
CHAPTER 15

MITIGATION AND MONITORING

15.1 Overview of Environmental Impacts

The study of, and commitment to, mitigate measures have become an extensive and meaningful part of the environmental impact assessment process. In many circumstances, potentially adverse impacts can be avoided or mitigated to acceptable levels through careful design and implementation of appropriate measures or techniques to reduce the severity of the effects.

All possible measures to mitigate potential impacts should be included in the proposed action. The CEQ regulations define mitigation to include:

1. *Avoiding* the impact
2. *Minimizing* the impact by limiting the degree or magnitude of the action
3. *Rectify* the impact by repairing, rehabilitating, or restoring the affected environment.
4. *Reducing* or eliminating the impact over time
5. *Compensating* for the impact by replacing or providing substitute resources or environments.

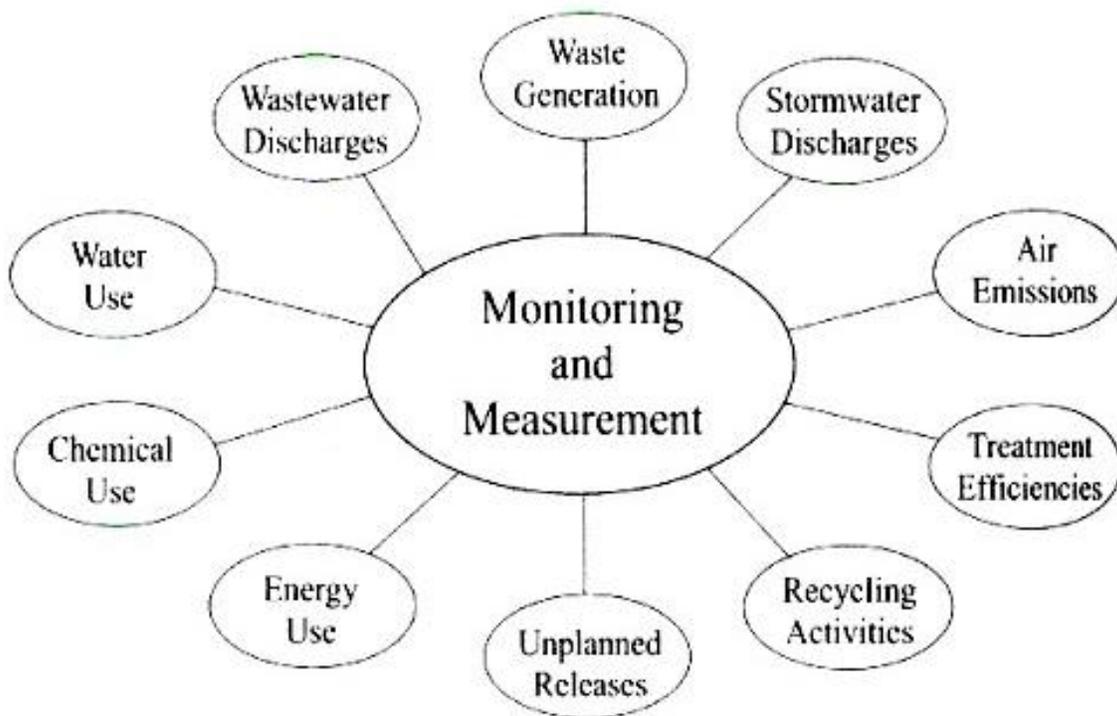


Figure 15.1 Mitigation and Monitoring Elements

The level of adverse, or alternatively, beneficial impacts on the ecosystem and in general of any given area in question is a function of the scope of the development, the ecological fragility or sensitivity of the receiving environment, and the conceptual value assigned to the integrity of the natural resources of the area by the wider community.

The connectivity or hierarchal nature of the impacts of the proposed project has been reinforced by the integration of a residual impact rating matrix outline in table 15.1. This matrix evaluates the mitigation measures options in the following terms:

- **Magnitude:** High (H), Medium (M), or Low (L);
- **Direction:** Beneficial (+) or Adverse (-);
- **Duration:** Instantaneous (I), Short term (S), Medium (M) or Long term (L);
- **Scope:** Instantaneous (I), Short term (S) , Medium (M) or Long term (L);
- **Significance:** Not Significant (NS), Low (L), Medium (M) or High (H) significance

The primary activities that are likely to result in some environmental impacts of note are the access roads enabling the proponent to reach the site, development drilling process, as well as the trenching aspect of the development. The potential for pollution from air, noise, solid waste and a shift in the increase of land property are also of relevance.

Table 15.1 Summary of Residual Impact Rating for the Proposed BNE Project

	Potential impact	Magnitude	Direction	Duration	Scope	Significance
Drilling Phase (Construction)	Soil Contamination	H	-	I,S	L	L,M
	Land Alteration	M	-	L	L	L
	Vegetation Loss	H	-	L	L	L
	Wildlife Displacement	M	-	S	L	L
	Fugitive Dust Emissions	M	-	S	L	L
	Point source Emissions	L	-	S	L	L
	Ground Water Contamination	M	-	M, L	R	M
	Surface Water Contamination	L	-	I,S	L	L
	Noise Generation	M	-	S	L	L
	Socio-economic Influence	M,L	+	S	L	M
Operational Phase (Testing, Exploitation)	Soil Contamination	M	-	I,S	L	L,M
	Land Alteration	L	-	M	L	NS
	Ground Water Contamination	M	-	M, L	L	H
	Surface Water Contamination	L	-	I,S	R	L
	Fugitive Emissions	L	-	S	L	L
	Point source Emissions	L	-	L	L	L
	Noise Generation	L	-	L	L	L
	Socio-economic Influence	M	+	M	L	L

Table 15.1 Summary of Residual Impact Rating for the Proposed BNE Project (Cont'd)

	Potential impact	Magnitude	Direction	Duration	Scope	Significance
Transportation (Pipeline)	Soil Contamination	H	-	I,S	L	L,M
	Land Alteration	M	-	S	L	M
	Vegetation loss	H	-	S	L	L
	Ground Water contamination	L	-	M, L	R	H
	Surface Water Contamination	L	-	I,S	L	L
	Fugitive Emissions	L	-	S	L	L
	Point source Emissions	L	-	S	L	L
	Noise Generation	L	-	S	L	L
	Socio-economic	M	+	S	L	L
Decommissioning	Soil Contamination	L	-	I, S	L	L,M
	Land Alteration	L	+	L	L	L
	Ground Water contamination	L	-	M, L	R	H
	Surface Water Contamination	L	-	I, S	L	L
	Fugitive Dust Emissions	L	-	I, S	L	L
	Point source Emissions	L	-	I, S	L	L
	Noise Generation	L,M	-	I, S	L	L
	Socio-economic Influence	L	+	S	L	L

15.2 Summary of Proposed BNE Impacts

The following sections describe the proposed impacts that can arise as a result of Belize Natural Energy operations in the area:

15.2.1 Water Pollution

Water pollution can occur as a result of direct and indirect impacts to the waterways and ground water. The waterways that influence the project sites are the Iguana Creek in the San Marcos area and the Belize River for the new Mike Usher wells. The Iguana Creek has several tributaries protruding throughout the landscape that collects surface water runoffs. These runoffs eventually discharge into the Belize River.

It is anticipated that the proposed project will not have a significant impact on the waterways during all the phases of operation. This is due to the fact that the developments wells and are located some distance away from the sites. Increased surface runoffs would be in this case the only relevant issue as siltation associated with the land clearing for road access and infrastructure development along with trench excavation could impact the waterways.

Due to the nature of the locations (~ 800 ft of clay) no impact is anticipated to the ground water as no wells are in the area. However prior to producing from any of the wells, the well bore will be cemented. This will prevent any possible contamination of ground water aquifer.

15.2.2 Soil Impacts

Given the relatively limited extent of the proposed project, the risk of a significant impact due to soil contamination is considered low. This is considering the proposed activities that will be carried out during the drilling, operation and decommissioning of the well sites. In this regard the main possible sources of soil contamination during the proposed project will be:

- Vegetation Loss- land clearing to accommodate drilling infrastructure and trenching to install pipeline.
- Spills – that can come from fuel storage
- Wastes –that will be derived during the drilling process, and
- Solid waste and liquid waste generation

Vegetation loss derived from the land clearing process and trench excavation does impact the soil directly. This is especially during the construction phase which will eventually give rise to access roads and drilling pads to accommodate the drilling rig and associated support services such as the generators, fuel and water tanks. Other infrastructures on site include workers quarters or accommodations, eating areas, storage areas and provisions for the collection, treatment and disposal of wastes. Trench excavation for the installation of the pipeline alters the vegetation cover because, even though covered up, a transit or inspection path must be maintained.

Another component of concern is erosion which can be caused by the construction of the access road and trench excavation. The operation, however, will not impact the site as erosion is expected to be minimized through properly constructed road ways and properly covered trench.

Spills and waste streams, even though localized, have the potential to contaminate the soils. Potential areas for spills include the fuelling stations, generator location and drilling site. Better Management Practices performed by BNE will mitigate these impacts.

A standard BNE exploratory site consists of a derrick, drilling mud handling equipment, cementing equipment, generators, and storage tanks for fuel and water. Possible impact sources during this phase include the cementing wastes; water based drilling fluid and associated cuttings, well completion and production testing wastes. Drilling fluids are reused and can only become a problem if it is disposed of improperly.

15.2.3 Wildlife

The impacts on wildlife relates to the modification and alteration of habitat, as well as the introduction of non-natural conditions that would modify the behavior of animals. During

the surveys, none of the species encountered were rare or of conservation value and the biodiversity value of the area are low as in the case of the new Mike Usher wells. This is largely to the location of the wells on agricultural land. Biodiversity in the San Marcos area is low as the fragmented ridge of lowland broad leaf forest has been heavily hunted by the locals. This in turn would drive the bigger predators and prey away from the area as they seek protection from hunting. Wildlife impacts related to land-clearing in preparation for the site will be minimal and insignificant.

15.2.4 Air-shed Impacts

Impacts to the air-shed quality are relevant to all phases of the proposed projects undertaken by Belize Natural Energy. The potential sources of air pollution could result from fugitive dust emissions, vehicular/ heavy equipment exhaust, drilling rig, onsite generators and the flaring or venting of the associated gas during well testing.

As indicated previously, heavy equipment will be used to clear the land thereby increasing the vehicular traffic in and around the project site. Furthermore, fugitive dust emissions from access roads, disturbed areas and non point sources could also impact the air quality in the area. Apart from these impacts to air quality these sources should not appreciably degrade the ambient air quality at the different sites. Moreover, the anticipated duration of the drilling phase for each well is relatively short (approximately 6-7 weeks).

15.2.5 Noise Pollution

Noise impacts can also occur to the surrounding environments as a result of improper sound attenuation measures. Noise pollution can arise from the drilling, operation and decommissioning processes. Impacts associated noise pollution includes drilling operations, vehicular/equipment transportation and equipment operations. It is anticipated that these activities are temporary in nature for the drilling phase. During the operation or production stage, noise levels would be minimal and therefore present no significant impacts to the receiving environment.

15.2.6 Socioeconomic Impacts

Consultations were held with both San Marcos and Spanish Lookout and the overall concern was the safety of the operation, jobs and the possible health risks involved by the exploitation process. In the San Marcos area, the project was seen with great expectation. Health impacts were an issue with the stakeholders since similar activities can be found throughout the area. BNE assured that these impacts will be minimal. Employment would be minimal as the proponent is in need of technical personnel, a field uncommon to the area. Nevertheless, the construction phase can give employment to several persons living in the area.

15.2.7 Transportation

Possible impacts associated with the transportation issues are positive, especially for the village of San Marcos. Presently, the road network for the village is presently being upgraded, with new culverts installed. Another impact is the construction of the access road; this would greatly benefit the San Marcos Village as BNE will only delineate the proposed sites.

15.3 Impacts and Mitigation Measures

Table 15.2 summarizes the proposed impacts and mitigation measures for Belize Natural Energy Limited. In some instances, some of the impacts and mitigation measures are discussed further in the relevant chapters.

Table 15.2 Summary of proposed impacts and mitigation measures for BNE

Development Activity	Impacts or Environmental Disturbance	Primary and Secondary Level Environmental Impacts	Mitigation Measures
1.0 Water Pollution	1a. Siltation of waterways due to access road and site development	1a1. Minimal nutrient alteration and turbidity increase in receiving source	1a1a. Proposed sites are located some distance away from any waterway
	1b. Contamination of ground water due to drilling	1b1. Alter the water quality of the ground water	1b1a. Well bores will be cemented properly.
2.0 Soil Contamination	2a. Vegetation loss due to land clearing	2a1. Loss of organism and soil aeration	2a1a. Keep impacted area to a minimum and operate within the designated limits
	2b. Spills on the soil due to drilling, operation and pipe line installation	2b1. Localized impact to resident organisms and soil nutrient reduction	2b1a. Carry out maintenance checks on equipment and operating procedures
			2b1b. SPCC Plan for each site.
			2b1c. Employ secondary containment measures where fuel, products are stored

Development Activity	Impacts or Environmental Disturbance	Primary and Secondary Level Environmental Impacts	Mitigation Measures
	2c. Drilling wastes associated with the drilling process	2c1. Loss of subsurface organisms	2c1a. Proper recycling by dewatering and disposal of drilling fluid at an appropriate facility.
	2d. Domestic and Liquid Waste streams	2d1. Damage of soil quality	2d1a. Waste Management Plan and disposal methods
3.0 Wildlife	3a. Loss of Habitat due to site construction and road access	3a1. Reduction in remaining biodiversity	3a1a. No significant impact to wildlife other than to grazing animals
	3b. Loss of habitat due to pipeline installation - trench	3b1. Reduction in biodiversity along impacted area.	3b1a. Impacted area will recover over time.
4.0 Air Pollution	4a. Fugitive dust emissions	4a1. Visibility Impairment and prolong health risk	4a1a. Utilize water trucks to suppress dust emissions
			4a1b. Reduce traffic movement and speed in the area and access roads.
	4b. Vehicular and equipment exhausts	4b1. Emission of green house gases	4b1a. Proper maintenance of all vehicular and equipment
			4b1b. Prohibiting of vehicular and equipment idling.
	4c. Flaring	4c1. Localized ecological disturbance.	4c1a. Will be mitigated by pipeline installation

Development Activity	Impacts or Environmental Disturbance	Primary and Secondary Level Environmental Impacts	Mitigation Measures
			4c1ab. Control flaring during well testing
		4c2. Prolong health risk from incomplete combustion.	4c1a. Will be mitigated by pipeline installation.
	4d. Venting	4d1. Health risk due to volatile gases inhalation	4d1a. Will be mitigated by pipeline installation.
			4d1b. Venting if any will be conducted with notice.
5.0 Noise Pollution	5a Increase in ambient noise levels and reduction in aesthetic value	5a1. Noise increase would impede planned development and increase health risks	5a1a. Application of sound attenuation measures to reduce noise levels to ambient conditions where applicable.
6.0 Socioeconomic Factors.	6a Population	6a1. Pressure on existing resources and social infrastructure	6a1a. There will be no pressure on the population nor will it impact their existing resources.
	6b. Employment	6b1. Creating employment is one of the activities that will result from the development. There will be a need for both skilled and unskilled labor	6b1a. Labor should be recruited from the area as much as possible. There exists a sizable pool of skilled and unskilled labor in this part of the country.

Development Activity	Impacts or Environmental Disturbance	Primary and Secondary Level Environmental Impacts	Mitigation Measures
	6c. Operational Activities	6c1. Human Health and Safety Issues	6c1a. Minimal impact due to the duration of the project
			6c1b. No Flaring will occur at the site as the oil/gas mixture will be piped to the Iguana Creek Facility.
7.0 Energy Generation	7a. Usage of diesel engines to generate energy.	7a1. Operation of diesel generators	7a1a. Alternative energy sources cannot be applied, especially considering the duration.
	7b. Grid energy from Spanish Lookout.	7b1. Grid can provide energy to well sites.	7b1a. Power will be supplied by a 35 KVA power line. Energy will be produced by a gas turbine engine, the same gas that would be used for flaring.
Other Impacts of Importance			
8.0 Human and Domestic Effluent Impacts	8a. Possible nutrient enrichment of waterways and ground water. Possible health risk factor during operation	8a1. Stimulation of microbial organism and water fouling.	8a1a. Implementation of portable toilets to address this issue during operation. Waste will be collected and disposed in accordance with DOE Standards.

Development Activity	Impacts or Environmental Disturbance	Primary and Secondary Level Environmental Impacts	Mitigation Measures
			8a1b. Proper septic system is in place at the Iguana Creek Facility for the production phase.
9.0 Solid Waste Management	9a. Accumulation of solid waste could give rise to feral animals and diseases	9a1. Solid waste can be a nuisance and cause aesthetic pollution.	9a1a. Proper solid waste collection, handling and disposal will be carried out by BNE.
10.0 Environmental Health and Safety	10a. Poor working standards and unhealthy workforce.	10a1. Reduce worker efficiency and capacity due to diseases and conditions	10a1a. Implementation of health and safety measures for work force (partially in place).
11.0 Decommissioning and Rehabilitation	11a. Removal of site equipment and ancillaries	11a1. Spills	11a1a Implement Site SPCC.
		11a2 Disturbance of ecological area	11a2a Revegetation of impacted area including drilling pad and pipeline route

15.4 Monitoring Plan

The principles underlying environmental monitoring as it relates to any given development is to document any changes in environmental parameters over time that would be associated with the development. These changes would in principle vary over time in both magnitude and direction. In the case of the latter it is important to understand that changes in environmental parameters may be positive (or beneficial), or negative (deleterious). The parameters that would be most judiciously chosen in an environmental monitoring programme are those that have been identified in the analytical process as being most significantly altered by the development.

15.4.1 Specific Monitoring Issues

The proposed monitoring plans for the BNE are those parameters and ecosystem components that have been identified as being significantly affected by the proposed

development. A number of these issues have also been highlighted in the mitigation plan in the previous chapter. These issues include:

- airshed and noise monitoring,
- water pollution
- soil contamination (spills)
- waste management
- environmental health and safety
- engineering aspects
- socio economic influence

The proposed monitoring programme has been developed not only in relation to satisfying the statutory requirements of the EIA process, but also as a proactive tool for the proper implementation of the proposed development, within the context of its relationship to the integrity of the environment as well as the stakeholders in the area.

The details of the proposed monitoring plan are outlined in Table 15.3 below:

Table 15.3 Proposed Monitoring Program for the proposed sites.

PARAMETERS	FREQUENCY	CRITICAL LEVELS	AREA/ LOCALE	PRIORITY
Air Impact				
Nitrogen Oxides (NO _x)	Annually	N/A	At Production Sites	Medium
Sulphur Oxides (SO _x)	Annually	N/A	At Production Sites	High
Carbon Oxides (CO _x)	Annually	N/A	At Production Sites	High
Volatile Organic Carbons (VOCs)	Annually	N/A	At Production Sites	High
Particulate Matter (PM ₁₀)	Annually	N/A	At Production Sites	High
Methane (CH ₄)	Annually	N/A	At Production Sites	High
Hydrogen Sulphide (H ₂ S)	Annually	N/A	At Production Sites	High
Noise Impact				
Noise Levels (Db)	Quarterly	75 dB	At Production Sites	High
Soil Contamination				
Spills and Leaks	Quarterly	Reportable Limits	At Production Sites	High
Effluent Impact				
Turbidity	Quarterly	30 ft. Secchi Depth	Water sources near project site, if any	Medium

PARAMETERS	FREQUENCY	CRITICAL LEVELS	AREA/ LOCALE	PRIORITY
Heavy Metals	Quarterly	26 - 39 mg/l (EPA/WHO)	Water sources near project site	High
Oil and Grease	Quarterly	9-10 ppm (IFC)	Water sources near project site	High
Engineering Aspects				
Site Integrity	Monthly	Visual inspection of site for spills, leaks	Storage areas, pipeline	Medium
Structural Integrity	Monthly	Visual Inspection for structural damage and operation	Derrick, pumping jack, pipeline, perimeter fence, vehicles and equipment	Medium
Health and Safety				
Education	Bi-annually	Pass	Project site	High
Training	Bi-annually	Pass	Project Site	High
Protective Equipment	Daily	Pass	Project Site	High
Socio Economic Influence				
Public Interaction	Quarterly	BNE must integrate with the impacted community to formulate strategic planning tools	Village	High
Consultations and Meetings	Quarterly		Village	High
Education Assistance	Quarterly		Village	High
Skill Enhancement	Quarterly		Village	High