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## **9.0 ECONOMIC ADJUSTMENT FOR SOCIAL AND ENVIRONMENTAL EXTERNALITIES AND FINAL COST-BENEFIT ANALYSIS**

The impacts caused by the construction of the Panama Canal have a permanent quality, because they generated significant changes over a relatively small portion of the national territory during the fourteen-year period the works lasted. The Chagres River was dammed to create Gatun Lake, at the time the world's largest man-made lake, flooding forests, crop lands, and pastures, displacing complete communities.

On the other hand, the magnitude of social, political and cultural transformations brought about irreversible impacts in all socioeconomic aspects of the country: “the construction and operation of the waterway, an extraordinary modernization of structures and transisthmian transportation technology, also contributed to disband the geographical space, to alter the ecological balance, and to delay the rising of a stronger national personality, forced to manifest itself as a defense mechanism against the foreigner instead of being born from the accumulation of common creative experiences” (Suarez, 1972.)

The expansion will have a lesser environmental and socioeconomic impact, because it will basically take place in areas already altered at the beginning of the 20th Century during the construction of the Canal.

It is worth introducing some conceptual elements to better understand the phenomenon of externalities in this part of the study. With that end in mind, it is necessary to define the concept of externality. An externality arises when certain actions by producers or consumers have unintentional indirect effects over other producers or consumers. Externalities may be positive or negative. They are positive when the action of an individual or group benefits others without them having to pay for it. On the other hand, they are negative when the action of an individual or group causes damage to others without their being compensated for it.

Summing up, for the present analysis, all of the costs of the productive process and consumption

that affect persons who are neither the seller nor the buyer, are called, in economic terms, externalities. A way of classifying negative externalities (that cause damage to third parties) is to differentiate *environmental externalities* from *social externalities*.

- *Environmental externalities*: contribution to climate change, degradation of the ozone layer, release of toxic substances or pesticides, contribution to the reduction of biodiversity, heating and/or contamination of water, accumulation of residues, noise pollution, and emission of gases that pollute the air.
- *Social externalities*: exploitation, work under precarious conditions, work without proper environmental conditions, displacement of populations, and reduction of cultural diversity, among others.

From this starting point, and for the particular case of this study, the social and environmental externalities caused by the Canal Expansion Project will be analyzed. In other words, which concrete elements of the expansion works will affect individuals and the environment and in what manner.

## **9.1 Monetary Valuation of the Environmental Impact**

Environmental externalities are a particular type of externality that must be considered in a good economic analysis. Environmental externalities are identified as part of the environmental evaluation. Whenever possible, they are quantified and included in the economic analysis as costs and benefits of the project. They are included in the cash flow, in the same way any other costs and benefits are included. Whenever they cannot be quantified, the environmental externalities are evaluated qualitatively.

### **Scope of the project and timeline**

Two important aspects were defined for the evaluation of the environmental impacts of the Canal

Expansion Project. In first place, the scope of the environmental impact was determined. In other words, the limits of the economic analysis were defined. This is clear when the costs and benefits of the project are internal, but becomes unclear when there is an attempt to evaluate the externalities of the project to determine its impact on society. In that sense, the environmental costs of the project were internalized so that they were included in the cash flow as another cost. To make this happen the physical and conceptual boundaries of the analysis had to be broadened. In second place, the timeline had to be defined because, like the physical horizon, it becomes blurred when moved from the financial analysis to the economic analysis. Due to the fact that in the project the impacts are estimated to last less time than the useful life of the project, their effects may be included in a regular economic analysis, so the timeline was moved up to the year 2025. This seems reasonable since it is the minimum period it takes the trees of a reforested area to reach maturity.

### **Monetary valuation of the impacts**

The first step to evaluate the costs or benefits of the environmental impacts was to determine the relationship between the project and the environmental aspects, as was described in the Chapter of Identification and Evaluation of Impacts. The second step was to assign a monetary value to the environmental impact. At this point, it should be emphasized that within our ambit of an underdeveloped country, in many instances the market value of many externalities was not available. There are even cases where the market value is not known nor the functional relationship between the level of activity and the environmental impact. Therefore, it is very difficult to determine the monetary value of the impacts. There are several methods for evaluating environmental externalities. However, the choice depends on the impact to be evaluated, the data and the time available for analysis, financial resources, and the social and cultural surroundings where the valuation exercise takes place.

For the analysis of the costs related to the environmental impacts of the Panama Canal Expansion Project– Third Set of Locks, we begin with the figures provided by the ACP in the

study titled Socioeconomic Evaluation of the Expansion of Canal Capacity through the construction of the Third Set of Locks [*Evaluación Socio-económica del Programa de Ampliación de la capacidad del Canal mediante la construcción del Tercer Juego de Esclusas (INDESA, 2006)*], which presents the following data summarizing the environmental as well as some social impacts that will be detailed separately in compliance with Law Decree No. 209 of 2006. It is worth noting that probably some of these costs may vary with the implementation of the mitigation measures of the Environmental Impact Study of the Project in relation to the final distribution in time. However, for the purpose of calculating the value those amounts are considered representative and close to the reality of projects of this magnitude where approximately 1% of project costs are allocated to the environment.

**Table 9-1**  
**Total Expenditures for Environmental Aspects**  
**(In millions of 2005 US dollars)**

<b>Direct costs attributable to the works</b>	
Construction of access channel to the Pacific	15
Construction of Pacific locks	11
Construction of Atlantic locks	14
Dredging	7
<b>Subtotal</b>	<b>47</b>
<b>Additional costs to be disbursed by ACP , which are not attributable to the works</b>	
Locks and access channel to the Pacific	4
Elevation of operating level of Gatun Lake	2
Atlantic locks	3
<b>Subtotal</b>	<b>9</b>
<b>Total</b>	<b>56</b>

Source: INDESA, 2006. Socioeconomic Evaluation, Annex B, Chart B.1

Table 9-2 shows the details of those costs throughout the construction phase of the project and beyond up to the year 2025.

**Table 9-2**  
**Total Annual Environmental Expenditures**  
**(In millions of US dollars)**

<b>Year</b>	<b>Cost</b>
2007	19
2008	10
2009	3
2010	2
2011	1
2012	4
2013	9
2014	6
2015-25	2

Source: INDESA, 2006. Socioeconomic Evaluation, Annex B, Chart B.2

Perhaps the element most visibly affected by the impacts in the construction phase is undoubtedly the vegetation cover that comprise the impact on plants, some of which are listed under the category of special interest, endemic or protected locally and internationally (CITES - the Convention on International Trade in Endangered Species of Wild Fauna and Flora, IUCN - The World Conservation Union- and/or protected by Panamanian legislation). This impact is concomitant with the loss and degradation of habitats that alter fauna distribution and behavior. Among the species of special interest reported in the inventories (The Louis Berger Group, 2004 and CEREB-UP 2005) are the howler monkey, the squirrel monkey, the jaguarundi, white-tailed deer, the capybara, the coatimundi, osprey, gray-headed chachalaca, the pale-vented pigeon, black-bellied whistling duck, the green iguana, the crocodile, the caiman, the jicotea turtle, and the American crocodile, among others. To mitigate the impact on the fauna, a wildlife rescue program based upon previous inventories has been proposed for a total cost of USD \$1,024,000.00.

To evaluate the loss of vegetation cover an investigative and analytical effort was carried out, based on available data, to allow quantification with the highest possible degree of certainty of the impacts using the concept of Payment for Environmental Services (PES). In this case, the

environmental services of the forests located within the boundaries of the expansion project will be analyzed as summarized in the following table:

**Table 9-3**  
**Environmental Services Provided by the Forest**

Service/Attribute
Carbon capture
Recycling of nutrients
Erosion control
Biodiversity
Tourism

Except for tourism, which is a potential service due to the exclusive use conferred to the ACP by the Constitution in the areas along the Canal, the rest are services effectively rendered by those forests. Table 9-4 shows the surface per hectare within the area of direct impact that will be affected.

**Table 9-4**  
**Areas by Cover Category Directly Affected by the Footprint of the Project (Has)**

Total Footprint	Zone 1		Zone 2		Zone 3		Zone 4		Zone 5		Zone 6		Total	
	Has	%	Has	%	Has	%	Has	%	Has	%	Has	%	Has	%
Areas of Urban Usage	0.00	0.00	4.28	1.62	1.21	20.35	3.72	0.99	60.99	6.43	0.00	0.00	70.21	3.59
Secondary Growth Mature Forests	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.09	13.55	1.43	0.00	0.00	13.88	0.71
Secondary	52.02	25.40	81.93	30.89	4.12	69.02	81.83	21.74	192.24	20.25	44.56	28.54	456.69	23.33



Total Footprint	Zone 1		Zone 2		Zone 3		Zone 4		Zone 5		Zone 6		Total	
	Has	%	Has	%	Has	%	Has	%	Has	%	Has	%	Has	%
Growth Intermediate Forests														
Mangrove	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.32	1.40	6.67	4.27	19.99	1.02
Shrubs and Thicket	48.40	23.64	4.82	1.82	0.28	4.71	54.57	14.49	76.56	8.07	53.40	34.20	238.03	12.16
Pastures and Grasslands	104.34	50.96	174.11	65.65	0.35	5.92	214.86	57.07	592.47	62.42	51.48	32.98	1137.62	58.11
Soil with no Vegetation	0.00	0.00	0.07	0.03	0.00	0.00	21.16	5.62	0.00	0.00	0.00	0.00	21.23	1.08
<b>TOTAL</b>	<b>204.76</b>	<b>100.0</b>	<b>265.22</b>	<b>100.0</b>	<b>5.96</b>	<b>100.0</b>	<b>376.46</b>	<b>100.0</b>	<b>949.14</b>	<b>100.0</b>	<b>156.11</b>	<b>100.0</b>	<b>1957.65</b>	<b>100.0</b>

Source: URS Holdings, Inc.

In the preliminary Environmental Evaluation of 2006 the ACP estimated that 470.57 hectares would be the area of secondary-growth forests to be affected by the expansion works and staging areas such as sites assigned for storage and building facilities.

Nevertheless, more recent estimates indicate that 13.88 hectares of mature secondary growth forests, 456.69 hectares of intermediate second growth forests, 19.99 hectares of mangrove trees, 238.03 hectares of shrubs and thicket, as well as 1,137.62 hectares of pastures and grasslands, for a total area of 1,866.21 hectares where the vegetation cover will be lost. Of these, 55.71 hectares of forests, 9.85 hectares of shrubs and ticket, and 59.82 hectares of grasslands and pastures will be compensated for according to the EIS for the project Earth Movement and Leveling of Cartagena Hill, approved through ANAM Resolution No. 219-2007. In addition, 197.91 hectares of shrubs and ticket, and 11.83 hectares of grasslands and pastures will be compensated for according to the EIS for the project to prepare Site T6 (In process of evaluation by ANAM).

ANAM Resolution No. AG-0235-2003 of June 12, 2003, established the rates of payment for

ecologic indemnity: USD \$10,000 for hectare of mangrove trees; USD \$5,000 for hectare of mature first or secondary-growth forest; USD \$3,000 for hectare of intermediate secondary-growth forest; USD \$1,000 for hectare of shrubs and ticket; and USD \$500 for hectare of pastures and grasslands. Table 9-5 shows the amounts to be paid once the rates, as established by ANAM, are applied.

**Table 9-5**

**Indemnity Amount pursuant to Resolution No. AG- 0235-2003**

<b>Type of Cover</b>	<b>Affected Hectares</b>	<b>Amount To Be Paid</b>
Mature second growth forest	13.88	69,400.00
Intermediate second growth forest	400.98	1,202,940.00
Shrubs	30.27	30,270.00
Mangroves trees	19.99	199,900.00
Grasslands	1065.97	532,985.00
<b>Total</b>	<b>1,531.09*</b>	<b>2,035,495.00</b>

Source: URS Holding, Inc. \*=Does not include the vegetation cover considered in the studies of Earth Movement and Leveling of Cartagena Hill and the Project to Prepare T6.

As an alternative, the loss of capability to capture carbon has been valued; therefore, some preliminary considerations have been made. The gases called Greenhouse Gases (GHG) are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrogen oxides (N<sub>2</sub>O), chlorofluorocarbons (CFCs), ozone (O<sub>3</sub>) and water vapor. Unlike other gases that are released while burning thermal fuels, such as CO, NO<sub>x</sub>, SO<sub>x</sub>, etc. that are harmful to the health of the those directly exposed to them, GHG contribute to global warming. This contributes to alter the way in which the atmosphere absorbs solar energy (greenhouse effect) affecting the balance of global climate.

Two ways to deal with this phenomenon are: reducing emissions, that is, reducing the burning of thermal fuels and forest biomass; and/or setting or capturing the carbon from the atmosphere, which is achieved by the growth of forest biomass. (Stavins and Newell, 1998)

Inasmuch as a market has been developed internationally that establishes prices for environmental services for setting or capturing carbon, some quantitative measures concerning the value of these services, useful for the purposes of this study, may be determined.

**Table 9-6**  
**Carbon Prices of Certain Projects \*JIA (US\$)**

Vendor country	Buyer	Name and type of project	Price US\$/mtC
Costa Rica	Norway	RFCAIJP-reforestation project Forest Protection	10
Bolivia	American Electric Power, USA	Noel Kempff National Park Forest Protection	0,5
Ecuador	GRF	Forest Protection	3-4
Guatemala	AES Thames, USA	Reforestation	
Paraguay	AES Barber Point USA	Agro-forestry and forest preservation	1.5
Malaysia	NEES	Sustainable forestry	2
Russia	Tenaska, USA	Forestation	1-2
USA	Pacific Cooperation, USA	Sustainable forestry	5

\*JIA: Joint Implementation Activities

Source: Otarola and Venegas 2000 in Social Impact of Carbon Markets in Costa Rica [*Impacto Social de los Mercados de Carbono en Costa Rica*]. CINPE, IIED. 2004.

Countries that have forested areas measure, in metric tons, the amount of carbon that their forests can capture. The capacity of the carbon watersheds [*cuencas de carbono*] is then translated into CTO's – Certified Tradable Offsets to put them on the market. CTO's are defined as the quantity of GHG emissions reduced and are measured in metric tons of carbon (mtC). Businesses and governments of developed countries are the potential buyers of these, since a mtC is equivalent to a mtG responsible for the pollution of the atmosphere. Some initiatives have begun at worldwide level. Prices have been established by each one of the countries involved (CINPE, IIED. 2004.)

The research to determine the capacity of carbon capture of several types of forests in different places produced the following results:

**Table 9-7**  
**Carbon Capture in Metric Tons**  
**Per Hectare Annually (mtC ha/y) in Forestal Ecosystems**

Forestal Ecosystem	Average setting rate (mtC ha/y)
First growth forest, control farms (Costa Rica)	0,83
Intervened first growth forest, protective canopy (Costa Rica)	0,21
Intervened first growth forest of Lomerio (Bolivia)	1,04
Second growth forest (Costa Rica)	2,5
Plantations (Chile)	2,8
Plantations (Costa Rica)	4
Plantations (Guatemala)	4.6
Second growth forest in Colombian Amazon	6.1
Plantations in Spain	7.5

Source: UNACHI-From different studies

Based on the data, the price of 10 US dollars per mtC was chosen for the calculation. It is the maximum price negotiated on the international market between Costa Rica and Norway, although the expectation of the countries that provide environmental services through their tropical forest is to establish a minimum price of \$20.00 per hectare, inasmuch as the international market is undervaluing those services. For the capacity to set carbon the value of 6 mT ha/y is utilized since similar forests have it. Therefore, the loss of capacity to capture carbon due to the loss of 13.88 hectares of mature second growth forest, 400.98 hectares of intermediate second growth forest, 30.27 hectares of shrubs and thicket, and 19.99 hectares of mangrove trees, has a market value of USD \$2,790.72 annually. For the remaining environmental services the

total value does not exceed USD \$500.00 for hectare annually.

On the other hand, a positive effect of a global nature will be the long-term reduction of greenhouse gases (after the year 2020), due to the utilization of the expanded Canal route instead of alternate routes.

The total costs of the environmental impacts are detailed in the following table:

**Table 9-8**  
**Costs of Environmental Impacts**

**Costs of Environmental Impacts - Physical Aspects**

**CONSTRUCTION PHASE**

Impact	Specific Mitigation Measures	Cost
Microclimate Change		0*
Loss of Potential Carbon Capture		0*
Deterioration of Air Quality	Maintain engines according to manufacturer's specifications and demand proof of maintenance record.	0
	Use combustion engines with exhaust and filter systems (if applicable), that use catalytic oxidizers, to reduce emissions.	0
	Keep work areas wet during the dry season.	0
	Establish suitable places for storage, mixing, and loading of construction materials.	0
	Ensure that loading and unloading are done minimizing dispersion of dust to the environment.	0
	Implement controls to avoid dispersing dust while handling materials.	0
	Keep material mixing equipment hermetically sealed.	0
	Grind rocks and aggregates using wet processes or using emission control systems.	0

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
	The concrete plant should have filter, dust collectors or humidifiers or other technique (as applicable) to control particles at every stage.	0
	Trucks carrying materials or residues must be covered with a canvas on public roads.	0
	Cover and confine stored materials.	0
	Regulate speed	0
	Compact, humidify, or treat the surface of temporary roads	0
	Use emission control systems for volatile organic compounds in fuel storage tanks	0
	No garbage shall be incinerated at the site.	0
	Comply with ACP regulations and World Bank and IFC guidelines	0
	Adapt oxidation catalyzers to the filters of vehicles and diesel equipments used for the construction to reduce CO, HC, and particle emissions.	0
Increased odor perception	Document the preventive maintenance of the vehicular fleet	0
	Maintain engines adequately	0
	Apply the Waste Management Program	0
Increased noise levels	Evaluate conditions of noise emission and critical sites	25,000.00
	Keep rolling and construction equipment in good condition, with proper muffler systems and demand a record of maintenance	0
	Minimize, as possible, operating time of the sources of noise emission and avoid having idle equipment on	0
	Organize truck loading and unloading, as well as driving operations	0
	Comply with official requirements and regulations for handling explosives	0
	Comply with the requirements, according to the type of explosive, distance to structures and towns	0
	Limit blasting operations to a schedule from 06:00 to 18:00 hours	0
	Comply with all rules and regulations for noise levels control	0

Impact	Specific Mitigation Measures	Cost
	Do not carry out works that produce noise over 80 dB, from 8 p.m. to 6 a.m., at sites located near housing areas	0
	Keep timely communication and coordination with sensitive receptors about construction works that produce high noise levels	36,500.00
	Keep communities near the development of the project informed about the timeline of the works	
	Avoid unnecessary use of alarms, horns, and sirens	0
	Locate noise-producing stationary equipment away from sensitive receptors. If necessary, use covers (fixed or movable barriers)	0
Increased vibration levels	Establish vibration limits according to sector	0
	Have a qualified blasting consultant to provide a plan and to begin blasting works	0
	Restrict blasting times, limit maximum instant loads, provide adequate tamping material and secure a precise drilling of the blasting holes, plan the delivery to and from the site to minimize impacts	0
	Monitor vibrations at critical (sensitive) sites	0* <sup>2</sup>
	Carry out structural integrity inspections before the blasts at critical (sensitive) structures	0* <sup>2</sup>
	Inform the public about possible effects, quality control measures, necessary precautions, and available communication channels	0* <sup>3</sup>
	Notify affected public whenever blasting works are going to be performed	0* <sup>3</sup>
	Observe the limits of blasting schedules to exclude any after 6 p.m. and before 6 a.m. on week days.	0
	Maintain appropriate blasting quality control measures	0
	Develop and implement a Blasting Plan	0
	Comply with the requirements and regulations of competent authorities concerning the use of explosives	0



Impact	Specific Mitigation Measures	Cost
	Comply with the requirements, according to the type of explosive used, concerning the distance to structures and populated centers, defined by the manufacturer and competent authorities	0
	Comply with the instructions from the manufacturer about how to handle explosives and detonators.	0
Undermining and cave-in		0*4
Increased risk of landslides	Controlled use of blastings	0
	Use slope terracing to intersect superficial flow currents with emphasis on the “La Boca” formation	0
	Record and add to the spatial analysis of the vulnerability for landslides the amount and intensity of rains, and a correlation with data obtained from the landslide monitoring program	0
	Determine accumulated precipitation for the previous 7, 14, or 30 days, in relation to a severe climate forecast with the potential to unleash landslides	0
	Design slopes according to geological zoning and vulnerability and limit of Safety Factor set at 1.00 or its equivalent	0
	Stabilize slopes with a history of landslide recurrence, reducing the forces that encourage landslides by excavating the slope summit or “head”, before dredging the base or “toe” under water	0
	Reduce the loads without increasing filtration at the slope, and if needed, make the surface waterproof	0
	Reduce slope inclination during the design of the most unstable ones using a slope ratio that guarantees stability	0
	Install horizontal or inclined drainages at unstable slopes	0
Increased soil erosion and sedimentation	Protect the surfaces of exposed soils with stabilizing material and plant areas in danger of erosion	200,000.00

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
	Use water flow retaining structures at the entrances and exits of drainage structures	30,000.00
	Place sediment traps inside the excavation sites	350,000.00
	Slopes with cuts of over 5 m high should be graded, maintaining slope inclination of 1:3 to 3:1.	0
	Stabilize the exposed side of the slopes using stabilizing materials or plant fast-growing grasses with high-density roots	150,000.00
	Install underground drainages inside saturated slopes and reduce surface infiltration using longitudinal sub drainages at the base of the slopes	0
	Stabilize sites that are prone to undermining, cave-ins, landslides, and other massive movements at the cuts of access roads to the new construction sites	0
	Stabilize the cuts of new access roads with appropriate retaining structures	0
Soil compaction	Restrict the operation of earth-moving machinery and equipment to a minimum, concentrating their movements inside the project construction area	0
	Scarify the top layer of the soil of the sites with no vegetation to encourage the growth and regeneration of natural vegetation	0
	Control the slopes of the surface of the disposal sites to ease water drainage	0
Soil contamination	Control and maintenance of construction machinery and equipment of the project	0
	Training of personnel specialized in handling fuels and machinery and equipment maintenance	0* <sup>5</sup>
	Control of disposal sites and temporary facilities	0
	Blasting control	0
	Control of possible contaminants in soils, sediments, and materials coming from excavations and blastings	0

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Deterioration of water quality	Optimize speed, suction intake, and disposal site pumping	0
	Limit overflow and/or hopper load	0
	Reduce water intake	0
	Design a discharge pattern that favors output density, or a 90 degree angle	0
	Use sediment control screens	200,000.00
	Reduce air content in the overflow mixture	0
	Optimize cutter, balance, and suction discharge speed	0
	Protect cutter or suction head	0
	Optimize cutter head design	0
	Use a visor over the bucket	0
	Final covering of disposal sites with rock material	0
	To the extent possible, place coarser dredged materials in aquatic disposal sites, and finer ones in land disposal sites	0
	Maintain a permanent coordination of dredging and disposal activities to avoid discharging fine dredged materials during adverse meteorological conditions and water currents	0
	Use sediment-control dumping sites	5,000,000.00
Fill up disposal sites while controlling the level in relation to perimeter retention		
Use sediment traps		
Use transversal intermediate walls		
Measures to control the effects of excavations on water quality	Control and maintenance of construction machinery and equipment of the project	0

Impact	Specific Mitigation Measures	Cost
	Training of personnel specialized in handling fuel and maintaining machinery and equipment	0
Measures to prevent the deterioration of water quality when excavated material is dumped on land	Material Compaction	0
	Install temporary and permanent drainages	0
	Use sediment traps	0
Measures to prevent the deterioration of water quality after changing the courses of the Grande (South Branch) and Cocoli Rivers	Design new channel with an adequate incline and resistant to maximum speeds	0
Measures to prevent deterioration of water quality resulting from construction, operation, and closure of field facilities	Adequate management of residual waters that include sewage and waste water produced at field facilities and work fronts	24,000,000.00
	Prevention and treatment of oil spills in workshops and any other area where construction equipment and machinery are given maintenance	0
	Construction of sediment traps at aggregate development sites and rehabilitation of those sites	0
	Retention of fine sediments from grinding by using sedimentation and clarification of wash water, if applicable	0
	Retention and sedimentation of the discharge produced when cleaning concrete plants	0
Alteration of the water flow regime	Control the new drainage patterns	
	Channel runoff through the new drainages	

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
	Use retention dikes, ditches, transversal walls, among others	1,000,000.00
	Provide adequate and timely maintenance to the works	
Measures to control the alteration of the ground-water level		0* <sup>6</sup>
<b>Total</b>		<b>B/. 8,991,500.000</b>

0 = Cost included in budget of the work. 0\* = Cost included in Flora and Fauna / Soil Protection Program. 0\*<sup>2</sup> = Cost included in air, noise, and vibrations monitoring. 0\*<sup>3</sup> = Cost included in the 36,500.00 US dollars allocated to timely communication and coordination. 0\*<sup>4</sup> = Cost included in Soil Protection. 0\*<sup>5</sup> = Cost Included in Environmental Education Plan. 0\*<sup>6</sup> = Cost included in the Water Quality and Sediment Program.

## **OPERATIONS PHASE**

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Microclimate change		0*
Loss of potential to capture carbon		0*
Deterioration of Air Quality	Adequate maintenance of engines according to manufacturers' specifications and a record of maintenance	0
	Use combustion engines with muffler systems, and if applicable, filters, in good conditions	0
	Establish a schedule for the operation of engines that minimizes, to the extent possible, the operating time of the sources of emission	0
Increased odor perception	Document preventive maintenance program of the equipment used in maintenance work	0

Impact	Specific Mitigation Measures	Cost
	Adequate engine maintenance	0
	Minimize, as possible, the operating time of the sources of gas emissions	0
	Apply the Waste Management Program	0
Increased noise levels	Maintain all equipment used in maintenance tasks in good condition and with muffler systems, and keep maintenance records	0
	Minimize, to extent possible, operating time of noise emitting sources and avoid having idle equipment on.	0
	Avoid unnecessary use of alarms, horns, and sirens	0
Vibration control	See Mitigations for Construction Phase	0
Increased risk of landslides	Adequate maintenance of bank slopes and drainages made during construction	0
	Control the use of blastings to avoid affecting slope stability	0
Increased soil erosion and sedimentation	Keep drainages, ditches and other infrastructure built during the construction phase in good condition	100,000.00
	Preserve areas where vegetation cover has been restored	
Soil contamination	Apply the Material and Residue Management Program	0

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Deterioration of Water Quality due to the Operation of the Third Set of Locks	Water Quality Monitoring through the installation of continuous evaluation gauges with indicators that allow detection of any change that may take place	0* <sup>6</sup>
Alteration of the water flow regime	Control new drainage patterns	0* <sup>7</sup>
	Channel water runoff through the new drainages	
	Use retention dikes, infiltration ditches, transversal walls, among others	
	Provide adequate and timely maintenance to the works	
<b>Total</b>		<b>B/. 100,000.00</b>

0 = Cost included in work budget. 0\* = Cost included in Flora and Fauna / Soil Protection Program. 0\*<sup>2</sup> = Cost included in air quality, noise, and vibration monitoring. 0\*<sup>3</sup> = Cost included in the 36,500.00 US dollars allocated to timely communication and coordination. 0\*<sup>4</sup> = Cost included in Soil Protection. 0\*<sup>5</sup> = Cost Included in the Environmental Education Plan. 0\*<sup>6</sup> = Cost included in the Water Quality and Sediment Program. 0\*<sup>7</sup> = Cost included in the soil and sediment instrument.

### **Costs of the Environmental Impacts - Biological Aspects**

#### **CONSTRUCTION PHASE**

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Loss of vegetation cover	Set boundaries to work areas with small flags or stakes	36,540.00
	Ecological indemnity pursuant to Resolution AG-0235-2003/ANAM	2,035,495.00
	Operate mobile equipment so that it causes minimum deterioration to surrounding vegetation and soil	0
	Provide training to operators on vegetation cover cleanup procedures	0*
	Under no circumstance will the disposal of biomass be allowed in areas where it may block drainage channels	0

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
	Use part of the biomass (tree trunks and stakes) to hold up saplings and to make range poles	0
	Use part of the biomass (tree trunks and stakes) as energy dissipaters to reduce the effect of water erosion	0
	Design and implement a Reforestation Plan	3,466,398.07
Loss of Forestry Potential	Mark the footprint area before cutting down the trees to guarantee that the area to be felled is exactly the one needed for the proposed works	0
	Include the planting of native forest species in the Reforestation Plan	0
	Explore an alternative use for the felled forest resources or donate it to a social welfare organization	0
	Ensure that trees fall in the area of direct impact to avoid damage to neighboring trees that need not be affected	0
Loss of habitat	Apply the Reforestation Plan	0*2
Disturbance to wildlife	Avoid unnecessary noises produced by whistles, horns, sirens, honking, and idling engines, among others	0
	Install and keep the mufflers of motor equipment (vehicles, equipment, and machinery) in good conditions	0
	Coordinate the rescue of animals that enter work areas	0
	Provide training to the work force on wildlife protection and prevention of poaching	0
	Point lights to specific work sites, to avoid shining lights over wildlife habitat	0



<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Risk of running over wild animals	Establish and maintain strict control of speed in general for all the vehicles of the project	0
	To prevent vegetation from blocking visibility, make sure the shoulders of the access roads are kept clear	0
	Make and install information signs about animal crossings on the appropriate stretches of road	10,000.00
Increased poaching	Prohibit any type of hunting or fishing within the area of the project	0
	Prohibit or control the use of firearms on the grounds of the project	0
	Abide by the laws and regulations established by the National Environmental Authority about wildlife protection	0
	Place warning signs indicating that hunting is prohibited	10,000.00
	Implement environmental training for workers	0*
Direct Elimination of Fauna		0* <sup>3</sup>
Alteration of Aquatic Ecosystems	Apply Air Quality, Noise, and Vibration Control Programs	0* <sup>6</sup>
	Apply the Soil Protection Program	0* <sup>6</sup>
	Apply the Water Resources Control Program	0* <sup>6</sup>
	Apply the Material Management Program	0* <sup>6</sup>
	Apply the Waste Management Program	0* <sup>6</sup>
<u>Total</u>		<b>B/. 558,433.07</b>

0 = Cost included in work budget. 0\* = Cost included in Environmental Education Plan. 0\*<sup>2</sup> = Cost included in Reforestation Plan. 0\*<sup>3</sup> = Cost included in Wildlife Rescue and Relocation Plan. 0\*<sup>4</sup> = Cost included in Air Quality, Noise, and Vibrations Monitoring; Soil Protection, Water Quality and Sediments, Material Management, and Waste Management. 0\*<sup>5</sup> = Cost included in Socioenvironmental Management Plan for Gatun Lake. 0\*<sup>6</sup> = Cost included in corresponding program.

## OPERATIONS PHASE

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Loss of vegetation cover (increased level of lake)	Carry out a study on existing species on the shores of Gatun Lake and islands to evaluate resistance to fluctuations of the level of the lake	0* <sup>5</sup>
Loss of forestry potential (increased level of lake)	Apply measures established for loss of vegetation cover due to the increased level of the lake.	0* <sup>5</sup>
Loss of habitat	Apply measures established for loss of vegetation cover due to the increased level of the lake.	0* <sup>5</sup>
Disturbance to the wildlife	The angle of inclination of the lights should be aimed specifically toward the facilities so that the lighting radius is restricted.	0
	The intensity of the light should be dimmed to decrease any disturbance to the wildlife	0
Risk of running over wild animals	Apply measures established during construction phase	0
Alteration of Aquatic Ecosystems	Follow up on the measures established during the construction phase	0* <sup>4</sup>
<u>Total</u>		00* <sup>6</sup>

0 = Cost included in work budget. 0\* = Cost included in Environmental Education Plan. 0\*<sup>2</sup> = Cost included in Reforestation Plan. 0\*<sup>3</sup> = Cost included in Wildlife Rescue and Relocation Plan. 0\*<sup>4</sup> = Cost included in Air Quality, Noise, and Vibration, Soil Protection, Water Quality and Sediments, Material and Waste Management. 0\*<sup>5</sup> = Cost included in the US \$250,000.00 established for the loss of vegetation cover (increased level of lake). 00\*<sup>6</sup> = Figure included within other costs.

## Costs of the Environmental Impacts - Socioeconomic Aspects

### CONSTRUCTION PHASE

Impact	Specific Mitigation Measures (representing a cost for the EMP)	Cost
Stimulus to the National Economy	Continue the communication process geared to national companies concerning the characteristics and requirements for each construction phase	0
	The contractors shall disseminate information to small and medium enterprises about the business opportunities that will be created with the development of the contracts linked to the expansion project	50,000.00
Increased revenues to the National Treasury	Transfer the operations surplus to the National Treasury	0
	See measures to stimulate the national economy and measures to promote job creation and working conditions	0
Job creation and working conditions	Promote the hiring of Panamanian workers, in compliance with recruiting requirements and general policies on labor and working conditions, in line with the Equator Principles and the IFC Performance Standards on Social and Environmental Sustainability	0
	Add to the bidding forms the information on employment opportunities to the national population and disclose it using relevant mass media communication	0

<b>Impact</b>	<b>Specific Mitigation Measures (representing a cost for the EMP)</b>	<b>Cost</b>
Increased population and migratory flows	Join efforts with the National Police, the Municipalities of Arraijan, Colon, and Panama, communities, and the Panama Canal Authority to keep squatters away from Socioeconomic Study Area (SSA).	50,000.00
Minimize Changes in Land Use	Make a comprehensive management plan for the Watershed, as well as for the updated land use plans of the region	250,000.00
Impact on vehicular traffic due to an increased demand for transportation	Preferably, transport materials and machinery by water or railway	0
	Once inside the area of the project, keep the usage of heavy equipment and transportation vehicles within the ACP internal road infrastructure	0
	In special situations, whenever the use of the public roads infrastructure is required, coordinate with the Traffic and Land Transportation Authority in compliance with existing traffic regulations	0
	Develop employee and materials transportation plans for ACP approval	0
	Establish alternative measures for Costa Abajo communities for those instances where it is necessary to limit the use of the land pass through Gatun Locks	0
Impact on Public Infrastructure	Build new pylons to replace those that will be affected, before the beginning of the construction phase	0

<b>Impact</b>	<b>Specific Mitigation Measures (representing a cost for the EMP)</b>	<b>Cost</b>
	Public infrastructures will be modified without affecting those services	0
Impact on structure	Take an inventory of the infrastructures to be affected as a consequence of the increased maximum operation level of Gatun Lake	0
	Relocate (Resettlement Plan) the users of affected structures in coordination with the corresponding government agency, according to the legal situation of each case	1,500,000.00
	Create and implement a long-term socioenvironmental management plan alongside the shores of the lake	2,500,000.00
	Design and build the new stretch of railway track that will be affected	0
Increased work-related illnesses	Implement the Solid Waste Management Program required by the ACP, which is geared to identify the problems related with inadequate handling of solid wastes and to design alternatives using appropriate technology in keeping with the characteristics of the region and the waste produced	0
	Strengthen ACP-MINSA Vector Control Program	100,000.00
	Keep selected health centers informed concerning the progress of the works and the amount of active workers so that they will be ready to provide immediate care in case of an emergency	0

<b>Impact</b>	<b>Specific Mitigation Measures (representing a cost for the EMP)</b>	<b>Cost</b>
Increased risk of work-related accidents	Apply a strict education and information policy for the employees of contractors and subcontractors concerning worker safety measures	0*
	Provide all workers with personal protective gear according to ACP standards and make sure they are used properly at the work sites	0
	Place adequate signs at work sites	0
	Implement preventive maintenance programs for machinery and equipment	0
	Provide workers with a safe and healthy environment taking into account the risks of their sector and the specific risks in client areas, including physical, chemical, biological, and radiological hazards	0
	Take appropriate measures to avoid accidents, injuries, and illnesses that may arise, may be related to, or occur during the course of the work, reducing to a minimum the causes of hazards.	0
	In a manner consistent with good international industry practices, address the different areas including: the identification of possible hazards to workers, with special attention to those that may be life-threatening; establish preventive and protective measures, including the modification, substitution, or elimination of hazardous conditions or substances; worker training; documentation and reporting of accidents, illnesses, and occupational incidents; and arrangements for the prevention, preparation, and response in case of emergencies.	

Impact	Specific Mitigation Measures (representing a cost for the EMP)	Cost
		0
Changes in crime levels	Disclose and require compliance with the Code of Conduct of the Project	0
	Strengthen the initiatives of organizations that are able to effectively carry out crime prevention programs and projects to ensure citizen safety in urban or semi-urban areas where the greatest numbers of immigrants of extreme poverty levels may relocate, even if they come from other parts of the metropolitan region	0
	Organize the co-sponsorship of a comprehensive and interagency program with local governments of selected districts and government organizations to curtail violence and criminal conduct (Education on Population and Comprehensive Prevention Offices of the Ministry of Education, Promotion Bureau of the Ministry of Health, National Police of the Ministry of Government, and the Office of Youth of the Ministry of Social Development)	0
	Supervise the preparation and implementation of the project for such purpose	0
Public Services overload	Inform businesses and institutions early on about the characteristics and implementation deadlines of the project so that they may include these in the planning an expansion of their operations, according to the project needs in the construction phase	20,000.00

<b>Impact</b>	<b>Specific Mitigation Measures (representing a cost for the EMP)</b>	<b>Cost</b>
	To the extent feasible, use private services to complement the services provided by government agencies, such as garbage collection and security or surveillance	0
Increased generation of waste	Require contractors to disclose to their workers and assure compliance of the requirements established by the ACP in its Materials and Waste Management Manual	0
	Establish defined areas for food and beverage distribution to avoid dispersing waste in other areas of the project	0
	Install signs and garbage bins at the sites of greater worker and visitor density	0
Increased tourism flows	Include as a policy for contractors to facilitate these activities, as long as they do not interfere with the development of the works, whether by guided visitors tours, observation sites, scheduled visits, and other measures to insure the best use of this activity as a way to make good use of the areas even before the project enters its operations phase and to maximize benefits to the local economy during the construction phase	0
	Design programs to run concurrently with the transit of vessels to allow the development of such sources of revenue maximizing even further the benefits obtained by the Panama Canal System. This is related to expanding the capacity to welcome visitors, not only at the current locks, but also at the new ones at both entrances and also at the intermediate locations of the stretch between one ocean to the other	0
	Provide information and access for the preparation at both the local and international levels of attractive tourism packages for local and foreign visitors	



Impact	Specific Mitigation Measures (representing a cost for the EMP)	Cost
		0
Impact on Known Archaeological Sites	Hire a professional archaeologist to implement the Archaeological Rescue and Salvage Plan	100,000.00
	Archaeological rescue and salvage, if applicable; this plan includes different field and office-work activities	250,000.00
	Constant monitoring of earth-moving works to detect other unreported archaeological deposits	0
Impact on Unknown Archaeological and Paleontological Sites	Suspend the action that caused it up to a radius of at least 50 meters	0
	Contact a professional archaeologist or paleontologist and notify the pertinent authority (DNPH-INAC)	0
	The professional shall undertake relevant actions to record the removed substratum and evaluate the non-disturbed contexts, during a prudent period of time to avoid harming the works of the project, but without diminishing the quality of the detailed and professional recording of the deposit or deposits discovered	0

<b>Impact</b>	<b>Specific Mitigation Measures (representing a cost for the EMP)</b>	<b>Cost</b>
	The Promoter shall take precautions to preserve those resources, as they existed prior to the initial moment of the finding. The Promoter will protect those resources and will be responsible for their preservation until the proper authority indicates the procedures to be followed	0
Changes in natural landscape	Effective control of dust and gas emissions, avoiding gas burners and/or particulate material	0
	Introduce information about the works in progress at the observation sites installed by the ACP	20,000.00
	Minimize the exposure of the excavations by reshaping and aligning the excavation slopes and fills as soon as possible	0
	Improve the visual aspect of excavation slopes and fills by replanting	0* <sup>2</sup>
<b>Total</b>		<b>4,840,000</b>

0 = Cost Included in Work Budget. 0\* = Cost Included in Environmental Education Plan.

0\*<sup>2</sup> = Included in Flora and Fauna Protection Program.

**OPERATIONS PHASE**

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
Job Creation and Working Conditions	Continue supporting existing training programs with educational organizations to maintain the supply of workers for the new needs of the Canal	To be defined
Increased Population and Migration Flows	Join efforts with the National Police, the Municipalities of Arraijan, Colon, and Panama, the communities, and the Panama Canal Authority to keep squatters away from the reference area of the project.	10,000.00
Minimize Changes of Land Use	Continue the application and improvement of a comprehensive watershed management plan	0
Public Services Overload	Promote within the ACP, energy and water saving campaigns among Canal workers and their relatives.	0
Increased Waste Generation	Abide by the Materials and Waste Management Manual	0
	Introduce informational materials on the works and the operation of the Panama Canal and its importance to international trade	30,000.00

<b>Impact</b>	<b>Specific Mitigation Measures</b>	<b>Cost</b>
	Provide observatories with instruments such as telescopes, among others	30,000.00
	Adequate maintenance and permanent replanting of excavation and fill slopes	0* <sup>2</sup>
<b>Total</b>		<b>B/.70,000.00</b>

0 = Cost Included in Work Budget. 0\* = Cost Included in Environmental Education Plan.

0\*<sup>2</sup> = Included in Flora and Fauna Protection Program.

At this point it is necessary to make some additional comments on the loss of capability to capture carbon due to the loss of forest caused by the expansion project. Recent studies have shown that rivers, lakes, and reservoirs also capture CO<sub>2</sub> as well as the atmosphere, the oceans, and the forests. A group of scientists, among them a researcher from the Spanish Scientific Research Council, Carlos Duarte, published a report in “Ecosystems” magazine, in which he points to the sediments from aquatic ecosystems as drainages of carbon. Thus, rivers, reservoirs, and lakes capture CO<sub>2</sub> and help mitigate climate change: 12% of the CO<sub>2</sub> is stored in their sediments, 48% is transported (rivers) to oceans and 40% will return to the atmosphere. Thus, the increase of the level of Gatun Lake and the corresponding increase of water volume as well as surface area will exert compensatory effects for the loss of carbon capture capability mentioned above in addition to the areas that will be reforested according to ACP plans.

## **9.2 Monetary Value of Social Externalities**

The social externalities involved in the Panama Canal Expansion Project are related to the impact of the construction activities that will first affect the neighboring population in terms of transportation, quality of roads, migration, waste generation, and others that were mentioned in the chapter of identification. However, the Panamanian society as a whole will be affected by the magnitude of the expansion works and by its long and medium-term results because of the role of the Canal Economic System in the Panamanian economy.

Regarding the impact on the population that resides in areas near the works and who will be physically affected in some way, the ACP has tried to grapple with these externalities. As a result

of this and based on the data from appendix B already mentioned the following table summarizes the costs of those externalities.

**Table 9-9**  
**Costs of Externalities**

<b>Components</b>	<b>Total cost</b>	<b>Comments</b>
Replacement and reconditioning of infrastructure	21,650,000	Reconditioning, repair, or replacement of infrastructure that may be affected by the project
Archaeological rescue	50,000.00	Estimated for Calabaza site and Cocoli
Public and community participation	900,000	Monthly meetings, publications, information
<b>TOTAL</b>	22,600,000	This represents 40.27% of the costs for socioeconomic aspects

Source: INDESA, 2006

The monetary value of some of the social externalities caused by the expansion do not have a clear market value within our ambit and in other instances it is clearly intangible. In those cases, a qualitative valuation is made to attempt to make an approximation of the effects on the social component.

The Environmental Management Plan contains mitigation measures not so much for the repairs themselves, because they are the responsibility of other State agencies, but for actions of coordination, notification, communication about closing or temporary rerouting of roads, signs, guiding lights, barriers, and signage equipment to guarantee road safety and minimize interruptions of vehicular flow to the extent possible.

During the field work, the residents voiced their concern over the effects of blastings and explosions on people and houses located near the areas where these activities will take place such as Paraiso, Pedro Miguel, and Gamboa. According to them, if the current improvement works have caused cracks and fissures, once the blastings are intensified with the expansion

works these effects may become more acute. It is worth noting that the ACP reports that the cracks mentioned have not been confirmed to be a result of the blastings. With this in mind, inspection programs should be undertaken to monitor any effects of this kind on these areas and establish mitigation and monitoring measures—subsequent to evaluation by specialists—and compensation if warranted.

Regarding the potential **increase of vector population** caused by containers of stagnant water such as cups, lids, tires, equipment, among others, the historical experience cited shows that in the past years no epidemic outbreaks of relevance have been recorded anywhere in the watershed. The measures proposed for the disposal of waste of all types in the EMP, as well as the close coordination recommended with the agencies in charge of sanitation safety should guarantee that this type of effects be kept at a minimum. The economic effect of an increase in the concentration of vectors would be disastrous for productivity at the works and this could endanger delivery times and health in general.

A positive externality worth mentioning is the one caused by the **elevation of the highest operational level of Gatun Lake** for the transportation of the population that moves in boats. When the level of the lake is low, transportation on the lake becomes difficult, because old tree trunks are exposed. In addition, the rivers that provide access to the lake are also affected because the low level of the lake almost paralyzes this activity. With an increased level of the lake, this activity will be possible even during the driest time of the year, with positive effects to the revenues of boatmen and people who will be transported with less loss of time and monetary expenditure.

Another positive externality is the reevaluation of the Jose Dominador Bazan area (formerly, Fort Davis), in which the development activities of the project, is expected to help activate the zone that is currently very abandoned. Likewise, the **expansion and deepening of the channels** will benefit companies providing port services such as Astilleros Braswell, APSA, and Panama Ports because they will be able to expand their operations during high as well as low tide, increasing their profit margins.

**Public services overload** due not only to the affluence of a greater number of persons related directly to the expansion works, but to a possible migratory affluence attracted by the services and sales of goods that this activity will generate is a negative externality to the current residents of neighboring areas because they will have to share existing services with all their shortcomings with a new influx of persons for which the services providers are not prepared. Thus, a great coordination effort is required—first, to keep squatters away from the area; and second, to take measures to ensure that public services are not overtaxed creating a difficult situation for the residents, for which they will not be compensated.

Although certain mitigation actions are given a value in the Environmental Management Plan for aspects such as the **loss of archaeological and paleontological sites and landscape**, these are elements that cannot be valued without a certain degree of subjectivity, consequently, it was deemed best to classify them as intangibles.

### **Compensatory effects for externalities through adjustments to market prices**

The total social evaluation of the expansion project must determine whether it produces a greater level of well-being for the Panamanian society. This is an even broader measure than the one covered by externalities because it considers the compensatory effect for all of society and not only in a specific ambit. This analysis begins at the economic evaluation based upon market prices to reach the social evaluation through adjustments to market prices to transform them into efficiency or social prices with the inclusion of indirect effects. These indirect effects are the result of the correlation between the increase of container traffic through the Canal because of the expansion, and the increase in the number of containers handled by Panamanian ports as a result of this increased traffic through the expanded canal. According to the study by INDESA (2006) the elements taken into account to make these adjustments were the following:

#### **1. Taxes on Sales, Tariffs, and Tax on Diesel**

Materials and equipments acquired by contractors shall pay sales taxes in addition to the taxes established by Panama as tariffs on imported goods. If these materials are acquired directly by the ACP, they will be exonerated from taxes according to the Law, but this is not the case for all the supplies used in the project. In addition, the unit cost of fuel that will be used in the construction was included at market price for diesel, which includes sales tax. **These taxes are considered a benefit to society** and the total amount for the entire construction phase will be **\$983 million**.

## **2. Generation and Use of Dollars: The Case of the so-called “Tradable Goods”**

The revenues from tolls the ACP will receive “with” the expansion compared to the situation “without” the expansion means new dollars that will enter the country. Thus, they are new service exports and their effect on the economy is that a percentage of them will translate into a reduction of other exports and the rest will go into greater imports, which will pay, on average, a tax to the Government that is not part of the business of the Canal as such. Since imports pay taxes at the border, the payment made by the importer has a tax component that will come to the National Treasury, which becomes a **social benefit** attributable to the project. These benefits will begin to be perceived once the expanded canal begins operations in 2014.

## **3. Income Taxes from Foreign Businesses**

The payment of income taxes by foreign businesses is a social benefit for the Panamanian economy. Contractors’ profits in comparison with the value of the contracts (based upon the experience of similar companies in Panama) has been estimated at 7 percent. Taxes to be paid on this value represents a **social benefit** to the country and the amount to be paid has been estimated at **\$70 million** for the duration of the construction works.

## **4. Cost of the Labor Used in the Project**

In general, the use of labor (that is, workers hired for the project) appears in the economic



evaluation flows as costs and not as benefits. However, when salaries paid to workers are greater than the workers' **"reserve salary"**, there is a **net social benefit** equivalent to the difference between them.

The difference between the salaries that will be paid for the works contracted by the ACP in the project and those that are paid in the rest of the national economy make the social evaluation especially important, not from the perspective of profitability, but because of its effects on poverty. The social benefit of salaries has been estimated at **\$10.49 million** for the duration of the works.

### **5. Taxes on Sales Paid by Local Workers**

The national economy (the State in particular) will receive payment for sales taxes from income **greater than the "price of offer or reserve"** of the workers. In relative terms, this figure is so low it has been ignored in this evaluation.

### **6. Sales Taxes Paid by Foreign Workers**

The possible foreign workers that could be hired at the project "would leave" in the country taxes that have been calculated as sales taxes that they would pay for their expenses. Consumption by these workers was estimated at 80 percent of their remuneration that would generate a five percent of sales tax, which constitutes a **social benefit** of the project. **This figure amounts to \$5 million** during the construction phase.

### **7. Extraordinary Gains of the Enterprises**

Any profit margin greater than what is "normal" is a payment to the owners of capital that is greater than their "opportunity cost" and results in a bonus that should be assigned as a **social benefit of the project**. In a competitive bidding, the offeror's prices are supposed to reflect normal profits of the company and that is why no social value will be attributed to them. The

fact that they are not included tends to adversely affect the social profitability calculated herein<sup>1</sup>.

In addition to those elements, the social cost includes the indirect effects that was already stated as the number of additional containers that will be handled by Panamanian ports as a result of the Canal expansion. Of every 100 new containers that transit through the expanded Canal, five will be handled by the ports. This, in turn, will translate into social benefits by way of taxes, better salaries for the workers, and others.

### **Macroeconomic Effects**

Among the macroeconomic effects brought about by the Canal expansion worth mentioning are the sustained growth of the gross domestic product (GDP) that according to forecasts will reach 28 billion by the year 2025 with the expansion, whereas without the expansion it would only increase to 23 billion for the same period. Investment also has very significant growth forecasts with the expansion as compared to the same without the expansion.

Due to this sustained growth of the economy for the upcoming years as a result in large part to the expansion, it is expected that for the year 2025 there will be a significant change in the proportion of the population in conditions of poverty. Figures show that in 2005, approximately 18 percent of the population was below the poverty line. However, with the expansion, forecasts show that the number of poor will be reduced by more than 100,000 persons, that is, that the percentage of the population below the poverty line in 2025 will be 11 percent.

### **9.3 Net Present Value (NPV)**

The net present value (NPV) of an investment project, is nothing more than its value measured in today's currency. That is, it is the equivalent in current dollars of all the future revenues and expenses that will be generated by the project during its useful life. In other words, NPV consists of bringing the cash flows of the future in the case of the expansion project from 2050 to 2007,

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<sup>1</sup> INDESA, 2006

using a discount rate known as Minimum Acceptable Yield Rate (MAYR). The NPV decision criteria points out that the project is economically and socially advisable when the NPV is greater than zero and not advisable when NPV is less than zero.

To calculate the NPV of a project the following elements are needed: 1) net value of the investment; 2) expected net benefits; 3) expected costs; 4) salvage value, should there be any; 5) useful life of the project, and 6) discount rate.

To obtain the net present value the following formula is used:

$$\text{NPV} = \sum_{t=0}^N \frac{Bt - Ct}{(1 + r)^t}$$

Where:

*Bt* – benefit for year *t* of the project

*Ct* – cost for year *t* of the project

*t* – year corresponding to project life from 0 to *n*

0 – initial year of project, in which investment begins

*r* – discount rate or minimum acceptable discount rate (MADR)

From this formula the internal rate of return (IRR), which is defined as the rate of return of an investment that is equal to the present value of benefits and costs, is derived. In other words, it is the discount rate that would make the net present value for a project equal to zero. That is:

$$0 = \sum_{t=0}^N \frac{Bt - Ct}{(1 + r)^t}$$

The criteria for acceptance or rejection of a project from the IRR perspective are that if it is less than MAYR, the project should be rejected, and if it is greater it should be accepted. However, it should be noted that IRR has serious methodological disadvantages so it should be used together with the NPV.

The other formula that is also derived from NPV is the benefit/cost ratio (B/C R) which compares the benefits discounted to rate  $r$  with the costs also discounted at the same rate. If that ratio is equal to 1, the project will not produce any benefit. A B/C ratio of less than 1 means that the project would be generating losses.

$$B/C R = \frac{\sum_{t=0}^N \frac{Bt}{(1+r)^t}}{\sum_{t=0}^N \frac{Ct}{(1+r)^t}}$$

These three indicators are complementary and depend on the same information. The financial information provided by the ACP to INDESA (2006) was used to calculate these three indicators.

The net present value (NPV) has been calculated under two different views; one is the economic NPV and the other is the social NPV. The difference between the two is that for the economic NPV the current market prices are used without including the costs or benefits that the project may generate for society. The criteria is mainly entrepreneurial, that is why it is also called private NPV. On the other hand, for the social NPV shadow prices will be taken into consideration. These are the ones that result from the adjustment of market prices by the inclusion of elements such as taxes, customs duties, and others, adding the indirect effects to achieve the total social benefits, all of which were explained in the previous section. In both cases the flows of costs and benefits for the two proposed scenarios: with **constant tolls** and with increasing **tolls** and in each scenario the two key situations: **with expansion** and **without expansion**.

To determine the discount rate  $dR$ , the cost of the debt ( $Kd$ ) was calculated using the reference rate of 6.5 percent (which is the yield of the T-bills or U.S. Treasury Bonds) and the inflation rate at a conservative two percent since the trend seems greater and all seems to indicate that it will remain the same for the mid term. Based upon that premise the cost of the debt  $Kd$  is

1.065/1.02 which equals 4.4118 percent. A 50-50 debt to equity ratio was assumed, that is, half is borrowed which is the most reasonable option, because a higher ratio would increase the cost of the debt to inconvenient levels. For ACP equity, 9.9 percent was taken as opportunity cost which is the average profitability of national capital for the period 1993 – 2004 according to data from INDESA, 2006. (Appendix H, p.161) The discount rate of the project was obtained with the following operation:  $dR = 0.5 (4.4118) + 0.5 (9.9) = 7.1559 \%$ .

### **9.3.1 Calculating Private Economic Metrics**

The following tables show the data that corresponds to the economic flows and the calculation of the three indicators already discussed that determine the economic or private profitability of the expansion project.

**Table 9-10**

<b>CONSTANT TOLLS</b>							
<b>(In millions of dollars)</b>							
	REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
YEAR	WITH EXPANSION	WITHOUT EXPANSION	Economic benefits	Net economic benefits	WITH EXPANSION	WITHOUT EXPANSION	DIFFERENCE
2007	392	500	0	-108	234	126	108
2008	169	515	0	-346	466	120	346
2009	-280	580	0	-860	942	83	859
2010	-786	626	0	-1412	1509	97	1412
2011	-378	700	0	-1078	1158	80	1078
2012	258	739	0	-481	561	80	481
2013	460	749	0	-289	369	80	289
2014	605	751	0	-146	226	80	146
2015	924	762	177	162	95	80	15
2016	999	782	232	217	95	80	15
2017	1063	794	284	269	95	80	15
2018	1126	805	336	321	95	80	15
2019	1194	816	393	378	95	80	15
2020	1252	823	444	429	95	80	15
2021	1314	833	496	481	95	80	15
2022	1381	844	552	537	95	80	15
2023	1451	854	612	597	95	80	15
2024	1524	864	675	660	95	80	15
2025	1616	875	756	741	95	80	15
2026	1689	891	813	798	95	80	15
2027	1765	907	873	858	95	80	15
2028	1845	924	936	921	95	80	15
2029	1927	939	1,003	988	95	80	15
2030	2013	956	1,072	1057	95	80	15
2031	2032	957	1,090	1075	95	80	15
2032	2033	958	1,090	1075	95	80	15
2033	2033	958	1,090	1075	95	80	15
2034	2034	959	1,090	1075	95	80	15
2035	2035	960	1,090	1075	95	80	15
2036	2036	961	1,090	1075	95	80	15
2037	2037	962	1,090	1075	95	80	15
2038	2038	963	1,090	1075	95	80	15
2039	2039	964	1,090	1075	95	80	15
2040	2040	965	1,090	1075	95	80	15
2041	2042	967	1,090	1075	95	80	15
2042	2042	967	1,090	1075	95	80	15

<b>CONSTANT TOLLS</b>							
<b>(In millions of dollars)</b>							
	REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
2043	2043	968	1,090	1075	95	80	15
2044	2044	969	1,090	1075	95	80	15
2045	2045	970	1,090	1075	95	80	15
2046	2046	971	1,090	1075	95	80	15
2047	2046	971	1,090	1075	95	80	15
2048	2046	971	1,090	1075	95	80	15
2049	2046	971	1,090	1075	95	80	15
2050	8193	4611	3,597	3582	95	80	15
	<b>Updated benefits</b>	<b>Updated costs</b>	<b>NPV</b>				
	<b>5078.47</b>	<b>\$ 3,624.67</b>	<b>\$ 1,452.99</b>				
<b>RATE</b>	<b>7.156%</b>						
<b>B/C R</b>	<b>B/. 1.40</b>						
<b>IRR</b>	<b>9.07%</b>						

<b>Table 9-11</b>							
<b>INCREASING TOLLS</b>							
<b>(In millions of dollars)</b>							
	REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
YEAR	WITH EXPANSION	WITHOUT EXPANSION	Economic benefits	Net economic benefits	WITH EXPANSION	WITHOUT EXPANSION	DIFFERENCE
2007	438	546	0	-108	234	126	108
2008	246	592	0	-346	466	120	346
2009	-166	694	0	-860	942	83	859
2010	-644	768	0	-1412	1509	97	1412
2011	-200	878	0	-1078	1158	80	1078
2012	485	966	0	-481	561	80	481
2013	728	1017	0	-289	369	80	289
2014	913	1059	0	-146	226	80	146
2015	1299	1115	199	184	95	80	15
2016	1444	1180	279	264	95	80	15
2017	1582	1239	358	343	95	80	15
2018	1725	1298	442	427	95	80	15
2019	1876	1359	532	517	95	80	15
2020	2039	1420	634	619	95	80	15
2021	2198	1486	727	712	95	80	15

**Table 9-11  
INCREASING TOLLS**

**(In millions of dollars)**

	REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
2022	2368	1552	831	816	95	80	15
2023	2554	1620	949	934	95	80	15
2024	2749	1690	1074	1059	95	80	15
2025	2961	1761	1215	1200	95	80	15
2026	2026	694	1347	1332	95	80	15
2027	3397	1923	1489	1474	95	80	15
2028	3636	2007	1644	1629	95	80	15
2029	3891	2095	1811	1796	95	80	15
2030	4161	2184	1992	1977	95	80	15
2031	4262	2185	2092	2077	95	80	15
2032	4263	2186	2092	2077	95	80	15
2033	4264	2187	2092	2077	95	80	15
2034	4265	2188	2092	2077	95	80	15
2035	4266	2189	2092	2077	95	80	15
2036	4267	2190	2092	2077	95	80	15
2037	4268	2191	2092	2077	95	80	15
2038	4269	2192	2092	2077	95	80	15
2039	4270	2193	2092	2077	95	80	15
2040	4271	2194	2092	2077	95	80	15
2041	4272	2195	2092	2077	95	80	15
2042	4273	2196	2092	2077	95	80	15
2043	4274	2197	2092	2077	95	80	15
2044	4275	2198	2092	2077	95	80	15
2045	4276	2199	2092	2077	95	80	15
2046	4277	2200	2092	2077	95	80	15
2047	4278	2201	2092	2077	95	80	15
2048	4279	2202	2092	2077	95	80	15
2049	4280	2203	2092	2077	95	80	15
2050	10424	5840	4599	4584	95	80	15
	<b>Updated benefits</b>	<b>Updated costs</b>	<b>NPV</b>				
	<b>\$ 8,609.96</b>	<b>\$ 3,624.67</b>	<b>\$ 4,984.47</b>				
<b>RATE</b>	<b>7.156%</b>						
<b>B/C R</b>	<b>2.38</b>						
<b>IRR</b>	<b>12.14%</b>						



From the results of the scenario with **constant tolls** it may be observed that based upon the acceptance criteria for NPV and IRR the figures are reasonably acceptable. The B/C ratio is \$1.40, which means that for every dollar invested 40 cents would be recovered. In the second scenario with **increasing tolls** all of the indicators are greater. While for the first case, NPV is \$1,452.99 million for the second case it reaches \$4,984.47 million which is over three times higher. As for the IRR it is 9.07 percent, which means that the project can withstand a discount rate of up to 9.07 percent without incurring in losses, while with increasing tolls the project tolerates up to 12.14 percent, that is, 3.07 percent more. On the side of the B/C ratio, with increasing tolls this improves substantially reaching \$2.38 which indicates that for every dollar invested \$1.38 is recovered.

### 9.3.2 Calculating Social Indicators

For the social evaluation, including indirect effects, the following data was grouped as a function of the two proposed scenarios: with **constant tolls** and with **increasing tolls**, subtracting social costs from social benefits to obtain net social benefits which are the basis for the calculation of the social NPV, the social IRR, and the benefit/cost ratio (B/C R). To calculate the benefit/cost ratio the social benefits and costs were updated to the rate established by dividing the first between the second to obtain the B/C R. As shown in the table the social NPV with **increasing tolls** exceeds by almost two and a half times the social NPV of **constant tolls**. Regarding the social IRR it may be noted that with **constant tolls** the project can take a discount rate of 11 percent, while for **increasing tolls** it can withstand a rate greater than 14 percent. As for the B/C R with **constant tolls** for each dollar invested a return of \$0.69 is obtained, while for **increasing tolls** \$1.69 is obtained, which is a favorable contrast.

**Table 9-12**  
**SOCIAL BENEFITS AND COSTS WITH CONSTANT TOLLS AND INDIRECT EFFECTS**  
(In millions of dollars)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Social Benefits	21	67	211	349	265	114	61	12	192	252	308	364	425	480	536	596	660	728	814	875	938	1005
Social Costs	110	351	874	1433	1094	487	292	147	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Net Social Benefit	-89	-284	-663	-1084	-829	-373	-231	-135	177	237	293	349	410	465	521	581	645	713	799	860	923	990

Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Social Benefits	1075	1148	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	1167	3674
Social Costs	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Net Social Benefits	1060	1133	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	3659

<b>Net Social Gain</b>	-89				-284	-663	-1084	-829	-373	-231	-135	177	237	293	349	410	465	521	581	645	713	799
<b>Rate</b>	<b>7.156%</b>																					
<b>SOCIAL NPV</b>	\$ 2,594.40																					
		<b>Benefits</b>					<b>Costs</b>					<b>B/C R</b>										
		B/. 6,195.74					B/. 3,675.24					1.686										
<b>SOCIAL IRR</b>																						

**Table 9-13  
SOCIAL BENEFITS AND COSTS WITH INCREASING TOLLS AND INDIRECT EFFECTS**

(In millions of dollars)

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Social Benefits	19	64	203	341	271	123	63	14	215	301	385	474	571	679	778	888	1013	1146	1296	1434	1584	1746
Social Costs	110	351	874	1433	1094	487	292	147	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Net Social Benefit	-91	-287	-671	-1092	-823	-364	-229	-133	200	286	370	459	556	664	763	873	998	1131	1281	1419	1569	1731

Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	
Social Benefits	1921	2110	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	2216	4723
Social Costs	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Net Social Benefit	1906	2095	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	2201	4708

Net Social Benefit

<b>Rate</b>	<b>SOCIAL NPV</b>	<b>Benefits</b>	<b>Costs</b>	<b>B/C R</b>
7.156%	\$6,287.09	\$9,842.57	\$3,675.24	2.68
	<b>SOCIAL IRR</b>			
	14.16%			

## 9.4 Conclusions

The results obtained demonstrate with the rigor of figures, that in either of the two options with constant tolls or increasing tolls, the benefits of the expansion are greater to a degree that outweighs any argument. For the economic NPV with expansion and increasing tolls the ratio is almost three and a half times better than the option without the expansion. With respect to the IRR with expansion and increasing tolls a greater capability is obtained to absorb contingencies or unforeseen situations that may arise owing to a certain type of variation especially at the international level that may generate increases in interest rates. The benefit/cost ratio is also acceptable.

If the economic evaluation of the project shows satisfactory results, the social evaluation shows even better results because the NPV with increasing tolls has figures that more than doubles the option of constant tolls. The results of IRR show that the project has the capability of absorbing increases of the interest rates of up to 7 percent without generating losses, which is almost double the discount rate (7.156) used. The benefit/cost ratio shows that \$1.71 is recovered for every dollar invested in the project, which is excellent. As for the macroeconomic impacts, forecasts point toward a GDP growth for the year 2025 of over 10 billion dollars, with very significant effects on employment and poverty rates. In general, these results demonstrate that the expansion project has a financial solidity, which should have a positive bearing on the entire Panamanian economy, generating greater levels of well-being for the Panamanian society.