EIA Report for the Proposed Moon Gate Hotel Development at

Half Moon Bay, Antigua.

5/13/2021

(Final Report)

This EIA Report provides an assessment of the proposed Moon Gate Boutique Hotel Development at Half Moon Bay, Antigua. It identifies potential impacts from construction and operational activities and recommends appropriate mitigation measures to help reduce the negative impacts.

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Acronyms:

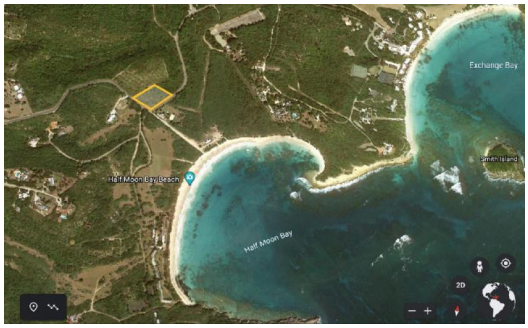
EIA	Environmental Impact Assessment
IPCC	International Panel on Climate Change
DOE	Department of Environment
ESAL	Environmental Solutions Antigua Ltd.
IC	Independent Contractor
DCA	Development Control Authority
ToR	Terms of Reference
MSDS	Material Safety Data Sheets
GPS	Global Positioning System
WWTP	Wastewater Treatment Plant
LID	Low Impact Development
CEs	Coastal Engineers
PVC	Polyvinyl Chloride
t_c	time of concentration
NOAA	National Oceanic and Atmospheric Administration
DBH	Diameter at Breast Height
CBH	Central Board of Health
C.I.P.	Citizenship by Investment Program
GDP	Gross Domestic Product
OECS	Organization of Eastern Caribbean States
SLR	Sea Level Rise
BOD_5	Biological Oxygen Demand (5-day)
COD	Chemical Oxygen Demand
TDS	Total Dissolved Solids
TSS	Total suspended Solids

Units

sf	square feet
mm	millimeter
in	inches
yr	year
°C	Celsius
°F	Fahrenheit
km/hr	kilometers per hour
dB	Decibel
MG	Million Gallons
cfs	cubic feet per second
gpm	gallon per minute
US-gpd	United States-gallons per day
kPa	kilopascal
m/s	meters per second
mph	miles per hour
cm	centimeter
ppm	parts per million
ppb	parts per billion
NTU	Nephelometric **Turbidity** Units
cfu	colony-forming unit
ml	milliliter
mg/L	milligrams per Liter

Executive Summary

The proponents of Moon Gate Hotel development plan to construct an All-Inclusive 4-star Boutique Hotel on 1.22 acres of land at Half Moon Bay, Antigua; the site is about 800 feet (244 m) from the near shore at Half Moon Bay (Figure A, orange rectangle). The Bay is located approximately 12 miles South East of St. John's city (the capital of Antigua).



The EIA includes:

- Conducting a Baseline Assessment
- Examining and Evaluating Impacts
- Proposing Mitigation Measures
- Developing an EMP

Figure A. Moon Gate proposed location

1. Development Proposed

Essentially, the proposed Moon Gate Hotel Development is a couples only Boutique Hotel comprising of 40 fully furnished units built in six (6) buildings. These buildings are supported by a reception area, centralized clubhouse, cocktail lounge, A la Carte Restaurant, infinity pool, gym and spa, and a gift shop.

2. Recommendations to Mitigate Construction Impacts

The ESAL technical team conducting the EIA, assessed/highlighted the potential negative environmental impacts possible during the Construction phase of Moon Gate development. Based on these impacts, the following mitigation measures were recommended to avoid/reduce such consequences:

1. **Soil & Vegetation Loss**

- As much as possible, try to save local large trees in and around proposed site
- Use, where appropriate, endemic plants for landscaping around Resort
- Stockpile cleared topsoil for landscaping

2. **Air & Noise Pollution**

- Wet aggregate and excavated soil regularly during dry periods
- Store aggregate and excavated soil away from storm runoff pathways
- Service equipment (filters, engine, etc.) periodically
- Work within normal work hours when using heavy-duty equipment
- Install Equipment with appropriate sound absorbers/mufflers and/or partitions
- Ensure heavy-duty equipment operators fitted with proper protective equipment

3. **Solid Waste & Hazard Material Pollution**:

- Place adequate waste disposal bins strategically and allow regular pick-up for haulage
- Transport debris and construction-waste to the landfill site rather than burnt
- Install temporary toilet facilities for construction workers
- Store oils and other hydrocarbons properly to avoid spillage and pollution
- Dispose of hazardous waste due to spills or leaks offsite at an approved facility

4. **Traffic Congestion & Insufficient Parking**:

- Install signposting, warning signs, barriers and diversions
- Site clearly visible and public warned of all potential hazards
- Safe crossing for pedestrians where construction traffic interferes
- Avoid major transport activities during rush hour times
- Avoid side road parking of construction vehicles/equipment for long periods

3. Recommendations to Mitigate Hotel Operational Impacts

The ESAL technical team also assessed/highlighted the potential negative environmental impacts possible during the Operational phase of Moon Gate development. Based on these impacts, the following mitigation measures were recommended to avoid/reduce such consequences:

1. **Stormwater Runoff Causing Flooding**:

- Catch and store storm runoff in tank/cistern
- Protect trees/plants and develop rain gardens
- Introduce permeable material for driveways and walkways
- Ensure drainage system adequately sized and maintained

2. Solid Waste & Hazard Material Pollution:

- Design a Solid Waste Collection and Disposal Plan
- Store sludge or dirty motor oil in leak proof containers for transportation off site
- Store oil/hydrocarbon supplies in facilities or areas not subject to flooding
- Place adequate waste disposal receptacles around property
- Position a central dumpster, with an attractive enclosure, to service individual receptacles

3. **Waste Water Treatment Plant (WWTP) malfunction and Sewage Pollution**:

- Ensure back-up power for electrical components of WWTP
- Conduct periodic analysis of effluent quality to meet manufacturers performance metrics
- Ensure operators trained in the daily operation and maintenance of WWTP
- Install alarm system on WWTP to signal malfunction in electrical/mechanical components
- Develop contingency plan for unexpected problems and downtime
- Install collection tank (about 35,000 gallons) to store excess effluent

4. Traffic Congestion & Insufficient Parking

- Promote golf cart (electrical battery operated) transportation
- properly marked (unit number matching parking slot) parking spaces
- Provide information indicating where motorists may and may not park
- Provide off-site parking (ex. at the beach) and then shuttled to restaurant

4. Socio-Economic Benefits

The project will induce opportunities and produce positive impacts to Antigua & Barbuda's economy. For example, the:

1. Forty (40) Unit C.I.P. approved high-class 4-star Caribbean property will attract investment dollars inclusive of government processing and due diligence fees.
2. Direct impacts include revenues (e.g. rooms, food & beverage, restaurant) that will be generated from consumers utilizing the hotel.
3. Direct impacts also include total payroll for employees hired at the hotel as well as payroll for temporary construction workers.
4. Fiscal impacts through additional Antigua & Barbuda Sales Tax are projected to be at least US $0.5 million annually. Further, additional property taxes will be collected by Inland Revenue from the owners of the resort.
5. Indirect impacts include income generated by businesses that supply goods and services to the resort; examples of businesses suppliers include room related goods, telecommunication vendors, food and beverage suppliers and other hotel related vendors.

5. Climate Change Impacts & Mitigation

Natural hazards that would negatively impact Moon Gate's operational sustainability were identified and mitigation interventions presented. The hazards examined include earthquakes, hurricanes, floods, droughts, and surges & wave action. These interventions, once adopted, would help to reduce the negative consequences and increase the operational resiliency of the Hotel. The natural hazards with a summary of respective interventions are shown in the Table A. below.

Table A. Summary of Natural Hazards and Intervention

hazard	intervention
earthquake	develop immediate Disaster Response Plan
	design buildings to meet least min. loading requirements
	promote eartquake safety protocols
	develop emergency survival kits
hurricane	create emergency vacuation plan and survival kit
	strengthen and secure roofs, windows, doors
	assess/repair drainage systems before/after storm
	pick-up outdoor chairs, loose items indoors safely
flooding	establish flood warning protocol
	adopt LID[1] (permeable pavements, rain cisterns)
	work with MET office, NODS regarding response
	assess/repair drainage systems before/after storm
drought	store runoff water in cisterns
	plan alternative sources water (RO, cistern, etc.)
	conserve water efficiently (shower heads/faucets)
	recycle grey water for washing, landscaping
surges & wave action	work with CEs[2] to better understand impacts SLR

[1] low impact development; [2]coastal engineers

6. Environmental Monitoring & Management Plan

Monitoring provides crucial information about how the project is performing, which helps decision makers and other stakeholders track how well 'promises' are being kept. In this regard, an Environmental Monitoring & Management Plan (EMP) was designed. The Plan lays out mitigation actions (for both construction and operational phases) and identifies the responsible party monitoring and reporting on interventions.

6.1 Construction Phase

Monitoring

An Independent Contractor (IC) will visit the site every two (2) weeks and meet with the Project Manager or designated party to monitor construction activities and ensure the EMP is properly implemented. If there are any pressing concerns/issues before the Quarterly Report submitted, the IC will contact the Department of Environment (DoE) immediately to address such matters. The DoE will collaborate with the appropriate agency for discussion and follow-up action.

Reporting

Throughout the construction period, the IC will compile and submit Quarterly Reports to the DoE. The Independent Contractor will collaborate with the on-site Project Manager (PM) or Designated Assistant regarding progress of work/concerns. If there are any pressing concerns/issues before the Quarterly Report is due, the IC will contact the DoE immediately to address such matters. The DoE will link with the appropriate agency for discussion and follow-up action. Any non-compliance must be documented and corrected action taken immediately with progress updates provided to the DoE and responsible agency; all records should be retained digitally and shared with the relevant regulatory agencies.

6.2 Operational Phase

Monitoring

Throughout the operation of the Moon Gate Hotel, a representative from the CBH will conduct annual visits and meet with the Hotel's Environmental Officer (EO) to monitor and audit:

- operation of WWTP (review of operation log, testing input/out effluent)
- holding tank for treated sewage properly aerated
- safety protocols implemented to handle and store hazard material

An Environmental Officer (EO), representing the Moon Gate Hotel, will also meet periodically with the DoE. Monitoring throughout the operational phase will be based on periodic communication between an EO from Moon Gate and the DoE. The DoE will visit/walkthrough the Development where the EO will provide an update on environmental issues related to pollution, health and safety protocols, and emergency planning.

The DoE will have an independent contractor (IC) conduct periodic testing of Half Moon Bay marine coastal water; tests are to be carried out biennially to allow for comparison with baseline parameters.

Reporting

The DoE annual visits/discussions with Moon Gate EO will allow the DoE to provide feedback on environmental matters of concern to the relevant agencies (e.g. CBH, Fisheries).

Verbal/written environmental concerns, during the operation of Moon Gate, made by neighboring community or businesses should be reported to the DoE. The DoE would investigate immediately and meet with EO/Hotel Management to discuss. If concern is deemed problematic then the DoE will request relevant government agency to meet and diagnose problem at hand. Once a problem is diagnosed then mitigation measure(s) will be implemented to rectify the issue.

The IC conducting annual seawater testing will provide a summary Report of findings to the DoE. If there is any notable changes in quality from the baseline then the DoE will immediately be informed. The issue will be investigated to determine the source of contamination in the surrounding area and mitigation measure(s) implemented.

7. Conclusion

The construction and operational activities that could potentially generate negative impacts on the environment could be meaningfully addressed by adopting adequate mitigation measures outlined in the Report. The proposed Project Design has some integrated measures so as to ensure compliance with regulations and procedures. During the construction activities of the Project, environmental compliance monitoring (material handling, noise & air quality, solid waste collection & disposal, etc.) will be undertaken bi-monthly by an independent contractor. For the operational phase, the DoE and the CBH will provide periodic oversight (e.g. WWTP, Safety, ERPs, etc.) to ensure environmental sustainability.

Given the proposed mitigation measures that will be incorporated during construction and operational phases of the development and the beneficial economic input to businesses and neighboring residents, it is our opinion that the proposed development is a timely venture that will contribute to the nations economy. It is, therefore, our recommendation that the project be allowed to go ahead provided the outlined mitigation measures are implemented.

1. Introduction & Overview

Environmental Solutions Antigua Limited (ESAL Inc.) prepared an EIA for submission to the Development Control Authority (DCA) and the Department of Environment (DoE) for the proposed Moon Gate Development Project. ESAL carried out a site analysis to facilitate assessing impacts of development and operation and recommend mitigation strategies to avoid/minimize the negative impacts.

The proponents of the proposed development, plan to construct an All-Inclusive 4-star Boutique Hotel (Moon Gate) on 1.22 acres at Half Moon Bay, Antigua; this site, which is about 800 feet (244 m) from the near shore at Half Moon Bay, is shown within the orange rectangle in Figure 1.1 below. Half Moon Bay is located approximately 12 miles South East of St. John's city (the capital of Antigua).

Figure 1.1 Moon Gate Site Location

Moon Gate is a couples only Boutique Hotel comprising of 40 fully furnished units built in six (6) buildings (E-1 to E-6) shown in Site Plan in Figure 1.2 below. These buildings are supported by:

- a reception area
- a centralized clubhouse
- a cocktail lounge
- an A la Carte Restaurant
- an infinity pool
- a gym and spa
- a gift shop

1.1. Scope of Work

The Study addresses the TOR, shown in Appendix 8.11, presented by the Department of Environment (DOE) and the DCA. The five (5) specific tasks for this EIA Study are identified below.

1. Collecting and Presenting Baseline Conditions
2. Assessing & Evaluating Impacts from construction and operational activities
3. Evaluating and Presenting Mitigation Measures to manage adverse effects
4. Developing Residual Impact Matrix for Pre/Post Construction activities as well as Natural Hazards
5. Developing a Monitoring Protocol

1.2. Study Objectives

The major objectives of the EIA include:

- **Collecting, Assessing, and Presenting Environmental and Socio-Economic Baseline Conditions** within the Study Area.

- **Assessing the construction and operational activities**, planned for the Project, to highlight the possible impacts.
- **Developing Mitigation Strategies** based on adverse impacts, so as to avoid and/or alleviate such effects.
- **Producing a Residual Impact Matrix** based on evaluation of the risks to the economy as well as the environment showing negative effects before and after mitigation.
- **Developing a Monitoring Protocol**, based on the possible impacts and risks from the development and their mitigation interventions.

1.3. Methodology

The methodologies employed to undertake this EIA Study include:

- Holding discussions and seeking clarification with the DoE and the DCA regarding the Terms of Reference (TOR).
- Conducting field surveys and quadrant mapping to better understand topographical, geological, and biological features.
- Collection baseline (environment, socio-economic) data, within the Study Area.
- Demarcating the sub-watershed area impacting the proposed development site.
- Evaluating direct runoff volumes (using SCS equation) and peak flow rates (using Rational equation) at pre-construction and post construction.
- Holding discussions and consultations regarding possible development concerns with stakeholders in and around proposed development site.
- Reviewing relevant documentation to seek further insights and trends.

At commencement of the EIA, ESAL's Biodiversity team carried out a comprehensive biodiversity base line study to ascertain the following:

- Species of Fauna (to include all vertebrates and invertebrates).
- Species of Flora (to include forest species, herbs, vines and other plant species).
- Condition of Biodiversity.
- Climatic and Edaphic (soil) conditions and their influence on habitats within the project area.
- Prior Habitat Disturbance and/or Destruction (if any) whether naturally or by man.

With the use of GPS technology to mark exact positions, the biodiversity team divided the project site into four (30x30 meter) sample grids in order to collect scientific data of the biodiversity; data such as dominant species, habitat condition (i.e. disturbance level of wildlife activities was observed, recorded and analyzed). This exercise was carried out over a two week period. The lands surrounding the proposed project site was observed for a comparative analysis.

1.4. Site Plan & Design

Design

Figure 1.2 Moon Gate Site Plan

1.5. Suites

1.5.1. STANDARD

The buildings designated as E-1 and E-6 (Figure 1.2) will each contain:

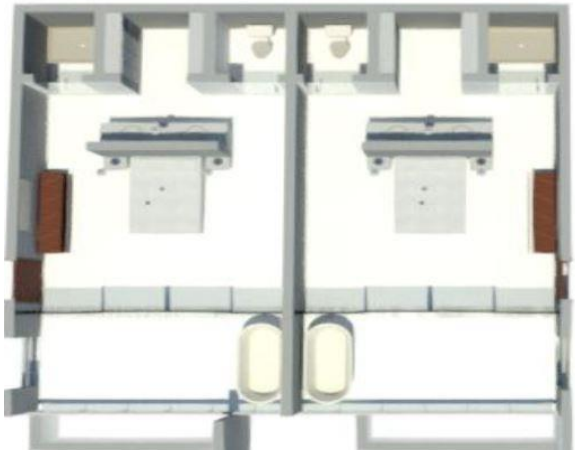


Figure 1.3 Plan layout of Standard Suite

- 2 ***standard suites*** (plan in Figure 1.3) on each building comprising of 4 floors (i.e. a total of 16 standard suites for E-1 and E-6))
- approximately 500 square feet (sf) of living area
- four (4) floors (ground floor + 3 floors up).

The buildings designated E-2 through E-5 (Figure 1.2) will each contain:

- 2 ***standard suites*** on mid-floor levels (i.e. 8 standard suites)
- approximately 500 sf of living area
- three (3) floors (ground floor + 2 floors up).

The 24 *Standard Suites* will feature:

- climate control
- standard shower
- double vanity
- king size bed
- wet bar
- outdoor soaking tub
- lounge area

1.5.2. PREMIUM

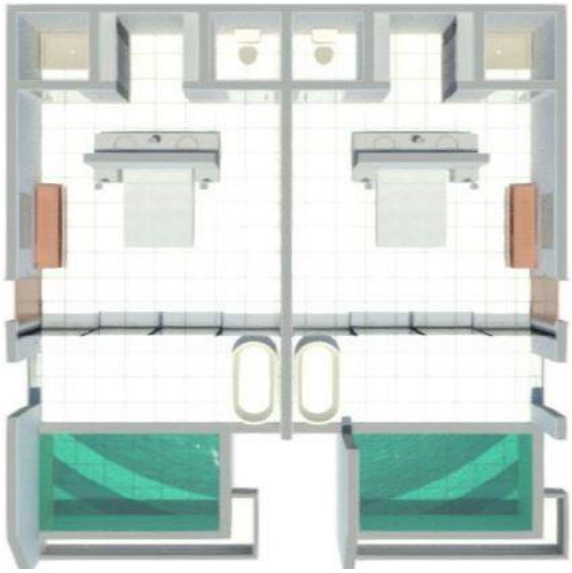
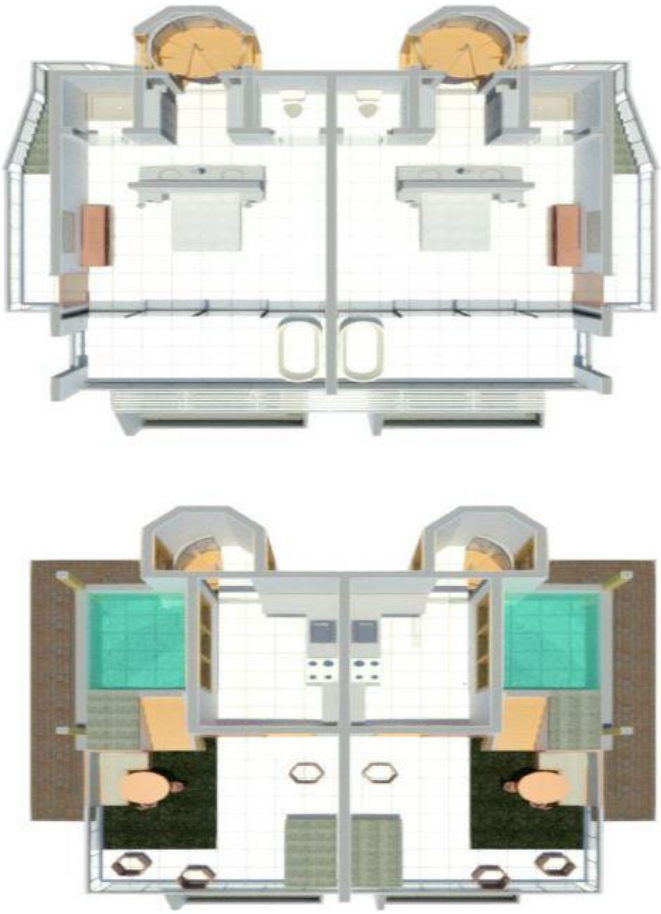


Figure 1.4 Plan layout of Premium Suite

The Buildings E2 to E5 will each contain two (2) Premium Suites on the ground floors (i.e. 8 premium suites in E-2 through E-5). Each of the Premium Suites (Figure 1.4) will:

- measure 600 sf.
- feature private plunge pool.
- be fully furnished and attractively arranged.

1.5.3. PENTHOUSE DUPLEX



The four (4) Buildings E2 to E5 will also contain Penthouse Duplexes. Each of these buildings will contain two (2) penthouse duplexes on the top floors (i.e. 8 penthouse duplexes).

Each of the Penthouse Duplexes (Figure 1.5) will measure 1,000 sf. The Roof Garden Level will feature:

- a climate controlled kitchen.
- outdoor dining
- lounge area.
- private plunge pool.

Access to the dedicated roof garden and plunge pool is via an internal spiral staircase. These fully furnished suites will be fitted with a completely fitted kitchen.

Figure 1.5 Plan layout of Penthouse Duplex

Drawings of Plan Views of Suites & Penthouse Duplex are shown in Appendix 8.1

The Development (refer to Moon Gate Site Plan, Figure 1.2 above) is supported by a:

- Wastewater Treatment Plant (back of building D)
- Back-up generator (location F)

In consultation with proponents of the Moon Gate Development, it was decided that the Reverse Osmosis Plant (location G in Figure 1.2) will no longer be considered for installation; due mainly to issues regarding sourcing feed water as well as conveying concentrated brine.

1.6. Wastewater Treatment Plant

The proponents of Moon Gate Hotel plan to install the CromaFlow Wastewater System. The modular units can treat wastewater flows up to 200,000 gpd; the Moon Gate development will be supported by a 15,000 gpd unit. The system is manufactured with corrosion proof materials and heavy-duty PVC piping,

incorporating SBR (Sequential Batch Reactor) technology to remove pollutants from applications such as this hotel.

The sewage treatment modules contain:

- SBR secondary treatment systems.
- Aerated pre-equalization systems.
- Sludge processing systems.
- Chlorine contact systems.
- Storage & general purpose tanks.

A typical cycle involves:

1. Fill/Separation: Flow enters the Solids Retention Section that is separated by a non-corrosive screen. Inorganic solids are retained behind the screen. Organic solids are broken by turbulence created with mixed liquor being forced through the screen by submersible aeration pumps.
2. Aeration: liquid and small organic solids pass through the screen into the continuing Aeration Section. Air and mixing are provided by submersible pumps with aspirators that receive air through a pipe intake from the atmosphere.
3. De-nitrification: conversion of nitrate to nitrogen gas; this phase is optional
4. Transfer/Settle: Treated mixed liquor is transferred by pumping to the Clarification Section. The transfer period overfills the Clarifier with the excess spilling through over-flow weirs back into the main Aeration section. Solids separation occurs under quiescent conditions.
5. Discharge: After settling, effluent is pumped out of the Clarifier for discharge. Return sludge is pumped from the bottom of the Clarifier back into the main Aeration Section using a submersible pump or the sludge can be wasted to a Sludge Processing Tank.

This secondary effluent will be used to irrigate landscape on the site. During excessive rain periods, when irrigation will not be required, the proponents plant to construct a holding tank (about 35,000 gallon capacity) to store approximately 7 days effluent.

2. Baseline

2.1. Climate

2.1.1. PRECIPITATION

The project site is located on the eastern coast of Antigua, within a rainfall zone that averages less than 45 inches per year. Records from a station in Bethesda Village, closest station to the Moon-gate Development, recorded average annual rainfall of 41.5 inches(1036.9mm) between 1982 and 1988.

Antigua experiences variable rainfall with pronounced wet and dry seasons. January to April is considered the dry season when rainfall averages about 2.06 inches per month. August to December (wet season) experiences about 4.6 inches of rainfall per month.

The Moon-gate Development will be influenced by the variability and unpredictability of rainfall experienced by the island.

Historical rainfall data suggest that Antigua experienced drought on an average of 1 in 4 to 5 yrs. In fact, over the past 60 years, Antigua has had at least 12 major drought periods i.e. less than 30 inches of rainfall in a year. The tropical nature of the island accounts for periodic storms and/or hurricanes which may produce marked intra-monthly variations in rainfall. For example, during a major storm event it is not uncommon to experience 7.87 inches (200mm) of rainfall over a 24- hour period.

2.1.2. TEMPERATURE

Average temperatures for Antigua are 29°C (82.2°F) during the Summer and 24°C during the Winter months. Extreme highs of 34°C (93.2°F) in August and 15°C (59°F) in January have been recorded especially in the Freetown area.

2.1.3. WINDS

The island lies in the path of the North-Easterly Tradewinds and experience steady winds off the Atlantic. Monthly average wind speeds range from 17 to 26 km/hr., with lowest speeds during September to November.

2.2. Geological Features

2.2.1. SOIL(S)

The watershed area, which is sparsely developed is characterized by light, shallow, well drained soils over calcareous sandstones. The Fitches Clay dominates the Study Area. The Study Area exhibits a soil erosion class of 1 (slight erosion), slopes ranging from 2° to 10°. With a pH of 7.9 to 8.0, the soil profile contains the following layers:

- Horizon #1 0-2 inches Grass-root, humus and mineral soil.
- Horizon #2 2-8 inches Dark brown.
- Horizon #3 8- 18 inches Light Yellow Brown.

Horizon 2 has limestone fragments and its grittiness is due to patches of weathered marl soil. In Horizon 3 the profile is calcareous.

2.2.2. RUNOFF & DRAINAGE

The proposed project which encompasses 1.22 Acres of scrubland, lies within a small sub-watershed (about 22 acres) with average slope 12 degrees.

A comparison of the Peak Runoff Intensities (pre and post development), applying the Rational Method, has been examined within the sub-catchment area (22 acres). The peak flows were based on a time of concentration (t_c) of approximately 5 minutes; this time was evaluated using the Kirpich equation.

A comparison of the Direct Runoff Volumes (pre and post development), applying the SCS Curve Number equation, has been examined within the 22-acre sub-catchment; The rainfall amounts were calculated using a NOAA precipitation frequency rainfall with similar characteristics of the Antigua rainfall.

The pre and post development comparisons, of peak volumes and intensities, include the 10, 25, and 50 year storm return periods.

2.2.3. LAND USE

The property is West of the Half Moon Bay and just north of the former Half Moon Bay Hotel. The area is very scenic with scrubs, grasses and small trees and allows a panoramic view of the Atlantic Ocean and rising sun.

Some of the land uses in the area include:

- businesses (restaurant, hotels, construction activity)
- scrub

The Site area is within 800 feet of the coastline with pristine waters where fishing, water sports, swimming, and snorkeling are very important to business, locals and visiting vacationers; in addition, picnics are a very common experience for locals and visitors to Half Moon Bay.

2.3. Vegetation

An assessment of the vegetation, within a 2-mile radius, was carried out, which confirms two major Alliances:

1) Pisonia subcordata-Bourreria succulenta lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance.
2) Melocactus intortus-Jacquinia arborea tropical or subtropical succulent-facultatively drought-deciduous dwarf-shrubland Alliance.

Refer to Appendix 8.2 Plant List within the Study Area.

A desktop review revealed that the project site had been cleared of vegetation as recently as 2014, which is quite evident from the present vegetation association on the parcel of land identified. The site is dominated by tall shrub and vine common to disturbed areas. The largest trees found on the site are all of the species *Pisonia subcordata* (White loblolly). This medium sized to large deciduous trees are expected to attain heights of 12m to 15m with a trunk diameter of 1m. The tree survey on the project (refer Appendix 8.3 Sample Tree Survey Form) site found all to be young trees, less than 1/3 of their

normal life expectancy age. The average stem diameter or DBH is less than .22m (See appendix for tree survey); refer to Appendix 8.4 Tree Quality Assessment Category.

2.4. Wildlife

2.4.1. BIRDS

Two Avi- fauna surveys were conducted within the 2-mile radius survey area. Both visits reveal a fairly healthy populations of avifauna represented for each visit.

All species identified are native to Antigua and Barbuda; and common to the area surveyed. The bird species are all known to frequent dry forest vegetation and though very shy, no physical signs of stress was observed.

2.4.2. MAMMALS

2.4.2.1. BATS

The site for the Moon Gate Boutique Hotel falls within the Eastern section of Antigua. This area is characterized by limestone, dotted with caves and crevasses, which serve as excellent options for day roost for bats. However, no bat roost was observed on the proposed project site. It is important to note that this section of the island is a hot spot for bat activity, where three bat species roost. The roost site lies within a two-mile radius of the proposed development.

Columnar cactus a favorite food source for some fruit eating bats, was recorded within the area of survey.

The semi-deciduous and the deciduous woodland on this section of the island are critical habitat for the *Natalus stramineus* and the *Brachyphylla cavernarum* two of the species that roost nearby.

2.4.3. INVERTIVRABES

Invertebrates are critically important to the forest ecosystem. Along with fungal and bacterial action, they consume tons of leaf litter, reducing them to the rich humus that covers the forest floor.

2.4.3.1. MOLLUSK

The *Bulimulus guadalupensis* was the only species identified for the site. Once common all over the island, the population numbers have dramatically reduced due to the introduction of the invasive African snail.

2.4.3.2. MONGOOSE

The Indian mongoose was introduced to the islands and has since impacted the equilibrium of most of the island's terrestrial wildlife. The mongoose, which is an invasive species, is a part of the area's wildlife population, however, none was seen/recorded on any of the visits made by the biodiversity team. Though this is not an indication of it being absent; the ubiquitous nature of this veracious hunter makes it of note.

2.5. Marine & Coastal Effects

2.5.1. BEACH & PONDS

The Half Moon Bay beach is currently in good condition and free of debris, however, a significant portion of the nearshore and foreshore is covered with seaweed (Sargassum). Sargassum is a genus of brown macroalgae in the order Fucales. Species of this genus of algae may grow to a length of several meters and are generally brown or dark green in color.

The Caribbean would usually experience a few small mats of Sargassum washing ashore each year prior to 2011, however, after that year the seaweed began arriving in unexpectedly large masses; 2015 and 2018 saw especially bad blooms. It is very hard to predict when and where future blooms will occur. Like hurricanes, we should assume that this is going to be an annual occurrence. In this regard, collaborative mitigation strategies have been proposed to reduce the effects of sargassum on the Moon-Gate development during the summer season.

2.5.2. SEA WATER QUALITY

Figure 2.1 Seawater Sampling locations (HMB)

Water samples were taken from two general locations (A and B) in Half Moon Bay (HMB), refer to Figure 2.1. Based on the analysis from the Department of Analytical services, Friars Hill, Antigua, all parameters tested were within the water quality criteria for coastal recreation waters.

The EPA is promoting water quality criteria using the pathogen indicator of enterococci in marine waters; the EPA recommends a geometric mean of 35/100ml. Based on the analysis of Half Moon Bay seawater samples, submitted on 29th March 2021, the enterococci bacteria was not detected.

Table 2.1 Half Moon Bay Sea Water Analysis

sample water	location	Enterococci[1] [35] (cfu/100ml)	pH [6.5 - 8.5]	TDS (ppm)	Turbidity (NTU)	Salinity (ppm)	TSS (ppm)	Nitrate (ppm)	Phosphate (ppm)
marine	A	ND[2]	8.07	34,090	1.92	34,040	120	<0.02	0.09
marine	B	ND	8.28	34,220	1.31	34,650	120	<0.02	0.15

[1]EPA recommendation (35 cfu/100ml); [2]Not Detected

3. Legislative & Regulatory Framework

3.1. Environmental Legislation

Antigua & Barbuda has established a set of laws to manage and protect the environment. The Acts which apply to the development of this project include the following :

- Forestry Act (cap 178)
- Litter Act (cap 250)
- Public Health Act (cap353)
- Physical Planning Act #6 of 2003
- Environment Protection & Management Act 2019
- Public Utility Act(1973)

3.1.1. FORESTRY ACT (CAP 178)

Section 5 of the Forestry Act states that any land that is in Forest shall be deemed to be "Forest Reserve". Once the area is deemed a Forest Reserve, section 6 further states that no person shall clear any land for cultivation, or any other purpose inclusive of cutting or felling any timber without having first obtained a written permit from the Chief Forest Officer.

Section 13 of part 4 of the Forestry Act states that "The Minister may make regulations for any of the following purposes, that is to say:

- For the granting of permits under the provision of this Act
- For the cutting and felling of timber within a Forest Reserve

3.1.2. LITTER ACT (CAP 250)

Transporting material to and from the proposed project site will be subject to the Litter Act. Section 4 subsection 1 of the Litter Act states, any person who transports in or on a motor vehicle or trailer along any motor-way, road, street etc. any substance or material which is likely to fall off or blow off the motor vehicle or trailer while being transported and it is not sufficiently well secured as to prevent it from falling off the motor vehicle or not so covered as to prevent it from blowing off the motor vehicle, is guilty of an offence.

3.1.3. PUBLIC HEALTH ACT (CAP 353)

Section 17 subsection 1 states, "No offensive matter, whether animal or vegetable, shall be thrown or placed or allowed to flow or fall on any street, foreshore or other public place or on any drain or watercourse."

Further, subsection 4 states " any person contravening the provisions of this section shall be guilty of an offence and liable on summary conviction to a fine not exceeding fifty dollars."

3.1.4. PHYSICAL PLANNING ACT (#6 OF 2003)

In this Act, unless the context otherwise requires -

"***Authority***" means the Development Control Authority established under the provisions of **Section 5**;

"*building"* includes any permanent or temporary erection or structure in, on, over or under any land, whether affixed to the land or not, and any part of a building so defined(but does not include plant or machinery comprised in a building);

"clearing" in relation to land ,means the demolition of buildings or parts thereof, the removal of materials from land, the leveling or grading of the surface of the land, the removal of vegetation or top soil and the carrying out of such other operations in relations in relation thereto as may be prescribed:

"Development permit" means a notice granting permission for development issued under the provisions of Part IV;

PART IV (CONTROL OF DEVELOPMENT OF LAND), **Section 17** of the Act states, **"**Notwithstanding the provisions of any other law to the contrary, no person shall commence or carry out any development of land, except in accordance with a **development permit** granted under this Act."

Section 23, sub-section (1) requires an EIA to be undertaken for operations identified in the **Third Schedule; item 10** of the Schedule lists hotel or resort complex as a requirement for an EIA.

Section 23, sub-section (8) states that once an applicant has been notified that an EIA is required; the Authority shall inform all relevant government agencies to withhold granting any document of authorization until all notices issued to the developer have been complied with and the Authority has issued a development permit.

Section 27, subsection (1) of the Act allows the Authority to add further conditions to the development permit by regulating the way the development, authorized by the permission, is to be carried out, including the:

- disposal of sewage, effluent or trade waste from the development.
- routing of any vehicles or vessels to be used for the purpose of or in connection with the development.
- continuous environmental monitoring of the development; and
- regulation of hours of work during which the development may operate.

If there is any breach with the development permit, **Part V** (Enforcement), **Section 34, subsection (1)** of the Act allows the Authority to serve an "***Enforcement Notice***" requesting the breach to be remedied. Even before the enforcement notice is addressed by the developer, **Section 38, subsection (1)** allows the Authority to issue a further notice (***stop notice***) which, in effect, prohibits the developer from continuing any specified operations on the land.

Some of the operations in the stop notice are identified in **Section 38, subsection (2**); these include the deposit of refuse or waste material on land or causing environmental damage or actions affecting the health or safety of persons where such action is a breach of planning control alleged in the enforcement notice.

3.1.5. ENVIRONMENTAL PROTECTION & MANAGEMENT ACT 2019

The Environmental Protection and Management Act provides for sustainable environmental protection and management under an umbrella framework; specifically, in Part V –Pollution Control Permits and Part (VI) Environmental impact Assessment Process.

Under section 26(1) & (2) no person shall deposit or release a pollutant on or into land, water, or the air, except in accordance with a pollution control permit issued by the Department of the Environment. Further, a permit issued under subsection (1) shall be subject to such conditions as the Department may determine.

Section 28(1) also states that "Any person who releases or proposes to release any pollutant into the environment shall apply to the Department for the grant of a pollution control permit in the form as determined by the Department."

Section 41 (1) also states "Further to section 23(2) of the Physical Planning Act 2003, if any proposed activity or development is planned in a national park or in a protected area, or may result in a negative impact on the environment, the Chief Town & Country Planner shall request the director to conduct a screening exercise to determine if the proposed activity or development would require an Environmental Impact Assessment or EIA.

3.1.6. PUBLIC UTILITIES ACT (1973)

The Antigua Public Utilities Authority, under the Public Utilities Act 1973, has the authority to install and operate sewage treatment plants on behalf of the government and for the administration of potable water in government or private entities.

The consultants have examined all laws and regulations impacting the construction and operation of the proposed development, in addition, discussions were held with relevant officers in government agencies to better understand their concerns with a view to ensure that all proposed Environmental Monitoring and Mitigation strategies were in-line with relevant laws.

4. Impact Evaluation & Mitigation

4.1. Construction Phase

4.1.1. SITE CLEARING

4.1.1.1. VEGETATION

During the land clearing and construction activities of the proposed development it is anticipated that approximately 1.0 acre of original land surface will be cleared to allow construction of buildings, driveways, parking lots and walkways. Such removal of vegetation will result in a loss of the existing mixed evergreen deciduous shrub-land and, as a result, a reduction in habitat for birds and lizards.

Recommendations:

- **As much as possible, try to save local large trees in and around the proposed site**
- **Use, where appropriate, endemic plants for landscaping around the Resort**

4.1.1.2. SOILS

Soil loss could result from:

- Indiscriminate clearing of vegetation by operators using back-hoes and bulldozers
- Improper storage of excavated topsoil and aggregate
- Excessive compaction of soil caused by heavy equipment which could cause runoff water to scour topsoil

Some of the indirect impacts of soil loss include:

- Sedimentation build-up in downstream waterways and ponds
- Reduction in drain/pond capacity would increase possibility of flooding
- Reduction in soil fertility due to loss of topsoil

Recommendations:

- **Collect and store topsoil and aggregate at areas that can be protected from storm runoff**
- **Utilize only back-hoes to clear land and cut trenches**

4.1.2. AMBIENT AIR QUALITY

There is the potential for fugitive dust formation, during construction activities, that is often associated with the use of heavy equipment and aggregate transport and storage.

Recommendations:

- **Wet aggregate and excavated soil regularly during dry periods**
- **Store aggregate and excavated soil away from storm runoff pathways**
- **Service equipment (filters, engine, etc.) periodically**

4.1.3. NOISE QUALITY

There is the potential for loud noise during construction with the use of heavy equipment. Although such sounds could prove to be a nuisance to nearby residents and workers, it is likely that with the proper equipment and servicing, as well as working within normal work hours, such impacts could be reduced significantly.

Recommendations:

1. **Work within normal work hours when using heavy equipment; avoid working on public holidays**
2. **Equipment properly outfitted with appropriate sound absorbers/mufflers and/or partitions**
3. **Heavy equipment operators fitted with proper protective equipment**
4. **Vehicles maintained/serviced periodically**

4.1.4. INFRASTRUCTURE

4.1.4.1. ROADS

If roadways are not properly sited and constructed this could potentially cause stormwater to damage road surfaces and drains which could further induce soil loss, sedimentation, and possible flooding.

The proponents have stated that they intend to ensure the roadways have proper drains and curbs for the collection and channeling of surface runoff to major roadside drains and other waterways.

Recommendations:

- **Major earth-work considered just after the hurricane season (July – November)**
- **Access roads and parking areas temporarily stabilized with crushed rock or gravel base**
- **Roadways and side drains properly maintained and inspected after heavy rains**
- **Swales lined with grass or stone along sloping areas that can generate runoff flows**

4.1.4.2. BUILDINGS

The proposed project includes 6 buildings containing suites and penthouses, totaling 40 units, as well as service area, gym, restaurant, bar and reception. In addition, the resort will be supported by a WWTP, and stand-by generator.
Recommendations:

- **Hotel suites, other buildings and cisterns should be sized and strengthened using standards set by the DCA and be made consistent to covenants governing design, construction and use of buildings.**

4.1.5. SOLID WASTE

During the construction phase the workers will generate solid waste onsite. This waste, if not properly managed, could pollute water, soil and air and cause an unpleasant smell.

Recommendations:

- **Place adequate waste disposal bins strategically to collect the solid waste and allow regular pick-up for haulage by solid waste operators.**
- **Transport debris and construction-waste to the landfill site rather than burnt.**
- **Install temporary toilet facilities for construction workers.**
- **Store oils and other hydrocarbons properly to avoid spillage and pollution.**

4.1.6. HAZARD MATERIAL

Any hazardous wastes recovered from a spill, either on land or in the marine environment, will be disposed offsite at an approved disposal facility. Provisions of site-specific hazardous/chemical materials management procedures will include, but are not

limited to:

- An inventory of hazardous materials that will be used onsite.
- MSDS for all hazardous materials in use or stored onsite.
- Location of hazardous materials storage areas.
- Spill prevention and response plans in place.
- An inventory and location of spill equipment stored onsite.
- A list of personnel trained to handle hazardous materials.

In general, during the construction phase, workers' PPE will comply with international good practice (always hardhats, as needed masks and safety glasses, harnesses and safety boots).

4.1.7. TRAFFIC & PARKING

The business owners, interviewed by the ESAL team in the immediate vicinity of the Project site, have expressed some concern with traffic safety and congestion during the construction phase of the Project. They are hoping that the Moon Gate owners/contractors would communicate and work with businesses in the immediate surroundings of the Project site to manage parking and general traffic flow through the area. In addition, pipe road crossings, construction activities near roadways may lead to temporary blockage or closure of roads and hamper movement of vehicles and people in the area.

Some impacts of traffic congestion include:

- frustrating delays.
- possible increased pollution.
- road rage.
- lack of ready access by emergency vehicles (fire trucks, ambulances).

In compliance with national regulations, the contractor will insist that the construction site is properly secured and construction related traffic regulated. This includes but is not limited to:

- Signposting, warning signs, barriers and diversions.

- site will be clearly visible and public warned of all potential hazards.
- safe crossing for pedestrians where construction traffic interferes.
- avoid major transport activities during rush hour times.
- avoid side road parking of construction vehicles/equipment.

Some options to consider in managing staff and equipment parking:

- explore possibility of getting permission to use adjacent property that is vacant.
- dedicate a corridor of land on the Project site; this could be an area that is considered last for construction activity.

4.2. Operational Phase

4.2.1. AMBIENT AIR QUALITY

The day-to-day operation of staff vehicles and equipment could impact air quality negatively due to toxic emissions. Vehicles and equipment at the Resort should be serviced periodically to ensure they meet performance standards.

Recommendations:

- **Service vehicles and equipment (generator, WWTP) regularly.**
- **Equipment sourced from reputable manufacturers with rated capacity to comply with acceptable international emission standards.**

4.2.2. NOISE QUALITY

Generators and other heavy equipment operating on site may impact the hearing of workers operating such equipment and prove to be a nuisance to nearby residents/businesses. To reduce the impact of such potential loud sounds emanating from the site, noise levels should be measured periodically to ensure compliance with noise level regulations.

Recommendations:

- **Generator(s) installed in "an acoustic enclosure" rated for maximum sound output of 55dB.**
- **Maintain equipment, machinery and vehicles according to manufacturers specifications.**
- **Heavy equipment operating within normal work hours; avoid working on public holidays.**
- **Workers, using heavy machinery and other noise hazards, equipped with proper protection (e.g. earplugs, earmuffs).**

In general, during the operational phase, workers' PPE will comply with international good practice (always hardhats, as needed masks and safety glasses, harnesses and safety boots).

4.2.3. WATER RESOURCES

The most significant impacts on the natural drainage system during the operational phase will be the:

1. Presence of built structures that will increase the roof-runoff volume and peak flow.

2. Failure to capture, store and contain storm runoff from hard surfaces at the hotel.
3. Inadequate design of the drainage system that captures hard surface runoff.

Due consideration has been paid to the surface drainage systems at the site, including roof catchments. To reduce this runoff, the proponents of Moon Gate Development will install:

- Step terraces on the steeper slopes of the site to hold and absorb water. Such terraces will be supported by landscape gardens that will have a structure that is both functional and attractive.
- Attractive permeable pavers along walkways, driveways, and parking lots.
- Roof gutters to collect rainwater runoff and convey to a sub-surface cistern.

Recommendations:

- **store water from buildings in adequately sized cistern (about 60,000 gal.).**
- **adequate drainage design to capture and convey storm runoff safely**
- **water from 3 sources (APUA, cistern storage, and treated effluent) utilized**
- **treated wastewater to be used only for landscape irrigation**
- **water saving devices (low flow faucets/showerheads, etc.) installed.**

4.2.3.1. SUB-WATERSHED: DIRECT RUNOFF VOLUMES

Figure 4.1 shows an approximate location of the proposed project site (orange rectangle) within the Moon Gate sub-watershed boundary (red curves); The sub-watershed (average slope = 12%) is approximately 22 acres and drains predominantly towards a rectangular drain 3 sf. in cross-sectional area that is located on the road leading to Mill Reef.

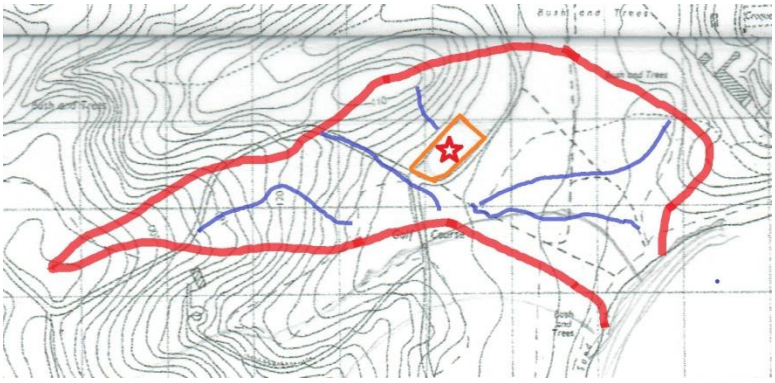


Figure 4.1 Moon Gate Sub-Watershed Boundary

The runoff volumes at pre and post development within the sub-watershed area (22 acres) was examined for 10, 25, and 50 year storm Return Periods. It is noted, as shown in Table 4.1 below that, the sub-watershed increase in runoff volumes, due to Moon Gate development, range from about 71,000 gallons (10-year storm), a percentage increase of about 2.3% to about 88,000 gallons (50-year storm), a percentage increase of approximately 1.5% (refer Table 4.1 below). This indicates that the Project's footprint will not impact the runoff volume to any significant degree. The major concern will be soil wash towards the coast during the construction phase. It is noted, however, that there is the potential for runoff volumes reaching the coast. This would indicate that some consideration be given to reducing impermeable areas as much as possible and plan to store/reuse storm water for landscape purposes.

Table 4.1 Pre and Post Development Runoff Volumes on Moon Gate Sub-Watershed

	pre dev	post dev	*runoff*	*runoff*	Runoff Volume
Return Period	**runoff vol**	**runoff vol**	**(post - pre)**	**(post - pre)**	**(post - pre)/pre**
Storm (years)	**(MG)**	**(MG)**	**(MG)**	**gallons**	**(%)**
10	3.10	3.17	**0.071**	**70,904**	**2.28**
25	4.59	4.67	**0.081**	**81,191**	**1.77**
50	5.94	6.03	**0.088**	**87,790**	**1.48**

Calculations for the "Direct Runoff Volumes" are shown in Appendix 8.5.

4.2.3.2. SUB-WATERSHED: PEAK RUNOFF FLOWS

Table 4.2 below shows the pre and post development peak runoff flows over the sub-watershed impacting the project site. As is expected, the additional hard surfaces from the project will increase the watershed peak runoff flows; for example the post development peak runoff flow for a 10-yr recurrent interval is 44.37 cfs, while the corresponding pre-development runoff was 38.44 cfs; this indicates that the post-development (Moon-gate Resort) will increase the watershed peak flow by 5.93 cfs (2,656 gpm), a

percentage increase of about 15%. The pre and post development "Peak Flow" calculations are outlined in Appendix 8.6.

Table 4.2 Pre and Post Development Peak Runoff Flows on Moon Gate Sub-Watershed

	pre dev	post dev	*runoff*	*Runoff*	Peak Flows
Return Period	**runoff vol**	**runoff vol**	**(post - pre)**	**(post - pre)**	**(post - pre)/pre**
Storm (years)	**(cfs)**	**(cfs)**	**(cfs)**	**(gpm)**	**(%)**
10	38.44	44.37	**5.93**	**2,656**	**15**
25	59.21	65.28	**6.08**	**2,722**	**10**
50	65.19	71.88	**6.69**	**2,997**	**10**

The goal of managing the stormwater runoff includes decreasing the volume and minimizing pollutants. The hard surfaces of the buildings, driveways, parking lots and walkways comprise approximately 40,000 sf of the proposed project site, which is about 75% of the total site acreage. Some ways to effectively manage the runoff includes catching and storing runoff, adding and protecting trees/plants, introducing permeable material for driveways and walkways and planting rain gardens. Such interventions would allow post development runoff to approach that of pre development levels.

Stormwater also has the potential to carry some of the stockpile of construction aggregates and excavation materials after intense rainfall. These stockpiles will need to be properly protected from stormwater runoff; contractors must ensure that the drainage system is adequately sized and maintained to safely channel runoff downstream.

Recommendations:

- **Comprehensive and functional drainage system designed and installed to consider the hydrologic features of the area**
- **Grass-crete/pervious material installed at some parking lots and walkways**

4.2.3.3. ROOF SURFACES

Another intervention to manage runoff would be to capture and store rainfall from the roof areas of buildings. The combined surface area for buildings is about 15,000 sf. If the rainfall from the major roof areas (each one above 1,200 sf) are not properly collected and stored this could prove to be a potential negative impact on the surface runoff regime leading to possible flooding and soil loss. The major roof areas (hotel units, restaurant, gym) occupy about 13,000 sf and this area with a 3-inch rain could potentially collect 25,000 gallons of rain water; for a 6-inch rain, the roof surfaces could provide about 88,000 gallons of water.

Recommendation:

- **Rainwater from roofs of major buildings collected and channeled to a 60,000 gallons sub-surface cistern to help meet the hotel daily demands; water table depth will need to be assessed to ensure water uplift forces won't damage cistern foundation.**
- **Smaller roof surfaces fitted with downspouts to channel water safely from foundations to rain gardens or drains.**

4.2.4. UTILITIES

Improper placement and containment of power lines and gas lines could potentially generate leaks thereby causing harm to unsuspecting individuals.

The water needs of the property should be met by a combination of roof catchment, water treatment effluent, and public supply from the APUA. The peak daily water supply needed would be approximately 24,000 US-gpd.

Recommendations:

- **Water, power, and gas lines properly installed and demarcated**

4.2.5. SEWAGE TREATED EFFLUENT

The proponents of Moon Gate plan to treat the wastewater from buildings (suites, restaurant/bar, etc.) using the CromaFlow treatment system that relies on turbulent aeration of incoming wastes and batch treatment of biomass in separate settling chambers.

This WWTS needs to be in place and properly operated, maintained, and monitored. Untreated spills (leaking pipes) and overflows pose a risk to public health and the environment. Safe management would require preventing loses from the WWTP network. Any leaks/overflows detected must be immediately brought to the attention of the CBH and DoE.

For rain days, when treated water is not required for landscape irrigation, the treated effluent must be stored in tanks. Given the tropical nature of Antigua and the possibility of extreme rain-storms, it is recommended that at least 7 days storage (i.e. volume WWT/d x 7 days) be provided. Such stored water is to be released when irrigation commences. For this treated water stored in a tank, there is need to install an aeration pump to aerate water; this secondary treated water will begin to produce an odor after approximately 24 hours due to the activity of bacteria.

The WWTP must be installed correctly and fully operational with added consideration to:

- back-up power supply
- an early warning alarm for system malfunction/failure
- plan in place for system malfunction/failure
- training for on-site operators
- daily records of flow, effluent pH and chlorine residual.
- holding tank for treated wastewater (about 7 days production)
- holding tank fitted with aerator to avoid odors

The Wastewater Treatment Plant (WWTP) can experience partial or complete failure which can result in unpleasant odors, health problems, and polluted stormwater. Steps must be taken to ensure human well-being and the natural environment are protected.

The proponents of the Moon Gate Development plan to install the CromaFlow Wastewater Plant. The Plant is manufactured with corrosion proof materials and heavy duty PVC piping, incorporating SBR (Sequential Batch Reactor) technology to remove pollutants from applications such as this hotel.

Recommendations for Treatment Plant:

- **Ensure back-up power for electrical components.**
- **Conduct Periodic analysis of effluent quality to meet manufacturers performance metrics.**
- **Ensure operators trained in the daily operation and maintenance.**
- **Install alarm system to signal malfunction in electrical and mechanical components.**
- **Develop contingency plan for unexpected problems and downtime.**
- **Perform regular maintenance operations on system modules & service periodically.**
- **Install collection tank (about 35,000 gallons) to store excess effluent during heavy rains.**

4.2.6. IRRIGATION

The irrigation system should be designed to operate in sync with the WWTP. A sustainable irrigation system will be a function of interactions between the soil, agronomic practices, effluent characteristics, and sound operational practices. Such interactions require good management to maximize use of effluent while protecting the environment. In this regard, the irrigation system should be:

- Designed to meet landscape peak daily water demands.
- Serviced (filters, pumps, valves, etc.) regularly to ensure operational.
- Fitted with drippers and micro-sprinklers where appropriate.

4.2.7. SOLID WASTE DISPOSAL

The volume of wastes expected to be generated by the resort would be significant. If the solid waste is not properly stored and managed this could potentially cause offensive odors, aesthetic problems, infestations of vermin, and general health concerns.

The accepted approach to solid waste disposal from a similar resort is to engage private operators following the standards and guidelines laid down by the National Solid Waste Management Authority (NSWMA) and the Central Board of Health (CBH). “The Polluter Pays” principle is applicable here; a principle where the polluting party pays for the impact caused to the natural environment.

Recommendations:

- **Design a Solid Waste Collection and Disposal Plan which includes terms of reference for the contracting of a private solid waste collection contractor.**
- **Store sludge or dirty motor oil in leak proof containers for transportation off site.**
- **Store oil/hydrocarbon supplies in facilities or areas not subject to flooding.**
- **Sensitize and encourage staff and guests to Best Practices in solid waste management.**
- **Place adequate waste disposal receptacles around property.**
- **Position a central dumpster to service individual receptacles from each building.**
- **install effective yet attractive enclosure for central dumpster.**

4.2.8. SOCIO-ECONOMIC

The Antigua and Barbuda Statistics Division conducted a Labor Force Survey in 2018.These types of surveys help the country to formulate appropriate and effective socio-economic policies and to properly monitor the implementation of these policies. The survey reinforced the fact that the economy of

Antigua & Barbuda is primarily a service economy, two out of every three worker works in service industries.

The Hotels &Restaurants industry were the largest employer, with 8,250 workers or 17.4% of the employed population. The majority (37.1%) of the employed population in Antigua & Barbuda reported a gross income at their main job of between $2,000 to $3,999 ECD. The survey also reflected that the St. Phillip Parish had a population of 3,689 (4%) and an unemployment rate of 5.6%.

The project will induce opportunities and produce positive impacts to Antigua & Barbuda's economy. For example, the:

1. Forty (40) Unit C.I.P. approved high-class 4-star Caribbean property will attract investment dollars inclusive of government processing and due diligence fees; hence, significant foreign exchange will accrue to the economy.
2. Direct impacts include revenues that will be generated from consumers utilizing the hotel. This will include the room revenues, food and beverage revenues from the restaurant as well as sources such as the gym and spa.
3. Direct impacts also include total payroll for employees hired at the hotel as well as payroll for temporary construction workers who construct the property.
4. Fiscal impacts through additional Antigua & Barbuda Sales Tax are projected to be at least US $0.5 million annually. Further, additional property taxes will be collected by Inland Revenue from the owners of the resort.
5. Indirect impacts include income generated by businesses that supply goods and services to the resort. Examples of businesses that will indirectly benefit from the development of the hotel include suppliers of room related goods telecommunication vendors, food and beverage suppliers and other hotel related vendors.

4.2.8.1. STAKEHOLDER PERCEPTIONS

To determine the potential social and economic impact of the project, ESAL conducted a series of face-to-face interviews with persons identified as primary stakeholders within the defined study area. That is, persons who are directly connected to the Half Moon Bay area. In total, 16 persons were interviewed: 9 individual residents, 5 persons representing businesses currently operating in the Half Moon Bay area and 2 persons who work in the area but resided outside of it.

The residents interviewed were associated with the area between 6 and 65 years. The business owners have been associated with the area between 5+ and 50 + years. Two of the businesspersons represented the two large hotel/residential properties in the area. The others were small business owners operating eating establishments.

Project Benefits

Most interview participants (13 of the 16) felt that the project would benefit the wider community, primarily because of the potential employment opportunities. Several of the individual participants commented that they hoped residents of the area – particularly young persons living in the Freetown Village - would be given priority in the recruitment process. Four (4) of the five business owners also felt that the project would be beneficial from the perspective of employment. The small business operators also anticipated increased patronage of their businesses by construction workers and ultimately by guests

of the hotel. One property owner felt however, that there may be a shortage of labour because of planned construction work on one neighboring hotel property, while another did not expect any significant impact on employment because he considered the project to be a 'small' one.

One business representative (neighbouring hotel property) was cautious about the overall benefit of the Moongate project. While agreeing that there is potential economic benefit to the people in surrounding villages and beyond, the businessman suggested that the project would be detrimental if it fails to preserve the natural, beautiful, 'unspoilt' character of the area. He expressed delight that the proposed property is a high-end one, as he noted this model aligns with those already existing in the area.

Specific Impacts

Respondents were asked to rate their perceptions of the project's impact on specific economic activities (refer to Table 4.3). Impact was defined as increased or decreased opportunity for the activity. Increased activity may be in terms of increased sales and increased opportunity to expand to meet demand. A negative impact may be reduced sales or increased competition from the hotel's operation.

Scores between 0 and 10 were applied; 0 being the highest possible positive impact and 10 the highest possible negative impact.

Table 4.3 Perceptions of Impact on Specific Economic Activity

FACTOR	AVERAGE RATING	PERCEIVED IMPACT
Employment	3	Moderately Positive
Crop Farming	3	Moderately Positive
Livestock Farming	3	Moderately positive
Fisherfolk	2	Highly Positive
Souvenir vending	4	Mildly Positive
Eating Establishments	3	Moderately Positive

Employment - The project is expected to have a positive impact on employment both during the construction and operation phases. Respondents felt the project may help to alleviate unemployment, especially among the youth in the surrounding villages.

Crop Farming - While there is minimal commercial farming within the study area, this activity occurs in areas within 5 miles. Additionally, small scale producers may view the hotel as a possible market for produce.

Livestock Farming – Similar to crop farming, livestock production is minimal within the study area, but the project remains a potential market to producers from surrounding villages on the outskirts of the study area

Fisherfolk – With the project's proximity to the sea, respondents felt that fisherfolk who ply their trade in the coastal waters near Half Moon Bay would likely benefit from the new hotel as a lucrative market.

Souvenir vending – This activity currently occurs on the beach near the proposed site of the hotel. One respondent suggested that any planning process for the operations of the hotel should involve consultation and collaboration with the existing beach vendors.

Eating Establishments – There are two such establishments in close proximity to the proposed site. Both offer casual dining with local currency. Both businesses are primary stakeholders and their proprietors have predicted they would be impacted in both construction and operation phases. Both welcome being kept 'in the loop' to avoid any negative impact.

Comments & Suggestions from Respondents about Development

Individual Residents:

- Hotel employment should first be sources from within the surrounding communities
- Ensure that the marine environment is protected and preserved
- The beach must still be accessible to local residents
- Please incorporate vendors currently selling on the beach
- Include tennis and golf as activities

Business owners:

- There are concerns about the location of the water treatment plant
- During construction, work with businesses in the immediate vicinity to manage parking and general traffic flow through the area
- Engage the other two hotel/residential property principals to collaborate on the preservation of the natural environment and maintenance of the area's esthetics
- Revisit building density on the proposed property
- Investigate potential electricity grid challenges

4.2.9. TRAFFIC & PARKING

The Project, once operational, will account for higher vehicle traffic along the connecting routes as well as to and from the offices at Moon Gate. The owners of Moon Gate must factor in adequate parking facilities at the site; recognizing that the site is only 1.22 acres. For example, with 40 units (2 beds per unit), one could envision about 80 vehicles at maximum occupancy. In addition, parking must be adequate for staff and visitors to the hotel (e.g. eating at restaurant). For a 40 unit high end hotel with featuring restaurant and other amenities, one could well imagine staff/management to be around 60 persons.

Consideration should be given to promoting and providing:

- golf cart transportation using electric batteries
- having parking spaces properly marked (unit with parking slot)
- provide information indicating where motorists may and may not park
- set time limits for restaurant use by visitors
- off-site parking (ex. at the beach) and then shuttled to restaurant
- encourage bicycle use by onsite residents

Table 4-4 and Table 4-5 below provides a Summary Assessment of the Environmental Impacts and suggested Mitigation Measures for the construction and operational phases respectively for the Moon-Gate Resort.

Table 4.4 Summary Assessment of Environmental Impacts & Mitigation - Construction Phase

Construction Phase			
Impacts	**Direct Impacts(s)**	**Indirect Impacts(s)**	**Mitigation Measure(s)**
Vegetation and Soil from Site Clearing	-vegetation loss -soil loss	-loss of birds & lizards -sedimentation -flooding	-use endemic plants for landscaping -stockpile excavated topsoil
Ambient Air Quality	-fugitive dust formation	-health -nuisance	-cover aggregate and topsoil transported - place aggregate and topsoil away from stormwater pathways -dampen aggregate and topsoil piles during dry periods
Noise Level	-nuisance to nearby residents & businesses -stress on wildlife		-heavy equipment properly muffled -avoid working beyond normal work hours and public holidays
Building Construction	-blocked waterways -dust/noise emissions	stormwater redirected -erosion, flooding	-runoff from roof areas are collected and stored -building materials must meet DCA codes
Solid Waste	-unpleasant smell -unsightly	-health	-install bins -install temporary toilet facilities -schedule regular removal to authorized dump site

Table 4.5 Summary Assessment of Environmental Impacts & Mitigation - Operational Phase

Operational Phase			
Impacts on	**Direct Impacts(s)**	**Indirect Impacts(s)**	**Mitigation Measure(s)**
Noise Level	-nuisance to nearby residents -loss of hearing after prolonged exposure		-install generator in acoustic enclosure - heavy duty equipment operators fitted with protective equipment -heavy equipment work during normal work hours
Ambient Air Quality	-PM formation	-human health -nuisance	-service vehicles and equipment regularly
Stormwater	-hard surfaces increase volume & peak runoff - waterways and surrounding properties	-erosion - sedimentation - flooding	-install grass-crete at some driveways, parking-lots, and walkways -install storage tanks to collect rain from roof areas
Utilities	-water leaks -electric shock	-flooding -health and safety	-ensure pipes are properly sized and installed -ensure electric lines are safely installed and locations marked
Sewage Treatment	-system failure generating pungent odors and pollution	-human health -environmental health	-ensure back-up power -ensure components of WWTP meets operational standards -monitor effluent regularly -install alarm to signal malfunction -service WWTP regularly
Solid Waste	-pungent odors -pollution -poor aesthetics	-human health -environment health	-install adequate toilet facilities -store oils and other hydrocarbons safely -place adequate waste bins at site -schedule timely solid waste collection

5. Risk & Disaster Management

Hazards are potentially damaging physical events that may cause loss of life, physical injury, property damage, environmental degradation, and socio-economic disruption. Such hazards may be man-made or natural.

The following man-made hazards will be analyzed during the construction and operational phases of the Moon Gate development:

1. Stormwater.
2. vegetation & soil loss.
3. air pollution.
4. noise pollution.
5. waste pollution.

In addition some natural hazards will be considered as it relates to developing some measure of resiliency for the Moon Gate development. These hazards are:

1. earthquakes.
2. hurricanes.
3. floods.
4. droughts.
5. surges & wave action.

For the man-made hazards, the impacts from Chapter 4 were considered and a rating score established for both economic and environmental impacts. These ratings were based on experience and historical reviews. Table 5.1 outlines the rating score.

Table 5.1 Rating scores

		score		
impacts	**symbol**	**low**	**medium**	**high**
environmental	**E_n**	0-3	4-6	7-10
economic	**E_c**	0-3	4-6	7-10
other metrics				
Vulnerability	**V**	0-3	4-6	7-10
Risk	**R**	**0-40**	**41-80**	**>80**

The summation of the "environmental" and "economic" scores will equal the "total hazard score." A second element in developing a "risk rating matrix," is the consideration of vulnerability (i.e. the likelihood or probability of losses). The vulnerability will be considered before and after mitigation measures are introduced. The mitigation measures should reduce the potential negative consequences of risk.

To evaluate the Risk (R) prior to mitigation:

$$R_{wm} = (En + Ec)(V_{wm})$$

where,

R_{wm} = Risk (without mitigation) score

En = environmental impact score

Ec = economic impact score

V_{wm} = Vulnerability (before mitigation) score

$$H_T = E_n + E_c$$

where,

H_T = total hazard score

To evaluate the Risk (R) after mitigation:

$$R_m = (H_T)(V_m)$$

where,

R_m = Risk (mitigation added) score

V_m = Vulnerability (after mitigation) score

5.1. Construction Impacts Generated

5.1.1. STORMWATER

Given the small size of the sub-watershed (22 acres) and the 1.22 acre foot print of the proposed Project site on sloping lands, the impact of storm water will be medium. With the installation of temporary drains and swales this hazard can be reduced to a low risk.

5.1.2. VEGETATION & SOIL LOSS

Because most of the construction site is to be cleared, the risk of soil loss will be high. To effectively reduce this risk to a low level would require proper collection and coverage of aggregates and topsoil as well as installing silt fences to capture soil loss from hillside areas.

5.1.3. AIR POLLUTION

There is the possibility of dust particles affecting construction workers as well as residents and other stakeholders within the areas surrounding the Project site; this introduces a high level of risk. Dust could be generated from dump trucks and land clearing activities. In this regard, stockpiles and temporary roadways should be dampened during dry conditions.

In addition, dump trucks with aggregate should be properly covered with waterproof vinyl tarps and equipment exhaust adequately filtered.

5.1.4. NOISE POLLUTION

During the land clearing and building activities, heavy machines, equipment, and dump-trucks will be active and likely to generate some noise for residents and other stakeholders in the general area. Considering these activities, the ambient noise quality could be high. To effectively reduce the potential for excessive noise, ensure adequate sound reduction for equipment and workers on site (mufflers, ear plugs); avoid working heavy equipment beyond normal work hours as well as public holidays; such interventions could reduce the level of risk to low.

5.1.5. SOLID/LIQUID WASTE

If not properly collected and contained, solid and liquid waste could pose a serious health concern for workers and nearby residents; the risk level is high. To reduce impacts and the risk level to low will require the installation of temporary bins and toilets. In addition, oils/hydrocarbons must be safely collected and stored and measures taken to avoid/contain any accidental spills.

5.1.6. RESIDENTS/BUSINESS

Stakeholders within the project site and its area of influence were informed of the proposed development. They expressed concern for noise and air pollution as well as solid waste collection and disposal.

Table 5.2 Summary of Risk Quantification - Construction Phase

hazard	E_n	E_c	H_T	V_{wm}	R_{wm}	intervention	V_m	R_m
stormwater	***6***	***5***	***11***	***7***	***77***	install swales to channel flows to establish drains	**2**	**22**
veg./soil loss	***7***	***5***	***12***	***7***	***84***	install temporary silt traps	**2**	**24**
						stockpile excavated soil		
						ensure proper coverage of aggregate and topsoil		
						positions stockpiles away from stormwater paths		
air pollution	***8***	***4***	***12***	***7***	***84***	damp loose soil (roadways, aggregate, trucks)	**2**	**24**
						ensure dust masks available & worn		
noise pollution	***8***	***4***	***12***	***7***	***84***	ensure heavy equipment propery muffled	**3**	**36**
						avoid working beyond work hours/public holidays		
						ensure ear plugs available & worn		
waste disposal	***6***	***4***	***10***	***7***	***70***	install temporary bins and toilet facilities	**4**	**40**
						store oils/hydrocarbons safely		

5.2. Operational Impacts Generated

5.2.1. STORMWATER

Although the Project area is small (1.22 acres), the hard surface footprint is likely to be at 75%, hence, design of drains to manage runoff will be important. The impacts of hydrology on the operational phase is rated as high. Maintaining some greenery on site as well as incorporating porous walkways, driveways, and parking lots. Proper fitted roof gutters are also required to safely convey water via drains to outlets or an on-site water cistern. Such mitigation measures could reduce the runoff risk to low.

5.2.2. VEGETATION & SOIL LOSS

At least 75% of the proposed Project site is to be developed, so the opportunity for soil loss is limited during Moon Gate's operation; as a result the vegetation and soil loss risks are considered low.

5.2.3. AIR POLLUTION

There is possible impacts from poorly designed and/or operated plants (WWTP, RO plant and generator) could see rick levels at medium. Proper measures such as training staff periodically and servicing all equipment and work vehicles could reduce risk levels to low.

5.2.4. NOISE POLLUTION

Poor design, operation and service of WWTP and generator could produce excessive noise impacting workers, guests, and neighboring residents/business; leading to a medium level of risk. Introducing proper servicing of generator, WWTP as well as effectively muffling sound (mufflers, insulation, etc.) could reduce risk to low levels.

5.2.5. SOLID/LIQUID WASTE

The operational phase could see solid/liquid waste levels at medium risk due to uncontrolled solid waste collection as well as toxic spills (oil, hydrocarbons). To reduce this risk to a low level would require training staff on measures that would reduce spills/leaks and safely storing oils/hydrocarbons on site. Adequate bins will also need to be positioned around the property with collection, transportation and disposal methods meeting CBH standards.

5.2.6. RESIDENTS/BUSINESS

The impact of this project on the economy and employment is considered to be beneficial.

Table 5.3 Summary of Risk Quantification - Operational Phase

hazard	E_n	E_c	H_T	V_{wm}	R_{wm}	intervention	V_m	R_m
stormwater	***7***	***5***	***12***	***7***	***84***	install drains (roofs, driveways, parking lots)	**2**	**24**
						channel runoff to storage collection tanks		
						install porous mediums (parking lots, walkways)		
veg./soil loss	***3***	***2***	***5***	***4***	***20***	incorporate landscape gardens;	**1**	**5**
air pollution	***7***	***2***	***9***	***6***	***54***	service equipment (WWTS, generator, WTP, RO)	**1**	**9**
noise pollution	***7***	***3***	***10***	***6***	***60***	vehicles, generator,WTP, WWTS,RO properly muffle	**3**	**30**
						periodic service (vehicles, generators and plants)		
Waste disposal	***7***	***4***	***11***	***6***	***66***	establish protocols to minimize spills/leaks	**2**	**22**
						store oils/hydrocarbons safely		
						ensure adequate waste bins installed.		

5.3. Climate Change Impacts & Mitigation

5.3.1. EARTHQUAKE

The earthquake hazard in Antigua & Barbuda is classified as medium. There is a 10% chance of an earthquake affecting the project area within a 50 year time period. Based on this data, the impact of earthquakes should be considered during the construction and operational phases of this project. Developing immediate response and damage assessment plans are important. In addition, buildings should meet the least minimum seismic design and loading requirements stipulated by the OECS building code.

5.3.2. HURRICANES

The Caribbean (which includes Antigua & Barbuda) lies in the North Atlantic Ocean, one of the six main tropical areas of the earth where hurricanes may develop every year. Within the 111 years between 1886 and 1996, approximately 1,000 tropical storms have been recorded in the North Atlantic. About half of these attained hurricane strength.

The hurricane pattern (1960 - 2020) indicates a return period of approximately every 3 to 7 years in Antigua. Emanuel (1987), suggested a 10% increase in hurricane intensity for every 1°C increase in global temperature. During 1995, with a global increase of 0.4°C, there was a 100% increase in the number of Atlantic storms. The destructive potential of hurricanes is significant due to high wind speeds and torrential rains that produce flooding and occasional storm surges reaching heights of several feet above normal sea level.

The pattern in recent times has been a reduction of deaths and injuries (because of better warning systems and other preparedness activities) but an increase in property damage (because of commercially-driven unsuitable building practices and locations).

A major hurricane (Luis) struck Antigua & Barbuda on 4th and 5th September 1995. Because of its overall size and slow forward motion, the hurricane impacted Antigua for an uncommonly long period. Severe

storm conditions lasted for about 48 hours during which time about 500 mm (20 inches) of rain fell. The level of losses in Antigua & Barbuda approximated 65% of GDP. There was damage to buildings, due to weak connections of light-weight roofing materials, impact damage from flying objects, inadequate material strength structures. Also there was water damage from the torrential rains. The actual wind speeds were not greater than should have been expected in a 1-in-50-year event. The regulation and effective enforcement of modern building standards and codes would have led to a significant reduction in losses.

The Caribbean Uniform Building Code (CUBC), which is incorporated in the OECS Antigua & Barbuda Building Code, assigns a reference pressure of 0.82 kPa to Antigua and Barbuda. This is equivalent to a 10-minute sustained wind speed of 37.0 m/s (83 mph) or an equivalent 3-second gust speed of 56 m/s (125 mph). These figures relate to a 50-year return period.

Some measures to consider to reduce the level of risk from high to medium include developing an emergency evacuation plan and survival kit, strengthening roofs, windows, and doors to match building codes. In addition, an assessment of drainage systems should be made before and after the hurricane season and any damages noted, repaired as soon as allowable.

5.3.3. FLOODING

The twin island state of Antigua and Barbuda is affected by Tropical Waves & Hurricanes during the rainy season. Each of these systems can bring from 10 to 30 inches of rain in a few days. The alternating wet and dry periods have led to the removal of significant topsoil and general soil erosion in many areas of the island.

To reduce flooding in AB watersheds will require field assessment of collection/conveyance drains and water bodies (before/after hurricane season). This will allow an investigation of any damage or blockage; such issues will have to be addressed as soon as the situation allows. In addition, water structures will need to be reassessed to ensure structural integrity and effectiveness (ability to collect and convey runoff). Where possible, drains should be designed/installed open rather than closed to reduce the effect of blockages from debris.

The Moon Gate development should establish early flood warning protocols and coordinate with NODS and the MET office regarding preparation and response. In addition, during the operational phase, the developers should consider adopting structural and non-structural Low Impact Development (LID) strategies. Such interventions will seek to:

- reduce impervious areas that can increase storm runoff and flooding
- limit as much as possible site disturbance

some of these strategies include installing:

- pervious/porous pavement (parking lots, walkways, driveways, roadways) with infiltration bed; these surfaces may consist of pervious asphalt, pervious concrete and paver blocks, and reinforced turf and gravel.
- micro rain gardens to manage stormwater by pooling water within a planting area and allowing it to infiltrate the garden
- vegetated roof systems to achieve water quantity and water quality benefits

- roof gutters to collect and convey rain water to a cistern or infiltration beds.

5.3.4. DROUGHT

Antigua & Barbuda form part of the outer arc of limestone low lying drought prone islands of the Caribbean archipelago. Antigua's average annual rainfall is about 40 inches (1,000 mm) while the average relative humidity is 82%. Since 1874, Antigua has experienced many consecutive years when the average rainfall has been much less than 30 inches. The last periods of drought were in 1983, 1994 & 1997.

Drought scenarios for AB indicate an incremental increase in drought of about 5% per decade. It is also anticipated that the demand for water will also increase to satisfy demands of a projected growing population and economic expansion.

Droughts also affect water and air quality, animals and coastal habitats. Air quality is reduced as dust particles in the air increases. Wildfires are also more likely during such times.

The island's vulnerability to drought needs to be foremost in any design concepts for the Moon-gate Development. It is imperative that water harvesting facilities (e.g. cisterns, WWTP) are established as part of this project to reduce risk levels from high to low.

5.3.5. SURGES & WAVE ACTION

The IPPC "Business as Usual Scenario" at year 2030 projects global mean sea level rise at 8 to 29 cm higher than today; for 2070, the rise is 21cm to 71cm. Most of the contribution is estimated to come from thermal expansion of oceans and increased melting of mountain glaciers and small ice caps.

Antigua & Barbuda's marine and coastal environments are characterized by mangroves, coral reefs, and seagrass beds; these ecosystems sustain the country's sandy beaches and fishery resources, while also serving as protective barriers during tropical storms. The Moon-gate Development which lies about 800 feet west of the ocean front and lies between the 74 and 104 foot contour (above SL); as a result it is not very susceptible to storm surges and sea level rise (SLR), hence the risk rating is considered low.

The Arbiter of Storms (TAOS), essentially a computer program modeling hurricanes approaching Antigua, shows that for a category 4 storm, one can expect storm surges to effectively reach a height of about 8 feet (2.5 meters). It is still important for the owners of Moon Gate to understand the impacts of SLR; this will require some interaction with coastal engineers MET office, and DoE.

Table 5.4 Summary of Risk Quantification - Natural Hazards

hazard	E_n	E_c	H_T	V_{wm}	R_{wm}	intervention	V_m	R_m
earthquakes	***7***	***8***	***15***	***5***	***75***	develop immediate response & disaster assessment plar	**2**	**30**
						buildings meet least min. loading requirements		
						promote eartquake safety protocols		
						develop emergency survival kits		
hurricanes	***4***	***7***	***11***	***7***	***77***	create emergency vacuation plan and survival kit	**4**	**44**
						strengthen and secure roofs, windows, doors		
						assess/repair drainage systems before/after storm		
						pick-up outdoor chairs, loose items indoors safely		
flooding	***7***	***7***	***14***	***7***	***98***	establish flood warning protocol	**3**	**42**
						adopt LID (permeable surfaces, rain cisterns)		
						work with MET office, NODS regarding response		
						assess/repair drainage systems before/after storm		
drought	***7***	***7***	***14***	***4***	***56***	store runoff water in cisterns	**1**	**14**
						plan alternative sources water (RO,WTP)		
						conserve water efficiently (shower heads/faucets)		
						recycle grey water for washing, landscaping		
surges/waves	***5***	***6***	***11***	***3***	***33***	work with CEs to better understand impacts SLR	**1**	**11**

6. Environmental Monitoring & Management Plan

This section provides an outline for dealing with adverse impacts associated with the construction & operational phases of the Moon Gate Development. The framework, which takes the form of an Environmental Monitoring & Management Plan (EMP), is an important tool that, once properly implemented, ensures management actions meet environmental and socioeconomic standards during all phases of the project's lifecycle. Consideration was given to the legal and regulatory requirements during the design of the EMP. Table 6.1 and Table 6.4 below provide a summary of the EMP for both the construction and operational phases respectively.

The DoE, given the lead role it plays in managing the EIA process, is expected to coordinate the involvement of government stakeholders in the implementation and monitoring of the recommendations and regulations. Some of these associates include:

- Central Board of Health (advise on management of waste and materials).
- Development Control Authority (advise on building codes and standards).
- Forestry Division (advise on vegetation and soil management).

6.1. Construction Phase

Monitoring

The EMP will outline the approach, during construction, for monitoring site clearance, materials handling/storage, storm runoff, emissions, and noise. An Independent Contractor (IC) will visit the site every two (2) weeks and meet with the Project Manager or designated party to monitor construction activities and ensure the EMP is properly implemented. If there are any pressing concerns/issues before the Quarterly Report is submitted, the IC will contact the DoE immediately to address such matters. The DoE will collaborate with the appropriate agency for discussion and follow-up action.

Reporting

Throughout the construction period, the Independent Contractor (IC) will compile and submit Quarterly Reports to the DoE. The IC will collaborate with the on-site Project Manager (PM) or Designated Assistant (DA) regarding progress of work/concerns. If there are any pressing concerns/issues before the Quarterly Report is due, the IC will contact the DoE immediately to address such matters. The DoE will link with the appropriate agency for discussion and follow-up action. Any non-compliance must be documented and corrected action taken immediately with progress updates provided to the DoE and/or responsible agency; all records should be retained digitally and shared with the relevant regulatory agencies.

Mitigation Actions

6.1.1. SITE CLEARANCE

The clearing and removal of vegetation needs to be monitored by the Independent Contractor. The IC, during the monitoring visits, will focus on ensuring:

- the site is adequately secured and access controlled.
- vegetation clearing minimized as much as feasible.
- topsoil and vegetation not indiscriminately removed.

- clearing of site along with roadways carried out using lighter machinery (e.g. backhoe)
- drainage ways clear of debris and soil-wash

6.1.2. MATERIAL MANAGEMENT

A variety of potentially hazardous materials will be used and stored onsite during project construction. Some such hazards may include propane, acetylene, form oil, paints, epoxies, antifreeze, batteries, hydraulic fluid, cleaners, solvents, and concrete additives and agents.

The IC, during the monitoring visits, will focus on ensuring:

- an area, that complies with regulatory requirements, dedicated for storing hazardous materials
- excavated soil and aggregate safely stockpiled to minimize release to drains and watercourses
- construction waste safely contained
- adequate waste bins placed within the construction site
- adequate temporary toilet facilities available for workers

6.1.3. STORM WATER RUNOFF

The provision for proper conveyance of stormwater runoff needs to be monitored by the Independent Contractor. The IC, during the monitoring visits, will focus on ensuring:

- proper drainage in place to safely divert storm runoff to major drains
- contaminated water pumped or drained from excavations filtered through silt traps
- concrete wash from mixers and chutes channeled to a dedicated wash out area located away from drainage paths and other water bodies

6.1.4. AIR QUALITY

To maintain an acceptable level of ambient air quality around the project site, it is important to monitor the air quality on a quarterly basis or whenever valid concerns are raised by residents/businesses in the area. The IC, during monitoring visits, will observe if there is any noticeable emissions at the site and discuss/inform project manager to rectify issue. If issue persists, then the IC must immediately contact the DoE and Central Board of Health so that appropriate mitigation measures can be designed and implemented.

The provision for mitigating dust emissions needs to be monitored by the Independent Contractor. The IC, during the monitoring visits, will focus on ensuring:

- dust from pneumatic drilling suppressed by ongoing water spraying.
- temporary dust screen enclosures in place at areas generating excessive dust.
- water applied to unsealed road surfaces to suppress dust generation during dry periods.
- no open burning of construction / waste material at site.
- no excessive idling of construction vehicles at site.
- tarps placed over trucks transporting fine debris material.

A waterproof vinyl tarp, shown in Figure 6.1, is recommended to contain dust generated by trucks transporting aggregate.

These vinyl tarps, sometimes known as flip tarps, or front to rear tarps, are of a universal design to allow them to serve as replacement tarps for most dump trucks and dump trailer tarp systems. Designed to keep the load fully protected from inclement weather, they feature reinforced webbing along the length of both sides, as well as rust-proof metal grommets to safely and completely secure the tarp in place and protect the load.

The concentration of Carbon Monoxide should remain within permissible levels if all vehicles, machinery, and equipment are maintained regularly during construction activities.

Figure 6.1 Truck with waterproof Vinyl Tarp

6.1.5. NOISE EMISSIONS

To maintain an acceptable level of noise around the project site, it is important to monitor noise on a quarterly basis or if valid concerns are raised by residents/businesses in the area. The IC, during their monitoring visits, will observe if there is any noticeable noise at the site and discuss/inform project manager to rectify issue. If issue persists, then the IC must immediately contact the DoE and Central Board of Health so that appropriate mitigation measures can be designed and implemented.

Equipment that emits noise and vibrations will be calibrated to perform using manufacturer specifications. The provision for mitigating noise emissions needs to be monitored by the Independent Contractor. The IC, during the monitoring visits, will focus on ensuring:

- engine covers and mufflers of generators, air compressors and other powered mechanical. equipment in place during operation
- individuals operating heavy equipment have necessary noise suppressing equipment
- construction occurs during predetermined daytime hours.
- limit night-time activities to lower noise-level equipment.

Table 6.1 Summary of Environmental Monitoring Program - Construction Phase

monitor	objective	Monitoring Parameters	frequency	Report
Site clearance	Maintain site integrity.	Vegetation removed to match Project demands. Excavated topsoil stored safely for landscaping. Silt fences erected to prevent soil from moving off-site.	fortnight	Any breach noted or complains from community (IC to DoE)
Material management	Prevent incorrect storage & handling of hazardous substances.	No visual spillage/leaks of hydrocarbons. Waste bins/toilets available & functional. Waste bins at locations with easy access for collection.	fortnight	Any breach noted or complains from community (IC to DoE)
Storm runoff	Prevent pollution of downstream water.	No turbid water exiting to main drain and coast. Dedicated wash areas to control concrete wash & leachate. Adequate roadside drainage to manage storm runoff.	fortnight	Any breach noted or complains from community (IC to DoE)
Air Quality	Reduce/avoid air pollution.	No unwanted emissions from equipment/dirt roads. Exposed soil areas dampened when dry. No burning of waste at site. Tarps placed over trucks carrying fine material.	fortnight	Any breach noted or complains from community (IC to DoE)
Noise Quality	Reduce/avoid excessive noise.	No excess noise from equipment & generator. Operators of heavy equipment/machinery fitted with adequate noise control gear.	fortnight	Any breach noted or complains from community (IC to DoE)
Compliance	Ensure objectives met	Mitigation actions implemented.	fortnight	IC
Reporting		Compliance to EMP	quarterly	IC

6.2. Operational Phase

Monitoring

Throughout the operation of the Moon Gate Hotel, a representative from the CBH will conduct annual visits and meet with the Hotel's Environmental Officer (EO) to monitor and audit:

- operation of WWTP (review of operation log, testing input/out effluent).
- holding tank for treated sewage is properly aerated.
- safety protocols implemented to handle and store hazard material.

An Environmental Officer (EO), representing the Moon Gate Hotel, will also meet periodically with the DoE. Monitoring throughout the operational phase will be based on periodic communication between an EO from Moon Gate and the DoE. The DoE will annually visit/walkthrough the Development where the EO will provide an update on environmental issues related to pollution, health and safety protocols, and emergency planning.

The DoE will have an independent contractor (IC) conduct periodic testing of Half Moon Bay marine coastal water; tests are to be carried out every two years around the locations indicated in the Figure 2.1, p. 10; these locations will allow for some comparison with baseline parameters.

Reporting

The DoE annual visits/discussions with Moon Gate EO will allow the DoE to provide feedback on environmental matters of concern to relevant agencies (e.g. CBH, Fisheries).

Verbal/written environmental concerns, during the operation of Moon Gate, made by neighboring community or businesses should be reported to the DoE. The DoE is to investigate immediately and meet with EO/Hotel Management to discuss. If concern is deemed problematic, then the DoE will request the relevant government agency to meet and diagnose problem at hand. Once problem is diagnosed then mitigation measure(s) will be developed and implemented to rectify issue.

The IC conducting biennial seawater testing will provide a Summary Report of findings to the DoE. If there is any notable changes in quality from the baseline then the DoE will immediately be informed. The issue will be investigated to determine the source of contamination in the surrounding area and mitigation measure(s) designed and implemented.

Mitigation Actions

6.2.1. MATERIAL MANAGEMENT

The material management effort needs to be monitored by the DoE or contracted party. The IC, during the monitoring visits, will focus on ensuring:

- a dedicated area provided to safely store hazardous materials/hydrocarbons
- adequate waste bins placed around hotel
- staff trained to handle hazardous materials

6.2.2. AMBIENT AIR

The air quality assessment around the proposed Moon Gate Hotel site is shown in Table 6.2. There were no Air pollution concerns at the proposed site. All parameters measured were below prescribed threshold Limits.

The ambient air should be monitored biennially at Moon Gate or if concerns are noted and presented by neighboring community or businesses. This monitoring is the responsibility of the DoE or designated party. The air quality parameters tested are to be compared with baseline results presented in Table 6.2.

Table 6.2 Air Quality Parameters at proposed Moon Gate Hotel Site

parameters	average concentration
Total Volatile Organic Compounds	**1258 ppb**
Carbon Dioxide	**371 ppm**
Carbon Monoxide	**1.5 ppm**
Nitrogen Dioxide	**0.07 ppm**
Sulphur Dioxide	**0.05 ppm**
Hydrogen Sulphide	**0.04 ppm**

6.2.3. WASTEWATER MANAGEMENT

The technicians at the Central Board of Health should work along with the Hotel's representative to test and monitor the effluent at the sewage plant to ensure:

- WWTP operating in accordance with National standards (e.g. inflow/outflow quantity and quality).
- Tank storage for treated effluent fitted with adequate aerator and operating in accordance with manufacturer specifications.

Given the fact that Moon Gate Hotel will be located approximately 800 feet from the Half Moon Bay coastline and the secondary treated waste may still contain some pollutants (non-biodegradable organics, odoriferous and coloring matter, and micro-organisms including pathogens), it is imperative that:

1. secondary treated effluent be used solely for landscape gardening.
2. tank storage of at least 7 days WWTP output be provided; this storage will facilitate securing. effluent during intense rain events; such rain will temporarily discontinue irrigation.
3. tank storage be fitted with effective aerator to avoid odors that could result in health effects.

The secondary treatment standards for WWTP are reflected in terms of five-day biochemical oxygen demand (BOD5), total suspended solids (TSS) removal, Chemical Oxygen Demand (COD), pH and color (refer Table 6.3).

Table 6.3 Secondary Treatment Effluent Standards (EPA)

parameter	30-day average (mg/L)	standard units	remarks
BOD_5	25		
TSS	30		
COD	125		
pH		6.0 - 9.0	
color		15	visible tint

For discharge to sensitive waters, the UK current quality requirements prescribe annual mean limits for total phosphorus (2 mg/L) and total nitrogen (15mg/L) where populations are between 10,000 and 100,000. Refer PDF online document, "EPA water treatment manual primary secondary tertiary1.pdf"

6.2.4. SEAWATER QUALITY

The DoE will have an independent contractor (IC) conduct biennial testing of Half Moon Bay sea water; test carried out around the locations indicated in the Figure 2.1, p.10; these locations will allow for some comparison with baseline parameters.

Table 6.4 Summary of Environmental Monitoring Plan - Operational Phase

monitor	objective	Actions	frequency	responsibility
Seawater quality	Half Moon Bay water meets recreational standards.	Test seawater samples against baseline results.	biennial	EO/DP
Material management	Prevent incorrect storage & handling of Hazardous Substances (HS).	Properly label & store HS. Train staff to safely handle toxic materials.	annual	EO/ED
Solid Waste Management	Prevent solid waste from being released into environment.	Install adequate waste bins. Ensure proper collection, storage, & disposal of waste.	annual	EO/CBH
Wastewater Effluent Quality	WWTP & holding tank operating at specification	No discharge of untreated WW. Treated effluent quality complies with national standards. Holding tank fitted with adequate aeration.	annual	EO/CBH
Ambient Air Quality	Reduce air emissions.	All vehicles and equipment maintained & fitted with required filters. Proper aeration of effluent storage tank.	annual	EO/ED
Noise Quality	Reduce the impact of noise.	Install proper engine mounts to avoid excessive vibration. Ensure proper silencers installed on vehicles, equipment, & generator.	annual	EO/ED
Compliance	Ensure objectives met	Sound operation of WWTP, & Effluent holding Tank. In place Safety protocols, Emergency Planning, Seawater quality testing.	annual	CBH DoE
Reporting		Compliance to EMP	annual	DoE

6.3. Moon Gate Responsibilities to support Environment

Based on the baseline sea water quality sample taken on April 9th, 2021, it was revealed (Section 2.5.2. Table 2.1) that enterococci bacteria was not detected. This is one indicator that presently highlights the excellent recreational quality of Half Moon Bay's seawater. The Moon Gate owners/managers would want to ensure that their WWTP and storage tank are operating efficiently and effectively so as to help maintain the quality of the coastal waters.

The quality of WWTPs effluents should be tested daily for BOD, TSS, and fecal coliform count and monthly for total nitrogen and phosphorus.

The treatment plant should have a built-in alarm system and an emergency backup power generator (automatically start once commercial power supply interrupted).

6.3.1. SPECIFIC IN-BUILT MONITORING ACTIONS/PLANS

Some in-built actions Moon Gate should consider in monitoring/complying with Environmental Regulations include:

- minimizing or substituting the use of hazardous substances including pesticides, paints, swimming pool disinfectants and cleaning materials with safe products.
- developing ERPs for
    - malfunction/repair of WWTP and effluent storage tank.
    - intense rain days when effluent storage tank at capacity.
    - spills, leaks, accidents and down-time due to malfunction/repairs.
    - hurricanes and droughts.
- training staff in environmental awareness & management (conserving resources, material handling, emergencies)

6.3.2. SPECIFIC IN-BUILT CONSERVATION ACTIONS

1. Renewable energy through optimization/partnership with local recycling agencies.
    a. working with recycling companies/guests to compartmentalize garbage (e.g. bottles, plastics, aluminum cans, and paper).
    b. working with suppliers to limit use of, and establish recycling for, product packaging.
    c. avoiding use of polystyrene foam in all operations;
    d. using glass or durable plastic instead of disposable plastic items (e.g. straws, cups).
2. Energy conservation/savings to include:
    a. measuring energy consumption daily/monthly and introduce measures to reduce it
        i. using LED bulbs in rooms to reduce electricity consumption.
        ii. installing motion detector switches and motion detectors in the back and front areas.
        iii. having corridors lit by a day/night lighting system through timer operation.
    b. measuring potable water consumption daily/monthly & introduce measures to reduce it
        i. installing water saving aerator in guest room.
        ii. fitting bathrooms with low-consumption shower heads and taps with flow regulators.
3. Using refillable, bulk dispensers (e.g. toiletries).
4. Testing irrigation system to ensure proper operation with no leaks, clogging, etc.

7. Conclusion

Based on interviews conducted in relation to Moon Gate Hotel development, the social and economic response was generally positive. Already the proponent has invested a substantial amount in the Project up to planning and design stage. The project will create employment and improve income earnings.

The activities that could potentially generate negative impacts on the environment could be meaningfully addressed by adopting adequate mitigation measures outlined in the Report. The proposed project design has some integrated measures so as to ensure compliance with regulations and procedures. During the construction activities of the Project, environmental compliance monitoring (material handling, noise & air quality, solid waste collection & disposal, etc.) will be undertaken bi-monthly by an independent contractor. For the operational phase, the DoE and the CBH will provide periodic oversight (e.g. WWTP, Safety, ERPs, etc.) to ensure environmental sustainability.

In relation to the proposed mitigation measures that will be incorporated during construction and operational phases of the development, as well as the development's beneficial input to society/business, it is our opinion that the proposed development is a timely venture that will contribute to nations economy.

It is thus our recommendation that the project be allowed to go ahead once the outlined mitigation measures are implemented and adhered to. Major concerns should nevertheless be focused towards minimizing the occurrence of impacts that would degrade the general environment. This will however be overcome through close follow-up and implementation of the recommended Environmental Management and Monitoring Plans (EMPs).

8. Appendices

8.1. Suites & Pent House Duplex

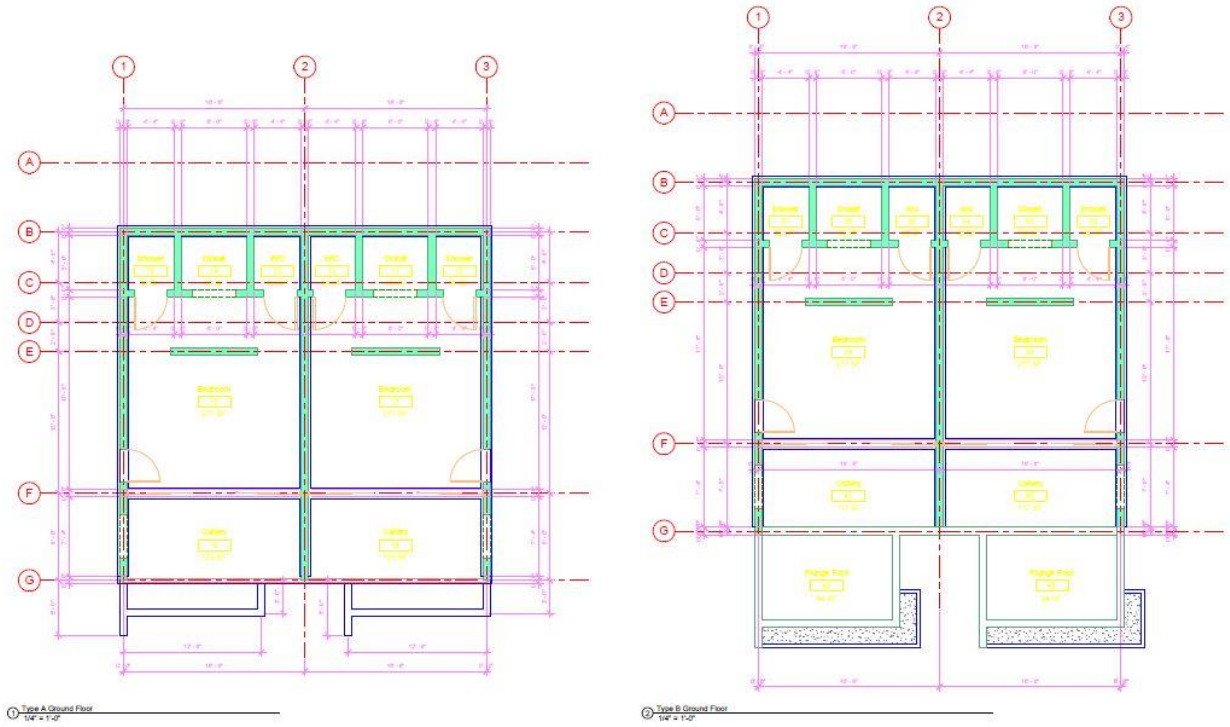


Figure 8.1 Ground Floor Plan View (Suites & Penthouse Duplex)

Ground Floor Plan:

- **Type A (without Plunge Pool)**
- **Type B (with Plunge Pool)**

8.2. First Floor Plan

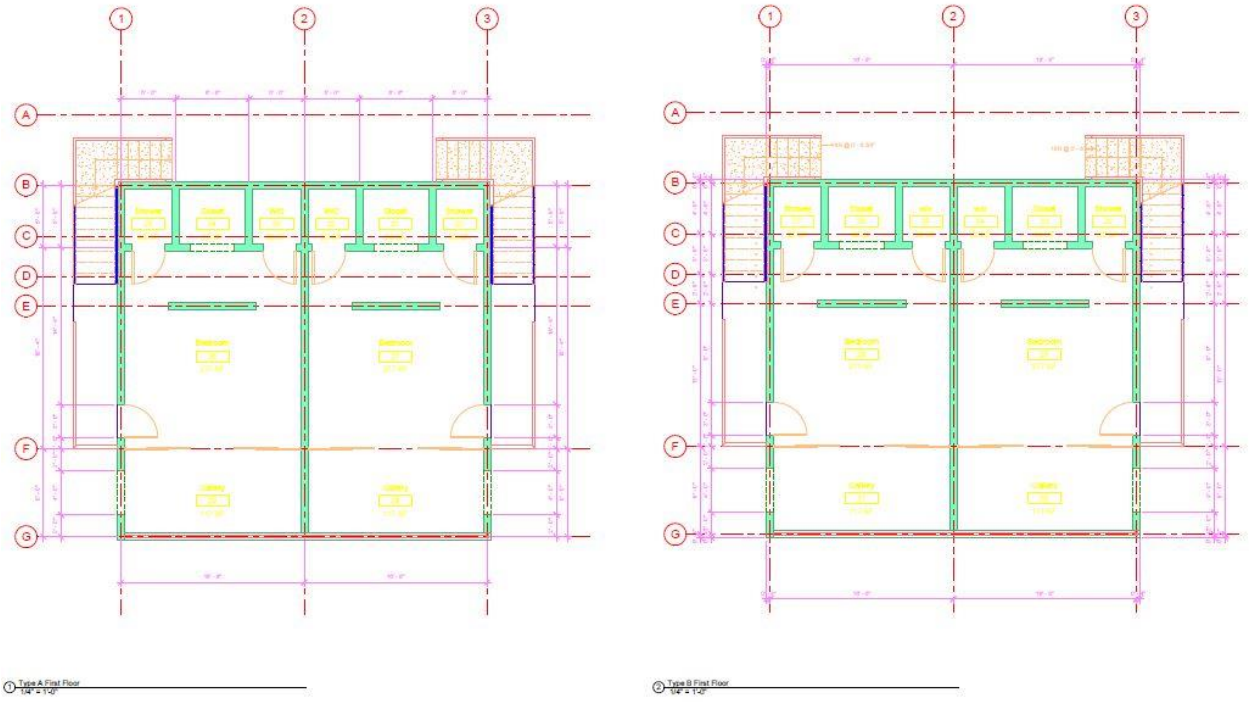


Figure 8.2 First Floor Plan View

8.3. Second Floor Plan

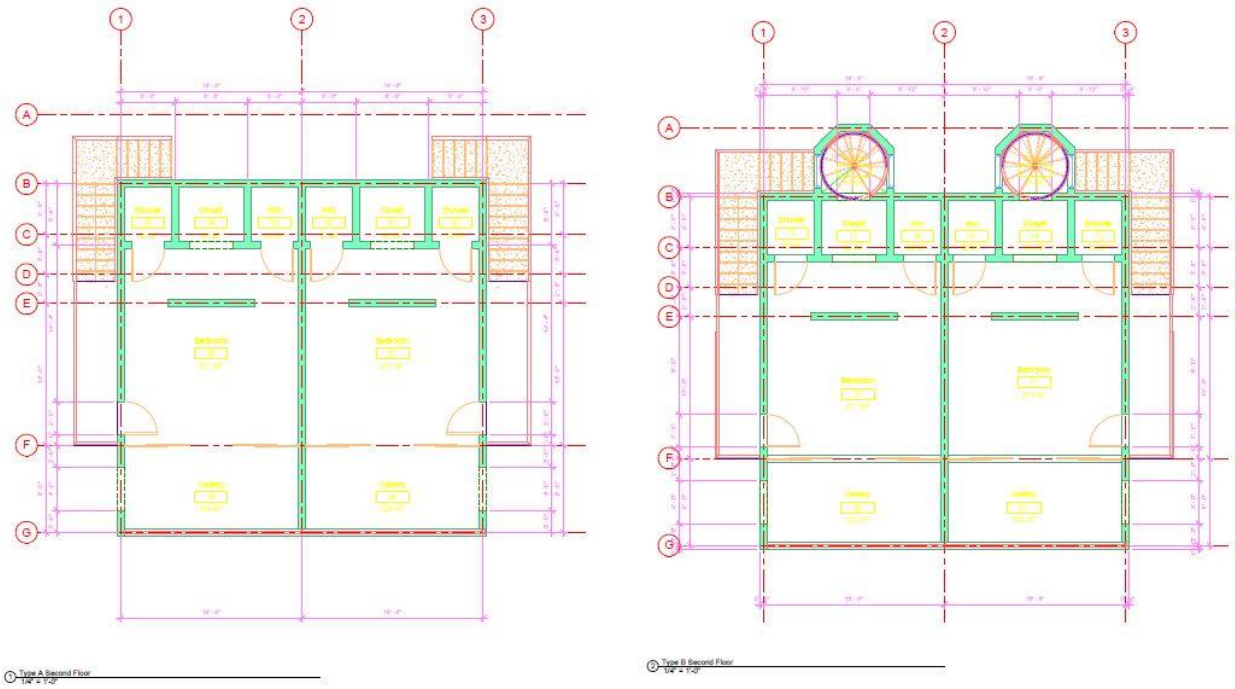


Figure 8.3 second Floor Plan View

Type A: left Plan in Figure 8.3 (no Plunge Pool)

Type B: right Plan in Figure 8.3 (Penthouse Duplex with spiral staircase to roof garden and plunge pool)

8.4. Garden Roof Plan

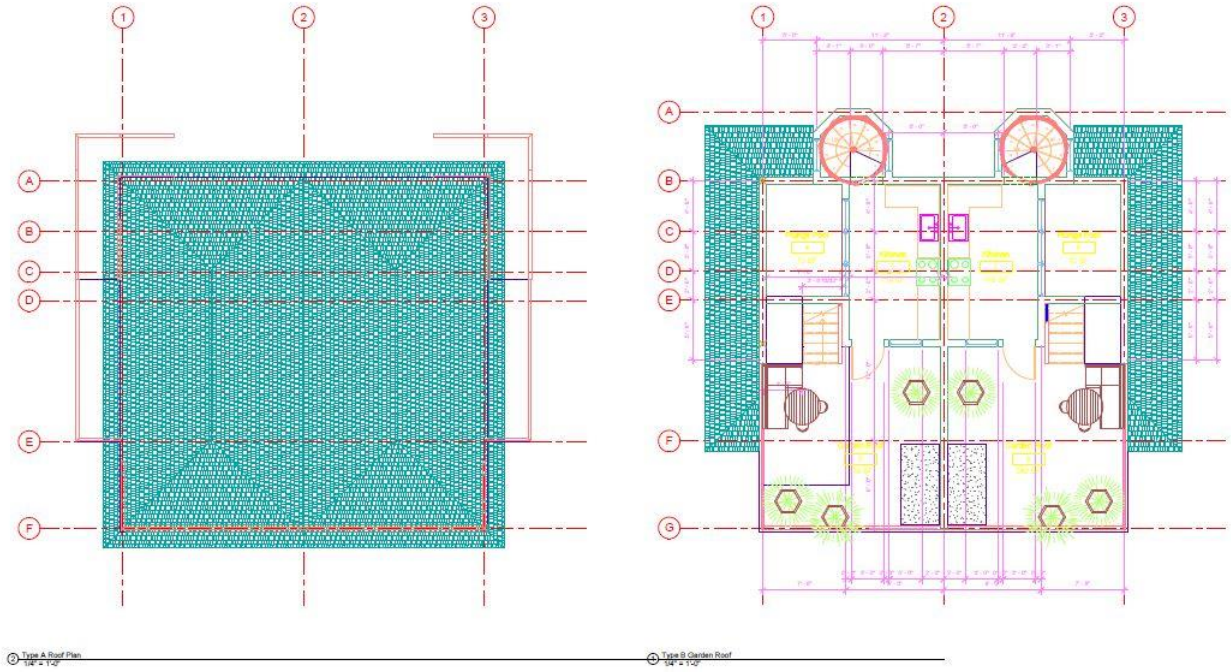


Figure 8.4 Garden Roof Plan

8.5. Plant List Within Study Area

LATIN NAME	LIFE FORM	COMMON NAME
Acacia macracantha		Alabama cassie
Agave karatto		Dagga log
Azadirachta indica		Neem
Bastardia viscosa		Mallow
Bourreria succulenta		Chinkswood
Bursera simaruba		Turpentine
Canella winterana		Cinnamon
Capparis cynophallophora		Black willow
Capparis indica		Willow
Colubrina arborescens		Soap bush
Comocladia dodonaea		hog bush
Cordia sebestina		Geranium tree
Cucumis dipsaceus		Hedgehog gourd
Malachra alceifolia		Wild okra
Momordica charantia		Maidens blush
Pilosocereus royeni		Dul_dul
Pisonia subcordata		White loblolly
Senna atomaria		Senna
Stachytarpheta cayennensis		vervain
Tabebuia heterophylla		White cedar
Terminalia catappa		Almond
Thespesia populnea		Seaside mahoe
Tillandsia utriculate		Giant air plant
Wedelia calycina		Piss-a-bed

8.6. Sample Tree Survey Form

Tree No.	**1**
Species	**Botanical name with common name in brackets :(*Tamarindus indica*)**
Age Class	**Young trees – less than 1/3 normal life expectancy** **Middle-aged trees – 1/3 to 2/3 normal life expectancy** **Mature trees – over 2/3 normal life expectancy** **Over-mature – beyond usually expected life span**
Height	**Estimated in meters: *15 meters***
Crown Spread	**North: 7 meter / East: 8 meters / South: 8 meters / West: 8.8 meters**
Crown clearance	**Approximate height between lowest branch and ground level (metres): (*1 meter*)**
Stem dia.	**Trunk diameter (3.85) measured at 1.5m above ground level, or ground level (gl), if multi-stem**
Vigour	**Objective assessment of a tree's vigour: (normal or low)**
Amenity	**Subjective assessment of a tree's contribution to the amenity value of the area: (High to Low)**
Water Demand	**(High) (Moderate) (Low)**
Condition	**Good ☐ Fair ☐ Poor ■**
Recommendations	**Remedial works in order to facilitate retention, or recommendation to remove** **Pruning and fumigation**
Ret.Cat.	**Based on B.S.5837 Retention categories:** **A = Those of High Quality & Value** **B = Those of Moderate Quality & Value** **C = Those of Low Quality & Value** **U = Remove (or Fell)**

8.7. Tree Quality Assessment Category

Definition			
Category U Those in such a condition that they cannot realistically be retained as living trees in the context of the current Land use for longer than **10 years**	• Trees that have a serious, irremediable, structural defect, such that their early loss is expected due to collapse, including those that will become unviable after removal of other category U trees (e.g. where, for whatever reason, the loss of companion shelter cannot be mitigated by pruning) • Trees that are dead or are showing signs of significant, immediate, and irreversible overall decline • Trees infected with pathogens of significance to the health and/ or safety of other trees nearby, or very low-quality trees suppressing adjacent trees of better quality *NOTE Category U trees can have existing or potential conservation value which it might be desirable to preserve.*		
	1 Mainly arboriculturally qualities	**2 Mainly landscape qualities**	**3 Mainly cultural values, including conservation**
Trees to be considered for retention			
Category A **Trees of high quality** With an Estimated remaining life expectancy of at least 40yrs	Trees that are particularly good examples of their species, especially if rare or unusual; or those that are essential components of groups or formal or semi-formal arboricultural features (e.g., the dominant and/or Principal trees within an avenue)	Trees, groups, or woodlands of particular visual importance as arboriculturally and/ or Landscape features	Trees, groups, or woodlands of significant conservation, historical, commemorative or other value (e.g. veteran trees or wood-pasture)
Category B **Trees of moderate quality** with an estimated remaining life expectancy of at least 20yrs	Trees that might be included in category A, but are downgraded because of impaired condition (e.g. Presence of significant though remediable defects, including unsympathetic past management and storm damage), such that they are unlikely to be suitable for retention for beyond 40 years; or trees lacking the special quality necessary to merit the category A designation	Trees present in numbers, usually growing as groups or woodlands, such that they attract a higher collective rating than they Might as individuals; or trees occurring as Collectives but situated so as to make little Visual contribution to the wider locality	Trees with material conservation or other Cultural value
Category C **Trees of low quality** with an estimated remaining life expectancy of at least years, or young trees with A stem diameter below 150mm	Unremarkable trees of very limited Merit or such impaired condition that They do not qualify in higher categories	Trees present in groups or woodlands, but Without this conferring on them Significantly greater collective landscape value; and/ or trees offering low or only temporary/transient landscape benefits	Trees with no material Conservation or other Cultural value

8.8. Direct Runoff Volume Calculation

1. MGBH Sub-Watershed data:
    a. size = 9 squares = 9 Ha = 9 x 2.471 = 22 acres
    b. slope = 12% = 7°
    c. HSG = C (sandy clay or loam; with mix of brush, grass with good fair ground cover)
    d. Hydrologic length = 600 m = 1500 feet
    e. developed area = 1.22 ac
    f. post development hard surfaces = 75% of 1.22 acres
2. Time of Concentration (T_c)

mixed sheet & conc runoff		C	L (ft)	(%)	(min)
FAA Method	1.80	0.28	1,500	12	**4.76**
Kirpich	0.0078	1	1500	0.12	**4.92**

3. Direct Runoff Volumes (Pre-Development)

RP[b] *(yrs)*	P[c] (in)	curve # (CN_{pd})[a]	NUM	DENOM	Q[d] (in)	WS[e] (ac.)	Vol (ac-ft)	Vol (MG)
10	8.30	74	57.7	11.1	5.19	22	9.52	3.10
25	11.00	74	106.0	13.8	7.68	22	14.08	4.59
50	13.40	74	161.2	16.2	9.95	22	18.23	5.94

[a]Curve # (pre-development); [b]Return Period; [c]Precipitation; [d]Direct Runoff; [e]Watershed

4. Direct Runoff Volumes (Post-Development)

RP[b] *(yrs)*	P[c] (in)	curve # (CN_w)[f]	NUM	DENOM	Q[d] (in)	WS[e] (ac.)	Vol (ac-ft)	Vol (MG)
10	8.30	75	58.3	11.0	5.31	22	9.74	3.17
25	11.00	75	106.8	13.7	7.81	22	14.32	4.67
50	13.40	75	162.1	16.1	10.09	22	18.50	6.03

5. Post - Pre-development Volumes

RP	pre dev Q_{po}	post dev Q_{pre}	Q $Q_{po} - Q_{pre}$	Q $Q_{po} - Q_{pre}$	Runoff Volume $(Q_{po} - Q_{pre})/Q_{po}$
(yrs)	(MG)	(MG)	(MG)	gallons	(%)
10	3.10	3.17	0.071	70,904	2.28
25	4.59	4.67	0.081	81,191	1.77
50	5.94	6.03	0.088	87,790	1.48

8.9. Peak Runoff Flow Calculation

1. Peak Flow Rate
    a. Pre-Development

RP *(yrs)*	C[g]	i[h] (in/hr)	WS (ac)	q_p i (cfs)	q_p (gpm)
10	0.24	7.28	22	**38.44**	**17,220**
25	0.32	8.41	22	**59.21**	**26,524**
50	0.32	9.26	22	**65.19**	**29,205**

[g]Runoff coefficient; [i]rainfall intensity; [i]peak flow

b. Post Development

RP *(yrs)*	C_{pd}[1]	C_{hs}[2]	C_w[3]	i in/hr	hs[4] ac	ns[5] ac	[6] ac	q_p[7] (cfs)	q_p (gpm)
10	0.240	0.95	0.277	7.28	1.15	20.85	22	**44.37**	**19,876**
25	0.320	0.95	0.353	8.41	1.15	20.85	22	**65.28**	**29,247**
50	0.320	0.95	0.353	9.26	1.15	20.85	22	**71.88**	**32,203**

[1]runoff coeff (pre-development); [2]runoff coeff (hard surfaces); [3]weighted runoff coeff; [4]hard surfaces; [5] (natural - hard) surfaces; [6]watershed area; [7]peak flow

8.10. Consultants Engaged

1. Miguelle Christopher - Socio-Economics Specialist
2. Everette Williams - Biodiversity Specialist
3. Walter Christopher - Natural Resource Engineer
4. Gerald Fernandez - Water Engineer