APPENDIX 1

TERMS OF REFERENCE FOR THE EIA

NATIONAL ENVIRONMENT & PLANNING AGENCY

PERMIT APPLICATION: 2012-05017-EP00136

TERMS OF REFERENCE

ENVIRONMENTAL IMPACT ASSESSMENT

FOR A PROPOSED RESIDENTIAL SUB-DIVISION AT LAND PARCEL (VOLUME 646 FOLIO 40), GREENCASTLE ESTATE, ROBINS BAY, ST MARY, JAMAICA

October 17th, 2012

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TERMS OF REFERENCE

FOR THE ENVIRONMENTAL IMPACT ASSESSMENT
FOR A PROPOSED RESIDENTIAL SUB-DIVISION AT LAND PARCEL (VOLUME 646 FOLIO 40), GREENCASTLE ESTATE, ROBINS BAY, ST MARY, JAMAICA

1 INTRODUCTION

1.1. These Terms of Reference (TORs) are submitted as the scope of work for an Environmental Impact Assessment (EIA), which the applicant is required to submit in support of his application for an Environmental Permit in accordance with the requirements of the National Environment and Planning Agency (NEPA). The Natural Resources Conservation Authority Act Permit and Licenses Regulations (1996) specify that sub-divisions of 10 lots and over require an environmental permit.

1.2. Greencastle Estate LLC (GCE) is seeking permission to sub-divide a 77.46 ha (191.41 acre) parcel of the Greencastle Estate, which comprise in total 1600 acres. Although the owners of Green Castle Estate have created a preliminary Master Plan which seeks to outline long-term development of the entire property, detailed planning of the aspects other than the sub-division is not yet sufficiently advanced as to facilitate the requirements of the permitting and approvals process. Consequently, permission is only being sought at this time for the proposed residential sub-division.

1.3. The proposed site is located within the Town and Country Planning (St Mary Coast) Confirmed Development Order (1963), which guides land use development within 1 mile of the shoreline. Under the Development Order, the sub-division is not zoned for any particular land use. Under the National Physical Development Plan (1970-1990) the area was zoned for agricultural use.

1.4. Further to a site investigation, the Rural Physical Planning Division (RPPD) has indicated in writing that "*taking into consideration the soil type, topography, and suitability for agriculture, the RPPD has no objection to change of use for the Green Caste Estate as proposed*". Being within 1 mile of the coast on lands with low agricultural potential, the sub-division site lies within a belt considered to be prime real estate for tourism and residential development, and would yield the highest return on investment if development in this manner.

1.5. The firm of Environmental Management Consultants (Caribbean) Ltd has been contracted to prepare the Environmental Impact Assessment, and liaise with the National Environment and Planning Agency on behalf of the applicant.

Figure 1 Location of Greencastle Subdivision

2 PROJECT OVERVIEW

Site Planning

2.1. The proposed residential development seeks takes advantage of the salubrious sea-side climate of the estate, as well as the spectacular views of the sea, surrounding landscape and the Blue Mountains.

2.2. Not more than 171 lots shall be developed, and these lots shall be not smaller than 1,193 m2 (12,265 sf), with an average size of 1,573 m2 (16,175 sf). All lots shall be properly surveyed and titles provided. The percentage of open space in the overall sub-division is ~50%. This works to ~23 ha of open space per 100 lots, which far exceeds the requirement of 1 ha per 100 lots.

2.3. Estimated maximum population at full build-out: 1026 (6 persons x 171 lots)

2.4. Lots occur on lands with slopes < 25 degrees. No grading of lots is planned or required.

2.5. Recreation: Lot B2 (0.4 ha or 1 acre) located in Phase 2 has been allocated as a community park/playfield. In additional all the riparian reserves can be considered parks, and will have maintained walking/jogging/biking trails. Lot B4 in Phase 2A (5.7 ha) has been allocated for the Estate Country Club and Spa (recreational land use).

2.6. Commerce and Management: Lot B3 (0.7 ha) in Phase 2A and Lot B1 in Phase 1A has been allocated for commercial development, inclusive of estate management and farm shops. In addition, various commercial establishments including restaurants are already available in the community of Robins Bay.

Utilities and Infrastructure

2.7. **Site access** roads: 4.3 km of new pavements, generally following existing farm roads. Interior sub-division road right of ways are 9.1 m wide, and main roadways have a 15.2 m reserve width at the entrances to the sub-division only. The main entrance shall be properly planned in collaboration with the National Works Agency (NWA), with due consideration for road crossings, culverts etc.

2.8. Estimated **water** demand at full build-out: 111,160 US GPD.

2.9. Estimated energy demand is 850 KW per year at full build-out (with a load of 10 KVA per lot).

2.10. Sewage treatment: individual lot disposal solutions (septic tank and reed/evapo-transpiration bed).

2.11. Stormwater disposal system consists of the following elements:

a. Maintain the existing natural gully system.
b. Transmit storm water from lots to gullies via roadways, culverts, spill-ways, and u-drains.

c. Intercept and settle the sediment load of first flush storm water discharges from the gullies with two detention ponds that overflow via culverts to the sea (robin's bay).
d. Create on-lot soak-away pits for lots on the northern boundary.

Amenities and Services

2.12. Fire-safety: Appropriate placement of fire-hydrants and design of cul-de-sac have been taken into account in the layout of the sub-division. In addition, fire-water storage and pressure have also assured in the water supply plan. The nearest municipal fire station is located at Annotto Bay ~5.5 km away.

2.13. Security: During construction, security will be provided by the developer to safe-guard construction materials. During the operational phase, the Owners Association will be responsible for security within the sub-division. Police Station at Islington (8.5 km away) has responsibility for this area, so any major incidents shall be reported at this location.

2.14. Health Care: The nearest hospital is located at Annotto Bay. Another smaller one is located at Port Maria. Basic emergency care can be obtained at these locations.

2.15. Disaster Management: Although the site is not flood-prone, it is vulnerable to hurricanes and earthquakes. To the extent possible, sub-division electrical wires will be located below ground to reduce the possibility of wind-damage during a storm. The home-owners agreement will impose construction standards on lot purchasers that take into account the recommended national building standards for hurricane and earthquake safety.

2.16. Maintenance: During the operational phase, the maintenance retained the home-owners association will ensure that storm drains are kept clear of debris at all times. Sub-division maintenance will also be responsible for ensuring that all sub-division roadways are passable as soon as possible after the occurrence of a storm or earthquake event. The home-owner's association will liaise with Parish Council and the Office of Disaster Preparedness to remain updated about emergency shelter information as necessary.

2.17. Solid Waste: Lot owners will be required to designate an area for garbage collection. The developers will discuss routine municipal collection and disposal with the North Eastern Parks and Markets (NEPM). It is estimated that at full build-out the sub-division will generate around 1 metric ton of waste per day[1]. NEPM presently provides collection and disposal services to the community of Robin's Bay.

2.18. Grounds Maintenance: In keeping with sound environmental practice for landscape management the more pristine wooded areas (wetlands, steep slopes and riparian zones) shall be preserved in as natural condition as reasonably practicable. The verges of roadways, centres of roundabouts and cul-de-sacs, and

[1] 6 persons per lot, 171 lots, 1 kg of solid waste per day per person.

other public areas within the sub-division will be planted with ornamental shrubs that require little water, and are acclimatized or indigenous to this area so that routine application of pesticides and fertilizer will not be necessary.

2.19. Trees already present at the site will be preserved as much as possible. Clearing of vegetation and grading has further been minimized by incorporation the existing farm roads in the design of the road layout of the subdivision. Aside from any vegetation clearance or grading necessary for the installation of roadways, curbs and engineered drains, individual lots will not be cleared or graded. Individual lots will be cleared as necessary by lot purchasers.

3 MINIMUM CONTENT OF EIA REPORT

3.1. The following describes the typical scope and content of the EIA report, and is subdivided according to the standard sections of the EIA, as are usually stipulated in the NEPA TOR for such projects.

Task 1: Non-Technical Executive Summary

3.2. This section shall allow for a clear understanding of the project proposal and summarize the main findings of the EIA study.

Task 2: Project Description

3.3. The aim of this task is to provide a comprehensive description of the project, noting areas to be reserved for construction, areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment. This should involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate.

3.4. This section will include at a minimum:

a) Description of the Project Proponent/Applicant. This shall include a profile of the company including its principals and any business alliances of the company.

b) Rationale or justification for the proposed development. This should include a background to the development proposal, including criterion used in selecting this site. Anticipated benefits (positive impacts) of the project should also be described here.

c) Location and setting (relative to other developments, environmental sensitivities and communities).

d) Project overview (main design elements and objectives) and general description (and spatial allotments) of the site plan (lay-out, boundaries and scale) including built areas, burial areas, site infrastructure and landscaping.

e) The proposed schedule for development of the various design components of the project. Phasing and timelines for each aspect of the proposed development

should be disclosed. For projects to be done on a phased basis it is expected that all phases be clearly defined the relevant time schedules provided and phased maps, diagrams and appropriate visual aids be included.

f) Design parameters and site planning:
   - Lotting Plan: lot sizes, numbers, phasing and layout,
   - Infrastructure: drainage, access roadways, sewage disposal options, water and power distribution, solid waste collection.
   - Utilities: estimated demand and provisions/sources to meet these estimated demands (phased and at full-build out) for potable water, electricity, and solid waste disposal shall be detailed.
   - Amenities and Services: fencing/lighting, security, landscaping/recreational land use, community areas.

g) Impact-causing aspects of activities conducted during both expected and upset conditions should be evaluated in terms of estimated resource consumption and waste streams, for all phases of the project (construction, operational/maintenance). This should involve the use of maps at appropriate scales, site plans, aerial photographs and other graphic aids and images, as appropriate.

h) Construction management:
   - site of any construction camps,
   - sources of labour and construction materials,
   - health, safety and security,
   - management of noise, dust, stockpiles, traffic, visual intrusion, site run-offs, sewage, construction waste;
   - equipment usage,
   - emergency planning etc.

i) Operational phase management. This will outline provisions for:
   - Restrictions and standards for lot-buyers.
   - Ownership of open space within the boundaries of the sub-division.
   - Maintenance of sub-division infrastructure and community services.

Task 3: Analysis of Alternatives

3.5. The purpose of this section of the EIA is to examine feasible alternatives to the project. The following land use options will be rigorously evaluated: tree crops, pasture land, residential, eco-tourism. This shall include an examination of the environmental, social and economic costs of (a) leaving the land as is (*status quo*), versus (b) the proposed option. Feasible land use options are compared below in terms of potential benefits and costs, using a range of factors or normative criteria.

3.6. This section should highlight the benefits of and general rationale for the project that need to be considered against any potential environmental cost. It should

outline in balanced way, the wider societal benefits of the development proposal that could arise if the environmental permit is granted.

Task 4: Legal and Institutional Framework

3.7. The objective of this task is to provide an outline the relevant environmental regulations, policies and standards governing. This shall include a regulatory controls and institutional frameworks with jurisdiction over the following main areas as they relate specifically to this site and project.

a) Development and Land Use Control:

- Permitting: environmental permits, planning permissions and other operational permits.
- Construction (including building codes and site management controls) and subsidiary inputs
- Traditional land use and prescriptive rights including public access etc.
- Public safety and vulnerability to natural disasters
- Physical planning controls (Water Resources Master Plan, National Physical Plan, plans for road and infrastructural development and other planned development projects for the area).

b) Environmental Conservation:

- Forestry, wildlife and biodiversity.
- Water resources (surface and ground water).
- Heritage and cultural resources.

c) Waste Management:

- Air quality
- Noise levels
- Public health and sewage
- Solid waste and landfill management
- Storm water.

3.8. The examination of the legislation should include at minimum, legislation such as the NRCA Act, the Public Health Act, Parish Councils Building Act and the appropriate international convention/protocol/treaty where applicable. In all cases the roles of agencies with responsibility for implementing legal mechanisms will be described. Where Jamaican standards or policies are insufficient, international standards and policies will be outlined.

3.9. This section should summarize (thematically) the key regulatory controls on the project (including environmental quality criteria, physical planning restrictions, building codes etc.). The degree of compliance with these controls (general acceptability) is a key criterion used in determining of the relative significance of environmental impacts.

Task 5 Description of the Environment (Baseline)

3.10. The EIA must include an overall evaluation of the existing environmental conditions, values and functions of the proposed development area. The purpose of this section is to describe sensitive environmental receptors in terms of pre-project status and trends (if the project is not implemented). This therefore provides a baseline against which future monitoring data can be compared to determine whether and how a project is actually impacting specific receptors.

3.11. It also allows for evaluation of contributions to environmental degradation from other sources (or cumulative impacts), and the carrying capacity of the environment in respect of specific stresses. The most basic use of the data is terms objectively determining the effect level of impacts, using a classification system.

3.12. Based on the preliminary environmental scoping, the following parameters should be included in the description of the environmental baseline, as they are considered to be valued environmental receptors that could potentially be impacted by implementation of the project.

Physical Environment

3.13. The following key parameters shall be described:

a) Climatic conditions shall include rainfall, temperature, humidity and wind. These shall be described using available data sets.

b) Views, ambient noise, air quality and artificial lighting. Existing sources of pollution shall be described.

c) Topography and landforms shall be described based on land surveys of the area and existing topographic maps and aerial photographs/satellite imagery. Drainage and controls on such shall be characterized. The slope assessment map shall be compared with the Mines and Geology Guidance classes for hillside development. An overlay of the lotting plan shall be included with this map. This map shall be further analyzed to review the locations and sizes of lots within the sub-division.

d) Geology and soils shall be described from existing geological maps and field observations identifying major lithologies underlying the site. Any faults or structural data that is likely to affect landform development or stability and foundations should be described. The results of a geotechnical survey of the site, indicating bearing capacity shall be described.

e) Hydrology: the catchment / watershed management unit (WRA designated) in which the site falls should be identified. The size of sub-basins, flow patterns and civil infrastructure associated with drainage of the area should be described. Factors affecting infiltration such as ground cover should be described. As the streams only contain water after major rains, at least one set of water samples should be collected after a rainfall event from each of the three major outfalls from the site. Permeability shall also be described.

f) Water quality: surface water samples shall be tested for BOD (Biological Oxygen Demand), Faecal Coliform, Nitrate, FOG (Fats, Oil and Grease), Phosphate, pH and TSS (Total Suspended Solids) using standard methods.

g) Natural hazards: the following shall be described relative to the site's vulnerability: earthquakes, hurricanes, flooding, and landslides.

Biological Baseline

3.14. The EIA shall include data from flora and fauna surveys of the area, detailed qualitative and quantitative assessment, including inventory (list) and distribution (map) of species. It shall also include:

a) Descriptions of habitats and communities indicating ecological health and functions, threats and conservation significance. Species inter-dependence, habitats/niche specificity and community structure and diversity must also be considered.

b) The field data collected shall include, but is not limited to:

- Vegetation: map of general cover types, species lists generated from transect surveys.
- Terrestrial Fauna (birds, bats, insects etc.): primary surveys shall be undertaken.
- Marine benthic ecology. Due to the proximity of the site and outfalls to Robins Bay, a rapid benthic assessment shall be undertaken to describe the species present, presence of macro-algae and other organisms. The health of seagrass meadows and corals, and associated fauna should be discussed. In addition, marine water quality shall also be assessed, with samples tested for Biological Oxygen Demand (BOD), bacterial load, nutrient load, fats oils and grease (FOG), and pH.

c) A review of available literature on seasonal variations in species distributions (including migratory species known to range in this bioregion) or assemblages, which should complement the field survey.

Socio-Economic Baseline

3.15. The following parameters shall be described using available census data for the parish as well as information gathered as part of a primary survey of at least 8% of all householders living in proximity to the proposed development:

a) Demographics. Available census data for the parish shall be reviewed.

b) Housing and land tenure. Relevant data for the parish shall be reviewed.

c) Economic activities, traditional use of site resources and land use at the site and surrounding region.

3.16. In addition, descriptions of the following shall be included:

a) The capacity of municipal services-providers to meet the needs of the development shall be detailed, according to the planned phasing and at full build-out:
    - potable water,
    - electricity,
    - telecommunications,
    - emergency services (police, fire, health),
    - education,
    - solid waste collection,
    - social/recreational facilities.

b) Heritage and archaeological resources likely to occur at the site or surrounding areas.

c) A Traffic Assessment Report shall be included in this section. This shall use data from a 2-day survey of traffic flows during of peak hours.

Task 6: Summary of the Stakeholder Consultation Process

3.17. Aside from the Environmental regulatory Agency (NEPA/NRCA), the following stakeholders shall also be apprised of the proposed development, and should be included in the EIA consultative process:

a) Relevant government agencies:
    - Water Resources Authority (WRA)
    - St Mary Parish Council
    - Rural Physical Planning Unit
    - National Works Agency (NWA)
    - National Water Commission
    - Office of Disaster Preparedness and Emergency Management (ODPEM)
    - Environmental Health Unit (EHU), Ministry of Health
    - Jamaica National Heritage Trust (JNHT)

b) Non-Governmental Organizations and community based organizations with an interest in the area.

c) Occupiers/Owners of adjacent lands:

d) Neighbouring communities.

3.18. The degree of public concern with specific issues (and general acceptability of the impact given proposed mitigation) is a key criterion used in determining of the relative significance of environmental impacts. The EIA process will only be considered valid if there are meaningful and valid opportunities for public scrutiny of the environmental effects of the project as proposed, including:

a) During the course of preparation of the EIA Report, direct written communication from the EIA preparer to relevant public agencies, NGOs and adjacent land

owners/occupiers advising them of the project, and seeking their concerns about it as they relate to potential environmental impacts.

b) Survey of the communities (Perception Survey) within proximity to the site to determine community organization, values and environmental awareness, and attitudes to a housing sub-division in this area.

c) Public Meeting held three weeks after the EIA is made available for review in accordance with the Guidelines for Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). This meeting should include presentations outlining the development proposal, environmental impacts, and proposed mitigations.

d) Availability of all EIA documents for public review, inclusive of: (1) these Terms of Reference (2) the EIA inclusive of all supporting technical appendices (3) the Public Meeting Report (containing presentations, summary, verbatim report of question and answer session and the register of attendance) and (4) Addendum Report (i.e. written response to EIA review comments).

3.19. The EIA shall contain section titled "Summary of the Stakeholder Consultation Process, which should summarize the key environmental concerns arising during the stakeholder consultations done prior to submission of the EIA. At a minimum, this section should:

a) Document the public participation programme for the project.

b) Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups. Append survey instruments used to collect information.

c) Summarize the issues identified during the public participation process.

d) Discuss public input that has been incorporated into the proposed project design, the EIA; and environmental management systems. Concerns that were raised by the public but not considered in the EIA must be justified.

Task 7 Assessment of Adverse Environmental Impacts

3.20. The impact of the development on the specific sensitivities of the area should be comprehensively evaluated. The purpose of this is (1) to identify the major environmental and public health issues of concern and (2) to indicate their relative importance to the design of the project and the intended activities, taking full consideration of the effectiveness and acceptability of any proposed mitigation measures in the protected area context.

3.21. Negative project impacts shall be identified using the following methods:

a) Stakeholder consultation.

b) Technical inputs from environmental specialists on the EIA team.

c) Review of the possible impact-causing aspects of the project.

d) Review of impact assessments done for similar projects.

e) Regulatory criteria governing aspects of the environment likely to be impacted.

f) The sensitivity of valued environmental components (VECs) likely to be impacted.

g) Review of the risks arising from the project and the range of environmental consequences that could arise under upset conditions.

3.22. Each identified adverse impact will be classified by Effect Level (no impact, minor, moderate or major) after feasible mitigation is considered (i.e. residual impact). Each identified impact is analyzed using a standard set of impact evaluation criteria. These criteria fall into three broad groups of environmental metrics (magnitude, vulnerability and manageability), which together give a more comprehensive picture of the character of the impact.

a) Magnitude Indicators: secondary/Indirect effects; spatial extent; environmental persistence; affected numbers and baseline change

b) Vulnerability Indicators: resilience; reversibility

c) Manageability and Validation Indicators: mitigation potential; uncertainty; acceptability

3.23. Following assessment, impacts shall be classified as either having no impact, or being minor, moderate or significant. Impacts shall be classified as minor or negligible if the change to baseline is not measurable or is less than normal fluctuations within the system. In many cases, where the change to baseline is very small, the effects are likely to be cumulative, and shall be assessed as such. If the change to baseline is measurable, the impact shall be classified as moderate or major.

3.24. A major adverse impact is defined as one where:

a) The geographic extent and persistence is

- Is widespread (effects extend beyond the project boundaries) and persistent after 2 years or impacts on a biological population continue to occur over a number of recruitment cycles after the cause has ceased.
- Associated with numerous indirect negative effects, with more than one generation and several trophic levels involved.
- Affects a large number of individuals or large proportion of the exposed community.

b) Receptors are vulnerable and the impact:

- Occurs within designated protected area or the habitat of protected species, and these receptors are unable to cope with the change resulting in mortality.
- Permanently damages habitat quality or creates ecological barriers.
- Contributes to the endangerment of threatened or protected species or reduces the stock of commercially important species.
- Occurs at the peak time when receptor is vulnerable.
- Results in a loss of revenue or amenity which is sustained after remedial action is taken or threatens cultural or heritage resources.

- Alters community lifestyles or requires long-term adjustments of local people in respect of traditional values and resource use.
- Represents a long-term nuisance or significant safety or health risk to other users.

c) Management of the impact:

- Is not easily or cost-effectively returned to previous state or be re-used for any other productive purpose.
- Is not cost-effectively mitigated or requires major design change to causative activities or no mitigation possible.
- Has little or no opportunity for environmental enhancement or no perceptible environmental benefit of the project.
- Involves public outcry against the impact or cause. Prohibitive legislation, plans or policies or the impact or cause exceeds legal thresholds, limits or criteria or maximum allowable levels.

3.25. Cumulative impacts are caused by (a) activities unrelated to the proposal being evaluated but are likely to occur at the same time that the project activities are occurring and (b) several activities associated with the implementation of the project as proposed. External activities form part of the baseline condition, and are taken into account in the examination of the baseline, as well as divergence from the baseline that might be expected to arise from project implementation. In this way the impact of the project on the surrounding area especially as it relates to the cumulative impacts of this project with any existing developments will be included. In respect of internal aggregations of impacts on specific VECs that may individually be assessed as having a "minor" effect, but that may collectively have a significant combined effect, the resultant cumulative effects are evaluated collectively where multiple project activities contribute to the same effect (however, these should be treated separately when the activities are spatially separated).

3.26. This section must conclude with the preparer's statement on whether, based on the various investigations and assessments of the project done as part of the EIA process, there is a Finding of No Negative Significant Impacts (FONSI). If the study finds that the project has the potential to result in significant negative environmental impacts that cannot be cost effectively mitigated, and which require project modification (in terms of design, site, technology use or scale/footprint), this must be clearly disclosed.

Environmental Sensitivities (Adverse Impacts)

3.27. The following table lists major environmental concerns that have been identified at this time for further evaluation. Other impacts that are identified during the course of scientific investigation or stakeholder consultation must also be assessed in the EIA.

3.28. Construction Phase impacts include the following.

	Activity	Impacts	Response
1	Land clearance for roads or other infrastructure or views.	Loss of trees; biomass; habitats Fugitive dust Soil erosion Visual disamenity	Phased vegetation clearance. Re-vegetated, re-cover or pave areas as soon as possible after final grade is achieved. Complete avoidance of riparian areas in accordance with the recommendations of the environmental consultants.
2	Change in land use from abandoned agricultural lands to housing	Loss of green space	Green design and planning approach. Low density use (~2 lots per ha). Stipulation in lot-owners agreements that built areas on each lot do not exceed a third of net area.
3	Haulage	Nuisances from haulage vehicles: dust, traffic, noise. Wear and tear on roadways Road safety particularly at access point to main road	Operate on well-defined roads (planned access). Use stabilized construction exits. Operate during off-peak day-time hours only. Spread axel loads. Ensure all haulage contractors maintain clean and well-serviced equipment.
4	Consumption of aggregate for roads and civil structures	Off-site quarry and transportation corridor impacts.	Contractor performance agreements and bonds.
5	Earthworks for storm water retention ponds, roadways, drainage and buried pipes/conduits	Possible effects on hill-slope stability Sediment loads to water bodies Archaeological discovery	Proper design and safe gradients. Sediment control Contact JNHT for assessment.
6	Overall carbon footprint (fuel, transported goods etc)		Ensure efficiency Utilize locally manufactured items Minimize use of concrete and steel products. Use sustainably produced timber products.
7	Equipment use	Noise	Limit construction activities to day time hours during week.
8	Material stockpiling	Visual aesthetic Sediment loads	Stock-pile management plan required of contractors. Must be located away from waterways, and covered or bunded.
9	Consumption of construction water	Sediment load in water bodies.	Control use of water, and outflows from wet areas, wash-downs.
10	Solid waste generation	Visual aesthetics; landfill; pests	Routine collection and disposal plan.
11	Sewage from construction camps	Possible water and soil contamination (bacterial and nutrient loads) Odors and unsightly conditions. Health issues.	Use of portable lavatories with temporary holding tanks.

12	Landscaping	Change in species assembly; soil, water, fertilizer and pesticide demands.	Maintain existing vegetation to the extent practicable. Use locally adapted species (2.11) Minimize use of fertilizer and pesticides, particularly near waterways and roadways.

3.29. Operational Phase impacts include the following.

	Activity	**Impacts**	**Response**
1	Individual lot development activities: Clearance, grading, haulage, construction, demand for aggregate, cement etc., equipment use	Nuisances to other home-owners: dust, visual aesthetics, traffic, noise Possible increased soil erosion and slope instability on individual lots.	Controlled by Development Standards (Lot Owner Agreements). The EIA shall make recommendations for individual lot developers to implement in respect of management of construction nuisances and sediment control measures. Lots that may be prone to land slippage shall be identified in the EIA, and appropriate mitigation measures indicated.
2	Pavements and housing; installation of drainage works; modification of slopes.	Impacts on surface hydrology on: • the marine area and beach, • adjacent flood-prone areas, • the main road, • structural integrity of the existing civil structures • Changes in drainage and flood patterns.	Engineered storm water disposal plan. Appropriately scaled engineered design options to address any potential adverse impacts of increased run-offs.
3	Introduction of pet and pest species	Spread of disease vectors Negative effects on natural eco-systems.	Homeowners will be required to ensure that there is no standing water in gardens to harbor mosquito larvae. Solid waste shall be stored in closed receptacles not accessible to dogs or cats.
4	Creation of ecological niches (e.g. gables in roofs for owls or bats etc.)	These species can become nuisances that may cause homeowners to exterminate or destroy nests.	Ensure roofs or outdoor structures are not accessible to wild-life (fence)
5	Landscaping	Change in species assembly in affected areas Introduction of lawn grass (single species) Noise from lawn mowers Loss of trees	Home-owners will be given a list of major species for landscaping; these should be made available through local suppliers. Trees should be retained to the extent practicable. Use of lawn mowers should be limited to specific days and times.

	Activity	Impacts	Response
6	Hiking, biking, jogging trail use	Possible degradation of natural preserves from collection or trampling etc. Noise introduction to quiet areas. Possible accidental fire	Home-owners will be discouraged from getting off the established trails. There are no plans for designated picnic areas etc. within the retained green areas. Discourage collection of plants from the wild.
7	Physical presence of built lineations - fencing, walls, hedge rows, roadways, drains	Ecological barriers Visual intrusion	Use of fences will be discouraged. Boundary fencing should not be higher than 5 feet.
8	Night-time lighting	Light pollution	Off-set by benefit of security and visual separation from coastal area. Limited street lighting.
9	Demand for potable water	Increased demand on limited municipal resources (carrying capacity).	Facilitation of on-site water production (rainwater harvesting, dams, and possible production) and storage. Phase 1a not likely to reach maximum demand before NWC water supplies are upgraded (2015).
10	Overall carbon footprint (fuel, steel and concrete use, transported goods etc)	Climate change	Design of buildings for natural ventilation. Encourage use of local materials. Other opportunities for off-setting the carbon footprint.
11	Water pollutants	"First flush" impact on coastal water from residential area - particulates with oil and grease/hydrocarbons, nutrients, floatables etc)	Detention/settling ponds engineered to accommodate and settle the first flush for the 25-year event.
12	Solid waste generation	Visual aesthetics; landfill& municipal services (carrying capacity); Pest and disease vectors	Routine collection and disposal plan.
13	Sewage generation	Possible water and soil contamination (bacterial and nutrient loads) Odors and unsightly conditions. Health issues.	Use of tertiary treatment solutions such as septic tanks and tile-fields.
14	Increased population	Increased potential losses from earthquakes and hurricanes Disruption in critical services (power, water, communications). Localized flooding or fire hazard. Increased demand for domestic labour. Negative social effects (sense of foreigners coming into community,	Buildings designed and built to code. Below ground conduits Maintenance of drains and culverts Negative social effects off-set by positive aspects: creation of jobs (construction, tourism/entertainment, gardeners, helpers) and retail services (commercial goods etc)

	Activity	Impacts	Response
		crime etc). Consumption relative to carrying capacity for municipal services (e.g. fire, police, health, education etc) and other social amenities (e.g. recreational resources etc).	
15	Traffic access	Possible impact on access to the main road	Determination of additional road safety measures that may be required at access points.

Flood Impact Assessment

3.30. The EIA shall specifically include a Flood Impact Assessment (see 3.29, item 2) which makes reference to the relevant engineering design report and plans (which should form an EIA appendix). At a minimum, this should include:

a) An estimate of pre- and post-development storm water run-offs.

b) Historic flood events in this area (based on literature).

c) Review of capacity of the existing drainage infrastructure (internal and in Robins Bay proper) to handle the runoff generated.

d) Potential impacts on the marine area, beach, any adjacent flood-prone areas, the main road, the structural integrity of the existing civil structures and drainage/flood patterns.

e) Details on proposed impact mitigation, including:

- Mitigation of flooding on main road
- Protection or improvement of the existing storm water system.
- On-site infiltration of storm water on the site (each) lot and not simply and indication of the drainage pathways from the site

3.31. This section should demonstrate how the findings of the flood assessment have been used to guide the design of civil structures and site planning in general.

Task 8 Environmental Management Plan

3.32. The Environmental Management Plan (EMP) outlines the following:

a) Environmental performance/quality objectives based on the specific impacts.

b) Summary of proposed mitigation measures, identifying the best timing for implementation, responsibilities and any required commitments of resources.

c) General guidelines to improve the project's overall environmental performance (e.g., in respect of waste management, water and energy conservation, soil conservation, community development, etc.) and to enhance any opportunities for environmental conservation.

d) General guidelines for dealing with the effects of climate change shall also be included, in connection to the following main areas: sea level rise, increased temperatures and humidity, increased occurrence of cyclones and increased potential for drought.

e) An evacuation plan shall also be included in the EIA.

f) Requirements for post-permit plans and approvals.

g) Outline monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit and/or license(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

Other Information

3.33. The EIA shall also include the following information:

a) A comprehensive list of references.

b) The report should include appendices with items such as the approved TOR; raw data; survey instruments, and other relevant information.

c) A list of EIA preparers and their credentials must be included. It is expected that EIA team shall include qualified persons with expertise and experience in hydrogeology-geology, geomorphology, hydrology, environmental impact assessment and environmental engineering.

d) Glossary of technical terms

****

APPENDIX 2

LETTER OF NO OBJECTION FOR PROPOSED LAND USE FROM RPPD

Ministry of Agriculture & Fisheries
Rural Physical Planning Division

191 Old Hope Road
Kingston 6
Jamaica

TELE: (876) 977-0322/927-0441
FAX: (876) 977-0326
EMAIL: rppd@cwjamaica.com

FACSIMILE TRANSMISSION FORM

To: Implementation Ltd

Attention: Mr. John Marcocchio

From: Mrs. Joan Brown Morrison

Fax No: 795-2273 Total No. of pages including cover page: 3

PhoneNo: Date: June 4, 2012

Re: Proposed Sub-division Part of Newry St. Mary Volume #335 Folio #1

◊ Urgent ◊ For Review ◊ Please Comment ◊ Please Reply ◊ Please Recycle

♣Comments Please see the attachment

MINISTRY OF AGRICULTURE & FISHERIES
RURAL PHYSICAL PLANNING DIVISION
HOPE GARDENS,
KINGSTON 6
TELEPHONE: (876) 927-0441/977-0233
FAX: (876) 977-0326
Email: rppd@moa.gov.jm

June 1, 2012

Please Quote
Reference No.

Mr. Gregory Bennett
Manager - Development Assistance Centre
National Environment and Planning Agency
10 & 11 Caledonia Avenue
Kingston 5

Dear Mr. Bennett:

Re: Proposed Land Use Change: Green Castle Estate, Robins Bay – St. Mary Vol 646 Folio 49

Reference is made to your letter dated April 26, 2012 on the captioned subject.

A team from the Rural Physical Planning Division (RPPD) conducted an inspection of the property and environs to determine agricultural suitability, development trends and constraints.

Taking into consideration soil type, topography and suitability for agriculture, the RPPD has no objection to change of use for the Green Castle Estate as proposed.

Sincerely,

Joan Brown Morrison
Director (Acting)

Copy to: John Marcocchio – MES, PMP
Implementation Ltd.
Development Consultants, Project & Construction Managers

MINISTRY OF AGRICULTURE & FISHERIES
RURAL PHYSICAL PLANNING DIVISION
HOPE GARDENS,
KINGSTON 6
TELEPHONE: (876) 927-0441/977-0233
FAX: (876) 977-0326
Email: rppd@moa.gov.jm

May 4, 2012

The Chief Executive Officer
National Environment and Planning Agency
10 Caledonia Avenue
Kingston

Attention: Mr. Roland Thompson

Dear Sir,

Re: Proposed Sub-division Part of Newry St. Mary Volume #335 Folio #1

Your letter dated May 11, 2012 on the above captioned. A team from The RPPD conducted site inspection to determine suitability for agriculture.

The property consists of 246.66 hectares to be divided into 2 lots for mixed use. Soil Types include Bellfield Clay #41, Salt Bay Gravelly Clay Loam #42, High Gate Clay #43 and Water Valley Silty Clay #21.

Taking into consideration soil type, topography and suitability for agriculture, the RPPD has no objection to the proposed sub-division of the property as proposed. We also recommend that there be no further sub-division of this property.

Yours sincerely,

Joan Brown-Morrison (Mrs.)
Director (Acting)

Copy to: John Marcocchio – MES, PMP
Implementation Ltd
Development Consultants, Project & Construction Managers

APPENDIX 3

STORMWATER MANAGEMENT SYSTEM ENGINEERING DESIGN REPORT

GREEN CASTLE ESTATES LLC

PROPOSED RESIDENTIAL SUBDIVISION GREEN CASTLE ESTATE, PHASES 1 & 2, ROBINS BAY, ST. MARY

ENGINEERING REPORT

ON

STORMWATER MANAGEMENT SYSTEM

Prepared by:

NOWAL N.O.WHYTE & ASSOCIATES LTD.

CONSULTING ENGINEERS | PROJECT MANAGERS

Suite #19 Montego Freeport Shopping Centre
Montego Bay, P.O. Box 1453 | Jamaica, W.I.
Tel: (876) 684-9545-7 | Fax: (876) 684-9548
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Unit 5, Seymour Park, 2 Seymour Avenue
Kingston 6 | Jamaica, W.I.
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Web: www.nowhyteassociates.com

March 2012

Stormwater Management System Engineering Design Report

For

GREEN CASTLE ESTATE LLC

Proposed Residential Subdivision Green Castle Estate, PHASES 1 & 2,

ROBINS BAY, St. Mary

Table of Contents

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2.0 Background..... 1

3.0 Hydrology..... 2 - 3

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5.0 Hydraulic design of drainage structures ..... 4 - 5

6.0 Findings..... 5

7.0 Design Summary and Recommendations..... 6

Appendices:

Appendix A: Hydrologic Analyses

Appendix B: Hydraulic Analysis of Culverts and Open Drains

STORMWATER MANAGEMENT SYSTEM ENGINEERING DESIGN REPORT FOR GREEN CASTLE ESTATE LLC

PROPOSED RESIDENTIAL SUBDIVISION, GREEN CASTLE ESTATE- PHASES 1 & 2, ROBINS BAY, ST. MARY

1.0 Introduction

N.O. Whyte & Associates Ltd. (NOWAL) was contracted by Green Castle Estates LLC to prepare designs and obtain the relevant statutory approvals for the Proposed Residential Subdivision Green Castle Estate- Phases 1 & 2 in Robins Bay, St. Mary. As part of NOWAL's services a storm-water management system is to be designed in keeping with the requirements of the National Work Agency (NWA) and the Water Resources Authority (WRA).

The Proposed Residential Subdivision Green Castle Estate – Phase 1 & 2 will consist of 171 residential lots. The proposed site has an area of approximately 100 acres and will be a major housing development in St. Mary. The proposed site is bounded to the north and south by gullies, to the east by Robins Bay main road and to the west by Tower Road, a parochial roadway. The proposed site is an existing forested land to be developed into a residential subdivision.

This report sets out the background, design procedures and computations for the stormwater management system.

2.0 Background

There is a gully in the middle of the proposed site (gully #2). The gully flows in a west to east direction and collects approximately 80 percent of the rainfall runoff from the proposed subdivision. The other 20 percent of the rainfall runoff is collected by two other gullies (gully # 1 & 3) along the northern and southern boundaries of the development (**Figure 2A**). The three gullies at the proposed site flow under the Robins Bay main road to the Caribbean Sea through existing culverts. The residential lots in the development are at high elevations and are not affected by flood waters in the gullies.

3.0 Hydrology

Rainfall runoff from the residential lots sheet flow onto the proposed roads, and is then channelized by kerbs and channels to low points in the roadways. Here, the storm water is collected by spillways and u-drains or spillway and culvert that discharge into nearby gullies. Where required, culvert-pipes and catch basins are used along the roadway to limit the run of the storm water on the road surface. The storm water then flows into detention ponds and finally into the Caribbean Sea via culverts below Robins Bay main road (**Figure 1A**).

The three gullies at the proposed site collect rainfall runoff from three separate drainage areas (**Figure 2A**). A comparison of the pre and post development storm-water runoff, reveal that there will be a marginal increase in the storm-water from the development as the site is relatively small compared to the drainage area of the three (3) gullies.

Storm water flows from the drainage areas for the pre and post development were computed using the Jamaica 2 Method and 24-hour rainfall precipitate from the Annotto Bay Rain Gauge. Curve Numbers 65 and 75 were used for the pre and post development rainfall runoff, respectively. Composite Curve Number 67 was used to calculate the increase rainfall runoff due to the residential development. The Jamaica 2 Method was used because it is suitable for the drainage areas.

The residential develo0pment drainage areas computed peak flows for the 25 year design storm events, which are used to design the main culverts within the development are summarized below:

- Drainage Area C: 25 year design storm event – 0.71 m^3/s
- Drainage Area B + D: 25 year design storm event – 0.26 m^3/s
- Drainage Area N: 25 year design storm event – 0.46 m^3/s
- Drainage Area R: 25 year design storm event – 5.33 m^3/s
- Drainage Area V: 25 year design storm event – 0.62 m^3/s

The residential development drainage areas computed peak flows for the 2 year design storm events, which were used to design the along street drainage are summarized below:

- Drainage Area C: 2 year design storm event – 0.3 m^3/s
- Drainage Area B + D: 2 year design storm event – 0.11m^3/s
- Drainage Area N: 2 year design storm event – 0.2m^3/s

The pre and post development computed peak flows for the 25 year storm event for the two main gullies (Gully # 2 & 3) that collect rainfall runoff from the development are as follows:

Drainage Area	Pre-development flow	Post-development flow
U	1.59 m3/s	1.96 m3/s
R	2.90 m3/s	5.33 m3/s

Excess storm-water from lots along the northern boundary (lots 156-171) will be drained into on-lot soak-away pits. Hence there will be no increase in rainfall runoff from the development to the gully north of the development.

Storm-water from Drainage Area U flows into the main gully south of the development. Storm- water from Drainage Area R flows into the main gully (gully #2) through the middle of the development. The 25-year design storm post development flow from drainage area U and R will be reduced to the pre-development flow before discharging through the existing culverts under the Robins Bay Main Road, using detention ponds. The capacities of the detention ponds are as follows:

- Detention Pond #2 (Drainage Area U) – 1,382 m^3
- Detention Pond #1 (Drainage Area R) – 9,361 m^3

Rainfall runoff computations for the drainage areas are shown in **Appendix A: Table 1A, 2A, 3A & 4A and Detention Pond Designs.**

4.0 Proposed Drainage System

The proposed stormwater management system is shown in **Appendix B**, **Figure 1B** and is summarized as follows:

- Concrete kerb and channel along roads
- Spillways at low points and along proposed roads
- Proposed 600mm diameter pipes culverts with catch basins
- Proposed open concrete u-drains 0.6mW x 0.6mD between lots and at low point along roads
- Proposed 600 mm diameter circular pipe culverts where small gullies cross the proposed roads within the development
- Proposed 600mm diameter pipe culverts and inlets along Hummingbird Drive
- Proposed 600mm diameter pipe culverts and inlets along Hummingbird Close
- Proposed 1.5mW x 1.5mD box culvert where Sandpiper Drive crosses main gully

- Proposed rip rap earth drains at drains outlets
- River training works
- Two proposed detention ponds
- Proposed trash racks at detention pond outlets

5.0 Hydraulic Design of Drainage Structures

The main storm-water drains, concrete box culverts, open concrete u-drains and circular pipe culverts were designed using the Manning's formula and rainfall runoff for the 25-year storm event. The design drains sizes and their capacities are summarized in Table 1 below.

Table 1: Summary of the Design Culverts and U-drains

Drainage Areas	Culvert Size	U-drain Size	Drain Capacity
C	600 mm Diameter	0.6mW x 0.6mD	0.81 m3/s
B + D	600 mm Diameter	0.6mW x 0.6mD	0.67 m3/s
V	600 mm Diameter	0.6mW x 0.6mD	0.67 m3/s
R	1.5m W x 1.5m D	1.5mW x 1.3mD	5.77 m3/s

The culverts and u-drains capacities were obtained from Appendix B & Table 1B

The detention pond outlet culverts were designed using the Hazen Williams Formula and the pre-development flows for the 25-year storm event and are summarized as follows:

- Detention #1: 750mm diameter pipe culvert – Culvert Capacity 2.9 m3/s
- Detention #2: 600mm diameter pipe culvert – Culvert Capacity 1.98 m3/s

The kerbs and channels and collector drains along the roads were designed using the 2 – year design storm event. The collect drains are located so that the required maximum spacing based on road gradient, as noted in the Jamaica Development and Investment Manual, Volume 3 Section 1, are not exceeded.

Hydraulic computations for the proposed drains and Kerb and Channels are shown in **Appendix B: Table 1B, 2B, 3B, 4B, 5B and Figure 2B.**

5.0 Hydraulic Analyses of Existing Drainage Structures Along the Robins Bay Main Road

Robins Bay main road storm-water drains used to discharge rainfall runoff from the development were analyzed using the Manning's formula and the 25-year storm event (Pre-development).

The analyzed drains and their capacities are summarized in Table 2 below.

Table 2: Summary of the Design Culverts and U-drains

Drainage Areas	Culvert Size	Rainfall Runoff	Drain Capacity
R	3# 600 mm Diameter	2.9 m3/s	2.75 m3/s
U	600 mm Diameter	1.59 m3/s	1.51 m3/s

The culverts and u-drains capacities were obtained from Appendix B & Table 8B

The capacities of existing culverts at Robins Bay that are used to discharge storm-water flows from gully #2 and gully #3 are close to the computed rainfall runoff from the gullies. Therefore, the existing culverts below Robins Bay main road have adequate capacities to safely convey and discharge rainfall runoff from gully #2 and 3 for the 25-year design storm event.

Hydraulic computations for Robins Bay main road existing drains and are shown in **Appendix B: Table 6B and Figure 2B.**

6.0 Findings

There are three gullies at the proposed site that collect storm-water from the development. One of the gullies (gully #2) is in the middle of the subdivision and the other two (gully #1 & 3) are along the northern and southern boundaries. The lots within the development are at high elevations and are not threatened by the gullies. The gully in the middle of the subdivision will flow under the Proposed Sandpiper Drive through a proposed 1.5mW x 1.5mD box culvert. The proposed culvert will have adequate capacity for the 25-year design storm event.

Rainfall runoffs from the proposed development only marginally increase the flows towards the Robins Bay main road culverts and bridge. There are two culverts along the Robins Bay main road that will be impacted by rainfall runoff from the development. To maintain the pre-development flow from the development towards these culverts two detention ponds are needed. The required capacities for the detention ponds are 9,361 m3 (detention pond #1) and 1,382 m3 (detention pond #2) for the flows in gully #2 & 3 in the middle and south of the development respectively.

The predevelopment flows from the lots along the northern boundary of the development (lots 156 – 171) will be maintained by using absorption pits to be constructed on the individual lots. Robins Bay main culverts have adequate capacity to safely convey and discharge rainfall runoff from gully #2 and 3 into the Caribbean Sea.

7.0 Design Summary and Recommendations

Our designs for the drainage system for the Proposed Residential Green Castle Sub-division include

- Concrete kerb and channels along roads
- Spillways at low points in and along roads
- Three proposed 600 mm diameter pipe culverts along John to Whit Avenue
- Proposed 600mm diameter at the crossing of existing gully and Mocking Bird Close
- Concrete u-drains 600mm x 600mm between lots and along proposed roads
- Earth Drains
- Proposed 600mm diameter pipe culverts and inlets along Hummingbird Close from chainage 0+340 to 0+442
- Proposed 600mm diameter pipe culverts and inlets along Hummingbird Drive from chainage 0+300 to 0+480
- Proposed 1.5mW x 1.5mD box culvert at the crossing of main gully and Sandpiper Drive
- Gully Training Works
- Two detention ponds (detention pond #1 9,361 m^3 & detention pond #2)
- Proposed 1.5m W x 1.3m D u-drain at inlet to main detention pond #1
- Proposed 1m W x 1m D u-drain at inlet to detention pond #2
- Proposed 750 mm diameter pipe culvert at detention pond #1 outlet
- Proposed 600 mm diameter pipe culvert at detention pond #2 outlet
- Clean the culverts below Robins Bay main road used to discharge storm water from gully #2 and 3 regularly.

The proposed storm-water management system is shown in **Appendix B**, **Figure 1B**.

D. Darling

Demmo Darling, P.E., M.Sc., BSc. (Eng)
Design Engineer

Karl McIntosh, P.E., M.A.Sc
Director

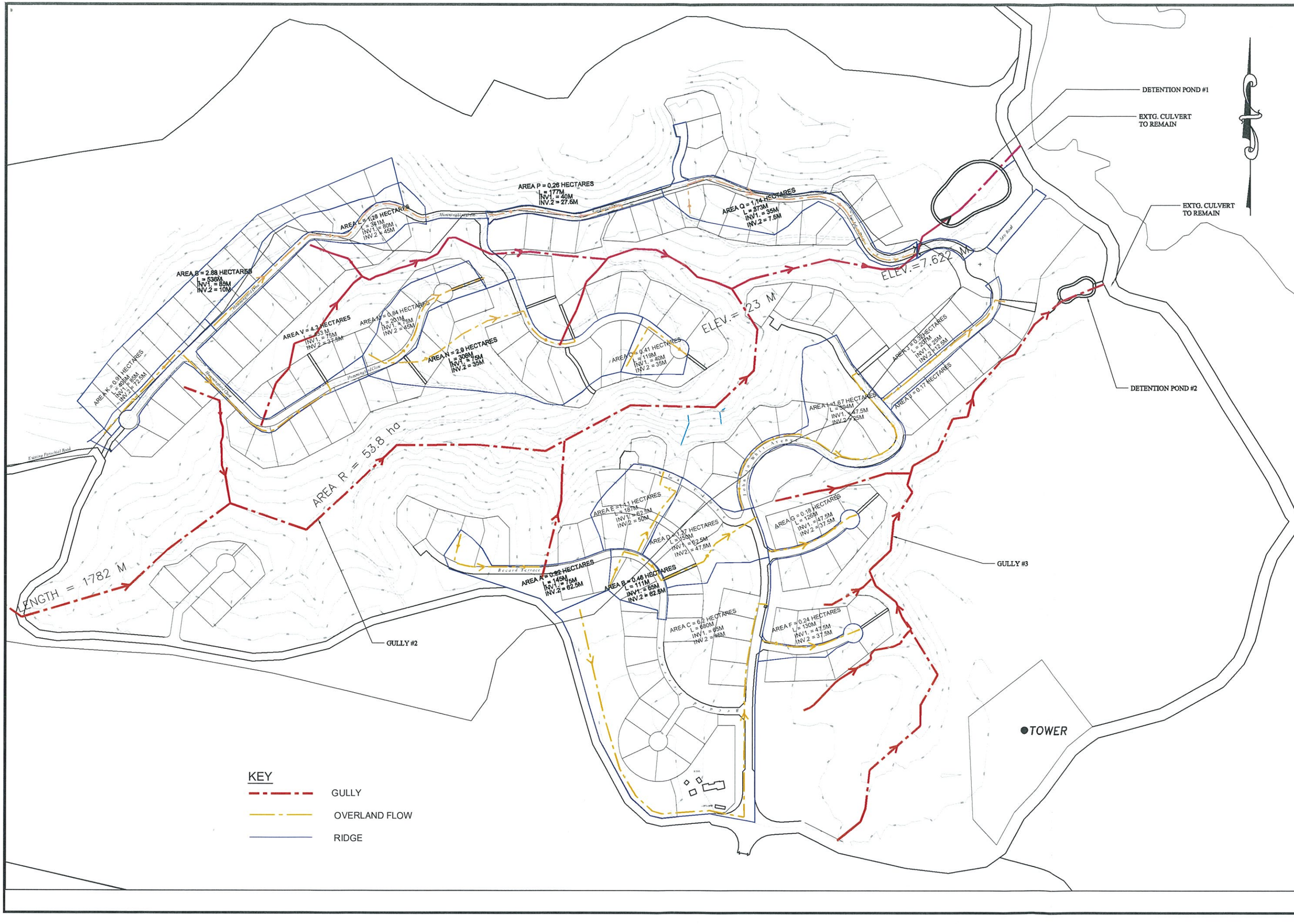
PROFESSIONAL ENGINEERS REGISTRATION BOARD
PE/01/0488
KARL R. McINTOSH
JAMAICA

N. O. WHYTE & ASSOCIATES LTD
March 5, 2012

Appendix A

Hydrologic Analyses:

- Figure 1A – Subdivision Drainage Areas
- Figure 2A – Gullies Drainage Areas
- Table 1A – Drainage Areas Rainfall Runoff Computations for 2 year Design Storms (Post – Development)
- Table 2A – Drainage Areas Rainfall Runoff Computations for 25 year Design Storms (Post – Development)
- Table 3A – Drainage Areas Rainfall Runoff Computations for 25 year Design Storms (Pre – Development)
- Table 4A – Drainage Areas Rainfall Runoff Computations for 25 year Design Storms (Post – Development)
- Green Castle Estate Pre and Post Development Rainfall Runoff Hydrographs Detention Pond #1
- Green Castle Estate Pre and Post Development Rainfall Runoff Hydrographs Detention Pond #2



CLIENT

Green Castle Estate
St. Mary, Jamaica

CONSULTANTS

Implementation Ltd
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26 Hope Road,
Kingston 6,
Jamaica, W.I.
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OMNI
SERVICES CO. LTD
13 Central Road, Kingston 10
Tel: 876-926-4365, 926-2548
Fax: 876-929-2054
ELECTRICAL & MECHANICAL
CONSULTING ENGINEERS

GREEN CASTLE ESTATE (PHASES ONE & TWO)

NO.	DATE	REVISION

ISSUE STATUS

PERMIT	PRELIMINARY	APPROVAL	TENDER	CONTRACT	CONSTRUCTION	MISCELLANEOUS

SCALE: 1:2000

SHEET TITLE

SUBDIVISION
DRAINAGE AREAS

PROJECT NO.:	2011-02
DESIGNED BY:	D.D.
DRAWN BY:	G.S.
CHECKED BY:	K.M.
APPROVED BY:	
DATE:	12' MARCH

FIGURE 1A

REV 0

KEY
GULLY
RIDGE

Mount Pleasant

Robins Bay

GULLY #1

LENGTH= 2148m

ELEV.= 190.55m

AREA W= 129.6 HECTARES

ELEV.= 0m

ELEV.= 0m

ROBINS BAY

ELEV.= 0m

GREEN CASTLE ESTATE

LENGTH= 1096m

LENGTH= 1932m

ELEV.= 130m

AREA R= 53.8 HECTARES

GULLY #3

GULLY #2

AREA U= 26.24 HECTARES

ELEV.= 99.1m

21

14K

CLIENT

Green Castle Estate
St. Mary, Jamaica

CONSULTANTS

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58 Hope Road,
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ELECTRICAL & MECHANICAL
CONSULTING ENGINEERS

PROJECT

GREEN CASTLE ESTATE (PHASES ONE & TWO)

NO.	DATE	REVISION

ISSUE STATUS

PERMIT	PRELIMINARY	APPROVAL	TENDER	CONTRACT	CONSTRUCTION	MISCELLANEOUS

SCALE: 1:1250

SHEET TITLE

GULLIES DRAINAGE AREAS

PROJECT NO.:	2011-02
DESIGNED BY:	D.D.
DRAWN BY:	G.S.
CHECKED BY:	K.M.
APPROVED BY:	
DATE:	12' FEB.

SHEET NO: FIGURE 2A

REV: 0

Appendix A: Drainage area runoff computations

Table 1A

Drainage areas runoff computations for 2 year design storms (Post - development)

Return period = 2 years

Drainage Areas	A(ha)	L(m)	H(m)	CN	$R=(1.4+(100-CN))/70$	$T_c=((4.7815*L^3*R^2)/H)^{0.234}$	P(mm)	$T_c < 60$ $i=2.6125*P*t_d^{-0.4814}$ and $T_c > 60$ $i=5.9487*P*t_d^{-0.6822}$	$p=i*t_d/60$	$R_1=((p*CN)-50.8(100CN))^2/CN((p*CN)+203.33(100-CN))$	Duration(t_d), Min	$T_b = (Tc*1.6467)+t_d$	$Q_p=(0.5052*A*R_1)/T_b$
C	6.20	680.00	20.00	75.00	0.38	44.14	156.00	56.78	56.78	12.75	60.00	132.68	**0.30**
B + D	1.57	216.00	17.50	75.00	0.38	20.36	156.00	56.78	56.78	12.75	60.00	93.52	**0.11**
N	2.90	308.00	40.00	75.00	0.38	21.52	156.00	56.78	56.78	12.75	60.00	95.44	**0.20**

A = Area of water shed in hectares
L = Length of longest watercourse in metres
H = Change in elevation along watercourse
CN = Run off curve number
R = Retardance to runoff for a channel with grass surface
Tc = Time of concentration (rainfall duration) in minutes
P = Maximum 24 hour rainfall measured at rain guage in mm
i = Rainfall intensity in mm/hr
p = Depth of rainfall in mm
R1 = Runoff in mm
Tb = Base time in minutes
td = Duration of the storm in minutes
Qp = Peak Flow in m3/s

Appendix A: Drainage area runoff computations

Table 2A

Drainage areas runoff computations for 25 year design storms (Post - development)

Return period = 25 years

Drainage Areas	A(ha)	L(m)	H(m)	CN	R=(1.4+(100-CN))/70	$T_c=((4.7815*L^3*R^2)/H)^{0.234}$	P(mm)	$T_c < 60$ $i=2.4556*P*t_d^{-0.53}$ and $T_c > 60$ $i=3.2696*P*t_d^{-0.5999}$	$p=i*t_d/60$	$R_1=((p*CN)-50.8(100CN))^2/CN((p*CN)+203.33(100-CN))$	Duration(t_d), Min	$T_b = (Tc*1.6467)+t_d$	$Q_p=(0.5052*A*R_1)/T_b$
C	6.20	680.00	20.00	75.00	0.38	44.14	302.00	84.67	84.67	30.10	60.00	132.68	**0.71**
B + D	1.57	216.00	17.50	75.00	0.38	20.36	302.00	84.67	84.67	30.10	60.00	93.52	**0.26**
N	2.90	308.00	40.00	75.00	0.38	21.52	302.00	84.67	84.67	30.10	60.00	95.44	**0.46**
R	53.80	1,782.00	122.40	75.00	0.38	56.81	302.00	84.67	84.67	30.10	60.00	153.55	**5.33**
V	4.30	433.00	37.50	75.00	0.38	27.75	302.00	84.67	84.67	30.10	60.00	105.70	**0.62**

A = Area of water shed in hectares
L = Length of longest watercourse in metres
H = Change in elevation along watercourse
CN = Run off curve number
R = Retardance to runoff for a channel with grass surface
Tc = Time of concentration (rainfall duration) in minutes
P = Maximum 24 hour rainfall measured at rain guage in mm
i = Rainfall intensity in mm/hr
p = Depth of rainfall in mm
R1 = Runoff in mm
Tb = Base time in minutes
td = Duration of the storm in minutes
Qp = Peak Flow in m3/s

Appendix A: Drainage area runoff computations

Table 3A

Drainage areas runoff computations for 25 year design storms (Pre - development)

Return period = 25 years

Drainage Areas	A(ha)	L(m)	H(m)	CN	R=(1.4+(100-CN))/70	$T_c=((4.7815*L^3*R^2)/H)^{0.234}$	P(mm)	$T_c < 60$ $i=2.4556*P*t_d^{-0.53}$ and $T_c > 60$ $i=3.2696*P*t_d^{-0.5000}$	$p=i*t_d/60$	$R_1=((p*CN)-50.8(100CN))^2/CN((p*CN)+203.33(100-CN))$	Duration(t_d), Min	$T_b = (Tc*1.6467)+t_d$	**$Q_p=(0.5052*A*R_1)/T_b$**
S	2.88	536.00	75.00	65.00	0.52	31.86	302.00	84.67	84.67	16.92	60.00	112.46	**0.22**
R	53.80	1,782.00	122.40	65.00	0.52	66.02	302.00	79.96	87.99	18.62	66.02	174.75	**2.90**
U	26.24	1,096.00	99.10	65.00	0.52	49.31	302.00	84.67	84.67	16.92	60.00	141.21	**1.59**

Table 4A

Drainage areas runoff computations for 25 year design storms (Post - development)

Return period = 25 years

Drainage Areas	A(ha)	L(m)	H(m)	Composite CN	R=(1.4+(100-CN))/70	$T_c=((4.7815*L^3*R^2)/H)^{0.234}$	P(mm)	$T_c < 60$ $i=2.4556*P*t_d^{-0.53}$	$p=i*t_d/60$	$R_1=((p*CN)-50.8(100CN))^2/$	Duration(t_d),	$T_b = (Tc*1.6467)+t_d$	**$Q_p=(0.5052*A*R_1)/T_b$**
S	2.88	536.00	75.00	66.16	0.50	31.38	302.00	84.67	84.67	18.26	60.00	111.67	**0.24**
R	53.80	1,782.00	122.00	75.00	0.38	56.85	302.00	84.67	84.67	30.10	60.00	153.62	**5.33**
U	26.24	1,096.00	99.10	67.95	0.48	47.40	302.00	84.67	84.67	20.42	60.00	138.05	**1.96**

A = Area of water shed in hectares
L = Length of longest watercourse in metres
H = Change in elevation along watercourse
CN = Run off curve number
R = Retardance to runoff for a channel with grass surface
Tc = Time of concentration (rainfall duration) in minutes
P = Maximum 24 hour rainfall measured at rain guage in mm
i = Rainfall intensity in mm/hr
p = Depth of rainfall in mm
R1 = Runoff in mm
Tb = Base time in minutes
td = Duration of the storm in minutes
Qp = Peak Flow in m3/s

Curve number for residential development CN = 75.00

Undeveloped area				**Developed area**			
S	=	129.60	ha	S	=	17.00	ha
T	=	53.80	ha	T	=	11.00	ha
U	=	26.24	ha	U	=	11.00	ha

Composite curve number

$$CN = \frac{\sum_{i=1}^{n}(CN_i * A_i)}{\sum_{i=1}^{n} A_i}$$

Green Castle Estate Pre and Post Development Rainfall Runoff Hydrographs Detention Pond #1

Pre-development Runoff hydrograph

Drainage Area R

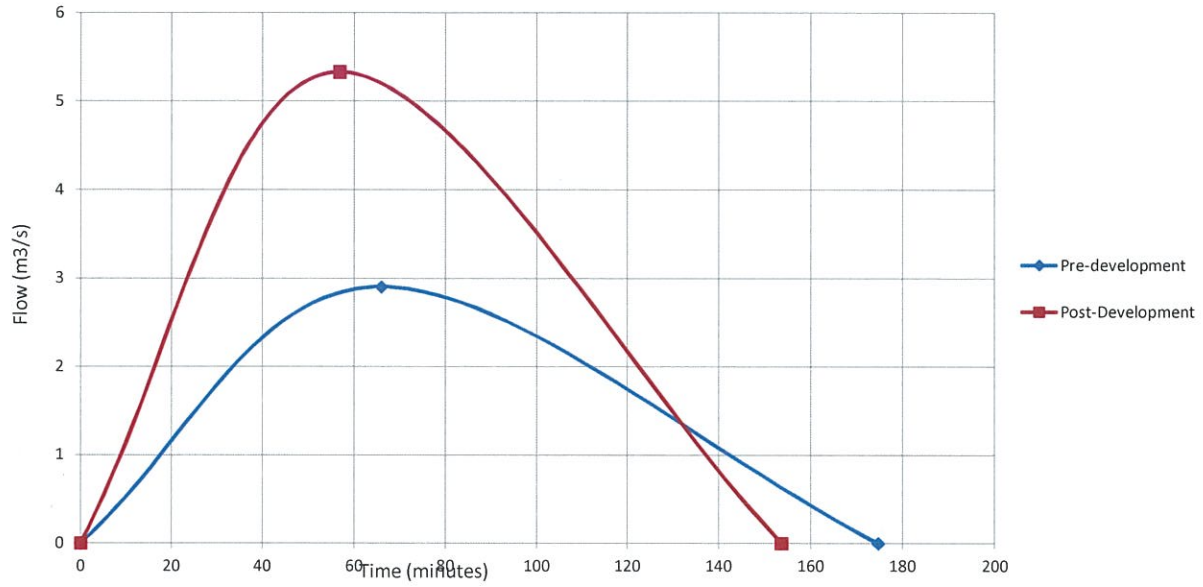
Time (minutes)	Flow (m3/s)
0	0
66.02	2.9
174.75	0

Post-development Runoff Hydrograph

Drainage Area R

Time (minutes)	Flow (m3/s)
0	0
56.85	5.33
153.62	0

Drainage Area R Rainfall Hydrographs 25 Year Design Storm Event



Rainfall Runoff Volume = Area under Post development Hydragraph - Area under pre-development hydrograph

Rainfall Runoff Volume = 1/2 x Base 1 x Height 1 - 1/2 x Base 2 x Height 2
= (1/2 x 174.75 x (60) x 5.33) - (1/2 x 153.62 x (60) x 2.90)
= 9,361 m^3

Embankment Height = 2 m
Pond Area = 4680.294 m^2

Green Castle Estate Drainage Area R Detention Pond #1 Outlet Pipe Design (25 year design storm Pre development)

Q	=	The Flow to be Carried by the pipe (m^3/s)	=	2.90
L	=	The Length of the pipe (m)	=	20
D	=	The diameter of the pipe (m)	=	0.75
C	=	The Hazen williams coefficient	=	100
H	=	Depth of water inside Pond (m)	=	1.5

Using the Hazen Williams Formula

$$Q = 0.2788 \times C \times D^{2.63} \times \left(\frac{H}{L}\right)^{0.54}$$

The Table below Shows the hydaulic characteristics for a 750mm diameter HDPE pipe

Pipe Size m	Pipe Area (A) Pi() x D^2 / 4 m^2	Q m^3/s	Pipe Velocity(V) $Q_{capacity}$ / A m/s	$Q_{capacity}$ Pipe Capacity m^3/s
0.750	0.442	2.900	7.312	3.23

Use 750 mm diameter pipe as detention pond outlet pipe

Green Castle Estate Pre and Post Development Rainfall Runoff Hydrographs Detention Pond #2

Pre-development Runoff hydrograph

Drainage Area U

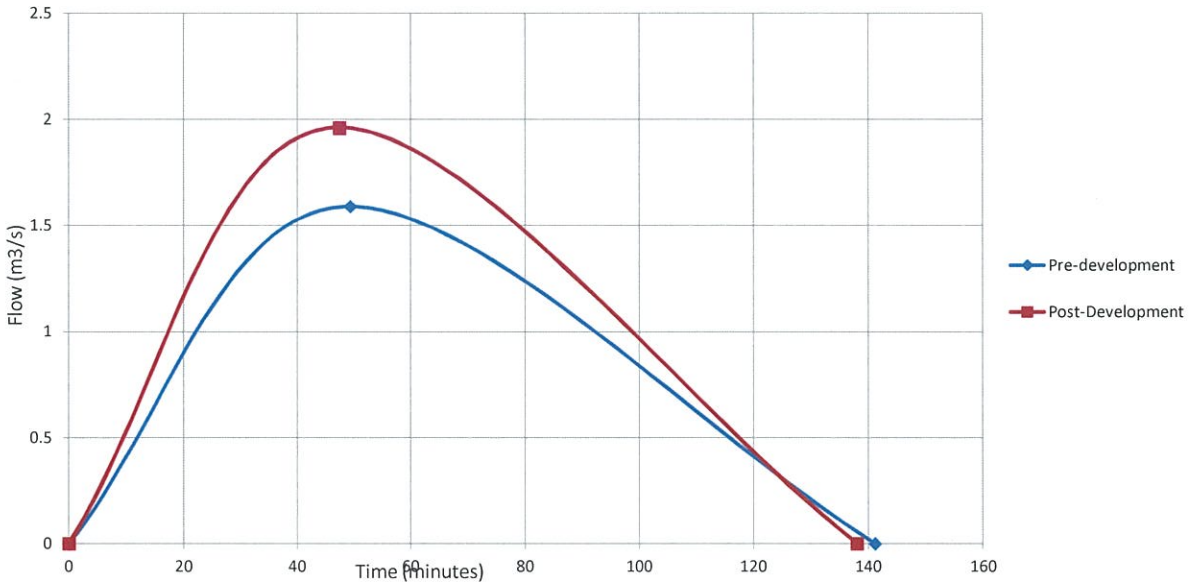
Time (minutes)	Flow (m3/s)
0	0
49.31	1.59
141.21	0

Post-development Runoff Hydrograph

Drainage Area U

Time (minutes)	Flow (m3/s)
0	0
47.4	1.96
138.05	0

Drainage Area U Rainfall Runoff Hydrographs 25 Year Design Storm Event



Rainfall Runoff Volume	=	Area under Post development Hydragraph - Area under pre-development hydrograph	
Rainfall Runoff Volume	=	1/2 x Base 1 x Height 1 - 1/2 x Base 2 x Height 2	
	=	(1/2 x 141.21 x (60) x 1.96) - (1/2 x 138.05 x (60) x 1.59)	
	=	1,382	m^3
Height	=	2	m
Area	=	690.81	m^2

Green Castle Estate Drainage Area U Detention Pond #2 Outlet Pipe Design (25 year design storm Pre development)

Q	=	The Flow to be Carried by the pipe (m^3/s)	=	1.96
L	=	The Length of the pipe (m)	=	20
D	=	The diameter of the pipe (m)	=	0.6
C	=	The Hazen williams coefficient	=	100
H	=	Depth of water inside Pond (m)	=	1.8

Using the Hazen Williams Formula

$$Q = 0.2788 \times C \times D^{2.63} \times \left(\frac{H}{L}\right)^{0.54}$$

The Table below Shows the hydaulic characteristics for a 750mm diameter HDPE pipe

Pipe Size m	Pipe Area (A) Pi() x D^2 / 4 m^2	$Q_{required}$ m^3/s	Pipe Velocity(V) $Q_{capacity}$ / A m/s	$Q_{capacity}$ Pipe Capacity m^3/s
0.600	0.283	1.960	7.010	1.98

Use 600 mm diameter pipe culvert as detention pond outlet pipe culvert

Appendix B

Hydraulic Analyses of Culvert and Open Drains:

- Figure 1B – Proposed Drainage Layout Plan Sheet 1 of 2
- Figure 1B – Proposed Drainage Layout Plan Sheet 2 of 2
- Figure 2B – Design Specification for Collector Drains/Sewers
- Table 1B - Hydraulic design for circular pipe culverts 25 years design storms (Post development)
- Table 2B - Hydraulic design for proposed box culverts 25 years design storms (Post development)
- Table 3B - Hydraulic design for proposed box u-drains25 years design storms (Post development)
- Table 4B - Hydraulic Analyses of Kerbs and Channels for 2 year design storms (Post development)
- Table 5B - Hydraulic Analyses of Kerbs and Grating inlets for 2 year design storms (Post development)
- Table 6B - Hydraulic Analyses of existing culverts below Robins Bay Main Road for 25 year design storm (Pre-development)

MATCHLINE 001

MATCHLINE 001

CONC. SPILLWAY

EARTH SWALE
BOTTOM WIDTH = 450mm
DEPTH = 200mm
SIDE SLOPE 1.5:1

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

CONC. SPILLWAY

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

CONC. SPILLWAY

450 D x 400 W mm CONC. OPEN DRAIN LINKING SPILLWAY TO CULVERT

CULVERT #3
600mm ø HDPE CULVERT

CULVERT #2
600mm ø HDPE CULVERT

CONC. SPILLWAY

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

V DRAIN SHAPED IN ASPHALT (TYP.)

CULVERT #1
600mm ø HDPE CULVERT

CONC. SPILLWAY

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

E.O.C.

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

600mm ø HDPE PIPE

E.O.C.

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

CONC. SPILLWAY

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 500mm
SIDE SLOPE 1.5:1

CONC. SPILLWAY

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 500mm
SIDE SLOPE 1.5:1

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

CONC. SPILLWAY

RIVER TRAINING REQUIRED UPSTREAM AND DOWNSTREAM

1.5m x 1.5m RC BOX CULVERT

CONC. SPILLWAY

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

CONC. SPILLWAY

600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

1.0x 1.0m CONC. OPEN DRAIN

500mm ø HDPE PIPE

EXTG. PIPE CULVERTS

CONC. SPILLWAY

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

DETENTION POND # 1
(VOLUME 9361m³)

1.5m W x 1.3m D OPEN DRAIN

750MM ø HDPE PIPE

2# EXTG. PIPE CULVERTS

E.O.C.

CONC. SPILLWAY

V DRAIN SHAPED IN ASPHALT (TYP.)

600mm ø HDPE PIPE

E.O.C.

RIP RAP EARTH DRAIN
BOTTOM WIDTH = 600mm
DEPTH = 600mm
SIDE SLOPE 1.5:1

DETENTION POND # 2
(VOLUME 1382m³)

JOHN TO WHIT AVENUE

PHASE ONE PHASE TWO

TOWER TOWER

MAIN ROAD

40 0 20 40 80 120M

NOTE:
ENERGY DISIPATOROR ALL DRAIN OUTLETS

LEGEND
- DIRECTION OF STORM WATER FLOW
- ROAD CAMBER

CLIENT
Green Castle Estate
St. Mary, Jamaica

CONSULTANTS

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CONSULTING ENGINEERS

NOWAL N.O.WHYTE & ASSOCIATES LTD
CONSULTING ENGINEERS | PROJECT MANAGERS

PROJECT
GREEN CASTLE ESTATE (PHASES ONE & TWO)

NO.	DATE	REVISION

ISSUE STATUS — 12' FEB

- PERMIT
- PRELIMINARY
- APPROVAL
- TENDER
- CONTRACT
- CONSTRUCTION
- MISCELLANEOUS

SCALE: 1:1250

SHEET TITLE
PROPOSED DRAINAGE LAYOUT

SHEET 1 OF 2

PROJECT NO.:	2011-02
DESIGNED BY:	D.D.
DRAWN BY:	G.S.
CHECKED BY:	K.M.
APPROVED BY:	
DATE:	12' FEB.

REV. 0

FIGURE 1B

LEGEND

- DIRECTION OF STORM WATER FLOW
- ROAD CAMBER

NOTE:

ENERGY DISIPATOROR ALL DRAIN OUTLETS

ROAD Existing Parochial Road

V DRAIN SHAPED IN ASPHALT (TYP.)

HUMMINGBIRD DRIVE

450 D x 400 W mm CONC. OPEN DRAIN

RIP RAP EARTH DRAIN BOTTOM WIDTH = 600mm DEPTH = 600mm SIDE SLOPE 1.5:1

CONC. SPILLWAY MIN SLOPE 1%

EARTH DRAIN BOTTOM WIDTH = 600mm DEPTH = 600mm SIDE SLOPE 1.5:1

3.00m DRAIN EASEMENT

CONC. SPILLWAY & 600x 600mm CONC. OPEN DRAIN MIN SLOPE 1%

600mm ø HDPE PIPE

CULVERT #3

600MM ø HDPE CULVERT

CB 5 MH 1 MH 2 CB 6 CB 7 CB 8 MH 4 MH 5 CB 9 MH 6 MH 3

EXTG. GULLY

PHASE ONE PHASE TWO

HUMMINGBIRD CLOSE

BROWN TERRACE

MOCKINGBIRD CLOSE

SANDPIPER DRIVE

RATOO CLOSE

600X 600mm CONC. OPEN DRAIN MIN SLOPE 1%

CONC. SPILLWAY

EARTH DRAIN BOTTOM WIDTH = 600mm DEPTH = 600mm SIDE SLOPE 1.5:1

CONC. SPILLWAY & 600X 600MM CONC. OPEN DRAIN MIN SLOPE 1%

MATCHLINE 001

MATCHLINE 001

40 0 20 40 80 120M

CLIENT

Green Castle Estate
St. Mary, Jamaica

CONSULTANTS

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ELECTRICAL & MECHANICAL CONSULTING ENGINEERS

NOWAL N.O.WHYTE & ASSOCIATES LTD.
CONSULTING ENGINEERS | PROJECT MANAGERS

PROJECT

GREEN CASTLE ESTATE (PHASES ONE & TWO)

NO.	DATE	REVISION

ISSUE STATUS: 12' FEB

PERMIT	
PRELIMINARY	
APPROVAL	
TENDER	
CONTRACT	
CONSTRUCTION	
MISCELLANEOUS	

SCALE: 1:1250

SHEET TITLE

PROPOSED DRAINAGE LAYOUT

SHEET 2 OF 2

PROJECT NO:	2011-02
DESIGNED BY:	D.D.
DRAWN BY:	G.S.
CHECKED BY:	K.M.
APPROVED BY:	
DATE:	12' FEB.

REV. 0

FIGURE 1B

proposed to be sited over a gully or other natural water channel, except for the provision of flood control measures for "probable maximum" storm events:

iv Wherever feasible, landscaping should be encouraged to maximize vegetative cover.

10.1.3 Roads

i All paved roadways are to be protected by kerb walls/ kerb and gutters, running parallel on each side of the road. Where design permits, well maintained grass verges are allowable in lieu of kerb walls.

ii Maximum recommended road grade shall be 15% for distances not exceeding 50 metres.

iii No proposed road or lot should drain storm water directly unto an existing road or property without the specific permission from the National Works Agency.

10.1.4 Collector Drains/Sewers

Regardless of the number of lots or gutter capacity, collector drains/sewers shall be constructed from any high point on the road for a distance not exceeding that as set out below.

Road Gradient (%)	Distance from high point (m)
<1.0	200.00
to 4.9	160.00
5.0 to 10.0	120.00
>10	60.00

10.1.5 Curb Heights

A minimum curb height of 150 mm is recommended, however, a height of 200 mm is recommended for gutters with transverse slopes greater than 4 % and road gradients flatter than 0.5 %.

FIGURE 2B: DESIGN SPECIFICATION FOR COLLECTOR DRAINS/SEWERS

Table 1B

Hydraulic design for circular pipe culverts 25 years design storm (Post development)

Catchment # C	Q_{runoff} m^3/s 0.71	Design Storm Years 25	Culvert size (Circular pipe) mm 600	Drain # 3	R m 0.3	n 0.012	S m/m 0.015	N 1	Pie (π) 3.143	A $\pi \times R^2$ m^2 0.28	P $2 \times \pi \times R$ m 1.88	M A/P m 0.15	$Q_{capacity}$ $Q=\frac{1}{n}\times S^{1/2}\times M^{2/3}\times A$ m^3/s 0.81	V $Q_{capacity}/A$ m/s 2.88	Comment OK
B + D	0.26	25	600	2	0.3	0.012	0.01	1	3.143	0.28	1.88	0.15	0.67	2.35	OK
N	0.46	25	600	1	0.3	0.012	0.01	1	3.143	0.28	1.88	0.15	0.67	2.35	OK
V	0.62	25	600	1	0.3	0.012	0.01	1	3.143	0.28	1.88	0.15	0.67	2.35	OK

The table above shows the hydraulic computation for the culverts along the proposed roads

The capacity of the pipes were calculated using Manning's formula:

$$Q = \frac{1}{n} \times S^{1/2} \times M^{2/3} \times A$$

Q_{runoff}	Overland flow from catchment
R	Culvert Radius
n	Maning's number for the culvert
S	Culvert Slope
N	Number of Culvert Pipes
A	X-sectional Area of flow in culvert
P	Wetted perimeter of culvert
M	Hydralic radius of culvert
V	Velocity of the flow
$Q_{capacity}$	Culvert capacity
V	Velocity of flow in culvert

Table 2B

Hydraulic design for Proposed Box Culvert 25 year design storms (Post development)

Catchment #	Q_{runoff} m^3/s	Design Storm Years	Box-drain Size mm	Freeboard m	U-DRAIN #	W m	H m	n	S m/m	N	A W x H m^2	P (2 x H + 2W) m	M A/P m	$Q_{capacity}$ $Q=\frac{1}{n}\times S^{1/2}\times M^{2/3}\times A$ m^3/s	V $Q_{capacity}/A$ m/s	Comment
R	5.33	25	1.5 X 1.5	0.3	1	1.5	1.2	0.015	0.01	1	1.80	5.40	0.33	5.77	3.21	OK

The table above shows the hydraulic computation for the box culvert

The capacity of the pipes were calculated using Manning's formula:

$$Q = \frac{1}{n} \times S^{1/2} \times M^{2/3} \times A$$

Q_{runoff}	Overland flow from catchment
R	Culvert Radius
n	Maning's number for the culvert
S	Culvert Slope
N	Number of u-drains cells
A	X-sectional Area of flow in culvert
P	Wetted perimeter of culvert
M	Hydralic radius of culvert
V	Velocity of the flow
$Q_{capacity}$	Culvert capacity
V	Velocity of flow in culvert
Q_{total}	Total culvert capacity
W	Culvert width
H	Culvert Height

From the above calculations, use a 1.5 m High x 1.5m Wide box culvert

Table 3B

Hydraulic design for Proposed u-drain 25 year design storms (Post Development)

Catchment #	Q_{runoff} m^3/s	Design Storm Years	Box-drain Size mm	Freeboard m	U-DRAIN #	W m	H m	n	S m/m	N	A W x H m^2	P (2 x H + W) m	M A/P m	$Q_{capacity}$ $Q=\frac{1}{n}\times S^{1/2}\times M^{2/3}\times A$ m^3/s	V $Q_{capacity}/A$ m/s	Comment
R	5.33	25	1.5X 1.3	0.3	1	1.5	1	0.015	0.01	1	1.50	3.50	0.43	5.68	3.79	OK
C	0.71	25	0.6X 0.6	0.05	1	0.6	0.55	0.015	0.01	1	0.33	1.70	0.19	0.74	2.24	OK
U	1.96	25	1.5X 1.3	0.3	1	1	0.7	0.015	0.01	1	0.70	2.40	0.29	2.05	2.93	OK

The table above shows the hydraulic computation for the u-drains

The capacity of the pipes were calculated using Manning's formula:

$$Q = \frac{1}{n} \times S^{1/2} \times M^{2/3} \times A$$

Q_{runoff}	Overland flow from catchment
R	Culvert Radius
n	Maning's number for the culvert
S	Culvert Slope
N	Number of u-drains cells
A	X-sectional Area of flow in culvert
P	Wetted perimeter of culvert
M	Hydralic radius of culvert
V	Velocity of the flow
$Q_{capacity}$	Culvert capacity
V	Velocity of flow in culvert
Q_{total}	Total culvert capacity
W	Culvert width
H	Culvert Height

Table 4B

Hydraulic Analysis of Kerb and Channel for 2 year design storm (Post development)

Cactment #	Q_1 Ft^3/s	Design Storm Years	Road #	Drain #	N	%	Q_2 $Q_2 = \frac{\left(Q_1 \times \frac{\%}{100}\right)}{N}$ ft^3/s	S_o	Z $1/S_o$	S	D ft	n	$Q_{capacity}$ $Q = 0.56 \times \frac{Z}{n} \times S^{1/2} \times D^{3/8}$ ft^3/s
C	10.60	2	John ot Whit Avenue	1	2	100	5.30	0.025	40	0.02	0.25	0.015	5.29
B + D	3.88	2	Parula Close	3	2	100	1.94	0.025	40	0.01	0.33	0.015	7.82
N	7.10	2	Mockingbird Close	2	2	100	3.55	0.025	40	0.01	0.33	0.015	7.82
L	2.83	2	Hummingbird Drive	2	2	100	1.42	0.025	40	0.039	0.33	0.015	15.43

The table above show the hydraulic analysis of the curb and channel along the proposed roads

The capacity of the curb and channel was calculated using Izzards equation:

$$Q = 0.56 \times \frac{Z}{n} \times S^{1/2} \times D^{3/8}$$

- Q_1 Flow from the catchment
- N Number of curb and channel section used to carry the catchment flow
- % Maximum percentage of the catchment flow to the left or right of the culvert
- Q_2 Flow to be carry by the Curb and channel
- S_o Roadway Cross slope
- Z Reciprocal of roadway cross slope
- S Curb and Channel longitudinal Slope
- D Depth of flow in gutter
- n Mannings number for concrete
- $Q_{capacity}$ Curb and channel capacity

Table 5B

Hydraulic Analysis of Curb and Grating Inlet for 2 year design storm (Post development)

Cactment #	Q_1 Ft^3/s	Design Storm Years	Road #	Drain #	N	%	$Q_2 = \frac{\left(Q_1 \times \frac{\%}{100}\right)}{N}$ ft^3/s	D ft	L ft	g ft/s^2	$Q_{spillway}$ $Q_{capacity} = \left(0.2 \times g^{1/2} \times D^{2/3}\right) \times L$ ft^3/s	Recommendation
A	10.60	2	John ot Whit Avenue	1	1	100	10.60	0.5	10	32.19	10.77	Spillway
B + D	3.88	2	Parula Close	3	1	100	3.88	0.5	8.5	32.19	9.16	Spillway
N	7.10	2	Mockingbird Close	2	1	100	7.10	0.5	8.5	32.19	9.16	Spillway
L	2.83	2	Hummingbird Drive	2	1	100	2.83	0.5	8.5	32.19	9.16	Spillway

The table above show the hydraulic analysis of the Kerb and channel along the proposed roads

The cacpacity of the Curb and grating inlet was calculated as follows:

Spillway inlet: $Q_{capacity} = \left(0.2 \times g^{1/2} \times D^{2/3}\right) \times L$

Grating Inlet: $Q_{capacity} = \left(C \times P \times D^{1.5}\right)$

Q_1	Flow from the drainage area
N	Number of spillway and grating inlets used to carry the catchment flow
%	Maximum percentage of the drainage flow to be carried by the inlets
Q_2	Flow to be carried by the spillway and Grating inlets
D	Depth of flow in gutter or spillway opening
L	The length of the grating inlet
g	Acceleration due to gravity
Q_{curb}	Capacity of spillway inlet
P	Grating Perimeter
C	Weir Coefficient (use 0.3 for spillways)
$Q_{grating}$	Capacity of grating inlet
$Q_{spillway} + Q_{grating}$	Capacity of spillway and grating inlet combine

Table 6B

Hydraulic analyses of existing pipe culverts below Robins Bay Main Road for 25 years design storm (Pre development)

Catchment #	Q_{runoff} m^3/s	Design Storm Years	Culvert size (Circular pipe) mm	Drain #	R m	n	S m/m	N	Pie (π)	A $\pi \times R^2$ m^2	P $2 \times \pi \times R$ m	M A/P m	$Q_{capacity}$ $Q=\frac{1}{n}\times S^{1/2}\times M^{2/3}\times A$ m^3/s	V $Q_{capacity}/A$ m/s	Comment
R	2.9	25	600	1E	0.3	0.015	0.049	1	3.143	0.28	1.88	0.15	1.18	4.17	
		25	600	2E	0.3	0.015	0.025	1	3.143	0.28	1.88	0.15	0.84	2.98	
		25	600	3E	0.3	0.015	0.019	1	3.143	0.28	1.88	0.15	0.73	2.59	Total capacity is 2.75 m^3/s Ok
U	1.59	25	600	4F	0.3	0.015	0.081	1	3.143	0.28	1.88	0.15	1.51	5.36	OK

The table above shows the hydraulic computation for the culverts along the proposed roads

The capacity of the pipes were calculated using Manning's formula:

$$Q = \frac{1}{n} \times S^{1/2} \times M^{2/3} \times A$$

Q_{runoff}	Overland flow from catchment
R	Culvert Radius
n	Maning's number for the culvert
S	Culvert Slope
N	Number of Culvert Pipes
A	X-sectional Area of flow in culvert
P	Wetted perimeter of culvert
M	Hydralic radius of culvert
V	Velocity of the flow
$Q_{capacity}$	Culvert capacity
V	Velocity of flow in culvert

APPENDIX 4

LETTER FROM JPS

Jamaica Public Service Company Limited
CHANGING LIVES WITH OUR ENERGY

6 Knutsford Boulevard, Kingston Jamaica, W.I.
Telephone: (876) 926-3190-9
Fax: (876) 511-2167
Website: www.jpsco.com

November 7, 2011

Raymond Richardson
Omni Services Company Limited
10 Central Road
Kingston 10

Attention: Mr. Raymond Richardson

Dear Sirs:

Re: JPS HV Supply – Green Castle Subdivision, Robins Bay, St. Mary

Jamaica Public Service (JPS) is hereby, confirming that there exists sufficient capacity on our distribution infrastructure to provide supply to the captioned location.

We eagerly awaits the submission of the designs for review and approval, and is pleased to be of service to you and fully appreciates your business.

Yours truly,
JAMAICA PUBLIC SERVICE

Osawaki Wickham, P.E.
Manager (Acting)
Engineering Department
693[A] Spanish Town Road
Kingston 11
Tel. # 937-9320 / Fax # 937-9259

APPENDIX 5

TRAFFIC DATA: TOTAL VEHICLE COUNT (2 DAY SURVEY)

APPENDIX 5

TRAFFIC ASSESSMENT

For Proposed Green Castle Residential Sub-Division

Prepared in by Kamille Dwyer, Marc Rammelaere and Ravidya Burrowes

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Introduction

The owners of Green Castle Estate in St Mary intend to sub-divide a 77.5 ha parcel located on the north-western side of the estate adjacent to the community of Robins Bay in St Mary on the north coast of Jamaica. The development proposal involves sub-division of this parcel into 171 residential lots. The main site access shall be via the old north coast road to Robins Bay. Robins Bay and this section of the old road was by-passed by the North Coast Highway (NCH) between Port Maria and Agualta Vale, which now runs via an interior alignment.

Site Access

The site relative to the municipal road network is shown in Figure 1 below.

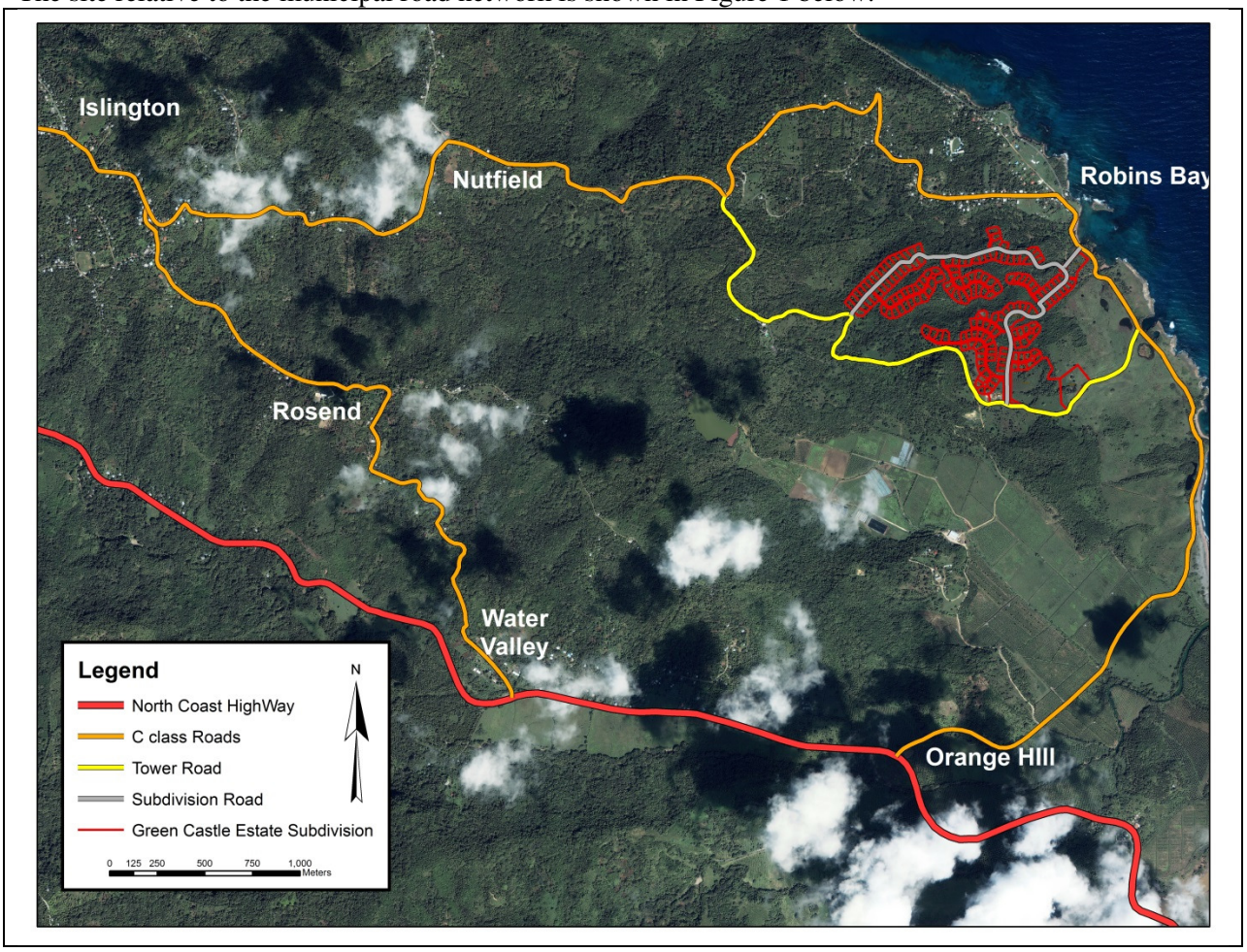

Figure 1: Main roads and intersection near the proposed subdivision

The site is generally accessed from the NCH via turn-off at Orange Hill into Green Castle Estate. That road traverses across Green Castle Estate to the old north coast main road. Presently, the main access to the site off the old north coast main road is via Tower Road (shown in yellow above). It is proposed that a new sub-division entrance be created ~556 m north-west (along the old main road) of the Tower Road entrance.

Traffic from Robins Bay heading to the NCH not using the old coastal main road would travel westwards via Nutfield/Islington, then south ~4 km to Water Valley via Rosend/Salem. Traffic heading eastward also has the option to connect to the NCH at White Hall, which is ~~2 km west of Islington (not shown on map above).

Both the Robin's Bay old coastal main road and the Robins-Bay to Nutfield road are typical country roads with road widths varying from single to dual lane. The condition of the road surface is just as variable, ranging from good to very poor. The Robins' Bay main road is a single lane road where it enters the village of Robin's bay. The dilapidated box culvert which serves as a bridge over the gullies west of the fishing beach is also a single lane structure. Works to replace this structure are scheduled to start at the end of March 2013. During heavy storms sections of the Robin's Bay main road near the seaget often blocked with material deposited on the road by storm surges.

The Robin's Bay main road and the Nutfield road are also connected by the Tower Road (see Figure 1). The Tower road is not surfaced and serves currently as the main access road to the Green Castle Great House. It has gates on both ends and is not open for through traffic. The Tower Road begins near the coast at the Robin's Bay road, passes the martello tower within the bounds of Green Castle Estate and the Great house and intersects with the road to Nutfield above the Mount Pleasant community.

The subdivision plan proposes to construct two roads which will connect the Tower road with the Robin's Bay main road. Both roads follow the alignment of existing farm roads. One intersects the Tower Road while the other one begins near the Green Castle Great House. These two roads will come together and intersect the Robin's Bay main road as one road just east of the Robin's Bay fishing beach.

Looking towards Annotto Bay


Looking towards Port Maria

Figure 2 Photograph of the Intersection at Orange Hill

The North Coast Highway is a two lane single-carriageway that connects Negril with Port Antonio and is intended to provide fast and comfortable access to the main urban centres on the north coast. The highway was designed to allow a safe traveling speed at 80 km/h in open areas and at 50 km/h in build-up areas. Near the intersection with the Robin's Bay old main road, the highway has the standard design dimensions and configuration. It has a carriageway of approximately 7.3 meters with shoulders of 2.4 meter wide and drainage on both sides of the road.

The intersection of the Robin's Bay main road near Orange hill is a T-intersection. The access to the highway from the Robin's Bay main road is controlled by a stop sign. The entrance to the Robin's Bay main road is approximately 40 m wide and has an asymmetric compound curve, allowing the traffic coming from Port Maria to leave the highway before reaching the intersection. Coming from the west (i.e.

Port Maria), the intersection is located at the end of long straight segment, in the beginning of a wide S-bend, which forms the embankment of the small concrete bridge over the Water River. That section of the road is governed by a 50km/h speed limit. There is clear unobstructed view to the west of the intersection, in the direction of Annotto Bay for a distance of 400 m and to east in the direction of Port Maria for a distance of approximately 450m.

Traffic Survey

Traffic counts were conducted on June 28 and July 1, 2011 at (a) the intersection of the North Coast Highway and Robin's Bay Road near Orange Hill, and (b) the Entrance point to Green Castle Estate from the Robins Bay main road. Two vehicles classes were identified in the survey: (1) Cars which included cars, SUVs, pick-ups, and light commercial vehicles and vans (2) Trucks which included heavy commercial vehicles, bus, trucks and trucks with trailers. The survey included traffic volume counts and turning counts for two hours during the established peak hours of Morning (7:00 - 9:00am), Afternoon (11:00 am - 1:00pm) and Evening (4:00 pm-6:00 pm).

The traffic survey at the Orange Hill intersection of the NCH and Robin's Bay main road shows that during peak hours a total of 250 vehicles are passing through the intersection per hour. Seven percent (7%) of that traffic is generated by the Robin's Bay community. The traffic towards Port Maria and Annotto Bay is balanced and does not show a statistical significant preference for either direction.

During weekends and public holidays is can be surmised there may be an increased level of traffic to and from Robin's bay when tourist facilities such as the Robins Bay Hotel, Strawberry Fields Together and River Lodge may be utilized.

The traffic through the Orange Hill intersection is dominated by cars. Only 11% of the vehicles are trucks. This bias is even stronger for the traffic on the Robin's bay road, with 6% of the vehicular traffic classified as truck.

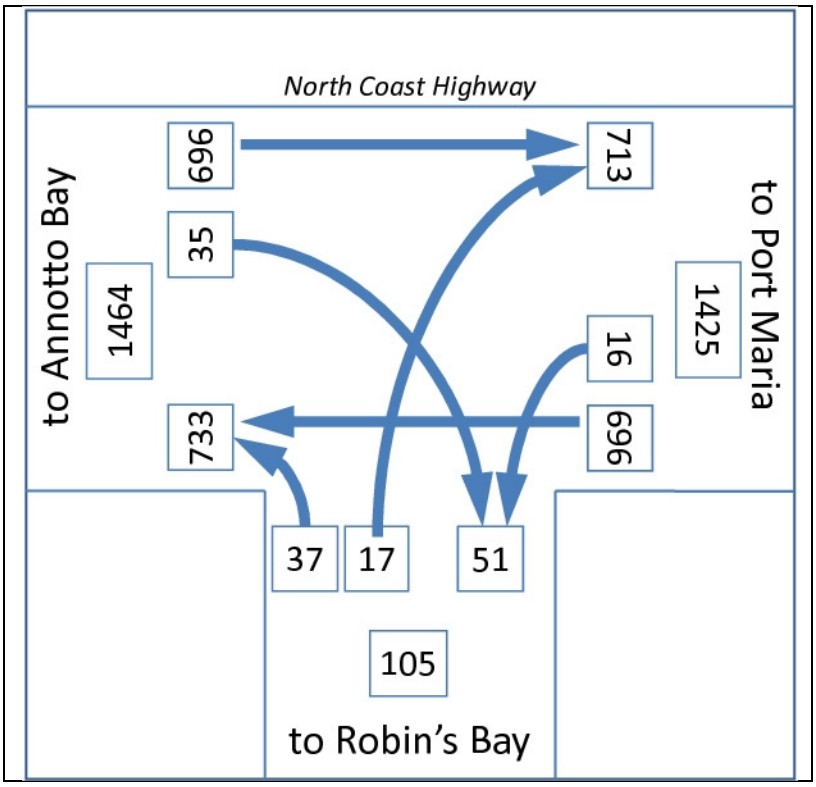

Figure 3. Total Average traffic count for the 3 daily peak hours combined at the Orange Hill intersection

	Routes Travelled													
Time													**Total**	
	Robins Bay to Port Maria		Robins Bay to Annotto Bay		Port Maria to Robins Bay		Port Maria to Annotto Bay		Annotto Bay to Robins Bay		Annotto Bay to Port Maria			
	Day 1													
	C	O	C	O	C	O	C	O	C	O	C	O	C	O
7:00-9:00am	4	1	11	0	4	1	244	18	9	0	209	26	481	46
11:00am-1:00pm	4	0	13	1	4	0	160	23	11	3	182	23	374	50
4:00-6:00pm	7	1	15	1	6	0	202	25	14	1	200	28	444	56
Sub-Total	**15**	**2**	**39**	**2**	**14**	**1**	**606**	**66**	**34**	**4**	**591**	**77**	**1299**	**152**
	Day 2													
	C	O	C	O	C	O	C	O	C	O	C	O	C	O
7:00-9:00am	3	0	8	1	1	0	212	30	5	0	190	28	419	59
11:00am-1:00pm	8	0	9	0	6	0	196	19	12	0	188	23	419	42
4:00-6:00pm	6	0	15	0	10	0	231	32	14	0	272	23	548	55
Sub-Total	**17**	**0**	**32**	**1**	**17**	**0**	**639**	**81**	**31**	**0**	**650**	**74**	**1386**	**156**
Total	**32**	**2**	**71**	**3**	**31**	**1**	**1245**	**147**	**65**	**4**	**1241**	**151**	**2685**	**308**

Traffic Survey Data

C = Car, SUV, Pick-ups, Vans and light commercial vehicles
O = heavy commercial vehicles, bus, trucks and trailer trucks.

(a) Entrance to Robins Bay Road off the North Coast Highway, view looking to the N

(b) Section of Tower Road leading to Green Castle Estate, view looking S

(c) View from entrance to Robin's Bay Community looking to the west.

(d) View from the entrance of the Robin's Bay looking to the east.

Figure 4 Views of the Robins Bay Road (including Traffic Survey Point)

Traffic Impact of the proposed development

Construction Phase

The main drawback to determining the level of impact during the construction period is the unavailability of bills of quantities for quarry and other materials. Consequently, construction traffic (trips generated) cannot be properly quantified at this time. The following is a qualitative or semi-quantitative assessment of likely trip generators in each phase of construction.

1. **Set up of the laydown site**. This will involve establishment of the management office, stockpile and storage areas, re-fuelling and equipment maintenance areas (including wash down) during the infrastructure construction phase. This will mainly involve transportation of vehicles for clearing and preparing the site, as well as transportation of materials required for the site office. It is uncertain whether a temporary or more permanent structure will be constructed as the site office. It is likely that a concrete pouring mixer truck will be required on at least one day for foundations. It is uncertain what other hard stands would be needed at the site office (potentially for driveway, parking, and fuel storage/dispensing).
2. **Construction of the detention basins and stabilized construction exits** (SCEs). This will involve the transportation to the site of heavy earth moving equipment such as bull-dozers and excavators. These will be brought to the site during off-peak hours (mid-night to 5 am). Earth materials excavated from the detention basins (~16,115 m3) will be reused on site as either fill or top-soil so there would be no off-site haulage traffic generated.
3. **Site preparation along proposed roadway alignments on a phased basis, involving limited vegetation clearance**. No major transportation is expected during this period, aside from commuter traffic (manager, project engineers, survey teams and bush-clearing workmen). Any vegetation debris generated by the clearance activities will be disposed onsite.
4. **Construction of the subdivision access roads (laying and compaction of sub-grade, and other layers and pavement)**. During this period it is expected that suitably sized aggregate will have to be brought to the site from a quarry. Aggregate, marly limestone and rip rap will have to be transported to the site for the road and drainage works. No accurate bills of quantities have yet been generated, but it is likely that this phase of construction will generate the most construction traffic.
   The specific routes of haulage vehicles and the periods during which these will be operational are unknown as the suppliers have not yet been determined. While it is likely that most of the haulage vehicles will use the NCH to the entrance to Green Castle at Orange Hill, and continue to the site via the Robins Bay old coast road via Newry, the developer is assessing to source some of the aggregate on the property. Much of the lower elevations of the site comprise Coastal Limestone, and there is an old limestone quarry on the property. In such case most of the haulage would be internal and not affect the NCH traffic situation.
5. **Installation of power and water mains and completion of verges**. This will require the transportation of pipelines (pvc) and trenching equipment to the site, as well as the electrical cables. It can be assumed that water and sewage pipes of equal length of the roads (4,512 m) will have to be transported to the site. Eight (8) to ten (10) times the length of electrical, cable and telephone lines would have to be brought in (most likely on rolls).
6. **Construction of concrete kerb and channel, concrete u-drains concrete pipes and culverts**. Detailed estimates of quantities of in-situ concrete requirements and pre-fabricated concrete are not yet available. There will likely be considerable transportation of mixed concrete, cement and pre-fabricated concrete associated with the drainage installations.
7. **Survey and field marking of sub-division lots for sale**. This is not expected to generate more than commuter traffic for the workers involved in clearing, and the survey teams.
8. **Sale and construction of individual lots by lot owners**. This will require transportation to the site of mixed concrete, concrete blocks, steel rebar, roofing and flooring materials, pipes and cables and a ranging of finishing materials (paints, plumbing fixtures, doors, windows, woodwork, etc). It is not

possible to estimate how many lots will be under construction at any given time on the sub-division. In addition to transportation of materials, there would be commuter transportation associated with supervisors, skilled workers (electricians, plumbers, masons, carpenters, roofers, tillers etc) and labourers. This phase is also likely to generate a significant amount of construction traffic depending on how many lots are under construction at any given time.

The main environmental effects associated with construction transportation include:

- Congestion delays due to slow moving laden vehicles (Level of Service)
- Road safety
- Wear and tear on roads
- Noise, dust and combustion emissions along transportation corridors.

Due to the uncertainties in quantifying the scale of these impacts, a precautionary approach must be adopted. It should be noted that the traffic impacts specifically associated with the sub-division infrastructure development are likely to be spread over 5 to 8 years, and that daily traffic is not likely to be more than 10 to 15 construction-related trips per day at peak construction periods, including both trucks and commuter traffic.

Congestion delays at the intersection (off the North Coast Highway at Orange Hill) can be mitigated during the construction phase with the implementation of the following measures:

- Clearance of vegetation at the intersection to ensure visibility of traffic turning onto or off the Green Castle Estate road.
- Construction traffic and deliveries entering or leaving the site shall be scheduled for off peak hours (10 am – 1pm and 6pm -7am) to minimize additional congestion at the intersection and or disruptions in the regular traffic flow.
- Heavy equipment should be transported to the site in the early morning (12 am to 5 am with proper pilotage.

Safety of motorist is of great concern and the following steps should be taken to mitigate or reduce accidents on the roads leading to the site:

- Secure and cover loads (steel rebar, concrete blocks, steel turbine components, aggregate, cement etc) to avoid presenting a hazard to other road users.
- Place appropriate traffic warning signs, advising road users of a construction site entrance ahead and instructing them to reduce speed, should be placed along the highway near to the turn off to Green Castle Estate at Orange Hill.
- Flagmen should be employed to control traffic and assist construction vehicles as they enter and exit the project site as well as the intersection.

In respect of emissions, the following mitigation measures are recommended:

- Maintain vehicles to avoid excessive noise and emissions.
- Wash vehicles to avoid excessive generation of fugitive dust from surfaces.
- Establish stabilized construction exits (SCEs) to prevent tracking of dust onto public roadways.

The impact of increased construction traffic and associated indirect impacts described above are restricted to occurring during the construction period of the project. Emissions and delays are not environmentally persistent after the causative activity has ceased. The effects of wear and tear on the surface, as well as poor road safety can be more long-term if mitigation measures are not implemented.

Operational Phase (Post-Lot Sale)

This discussion pertains to the effect of vehicles entering and exiting the property (which cause traffic delays at the intersections). Emissions are addressed above, and no significant wear and tear is expected to arise from the average class of vehicle that would be used during the operational phase. Measured baseline levels of traffic passing the Orange Hill intersection is 250 vehicles per hour. The hourly increase in traffic flow of generated by the subdivision is difficult to predict.

The market that is targeted is the up-market tourist market and most of the traffic generated is therefore expected to be concentrate around the typical holiday season and should not significantly affect the normal working day peak hours. **Typical commuter traffic associated with trips to school or a work place is not anticipated for this development**. In the event that people live there, peak flows would also be expected if there are functions or parties. With occupancy rate of 50% at full development it is estimated that the development could generate an additional traffic of 15 vehicles per hour at the Orange Hill intersection during peak season or AADT increase of 55.

Due to the relatively low flows along the Robins Bay main road, no mitigation measures are proposed for this area, particularly as residents are expected to turn eastwards towards Newry using the estate road to exit via the Orange Hill intersection when leaving Green Castle Estate.

Recommendations

The project engineers and project managers must continue to have dialogue with the NWA to ensure that the best practices are implemented to minimize traffic impacts.

Manage traffic issues (during infrastructure development phase):

- Review bill of quantities and determine how much of the required fill, top-soil and other earth materials can be sourced on property or within the parish.
- Dispose vegetation and earth material debris onsite.
- Facilitate worker shuttles if possible.
- Use traffic calming devices and install traffic warning signs along the main road near to the Orange Hill turn-off: *construction site entrance ahead*, *reduce speed*, *slow-moving vehicles*.
- If necessary, employ flagmen to assist with traffic control traffic and to assist construction vehicles as they enter and exit the project site and at the Orange Hill intersection.
- Maintain vegetation at the intersection at the Orange Hill intersection with the North Coast Highway to ensure maximum visibility of traffic turning in and off to Robin's bay
- Schedule construction traffic and deliveries for off peak hours (10 am – 1pm and 6pm -7am) to minimize additional congestion of the intersection or disruption in the normal traffic flow.
- Heavy equipment and oversized loads should be transported to the site in the early morning (12 am to 5 am) with proper pilotage (as necessary).

Implement controls on vehicle operation and maintenance

- Limit load size to avoid spillages.
- Haulage vehicles should have proper axel spreads for their loads (consistent with NWA standards).
- Ensure that haulage trucks are covered and secured to avoid presenting a hazard or nuisance to other road users.
- Ensure that all vehicles are properly maintained.
- Wash vehicles to avoid excessive generation of fugitive dust from surfaces. Set up wheel wash and truck wash-down facilities. Run-off from wash down areas should be routed to a settling pond or tanks.

APPENDIX 6

HOUSEHOLD SURVEY QUESTIONNAIRE

APPENDIX 6 QUESTIONNAIRE

SOCIO-ECONOMIC SURVEY (June 2011)
Proposed Residential Sub-Division Development Project, Green Castle, St. Mary, Jamaica

PERSONAL/CONFIDENTIAL

Personal Interview Schedule (Target: Persons above 18 years of age)

Interviewer: _____ Respondent ID: _____
Date: _____ Location: _____

In order to determine the social and economic characteristics of the area, and garner your views, perspectives and acceptance of the proposed development I would like to ask you some questions.

Interviewers: Please note that more than one answer can be provided for a particular question

Demographic Profile

1. Sex: Male ☐ Female ☐ (please provide the sex of the head of household_____)

2. To what age group do you belong?
   18-29 ☐ 30-39☐ 40-49 ☐ 50-59 ☐ 60 and over ☐

3. How long have you lived there (here)? _____

4. Where are you originally from (Town and Parish)? _____

Education

5. What is the highest level of education you have attained?
   None☐ Primary/All Age ☐ Training/Skills Institution☐
   High School☐ College☐ University ☐
   Other, specify _____

6. Are you presently attending school? Yes ☐ No☐

Quality of Life Indicators

Employment and Income

7. Are you employed? Yes ☐ No ☐
   Please tick the box which best describes your type of employment
   Full-time ☐ Part-time☐ Self-employed☐ Other, specify _____

8. What is your present means of livelihood (occupation)? _____

9. What is your main means of travel? (work, shopping etc.)?
   Private vehicle ☐ Bus☐ Taxi☐ Other, specify _____

10a. What is your weekly/monthly income in Jamaican Dollars (JMD)? (optional)

   Less than $10,000 ☐ $10,001-$30,000 ☐ $30,001-$60,000 ☐
   $60,001-$90,000 ☐ $90,001-$120,000☐ $120,001 – $150,000 ☐
   Above $150,000 ☐

10b. Do you have any additional sources of income?
Remittances ☐ Spousal support ☐ Family ☐ Savings ☐

Municipal Services

11a. Do you have access to a steady supply of water? Yes ☐ No ☐
11b. What is the main source of domestic water supply for the household?
Public piped water into dwelling☐ Private Tank☐ Public piped water into yard☐
Community Tank ☐ Government Water Trucks (free) ☐ Public Standpipe☐
Private Water Trucks (paid)☐ Spring or River☐ Other, specify _____

12. What is the main source of lighting for your home?
Electricity☐ Kerosene☐ Candles☐ Other, specify _____

13. What is the main method of garbage disposal for your household?
Public Garbage Truck☐ Private Collection☐ Burn☐ Other, specify _____

14. Do you have access to the following services?

Type of Service	**Location**	**Distance Travelled (km)/miles**
Health Care		
Police Station		
Fire Station		
Post Office/Agency		

14b. Do you have health insurance? Yes ☐ No ☐

Community and Recreational Development

15. What do you value most about your community?
_____
_____
_____

16. What types of improvement are needed in the community?
_____
_____
_____

17a. What types of recreational resources are available in your community? (Please tick one)
NB administrator: State the location of recreational facilities or resources if not in community

Dance/parties ____ Youth Clubs _____
Sports Clubs _____ Charity _____
Church groups _____ Other, specify_____
Beach _____ River/Stream/Pond_____

17b. If you selected beach and/or river, what is the name of the beach/river you most frequently use?
_____

17c. Do you use the community centre located in the town? Yes ☐ No ☐
If yes, how often and for what purpose(s)? _____

18. Is the community usually affected by Hurricanes/natural disasters (flooding, fire, earthquake etc.,)
How did you fare in the last Hurricane/tropical storm/natural disaster?
_____
_____
_____

19. How long was it before water, power and telephone were restored after each disaster?
_____

20. Where do people go in the event of a disaster? _____

Social Capital

21. Does your community have a citizen's association? Yes ☐ No ☐

22. Are there any other organisations within your community (voluntary or otherwise)? Yes ☐ No ☐

Please state_____

23. What is the role of the church in your community?_____

24a. Are there outreach programmes/ adult literacy programmes in your community? Yes ☐ No ☐

24b. If yes, Who or what organisation is in charge of these programmes and how are they funded?
_____

25a. Does the community undertakes labour day or other voluntary projects? Yes ☐ No ☐
Please state type of project_____

25b. What groups or organisations arrange these projects?_____

25c. Are the work skills required for these projects available in the community? Yes ☐ No ☐
If no, where do the workers come from?_____

25d. For construction projects in your community, where do the workers come from?
_____

26. Does your community have sports clubs and/or teams? Yes ☐ No ☐

26b. Do they participate in community, parish and/or national competitions? Underline response

26c. Who provides the funding for these teams?_____

27a. How are decisions about the community's development made?_____

27b. Are there elders in your community that residents go to for advice? Yes ☐ No ☐

Natural Resources Usage and Management

28. Which of the following natural resource is available in your community?

Water: beach ☐ river ☐ pond ☐ lake ☐ **Vegetation**: plants ☐ fruit crops ☐
Animals: birds☐ fish ☐ **Land**: Forestry ☐ mangrove ☐ Minerals ☐

29. Do you use any of these resources? Yes ☐ No☐ If Yes, which ones and for what purpose(s)?

_____

_____

30. Are there any pollution sources or stress factors affecting these resources? Yes ☐ No☐
If yes, please state source_____

Wildlife

31a. Are there birds within your community? Yes ☐ No☐

31b. Do you get different birds other than local birds at various times in the year? Yes ☐ No☐
If yes, at what times during the year are they most visible?_____

32. Are there turtle nesting sites on the beaches? Yes ☐ No☐

33. Have you ever seen the lion fish? Yes ☐ No☐
If yes, have you ever caught it for consumption Yes ☐ No☐

Perception of the Housing and Land Markets in Jamaica (community and parish specific)

34. Do you _____ your house?
Own ☐ Lease☐ Rent ☐ Other, specify _____

35. Do you _____ the land on which your house is located?
Own☐ Lease☐ Rent ☐ Other, specify _____

36. Do you think housing and lands being offered for sale in your parish are affordable? (yes or no and explain answer)

_____

_____

_____

37. Do you think there are enough low and middle income residential development projects taking place within your community and parish? (yes or no and explain answer)

_____

_____

_____

38. What are some of the challenges facing the housing and land markets in your community and parish?

_____

_____

_____

39. What steps or measures do you believe are required to solve the problems being faced within the housing and land sector?

_____

_____

_____

Perception of the Proposed Development

40. Are you aware of the proposed residential sub-division project at Green Castle? Yes ☐ No ☐
If yes, through what medium?_____

41. Do you support the use of former plantation lands/historic sites for housing development?
Yes ☐ No ☐ (give reasons for your answer)

_____
_____
_____
_____

42. What do you think will be the impacts (positive and negative [if any]) of the proposed residential development project to your community and parish?

_____
_____
_____
_____

43. How do you think the housing and land market in the community and parish will be affected by the proposed project?

_____
_____
_____
_____
__

Tourism Development

44. What are your views about the development of tourism products in your community?

45. What are your views on the utilization of natural resources to support tourism business development initiatives/interests?_____

46. What kind of tourism would you like to see developed in your community? e.g. eco-tourism, cruise ship, all inclusive hotels etc.? _____

47a. Do you travel overseas? Yes ☐ No☐

47b. If yes, what are your reasons for travelling? Visiting Family ☐ Vacation ☐ Business ☐ Sports/Recreation ☐ Other ☐_____

Thank you for your cooperation and participation in this survey☺

Interviewer Comments and Observations

_____
_____
_____
_____