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POWER PLAY: IMPACT ASSESSMENT OF POWER PLANT IN BARBADOS

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Introduction

The Barbados Light and Power Company (BLPC) Spring Garden Generating Station (SGGS) is located on the Western side of the Spring Garden Highway above the high water mark of the Brandon's Beach (Figure 1.1.1). The 124.6 MW power generation plant provides the base-load, mid range and peaking requirements of the electricity generation system using oil fired steam units and low speed diesel engines which all use heavy oil. Medium speed diesels using light or heavy fuel oil and gas turbines using light fuel oil complete the generation.

Methodology

This study was completed through literature searches, based on literature found in academic and nonacademic databases, through the review of governmental and nongovernmental studies, and through various site visits and interviews undertaken.

Case Study Details

1. History of the Case

Electricity Generation and Transition Phases

In order to meet the electricity demands of Barbados the further capacity increase in electricity production became inevitable. Between 1968 and 1980, electricity use in Barbados increased from 98 GWh to 282 GWh, finally increasing to 468 GWh, with a peak demand of 87 MW, by 1990. Studies conducted predicted an increase to 601 GWh with a peak demand of 112 MW, finally increasing to 770 GWh and a peak demand of 144 MW by the year 2010. Sectorally, commercial, industrial and institutional use together account for approximately 70% of the present electricity demand, with residential, other uses and line losses accounting for the remainder (AGRA, 1994).

Generation at Spring Garden began in 1963. To date about 30% of BLPC generation equipment is 20 – 30 years old with increase maintenance cost and lower levels of reliability and efficiency make it uneconomic to extend the life of this equipment. Hence, full development to provide for expected growth and replacement of the retired plant will require the installation of 148 MW of generating capacity. This will be achieved by adding six low speed diesel generating units (4 x 22 MW plus 2 x 30 MW). Hence, the

proposed expansion to meet the electricity demand is the basis for which an environmental impact assessment (EIA) was conducted.



Figure 1.1.1: BLPC Power Generation Station at Spring Garden, Barbados

Historical and Current Operation

Generation equipment at Spring Garden facility consisted of four bunker/diesel fuelled engines of 4MW constituting the Mirrlees Station (MS), Low speed Diesel Station (LSDS) consisting of 4 bunker fuelled engines of 13 MW each. The LSDS also includes a small steam turbine which recovers waste heat from the diesel exhaust and provides 1.5 MW of power, the steam station (SS) consisting of two bunker fuelled boiler/turbines of 20 MW each, the Gas Turbines (GT) a single diesel fuelled unit of 17.5 MW. The MS and GT stations were decommissioned and the remaining plant will be decommissioned by 2016. Brackish water drawn from onsite wells is used by the plant untreated for thermal cooling and potable water is used in the boilers after softening, dealkalisation and evaporation. The softeners and dealkalysers are regenerated with rock salt and the waste discharged with the condenser cooling water. Softened water is distilled in an evaporator to which is added sodium sulphite, ammonia and disodium phosphate. Evaporator sludge is discharged with the condenser cooling water.

Wastewater effluents generated from the cooling process is approximately 44, 000 m³ per day and discharged to the sea. Oily water from floor draining on the compound is subjected to oil water separators before final discharge to a soakaway pit with most of the oil component recovered. Waste oil sludge which cannot be used as fuel, is stockpiled until there is a sufficient quantity for bulk disposal. It is then combined with "tank bottom sludges" and both are mixed with marl, which immobilizes the metal ions, prior to disposal at a landfill. The boilers from the SS are cleaned once per year and the solid components of the waste are collected, packaged and shipped to the US for metal recovery.

Air emissions consist mainly of approximately 0.15% particulate matter from the burning of fuel. Deposits are removed by soot blowers which are

engaged 3-6 times per day to remove the deposits from the heat recovery steam generator.

Surrounding Establishments

The SGGS is bounded by the Caribbean Sea to the west, residents, industries, recreation and tourism facilities all within 1 Km radius of the plant. The closest residential community exists within 50 m (AMEC, 2003) of the north fence of the power plant extending to the now Four Seasons Hotel compound. Major industries include the West Indies Rum Distillery (WIRD), the storage and distribution facility of Texaco and Shell Antilles Limited.

Expansion of Generation

When fully developed, the station will have 148 MW of new generation capacity and the powerhouse will have 22/30 MW low speed, two-stroke turbo-charged diesel electric generator units in the following configuration: 4 x 22 MW and 2 x 30 MW. Because the station will be used for base load application, the engines will operate continuously. Engine combustion air which have been pressurized and filtered will be drawn from within the powerhouse building. Exhaust gases from each unit will pass through waste heat recovery boilers to produce steam for fuel oil heating and for driving an auxiliary steam turbine generator and air emission will be vented through stacks of sufficient height to disperse criteria pollutants and particulate material so that ambient air at potential points of impingement will satisfy North American Standards.

The engines will burn heavy fuel oil (Bunker C) for power generation and will be sound-insulated to restrict external noise to levels typically no more than 60 dBA measured 15 m from the powerhouse wall. Silences will be also installed in parallel with waste heat recovery boilers to control noise from stacks. The appropriate selection of engines and foundation characteristics will minimize engine induced vibrations to surrounding areas.

Cooling Systems

The cooling system for the LSD engines will have an individual closed circuit freshwater system. This internal cooling system uses 1400 m³ of de-mineralised freshwater per hour in a closed circuit. Raw water from a groundwater source will be circulated through central heat exchangers on a "once-through" cycle to cool these freshwater circuits. The system will require 15 600 m³ of raw cooling water per hour. The temperature of the effluent entering the environment is expected to be 5°C above ambient at 35°C which is within World Bank guidelines.

Atmospheric Outputs

At full operating capacity, exhaust gas flow is estimated at 200,000 kg/hr from a 22 MW unit and 270,000 kg/hr from a 30 MW unit. The estimated

temperature at the point of discharge from the engine is 310°C and after passing through the heat recovery steam generator (HRSG) and other systems, a temperature of 185°C is expected at the end of the stack.

The amount of particulate matter produced during the generation of energy is estimate at 0.25% of the fuel used (AGRA, 1994). 39.4 kg of particulate material per hour would be produced which will be vented through the stacks during regular operations as well as "soot-blowing" operations which take place 3-6 times daily. For gas emissions it is expected that oxygen, carbon dioxide and water vapour would dominate but nitrogen dioxide (80 ppm) nitric oxide (1580 ppm), sulphate (SO₃ 35 ppm) and sulphur dioxide (SO₂ 510 ppm). Nitric oxide is converted to nitrogen dioxide in the atmosphere under sunlight. With adequate atmospheric turbulence, the gaseous plume is dispersed to reduce ambient concentrations to level which have no observed environmental effects.

Reducing the impact of the atmospheric pollutants from the generation activities would be accomplished through the use of stacks of appropriate size and height. The higher stacks allow better dispersion by buffering the exhaust from low-level atmospheric conditions and increasing the distance between the source and potential points of impingement (AGRA, 1994).

2. Regulatory Framework

Town and Country Planning Act

The Town and Country Planning (TCP) Act Chapter 240 of 1968 and subsequent revisions to 1998 is an Act to make provision for the orderly and progressive development of land in both urban and rural areas and to preserve and improve the amenities thereof, for the grant of permission to develop land and for other powers of control over the use of land, to confer additional powers in respect of the acquisition and development of land for planning, and for purposes connected with the matters aforesaid.

Under the Act there is no express statutory basis for requesting an environmental assessment the Chief Town Planner (CTP) is authorized to request further information before issuing development permits. This is used as the basis for the request of an Environmental Impact Assessments (EIA). Furthermore, the Act confers power on the Minister to secure consistency and continuity in the framing and execution of a comprehensive policy for the use and development of all land in Barbados. This is particularly applicable to the use and development of land in the coastal zone management area and requests the integration of that policy in accordance with the coastal zone management plan referred to in the Coastal Zone Management Act.

To further facilitate the inter-sectoral input in the administration of physical development in Barbados the Act establishes the Town and Country Planning Advisory Committee and vested power in the Minister to further determine the constituent thereof. The committee shall, with a

view to the proper carrying out of the provisions and objects of this Act, advise the Minister on the preparation of development plans and generally as to the planning of development in Barbados.

The Act specifies that a Physical Development Plan (PDP) should be developed by the CTP in consultation with any person or bodies as he sees fit. The approval of this plan is done by the Minister subject to modifications as necessary.

Supplementary provisions as to applications for planning permission were included in the 1998 revision to include an assessment of the impact that the development in respect of which planning permission is being applied for is likely to have on the environment of Barbados including the coastal zone management area. Furthermore, the CTP may by notice in writing require the applicant to submit such further information as deemed necessary. Consultations with the Coastal Zone Management Unit (CZMU) and orders for regulating the manner in which applications for planning permission are to be dealt with by the CTP, enabling the Minister to give directions restricting the grant of planning permission, consulting with the TCP Advisory Committee or with such other authorities as necessary.

The other components of the Act look at enforcement notices, compensations and schedules.

Health Services Act

The Health Services Act Chapter 44 of 1997 gives the Minister responsibility for the preservation and promotion of health of the residents of Barbados. This includes *inter alia*: the prevention, treatment, limitation and suppression of diseases; the abatement of nuisances and the removal or correction of any condition that may be injurious to the public health.

Factories Act

The Factories Act addresses aspects such as waste disposal as a result of the manufacturing process, effluents, ventilation, noise, removal of gas, fumes and protective equipment. Furthermore the Act stipulates that all fumes, dust, and other impurities that are likely to be injurious to health and are generated in the operation of the factory shall be rendered harmless. Additionally, no gas, dust fume or other impurity and no exhaust gases shall be conducted into the open air if they are of such a nature as to be likely to cause injury to the public. Despite that the Act does not make provisions for the regulation of the quality of the liquid effluents or gaseous emissions, the Minister is authorised to make regulations for the effective implementation of the provisions contained therein.

Marine Pollution Control Act 1998-40

The Act serves the purpose of prevention, reduction and control of pollution of the marine environment of Barbados from whatever source and stipulates that no person shall release or cause to be released any

pollutant into the environment which is in violation of any applicable standards, conditions or requirements specified under this Act or regulations. The Act is administered by the EPD in which the director is required to conduct a number of activities such as investigation of premises to ascertain the extent of the pollution and significant sources of pollution, characterize and describe pollution, develop a register of pollutants, develop and implement a pollution management programme and develop a list of pollutants and prohibited concentrations. The administrative requirements for the Act also entail the appointment of inspectors, monitoring, enforcement and fines.

Coastal Zone Management Act (Chap. 394 of 1998)

The Coastal Zone Management Act provides for the more effective management of the coastal resources of Barbados, for the conservation and enhancement of those resources and for matters related thereto. Important elements to realise the object of the act included allowances for a coastal zone management plan and orders delimiting the coastal zone.

The composition of the coastal zone management plan is outlined such as policies, strategies and standards that provide for the management and conservation of coastal resources. Key stipulations include:

- Policies, strategies and standards for the development and the standards for environmental impact assessment for development which may affect the conservation and management of coastal resources;
- Standards for water quality in coastal and marine areas to effect the maintenance, rehabilitation and enhancement of coastal and marine habitats.

However, notwithstanding the provisions of this Act, the management plan shall not be construed as authorising any development that is not permitted under the Town and Country Planning Act or any other enactment.

The remainder of the Act looks at conservation and preservation of marine and coastal resources, administration and enforcement.

Policies

Historically, the need for a policy framework for the protection of the natural resource in was recognized and initiated in the 1960's. The Barbados Physical Development Plan, amended 1986 outlined a national settlement development strategy to the year 2000. This strategy included land use, economic activities, housing, services, recreation and conservation. However, there was little explicit integration of the ecological/environmental dimension into the activities and programmes of sectoral ministries and private sector organizations (Calixte, 2000).

Currently, the stipulation for EIA and the identification of development projects for which EIAs are mandatory within the Draft National Physical Development Plan (DNPDP) of 2000. This plan preceded the establishment of the Ministry of the Environment, Energy and Natural Resources in 1998 with the mandate of developing environmental policy and strategies. Of importance is the attempt made in the DNPDP to integrate and develop a coordinated approach to natural resource management utilizing:

- Environmental management policy;
- Integrated coastal zone management plan;
- Comprehensive tourism policy;
- Resource extraction policy;
- National resource reserve policy;
- Comprehensive land use policy;
- Water protection and management policy;
- Natural heritage conservation areas.

The DNPDP explicitly states that, "The CTP and the Chief Environmental Officer (CEO) may require applicants for planning permission to prepare and submit an EIA if, in their opinion, a proposed development may have a significant negative effect on coastal or other environmental resources, Natural Heritage Conservation Areas or adjacent land use." The plan outlines and identifies the types and classes of developments for which applicants are required to prepare and submit an EIA including electricity generating plant.

3. EIA Institutional Framework

Despite the absence of a formal legislative stipulation for an EIA to accompany application for permission to undertake development projects in Barbados, the CTP uses his office and guidance contained in the DNPDP to request this sustainable development tool. This is particularly relevant to development projects in the coastal zone for which it is the norm for such plans to be submitted to the CZMU for review.

Inter-agency collaboration and sectoral input are the main elements used for the request and review of EIAs that are to be conducted for development projects. Although there are no specification for which agencies should be consulted for types and classes of projects the Barbados Water Authority (BWA), Chief Fire Officer (CFO), CZMU, Environmental Protection Division (EPD), Ministry of Transport and Works (MTW), and the Environmental Units form the core of agencies referred to. Depending on the nature of the application other government Ministries, National Trust, Museum, Port Authorities and Lecturers of University of the West Indies (UWI) are usually also consulted (Calixte, 2000).

Although not explicitly detailed in the TCP Act (1998), the level of inter-agency collaboration with respect to developments has been formalized with the Port St. Charles Marina and the Barbados Light and Power Generating Station projects providing the foundation. The EIA process is outlined in Figure 23.1 and shows that sectoral agencies are consulted and

they provide input to the EIA at the scoping, application review, development of the TOR, final review of the EIA, report and recommendations to the Town and Country Planning Department (TCPD) on the development and impacts.

The developer applies for planning permission which triggers the inter-agency collaboration with the proposal and plans reviewed by various sectors. The comments are used by the CTP in the determination for request of an EIA and if required then the developer prepares the draft TOR which is submitted to the TCPD. This is further reviewed again by the inter-sectoral agencies and finalized by the TCPD to guide the EIA study. The developer conducts the EIA which is submitted to the CTP who circulates the document for review by the sectoral agencies. The TCPD organize meetings and formalize a committee among the representatives from the sectoral agencies to discuss the report. Meetings are also organized (Town Hall meeting) to inform and obtain public comments on the project. The comments from the agencies and public are consolidated by the TCPD and submitted to the developer. The EIA is completed and accepted when in the opinion of the CTP all concerns by the public and committee are addressed in the re-submitted EIA document. The final approval of the project rests with the Minister responsible for planning.

Government executed projects are subjected to the same EIA process which are reinforced by the restrictions of the funding agencies such as the World Bank, Inter-American Development bank (IDB) and Caribbean Development Bank (CDB). These institutions include the EIA as part of their project cycle and in most cases ensure that they are conducted for national projects.

Public consultations allow for dialogue between the developers, regulators, interest groups and concerned citizens. The public consultation may be organized based on the coordination by the CZMU and the TCPD to engage residents on a particular development project. Alternatively, the developer usually organizes public meetings as part of the conduct of the EIA.

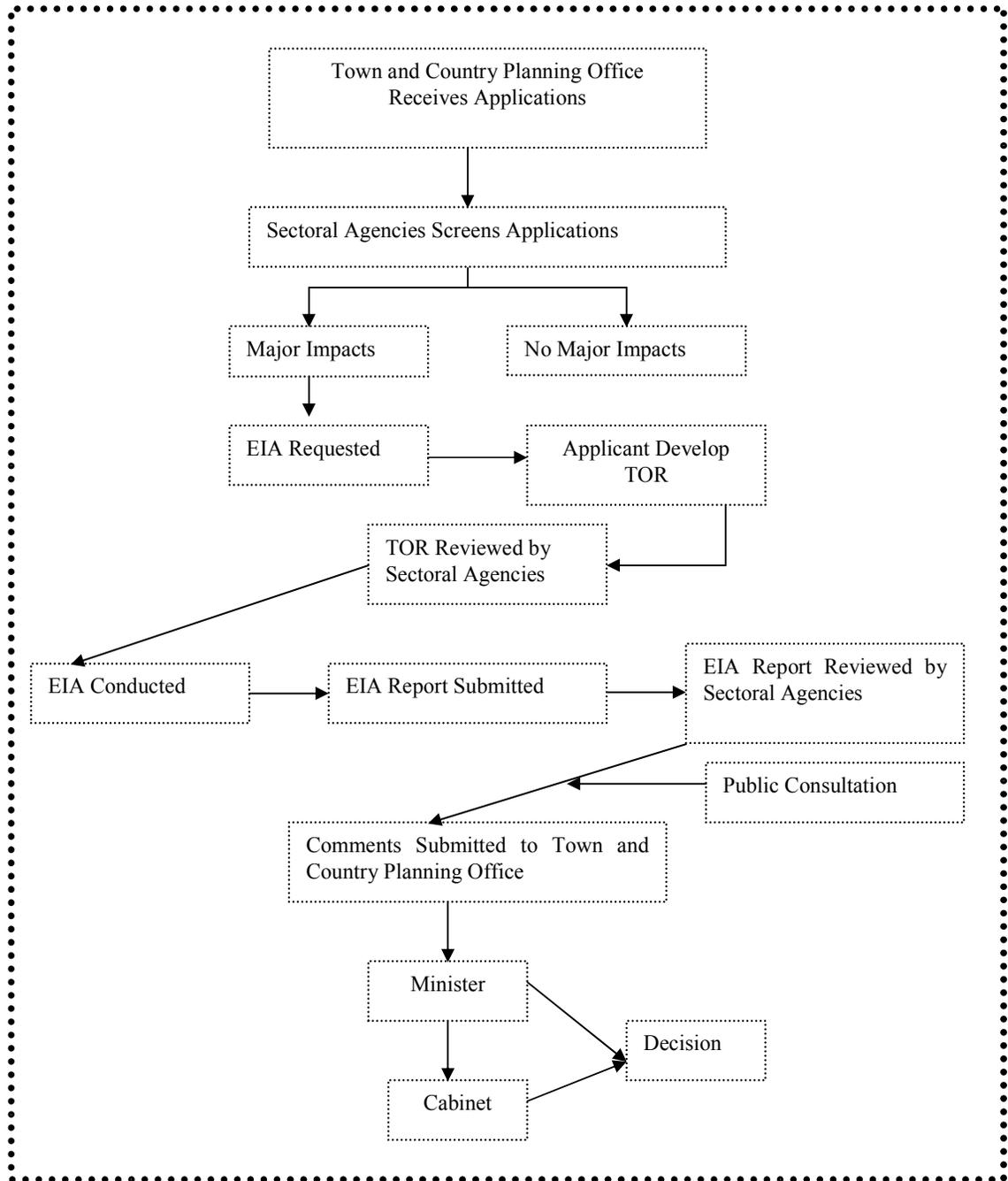


Figure 2.3.1: EIA Processing Barbados (Modified from Calixte 2000)

Development Application and EIA Process Realized

Application and Outline Permission for Development

In accordance with the need to expand the generation capacity for the supply of electricity in Barbados the BLPC issued a study for the evaluation of candidate sites. Four sites were considered and based on an arrangement to relocate the Shell Antilles and Guianas Limited facility located to the northeast of the existing SGGs it was decided that the Spring Garden site was the most appropriate. The site has the advantage of hosting the existing power generating plant and is surrounded by industrial activities making public and regulatory acceptance relatively easier.

The development project for the expansion of the BLPC generation capacity represents the infancy stage of request for EIA by the TCPD to effect the policies of environmental management in Barbados. Application to develop the site at the Deep Water Harbour was made and permission was granted in outline only. This was used by BLPC to engage key stakeholders in consultation and evaluate existing environmental data. At a meeting held with the Risk Assessment and Monitoring Committee for Industrial Development (RAMCID) there were concerns about the appropriateness of the Deep Water Harbour site following a presentation of a baseline study report. Hence, a site selection study using environmental data, engineering considerations and costs, was conducted and determined that re-development at Spring Garden presented the most appropriate and cost effective alternatives available.

Permission in outline was granted in 1993 to redevelop the SGGs with two conditions stipulated to eliminate negative impacts on the surrounding environment.

1. Submission of detail application including plans on all aspects of building and operations;
2. Submission of a comprehensive environmental statement covering:
 - a. Operation processes, effluents, disposal means and mitigation measures for all environmental consequences;
 - b. Identification of an acceptable solution to the present environmental problems in Spring Garden;
 - c. An engineering assessment on the cost effectiveness of the use of an open cooling system as opposed to a closed cooling system;
 - d. Social impacts analysis and mitigation measures.

EIA Process Realised

The conditions of the outline approval led to the commissioning of a number of studies complemented by focus group meetings and public consultations which were components of the EIA study. They include:

- Environmental Audit;
- Ambient air survey and stack sampling study;
- Spring Garden water quality, coastal/marine and marine impact assessment;
- Spring Garden power station beach monitoring study;
- Comparative cooling options study;
- Social impact analysis study.

These studies once completed were submitted to the TCPD for revision and approval. The process followed is outlined in Figure 3 below:

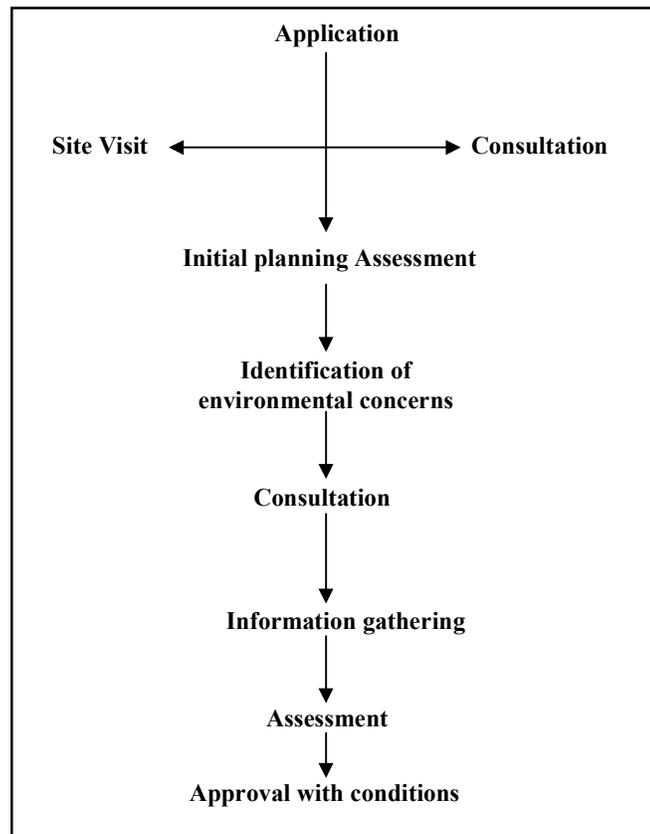


Figure 3: EIA Process Followed by BL&P

Public consultations

Due to the magnitude of the project, stakeholder input was deemed a requisite from inception. This was done in two ways:

1. The BLPC engaging the general public and key stakeholders;
2. The TCPD soliciting the expertise of various resource persons to highlight concerns based on their respective sector.

In 2002 approximately 700 community residents were invited to two days of public consultations held by BLPC prior to project start. All studies conducted, EIA reports, pertinent data and written comments made by Government agencies were made available to the public. No objection to the proposal was made by the participants but concerns raised included the following:

- Stack emissions, changing wind direction and mitigation plans;
- Noise associated with the new plant;
- The loss of a communal bathing pool at the rear of the plant;
- Access road blockage and damage during construction;
- Vibrations and smoke;
- Availability of new jobs;
- Spills by fuel pipeline in the catchment area of the desalination plant;
- Safety valve testing of steam plant.

Survey of Stakeholder Participation

As part of the case study a survey was conducted among sectoral agencies and residents in the vicinity of the SGGs. In some cases it was felt that considerable effort is placed in public consultation both by the developer and the regulator. However, it was also expressed that the public participation can be made a more genuine consultative process and the client is given too much responsibility for this important element. The establishment of walk-in centers allowing more time for interactions, asking of questions and providing responses would be more effective.

At the community level there were expression of dissatisfaction in the level of community participation and interactions with the low income residents were limited. There were indications of lack of awareness that public consultations were held by some individuals.

Interagency Collaboration

Interagency collaboration has been a component of the planning process from the onset of the application permission to increase the power generation capacity of the BLPC facility. This was the impetus behind the decision to develop the existing site at Spring Garden rather than relocate to alternative sites. In referring the application to the Minister for her final approval the TCPD indicate that consultations were conducted both inter-governmental agencies and public. The government agencies consulted included:

1. Barbados Water Authority (BWA);

2. The Ministry of Physical Development and Environment (PDE);
3. Environmental Engineering Department (EED);
4. Coastal Zone Management Unit (CZMU).

The responses of the referral agencies to the development were included as appendix to the correspondence while the main issues raised were summarized and included for immediate review by the Minister. Physical development considerations noted that the DNPDP did not allocate lands specifically for new special industrial developments but informs that such developments be directed towards areas which meet certain criteria such as *inter alia*:

- Locations which are not proximal to Zone I Water Protection Areas;
- Locations which will not result in significant negative impacts to sensitive land uses such as residences, open space, community facilities, tourist districts or recreational/beach areas;
- Application for special industrial development will be encouraged to locate adjacent to existing special industrial operations, provided that the above considerations can be satisfied (TCPD, 2002).

Main issues raised include:

- Planning
 - a. Effect of the development on the existing residential community;
 - b. Effects on the character and appearance of the area;
 - c. Effects on existing amenities;
 - d. Effects on the marine environment.
- Air Emissions
 - e. Visual and aesthetic impacts from soot;
 - f. Odor and chemical impacts on persons at sea at eh point of contact during times of incomplete mixing due to adverse wind conditions;
 - g. Nuisance to residents from odor and chemical contamination approximately 8-9 days per year.

Mitigation measures included the use of higher stacks than the existing to enhance plume dispersion, mixing and potential receptor distance reducing the frequency and extent on potential impact on residents.

- Noise

It was noted by the EPD that the noise impact survey done as part of the EIA study excluded the nearest resident who are located 50 m from the plant. The EIA proposed to improve the overall noise efficiency by having generating units and associated facilities in a sound proof building. This will ensure that the noise level at a distance of 15m from the powerhouse will be 60 dB (A) or less. Geotechnical test were also indicated to be conducted to determine the appropriate foundation characteristics minimize the transfer of engine-induced vibration to the surrounding terrain.

- Coastal Issues

The effect of the discharges from the generating station on the marine benthic communities as a result of toxic chemicals due to the high risk factor associated with the wind direction in the area.

- Health and Safety

Prolonged exposure to SO₂ and NO_x may have damaging effect on human health and the viability of the environment. The EIA examines health and safety matters by proposing the application of best practices for the Environmental Management Plan (EMP). It acknowledges responsibility to minimize risk and damage to the general community by employing safe technologies and operating procedures and by constantly prepared for emergencies.

The CTP indicated to the Minister in the correspondence that the concern raised by the referral agencies will be included in the conditions under which planning permission is granted.

Efficiency and Effectiveness of Regulatory Process

In the absence of the laws that specifically outlined the EIA process, referral and collaborating arrangements the approach used by the TCP can be viewed as an acceptable measure in light of national circumstances. Allowing the sector agencies to have an input in the approval of the development as early as the application in principle provides an opportunity for requisite measures to be included that will protect the integrity of the environment of Barbados and the health of the residents.

Notable absent in the list of referral agencies was the Ministry of Health that would have covered the Environmental Health Department, the Epidemiological Unit and the clinical medical services. This indicates a gap in the comprehensive inclusion of health as part of the overall assessment for a project that has potential for affecting the health of the communities adjacent to the development.

Project Approval Conditions

After consolidation of the comments emanating from the review by the governmental regulatory agencies, the TCPD compiled a list of 15 conditions with supporting reasons for each one to accompany the approval of the development. These were included in the submission to the Minister for final concurrence and confirmation. These conditions include *inter alia*:

- The facility shall not release any CO, NO₂, SO₂, and NO_x in quantities or durations injurious to human health, plant or animal

life or would reasonably impact negatively on the enjoyment of life or property.

- The submission to the CTP an Environmental Management Plan to illustrate how the facility will be operated and maintained.
- The new generating station shall be sound proof to allow for sound levels not greater than 60 dBA at the northern perimeter of the site at all times.
- The developer shall carry out a study to determine what impact the deposition of drift salt, particulate matter and chemicals have on the environment and coastal vegetation.
- Submission of a site management plan for construction activities.
- Water quality monitoring should be carried out for the marine environment receiving the effluent of the cooling process and the water used in the cooling tower.

The conditions were demanded in order to protect public health, ensure the safety of the environmental quality of the area and prevent harmful effects on the marine environment (TCPD, 2002).

BLPC Corporate Environmentalism

The BLPC has in addition to the conditionality outlined in the project approval documents exceeded the regulatory requirements. This was due to recognition of its responsibility to minimize the effect of its operation on the environment and the desire to provide leadership by promoting environmental awareness and accountability. Hence, on this premise and as required by the TCPD, the BLPC developed an Environmental Management Plan (EMP) to guide the operation of the company and achieve the environmental objectives. The Company indicated commitment to:

- Resource conservation;
- Waste reduction and disposal;
- Product safety;
- Risk reduction;
- Education and training;
- Public information;
- Quality management.

The EMP provides a framework for addressing environmental issues for the operation of new LSD plant (units D14 and D 15) in a repeatable, organized and responsible manner consistent with the policy of the Company as a corporate environmental facility. It identifies the scope of the environmental requirements, provides implementation guidelines, sets quantifiable targets and includes provision for checking and corrective action and management review to ensure compliance with regulations.

Environmental and Health Interactions Models Used/Evaluation Techniques

Wastewater Discharges

Applicable standards for discharge water quality include the Coastal Zone Management Act (1998) and the Marine Pollution Control Act (1998). These Acts have been mandated to establish regulations which are still outstanding. Hence, World Bank Guidelines for effluent from power plants (Table 4.1.1) were applied.

Table 4.1.1: World Bank Guidelines for Power Plant Effluent

Parameter	World Bank Guidelines (mg/L)
pH	6-9
Total suspended solids	50
Total oils & grease	10
Total chlorine residue	0.2
Chromium (total)	0.5
Copper	0.5
Iron	1.0
Zinc	1.0
Temperature at edge of mixing zone	3 ⁰ C above ambient

Minor discharges from the plant floor drains will contain oils, grease and PAH's. Oily water treatment will be administered before discharge to the environment. Monitoring includes taking of monthly samples to be reduced to quarterly based on the level of compliance.

Discharge Plume Monitoring

The BLPC was required to monitor the wastewater effluent in the marine environment at 50 m intervals to 250 m from discharge point and submit result to the Environmental Protection Department (EPD) for assessment. The monitoring was stipulated to be monthly for the first year and quarterly for the second year. Sampling times will then be adjusted based on the findings.

The sampling programme developed in response involved the geo-referencing of all sampling points, collection of composite samples at each site, analyzing for oil, grease and metals, observing the sample collection and handling protocols and use of a qualified laboratory for analyses.

Groundwater

The plant incorporates cooling towers to dissipate heat with reject water from the desalination plant used to make-up water loss from the cooling tower system. Periodic blow down of the cooling tower will discharge salts to the recharge well located on the BLPC property.

The monitoring programme involved the collection of representative samples of the blowdown from the cooling towers for analysis. This includes: metals and general chemistry (pH, TSS, TDS, Si, PO₄³⁻ and NO₃⁻). This monitoring was complemented by establishment and sampling of monitoring wells, tabulation of results and comparison with seawater

characteristics and pre-operational groundwater quality, submission of reports covering the monitoring programme.

Air Emissions

Confirmatory testing to ensure that the emissions meet the World Bank specifications was conducted. This was followed by continuous emissions monitors (CEM), such as for NO_x and opacity to provide real time measurements of the emissions. Monitoring for SO₂ was conducted in the short-term and long-term with stations established easterly of the plant where the residential and business communities are concentrated. The World Health Organisation guideline of 500 µg/m³ based on a 10 min period and World Bank's 150 µg/m³ based on hourly period were used. If these levels were exceeded mitigatory action such as change of fuel and load shifting to other plant were suggested (AMEC, 2003).

The monitoring programme involves 3 sampling sites within 1 km of the plant (east, north and south) with a control point remote of the site to observe conditions outside the influence of the plant. The monitoring programme was commenced 3 months prior to start up and continue for 6 month after successful start-up. Quarterly sampling was then conducted for the next 6 months. Review of the results will guide the appropriate control measures.

Noise Management

Approval conditions stipulated a threshold level of 60 dBA at the northern parameter of the site at all times. The monitoring programme was scheduled for time of commissioning and during operation at varying loads with the report to be submitted to the EPD for assessment. Additionally, noise measurements was proposed for the nearest residence on a quarterly basis considering daytime and night time conditions commencing 6 months prior to plant start up. Operational measure such as sound proofing and keeping doors closed were proposed to reduce the noise impact.

Coastal Vegetation and Dustfall Study

BLPC was mandated to carry out a study to determine what impact the deposition of drift salt, particulate matter and chemicals have on the environment and coastal vegetation. The monitoring programme entailed vegetation and soil sampling stations were established at eight locations to ensure the direct effects of the cooling tower can be compared with the baseline conditions. The samples of soil and vegetation were collected 6 months prior to the start up to allow adequate accumulation of materials in the foliage or any injury symptoms to develop. The sampled were analysed for sodium chloride, and metals at a certified laboratory.

Waste Management

Barbados is signatory to the Basel Convention on Hazardous Waste and as such waste is managed according to the requirements contained in the guidelines. However, waste minimisation is practiced through the reduction, reuse and recycling, recovery of boiler ash to be used in specialty steels requiring vanadium. Product substitution for non-hazardous alternatives, preference to recyclable products, procurement procedures and the adoption of operating procedures to minimize waste are some of the suggested alternatives.

The disposal option for the waste will depend on the classification of hazardous or non-hazardous according to the Basel Convention Guidelines. Hazardous solid and liquid waste to be disposed locally will be according to the stipulations of the EPD while the non-hazardous will be disposed of at the municipal landfill. Keeping of appropriate records in accordance with the Basel Convention will be adhered to.

Hazardous Material Management

Storage, handling and management of chemicals will be given priority. The material safety data sheets will be used and will guide the use and management of the chemicals. Substitution of less hazardous materials and reduction of chemical use will be explored where possible.

Measures for the prevention and management of spills will be adhered to. Emphasis will be placed on the adoption of engineering aspects for storage such as positioning, containment pads, catch basins and containment. The protocol and procedure for the reporting and intervention regarding the spills and prevention of future occurrence will be developed and adhered to. The overall response will be containment, removal, remediation and rehabilitation.

Disposal options for the hazardous waste include: recycling, transport off-island and construction of an engineering disposal cell. Special measures will be employed to control and remediate the soils and liquids contaminated with oily sludge. Final disposal will depend on the level of treatment used and the approval of the EPD.

Emergency Management

The completion of a detailed fire contingency plan for submission to the TCPD was also a component of the approval conditions. Importantly measures were taken to coordinate the fire plan, the spill contingency plan and the environmental management plan. This will be complemented by the environmental training programme to enhance the efficiency and effectiveness when responding to industrial or natural disasters.

4. Enforcement

Measures Recommended or Stipulated

Collating and harmonising the comments and recommendation of the referral agencies led to the formulation of 15 conditions to be adhered to in accordance with the planning permission. However, it is important to note that in the absence of specific regulations addressing all the areas of interactions between the project the environment the EMP and performance monitoring provided the foundation for the enforcement. Here, the BLPC will have to demonstrate self policing, compliance beyond the regulatory framework and corporate environmentalism.

The various monitoring programmes established for the emissions will allow for an assessment of the environmental performance of the company. Additionally, inspections and checking of environmental control equipment and environmental audits will assist with the review and maintenance of a high level of environmental performance.

Confirmation to Recommendations

In accordance with information gathered from both the BLPC and the regulatory agencies there has been a high level of compliance with the recommendations and conditions associated with the granting of planning permission. Continual compliance can be determined through the environmental audit which BLPC has committed to undertake with assistance from an external independent auditor every two years. The purpose of the audit includes:

- Provision of true and factual assessment of the Company's operations with regard to environmental matters;
- Document the environmental status of the Company's operation;
- Act as a feedback mechanism to determine where improvement are required;
- Identify risk exposure with regard to environmental issues;
- Improve employee awareness with regard to environmental issues;
- Allow for the documentation of all environmental matters regarding the Company.

Environmental Reporting

The report from the auditing process will serve the dual purpose of allowing management review and provide the pertinent documentation for the regulatory agencies to assess compliance with various environmental standards. This will be complemented by an annual environmental report covering the results of the monitoring with agreed environmental standards.

Receptor Capacity

Receptors proximal to the power generation facility include the residential communities to the north, south and east along with the industrial activities surrounding the plant. The economic status and education level of the receptors varies widely from upscale business associates and entrepreneurs to low income fisherfolks and labour workers. Discussions with individuals during interviews indicated varying perspectives of the

impacts of the plant on health and the environment. The level of impacts felt by the residents also varied with some indicating noise, vibrations and air emission are insignificant stressors while others view them as major sources of discomfort and adverse health elements.

Strengthening of Receptor Capacity

An education and awareness building programme will serve to develop the receptor capacity to identify and recognize adverse health and environmental effects. This initiative can be championed by the regulators and implemented with assistance and partnership from the BLPC. Training programmes can be conducted in the health and environmental impacts of power generation with specific reference to the existing plant and the sensitivity of the surrounding environment. Residents and workers in the vicinity of the plant can develop the ability to identify symptoms of health impacts as a result of the various emissions or identify the effects of the various stressors on the environment. Specific emphasis should be placed on hypersensitivity and measures to be taken to reduce the level of discomfort associated with this phenomenon.

Due to proximal location of the residents to the power plant training in response, evacuation and safety with regards to industrial disasters and natural disasters are critical. This is particularly important since the operation involves the storage and use of hazardous materials which can result in explosion and fires. The communities surrounding should be involved in contingency planning and should be knowledgeable of required actions in times of disasters. This will be inclusive of evacuation routes, warning systems and protective measure to be taken.

Successful Outcomes

The EIA conducted by the BLPC to support the request for planning permission to expand the power generation capacity at Spring Garden represent the first real test of the regulatory framework with respect to interagency collaboration. The significance of the project is that the risk to health and the environment from the construction and operation were regarded as significant and every effort was made to undertake regulatory measures to reduce the impacts. Of importance was the level of cooperation among the agencies and the procedure used by the TCPD to ensure consultation among key stakeholders in the absence of specific laws and regulations addressing EIAs.

The input of the various agencies with specific capacity and regulatory powers governing sectoral areas was able to ensure that certain issues of concern are addressed in the EIA. This was basically through the review of the application in principle and contribution to the formulation of the TOR which guided the assessment study. Additionally and significantly, the review of the EIA report allowed for interjection in areas where the study was deemed to be deficient and provided an avenue to allow conditions to be developed to guide every aspect of the development. The conditions

once adhered to along with the EMP are expected to reduce the impact of the generation station on the environment and health.

Consultation with the public and in particular the community most likely to be affected by the development is becoming an inherent component of the EIA. The consultation conducted along with the issues raised were outlined in the EIA for due consideration by the regulatory agencies and the BLPC and once addressed will lead to a higher degree of harmonization between the existence of the development and the residents.

Socio-Economics

A full socio-economic assessment of the development was not conducted however, stakeholder involvement and interagency collaboration is indicated in section (--) above. The public meeting conducted during the study period was used to gauge the public opinion on the development proposal and secure public input into its planning. Concerns focused on health risks resulting from noise pollution, environmental degradation, marine pollution, beach erosion, power plant operation, contingency planning and evacuation plans in cases of emergencies. Representation by senior level of management of BLPC was requested to ensure that the views of the general population would be heard and acted upon. The Company was generally viewed as a responsible corporate citizen and pledged to maintain that image. Recognizing the need to protect the environment and public health BLPC indicated commitment to develop and appropriate "environmental management system" which will be incorporated into its overall management activities to address issues as they arise and also to plan for mitigation of environmental and health impacts. Furthermore, BLPC plans to continue its public meetings with future sessions emphasizing the company's activities to maintain environmental sustainability (including social and community awareness) while delivering superior products and services.

Level of Community Participation

The EIA process has a strong built-in public participation element and the public is encouraged to write and submit their concerns. Public consultation, focused group meetings and community participation in the EIA process is documented in the report. This took the form of public meetings with representation from senior company officials. However, during the residential survey persons living in the communities, whose tenure exceeded the EIA study period and dates on which the public meetings were held, indicated that they had no knowledge of consultations convened on the project. Hence, they were not provided with an opportunity or avenue to voice their concerns with regards to the health and environmental aspects of the project.

Resource persons interviewed are of the opinion that there should be novel ways to get information out to the public and obtain feedback. The traditional Town Hall meeting should be limited and focused on specific areas. Meeting with residents should be more on a community small group

level since people usually feel inundated by large meetings. Close working relationships should be developed with key NGOs and private sector agencies. Additionally, the EIA process should be simplified and demystified.

Feedback of Consultations into Development Process

Inter-agency consultation and collaboration at the level of the regulatory arm constituted the bulk of the input to the development process. The consultative process is made compulsory by the Act allowing for collaboration with any agency as may be required. Engagement at the inception stage and for the screening of candidate sites allowed significant sectoral dialogue and debate to arrive at a consensus on Spring Garden as the most appropriate location. Furthermore, the contribution to the TOR which guided the EIA process offered an additional avenue for reducing the health risk and environmental degradation associated with the project. The final and critical input component was the review of the EIA and identification of study components which will more thoroughly evaluate the impacts of emissions on health and the environment. The sectoral comments were compiled and consolidated to form the approval conditions dictated by the TCPD which forced the company to comply with the sectoral requirements.

Most of the issues raised by the public were already covered by the agencies that collaborated on the regulation of this power generation development project. The request for senior company officials at the focused group meetings indicate that the public insisted that their concerns should be addressed and senior level personnel were identified and held responsible. Concerns raised by the public such as stack emissions and wind directions, noise, vibrations and chemicals were addressed in the conditions stipulated in the approval. The issue of creation of jobs was addressed by the company directly through the hiring of personnel resident within the vicinity of the power plant.

5. Integrating Health and Environment

Method and Level of Integration

A power generation project such as that of the BLPC at Spring Garden will have health risk and environmental impacts due to the close proximity of various receptors and the interaction of the construction and operation of the facility with the environment. Hence, from inception health and environmental considerations should be integrated comprehensively to allow for a full impact assessment of the project. The impact on the health of residents can be as a result of direct exposure to the emissions or emergencies associated with the development or through contact with the receiving environment. Of significance is the fact that manifestations of associated health conditions can be both subtle and long-term. Hence, it is important that the relevant health and environment sectors with the specific knowledge and capacity to identify, determine, monitor and

recommend mitigatory actions are engaged from inception and are collaborated with to allow full input.

Sectoral screening by the project review committee offered the first level of integration. Representation by the Environmental Engineering Division of the Ministry of Health (at that time 1990) allowed for the integration of health aspects in the impact assessment. In the identification of stakeholders for discussions and consultation on the most suitable site for project location and evaluation of the existing environmental data there were no health representation. The concerns raised by some of the referral agencies on review of the EIA report raise some health issues to be addressed in a cursory manner but specific reference to health aspects or request for pertinent studies related to public health or epidemiological matters were not discernable.

On commencement of the Air Pollution Modeling Study and the Environmental Management Plan (EMP) to complement the EIA study that was conducted, the Environmental Engineering Department was now subsumed under the Ministry of Physical Development Environment and Housing further marginalizing the role played by the health sector in the impact assessment process. Comments, concerns and recommendations were not obtained from the Environmental Health Department or epidemiological personnel within the Ministry of Health.

Gaps in Integrating Environmental and Health Aspects

In the impact assessment and subsequent supplemental studies conducted for the expansion of the power generation facility at Spring Garden a number of gaps existed in the integration of the environmental and health aspects of the assessment process. These include:

- Lack of direct involvement and input of health related agencies in all components of the impact assessment study;
- Absence of health risk assessment of the operation;
- Incomplete socio-economic assessment component of the impact assessment study that should have covered the implications of the development on aspects pertaining to the broader definition of health;
- Lack of consideration given to the specific studies that will discern the health impacts of operation of the facility in the long-term;
- Absence of health indicators and monitoring mechanism;
- Need for health constituents to be included in the management plan to allow for the development of an environmental and health management plan;
- Lack of empowerment of the community in the identification of adverse health and environmental effects of the operations;
- Lack of capacity among the community to respond to incidences of emergency that may arise as a result of industrial or natural disasters;

- EIAs conducted are weak in the components that covers social, economic and cultural aspects;
- Studies conducted concentrated on the hard engineering aspects;
- There is a bias towards the bio-physical matters and the study teams are in many cases devoid of resource persons in the health discipline;
- Tiers of bureaucracy to be traversed for the review and comments on the EHIA can be prohibitive.

6. Conclusions

Needed Changes in Laws and Policies

In Barbados there is no formalized legal requirement for the application of environmental impact assessment to projects (Calixte, 2000). In fact, there is no express statutory basis for requesting an EIA. The present Town and Country Planning Act (1972) does not directly provide for an EIA of a project. However, section 17 (1) of the Act authorizes the CTP to require that applicants provide "such further information as he thinks fit" for development permit. This forms the basis under which the regulatory bodies request EIAs for development project with much success since this was never challenged in court by a developer.

Alternatively, the request for EIAs is stipulated in the Draft National Physical Development Plan of 1998 (DNPDP) if in the opinion of the CTP and Chief Environmental Officer (CEO) a proposed development may have a significant negative effect on coastal or other environmental resources, natural heritage conservation areas or adjacent land use. Furthermore, a list of proposed development for which an EIA is required is outlined such as *inter alia*: chemical or manufacturing plant, refinery, electricity generating plant, a cement plant and a waste management facility. All the types of industries mentioned have significant environmental and health risk and it is necessary that assessments conducted integrate both.

In this regard, amendment of the Town and Country Planning Act to request impact assessments that stipulates the integration of health and environmental aspects is needed. Environmental health will have to be identified as one of the areas to be covered in the impact assessment study. This is the most appropriate alternative in the absence of an environmental management or environmental protection agency. Additionally, model legislation on physical development, which outline request for EIAs, exist for the Organization of Eastern Caribbean States (OECS) which can be used as foundation and tailored to the Barbados situation. Similarly, these legislation do not integrate health impacts and environmental impacts in a holistic way and much emphasis will have to be placed on the integration of these elements prior to legislating.

New Forms of Logistical and Financial Support

Developing new legislation or modifying existing legal instruments to request impact assessments that comprehensively integrate health and

environmental impacts will be challenging. In the case of Barbados, capacity do exist within the University of the West Indies (UWI) to draft and develop environmental legislation however, support, collaboration and intensive consultation will be needed to integrate specific and less discernible health concerns and environmental impacts. This can be conducted through the formation of a Technical Advisory Committee (TAC) to guide the process consisting of specialist in the areas of health, environment and legal drafting.

Intervention by International Institutions

Addressing the issue of impact assessments that integrate health and the environment will have to be approached at the regional level. Hence, the development of the capacity and capability to institutionalize and administer planning and development control that require comprehensive environmental and health impact assessment will be needed. The use of Barbados as a pilot State and extending to the rest of the region over specified time period will be the most feasible alternative. In this regard, there is a need for intervention by international institutions to provide technical assistance and financial support towards the promotion and implementation of impact assessments that integrate health and the environmental.

Elements of New Accords and/or Instruments

Most States of the Caribbean region have similar institutional, administrative and regulatory framework for development control and request for impact assessments. In fact, the request for EIAs to be a component of the applications for planning permission to undertake development evolved and spread throughout the Caribbean post Rio 1992 Agenda 21. In States like Barbados where it is not yet a specific legal requirement, it has become the norm for EIA studies to be conducted and resistance to such is negligible. Furthermore, most developers exhibit corporate environmental responsibility and volunteer to have the studies completed to support and guide their development.

An agreement throughout the Americas will procure the commitment from States to have environmental and health impact assessment (EHIA) conducted. This will provide the catalyst to replace the traditional EIA or Health impact assessment with a comprehensive impact assessment that integrates health and the environment. Hence, the health risk and impacts associated with a proposed development will be given due consideration and priority as the environmental impacts component. However, any accord or instrument developed will have to consider:

- Technical assistance: Limited capacity exists in the Caribbean region to conduct EHIA and training will be required to have a cadre of professionals with the requisite skills. Additionally, from a regulatory perspective capacity will be needed in the planning agencies to conduct meaningful reviews and set approval conditions based on the findings of the EHIAs.

- Financial assistance: States that have signed onto the agreement will have to be provided with financial assistance to develop the capacity and capability to institutionalize and administrate the EHIA.
- National administration: Amending the local laws that governs impact assessments to include the elements of a new EHIA agreement will be challenging. Most of the States have laws specifying EIAs including structure and composition. Hence, the Acts, regulations, schedules and guidelines will need to be amended to include aspects that will stipulate a thorough EHIA for proposed projects.
- EHIA promotion: Measures will have to be taken in the administration of the instrument to allow for continuous promotion throughout the Americas. This will facilitate the signing, accession, ratification and implementation at the national level.
- Timing: It is important to have a time element included in the agreement which will allow States to make the necessary legal and administrative arrangement to implement the requirements of the EHIA agreement at the national level.
- Private sector: Any agreement of this sought should make allowances for the input of the private sector or NGOs at all stages. Health and environmental management services are conducted by the private sector and the EHIA studies will be conducted through consultancies. Hence, continuous dialogue with these sectors will add to the robustness of the agreement and in many cases the private sector can lobby governments to implement.
- Technical cooperation among countries: States with greater resources and more advance regulatory and institutional framework can advance the process of environmental health impact assessment with the guidelines, procedure and process developed available to be used by other States. Through collaborative efforts technical assistance can be provided to less fortunate States in the legal and institutional revisions.

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