

ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The Phuoc Hoa Water Resources Project will increase water supply, make it more reliable, and produce benefits through irrigation and domestic, municipal, and industrial (DMI) water use. The primary irrigation benefit is increased agricultural production, which is measured by the incremental value of increased production between future without-project and with-project situations. Water for DMI use will also produce economic benefits as an alternative to other, more expensive sources and as a factor of industrial production.

2. Secondary benefits that cannot necessarily be fully quantified include (i) salinity abatement in the Saigon River basin; (ii) improved drainage associated with irrigation infrastructure; and (iii) other multiple use and domestic use benefits such as the recreational use of reservoirs, improved water supply for cleaning and drinking in rural households and watering home gardens, and positive impacts on health and livelihood.

B. Methodology and Key Assumptions

3. The economic analysis follows a conventional cost–benefit analysis of calculating with-project costs and benefits minus without-project costs and benefits, with all costs and benefits converted to economic values and the results expressed as the economic internal rate of return (EIRR) and net present value, which can be compared with the opportunity cost of capital, assumed to be 12%. The economic analysis adheres to the following:

- (i) Costs and benefits are expressed in dong at 2010 constant prices using an exchange rate of D18,980 = \$1 (June 2010).
- (ii) Civil works and irrigation are assumed to have an economic life of 30 years, though the infrastructure can be expected to last much longer. The life of the project is restricted to 30 years.
- (iii) Economic costs of capital construction and maintenance costs are based on financial cost estimates adjusted to allow for transfer payments, taxes, and duties and to correct market distortions.
- (iv) The shadow value of labor is 0.8, in recognition of the low marginal productivity of unskilled labor in agriculture, construction, and maintenance.
- (v) Separate economic analyses are presented for three scenarios: phase 1 only, phases 1 and 2 combined, and phase 2 only. Separate analyses were also prepared for the Tan Bien and Duc Hoa subprojects.

4. Without supplementary financing, the project is assumed to stop with phase 1 and the completion of the barrage headworks, transfer canal, and Tan Bien main canal. The development of the two irrigation systems would not be completed, so the full benefits of irrigation development and industrial water supply would not eventuate. The economic performance of phase 1 can be compared with the economic return for phases 1 and 2 combined. Another case is supplementary financing being provided and the scope of works completed. The economic assessment of phase 2 alone with supplementary financing includes only the investment costs associated with phase 2, excluding the sunk costs incurred in phase 1, which are assessed against the benefits generated by the two irrigation systems disregarding DMI benefits already produced by the incomplete phase 1 of the project. Adopting a sunk cost approach means that the expected benefits from the original project are assessed against the reduced investment cost to complete the project. This means that the economic return from the

supplementary financing can be expected to be significantly higher than the economic return from the original feasibility study including all its investment costs.

C. Benefits

1. Agricultural Benefits

5. The project develops improved irrigation infrastructure for two subproject areas—Tan Bien and Duc Hoa—each served by its own main canal. The potential irrigable command area has been assessed as 6,725 hectares (ha) for the Tan Bien subproject, made up of 5,230 ha served by gravity and 1,495 ha served by a pump station. The Duc Hoa subproject has an irrigable area of 13,821 ha. A reduction in the irrigable area in the future with-project situation of 2.5% is assumed to allow for land taken out of production to construct canals and structures.

6. Water from the Duc Hoa main canal will also provide an alternative and more reliable supply of irrigation to two other areas for which the project does not develop irrigation systems: 900 ha in Ho Chi Minh City (HCMC) and 2,657 ha in Tay Ninh Province. A reduced benefit from irrigation has been assumed for these areas equal to 30% of the average incremental benefit for Duc Hoa for the HCMC area and 50% of the benefits of the Tan Bien scheme for the area in Tay Ninh Province.

7. The cropping pattern in the current without-project and the future with-project situation was assessed using previous studies of the project, particularly the 2000 feasibility study and the 2008 midterm review and current information provided by the design consultants for the primary, secondary, and tertiary irrigation systems. The cropping percentage for the three annual cropping seasons is assessed as 250% for Tan Bien and 190% for Duc Hoa. In the future with-project situation, this percentage is assumed to increase to 271% for Tan Bien and 278% for Duc Hoa.

8. Crop budgets were prepared for the main agricultural crops cultivated in the two scheme areas (rice, maize, peanuts, cassava, sugarcane, vegetables, and fruits) based on the input and output parameters applicable for the area. Crop budgets are calculated in financial prices using current financial prices, and in economic prices using border-parity prices for the main traded crops and crop inputs based on the latest World Bank international commodity price projections of June 2010.

9. Crop budgets in financial and economic prices were combined with the cropping pattern to generate the incremental benefits for each subproject. The average incremental benefit per hectare for Tan Bien is D13.2 million (\$695)/ha at full development, while for Duc Hoa the incremental benefits is considerably higher at D26.4 million (\$1,157)/ha. Duc Hoa has a lower cropping intensity in the future without-project situation, and its proximity to consumer markets in HCMC makes vegetable and fruit production more attractive.

2. Domestic, Municipal, and Industrial Water Use

10. The project will supply water for DMI use at 38 cubic meters per second (m^3/s). The value of DMI water is included as an economic benefit, with rising demand assumed over the 15 years from 2011 as infrastructure and industrial capacity is developed to fully utilize this water.

D. Costs

11. **Phase 1.** The cost of completing all works associated with phase 1 (the construction of the headworks barrage, transfer canal, and Tan Bien main canal) is estimated to be \$174.6 million, allowing for expenditure incurred to date and the completion of approved contracts and estimated pending contract variations to complete the work.

12. **Phase 2.** The cost of phase 2 (completing the construction of the Tan Bien irrigation system and the construction of the Duc Hoa scheme with its main canal and irrigation system) is estimated to be \$154.9 million. However, a carryover of ADB loan funds from phase 1 of \$23.3 million is expected, reducing the actual supplementary financing required to \$131.6 million (D2,574 billion).

13. **Phases 1 and 2.** The total cost of phases 1 and 2 is estimated to be \$329.5 million over the 9 years from 2007 to 2015 and is expected to construct the planned infrastructure and develop irrigation for 20,545 ha in the Tan Bien and Duc Hoa schemes.

E. Economic Prices

14. **Conversion factors.** Costs are converted to their economic value by removing taxes, transfer payments, and the shadow value of unskilled labor. The conversion factors shown in Table 1 were applied to convert costs to their economic values.

Table 1: Economic Conversion Factors

Item	Conversion Factor
Civil works	0.90
Design and overheads	0.93
On-farm irrigation system	
Structures	0.85
Canals	0.80
Environmental management	0.93
Project management	0.93
On-Farm and Social Development Program	0.93
Consultants	1.00
Resettlement	
Compensation	0.00
Implementation	0.93
Income support	0.93

Source: Asian Development Bank estimates

15. **Operation and maintenance costs.** Operation and maintenance (O&M) costs for the water transfer and irrigation infrastructure is 1.5% of the original capital cost per year over the life of the project. At full development in economic prices terms, this is equal to D52,737 million per year (\$2.78 million).

16. **Pumping costs.** The cost of pumping Tan Bien pumped irrigation is calculated to be \$22.50 per hectare per year based on a pumping head of 8 meters and a long-run economic cost of electricity of \$0.08 per kilowatt-hour.

F. Value of Domestic, Municipal, and Industrial Water Use

17. The value of DMI water is calculated as the opportunity cost of forgoing its use in agriculture, with the average return on water for irrigation in the project area estimated at

D750/m³. An analysis of the crop water demand and the incremental economic return on water in the Tan Bien and Duc Hoa irrigation area indicates an average return on water in the winter–spring cropping season of D1,168/m³ and lower return on incremental water use in the other cropping seasons, when irrigation is not as critical for crop production.

G. Results of Economic Evaluation

18. **Phase 1.** The economic analysis of phase 1, with estimated costs of \$174.6 million and benefits of 34 m³/s of DMI water (Duc Hoa DMI excluded), resulted in an EIRR of 10.8%.

19. **Phases 1 and 2.** The economic analysis of the total project (phases 1 and 2) implemented from 2007 to 2015, with costs estimated at \$329.5 million and including benefits from 20,545 ha in the Duc Hoa and Tan Bien irrigation systems plus benefits from supplying supplementary irrigation water to a further 3,557 ha directly from the Duc Hoa main canal, resulted in an EIRR of 12.3%. DMI benefits arise from the 38 m³/s distributed by the project in the four provinces and HCMC.

20. **Phase 2.** The economic return for phase 2—with supplementary financing of \$131.6 million to complete the Tan Bien and Duc Hoa irrigation systems, all investment in phase 1 considered a sunk cost, agricultural benefits from the two irrigation areas and supplementary irrigation, and 7.5 m³/s of DMI water—results in an EIRR of 16.9%.

21. The economic analysis shows that continuing investment in phase 2 to complete the project is viable, with a higher economic return than the option of stopping the project with phase 1. However, the economic return is sensitive to the timing of benefit realization, with any delay in completing the infrastructure and the primary, secondary, tertiary, and on-farm irrigation network significantly damaging economic performance. Adequate maintenance of the completed infrastructure, ongoing support to farmers in irrigation management, and the functioning of participatory irrigation management are also important to achieving the full potential of the investment.

H. Sensitivity Analysis

22. The base case economic returns for the three scenarios and the two irrigation schemes were tested for changes in the main parameters affecting economic performance: capital costs, agricultural benefits, DMI benefits, and timing of agricultural benefits. Switching value (the percentage change required in a parameter to realize an EIRR of 12%) is also calculated (Table 2).

Table 2: Sensitivity Analysis and Switching Values
(%)

Scheme Option	Base Case	Capital Costs Increased by 20%	Agricultural Benefits Reduced by 20%	2-Year Delay in Agricultural Benefits	Recurrent Costs Increased to 2.5%	DMI Value Reduced by 20%
Phases 1 and 2	12.3	11.0	8.7	11.6	11.8	11.1
Phase 1 only	10.8	9.7	na	na	10.4	9.1
Phase 2 only	16.9	14.6	12.5	14.7	16.4	16.2
Tan Bien scheme	18.8	16.5	14.3	16.6	18.4	17.9
Duc Hoa scheme	16.4	14.1	12.0	14.1	15.8	15.8

DMI = domestic, municipal, and industrial, EIRR = economic internal rate of return, na = not applicable.

Source: Asian Development Bank estimates

23. The project is most sensitive to reduced agriculture benefits and increased capital costs, with a 2% reduction in agricultural benefits sufficient to depress the EIRR to 12% for the whole project. A 5% increase in capital costs has the same affect. An increase in recurrent O&M costs from 1.5% to 2.5% does not significantly affect the EIRR. The phase 2 scenario is robust to significant changes in all the parameters on account of the sunk capital costs, with capital costs required to increase by 47%, or agricultural benefits to fall by 21%, to reduce the EIRR to less than 12%. Each of the two separate irrigation schemes, Tan Bien and Duc Hoa, has a robust economic return, with a large increase in capital costs or reduction in agricultural benefits required to depress their EIRRs. A delay in the start of agricultural benefits of 2 years does not have as much affect as other parameters. While the value attributed to DMI water is important to the analysis of the whole scheme, it is not important to the case of phase 2 only, as the two subprojects would still achieve EIRRs of over 12% without any economic benefits from DMI water.

I. Financial Analysis

24. A farm model analysis has been prepared to show the impact of irrigation development on a typical farm and the change in household income expected after the full development of irrigation and more intensive agriculture. The same crop budgets and cropping pattern in Tan Bien and Duc Hoa as was used in the economic analysis has been assumed but with current financial prices rather than economic prices. The parameters for the farm models (size and seasonal cropping pattern) are based on the information obtained from the area and from the comprehensive household survey conducted for the previous feasibility study.

25. Net incremental farm income after the full development of irrigation for all the farm models assessed is considerable, ranging from D21.83 million to D31.93 million (\$1,150 to \$1,682) per hectare, or by 102%–258%. The increase in farm income is higher in Duc Hoa than in Tan Bien because more intensive agriculture is practiced in Duc Hoa and the impact of improved irrigation is greater. The high returns are possible because farmers do not have to bear the full cost of developing irrigation infrastructure, investing only in on-farm development and contributing labor to construct the tertiary canal system.

26. The project is considered to be financially sustainable. The O&M of tertiary irrigation systems will be the responsibility of water users groups supported by the On-Farm and Social Development Program, which is scheduled to continue after the completion of civil works construction. The financial benefits farmers gain from irrigation are sufficient for them to contribute to O&M, and the project will assist the formation and operation of water users groups.