrigation system enhanced the irrigation sector as a whole in Armenia.

Projects investing in irrigation infrastructure need a feasibility phase to understand and adapt the proposed solutions to the on-the-ground realities of the topology, local capacity, and social context of the irrigation infrastructure. The most significant design flaw of this project was the lack of on-the-ground feasibility study of the condition of the irrigation infrastructure and network as well as a limited understanding of the needs and perceptions of the different stakeholders involved.

Site selection for irrigation development need to look beyond the agroeconomic benefits of an irrigation scheme and include the perception and concerns of all stakeholders (within and around the irrigation scheme) that rely on the same source of water. Local communities in and around the water source of two targeted schemes raised concerns about broader-level water availability and the impact of the infrastructure works on the environment as well as cultural heritage. These complaints by local communities illustrate the obvious need to involve all local stakeholders in decisions on where and how to develop irrigation sites.

13. Assessment Recommended?

No

14. Comments on Quality of ICR

The ICR was logically written with enough information on the project background, implementation, and achievements and it complies with OPCS guidelines. The arguments made in the different sections are to-the-point, yet with sufficient detail and some concrete examples. In general, the ICR provides a candid discussion of the achievements and design (issues) of the project. Many of the issues identified in this review were acknowledged by the ICR, although in a less direct manner and with more subtle language. The ICR also critically assessed the data and reporting on project indicators received from the borrower's M&E system. The updated financial and economic analysis, despite some unclear assumptions, critically reviewed and extended the efficiency analysis.

This candid discussion is, however, not fully reflected in the conclusions it draws. At some points in the ICR, the text is optimistic and not justified based on the narrative in the preceding text. For example, in paragraph 74, the ICR states that "it can be concluded that the Project will likely have a lasting positive impact on the achievement of the 'twin goals' in Armenia". Given the ICR's description of implementation delays, the unlikely prospect of the finalization of infrastructure works in the future, and the lack of any indicator on household-level outcomes, the quote from paragraph 74 is a strong and unfounded statement.

The ICR is very brief in discussing several crucial parts of the report. Most importantly, there is only one paragraph in the 'quality at entry' discussion as part of the Bank performance section, although the project suffered from substantial design flaws at entry. The ICR does discuss the consequences of these issues

throughout the other sections, but a critical and detailed assessment of the project's design flaws at entry is missing.

a. Quality of ICR Rating
Substantial