

ENVIRONMENTAL IMPACT ASSESSMENT

Proposed Mixed Residential Building in Plot No. D2-3, Hulhumale' – Rainbow Oceanfront Residence



Proponent:

Rainbow Construction Pvt. Ltd.

Consultant:

Amir Musthafa (EIA01/13)

December 2016

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Consultants Declaration

This EIA has been prepared according to the EIA Regulations 2012. I certify that the statements in this Environmental Impact Assessment study are true, complete and correct to the best of my knowledge and abilities

A handwritten signature in blue ink, appearing to read 'Amir Musthafa', is written over a light blue grid background.

Amir Musthafa (EIA 01/13)

27th December 2016

Proponents Declaration

(attached in the following page)



**RAINBOW
CONSTRUCTION (PVT) LTD.**

G. Maarana, Alikilegefaanu Magu, Malé 20-04, Republic of Maldives Tel: (+960) 334 0460, Fax: (+960) 332 7374, e-mail: info@rainbowconstruction.com.mv

26th December 2016

**Ibrahim Naeem
Director General
Environmental Protection Agency
Ministry of Environment and Energy
Male', Maldives**

Dear Mr. Ibrahim Naeem,

**Project: EIA for the proposed Mixed Residential Building in Plot No. D2-3, Hulhumale' –
Rainbow Oceanfront Residence**

Sub: Proponents Declaration and Commitment for Monitoring and Mitigation

As the proponent of the project, we guarantee that we have read this EIA report and to the best of our knowledge, all non-technical information provided here are accurate and complete. We are aware that this report has been prepared in accordance with the EIA regulations.

We confirm our commitment to undertake all mitigation measures and carry out the monitoring program as specified in the report.

Thanking you

Yours Sincerely

Mohammed Afrah

Operation Manager



Non Technical Summary

This report is based on the proposed mixed residential building construction in Plot No. D2-3, Hulhumale'. 12 storeys in the structure will be allocated for residential purposes. The project is being developed and constructed by Rainbow Construction Pvt. Ltd. They are to undertake the construction works and project management including overseeing the EIA process.

An Environmental Impact Assessment was necessary for the works as per the requirements of the signed agreement between Rainbow and Housing Development Corporation (HDC), and due to the fact that the structure exceeds 11 storeys as specified in the EIA regulation 'Jadhuvalu R' in the list of type of projects for which EIAs are required. In addition to meeting the regulatory requirements, the report would further assist the proponent and important stakeholders to make decisions based on favourable environmental conditions with the main focus on sustainability. The project also adheres to several other rules and regulations in the Maldives and has obtained permit from HDC to proceed. HDC is a 100% government entity being given the responsibility to set guidelines and oversee all developments in Hulhumale'.

The project is part of larger program by HDC to establish mixed residential buildings in Hulhumale'. Apartments in these buildings can generally be regarded as being targeted towards middle to lower class members of the community. The project will contribute to the grand plan of reducing congestion in Male' by providing more moderate to high quality housing opportunities in Hulhumale'. By 2019, it is projected that there will be over 1000 such housing units built in Hulhumale'.

The existing environment at the project site does not consist of any significant vegetation and the water test result shows normal water quality. The only large vegetation that will still be removed are the roadside Fithuroanu gas. There are no residents living in close proximity to the site and there is no other structure at the site as well. Therefore, the project will not have any significant impact on a significant receptor.

During the construction stage, health and safety standards of the workers at site, and waste generation is the only areas of concern. With proper planning and project management, this can be easily mitigated. Waste is the main concern during the operational stage of the project as well. Since this will be developed as a condominium with multiple tenants owning the rights of the building, it has to be ensured that the tenants are held responsible to properly manage the waste in addition to maintaining the building beyond the 2 years the developer is contractually responsible for.

Regarding alternatives, there are no viable alternatives available for the project with respect to location. The no project option is also not plausible at this stage and possibilities are outside the scope of this study. Other alternatives including material, foundation type, construction methodology are not necessarily recommended. Recommendations had been made to proceed with the project as planned.

An environmental monitoring plan is proposed to be carried out with 2 phases; one for the construction stage, and one for 2 years post construction. Factors to investigate include surveying the amount of waste generation, noise pollution, traffic flow, health and safety at site and water quality.

All the impacts as highlighted in the project can be mitigated. The socio-economic benefits to Greater Male' City from projects such as these is high. It also provides additional housing opportunities, which would contribute to alleviating the housing issues in Male' City, and therefore mitigating the issues related to congestion. Thus, after consideration of all these perspectives, it is recommended that this project proceed as planned, after incorporating the mitigation measures given in this study with the commitment to implementing the monitoring plan given.

1. Introduction

1.1 Background

This Environmental Impact Assessment (EIA) report has been prepared in order to meet the requirements of Clause 5 of the Environmental Protection and Preservation Act of the Maldives to assess the impacts of the proposed mixed residential building construction in Plot D6-2C.

The report will look at the justifications for undertaking the proposed project components and it will identify and determine the significance of the potential impacts of the proposed works. Alternatives to proposed components or activities in terms of location, design and environmental considerations would be suggested along with measures to mitigate any negative impact on the environment. Environmental monitoring programme is vital in order to demonstrate the long-term sustainability of the proposed project as well as to undertake mitigation measures before any impact leads to long-term significant effects. Long term monitoring helps to understand uncertainties in impact analysis improving future impact predictions and project implementation. Therefore, a building monitoring and management plan would be suggested.

The major findings of this report are based on qualitative and quantitative assessments undertaken during site visits in October 2016. Available long-term data were collected from available sources, such as long-term data on meteorology and climate from local and global databases. Long-term data on the project site is lacking. However, to compensate for this, data collected over the years in Hulhumale' for similar projects will be used.

1.2 Aims and Objectives of the EIA

This report addresses the environmental concerns of the building construction works and also those that will occur during the operational stage of the development. The report attempts to achieve the following objectives.

- Describe the project components to the relevant authorities and to the public
- Allow better project planning and decision-making based on the sustainable development.
- Identify environmental impacts that will occur and gauge their significance for such a project undertaken in the particular location.
- Mitigating impacts caused due to the works outlined in the project
- Promote informed and environmentally sound decision making

- To demonstrate the commitment by the proponent on the importance of environmental protection and preservation.

1.3 Methodologies

This EIA has been prepared by Amir Musthafa, a registered permanent EIA consultant with a few years of experience in Environmental Impact Assessment in the Maldives and has been actively involved in numerous coastal protection projects and building construction undertaken in the country. The consultant was assisted by the developer's staff throughout the project, most notably for water sample collection from the site.

Internationally recognized and accepted methods have been used in this environmental evaluation and assessment. This EIA is based mainly on data collected during field investigation missions in October 2016. The data collection methods are described in detail under the following Section.

1.4 Methods of data collection

Conditions of the existing environment of the study area were analysed by using various surveying techniques and scientific methods. Field surveys were carried out to get a further understanding of the existing conditions at the project location, and were carried out during October 2016 to collect baseline data.

The following investigations were carried out on site.

- Groundwater quality parameters
- Existing noise pollution on site
- Traffic flow at the project site
- Socio-economic conditions in the area

As the area does not include any structures or vegetation of notes, vegetation and structural surveys were not required.

1.4.1 Groundwater quality

Groundwater quality was measured at the project location. Groundwater was collected by dipping into groundwater wells using 1500ml glass bottles. The containers were filled and taken for testing at the MWSC laboratory within 3 hours for sampling.

1.4.2 Noise Pollution

Noise pollution at the project area was measured using a handheld noise measurement device using Decibel 10th 3.8.1 software. Noise measurements were undertaken for 60 seconds at the locations shown under Existing Environment section.

1.4.3 Traffic flow

Traffic flow was measured by visual observation of traffic within a predetermined area at the project location within a specified period of time using a stop-watch. The no. of heavy duty vehicles, cars, motor-cycles, and pedestrians at the area in a 15 minute period were noted down by visual inspection, and extrapolated to 60 minutes. Traffic surveys were undertaken at different times and due to the low traffic flow in the area, the maximum flow is presented in the report.

1.4.4 Stakeholder consultations

Stakeholder consultations was initially carried out in the EIA scoping meeting. The EIA scoping meeting gave the opportunity to consult with the Environmental Protection Agency, project developer and contractor, and Housing Development Corporation (HDC) in one sitting. Additionally, consultation with the Ministry of Housing and Infrastructure, STELCO, MWSC and Project engineer, were carried out throughout this study, via mail, telephone and in person.

1.4.5 Built Environment

An overview of the built environment around the project site was undertaken by visual inspection with the aid of photographs. A structural defect inspection study is not recommended as is the case for structures usually built in high congestion areas in Male'.

Once the EIA has been submitted it is expected that the review process will not take more than 2 weeks. The review process may result in the request for additional information before issuing a decision statement. However, all efforts have been made to ensure that adequate information has been provided with specific attention paid to meet all requirements of the Terms of Reference (TOR). The TOR for this EIA is given in Annex 1.

1.5 References to similar studies

As there have been several multi-storey building projects undertaken in Male' City recently by various consultants, several of them were studied. These include the following:

- EIA for Proposed 6 Storey Building with a basement, Land Lot A-10079 Hulhumale', Maldives.

- EIA for the proposed 11 storey building construction at MA. Andhalus, Male' (Musthafa 2015)
- EIA for 14 Storey building construction in Ma. Manaage, (Musthafa 2015)
- EIA for Hulhumale' mixed use residence, 2015 (Zuhair 2015)
- EIA for 11 Storey building construction in M. Thulhaadhooge, 2015 (Zuhair 2015)
- EIA for 14 Storey building construction in G. Hudhukoka, 2014 (Musthafa 2014)
- EIA for the proposed 10-storey building in Plot No. D6-2C, Hulhumale' – Renaatus Ithaamuiy Musthafa, A. (2016)

1.6 The Proponent

The project is being proposed by Rainbow Construction Pvt. Ltd. Rainbow construction is both the developer and the contractor for this project. Rainbow Enterprises Pvt Ltd (Rainbow) is the holding company and was registered in Republic of Maldives in 1990 had its origin in the building industry. The founding shareholders of Rainbow were the group who started the first registered architectural and engineering firm (Tekton Design Associates Pvt Ltd) in the Maldives.

Rainbow Construction will handle project management, consultancy, and the physical construction of the project. They provide total solutions encompassing all the components of major construction works.

This project had been awarded to Rainbow by Housing Development Corporation (HDC) on 3rd August 2016.

1.7 The Project Location

The project is based in Hulhumale', Plot No. D2 – 3. Location coordinates are at around 4°13'10.00"N, 73°32'19.98"E. As can be seen from the Figure below, it is in close proximity to the Hulhumale' Ferry terminal.

There are no buildings in the direct vicinity of the proposed site. However, 2 other similar apartment building projects have been proposed.

The precise location is shown in the following image (Figure 1). A more detailed site plan is

given in Annex.



Figure 1 Location of Plot No. D2 - 3, Proposed "Oceanfront Residence" Building in Hulhumale'



Figure 2 Location of Plot No. D2 – 3, Proposed “Oceanfront” Building in Hulhumale' (location highlighted in red)



Figure 3 Impact Area and Study area for the project including the traffic and noise survey regions (highlighted in red)

1.8 Need and Justification

Hulhumale' has been regarded as the main residential area in the greater Male' region and as such all upcoming housing projects are being proposed to be developed in Hulhumale'. Hulhumale' is currently a hub for development and is very much intended to be a hub to drive the housing industry forward. There are additional housing projects being proposed, while a yacht marina, IT city, tourism zones, and others. All these developments are believed to generate several employment opportunities and therefore will attract additional migration to the area.

With the development of Hulhumale' Phase 2, it appears that there is an urgency to complete the entire Phase 1, and as such there has been a flurry of housing projects proposed. The proposed project in this study is one among about 10 other similar apartment building projects. The completion of these buildings would greatly alleviate the housing issues in the region, and provide a much-needed relief to the congestion in Male'. The need for such a

relief has never been greater, as the living conditions in Male' have deteriorated with each passing year.

In order to alleviate the issues, a major housing scheme was underway for the past 2 years titled 'Gedhoruverikurun', to provide housing opportunities to residents in Male'. As it is a social housing scheme, the recipients of the scheme is targeted to those that are in need of government subsidised housing. Other bigger housing opportunities such as purchasing own land plots, row houses, luxury condominiums have been quite expensive, and the price is projected to escalate with each passing year. Therefore, it appeared there was not much housing opportunities for the middle class. Developments such as proposed Rainbow Oceanfront building provides these opportunities to the middle class. Although these are commercial buildings, HDC does impose on the developer to sell a certain percentage of units in a controlled price, and therefore the developments are intended to alleviate the housing issues among the working middle class Maldivians living in Male' City.

2. Project Description

The project proposes to develop 2 towers, 13 storeys with a basement parking, in the allocated land plot with a total of 145 housing units.

Tower A consists of the following:

- 12 3 room apartments
- 30 2 room apartments
- 6 1 room apartments
- 9 Penthouse
- Infinity Pool in between 2 towers
- Fully equipped gym
- Fully equipped kids club house
- Basement parking
- Garbage chute

Tower B consists of the following:

- 55 3 room apartments
- 33 2 room apartments
- Infinity pool
- Fully equipped gym
- Fully equipped kids club house
- Basement parking

- Garbage chute

The land plot is shown in the Figure below.

The site allocated for the development has now been cleared and handed over to the developer.

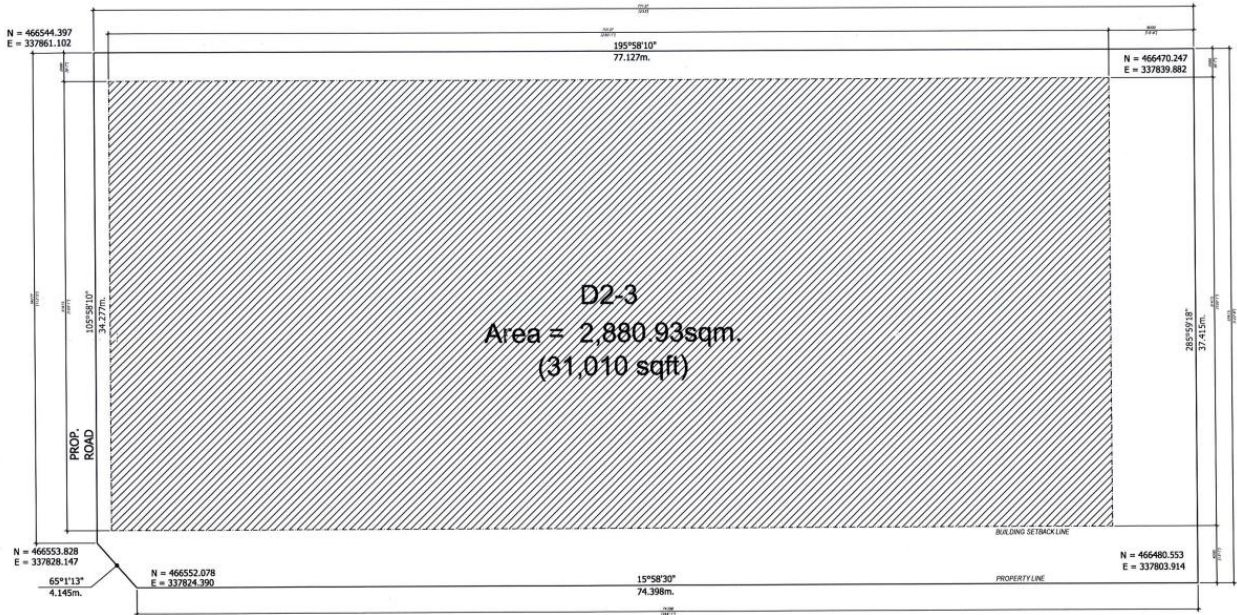


Figure 4 Project Site Plan

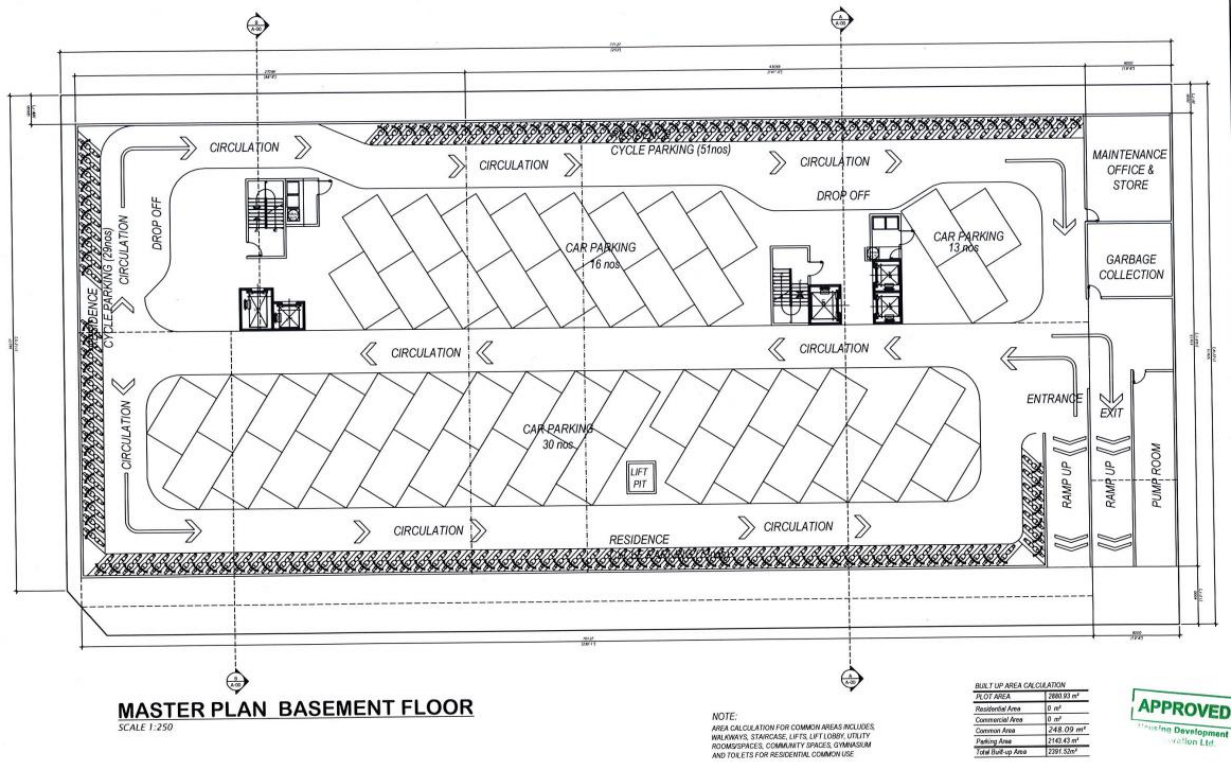


Figure 5 Basement Floor plan

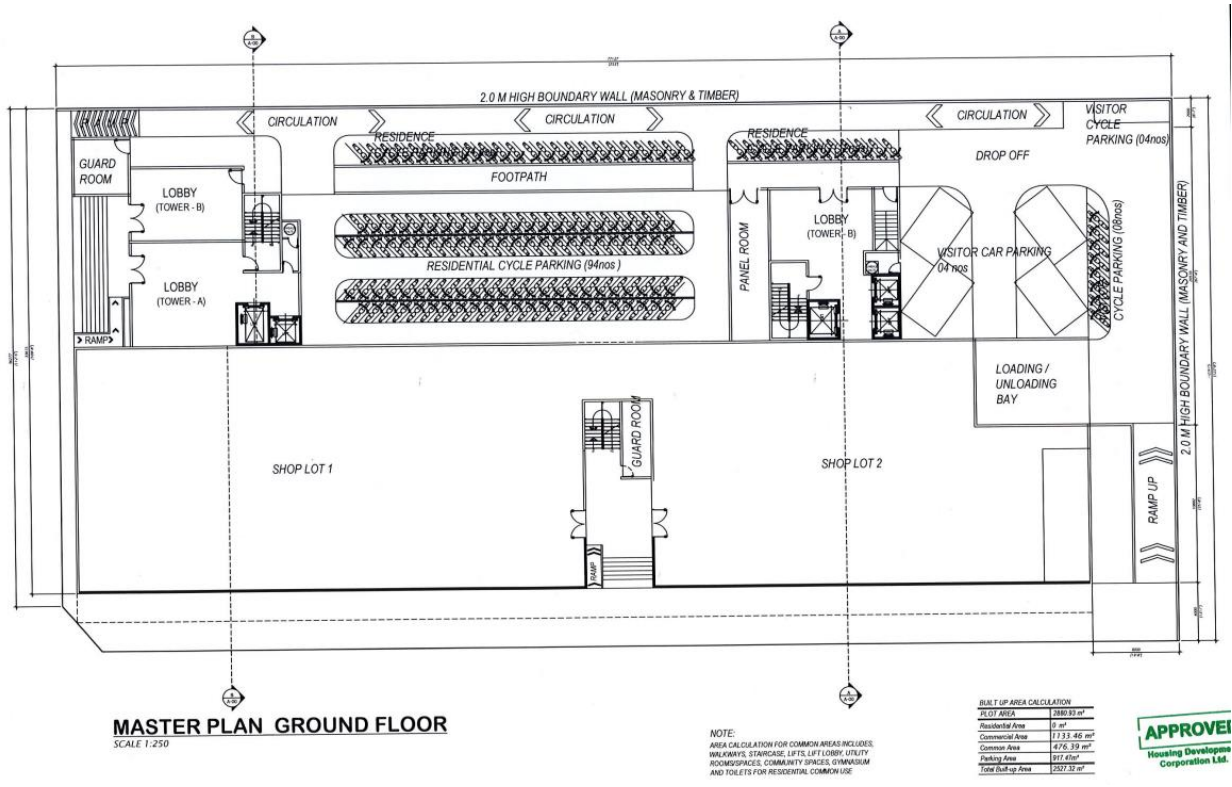


Figure 6 Master plan ground floor

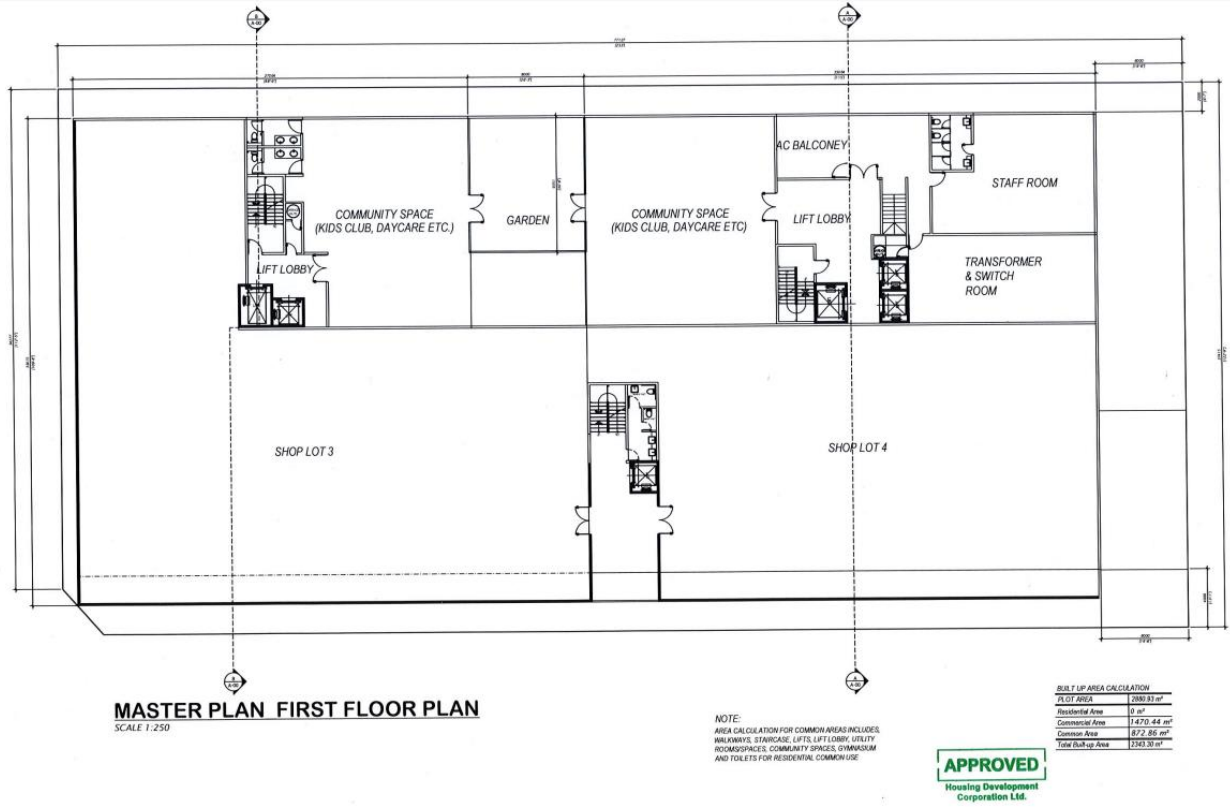


Figure 7 Master plan first floor

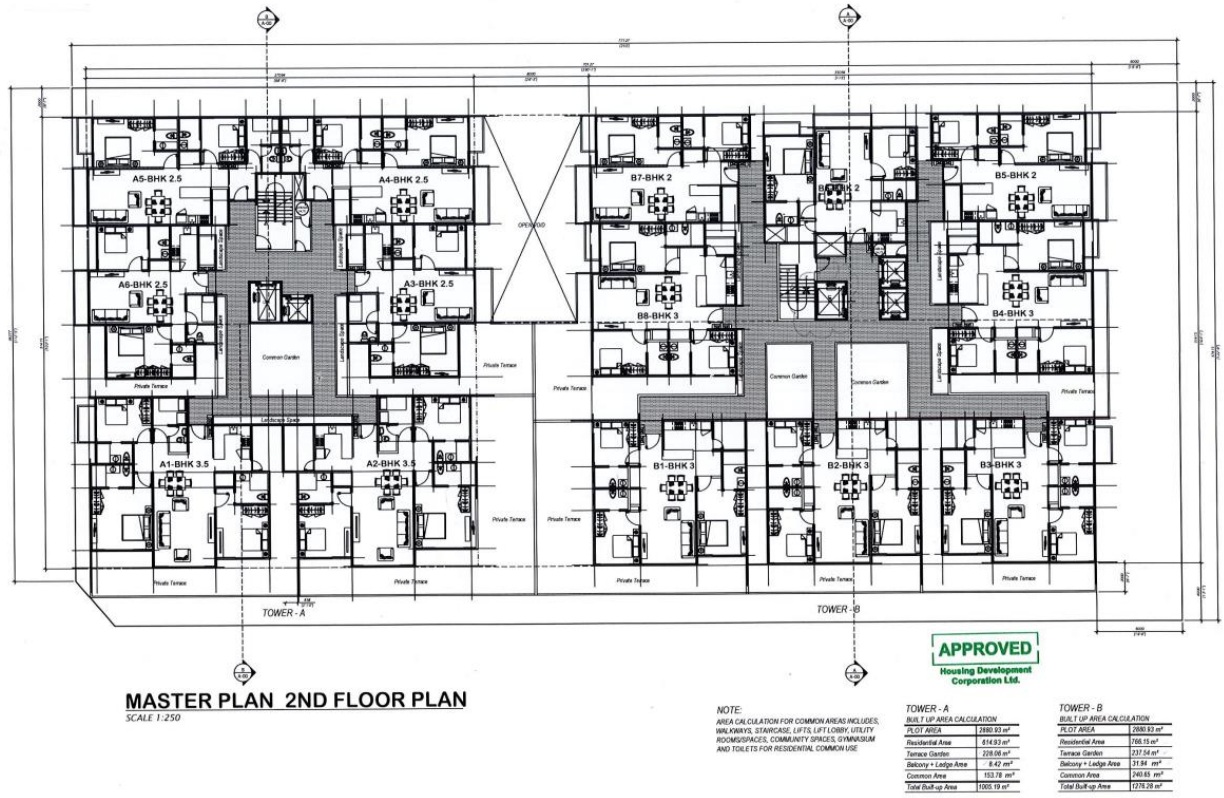


Figure 8 Master plan 2nd floor

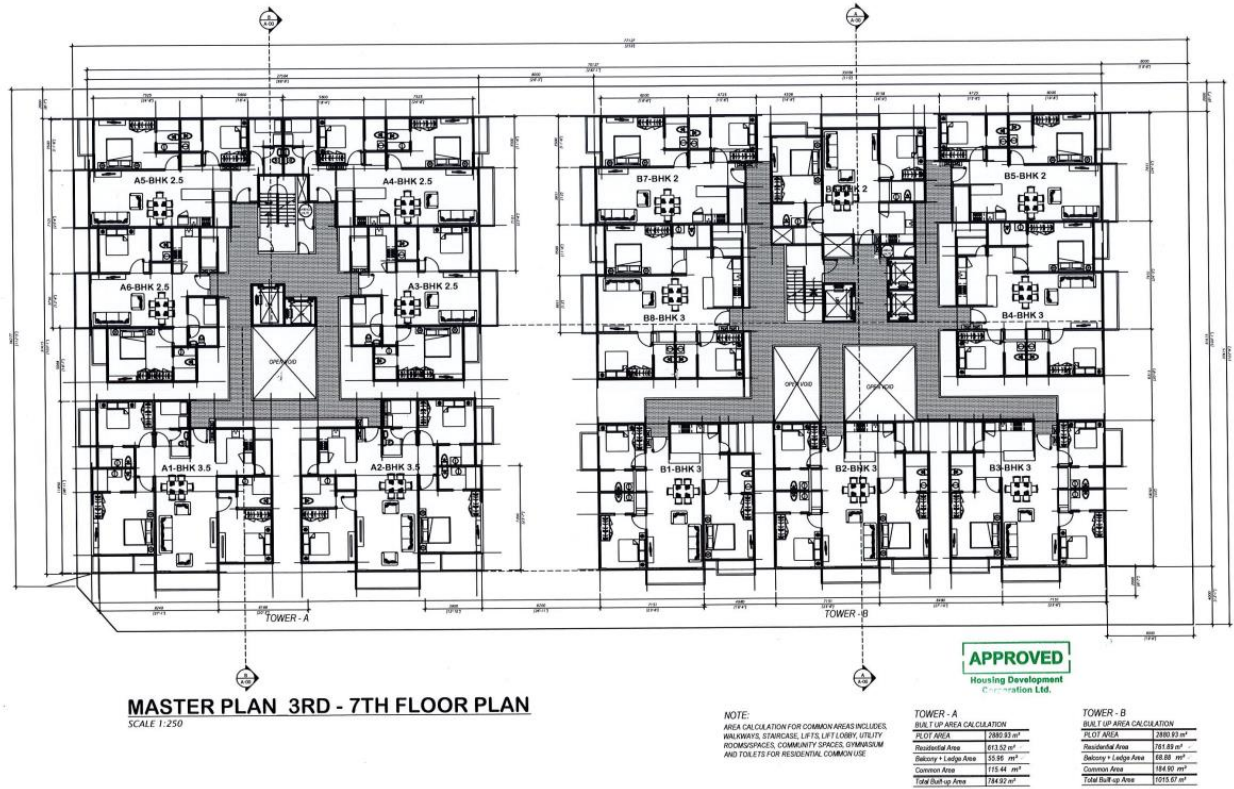
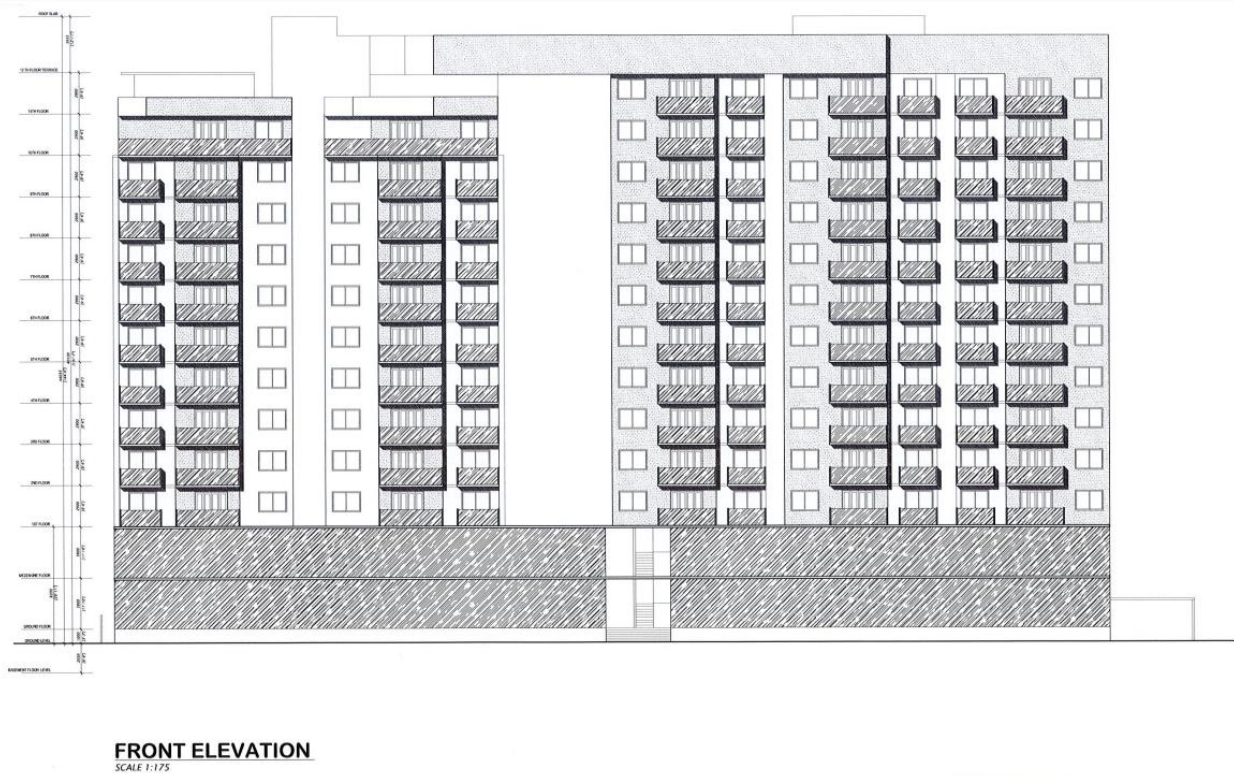
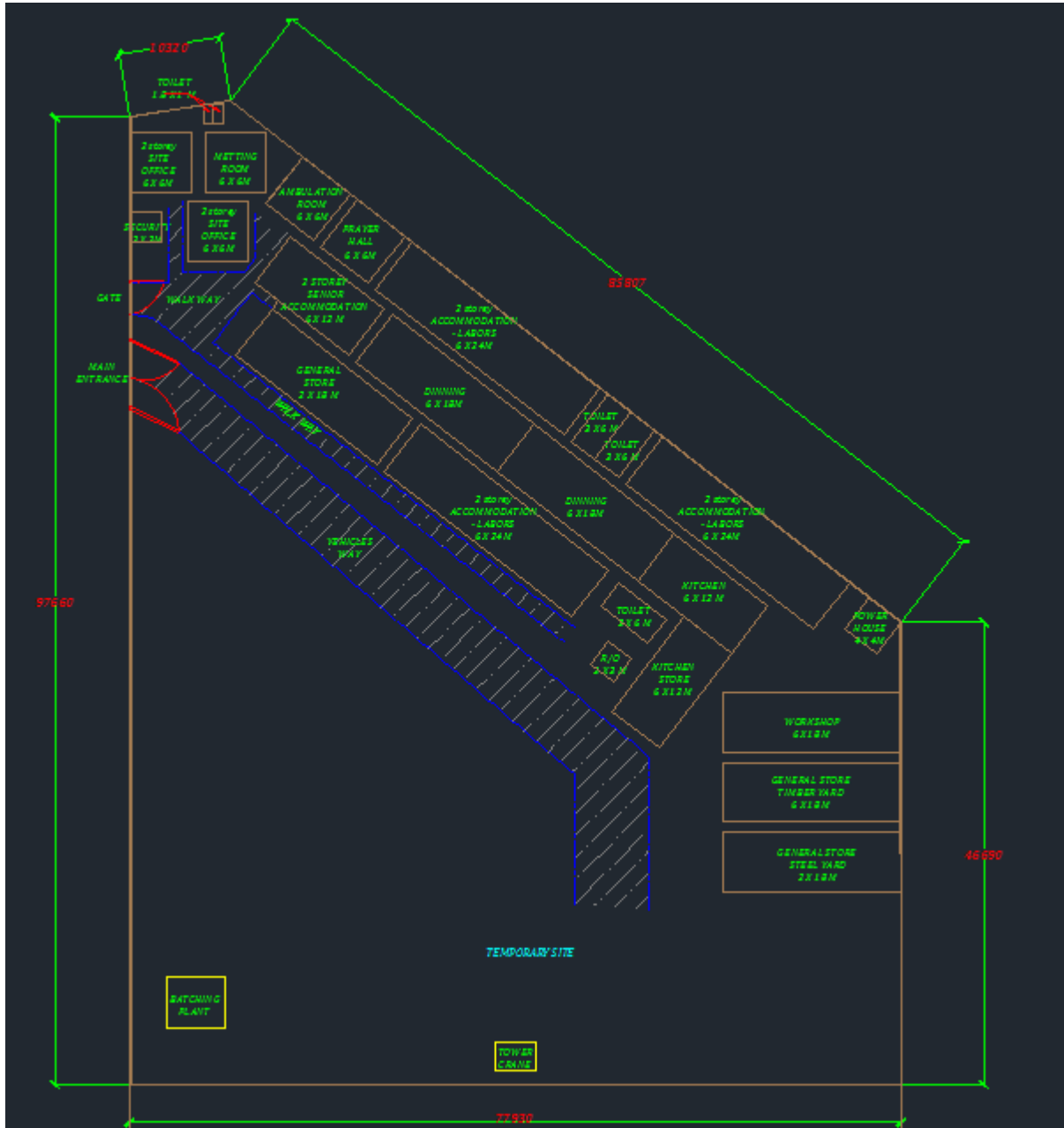


Figure 8 Master plan 3rd to 7th floor



2.1 Site setup

HDC has allocated a temporary land of over 60,000 sqft for material and equipment storage and staff accommodation. The location of the site is behind the proposed project site. The tentative temporary site layout is given below.



2.2 Excavation works

It has been established that the depth of foundation will be over 3.0m below the existing ground level. The estimated depth of water table in the area is 1.50m from ground level.,

dewatering will have to be continuous until casting of the foundation. Excavation will be undertaken with a backhoe excavator. Total excavation quantity is approximately 3,800 cum. Part of this this will be used for back filling

When all the necessary excavation is complete, a 50 mm thick lean concrete (Grade C15, 15MPa) layer will be laid to provide a level surface to assemble the reinforcement of foundation raft slab and beams.

2.3 Foundation Protection

The lateral pressure on the material adjacent to the excavation could be prevented materially by means of proper and careful placement of sheeting and bracing, i.e. around the perimeter line, 6mm thick steel sheets may be driven down to a depth of 1000mm below the proposed foundation depth in between 2 welded 75x75x6mm steel L-Angle sections (to form a T-section) at 1.22m intervals. Grouting and welding will be done at all joints to minimise water seepage to provide lateral stiffness.

Onsite close observation, frequent measurements and recording of the vertical and lateral movements and behaviours of the sheeting and bracing will be done to provide early warning of unfavourable development which might cause settlement of the adjacent road/property.

2.4 Dewatering

Dewatering is the localized lowering of the ground water table from its natural level, in order to create a dry environment for construction works. This is a critical process for creating the correct working conditions to establish the building substructures.

As previously stated, dewatering will be a continuous process and will be on-going simultaneously while excavation is being undertaken. The process will be continued throughout until casting of the foundation. It is envisaged that 5 or 6 pumps each with the flow rate of 30 litres per second will be located at specific locations to pump out the water to the sea, west of the site. The dewatering works will be done entirely by the contractor.

Water will be dewatered to a site close to the project site as identified by HDC. The current proposed dewatering site is shown below.

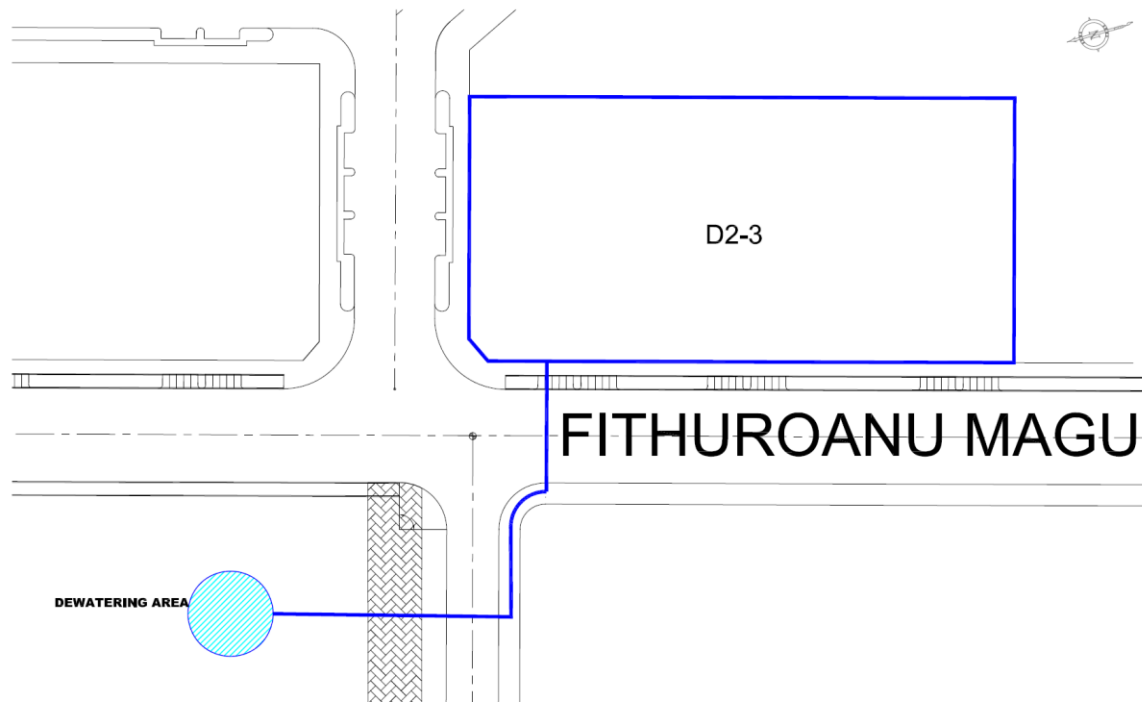


Figure 5 Dewatering location

2.5 Building Foundation

For the foundation works, a raft foundation be used. This is currently the most commonly adopted method of construction in Maldives. It enables to spread the load from a structure over a large area, minimizing the pressure exerted on the base. Beams will then be incorporated into the structure to stiffen the foundation.

Excavation in loose sand requires continuous support, and therefore supports will be placed immediately as excavation commences. Sheets would be closely spaced and horizontal support bracings provided as excavation progresses. Supports and bracings will be placed concurrently with excavation, moving along the periphery of the plot successively. The concrete works for the raft foundation will be done using C30 Grade concrete.

2.6 Construction materials and machinery

The heavy construction materials to be used are

- Excavators
- Concrete Mixers
- Dump Trucks
- Cranes

- Tower crane

All the materials such as cement, aggregate and sand will be delivered to site based on consumption. Steel and Plywood will be stored at the contractor's warehouse. Barb bending and carpentry work will be prefabricated at company work yard or given to sub-contractors and transported to site.

2.7 Utilities

Water and sewerage facilities will be provided by the MWSC water and sewerage network. Therefore water will be desalinated water from the main supply. And sewage will be disposed untreated along the main water outfall

Electricity will be provided by STELCO. STELCO has assured that they will be able to provide upto the requirements of the site. Backup generator will be placed on site during construction activities. A Sound Proof Diesel Generator, with specifications of 100 KW, 125/140 kva will likely be in place.

It is anticipated that the project site will require approximately 30 kW of power during the construction phase, while 25 m³ per day of desalinated water is anticipated during the construction stage of the development

During the construction, the amount of wastewater generated would be relatively low compared to its generation during the operation phase of the development.

2.8 Project Management

The project is managed by the contractor Rainbow Construction Pvt. Ltd. under the Rainbow group of companies. Construction works is undertaken entirely in house using company staff, most of which are made up of expatriates, who are already established in Hulhumale' for previous construction projects undertaken by Rainbow.

All labourers will be accommodated at Company Labour Quarters at the temporary site. There will be a consulting engineer hired in addition to an in house site engineer and site supervisor to manage the project.

All operations, work planning for the on-going construction work will be done at Site Office; Major operations will be done at company head office. Heavy machinery such as excavator, dump truck, tower crane, cement mixer, cement pump, and crane will be used during excavation and casting. Most of the machineries are rented while some equipment and machinery are owned by the company.

2.9 Waste Management

Sand excavated during foundation work will be stockpiled at the site. Upon completion of foundation works, sand will be reused for back filling. Excess sand can be transported to a stockpile as instructed by HDC.

It is estimated that during the construction phase, the project will generate wastes around 4 – 5 tons per day which will be collected on site, and stockpiled to a location identified by HDC. HDC will arrange the transportation of waste outside of Hulhumale' to Thilafushi if required. None of the waste will be placed outside the project boundary at any time. Temporary waste storage will be within the project-demarcated area.

All waste generated during concrete works phase and finishing phase will be collected at the end of each work day and temporarily stored in the ground floor. Construction solid waste will be transported to land fill site once a week. Hazardous waste such as empty oil-cans (lube-oil), paint cans or strainers will be kept separate and disposed according to the standards established by relevant government authority.

For waste generated during operations, waste collection bins will be kept at ground floor garage area.

2.10 Road closure and traffic re-routing

Road closure and traffic rerouting will not be necessary as part of this project, as there will not be any significant obstruction to the main road. The temporary site provided by HDC is adjacent to the project site away from the road, and all temporary storage of materials will also be at this designated site. The tower crane will also be fixed at the site. Therefore there will not be any need for road closures.

2.11 Work Schedule

The project is expected to commence soon after the approval of this EIA report, which should take approximately 2-3 weeks from submission. Dewatering permit will then be obtained.

Initially the architectural and structural design works had been completed and approved before undertaking the EIA. The site has already been cleared by HDC. Dewatering is scheduled to commence next, which will be carried out by contractor. Upon completion of dewatering, foundation works will begin and soon thereafter structural works will be carried out. Masonry work and interior works will commence afterwards.

The detailed project work scheduled is attached in Annex 5.

2.12 Safety on site

All precautions will be taken for safety of workers during the construction stage. Barricades, warning signs or devices will be placed on the road during casting or road works (connection of water lines and sewer lines) for safety of pedestrians and vehicles.

All workers are given instructions about the health and safety at Site. The Site Engineers and Supervisors will give a brief on daily basis before the work starts to all workers and all proper health and safety precautions will be implemented on site. Safety signs will be used on site, some of which are shown in the following Figure 6.

Personal protective equipment will be available for all the workers, for falling objects, hazardous dust or chemicals, or high working areas. Emergency first aid kit will be at site for minor injuries. First aid kit will be provided in the temporary office on the ground floor, after completion of ground and first floor slab where all safety clothing and equipment will be held. All workers and personnel entering the premises will be given hard hats and safety shoes.



Figure 6 Some safety signboards to be used on site

2.13 Accident and hazard scenarios

Assessment for accident and Hazard is given below.

The following hazard and accident assessment is based on the following 3 stages of the building lifecycle, including construction, use, and maintenance of building. Risk levels & probability are qualitatively assessed based on the following parameters; High, Moderate and Low.

Table 1 Accident and Hazard Risks

Performance Consideration	Risk Level	Risk Probability	Responsible Personnel
Presence of hazardous substances, which impact on construction work eg: asbestos, SMF, hydrogen chloride, etc.	High	Low	Project manager, Site Supervisor

Sufficient access / space around new section or building for use of cranes, scaffolding during construction	Moderate	Moderate	Project Engineer
Construction workers will be protected from / proximity to HV electrical, high risk energy sources	High	Moderate	Site Supervisor
Traffic / pedestrian risks are minimised for planned loading & unloading for construction vehicles	High	Moderate	Site Supervisor, Project Manager
Neighborhood construction considerations eg:, school vicinity, site location	Low	Low	Project Manager, HDC
Roof design will reduce /eliminate the risk of falls from height during construction	Moderate	Moderate	Project Engineer
Sufficient space is planned for access & to install / major fixed plant or equipment or specialised equipment, plant rooms	Low	Moderate	Project Engineer
Floor loading design has been assessed by engineer to be able to accommodate heavy equipment / plant to be installed in future	Moderate	Moderate	Project Engineer
Floor surfaces – even level with no sudden changes in levels – floor coverings non slip, suitable for levels of traffic use and suitable for type of tasks to be done	Moderate	High	Project Engineer
Stairs and balcony – edge delineation, slip resistant (SR) stair nosing, construction / design suitable for	Moderate	High	Project Engineer

intended use, handrails, non-horizontal railings in balcony			
Window positioning and solar glare	Low	High	Project Engineer
Safe Access to lighting fixtures to change fitting, bulbs	Low	Moderate	Project Engineer
Safe Access to plant rooms – locked, lighting.	Low	High	Project Engineer
Access to roof tops – safe access to within safety zone, minimised manual handling of material, equipment tools.	Low	Moderate	Project Engineer
Accessible window cleaning methods	Low	High	Project Engineer
Accessible gutter cleaning methods	Low	High	Project Engineer
Accessible dirt or rubbish collection points	Moderate	Moderate	Project Engineer Maintenance Officer

2.14 Project Inputs and Outputs

Each component of the project has inputs and outputs based on human resources, economics, and the environment. However, since the operation is carried out in house, project inputs and outputs are greatly conserved and limited.

The major inputs and outputs associated with the project encompassing all the components, are tabulated below. Table 1 highlights the main inputs, while Table 2 highlights the major outputs.

Table 2 Main inputs from the proposed project

Input resource(s)	Estimated Quantity	Main sources of resource
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Construction workers	<p>01 Project Manager</p> <p>01 Project Engineer</p> <p>01 Consultant Engineer</p> <p>01 Local Supervisors</p> <p>20 Skilled Foreign Laborers</p> <p>20 Non Skilled Laborers</p> <p>03 Security Staff (24 Hours security)</p>	Contractor's permanent staff. Project staff. Labourers mostly registered workers from India.
Machinery and equipment	<p>Excavator</p> <p>Cement Mixer</p> <p>Concrete pump</p> <p>Dump Truck</p> <p>Crane</p> <p>Tower crane</p>	Sourced from contractor's own equipment/machinery. If new machinery required, sourced from local rentals.
Energy supply (during construction)	~30kW	From STELCO mains
Cement (Ordinary Portland cement)	+5,000 bags	Procured from local supplier
Sand	+12,500 bags	Imported from abroad
Aggregates	+20,000 bags	Imported from abroad

Ply wood (12mm thick),	+1300 No.	Procured from local supplier
Timber (Hard wood)	+7500 No.	Procured from local supplier
Steel	+85 tons	Procured from local supplier
Painting Exterior (Seamaster, or Equivalent Emulsion) Interior (Seamaster or Equivalent Emulsion)	Not yet determined	Procured from local supplier
Masonry Blocks (300x150x150)	+65,000 No.	Developers material sourced from India
Hydraulics and Drainages	All the UPVC pipes and fittings shall be used high pressure pipes.	Procured from local supplier
Tiling materials	General Floor - Homogeneous tile. Toilet floor - Ceramic tile. Toilet wall - Ceramic tile.	Procured from local supplier

Table 3 Major outputs from the proposed project

Products and waste materials	Anticipated quantities	Method of disposal
Waste generated during construction	2-3 tons per day	Collected and sorted at site, and taken to Thilafushi waste collection area.
Waste water (dewatering)	30 litres/second	Water flow towards the lagoon on the west of hulhumale'
Waste oil and grease	Minute quantities	Collected in used containers and transported to waste site
Air pollution	Debris in minute quantities	External influence minimised by site demarcation temporary boundary walls.
Noise pollution	>80 db(A)	Minimised by site demarcation barriers. Ear muffs and safety equipment for workers on site.
Waste generated during operations	3 – 5 tons per day	Collected on site and transported to waste collection site in Hulhumale'
Waste water generated during operations	165 tons per day	Via MWSC sewerage network

3 Description of the Existing Environment

This section covers the existing environmental conditions of the project site. Since this is a housing project, the key components with respect to the project under consideration are described below.

- Climate
- Existing structures
- Vegetation
- Traffic flow
- Noise pollution
- Water quality
- Hazard vulnerability

Data was collected using methods discussed in Section 1.4.

3.1 Climate

This section deals with the regional and local climate of the study area.

Data has been taken from the weather station at Hulhulé, the island which accommodates the International Airport, and adjacent to Hulhumale'. Long-term meteorological data for Hulhulé is available and being less than a kilometre away from the project location, the station is at an ideal location.

The Maldives, has a warm and humid tropical climate with average temperatures ranging between 25°C to 30°C and relative humidity ranging from 73 per cent to 85 per cent. The country receives an annual average rainfall of 1,924.7mm in the central parts of Maldives, where Male' is located. (Department of Meteorology, 2012).

The climate of the Maldives is dependent upon the Indian Ocean Monsoons. Monsoon wind reversal plays a significant role in weather patterns.

The two monsoon seasons observed in the Maldives include the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The northeast monsoon is the dry season that occurs from December to February and the southwest monsoon is the rainy season, which lasts from May to September. The transition period of northeast monsoon occurs from October to November while that of southwest monsoon occurs between March and April. The 'four seasons' of the Maldives is highlighted in the following Table 4.

Table 4 Four Seasons of the Maldives

Seasons	Duration
South West Transition	March to April
South West	May to September
North East Transition	October to November
South West Transition	December to February

3.1.1 Wind

Wind is an important indirect process affecting formation, development and seasonal dynamics in the Maldives. Winds often help to regenerate waves that have been weakened by travelling across the reef and they also cause locally generated waves in lagoons. Therefore winds are an important factor, as being the dominant influence on the hydrodynamics in most coastal areas. With the project site only about a 100m away from the coast, this is an important factor.

The two monsoon seasons have a dominant influence on winds experienced across Maldives. Since Maldivian islands are spread across the equator, monsoons are relatively moderate while strong winds and gales are rare. However, during South West monsoon gusts of up to 60 knots have been recorded at Male'. Wind is an important indirect process affecting the formation, development and seasonal dynamics of the Maldivian islands. Reversal of winds in the Maldives means change of seasons from North East monsoon to South West or vice versa.

General wind surface wind pattern over the country during North East monsoon is north-easterly direction whereas during South West monsoon mean wind flow is westerly.

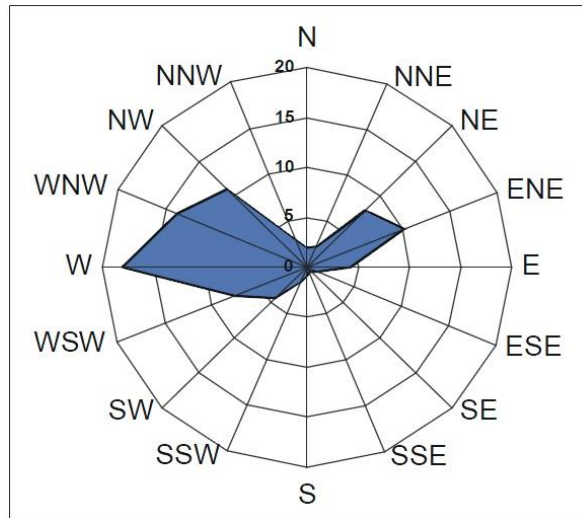


Figure 7 General wind rose diagram (MEEW, 2006)

3.1.2 Waves

Wave climate is not as important for a structure situated directly at the coast. Therefore, for the purpose of the EIA, there were no measurements carried out for the wave generation on a local scale. However, regional data has been studied and visual observation on site was used to analyse the environment, as even though there is low probability that direct wave impact will occur at the project site, inundation due to larger swells is possible for the area.

Two major types of waves are formed on the Maldives coasts: wave generated by local monsoon wind and swells generated by distance storms. The local monsoon predominantly generates wind waves, which are typically strongest during May-July in the aforementioned southwest monsoon period. During this period, swells generated north of the equator with heights of 2-3 m with periods of 18-20 seconds have been reported in the region. Local wave periods are generally in the range 2-4 seconds and are easily distinguished from the swell waves.

The coastline facing the project site is about 700m away from the reef edge, and is therefore well protected. Furthermore, the reef flat facing the area has been reclaimed to extent providing a good protection as a breakwater. Additionally, the western side shoreline is sheetpiled with a concrete capping.

3.1.3 Rainfall

The average annual rainfall for the archipelago is 1,937mm. There are regional variations in average annual rainfall. Southern atolls receive more rain compared to the northern atolls (MEC, 2004). Mean monthly rainfall also varies substantially throughout the year with the dry season getting considerably less rainfall. The north east monsoon is known as the dry

season and the south west monsoon the rainy season. It is not expected that the project team will have to endure heavy rainfall during the excavation and foundation works based on the current schedule.

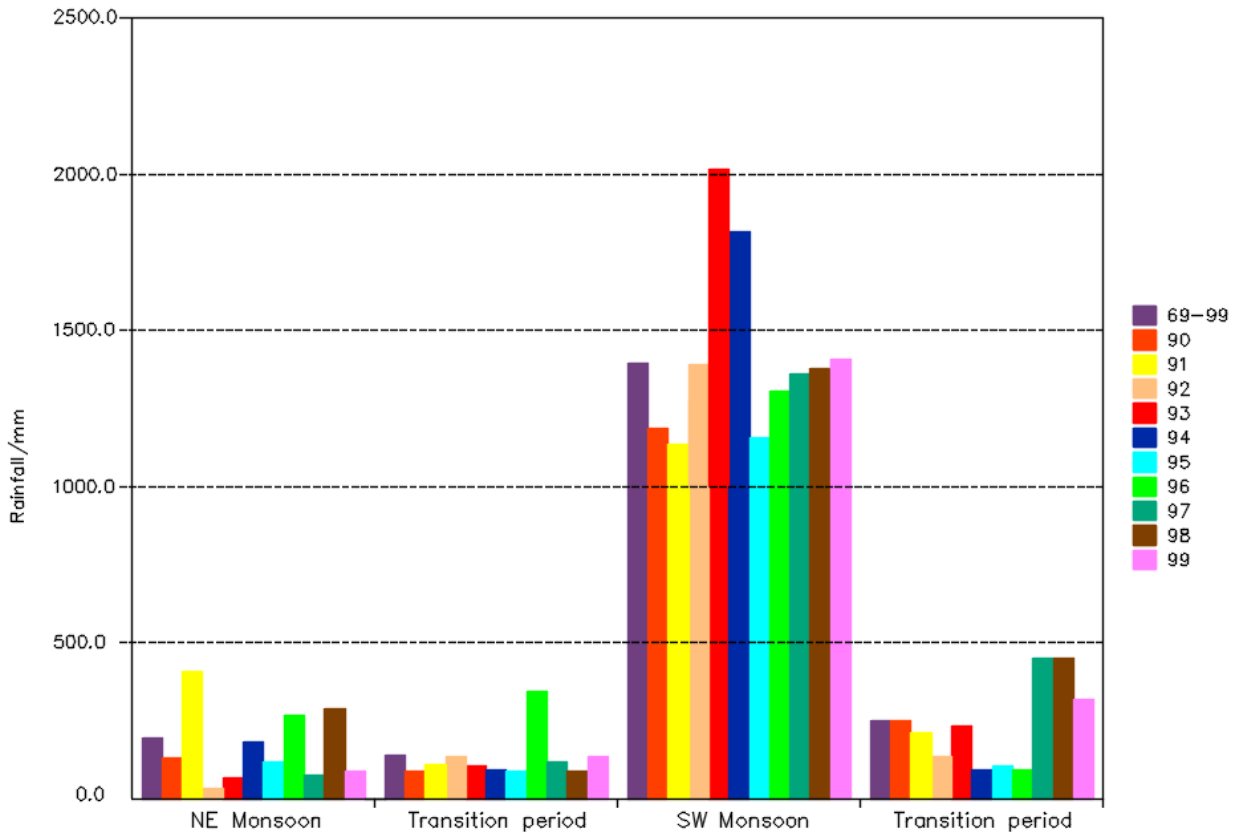


Figure 8 Annual Seasonal rainfall variation in Hulhule'

3.2 Existing structures

There are no other buildings on the same block as Rainbow Oceanfront. There is a structure on the adjacent block west of the proposed site, the MPL harbour port. This is also the main public property near the project site along with the passenger ferry terminal, which is about 150m away from the proposed site. It is not envisaged the project will have any impact on a structure within such distance.

Condition of the road near the project location was good.

3.3 Vegetation

This is a site that has not been used for any purpose. The vegetation that was planted after reclamation of the island, has been cleared from this area and therefore there is no vegetation of note to be found at the site, except for grass and few bushes. Roadside vegetation will be removed to provide better access to site during the course of the project. This includes 4-6 Fithuroanu Gas (Beef wood) *Casuarina equisetifolia*. The vegetation condition at site can be seen from the following images.



Figure 9 Terrestrial conditions at site

3.4 Traffic Survey

Traffic load at Fithuroanu Magu was expected to be low to moderate relative to the busier roads of Hulhumale'. The main trajectory of vehicles and pedestrians arriving in Hulhumale' is towards North rather than South. However, not in the western edge of the island, where this project is proposed. Taking the Ferry terminal as a reference point, majority of the traffic flow directly towards east. Therefore, the no. and frequency of vehicles in this area is currently remarkably low.

A traffic survey was undertaken on Fithuroanu Magu in front of the project site. The survey results can be seen below.

Throughout the survey, the traffic in the area was very limited.

In this regard traffic counts were carried out on 25th October to 30th October from, 18:00 - 19:00. Summary of data recorded is provided in the following figure.

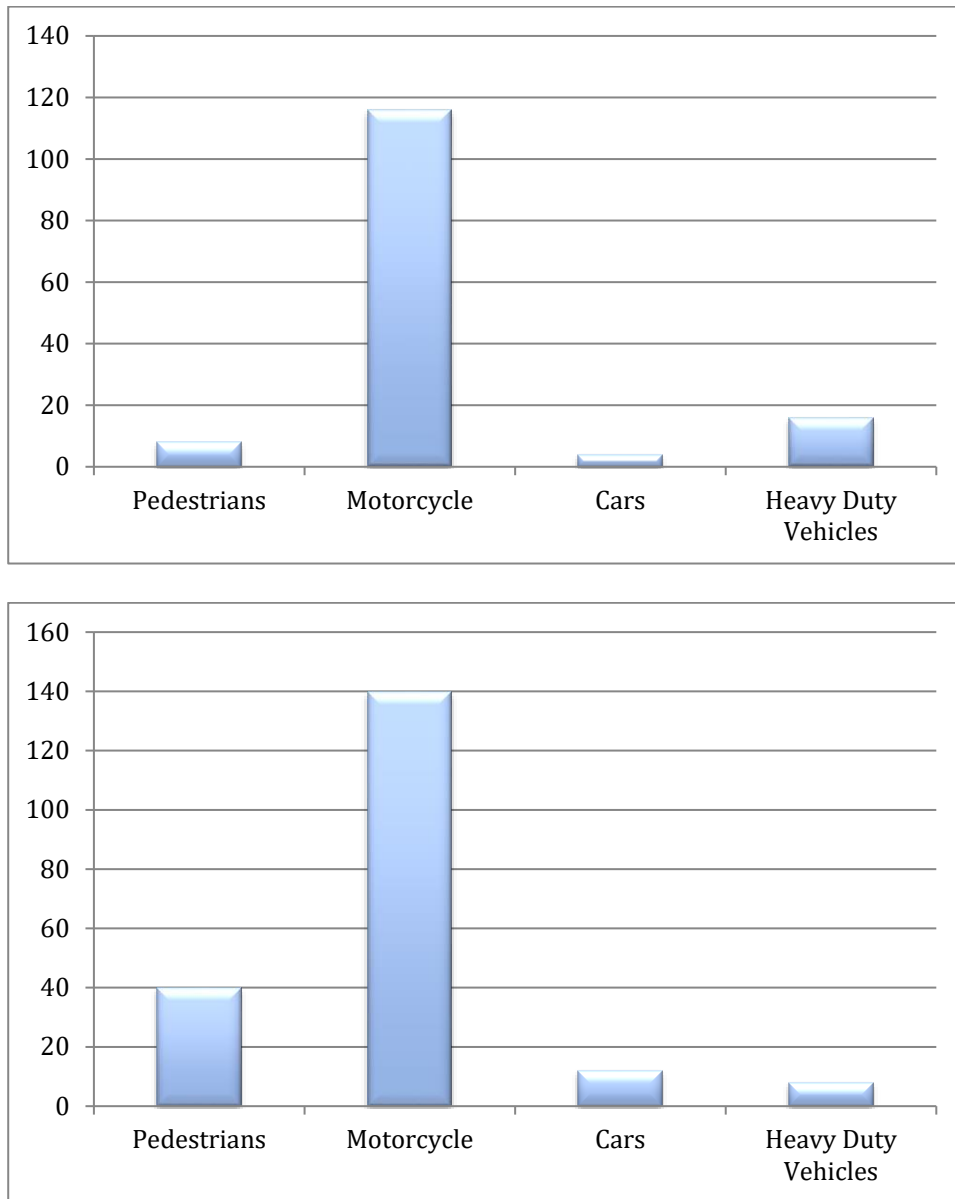


Figure 10 Traffic flow from 15:00 – 16:00 (top) 18:00 - 19:00 (bottom) in front of project site.

As the results demonstrate, the traffic in the area is very low. Any potential road closures will not have a significant impact. However, for this project, the road will not need to be fully closed for prolonged period, as there is sufficient area to work in behind the project site.

3.5 Noise Pollution

Noise pollution can be an environmental and health hazard. However, there are no currently no guidelines for noise levels at residential areas in general. Examples of guidelines with regard to noise for residential areas as set World Bank Environmental Health and Safety guidelines for noise at residential areas are:

Daytime reference value for noise as set by the bank is 50 dBA while night time value is set at 45 dBA. For industrial area the noise reference level is set at 70dBA.

Figure 11 gives the noise levels measured at the selected sites in the vicinity of the project area. These measurements were taken during evening to include ambient noise from traffic that is present in the vicinity in general. As stated in the traffic flow section, this area undergoes very low traffic throughout the day and therefore noise pollution is generally low, with sudden spikes, usually when a motorcycle passes by. During the spikes, the measurements exceeded the reference levels.

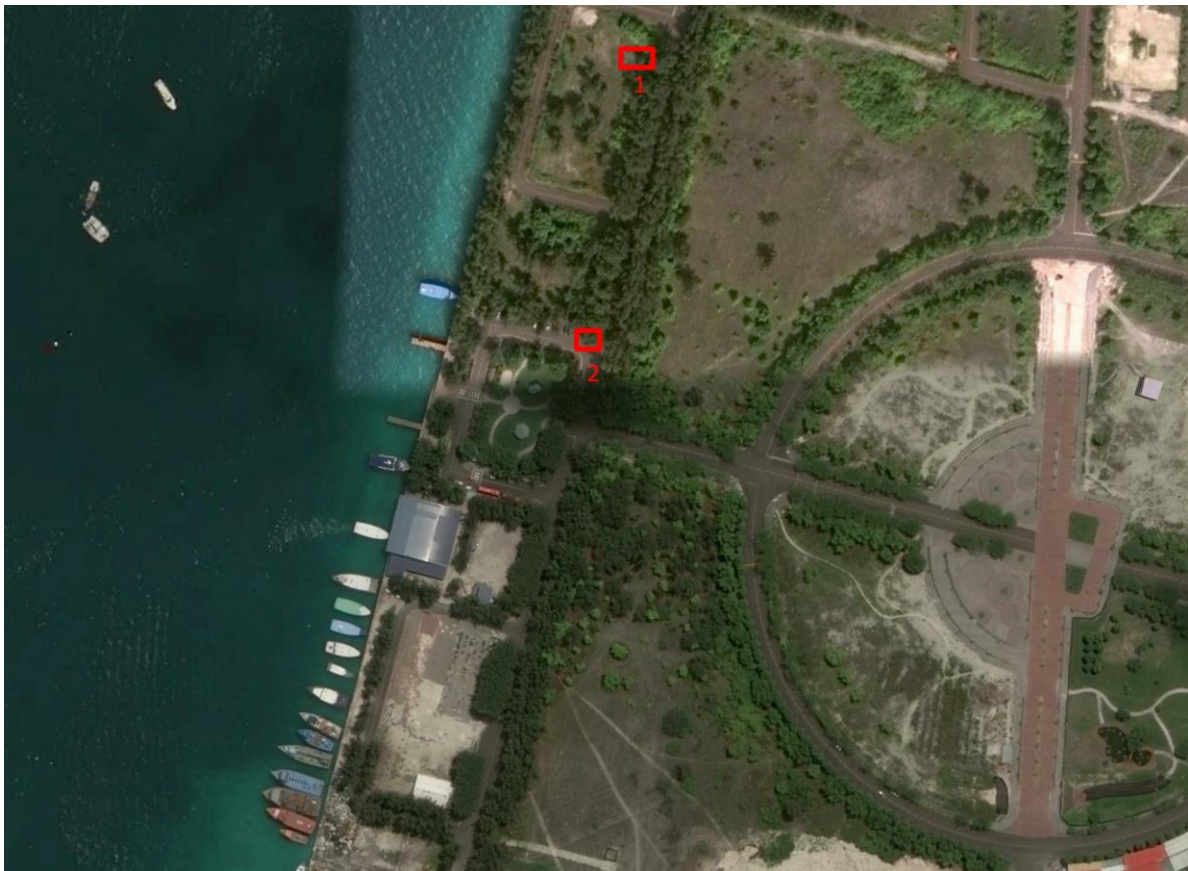
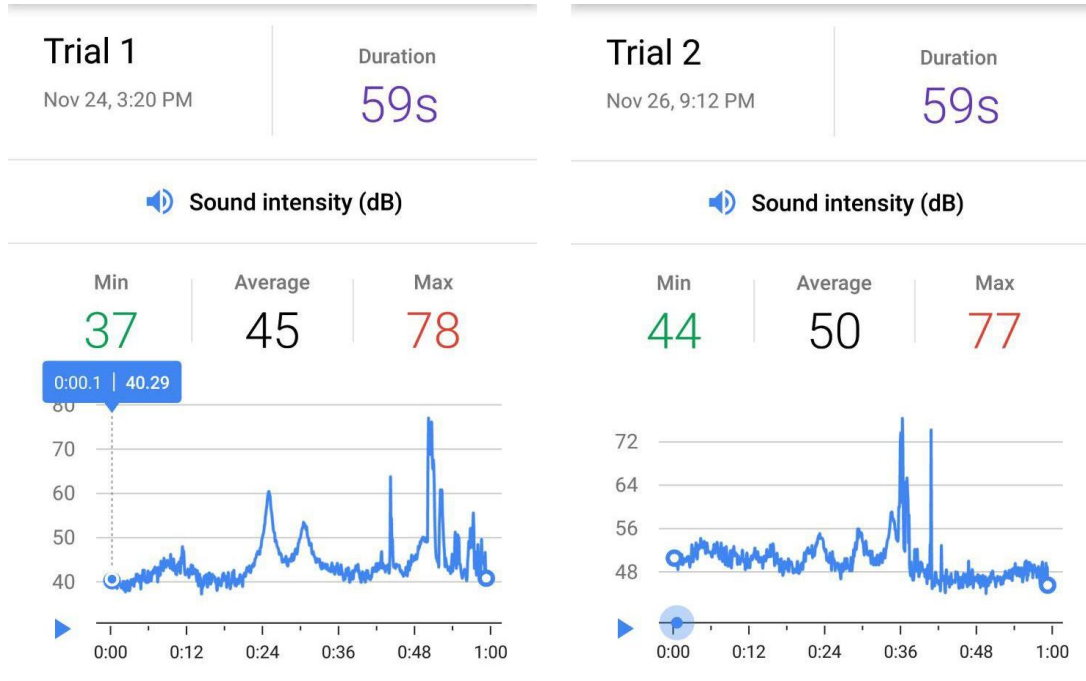


Figure 11 Noise Graph for 2 Sites near project area

The average noise level as can be seen is about 50 dB, and the lowest go down to 37 dB, which is quite low. Spike maximum goes to about 80dB. Noise levels were almost entirely

determined by traffic, with the spikes occurring during loud occasional motorcycle or heavy vehicle transport.

3.6 Water quality

Ground water in the location was sampled and sent for testing to MWSC, Results of this test are shown in Table 5 below (see Annex 4 for results sheet).

It is noted that the groundwater quality of Hulhumale' has deteriorated slightly over the past several years due to extraction of groundwater for several development projects such as water and sewerage and road construction projects, along with major building infrastructure project. However, the quality is much better relative to that of Male'. Moreover, the proposed site does not have any significant development thus far.

Table 5 Groundwater quality

	Unit	Project Site 1	Project Site 2
GPS Location	-	4°13'9.43"N, 73°32'20.41"E	4°13'9.15"N, 73°32'20.08"E
Electronic Conductivity	µs/cm	451	446
pH	-	8.17	8.69
Salinity	ppt	0.22	0.21
Temperature	°C	20.6	20.6
Total Petroleum Hydrocarbon (TPH)	mg/L	7.1	6.4
Total Dissolved Solids (TDS)	mg/L	225	223
Turbidity	NTU	2.99	1.08

As seen from the results, the parameters from the project site show good water quality, especially with respect to sites in Male' and some other sites previously tests in Hulhumale'. Electrical Conductivity is a very important parameter with regards to groundwater over extraction and increase in groundwater salinity. The EC value is at a good level. The

following figure shows the water collection pit, where the soil profile in the area can be observed. The water was collected from about 1.5m below ground level. A detailed soil test has also been carried out for the project, the result of which is attached in the Annex.



Figure 12 Groundwater collection pit including soil profile.

3.7 Socio – economic Environment

3.7.1 Population

The population of Hulhumale' based on most recent official results is 15,769 divided to 8,175 males and 7,594 females. Total no. of foreigners residing in Hulhumale' is about 1200. However, HDC data shows current residential population in Hulhumale as 65,520 people.

Hulhumale' population is growing rapidly and is the fastest growing in the country. In 2006 census the total population of Hulhumale was only 2866 people. Therefore the exponential growth is set to continue. The population is projected to rise up to about 100,000 in 2020. There are many housing projects proposed in the island, and migration from Male' and even from other island is anticipated to increase at a greater rate. Moreover, Male'-Hulhumale' bridge project is currently ongoing and will complete in 2018. This gives incentives to residents in Male' to move away from the congestion in the capital island.

3.7.2 Transport

Access to Hulhumale' is by ferry operated by the Maldives Transport and Contracting Company Plc Ltd (MTCC). Ferry is available throughout the day except between 3am to 5am.

The average carrying capacity of the ferries are about 100 people per boat. Regular bus is available to travel from the Ferry terminal to the several location in the residential areas.

There is also a regular bus traveling between Hulhumale' and Hulhule' every 30 minutes. There are more options to travel between Hulhumale' and Hulhule' currently; by private vehicles of guest houses operating in Hulhule'. The vehicles, usually vans provide taxi services to locals.

Traveling within Hulhumale' is by taxi services and also private motorcycles. Currently bicycles are also getting increasingly popular. The island is designed is a pedestrian friendly manner with big pavements available through the island, and especially in the main roads.

3.7.3 Education

Hulhumale' currently have 3 secondary and higher secondary schools, namely; Ghaazee School, Rehendhi School and Lale' International School. Lale' International School is currently up for bidding and it is anticipated another international group will run the school from next year onwards.

Preschooling options in Hulhumale' currently consists of Little Gems Preschool and Lale' International School. A new preschool is currently being built and is anticipated to be operational from 2017 onwards. While most of the local residents obtain schooling from the local schools, some do travel to Male' daily. There are fewer occasions where students from Male' come to Hulhumale' schools.

3.7.4 Health

There is a main public hospital in Hulhumale' on the main road. It is the central health care provider in the island. The hospital was previously run by the Ministry of Health and recently management has been shifted to Medical Insurance Provider 'Aasandha'. Due the relatively less congestion at the site relative the Male', the hospital does get patients from Male' in addition to Hulhumale' residents. Currently, there are some major renovation works being undertaken at the hospital.

A multi speciality international hospital has been proposed for Hulhumale' and is nearing completion. The hospital is expected to be operational sometime in 2017. When fully

developed, the hospital will have a capacity of 600 beds and will have private access to emergency facilities.

Additionally, there are few clinics currently being opened in Hulhumale', including dental clinics and general clinics.

3.7.5 Utilities

Utility services are provided by the biggest utilities in the Maldives; STELCO and MWSC. Both companies inform they have the capacity to deal with the current developments in Hulhumale' and are poised for expansion as new developments come in. Current power generating capacity at STELCO, Hulhumale' is 12MW, while there are plans to upgrade to an additional 3MW in the coming months.

3.7.6 Tourism

Hulhumale' has been a hub for budget tourism and guest house development. Currently it is estimated there are about 94 guest houses in the island, with the total capacity to cater for about 2000 guests at any one time. International visitors numbers provided by HDC states that in 2016 alone over 126,385 guests visited the island and is projected to rise exponentially to over 650,000 guests in 2020.

Hulhumale' is also a popular destination for local tourism with many locals travelling to the island on weekends on holidays, mainly from Male'. In 2016, about 820,144 locals visits are accounted for and the number is projected to rise to over 1,200,000 in 2020. However, this could be a gross over estimate.

3.8 Hazard Vulnerability

Maldives in general does not experience natural disasters and hazards on a frequent basis. However, the Indian Ocean Tsunami in 2004 was a historic reminder on potential hazardous threats the country faces. The islands across Maldives face similar type of threats and hazards to varying degrees and magnitude depending on several factors.

The vulnerability of islands to natural hazards depends on geological and more importantly geographic aspects of the island. As such, the location of the island, with respect to the country and atoll is quite important. Likewise, the level of protection the island is offered from

neighbouring islands, and the house reef, shape and orientation of the island are also important factors.

Based on the UNDP Disaster Risk Assessment Report of Maldives in 2006, Hulhumale' is located in an area that has been designated as a low-risk hazard zone. However, as stated in the report, sea level rise due to climate change is a uniform hazard throughout the country, and will have high impact on Hulhumale' as well. Figure profiling the Maldives based on the hazard zones are given in Figure 20.

Oceanfront being located virtually on the western rim of the island, any impact at the project site will be minimum compared to those at eastern side. However, in an event of a disaster such as a tsunami, where the impact will be felt throughout the island, the project site will also be vulnerable. It should be taken into account that the impact from the 2004 Indian Ocean Tsunami, was felt more on the eastern side rather the west.

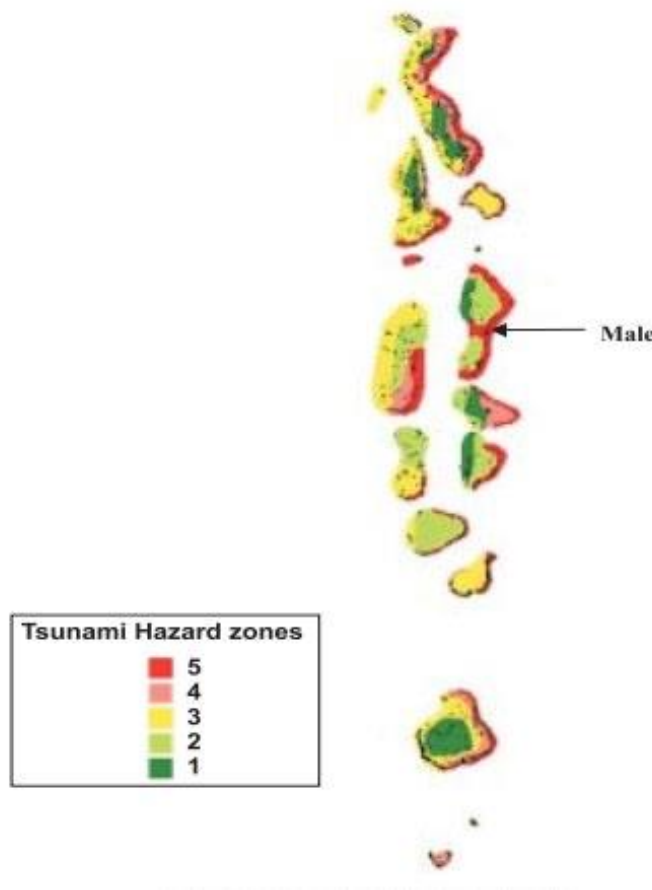


Figure 13 Disaster risk profile of the Maldives (UNDP, 2006)

4 Legislative and Regulatory Considerations

The legislative and regulatory consideration the project adheres to is mostly at a national level, since it takes place on a local scale within the Maldivian environment. The extent to which the project conforms to existing plans, policies, guidelines, regulations and laws of the Maldives are considered in this Section. Some of the more important regulations are stated within the context of this project scope. The regulatory context in which the project activities take place and the legal and policy aspects relevant to those activities will be discussed in the Section.

4.1 Environmental Protection and Preservation Act (Law No. 4/93)

The major legal instrument relating to environmental protection is the Environmental Protection and Preservation Act (Law No. 4/93) of the Maldives passed by the Citizen's Majlis in April 1993. This Act provides the Ministry of Environment with wide statutory powers of environmental regulation and enforcement. This umbrella law covers issues such as environmental impact assessment, protected areas management and pollution prevention. The following clauses of the Environmental Protection and Preservation Act (Law No. 4/93) are relevant to the project:

Clause 5a: An impact assessment study shall be submitted to the Ministry of Environment, and Energy before implementing any development project that may have a potentially detrimental impact on the environment.

Clause 5b: The Ministry of Environment, and Energy shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

Clause 6: The Ministry of Environment, and Energy has the authority to terminate any project that has an undesirable impact on the environment. A project so terminated shall not receive any compensation.

Clause 9a: The penalty for minor offences in breach of this law or any regulations made under this law, shall be a fine ranging between Rf5.00 (five Rufiyaa) and Rf500.00 (five hundred Rufiyaa), depending on the actual gravity of the offence. The fine shall be levied by the Ministry of Environment, and Energy or by any other government authority designated by that Ministry.

Clause 9b: Except for those offences that are stated in (a) of this clause, all major offences under this law shall carry a fine of not more than Rf100,000,000.00 (one hundred million Rufiyaa), depending on the seriousness of the offence. The fine shall be levied by the Ministry of Environment, Energy and Water.

Clause 10: The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment. This includes all activities mentioned in Clause No. 7 of this law as well as those activities that take place outside the projects that are identified here as environmentally damaging.

4.2 Regulation on Aggregate and Sand mining

This regulation addresses sand mining from uninhabited islands that have been leased; sand mining from the coastal zone of other uninhabited islands; and aggregate mining from uninhabited islands that have been leased and from the coastal zone of other uninhabited islands.

Coral mining from the house reef and the atoll rim has been banned through a directive from the President's Office dated 26th September 1990. Under Article 7 (c) of the Regulation on Sand and Coral Mining issued by the Ministry of Fisheries, Agriculture and Marine Resources (MOFAMR) on the 13th of March 2000, it is an offence to mine sand or coral from the beach, lagoon or reef of any inhabited island and islands leased for the purpose of building a tourist resort.

This regulation would not have any implication on the project, as manufactured sand will be used for the construction works.

4.3 EIA Regulations

The EIA Regulations, which initially came into force in May 2007 has been amended and re-published in May 2012 based on the Environmental Protection and Preservation Act. The EIA Regulations have been the basis for Environmental Impact Assessment in the Maldives and since its inception; it had helped to improve the quality of EIAs undertaken in the country. Today, registered consultants are required to sign EIAs and the reports are subsequently reviewed by two independent reviewers and a final decision is made by EPA based on the

reviews. Likewise, this EIA report would also be subject to these requirements and review criteria.

'Jadhuvalu Raa' of the new EIA Regulations lists the different environmental projects that require an Environmental Impact Assessment study. High rise building construction works is among this list and thus a full Environmental Impact Assessment was needed to be carried out for this project. It is specifically stated that buildings with foundation deeper than 5ft / 1.5m will require Environment Impact Assessments to be carried out. This project proposes a foundation 2.77m deep.

The EIA Regulations sets out the requirements for the contents of Environmental Impact Assessment reports in 'Jadhuvalu Baa' and format for monitoring reports have been given in 'Jadhuvalu Laamu'. Therefore, these requirements have been taken into consideration in preparing this EIA report.

On 9th April 2013, a further amendment to the EIA Regulation 2012 has been published, which deals with repeated offenders of the regulation. Under Clause 20 of the regulation, the amendment proposes a new Schedule. 'Jadhuvalu Taviyani, which lists penalties for repeated offenders. Under 'Jadhuvalu Taviyani', repeated offenders of the regulation will be fined based on the following criteria

- For Initial offence: 20,000 MVR
- If an offence is repeated for the 2nd time: 60,000 MVR
- If an offence is repeated for the 3rd time: 120,000 MVR
- If an offence is repeated for more than 3 times: 200,000 MVR for each offence.

On 11th August 2016, a third amendment was published, which mainly deals with revised criteria for EIA evaluators, environmental consultants and their performance evaluations.

4.4 Maldives National Building Act 2010

The Maldives National Building Code is currently at the draft stage. It recommends best practices, in addition to regulations to be adhered to during construction work. It covers aspects such as structural stability, fire safety, access, moisture control, durability, services and facilities, and energy efficiency. Once the building act is published, it will be enforced

and all contractors will need to adhere to the regulations provided. Currently the contents are followed as a guideline.

4.5 Waste Management Regulation, 2013

Waste Management Regulation (No. 2013/R-58) came into effect on 6 February 2014. The Regulation was gazetted on 05 August 2013. The regulation provides a set of comprehensive guidelines and on collecting, storing, transporting and managing waste as well as management of hazardous waste. The waste management regulation prohibits dumping of waste on to parks and roads; protected areas under the Environmental Protection and Preservation Act. Moreover, waste management regulation states that those involved in waste management must be permitted by the Environmental Protection Agency.

Clause 11 of the regulation deals with terrestrial wastes and states that waste should be deposited and managed only at sites allocated by the relevant authority.

Clause 26 of the regulation deals with the transportation of wastes.

Clause 34 of the regulation states the procedure for penalties for those that do not abide by the regulation.

Jadhuvalu (annex) Haa 1.1 states the regulation applicable to household wastes.

- Waste should be stored within the household in a container with a lid, such that there is no opening for any leakage. This is the responsibility of the household dwellers.
- There should not be any leakage of waste from waste storage to waste transport vehicle
- Any waste that can potentially leak out liquid should be properly sealed
- Waste should be sealed such that no insect or animal will be able to access the contents of the stored wastes

Jadhuvalu (annex) Haa 1.4 of the regulation states the conditions applicable to building and construction waste. From the clause, the notable points are as given below:

- Construction projects should be planned and managed in such a way to ensure minimum amount of waste is produced.

- Steps should be in place to ensure minimum waste generation during building and construction
- Building and construction waste generated from demolition should be reused as much as possible
- Building and construction waste should be within the site boundary of the project and should not cause any disturbance to the public
- All building and demolition works shall be arranged in such a way to ensure that during the course of the project, there shouldn't be any disturbances to the neighbouring entities and public due to the generation of wastes

It should be noted that demolition is not part of this project, as there is no structure in the area currently. Moreover, the way the site is setup, it is virtually guaranteed that waste will be contained within the site and will not pose any nuisance to the public or any potential neighbour.

Jadhuvalu (annex) Haa 2.1 states the conditions applicable to land transport of waste.

- Waste should be properly concealed during transportation such that any waste or smell of waste will not be exposed to the surrounding environment
- Waste transporting vehicle should be properly washed and cleaned regularly
- If waste is to be transported on a wheel burrow, it has to still be ensured that the burrow is able to handle the entire content of the waste and that there is no chance for waste to spill out
- If waste is transported by individuals personally, still the condition as stated in this clause is applicable.

During the operational stage of the project, waste management of the building will be handled by the building monitoring board members, whom are unanimously elected among the tenants. Waste management will likely be outsourced to a third party by the board, which is the intended process by the developer.

4.6 Dewatering Regulation,2013

A Dewatering Regulation (No. 2013/1697) came into effect in December 2013. The main purpose of the regulation is to protect groundwater resources found in the islands from impacts of dewatering, pollution and protect the environment from release of groundwater by

dewatering. As per the regulation, a dewatering permit shall be obtained from EPA prior to any dewatering operations required for all development projects.

Further, the regulation states that 30m radius boundary shall be considered as impact area from all dewatering operations and any entities within the boundary shall be informed 24hrs before the dewatering operation. EPA approved dewatering signage must be placed during the process of dewatering. There are no structures or any development within a 30m radius from the project site.

Dewatering can only be to be carried out, after gaining approval by submitting “the dewatering approval form” in the annex 1 of the Regulation to the enforcing body for approval with all the required documents expressed and with an administrative fee of 500 MVR. Water quality tests results also have to be submitted as one of the required component.

The regulation also guides on where and how the extracted water shall be disposed of, and how it has to be handled. According to the regulation, permission can be granted for dewatering at a stretch for a maximum of 28 days, for which a sum of 500 MVR should be paid per day. This amount is liable to be increased with the number of days increased.

4.7 Management, Use and Control of HCFC Substances Regulation, 2010

The HCFC Regulation is developed under the Environmental Protection and Preservation Act (4/93) towards regulating phasing out of import, use, selling of HCFC substances by 2011 and completely eliminating use of HCFC substances in the Maldives by 2020 through controlling importers, registering importers, establishment of a quota system, control mechanisms for selling, maintenance of import, selling, purchase and service providers statistics. This regulation is more relevant to the operational stage of the project

4.8 Maldivian Land Act, 2002

The Act governs the allocation of Maldivian land for different purposes and uses and other issues regarding the issuing of land, issuing of state dwellings for residential purposes, conduct regarding state dwellings or private dwellings constructed for residential purposes and the sale, transfer and lease of Maldivian Land.

In accordance with section 3 of this Act, land shall be allocated for the following purposes and uses: for the construction of households and buildings for residential purposes, for commercial use, for social use, for environmental protection and for government use.

Clause 38 of the Act states the conditions for Articles found during the excavation of land. Sub-clause A states Except for coconut palms owned by the person, all other natural resources and gold, silver, jewellery, money, utensils, historical artefacts and metals that do not have a legal owner shall be a property of the government. Sub-clause B states Any jewellery, vessel or money or artefacts or metal as mentioned in subsection (a) of this section, if found in the soil of Maldives then the party who found the articles. As the project is being undertaken in Hulhumale', an artificially reclaimed land, it is highly unlikely the clause will come into effect.

4.9 Land Use Plan and Implementation Regulation

Under the Maldivian Land Act of 2002, all lands in the islands under the lands development policy, a Land Use Plan shall be developed and approved from Ministry of Housing and Infrastructure prior to use of the lands. The regulation outlines key aspects that need to be considered while preparing land use plans as well as describes guidelines on developing and allocating lands for various purposes. In this regard, various categories of lands are identified under which a government agency shall implement the land use plan.

The project falls under Category D, which are described as islands reclaimed as special projects. The land use plan will be made for such islands by the developer as stated in the regulation, which in this case is HDC.

4.10 Condominium Law 2006

Condominium Law or 'Emmedhu Imaaraathaa behey Qavaaidhu' came into effect on 21st May 2006. The law states that a Condominium is defined by buildings in which in different tenants own floor areas/apartments in the same building, as would be the case in this project.

Clause 18 of the law states that Public Spaces and Services in Condominiums will have to be maintained by the tenants

Clause 19 of the law states that It has to be stated in the contract on how Public Spaces and Services in Condominiums will be monitored and maintained.

Clasue 20 of the law states that apartments in condominiums can only be owned by local citizens of the Maldives.

The tenants would need to be contractually obliged to maintain the building.

The law is very brief and is in need up revision in light of the many upcoming condominiums projects.

4.11 Permits required for the Project

4.11.1 Design Approval

The floor plans and design has to be currently approved by Housing Development Corporation (HDC). The approval is attached in the Annex 3. There need not be any approvals required from the Ministry of Housing Infrastructure to implement the project.

4.11.2 Dewatering Permit

A dewatering permit shall be obtained from EPA prior to undertaking any dewatering works. Before dewatering approval is given, an EIA would need to be done if the project falls under 'Jadhuvalu R' of the EIA regulations.

4.11.3 EIA Decision Statement

A decision regarding this EIA from the Environmental Protection Agency (EPA) need to be obtained before construction commences. The EIA Decision Statement, as it is referred to, shall govern the manner in which the project activities must be undertaken. This EIA report assists decision makers in understanding the existing environment and potential impacts of the project. Therefore, the Decision Statement may only be given to the Proponent after a review of this document following which the EPA may request for further information or provide a decision if further information is not required.

5 Identification of Impacts & Significance

This section is based on the potential environmental impacts due to the project components including:

- Demolition
- Excavation and Dewatering
- Material sourcing, transport and storage
- Construction of the foundation
- Super structure construction and masonry works
- Waste management
- Establishment of utilities
- Building operation
- Building maintenance

The section describes the mitigation measures for each identified impact. Since the components are all building related some impacts are general to all the components of the project, and some are specific. Likewise, the same applies for the mitigation measures. Methods of identification of potential impacts and assessing the significance of the impacts are described in the following sections.

5.1 Identification of Impacts and their Significance

Impacts on the environment from various activities of the proposed project have been identified through:

- Public consultation with important stakeholders. Including during the scoping of the project and formulation of the Terms of Reference for the EIA.
- Using decision frameworks for assigning significance to impacts
- Existing environmental studies carried out similar developments in other similar environments
- Research data that has been accumulated specific to the Maldivian context.
- Baseline environmental conditions collected.
- Past experience of the consultants with similar projects.

Possible negative impacts on the environment have been considered in worst-case scenario to recommend mitigation measures in the best possible ways so that these impacts would be minimized and perhaps eliminated in the implementation phase.

The impacts highlighted in the TOR for this EIA has been used as a guideline in identifying important impacts. However, this was not used as a strict instruction for the identification. Once new impacts not highlighted in the TOR were foreseen, they were given equal importance.

Following are the major types of negative impacts that commonly occur due to the implementation of building construction projects in Greater Male' City.

- Loss of visual amenity during demolition and construction
- Loss of vegetation and impact on terrestrial habitats
- Groundwater degradation
- Mosquito growth
- Noise Pollution
- Air Pollution
- Traffic disruption leading to congestion
- Generation of building and construction waste
- Impact on adjacent structures
- Health and safety of workers and neighbours
- Generation of household waste during operational phase
- Building maintenance issue

The project impact area is the project site as shown in the following figure, with no significant impact anticipated beyond the area.

5.2 Description of Impacts

5.2.1 Loss of visual amenity during demolition and construction

There is no existing building at the site and therefore there is no impact.

5.2.2 Loss of vegetation and impact on terrestrial habitats

The site has already been cleared and therefore there is no further impact. Removal of Fithuroanu trees on the roadway to provide access is the only vegetation removal. The project will have far more vegetation plantation within the structure in the garden areas that is proposed.

5.2.3 Groundwater degradation

The major cause for concern with regards to groundwater is the water extraction process, dewatering, to lay the foundation. Dewatering would remove a moderate volume of water from the project site. This water will be disposed nearby the project site on land to be used for groundwater recharge. The impacts of the operation are short term.

The short-term impacts due to dewatering is mainly the impact on the groundwater lens due to saline intrusion resulting from coning and the impact of such sudden increase in salinity on the freshwater lens in the vicinity of the site. As stated previously, there are no mature trees that will undergo an impact from this. Desalinated water from MWSC water network is widely used by the residents in Hulhumale'. Moreover there is no established development in this project area. Therefore the sudden increase in salinity in the area will not have any impact. Moreover, groundwater will be recharged at a nearby site.

It is not expected that the impact will be significant on the surrounding infrastructure in accordance with the permit given by Environmental Protection Agency. In any case, dewatering is an unavoidable component of the project.

5.2.4 Mosquito growth

Mosquito growth has become a significant issue at all major construction sites, due to potential spreading of dengue among other reasons. Mosquito growth at construction sites mostly occur due to negligence. After foundation is laid, and construction takes place at ground floor and beyond, the elevator pit is usually left without any such construction. As a result, water gets accumulated in the area; and if left without intervention, provides a favourable environment for mosquito growth.

5.2.5 Noise Pollution

As stated previously under Description of the Environment, ambient noise pollution in the area is low - moderate due to relatively low traffic. Construction activities will increase the amount of noise, especially during the concrete mixing operations. Also, there will be consistent noise emitted from Stationary equipment such as air compressors, cranes, and generators. They generally run continuously at relatively constant power and speed, although

sound levels may vary according to the work cycle (e.g., loading). These types of noises are temporary and are relatively intermittent.

5.2.6 Air Pollution

Air pollution is an issue during construction when debris may be seen accumulating in the project area. Impact of debris on human health is significant. Pollutants will include dust from demolition, excavation, movement of transportation vehicles, loading and unloading of materials, earthwork and during concrete mixing work. Dusts may also be transported to surrounding areas by wind, affecting residents and workers of surrounding areas.

In addition to dusts and debris, harmful gases released by heavy machineries and vehicles and other construction work include carbon monoxide, carbon dioxide, hydrocarbons, and nitrogen oxides. Other harmful gases can be released from vapors of oils, glues, thinners, paints and wood treatment during construction and interior finishing. These are all atmospheric pollutants and can also cause respiratory problems and other detrimental health issues upon repeated inhalation.

5.2.7 Traffic Congestion

From the nos. obtained during the observation of traffic, and how the project has been planned it can be seen that this project will have virtually no impact on the traffic flow in this area.

The only impact is during dewatering process when a pipe will be placed along the width of the road. This pipe will be protected using a concrete or steel casing, and will act as a speed breaker for the duration of the dewatering process. This will not lead to any serious traffic congestion. Alternatively, this will have a positive impact in reducing the speed of vessels in the area. During traffic survey, it was observed that some motorcycles raced through the area at speeds greater than 70 km/hrs, well beyond the imposed speed limit.

5.2.8 Generation of building and construction waste

There will be a significant volume of building and construction waste generated from a near 15,000 sqft land area. This would result in a negative input to the environment and can be a nuisance to the surrounding areas. Construction waste such as wood, concrete, metals, bricks, plastic and domestic waste will be generated in addition to excavated waste and municipal waste.

5.2.9 Impact on adjacent structures

As there are no adjacent structures, there will be no impact.

5.2.10 Health and Safety of workers and neighbours

Health and safety of workers and neighbours have been discussed to some extent under noise pollution and air pollution. As stated in the preceding sections, the construction site will indeed be a health hazard and care must be taken at all times while at or near the site. Moreover, in addition to impacts arising from noise and air pollution, there is also the significant possibility of direct impact from accidents from the work area. This could occur due to falling objects, misplaced equipment and materials, temporary structures not properly fixed, etc.

5.2.11 Alleviating congestion issues in Male'

Male' is already among the most densely populated island cities in the world. Based on the 2006 census, the population density of Male' is 18,000/km². Currently over one third of the total population lives in Male'. It is a widely held belief that projects of these types contribute to alleviating the ever increasing population in Male'. More housing has traditionally resulted in more migration to the Male', and the process has continued to grow exponentially.

Decentralisation is a key policy for all the major government stakeholders and policy makers and this has resulted in reducing the increase in the population density. One of the key actions for this has been the development of Hulhumale', which has resulted in people moving to the island away from Male'.

Hulhumale' offers more public spaces, better ventilation, and an overall better environment compared to Male', and therefore it is a positive impact to offer more housing in the area, albeit with some controls in place to preserve the current environment.

5.3 Impact Significance Assessment

This section provides a summation of the impacts of the project components discussed above. The impacts of the project have been evaluated according to the criteria proposed by Posford Haskoning (2004). The decision framework is given in the following figure

In order to make the evaluation quantitative, the framework proposed by Haskoning has been modified. Spatial distribution of impact is also added in order to make the significance of the impacts more realistic. Scores are given for each impact once it is identified that the resource is vulnerable to the impact. Scores are based on the following factors.

- Sensitivity of Receptor
- Recoverability of Receptor

- Importance of Receptor
- Spatial Distribution of impact

The scales associated with the above criteria are given in the Table 6.

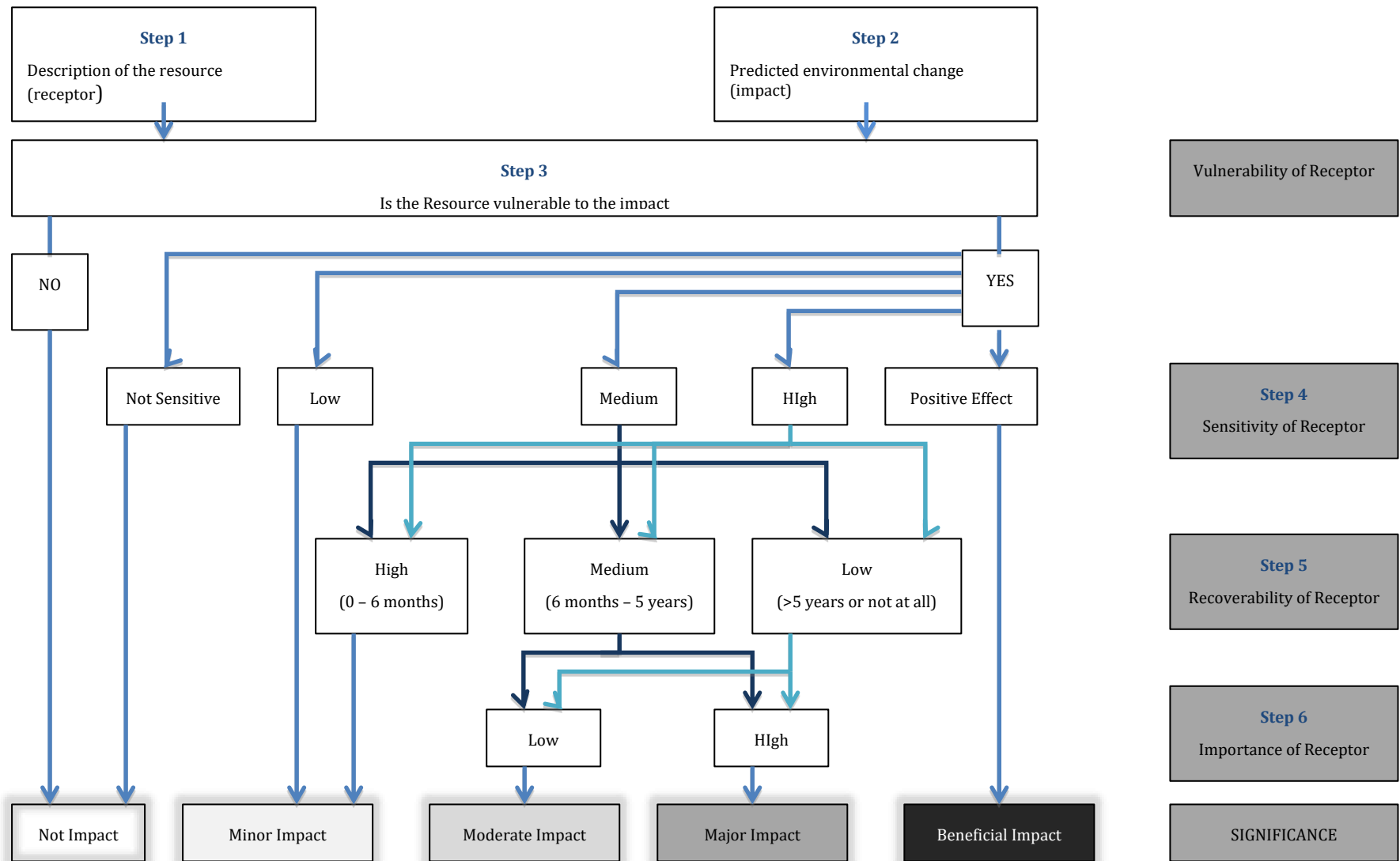


Table 6 Impact Evaluation Criteria

Criteria	Scale	Attribute
Sensitivity <i>How sensitive the receptor is to the impact</i>	-1	Positive Effect
	0	Not sensitive
	1	Low
	2	Medium
	3	High
Recoverability <i>How long it would take for the receptor to recover from the impact</i>	1	Short
	2	Medium
	3	Non-recoverable
Importance <i>The importance of the receptor to the environment</i>	1	Low
	2	Medium
	3	High
Spatial Distribution <i>Distribution of impact</i>	1	local scale
	2	regional scale
	3	global scale

If the impact receives a -1, it deems the impact to have a positive effect on the receptor and the other criteria is then not applied. The impact is referred to as a Beneficial impact as is done by the Haskoning framework.

The significance of the negative impacts will be given based on the following range:

- 1 – 5 : Minor Impact
- 6 – 9 : Moderate Impact
- 10 – 12: Major Impact

Table 7 Analysis of potential impacts and their significance

Potential Impact	Nature of Impact		Significance Evaluation Criteria				Significance
	Direct/Indirect	Immediate/Cumulative	Sensitivity	Recoverability	Importance	Spatial Distribution	
Loss of visual amenity during demolition and construction	Direct	Immediate	2	1	1	1	5 (Minor)
Air pollution during demolition and construction	Indirect	Cumulative	2	1	1	1	5 (Minor)
Groundwater degradation during dewatering.	Direct	Immediate	1	1	2	1	5 (Minor)
Mosquito growth during dewatering stage, and at locations where structural construction is scheduled at a later stage	Direct	Cumulative	1	2	1	2	6 (Moderate)
Noise pollution during construction.	Direct	Immediate	1	1	1	1	4 (Minor)

Disruption of regular traffic and traffic congestion	Direct	Immediate	1	1	1	1	4 (Minor)
Generation of waste oil and building and construction wastes	Direct	Cumulative	2	1	2	2	7 (Moderate)
Structural impact on adjacent structures	-	-	0	-	-	-	No impact
Health and safety of workers	Direct	Cumulative	2	3	2	1	6 (Moderate)
Health and safety of neighbours	-	-	0	-	-	-	No impact
Indirect contribution to alleviating congestion in Male'	Indirect	Cumulative	-1				Beneficial
Waste Generation during the operational stage of the project	Direct	Cumulative	3	2	2	1	8 (Moderate)
Indirect Economic impact on the community, by creating additional jobs for construction and building maintenance	Indirect	Cumulative	-1				Beneficial

The potential impacts, their significance and mitigation measures to be undertaken are given in Section 6 for the construction and operation phase together since the components of the project are all continuous processes.

In conclusion, the project will have minor to moderate impacts on the environment. While some moderate impacts are important, probability of these impacts occurring is rather low.

5.4 Uncertainties in Impact Prediction

The impact prediction has been carried out based on literature and tested methods. However, the prediction relies heavily on the judgement of the consultant, and would therefore lead to uncertainties. Alternatively, such projects as has been described in this report has been carried out on numerous occasions in Male' and Hulhumale'. Therefore, observing past literature on a local context, the uncertainty would be severely reduced. Based on this, the level of uncertainty in the case of the proposed project may be expected to be low as similar projects in similar settings has been carried out.

Uncertainties will be further reduced by undertaking the monitoring program and re-analysing impacts, after comparing the monitoring data with the baseline data in this report and previous recent environmental studies done for Male'.

6 Environmental Management and Mitigation Measures

Mitigation measures are proposed where significant impacts are expected. Once an impact is identified to have 'moderate' or 'major' impact, appropriate mitigation measures are given for the project, if possible.

Successful implementation of the measures given would lead to a major reduction and/or nullification of the impacts on the environment and thereby ensuring that the project is environmentally sustainable.

6.1 Loss of visual amenity during demolition and construction

Some impacts from demolition and construction generally arises due to poor project planning. To avoid loss of visual amenity and also other such minor impacts, it is recommended that the project site be hidden to the public by means of a temporary boundary wall straight after demolition. Warning signs should be placed which states

that only staff is allowed within the boundary wall. The wall height should not be less than 10ft, and it could be made of wood or roofing materials.

6.2 Mosquito growth

As a mitigation measure, some project managers put an oil layer on top to make the area inaccessible for mosquito growth. However, this also leads to groundwater contamination. It is recommended to put a wax layer on top of the area instead of an oil film. This practice is already carried out by some contractors and results have been positive. Alternatively, regular monitoring of any water logged area at the site can be carried out and removed or lidded with immediate effect.

6.3 Noise Pollution

Noise protection gears such as ear muffs are to be used by workers on site. Components that require heavy vehicles such as casting of the slabs and columns are scheduled to be undertaken on weekends, during morning or at noon as to minimize the impact of noise to the shops, offices mosques. Works emitting noise at high decibels are not to be undertaken during night time. Furthermore, the boundary wall should be able to contain some amount of noise within the project site.

6.4 Air Pollution

For mitigation, dust screens and regular water spraying and dampening should also be practiced to reduce the spread of dust to surrounding areas. All heavy machineries should be inspected and fine-tuned to make sure the harmful gases released to the atmosphere do not exceed allowed standards. Building materials should be covered or contained during loading, unloading and storage. The boundary wall or fence should also be able to restrict the movement of dusts and debris within the project site. Construction workers should wear dust masks during dust sensitive work.

6.5 Generation of building and construction waste

It is recommended to re-use as much construction waste as possible, although this may be difficult to manage. The reusable waste includes wood and blocks. Metals can be recycled, and a recycling group such as Secure Bag can be contacted to remove such materials. All such recyclable or reusable wastes should be segregated on site. Waste that cannot be reused or recycled (which will be in the majority) are to be taken away from site for disposal. HDC will later arrange to transport the waste to Thilafushi.

Reusing formwork material as much as possible is another measure that can be taken to reduce waste.

6.6 Impact on adjacent structures

For potential mitigation, soft/silent piling can be used, which would be approximately 6m of piles at regular intervals around the land plot for retaining the earth to a depth of 10 metres below the ground level. The piles would be driven into the ground to hold the boundary wall that would be constructed for the shoring of the foundation. As added horizontal protection, the compacted soil should be placed along the periphery of the construction area, preferably in gunny bags, to minimize stress and risk of overturning. The construction methodology adopted for the proposed project has been decided in order to minimise the impact on any future buildings nearby. Unlike the deep pile foundation, the raft foundation is shallow and does not require deep piling.

Furthermore, it is recommended that dewatering will be timed when rainfall is less or there is no rainfall (NE monsoon). This is to avoid rainwater percolating into the soil beneath the foundations. If rain does occur, measures should be taken to reduce the amount of water to the site, as the water particles may loosen the soil reducing its shear strength.

6.7 Health and Safety of workers and neighbours

Awareness of the works on site is the first and foremost mitigation measure that can be taken to reduce any risk of accidents and other minor health impacts. For awareness, the commonly used method is to put up warning signs around the project area. These include:

‘Caution: Construction works in progress!’.

“Warning: No entry beyond this point!”.

“Wear Safety Hats at all times!”, etc.

Aside from awareness, second method is to encourage wearing safety cloths and equipment at the construction site always. This applies more to construction workers. As such, they should be instructed to wear safety helmets at all times, dust masks during sensitive work, conspicuous fluorescent cloths, earmuffs, etc.

6.8 Waste Management

Waste management is the main issue during the operational stage of the project. A large number of wastes will be generated from over 70 apartments in a concentrated area. Currently the proponent has stated that this is a service that would cost the tenants in addition to the rental of apartments, and assured that daily collection and disposal services will be offered for the first 2 years that the developer would be overseeing operations.

In addition to the general waste management method, it is recommended to separate recyclables from non-recyclables at the site. This will reduce the total no. of waste produced and the system will be easier to manage ensuring sustainability.

Furthermore, it is recommended for the developer to put in place a system for hazardous wastes and large waste collection. It is recommended to collect such large wastes on a quarterly basis.

Table 8 Mitigation management plan summary

Mitigation measures	Implementing Responsibility	Implementing Stage	Cost
Ground water degradation			
Dispose water to site as shown by HDC for groundwater recharge.	Project Engineer	Construction	65,000 MVR
Regular monitoring of groundwater condition on site	Project Engineer	Construction	750 MVR/test
Mosquito Growth			
Ensure still water does not remain on site	Site Supervisor	Construction	na
Place a layer of wax on top of area in which water is prone to accumulate. Or provide a temporary lid	Site Supervisor	Construction	na
Noise Pollution			
For workers, use of earmuffs at construction site.	Project Manager	Design	In project cost
Construction to be scheduled in such a way that noise pollution will be at a minimum to the public.	Project Manager & Site supervisor	Design and Construction	In Project cost
Ensure proper site demarcation and boundary wall condition before commencing such work	Site supervisor	Construction	In Project cost
Air Pollution			

Workers should be made to wear dust marks during dust sensitive work.	Project Manager	Construction	In Project cost
Place dust screens demarking the concrete mixer	Project Manager	Construction	In project cost
Daily water spraying and dampening to reduce spread of dust to surrounding areas.	Site Supervisor	Construction	In Project cost
Inspect and fine-tune all machinery and vehicles before work commencement to ensure harmful gases released to atmosphere are at a minimum.	Site Engineer	Construction	In Project cost
Cover building materials such as cement and sand, and should be contained during loading, unloading and storage.	Site Engineer	Construction	In project cost
Traffic Congestion			
Schedule transport of heavy-duty vehicles to site during off peak hours such as the morning.	Project Manager	Construction	0
Generation of building and construction waste			
Re-use construction waste where possible.	Project Engineer	Construction	0
Metals are to be collected separately and handed over or sold to a metal recycling group.	Site supervisor	Construction	0
All waste should be segregated on site.	Site supervisor	Construction	5,000
During and straight after demolition works, all waste that cannot be recycled or reused, are to be transported daily to the waste disposal site in Thilafushi.	Site supervisor	Construction	In Project cost
Reusing formwork material as much as possible.	Site supervisor	Construction	0
Health and safety of workers and neighbors			
Undertake health and safety training for workers before project commencement.	Project Manager	Pre-Construction	In Project cost
Put up warning signs around the project area including signs indicating ongoing works, and restricting entry into the project area, and signs reminding the use of safety gear at site.	Project Manager	Construction	In Project cost
Encourage use of safety cloth and equipment at the site at all times. These include safety helmets, dust masks, conspicuous fluorescent cloths, earmuffs, safety shoes, etc.	Project Manager	Construction	In Project cost
Generation of household wastes			
Separate collection of recyclables and non-recyclables at the building and transport the waste	Site Supervisor	Operation	In Project cost
Collect hazardous wastes on a separate schedule.	Site Supervisor	Operation	In Project cost
Have a quarterly large waste collection schedule in place	Site Supervisor	Operation	In Project cost

7 Alternatives

This section looks at different alternatives for the proposed project. The main alternative is the no project option. After extensive discussion of this alternative, then options for the project components are investigated. Alternatives are given for each component based on location and design. Each alternative is discussed based on economic, social, and environmental factors. Finally, the recommended alternatives are suggested to assist in the project decision-making process.

These alternatives are not as intensively investigated as the original scope of the project. However, investigating and discussing alternatives is important so that it is ensured that the best available option(s) is/are chosen to solve the issues/problems of the project.

7.1 No project option

Initially the no project option is discussed in order to hypothesise whether the project should be taking place first of all. Sometimes, projects are proposed without much thought given to the socio-economic motivation of such development and the unnecessary impacts it may have on the environment, especially those that are long term. Therefore, carrying out this exercise is important to avoid such a scenario and to ensure that undertaking this project at this stage makes good socio-economic sense without any significant impact on the environment.

The no project option is analysed on the basis that no such project is to take place in Male' City, and not specifically for this development. As this development is part of a larger program, discussing no project option for this specific project alone will not make much sense.

The advantages and disadvantages of not undertaking the project is given below.

Table 9 Advantages and Disadvantages of the no project option

Advantages	Disadvantages
Will not lead to health and safety concerns at project site	Will not be able to alleviate the issue of people living in small crowded places in Male'

Will not cause any noise and air pollution at project location	Will decrease economic opportunities for construction companies and their employees
Will not cause any traffic disruptions	Will be a missed opportunity for middle to upper class still looking for housing options in Male' City.
Will offer greener quasi-natural public areas without built areas	Will hinder the development of Hulhumale'
Will not lead to production of waste at a concentrated site as the apartment building.	

A comparison of the no project option with the project going ahead as proposed, indicate that the no-project option is practicable, but involves losses to the developers and to the development of Male' City in general.

There are a few advantages of the no project option from an environmental perspective, although they are not strong as impact from the project is minor. Local environmental impact from this project is small in nature, and the advantages stated is not significant, since most of the environmental impacts can be properly mitigated. Alternatives for components of the project are discussed further.

7.2 Project Alternatives

The Proponent initially decided that the best option not encompassing excessive costs would be adopted after evaluating different options. Therefore, the different alternatives for the project components were considered before finalising a particular option. Alternative options; mainly based on design and methodology for the construction are given below.

7.2.1 Project Location

Alternative locations are not as important for this project, as the location cannot be changed under any circumstances. The plot was awarded to the developers by HDC, and at this stage changing the plot would not be an option.

7.2.2 Project design

Several component of the project design can be changed, taking the community more into consideration, such as:

Making space for a mini mall or office space for the first 4 or 5 floors so that it would provided activities in the area. Vertical development is important since it would encourage shop/office goers to get concentrated to particular areas, rather than spread out into the streets as the case in Male' thereby making them crowded & disrupting traffic.

Provide a larger parking space within the building. The current parking space proposed will likely be sufficient for the tenants of the building. But a larger public parking space would alleviate potential parking issues for Hulhumale'. Providing such a space in the building will be an important service to the community.

Design for a rooftop garden area, which will contribute to making the city greener, while continuing with the infrastructure development in the given area.

These project designs are given as suggestions, the feasibility of which the developer should take into consideration before implementation.

7.2.3 Power generation.

Currently it is proposed to utilise the existing power system in Hulhumale'; that is to obtain power from STELCO mains. However, other alternatives such as use of solar energy is recommended especially given the large empty terrace. The proponent informed that this had been considered subject to utility, practicality and feasibility. Furthermore, it is also an alternative to have a backup power generator at site.

7.2.4 Foundation

A deep pile foundation can be constructed, which will likely provide more stability to the 10 storey structure in the long term. However, the methodology have endured negative reception in Male', most notably that of the Traders building (formerly Holiday Inn) at Athireege Aage. For the structure, metal load bearing piles were driven to depths of 30 to 40 metres. The deep piling, lead to several neighbours complaining of tremors and cracks in their walls. Due to the close proximity of buildings structures, use of deep pile technology may not be ideal for high rise buildings in Male'. However, it can be considered for this development, although with 10 storeys it is not a necessity.

8 Stakeholder Consultations

Stakeholder consultations were carried out with the construction management team of Rainbow Construction Pvt. Ltd. Officials from the Environmental Protection Agency were also met for consultation. The EIA scoping meeting held at Environmental Protection Agency provided a good opportunity to discuss issues with all the major stakeholders present. Further consultations were carried out with the Project Manager for the project, and other stakeholders such as STELCO, MWSC, HPA Ministry of Housing and Infrastructure and Housing Development Corporation.

Table 10 Important stakeholders met during the consultation process

Name	Office	Contact	Designation
Ramesh Babu.R	Rainbow Construction Pvt. Ltd.	+960 7789323 projectmanager@rainbowconstruction.com.mv	Senior Project Manager
Mohamed Azim	MHI	mohamed.azim@housing.gov.mv	Director General
Akram	HDC	7970007	-
Aminath Shaufa	HPA	shaufa@health.gov.mv	Public Health Program Coordinator
Ali Irushad	MWSC	+960 7968987	Business development manager
Azzam Ibrahim	STELCO	+960 7782574	Senior Engineer

8.1 Consultations with the Developer

Numerous consultations were undertaken with the developer to ensure the details of the project components. Consultations were also important in order to identify the most environmentally sensitive components and discuss potential mitigation measures.

The developer informed as per their contract with HDC, general maintenance of the building along with waste management will be handed over to the tenants completely after 2 years in operation and the developer will have no role to play in this regard from then onwards.

In addition to waste management the developer also stressed on the importance they give to the health and safety procedures for both staff and general public.

The concerns raised by the developer included the time delays for project component approvals from the government and discussed on the need to expedite bureaucratic processes. As such, Environmental Impact Assessment approvals were also discussed.

The developer further gave their assurance that this project will go ahead as planned and that they do not anticipate much delays during the project. Assurance was given that the funding for the project was also secured.

8.2 Project Engineer

Stability of the structure and nearby properties was mainly discussed with the project engineer. The engineer informed that the current foundation design as proposed for this project has been tried and tested in the Maldives environment with good success. Moreover, since there are no structures in the vicinity, the engineer does not anticipate any significant impact on nearby properties. Foundation protection will nevertheless be in place to ensure minimum probability of any undermining as there will be other buildings constructed in the area in the near future.

Among the concerns the engineer had, was delays to project commencement, effective project management and supervision on site and on site safety.

8.3 Ministry of Housing and Infrastructure

The Ministry informed that under recent changes, Male' City Council currently has no role to play in infrastructure developments in Male'. The unit that was undertaking building and land approvals now come under the Land and Building Department under the Ministry of Housing and Infrastructure.

With regards to safety on site the Ministry informed that they are getting more strict with site supervisions to ensure the safety of the public both during construction and operations of the project.

The structure and architectural works for the project are to be undertaken by consultants registered at the Ministry. The foundation protection method along with other structures will need to be certified by these registered licenced consultants.

The Ministry informed that they do not have any further concerns if the necessary approvals for the project have been obtained. They also further informed that the Ministry does not give approvals for such projects undertaken in Hulhumale'. HDC is solely responsible for giving planning approvals and detail drawing approvals. It was informed that Hulhumale development falls under 'Binaaveshi Qavaaidh' Clause 2.2.4, which refers to islands that are developed as a special project. Clause 3.1.3 of the Regulation states Planning for such islands will be carried out by the developer of the island, which in this case is HDC. It was further informed that Hulhumale' is also by law regarded as a land owned by HDC>.

8.4 State Electric Company (STELCO)

STELCO was consulted as the main power supplier for Hulhumale' for residential, industrial and commercial areas as well. Discussion was held over the phone. The company informed that they had not received previous information about the project until recently. However, it was informed that there will not be any issue in providing power/electricity to the area. Since the area is going to be newly developed, cabling works will be undertaken along with the project construction duration.

It was informed that difficulty STELCO faces in accommodating new developments, when the plans for the upcoming developments are not shared with the company pre-emptively. If such a system is in place, STELCO can be even more efficient in accommodating their services for new development projects in Hulhumale'. It was also informed that STELCO has the capacity to provide electricity to such new developments, and that the power plant will be gradually upgraded with new gensets as more developments come in. In this regard, further information was shared that there were concerns on the lack of expansion possibilities in the existing land provided for STELCO in Hulhumale'. It was nevertheless ensured that all the power requirements of the upcoming new developments will be met by STELCO.

8.5 Male' Water and Sewerage Company (MWSC)

MWSC provides water and sewerage services to the whole of Hulhumale'. MWSC also provides dewatering services to similar developments in Male'. However, it was informed that for such developments based in Hulhumale', currently MWSC does not provide any such services.

It was informed on the difficulty in obtaining valid information in a timely manner on the new developments in Hulhumale'. MWSC team had shared a map where the most immediate new developments were noted, however the current development was not identified on the map.

Information was provided on the current water and sewerage network in Hulhumale'. There was no connection to the proposed development area currently. However, it was informed that connection can be made as soon as it is requested. Both water and sewerage lines were nearby the area, and as such a connection can be made without much difficulty.

Regarding temporary site, if a connection cannot be made in time, it was informed that the contractor can utilise septic tanks on site and dispose of the contents to an MWSC pump station nearby after obtaining approval. However, this was discussed more as a backup plan. A sewerage line could be put in for the temporary site as well. For the operational phase of the project, it was ensured that the water and sewerage network will be extended to the area.

8.6 Health Protection Agency (HPA)

HPA had informed that information regarding upcoming projects were not shared with them previously and they were not aware of the proposed development. The main concern from HPA side is with respect to workers health and safety on site, and issues with respect to hygiene. However, they mentioned that there were no local regulations or guidelines currently specifying the standards for health and safety of workers.

The other main concern from HPA was regarding mosquito control at construction sites. They informed that a survey had been undertaken recently in Male' and the condition was quite bad at most site and they had notified numerous developers on the issue of mosquito growth at their sites. Details of the survey has not been published at the time. HPA informed that they do carry out inspections at site, and that some work had already been undertaken in Hulhumale' as well.

HPA further stated that they are currently in the process of making regulations and guidelines which would enforce and assist certain standards within construction sites with respect to both mosquito control and worker health and safety.

9 Environmental Monitoring

This section deals with the Environmental Management and Monitoring plan for Rainbow Oceanfront building construction project with respect to the developments proposed in this EIA. The proposed monitoring plan is for the construction and operation phase of the project. The data collected for this assessment will be used as baseline data while undertaking the monitoring plan. Undertaking environmental monitoring is essential for several reasons including:

- To ensure that potential impacts are minimized and to mitigate unanticipated impacts.
- To aid in impact management,
- To improve impact prediction and mitigation methods.
- To gather long term data to minimise uncertainty
- To ensure sustainable development

The proposed monitoring programme will yield beneficial results if it is undertaken for a long period. As required in the TOR, the monitoring is to take place during the construction phase once every 3 months up to 1 year, and then on an annual basis for 2 years, after which the developers commitment to the development will cease.

The proponent expressed their full commitment to carry out the monitoring program outlined in this report. The proponent's commitment to undertake the environmental monitoring and mitigation measures is given in the Annex 7.

9.1 Monitoring Methodology and Costs

The methodology used for monitoring will be similar if not the same as those used in this environmental assessment. However, field water quality testing equipment can be employed to decrease the uncertainties of the results as they can be compared to those obtained from the Laboratory from MWSC. To carry out field water testing, such equipment needs to be procured, which may not be feasible based on this project alone.

The costs given in Table 11 and Table 12 are calculated for monitoring to be undertaken by hiring environmental consultants for each monitoring program. However, field data collected for the proposed environmental monitoring program can be carried out by an in house team of engineers and/or technical assistants since most of the parameters are to be investigated monthly and quarterly, and therefore hiring a consultant for each occasion may not be feasible. Nevertheless, if the contractor does not employ environmental experts among its staff, it is highly recommended that an arrangement is

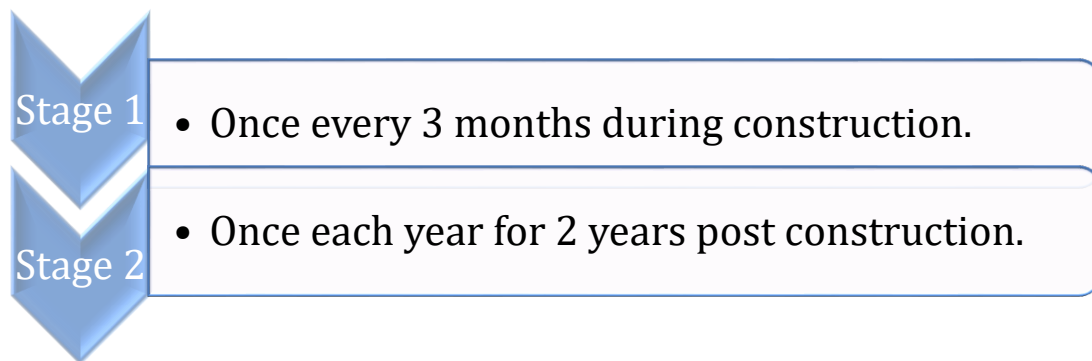
made with an environmental consultant on a long-term basis to carry out and supervise the execution of the monitoring program.

The parameters that are most relevant for monitoring the impacts that may arise from the project are included in the monitoring plan. Therefore, the monitoring programme will cover the following aspects of the project:

- Ground water quality
- Generation of wastes
- Noise pollution
- Traffic congestion

9.2 Recommended Monitoring Programme

As instructed in the TOR, the monitoring programme will be divided into 2 stages.



Stage 1

- Ground water quality for pH, temperature, electronic conductivity, total hydrocarbon and salinity at project site
- Determine number, type and respective quantity of waste produced within the past quarter. Assistance from the contractor's project management team will be required. Waste present at site during inspection should be noted.
- Noise measurement. Measure noise at the locations as was studied in the EIA.
- Survey the traffic within the same area as undertaken for this EIA

- Inspect the use of health and safety equipment on site. Take a head count on the number of staff at site not using proper health and safety equipment including safety shoes, fluorescent vest, safety helmets.

Stage 2

- Ground water quality for pH, temperature, electronic conductivity, total hydrocarbon and salinity at project site
- Determine number, type and respective quantity of waste produced (on daily basis, extrapolated to monthly data). Long term data can be taken in coordination with the maintenance office. During monitoring, general inspection of the building common areas should take place to take note of any loose wastes in the common areas. Will have to depend on secondary data collected by building monitoring officers based at the site.
- Noise measurement
- Survey the traffic within the same area as undertaken for this EIA

9.3 Cost of monitoring

The following tables outline the cost estimate for each stage of the monitoring plan given. The costs are calculated assuming the monitoring will be undertaken by hiring environmental consultants on a project basis. Since this monitoring is in Hulhumale' and does not involve expensive surveying equipment, and most are based on visual observation and consultation, the overall cost is low relative to most monitoring programs.

Table 11 Estimated costs of Stage 1 Monitoring Programme

Item No.	Details	Unit cost (US\$)	Frequency	Total (US\$)
1	Field allowance for 1 consultants for 1 day	75.0	10	750.00
2	Surveying and monitoring equipment depreciation	50.00	10	500.00
3	Laboratory charges	110.00	10	1100.00

4	Compliance reporting (annual report)	800.00	2	1600.00
	Total			3,950.00

The monitoring is for a period of 2 years (duration of construction phase), where data is collected quarterly.

Table 12 Estimated costs of Stage 2 Monitoring Programme

Item No.	Details	Unit cost (US\$)	Frequency	Total (US\$)
1	Field allowance for 1 consultants for 1 day	150.00	2	300.00
2	Surveying and monitoring equipment depreciation	50.00	2	100.00
3	Laboratory charges	110.00	2	220.00
4	Compliance reporting (annual report)	1000.00	2	2000.00
	Total for 5 years			2620.00

This monitoring is for a period of 2 years, where a data is collected annually. Therefore for each year the cost will be approximately USD 1310.00, not taking into account any effects of inflation and other such economic scenarios.

Considering the 2 stages of monitoring, monitoring costs in the first year would be approximately **USD 1975.00**. The proponent has to endure the greatest cost during the first 2.5 years, as frequency of monitoring is greater. However, in the following years the frequency considerably decreases.

9.4 Monitoring Report

Monitoring report should be compiled based on the baseline data collected. This report should be submitted to the EPA and any other relevant government agencies for compliance annually or at a greater frequency, if requested. The report structure may include but not limited to;

- Introduction
- Details of the site at the time of investigation,
- Data collection and analysis,

- Details of methodologies and protocols followed
- Quality control measures,
- Sampling frequency and monitoring analysis
- Conclusion and recommendations

10 Conclusion

The project is part of larger program by Housing Development Corporation to establish mixed residential buildings in Hulhumale'. Apartments in these buildings can generally be regarded as being targeted towards middle to higher class members of the community. The project will contribute to the grand plan of reducing congestion in Male' by providing more housing opportunities in Hulhumale'.

The existing environment at the project site does not consist of any significant vegetation and the water test result shows good water quality. There are no residents living near the site and there is no other structure at the site as well. Therefore, the project will not have any significant impact on a significant receptor.

During the construction stage, which takes 2.5 years, health and safety standards of the workers at site, and waste generation is the only areas of concern. With proper planning and project management, this can be easily mitigated. Waste is the main concern during the operational stage of the project as well. Since this will be developed as a condominium with multiple tenants owning the rights of the building, it has to be ensured that the tenants are held responsible to properly manage the waste in addition to maintaining the building beyond the 2 years the developer is responsible for. HDC needs to play a more active role to ensure this, and stronger regulations need to come in place.

Regarding alternatives, there are no viable alternatives available for the project with respect to location. The no project option is also not plausible at this stage and possibilities are outside the scope of this study. Other alternatives including material, foundation type, construction methodology are not necessarily recommended. Recommendations had been made to proceed with the project as planned.

All the impacts as highlighted in the project can be mitigated. The socio-economic benefits to Greater Male' City from projects such as these is high. It also provides additional housing opportunities, which would contribute to alleviating the housing issues in Male' City. Therefore, after consideration of all these perspectives, it is recommended for the project to proceed as planned after incorporating the mitigation measures given in this study with the commitment to implementing the monitoring plan given.

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Annex 1 – Terms of Reference



ToR No: 203-EIARES/PRIV/2016/653

Terms of Reference for Environmental Impact Assessment for the 12 Storey Mixed Residential Building K.Hulhumale'

The following is the Terms of Reference (ToR) following the scoping meeting held on 17/11/2016 for undertaking the EIA of the Proposed Mixed Residential Apartment Building, Hulhumale' – Rainbow Oceanfront Residence (Plot D2-3). The Proponent of the Project is Rainbow Construction Pvt Ltd

While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report.

1. **Introduction to the project** – Describe the purpose of the project and, if applicable, the background of the project and the tasks already completed. Clearly identify the rationale and objectives to enable the formulation of alternatives. Define the arrangements required for the environmental assessment and if relevant, including how work carried out under this contract is linked and sequenced with other projects executed by other consultants, and how coordination between other consultants, contractors and government institutions will be carried out. List the donors and the institutions the consultant will be coordinating with and the methodologies used.
2. **Study area** – Submit an A3 size scaled plan with indications of all the proposed land infrastructures. Specify the boundaries of the study area for the environmental impact assessment highlighting the location and size of the proposed construction. The study area should include nearby environmentally sensitive areas. Justification for site selection is required. Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites.
3. **Scope of work** – Identify and number tasks of the project including site preparation, construction and decommissioning phases.

Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the project, using maps at appropriate scales where necessary. All inputs and outputs related to the proposed activities shall be justified.

1. Provide a clearly labeled concept design and scaled site plan of the project boundary.
2. Submit a detailed description of the components of the project and how the project activities will be undertaken.
3. A project schedule should be included.
4. A matrix of inputs and outputs related to the proposed activities shall be included
5. Need and justification for the proposed project
6. Waste management during construction period including construction waste, demolition waste, and green waste where applicable.
7. Dewatering plan

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8. Description of any underground structures such as basement or wells.
9. Plans for road closures during construction
10. Details of vegetation clearance if any
11. Use of any energy conserving utilities
12. Details of the backup generator to be installed
13. Estimated consumption of water and electricity and their sources

Project management: Include communication of construction details, progress, target dates and duration of works, construction/operation/closure of labor camps, access to site, safety, equipment and material storage, water supply, waste management from construction operations, power and fuel supply for backup generators;

Task 2. Description of the environment – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the project (e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks. All survey locations shall be referenced including water-sampling points.

All data must be collected as per the requirements of the EPA Data Collection Guideline (published on www.epa.gov.mv). The report should outline detailed methodology of data collection utilized.

Physical and Biological Environment

- Noise levels in the vicinity of the site including any noise sensitive location
- Traffic flow (size and direction) around the project site
- Vegetation in the project site and major trees around it, if any
- Water quality of groundwater wells in project site. Following parameters are to be tested: Conductivity, pH, Salinity, Temperature, TDS, Turbidity

Built Environment

- Nature of adjacent buildings if any
- Condition of the surrounding roads
- Existing structure/uses of the proposed site
- Public facilities nearby

Socio-economic Environment

- Demographic data for greater Male' area.
- Brief description of social environment of Hulhumale' in general and adjacent residential units in particular
- Identify types of vehicles and peak traffic hours in or near the project site

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. Legal requirements:

- Approval from the Housing Development Corporation

Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages – The



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EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

- Loss of vegetation if any
- Loss of visual amenity
- Land preparation and piling works if any
- Impacts on ground water table and water quality
- Impacts related to construction works on land including materials sourcing, transport and storage, building construction methodology and piling.
- Mosquito growth
- Noise, fugitive dust, traffic obstruction and other impacts related to traffic due to the project
- Impacts due to generation of waste
- Potential impacts of the development on adjacent properties and residential areas, especially sensitive areas like schools, pre-schools and mosques.
- Safety and security of the building
- Risk of accidents to workers and public
- Impacts on employment and income such as job opportunities
- Disturbances to residents and public facilities/activities nearby

The methods used to identify the significance of the impacts shall be outlined. One or more of the following methods must be utilized in determining impacts; checklists, matrices, overlays, networks, expert systems and professional judgment. Justification must be provided to the selected methodologies. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable.

Task 5. Alternatives to proposed project – Describe alternatives including the “no action option” should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the “no action alternative”. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan (see appendix)– Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for ground water as well as defects in neighbouring structures. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided.

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INTERNATIONAL YEAR
OF FORESTS 2011



Task 8. Stakeholder consultation, Inter-Agency coordination and public/NGO participation) – Identify appropriate mechanisms for providing information on the development proposal and its progress to all stakeholders, Housing Development Corporation, engineers/designers, development managers, staff, members of the general public, MWSC, Stelco and HPA. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes.

Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.


20.11.2016



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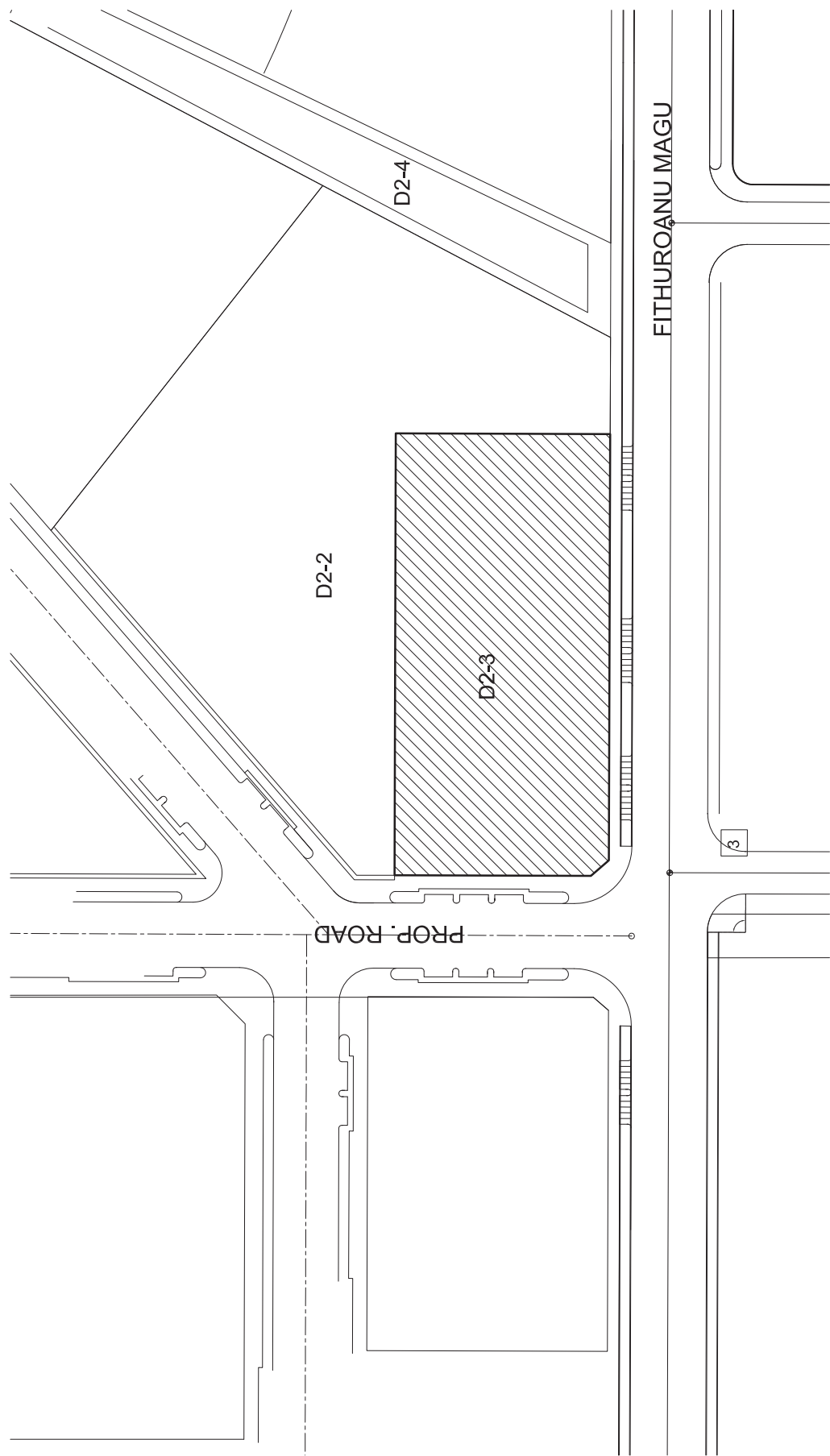
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Annex 2 –Site layout



DRAWING: SITE PLAN

PROJECT: D2-3

Date: 25 / 2 / 2016

Checked by:

Drawn by: Kristina

Remarks:

N15

Annex 3 – Design approval from HDC

Ref No: HDC(161)-CM/(9)/2016/200

To Whom It May Concern

Please be informed that on 12th April 2015, Rainbow Construction Pvt. Ltd submitted a proposal for the development of Mixed-Use Residential Complexes. Housing Development Corporation Ltd. (HDC) evaluated this proposal using pre-set due diligence procedures of HDC and the project was conditionally awarded to Rainbow Construction.

Upon fulfilment of the conditions mentioned in the conditional award letter including the submission and approval of concept drawings, HDC signed an agreement with Rainbow Construction Pvt. Ltd. (agreement number HDC/LDS/16/9) on 3rd August 2016 for the Development and Sale of Mixed-Use Residential Complexes in Hulhumalé plot D2-3. Attached please find the highlights of the major terms of the aforementioned agreement.

31st August 2016

Yours Sincerely,



Nashwa Abdulla

Director

Business Development, Sales and Marketing

Highlights of the major terms of the agreement

Plot Number	D2-3
Plot Area (Sq.ft)	31,011 Sq.ft
Project Type	Mixed-use residential
Parties to the Agreement	Housing Development Corporation Ltd HDC Building Hulhumalé Rainbow Construction Pvt Ltd and Rainbow Aluminium Pvt Ltd G. Maarana Alikilegefaanu Magu Malé
Objective	HDC has opened up opportunities for locals and internationals to undertake development such as Housing, commercial, in Hulhumalé. [Developer] has submitted their proposal to HDC to undertake the development of [number] of housing units along with the commercial units at ground and first floor.
Conditions precedent	<ul style="list-style-type: none"> • Performance security will be MVR 5,000,000 • Concept drawings
Housing Segmentation	<ul style="list-style-type: none"> • This is a mixed used residential development, which means that the ground and first floor will be of commercial use and 2nd floor and above will be for residential housing • The target market for this housing project shall be mid to high income group • Minimum of 60% of the housing units shall be price at a maximum of 2400 per sq.ft of the floor area. • Maximum of 40% of the housing units can be sold at open market price.
Commercial units	<ul style="list-style-type: none"> • The ground and first floor of the development has to be of commercial units • The developed commercial units shall be handed over to HDC at cost, • The cost of the handed over commercial units will be offset with the land cost which developer has to pay to HDC • HDC engineers estimation for cost of commercial units is Max MVR 956.52

12/2/2017

Time Line	<ul style="list-style-type: none"> • Performance guarantee has to be submitted to HDC within 30 days of Conditional award letter • Concept drawings has to be submitted to HDC within 30 days of Conditional letter • Detailed drawings has to be submitted to HDC within 60 days of agreement signing • The development site will be handed over to the developer within 7 working days of detailed drawing approval • EIA has to be submitted to HDC within 30 days of detailed drawing approval if applicable by EPA • BOQ and the work schedule has to be submitted to HDC within 30 days of detailed drawings approval • The construction period for the project shall be 28 months from the approval of the detailed drawings
Financing of the project	<ul style="list-style-type: none"> • The developer has to secure finance for the project • The land provided shall not be used as the source of financing the project, under no circumstance HDC will allow the mortgage of the bare land
Sale of the housing units	<ul style="list-style-type: none"> • The developer can sell the housing units to the individuals allowed under the Maldivian land law • Developer has to complete 20% of the civil work before starting the pre-sale of the housing units • Developer can start the marketing and promotion of the housing units after agreement signing • A booking fee of maximum MVR 50,000 can be collected from the customers when booking, however this has to be part of the price of the housing unit.
Termination	<ul style="list-style-type: none"> • HDC should have the right to terminate the agreement without any compensation in case of breach of agreement by the developer

Handwritten signature

Project Title

PROPOSED MIXED RESIDENTIAL BUILDING AT HULHUMALE

Client

RAINBOW CONSTRUCTION PVT LTD

Job No

TDA 2016 - 1175

Date

09TH SEPTEMBER 2016

Preliminary Approval given on condition that revisions & corrections and additional drawings/documents be submitted as per the given comments for final approval.

APPROVED

Housing Development Corporation Ltd.

Date: 28/09/16

Name: Ismail Shan Rasheed.

Sign:

TEKTON
DESIGN
ARCHITECTS
& ENGINEERS

TEKTON DESIGN ASSOCIATES Pvt. Ltd.

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N = 466553.828
E = 337828.147

N = 466552.078
E = 337824.390

N = 466480.553
E = 337803.914

195°58'10"
77.127m.

PROP. ROAD
105°58'10"
34.277m.

D2-3
Area = 2,880.93sqm.
(31,010 sqft)

BUILDING SETBACK LINE

PROPERTY LINE

FITHUROANU
MAGU

MASTER PLAN SITE PLAN

SCALE 1:250

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
BUILDING FOOT PRINT AREA	2205.04 m ²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

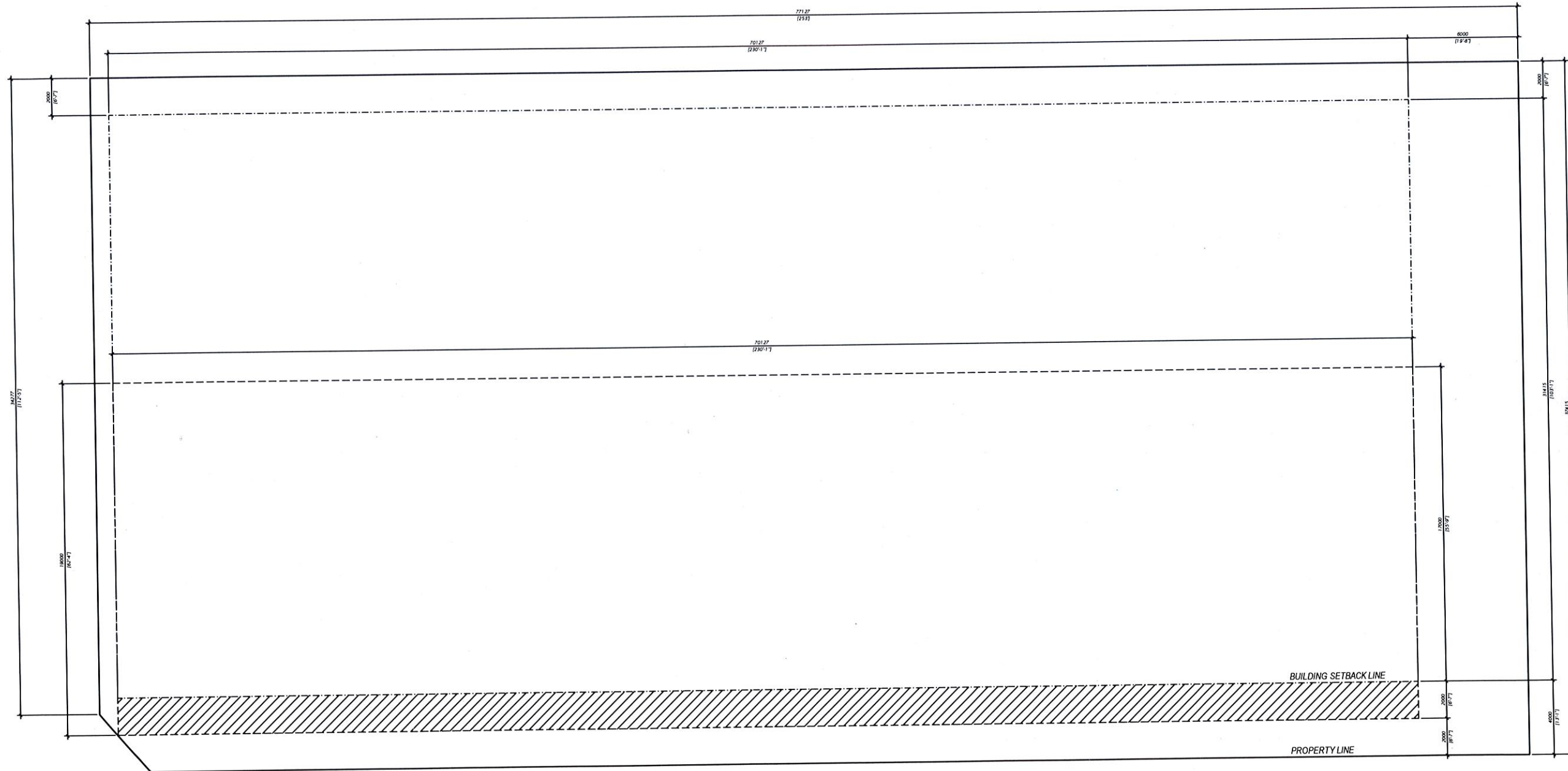
Dwg. Title:
FLOOR PLANS

Owner:
RAINBOW CONSTRUCTION



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Architect/Designer:	Job No:
ALI SHAREEF	TDA 2016 - 1175
Struct. Engineer:	Rev. No:
-	-
Drawn:	File No:
ALI / ISHAN / ZAF	-
Surveyed:	Date:
-	08 SEPT. 2016
Checked/Approved:	Scale:
-	AS GIVEN
Dwg. No:	
MRC -A - FPL00 - 01	



MASTER PLAN SITE PLAN COMMERCIAL
SCALE 1:250



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

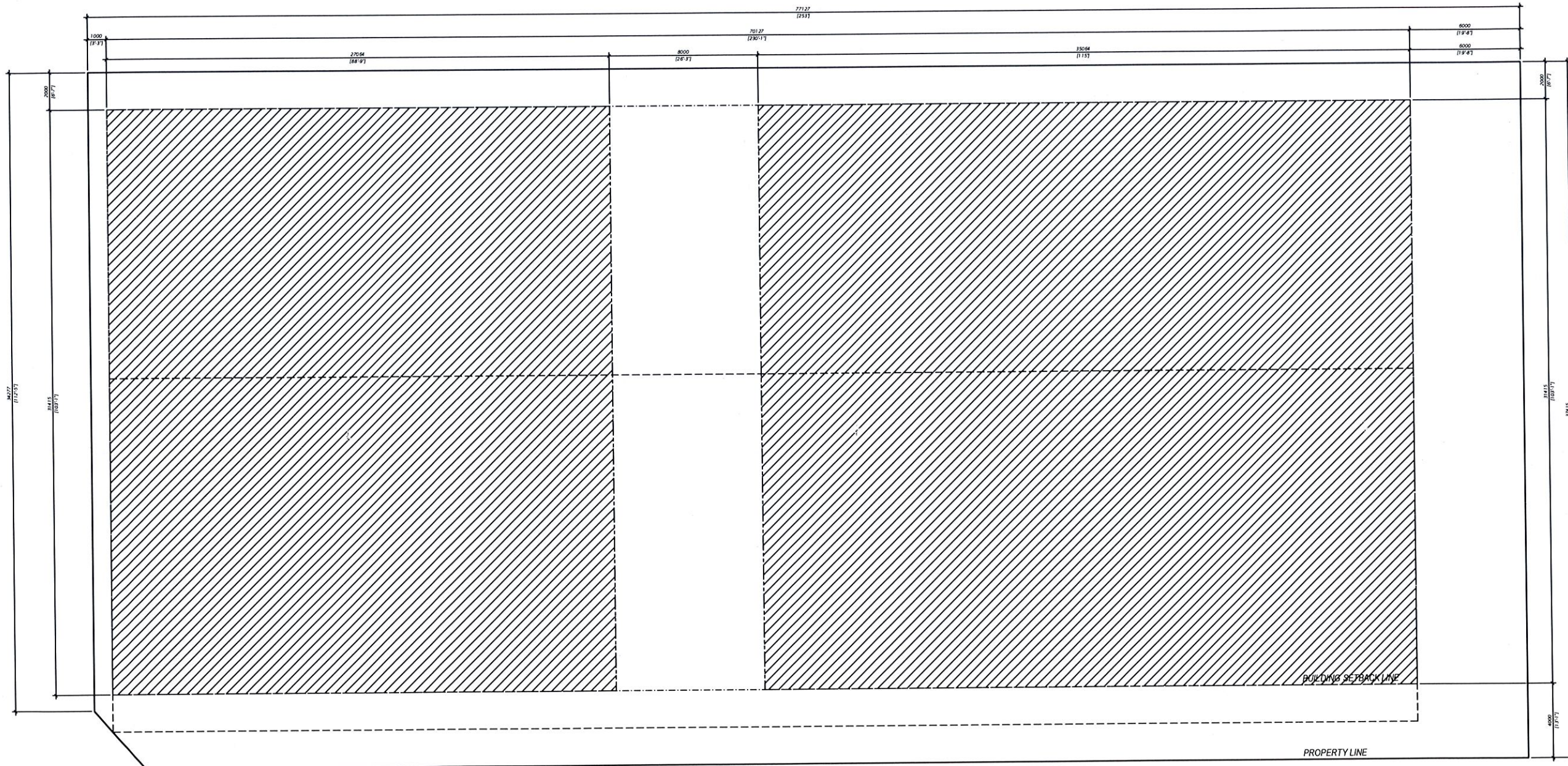
Owner:
RAINBOW CONSTRUCTION



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Struct. Engineer: -	Rev. No: -
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Dwg. No: MRC -A - FPL01 - 02	



MASTER PLAN SITE PLAN RESIDENTIAL
SCALE 1:250



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

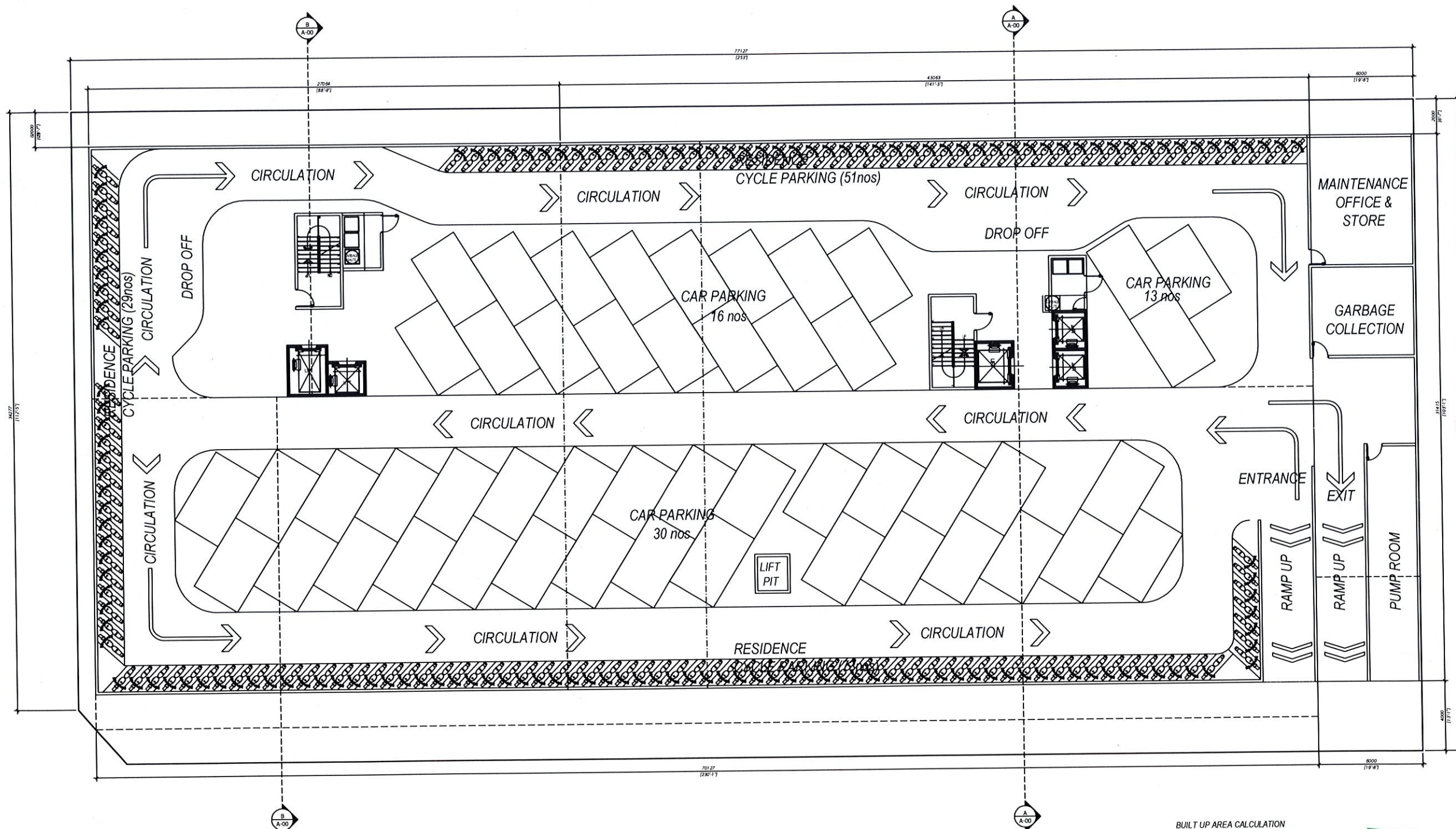
Dwg. Title:
FLOOR PLANS

Owner:
RAINBOW CONSTRUCTION



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Architect/Designer: ALI SHAREEF	Job No: TDA 2016 - 1175
Struct. Engineer: -	Rev. No.: -
Drawn: ALI / ISHAN / ZAF	File No.: -
Surveyed: -	Date: 08 SEPT. 2016
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Dwg. No.: MRC -A - FPL02 - 03	



MASTER PLAN BASEMENT FLOOR
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES,
WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
AND TOILETS FOR RESIDENTIAL COMMON USE

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	0 m ²
Commercial Area	0 m ²
Common Area	248.09 m ²
Parking Area	2143.43 m ²
Total Built-up Area	2391.52m²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

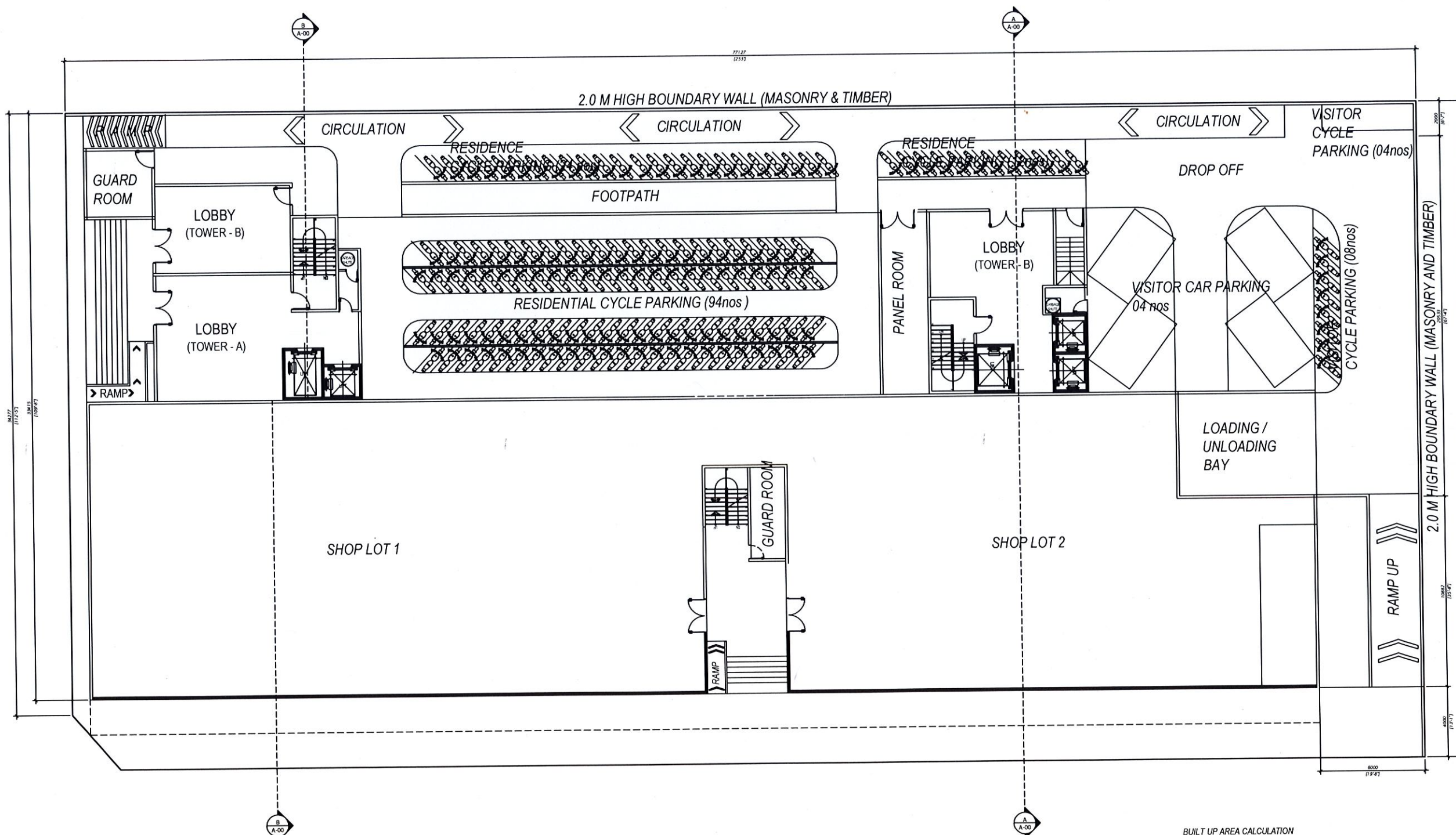
Owner:
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Dwg. No:	
MRC -A - FPL03 - 04	



MASTER PLAN GROUND FLOOR
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES,
WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
AND TOILETS FOR RESIDENTIAL COMMON USE

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	0 m ²
Commercial Area	1133.46 m ²
Common Area	476.39 m ²
Parking Area	917.47 m ²
Total Built-up Area	2527.32 m ²

APPROVED
Housing Development
Corporation Ltd.

NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

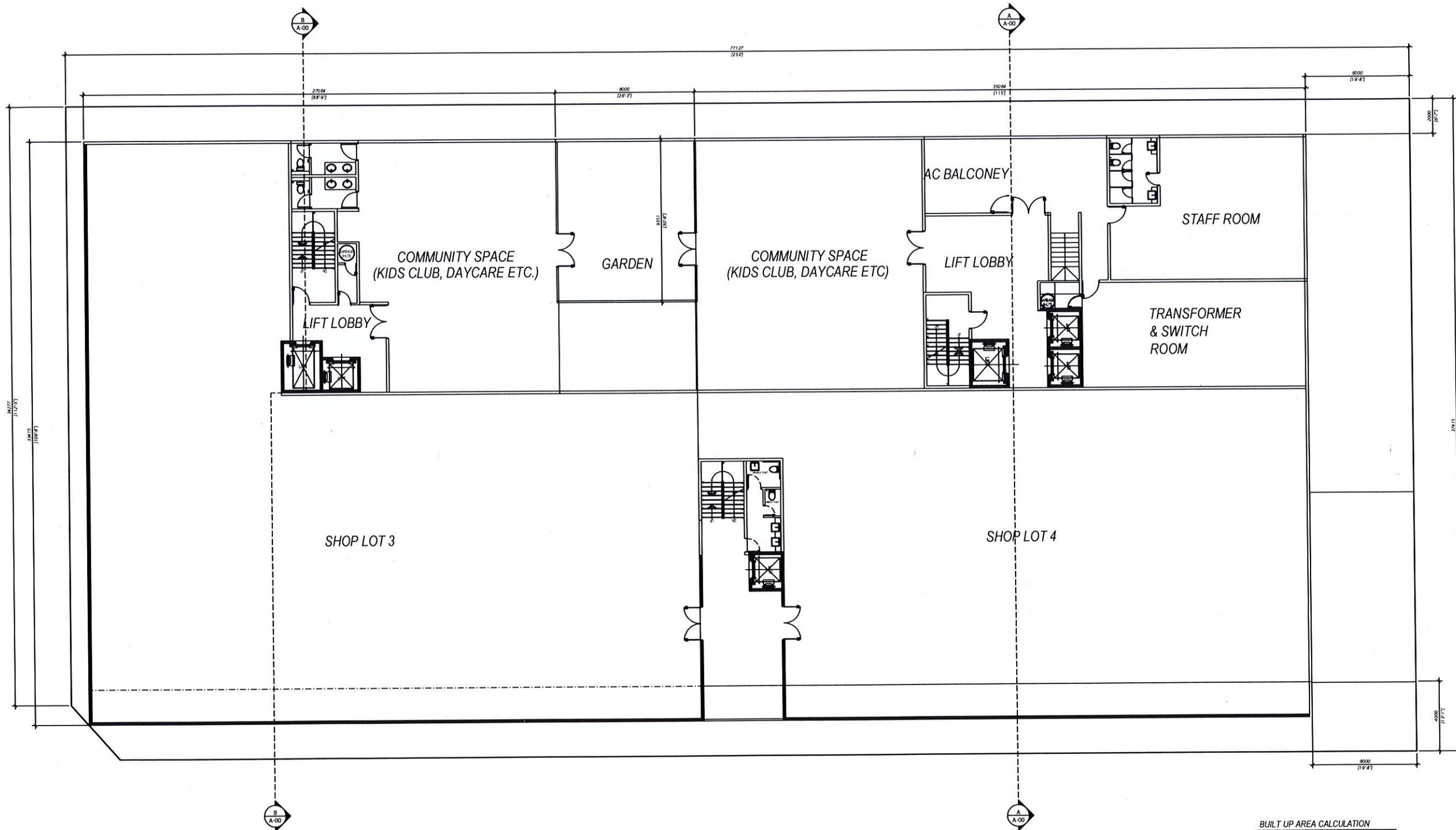
Owner:
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MRC - A - FPL04 - 05	



MASTER PLAN FIRST FLOOR PLAN
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES:
WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
AND TOILETS FOR RESIDENTIAL COMMON USE

BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	0 m ²
Commercial Area	1470.44 m ²
Common Area	872.86 m ²
Total Built-up Area	2343.30 m ²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

Owner:
RAINBOW CONSTRUCTION

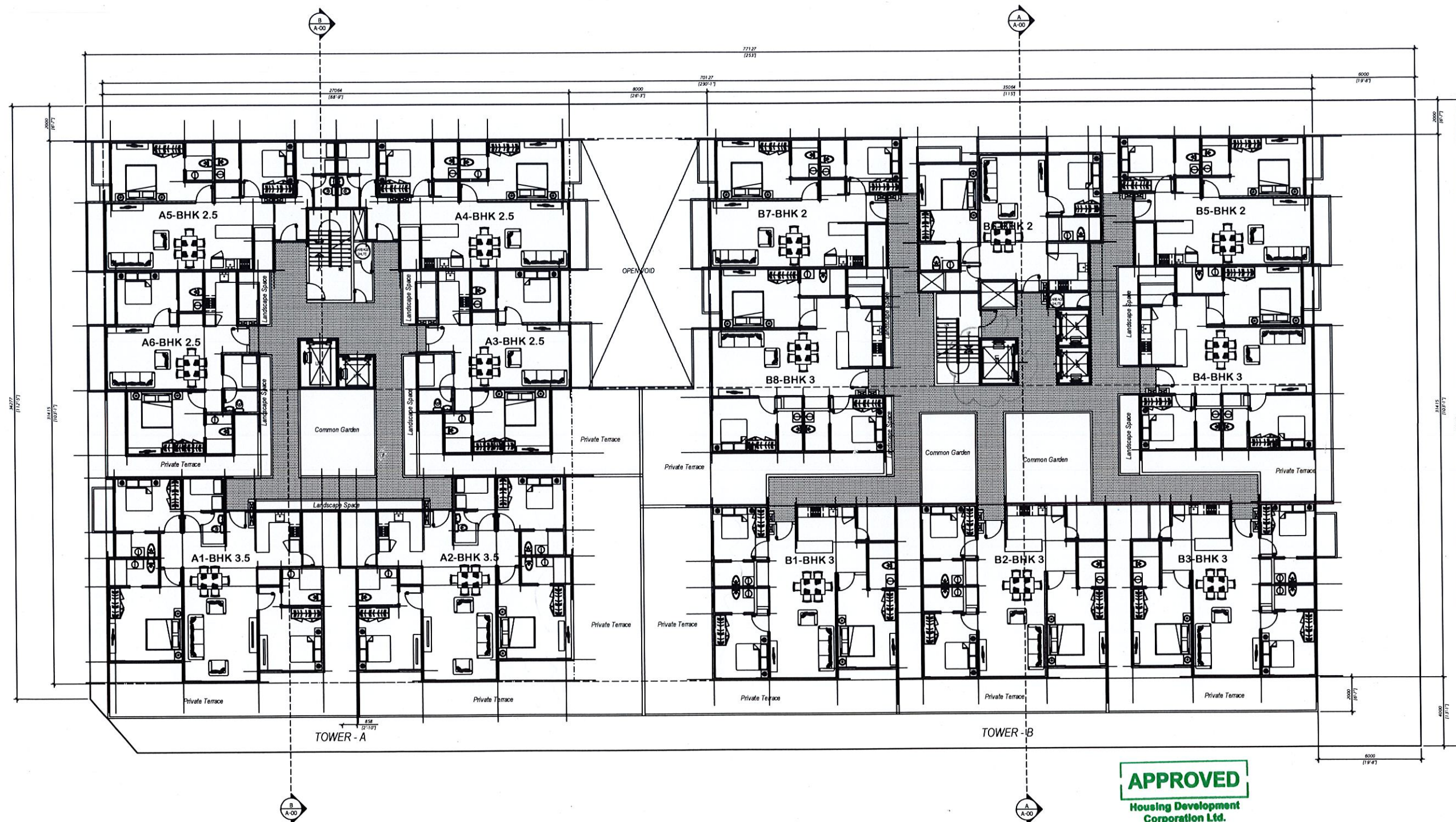
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Dwg. No:	
MRC -A - FPL05 - 06	

NOTES:



MASTER PLAN 2ND FLOOR PLAN
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES,
WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	614.93 m ²
Terrace Garden	228.06 m ²
Balcony + Ledge Area	8.42 m ²
Common Area	153.78 m ²
Total Built-up Area	1005.19 m ²

TOWER - B
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	766.15 m ²
Terrace Garden	237.54 m ²
Balcony + Ledge Area	31.94 m ²
Common Area	240.65 m ²
Total Built-up Area	1276.28 m ²

APPROVED
Housing Development
Corporation Ltd.

No.	Revision/Issue	Date
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CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

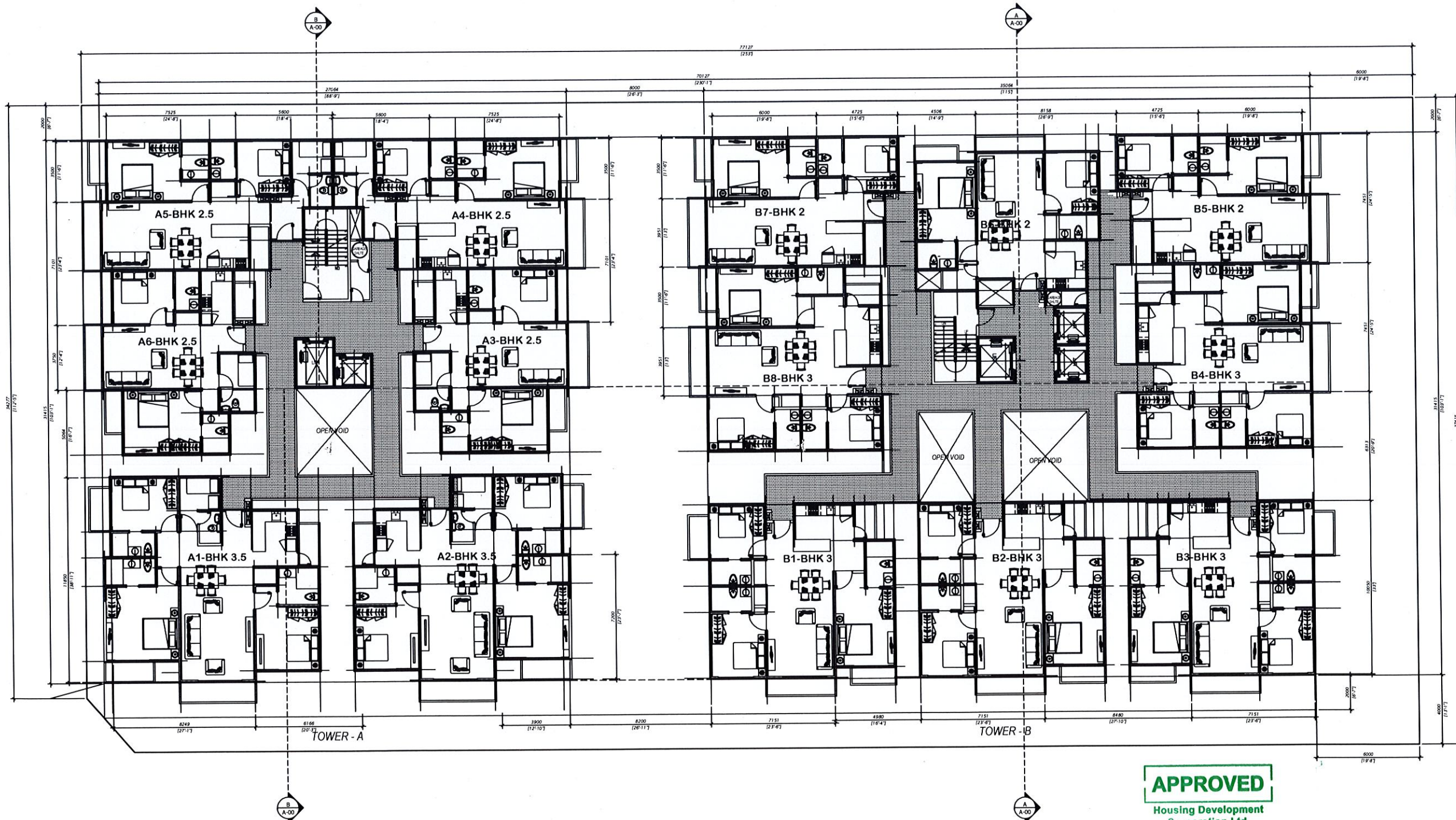
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Owner:
RAINBOW CONSTRUCTION



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MRC -A - FPL06 - 07	



MASTER PLAN 3RD - 7TH FLOOR PLAN

SCALE 1:250

NOTE:
 AREA CALCULATION FOR COMMON AREAS INCLUDES:
 WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
 ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
 AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	613.52 m ²
Balcony + Ledge Area	55.96 m ²
Common Area	115.44 m ²
Total Built-up Area	784.92 m²

TOWER - B

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	761.89 m ²
Balcony + Ledge Area	68.88 m ²
Common Area	184.90 m ²
Total Built-up Area	1015.67 m²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
 MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

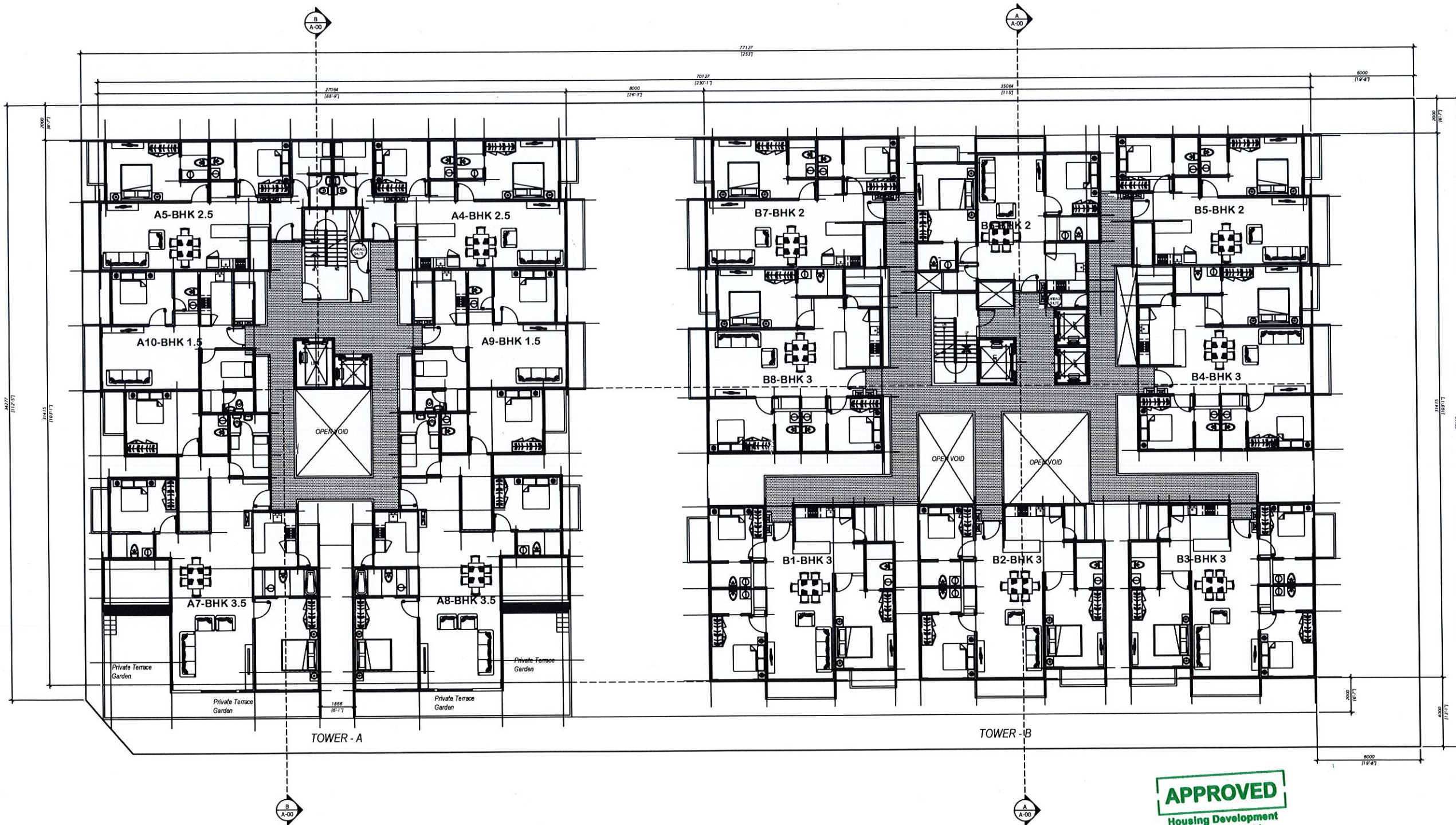
Owner:
RAINBOW CONSTRUCTION

TEKTON DESIGN ASSOCIATES PVT. LTD.
 ARCHITECTS & ENGINEERS

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Struct. Engineer:	Rev. No:
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Drawn:	File No:
ALI / ISHAN / ZAF	-
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-	08 SEPT. 2016
Checked/Approved:	Scale:
-	AS GIVEN
Dwg. No:	
MRC - A - FPL07 - 08	



MASTER PLAN 8TH - 10TH FLOOR PLAN
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES, WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	614.24 m ²
Terrace Garden	98.30 m ²
Balcony + Ledge Area	34.78 m ²
Common Area	102.93 m ²
Total Built-up Area	850.25 m²

TOWER - B
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	761.89 m ²
Balcony + Ledge Area	68.88 m ²
Common Area	184.90 m ²
Total Built-up Area	1015.67 m²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
PROPOSED DEVELOPMENT MIXED-RESIDENTIAL D2-3

Dwg. Title:
FLOOR PLANS

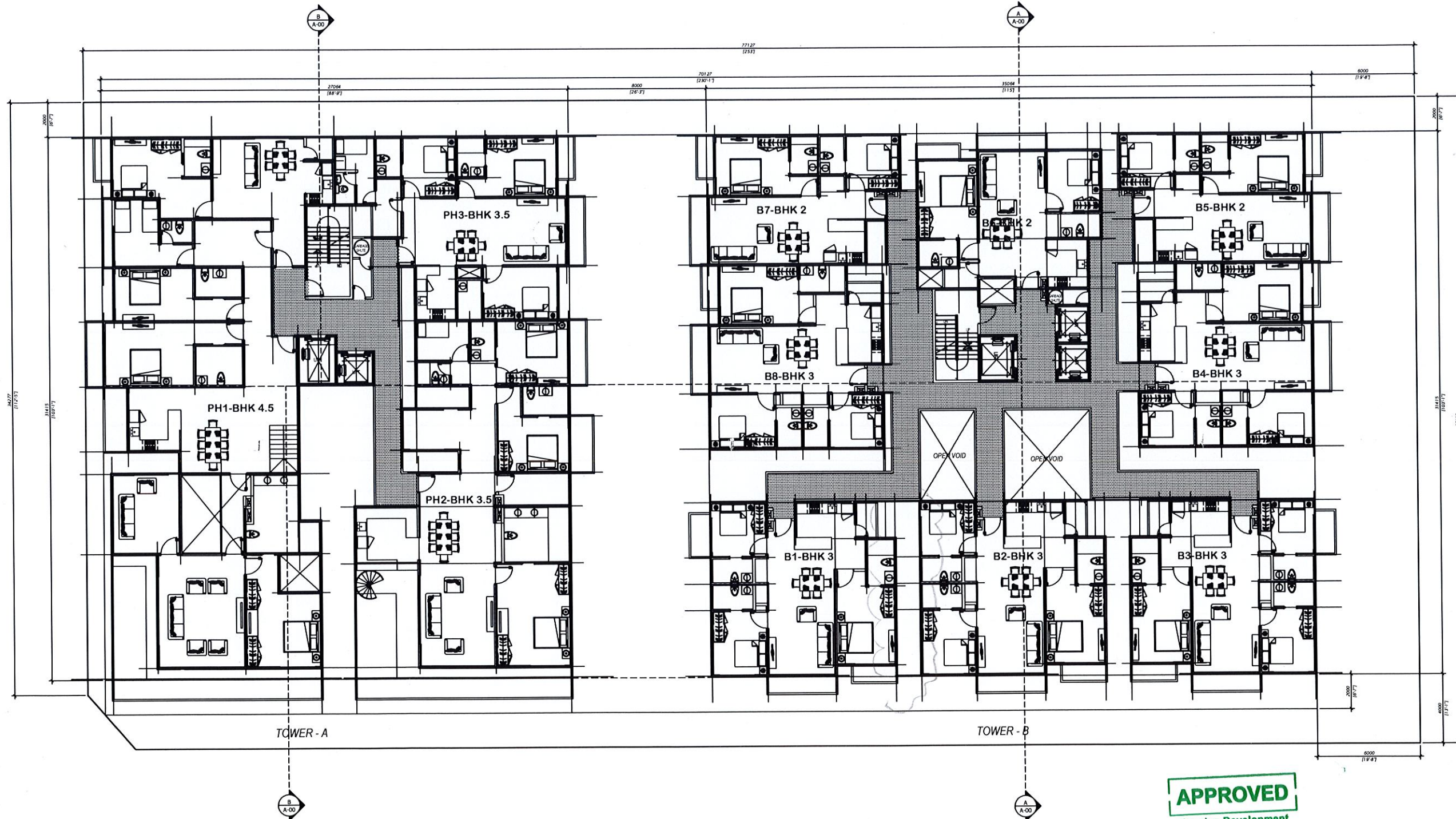
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MRC -A - FPL08 - 09	



MASTER PLAN 11TH FLOOR PLAN RESIDENTIAL

SCALE 1:250

NOTE:
 AREA CALCULATION FOR COMMON AREAS INCLUDES,
 WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY
 ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM
 AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A
 BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	638.57 m ²
Terrace Garden	82.75 m ²
Balcony + Ledge Area	25.96 m ²
Common Area	73.72 m ²
Total Built-up Area	821.00 m²

TOWER - B
 BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	761.89 m ²
Balcony + Ledge Area	68.88 m ²
Common Area	184.90 m ²
Total Built-up Area	1015.67 m²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
**PROPOSED DEVELOPMENT
 MIXED-RESIDENTIAL D2-3**

Dwg. Title:
FLOOR PLANS

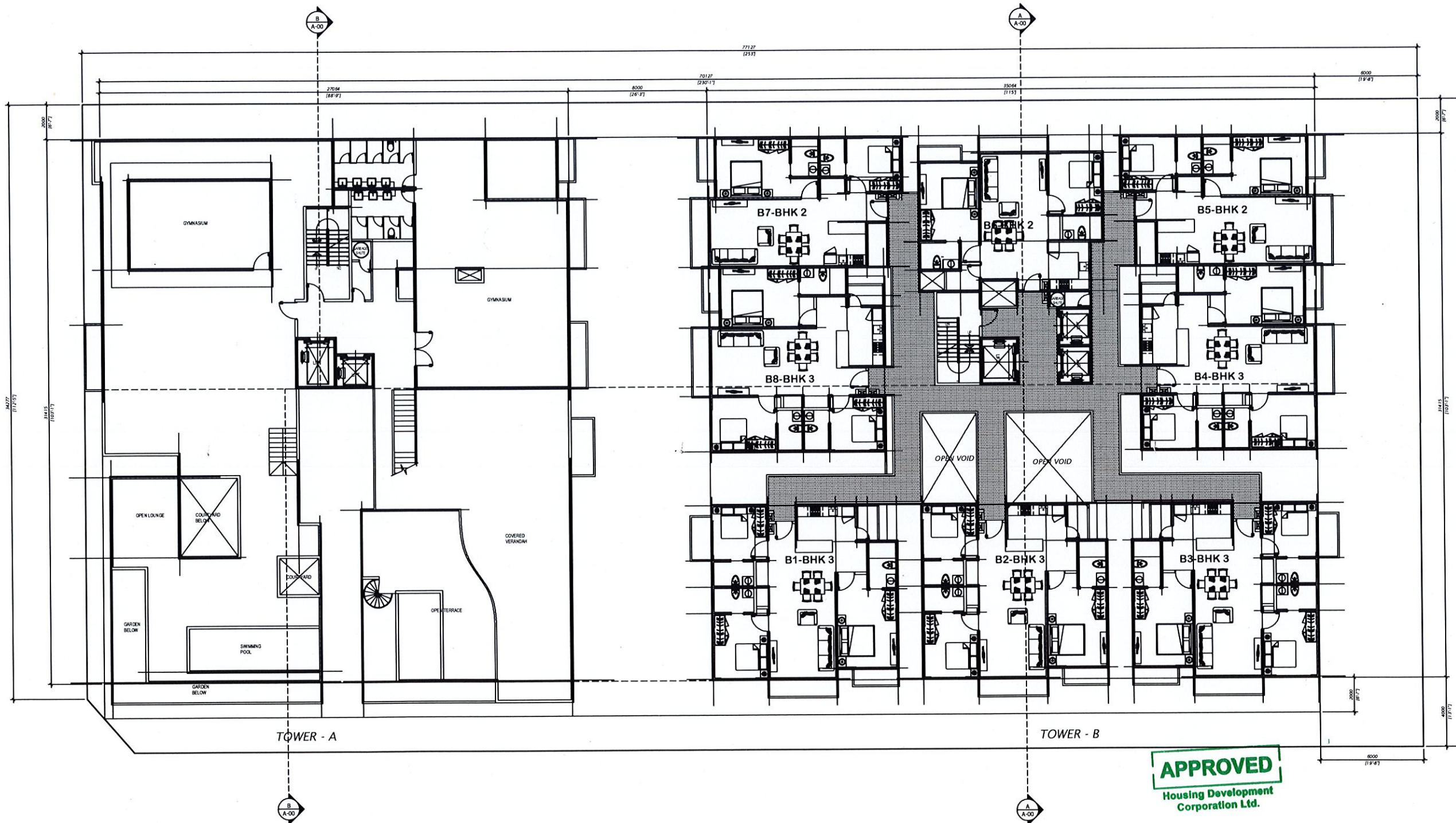
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Struct. Engineer:	Rev. No:
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Drawn:	File No:
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-	08 SEPT. 2016
Checked/Approved:	Scale:
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MRC - A - FPL09 - 10	



MASTER PLAN 12TH FLOOR PLAN RESIDENTIAL
SCALE 1:250

NOTE:
AREA CALCULATION FOR COMMON AREAS INCLUDES, WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	44.63 m ²
Residential Terrace Area	292.15 m ²
Common Area	353.21 m ²
Total Built-up Area	689.99 m ²

TOWER - B
BUILT UP AREA CALCULATION

PLOT AREA	2880.93 m ²
Residential Area	761.89 m ²
Balcony + Ledge Area	68.88 m ²
Common Area	184.90 m ²
Total Built-up Area	1015.67 m ²

APPROVED
Housing Development Corporation Ltd.

NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
PROPOSED DEVELOPMENT MIXED-RESIDENTIAL D2-3

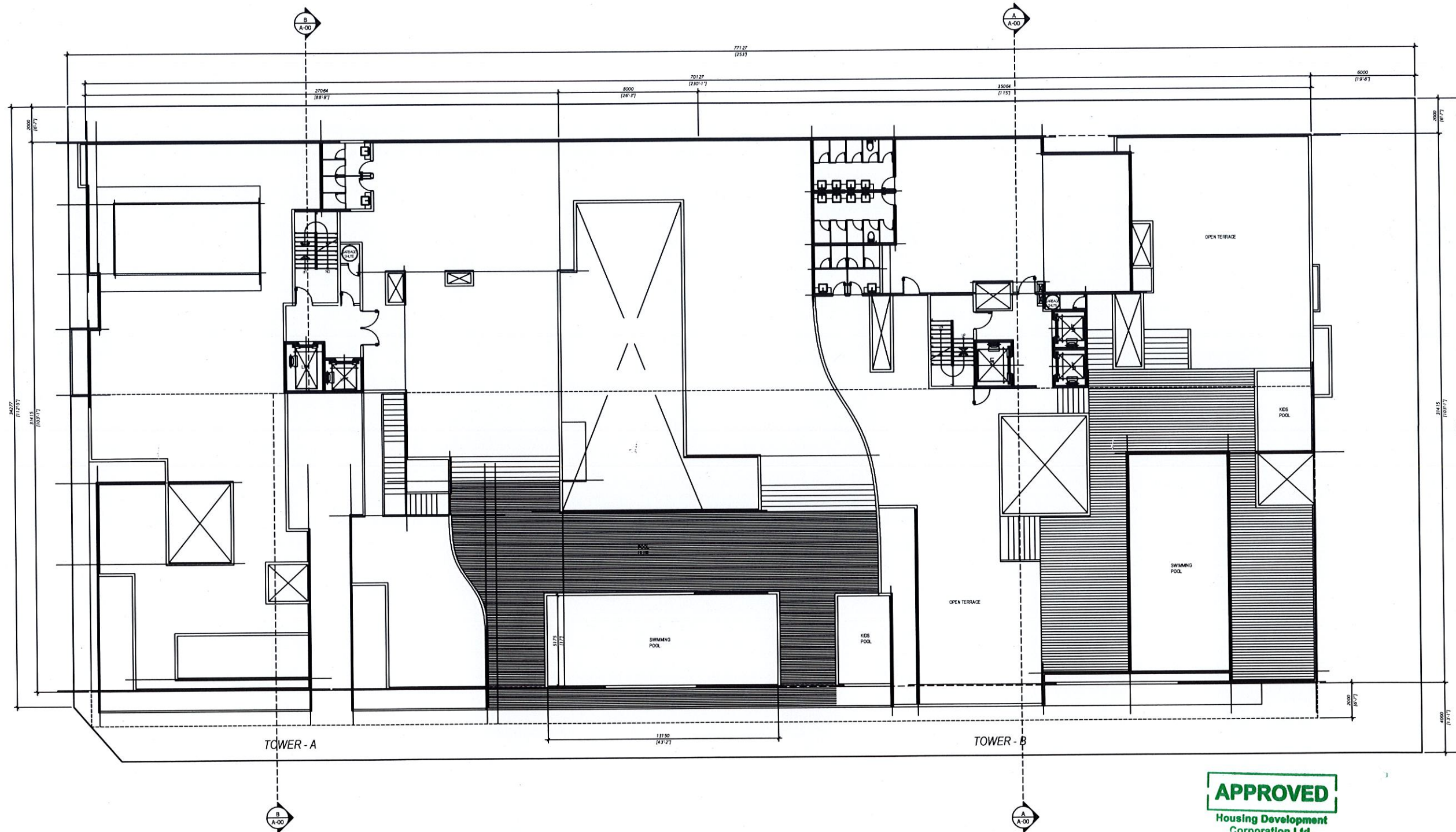
Dwg. Title:
FLOOR PLANS

Owner:
RAINBOW CONSTRUCTION



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Email: tekton@tektondesign.com, www.tektondesign.com

Architect/Designer:	Job No:
ALI SHAREEF	TDA 2016 - 1175
Struct. Engineer:	Rev. No:
-	-
Drawn:	File No:
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MRC -A - FPL10 - 11	



MASTER PLAN TERRACE FLOOR PLAN
SCALE 1:250

AREA CALCULATION FOR COMMON AREAS INCLUDES, WALKWAYS, STAIRCASE, LIFTS, LIFT LOBBY, UTILITY ROOMS/SPACES, COMMUNITY SPACES, GYMNASIUM AND TOILETS FOR RESIDENTIAL COMMON USE

TOWER - A

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	0.00 m ²
Common Area	772.52 m ²
Total Built-up Area	772.52 m ²

TOWER - B

BUILT UP AREA CALCULATION	
PLOT AREA	2880.93 m ²
Residential Area	0.00 m ²
Balcony + Ledge Area	0.00 m ²
Common Area	776.10 m ²
Total Built-up Area	776.10 m ²



NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title:
PROPOSED DEVELOPMENT MIXED-RESIDENTIAL D2-3

Dwg. Title:
FLOOR PLANS

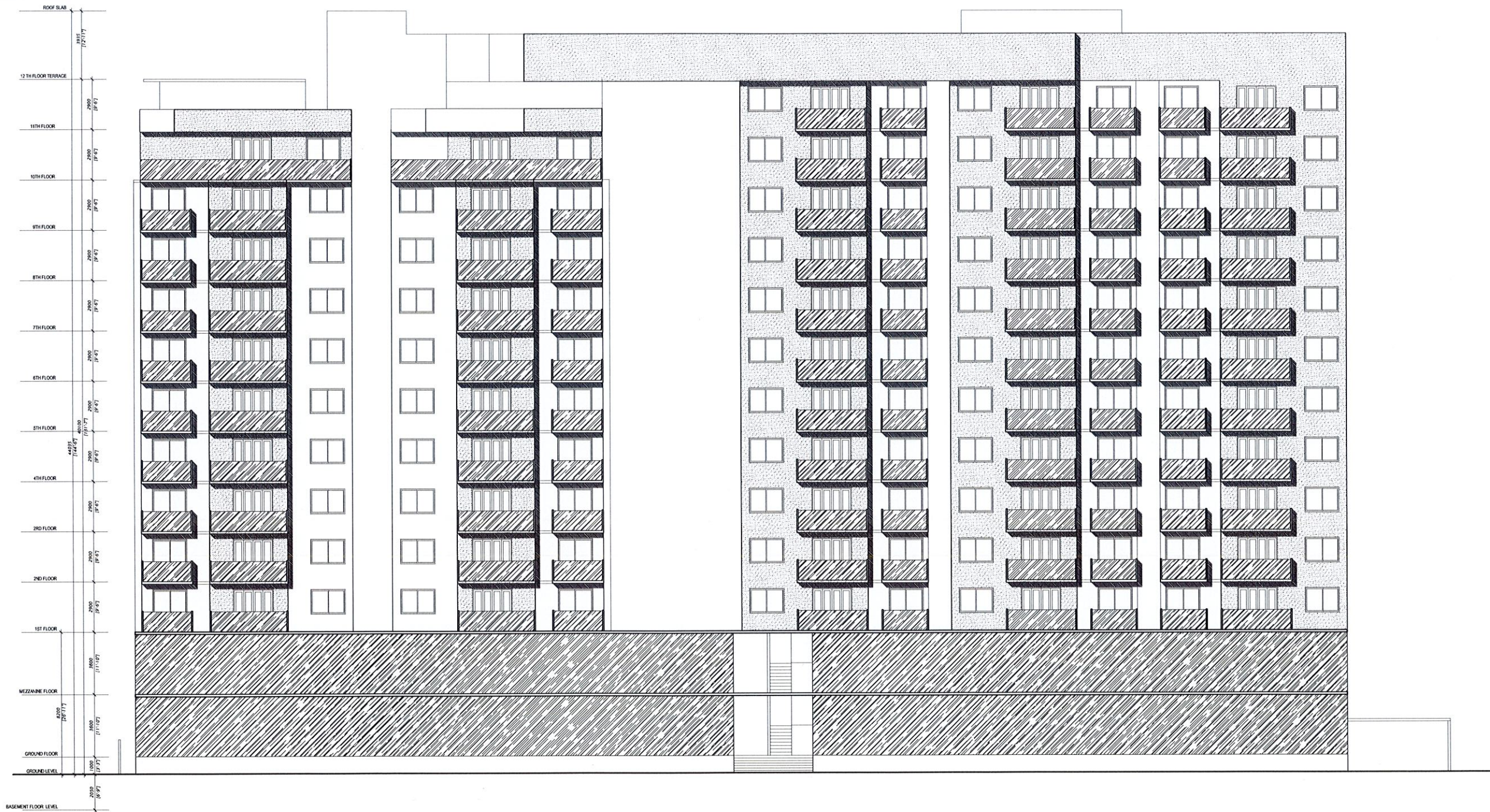
Owner:
RAINBOW CONSTRUCTION

TEKTON DESIGN ARCHITECTS & ENGINEERS

TEKTON DESIGN ASSOCIATES Pte. Ltd.
2810, Marlin Spike Building, Alhambra Road, Galle, Sri Lanka.
Rep. of Maldives, Tel: (960) 33 4569, (960) 33 3639, Fax: (960) 33 7374
Email: info@tektondesign.com, www.tektondesign.com

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Architect/Designer:	Job No:
ALI SHAREEF	TDA 2016 - 1175
Struct. Engineer:	Rev. No:
-	-
Drawn:	File No:
ALI / ISHAN / ZAF	-
Surveyed:	Date:
-	08 SEPT. 2016
Checked/Approved:	Scale:
-	AS GIVEN
Dwg. No:	
MRC - A - FPL11 - 12	



FRONT ELEVATION
SCALE 1:175

APPROVED
Housing Development
Corporation Ltd.

NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title :
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title :
FRONT ELEVATION

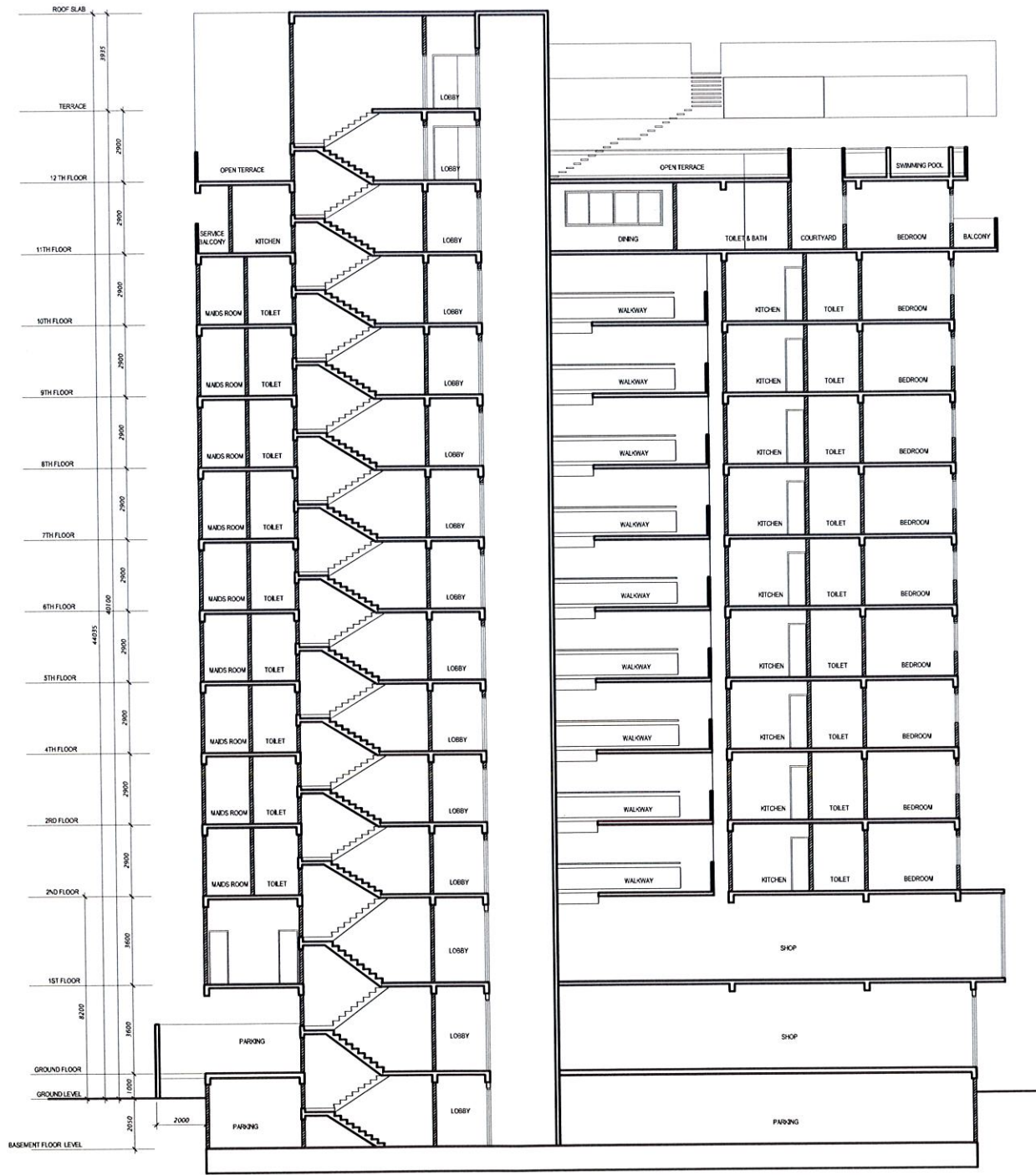
Owner
RAINBOW CONSTRUCTION

**TEKTON
DESIGN**
ARCHITECTS
& ENGINEERS

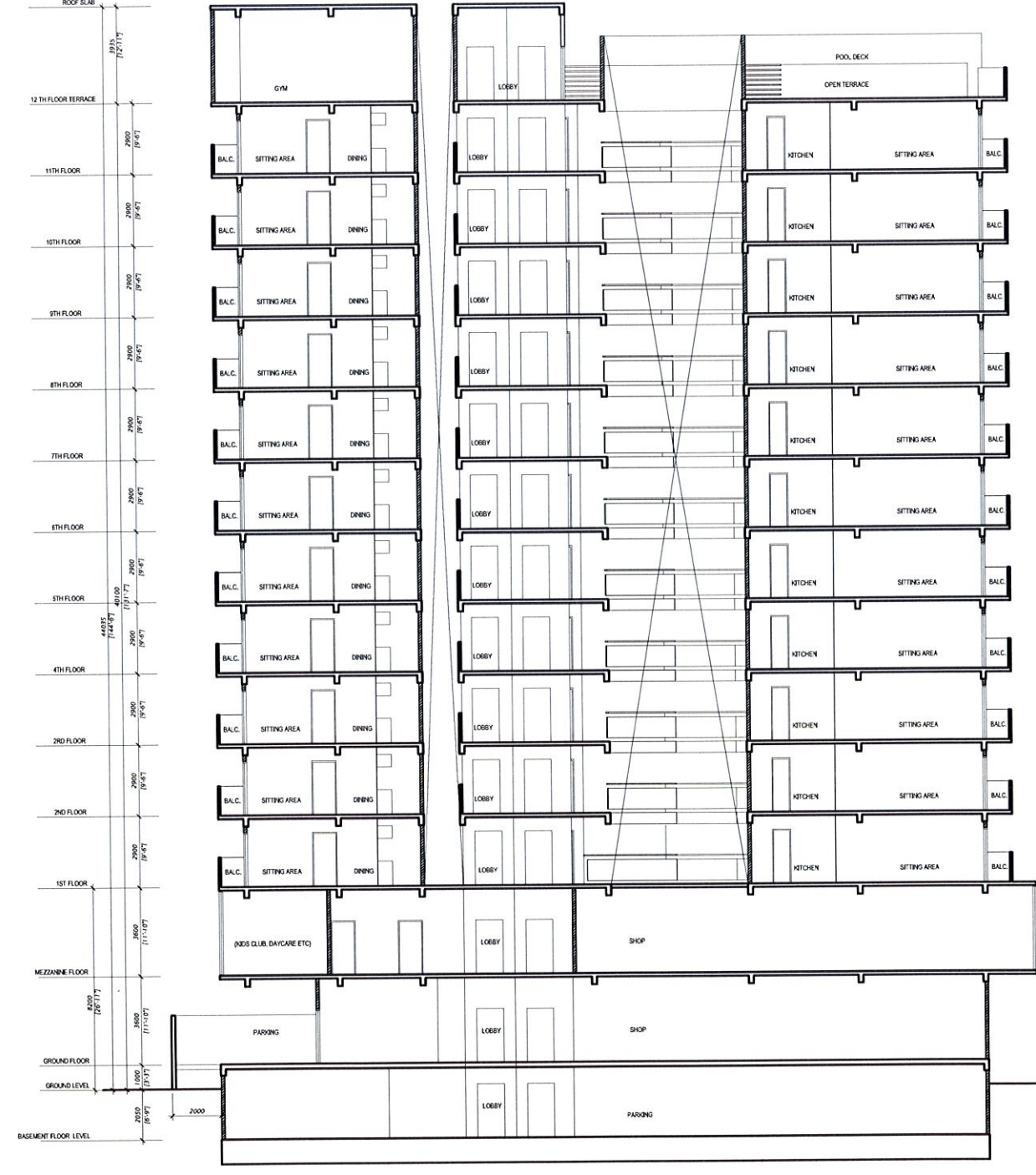
TEKTON DESIGN ASSOCIATES PVT. LTD.
02/15, Marlin Sphe Building, Alibon Road, Doha, Qatar
P.O. Box 11111, Doha, Qatar. Tel: (974) 33 4956, (974) 33 1836, Fax: (974) 33 7314
Email: tektor@tektordesign.com.qa, www.tektordesign.com.qa

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Architect/Designer :	Job No :
ALI SHAREEF	TDA 2016 - 1175
Struct. Engineer :	Rev. No :
-	-
Drawn :	File No :
ALI / ISHAN / ZAF	-
Surveyed :	Date :
-	20 JUNE 2016
Checked/Approved :	Scale :
-	AS GIVEN
Dwg. No :	
MRC -A - ELV00 - 12	



SECTION B-B (TOWER A)
SCALE 1:175



SECTION A-A (TOWER B)
SCALE 1:175

APPROVED
Housing Development Corporation Ltd.

NOTES:

No.	Revision/Issue	Date

CONCEPT DRAWING

Project Title :
**PROPOSED DEVELOPMENT
MIXED-RESIDENTIAL D2-3**

Dwg. Title :
SECTION A-A & B-B

Owner
RAINBOW CONSTRUCTION



TEKTON DESIGN ASSOCIATES PVT. LTD.
0210, Marlin Baha Building, Alhambra Road, Ghatkoti, Kathmandu, Nepal
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Architect/Designer : ALI SHAREEF	Job No: TDA 2016 - 1175
Struct. Engineer : -	Rev. No. : -
Drawn : ALI / ISHAN / ZAF -	File No. : -
Surveyed : -	Date: 20 JUNE 2016
Checked/Approved : -	Scale : AS GIVEN

Dwg. No. :
MRC -A - SEC00 - 13

Annex 4 – Water test results

WATER QUALITY TEST REPORT
 Test Report No: 300827/2016/40

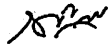

Customer Informations :

Mr. Amir Musthafa
 Flat 11-2-3,
 Hulhumale'
 Rep. of Maldives

Date: 27/11/2016

Sample Description / Location~	Rainbow Oceanfront		TEST METHOD	UNIT
	Ground Water 1	Ground Water 2		
Sample Type~	Ground water			
Sampled Date~	07/11/2016			
Sample Received Date	09/11/2016			
Test Requisition Form No.	900168749			
Sample No.	829649	829650		
Date of Analysis	9/11/2016 - 11/11/2016			
PARAMETER	ANALYSIS RESULT			
Physical Appearance	Pale yellow with particles	Pale yellow with particles	Visual	-
Conductivity	451	446	Method 2510 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	µS/cm
pH	8.17	8.69	Method 4500-H+ B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	-
Salinity	0.22	0.21	Method 2520 B. (adapted from Standard methods for the examination of water and waste water, 21st edition)	%e
Temperature	20.6	20.6	Electrometry	°C
Total Petroleum Hydrocarbon (TPH)	7.1	6.4	UV Fluorescence	mg/L
Total Dissolved Solids	225	223	Electrometry	mg/L
Turbidity	2.99	1.08	HACH Nephelometric Method (adapted from HACH 2100N Turbidimeter User Manual)	NTU

Keys:
 µS/cm: Micro Seimen per Centimeter, ‰: Parts Per Thousand, mg/L: Milligram Per Liter, °C: Degree Celcius, NTU: Nephelometric Turbidity Unit

Checked by:  Nihaz Ali Zahir Laboratory Executive	Approved by:  Mohamed Eyman Senior Technical Officer
--	---

Notes:
Sampling Authority: Sampling was not done by MWSC Laboratory
 This report shall not be reproduced except in full, without written approval of MWSC
 This test report is ONLY FOR THE SAMPLES TESTED.
 ~ Information Supplied by the customer

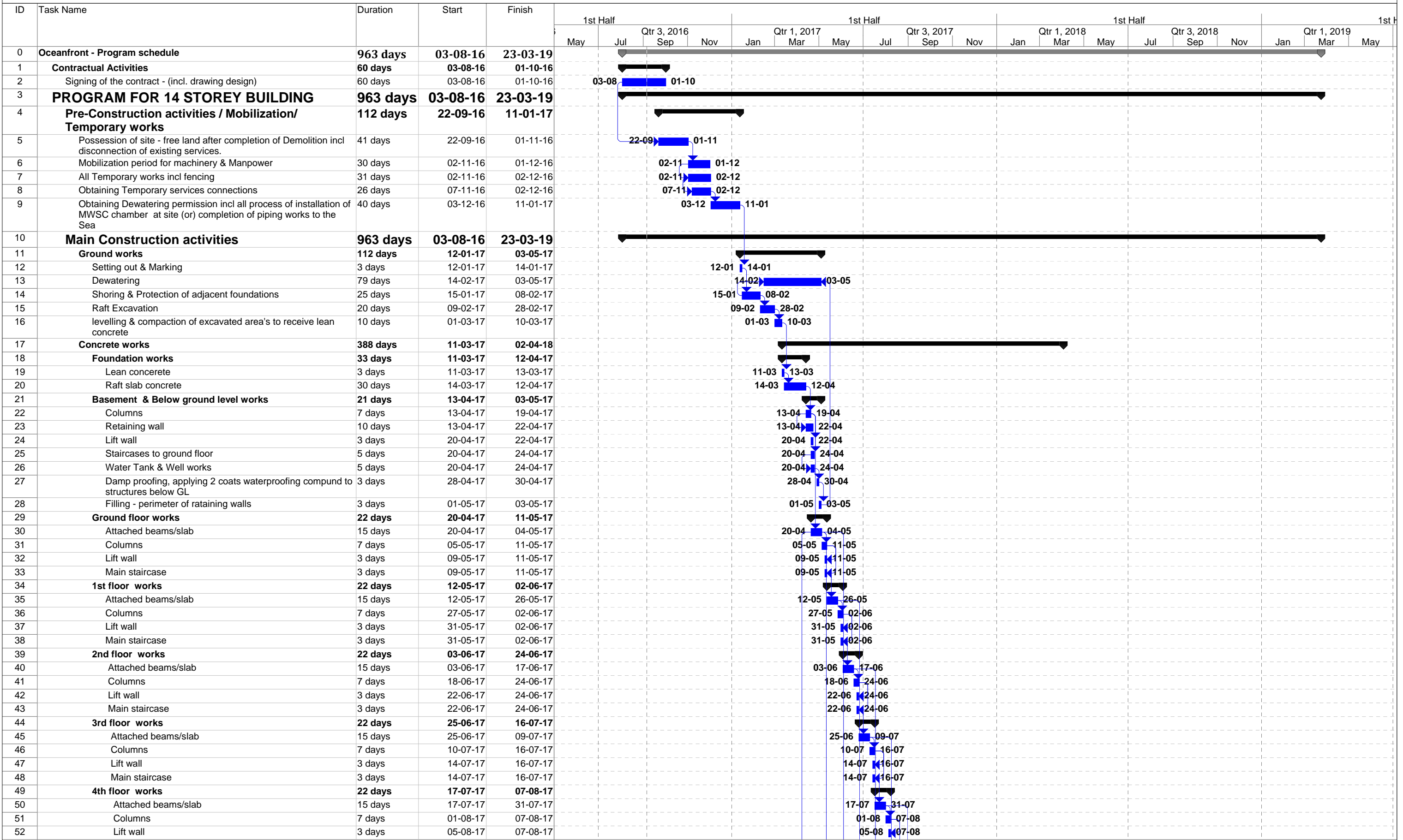
*****END OF THE REPORT*****

Amir
 5/12/16


Annex 5 – Work schedule

Work schedule

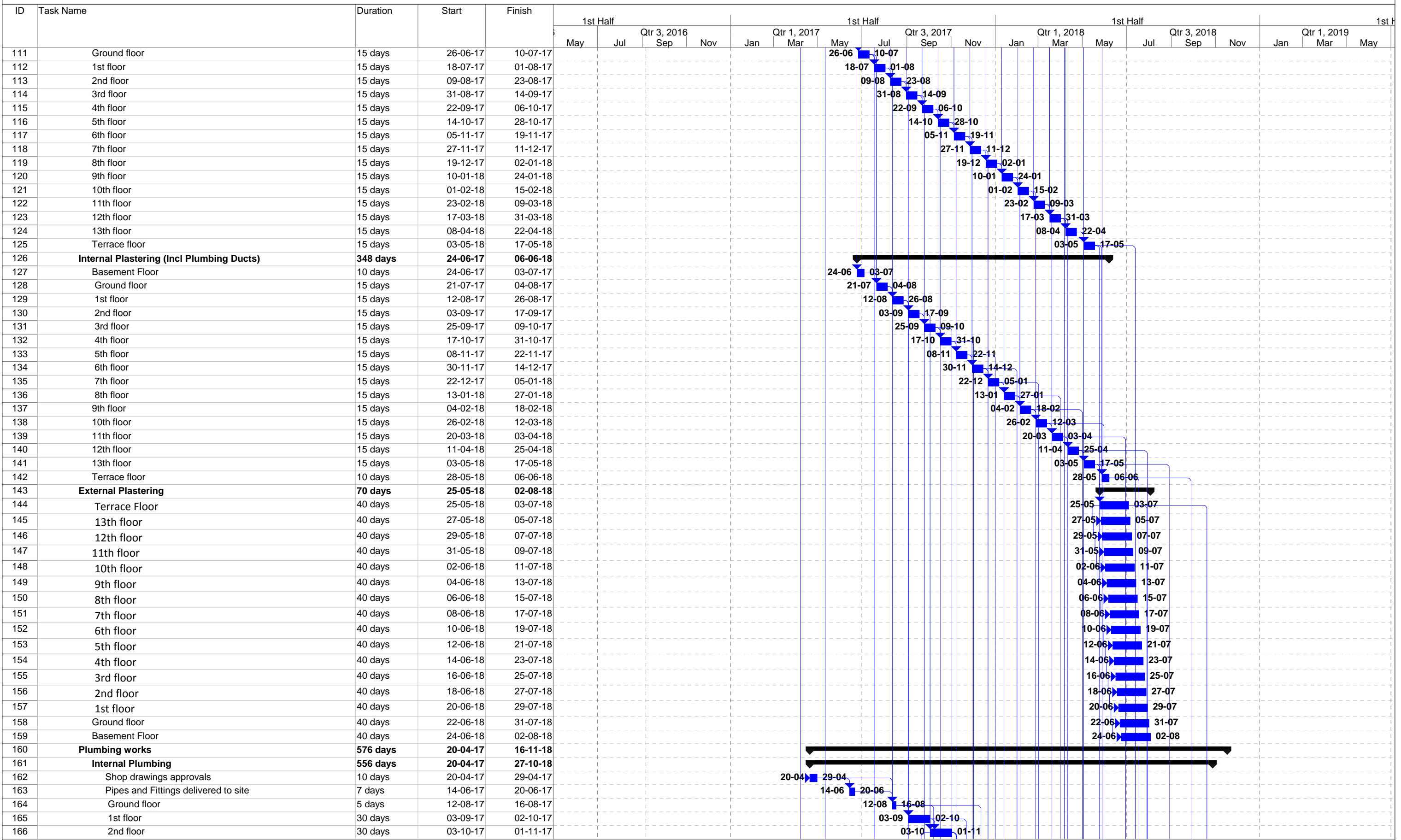
OCEANFRONT



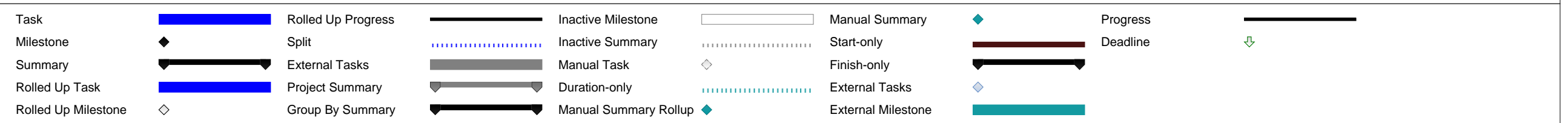
RAINBOW CONSTRUCTION PVT,LTD.	Task		Rolled Up Progress		Inactive Milestone		Manual Summary		Progress	
	Milestone		Split		Inactive Summary		Start-only		Deadline	
	Summary		External Tasks		Manual Task		Finish-only			
	Rolled Up Task		Project Summary		Duration-only		External Tasks			
	Rolled Up Milestone		Group By Summary		Manual Summary Rollup		External Milestone			

Work schedule

CONFIDENTIAL

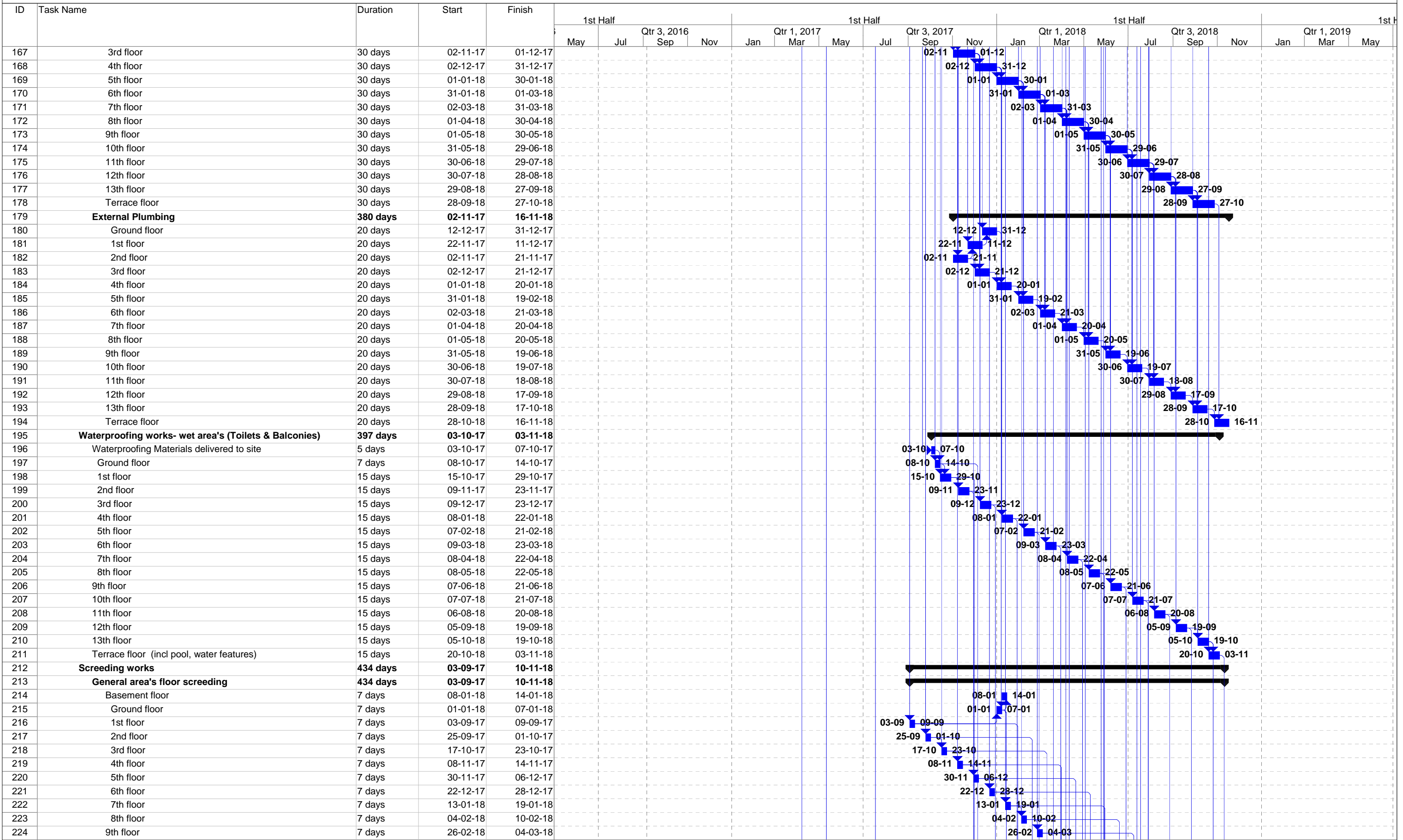


RAINBOW CONSTRUCTION PVT,LTD.



Work schedule

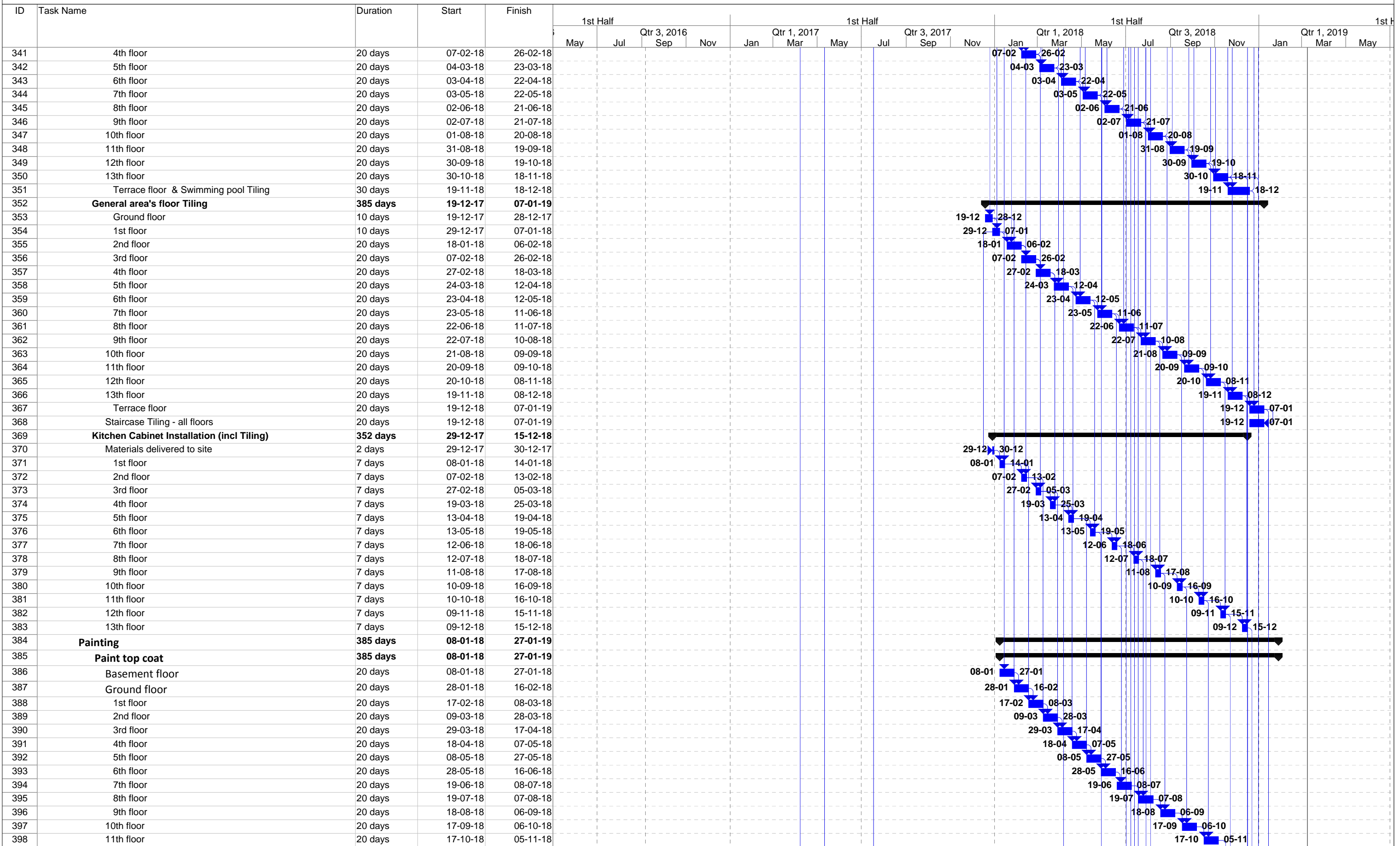
GENFORNSIDE



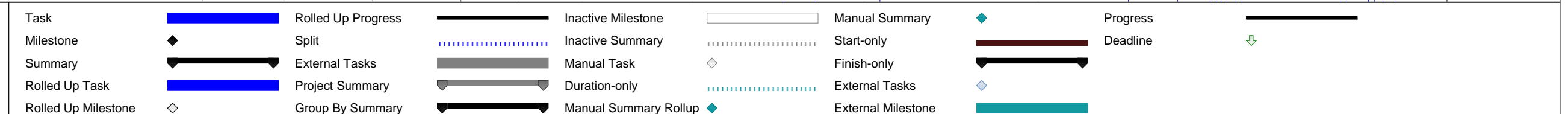
RAINBOW CONSTRUCTION PVT,LTD.	Task		Rolled Up Progress		Inactive Milestone		Manual Summary		Progress	
	Milestone		Split		Inactive Summary		Start-only		Deadline	
	Summary		External Tasks		Manual Task		Finish-only			
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	Rolled Up Milestone		Group By Summary		Manual Summary Rollup		External Milestone			

Work schedule

CONFIDENTIAL

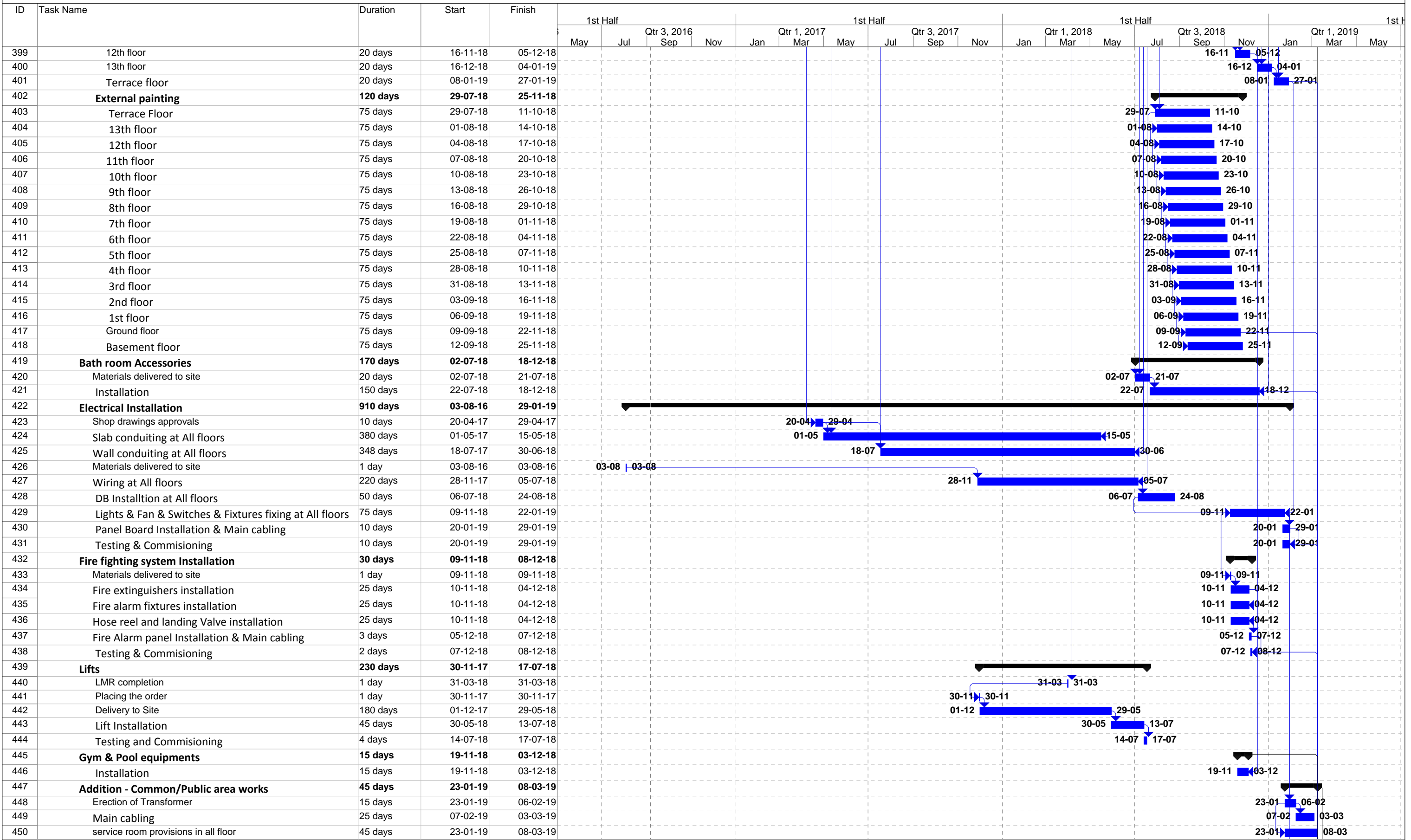


RAINBOW CONSTRUCTION PVT,LTD.



Work schedule

RAINBOW CONSTRUCTION



RAINBOW CONSTRUCTION PVT,LTD.

Task		Rolled Up Progress		Inactive Milestone		Manual Summary		Progress	
Milestone		Split		Inactive Summary		Start-only		Deadline	
Summary		External Tasks		Manual Task		Finish-only			
Rolled Up Task		Project Summary		Duration-only		External Tasks			
Rolled Up Milestone		Group By Summary		Manual Summary Rollup		External Milestone			

Annex 6 – Proponents Commitment for Monitoring and Mitigation



**RAINBOW
CONSTRUCTION (PVT) LTD.**

G. Maarana, Alikilegefaanu Magu, Malé 20-04, Republic of Maldives Tel: (+960) 334 0460, Fax: (+960) 332 7374, e-mail: info@rainbowconstruction.com.mv

26th December 2016

**Ibrahim Naeem
Director General
Environmental Protection Agency
Ministry of Environment and Energy
Male', Maldives**

Dear Mr. Ibrahim Naeem,

**Project: EIA for the proposed Mixed Residential Building in Plot No. D2-3, Hulhumale' –
Rainbow Oceanfront Residence**

Sub: Proponents Declaration and Commitment for Monitoring and Mitigation

As the proponent of the project, we guarantee that we have read this EIA report and to the best of our knowledge, all non-technical information provided here are accurate and complete. We are aware that this report has been prepared in accordance with the EIA regulations.

We confirm our commitment to undertake all mitigation measures and carry out the monitoring program as specified in the report.

Thanking you

Yours Sincerely

Mohammed Afrah

Operation Manager



Annex 7 – Soil test report



ELS & AMIN INTERNATIONAL PRIVATE LTD
Geotechnical Engineering Division
Quality is Our Trademark

GEOTECHNICAL INVESTIGATION REPORT

OVE 115

PROJECT

Soil Investigation for the Proposed Ocean Front Project at Hulhumale

CLIENT

M/s. Rainbow Construction Pvt (Ltd)

October 12, 2016



ELS&AMIN
International private limited

Tel/ Fax: +960 334 6000, Mobile Hotline: 790 6000
52, Boduthakurufaanu Magu, Maafannu, Male' 20-01, Maldives.
Email: info@elsamin.com.mv, Web: www.elsamin.com.mv

			Document No:		OVE/115
0	12/10/2016	Soil Investigation Report at Hulhumale	K.K.Diana Perera	Prof. H.S.Thilakasiri	R.M.Wasantha Ratnayake
Rev	Date	Description	Prepared By	Foundation Recommendation given By	Approved By

Engineering & Laboratory Services (Pvt) Ltd

62/3 Neelammahara Road

Katuwawala, Boraesgamuwa, Sri Lanka

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Fax: 011-2509806

Email: els@elslanka.com

Web site: www.elslanka.com

SOIL INVESTIGATION FOR THE OCEAN FRONT PROJECT AT HULHUMALE

(TWO NUMBER OF FORTEEN STORIED BUILDING TOWERS)

1.0 Introduction

Geotechnical investigation phase of foundation engineering plays a vital role in the process of designing a foundation structure intelligently. This work includes borehole drilling, sampling of disturbed and un-disturbed materials, laboratory investigation of samples and in-situ testing. The scope of borehole drilling which means the number, location and depth of boreholes depend on the loads imposed by the structure, size of the structure and sub-soil conditions.

This report embodies the findings of the site investigation including, nature and depth of soil strata, ground water levels at the site, physical and mechanical properties of soils and other relevant details of the geotechnical investigation

2.0 Project Description

A comprehensive geotechnical assessment has been conducted by **M/s. ELS & AMIN International (Pvt) Limited** for **M/s. Rainbow Construction (Pvt)Ltd** at Hulhumale', Maldives to determine the geotechnical conditions present within the investigated land. This report includes the work carried out by **ELS & AMIN International (Pvt) Limited** to determine the sub soil and ground water conditions at the site along with the foundation recommendation for the proposed Ocean Front [D2-3] project at Hulhumaleale', Maldives.

The project includes construction of two number of fourteen storied tower buildings ajecent to each other at Hulhumale.



Figure 1(a): Aerial Photographs of the Investigated Area (Google Earth)

3.0 General Geological and Sub Grade Characteristic of Site Area

When the underneath geological formation of the site is considered, the coral reef formation is predominated at all the Maldivian islands, it may be stated that a classic atoll chain and the reef limestone, of which they are built, have accumulated on a volcanic ridge foundation associated with a transform fault on the floor of the Indian ocean which is now inactive. As mentioned above the Male Island also had been formed under volcanic ridge foundational phenomena.

When describing the soil conditions in the Maldives, it has been observed from previous investigations that the structure of the reef flats generally consists of either coral sand, soft or hard coral rock and is usually overlaid with a relatively thick layer of coral sand. On the lagoon side of the reef edge the reef is mostly covered with dead corals and a few colonies of live corals. The cavities between the coral heads are constantly being filled up with coral sand and pieces of broken and dead corals and will ultimately become a substantially hard cemented material.

When considering the climatic characteristics, Maldives experience a monsoonal climate, as the northeast monsoon is from January to March; hot days, cooler nights and relatively dry periods are common feature during this season. The wet, southwest monsoon prevails from mid-May to November. Gales and heavy rainfall occur during this season.

3.1 Formation of Coral in the Region

With respect to coral formation in general corals are preserved as calcareous skeletons,

originally secreted by a simple animal known as polyps. Reef building polyps avoid deep water more than 25m deep and grow optimally at depths within 10m. The sea water temperature should be between 25⁰C-29⁰C. Emersion or exposure above water could be tolerated only for short periods during tidal cycles. Salinity levels should generally be between 2.7% and 4.0%. The water turbulence is desirable in order to disperse carbon-dioxide to bring in plank tonic food and oxygen.

A moderate fall out of fine sediments from the water can be tolerated because corals have self cleansing mechanisms but burial beneath sediment for lengths of time could result in an asphyxiation and death. The polyp sack like body had an internal cavity which acted as its stomach. There was only a single opening to the out side, surrounded by tentacles. The polyp sat in a cup like depression on to pot its calcareous skeleton, or corallites, which is built upwards to form a support as it grew. Coral are classified according to this internal structure, which cannot often be observed directly.

3.2 Site Description

The Maldives is situated on the Central Indian Sill, running from the southern point of India via the Kerguelen – Gauberg – Ridge to the Antarctic continent. The investigated site is situated in Hulhumale. Hulhumalé or Hulhumale is a reclaimed island located in the south of North Male Atoll, Maldives. The artificial island was reclaimed to establish a new land mass required to meet the existing and future housing, industrial and commercial development demands of the Malé region.

The site is approximately 78.5m×38.5m in extent. The front boundary of the site is formed by

the road leading to Hulhumale Phase II. There were lots of trees surrounding the other three boundaries of the site. There were no any buildings near the investigated land. The locations of the boreholes and the other details of the site are shown in Figure 1(b)

When considering the climatic characteristics, Maldives experience a monsoonal climate, as the northeast monsoon is from January to March; hot days, cooler nights and relatively dry periods are common feature during this season. The wet, southwest monsoon prevails from mid-May to November. Gales and heavy rainfall occur during this season. As most of the equatorial cities, male' experiences relatively consistent temperatures through put the year with an average high and low of 30°C and 26.5°C.

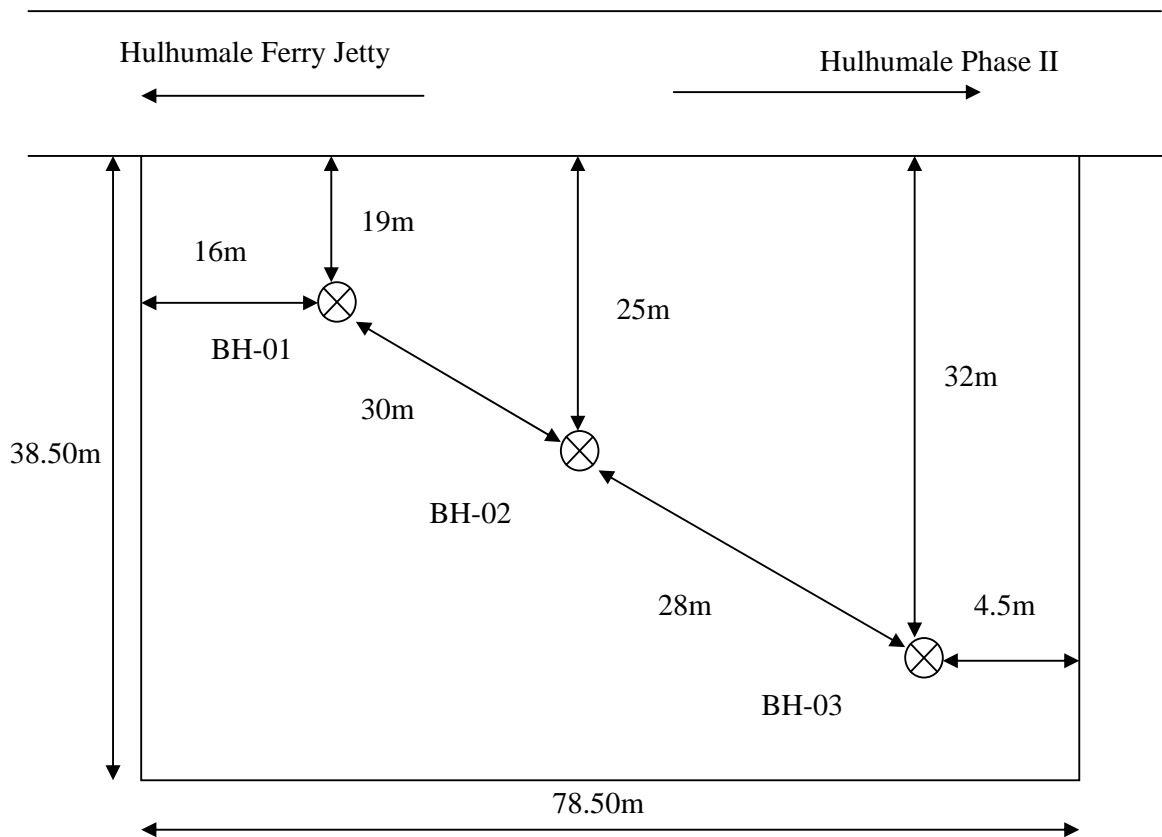


Figure 1(b): Location of the boreholes

4.0 Field I

Field investigation consisted of advancing three boreholes at the locations marked in Figure 1(b). The field investigation was commenced on 19th of August 2016 and completed on 26th of August 2016. This factual report consisted of the detailed summary of the three boreholes.

4.1 Borehole Investigation

The boreholes were advanced by means of rotary drilling machine and the drilling was carried out with overburden cutting tools and the wash boring process was adopted to remove the cuttings from the bottom of the borehole. During the drilling operation the walls of the boreholes were supported by 82 mm dia. NX type flush coupling casings. In order to achieve better alignment of borehole NWY flush coupling drill rods were used. Details of the depths of drilling are indicated in the Table 1.

Table 1: Summary of the Borehole Investigation

Borehole No.	Ground water level (m)	Overburden/Soil Drilling (m)	Rock/Boulder Drilling (m)	Total Depth(m)
BH-01	1.62	16.95	3.50	20.45
BH-02	1.58	16.95	3.50	20.45
BH-03	1.60	16.95	3.50	20.45

4.1.1 Standard Penetration Test (SPT)

In this investigation the SPT was carried out in regular intervals in the overburden, at each of the borehole. The performance of this test is based on the test method specified in BS 1377. Disturbed samples of soil were collected from SPT tube.

4.1.1.1 Test Procedure

- SPT sampler (Split spoon sampler) inserted in to the boring and it has been connected via steel rods to 63.5kg hammer.
- Using automatic safety hammer mechanism, hammer was raised a distance of 760mm and allowed it to fall freely and the energy drives the sampler in to the bottom of the boring. The process was repeated until the sampler has penetrated a distance of 450mm. The numbers of blows were recorded for first 150mm (Seating drive) and then two consecutive 150mm intervals (Test drives).
- The N value was computed by summing the blow counts for the two 150mm intervals of penetration. The blow count for the first 150mm is retained for reference purposes but not used to compute N value because the bottom of the boring is likely to be disturbed by drilling process and may be filled with loose soil that fell from the side of the boring.
- The SPT samples were extracted from the sampler and saved the obtained soil samples in appropriate manners.
- Boring to the depth of the next test been done with the above procedure.

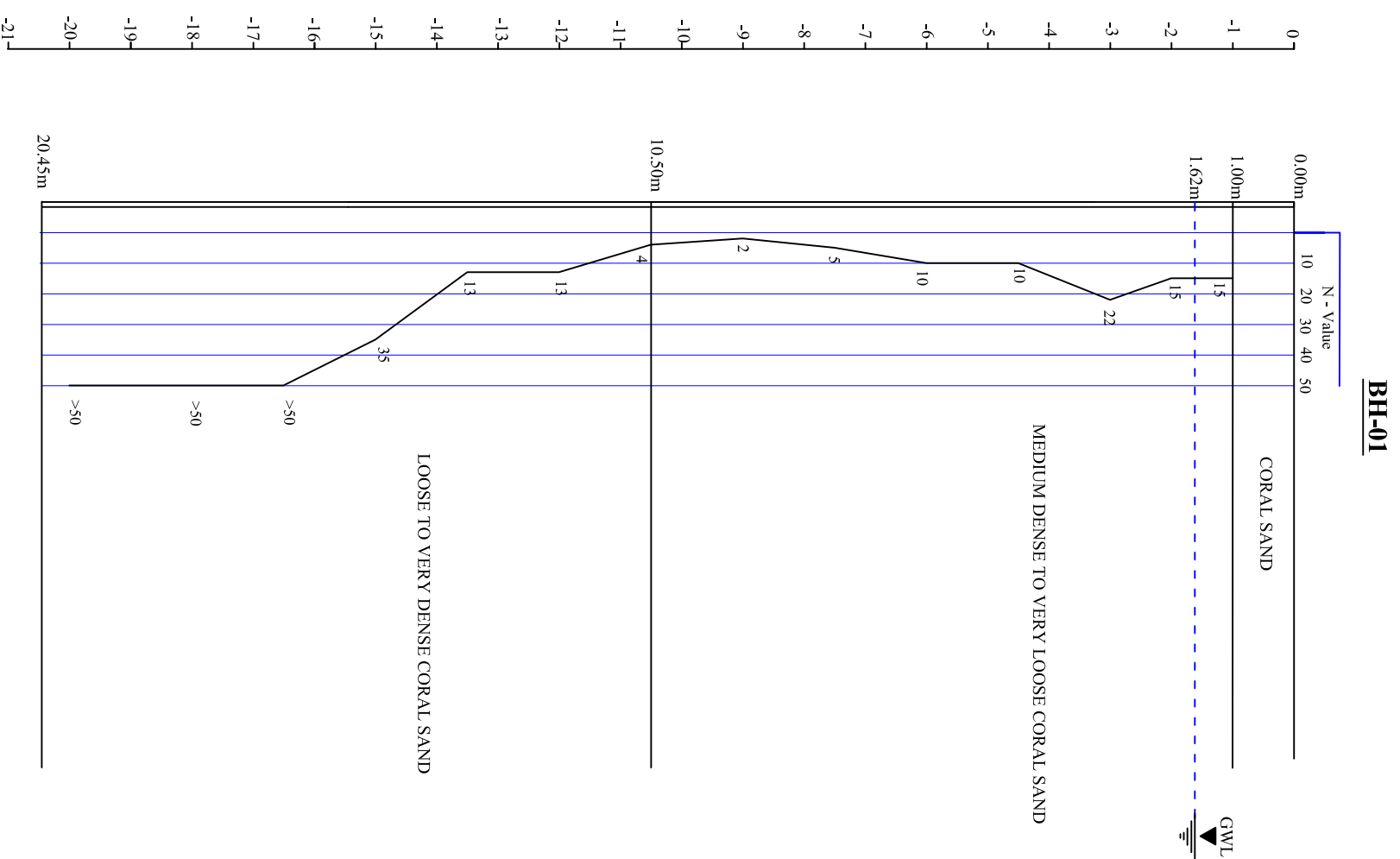
4.2 Ground water conditions

Ground water measurements were obtained from the open boreholes where the water levels were obtained after a considerable response time. The ground water levels obtained can fluctuate with the seasons, periods of precipitation and temperature.

5.0 Sub-Surface Conditions

The sub surface conditions encountered at the site are graphically presented in the borehole logs attached in Annex I. The soil horizons identified at the borehole locations are inferred from the samples taken from the borehole locations. Soil horizons/layers generally represent a transition from one soil type to another and that should not be assumed to be representing an exact plane of geological change.

Further, the conditions may vary between and beyond the borehole locations. A comprehensive detail about the sub soil conditions at /across the boreholes is graphically shown in the Figure 2(a) to Figure 2(c).



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

PROJECT: Soil investigation for the Proposed Stelco Fifth Power Development Project at Hulhumale

FIGURE 2(a): Possible Soil Profile across the borehole, BH-01

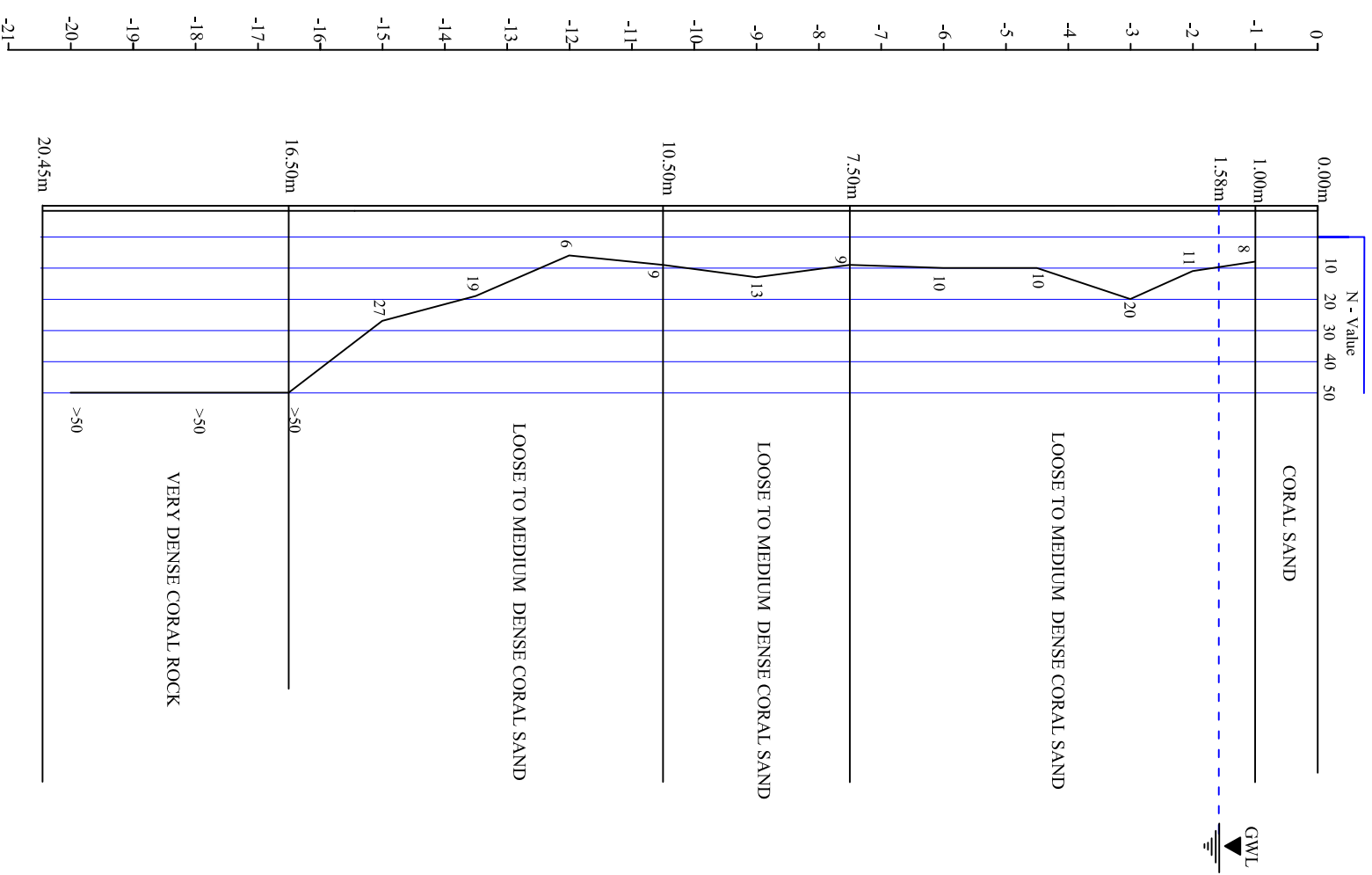
SCALE : 1:130

PAGE : 9



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 E-mail : info@elsamin.com.mv , Web: www.elsamin.com.mv

BH-02



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

PROJECT: Soil investigation for the Proposed Stelco Fifth Power Development Project at Hulhumale

FIGURE 2(b): Possible Soil Profile across the borehole, BH-02

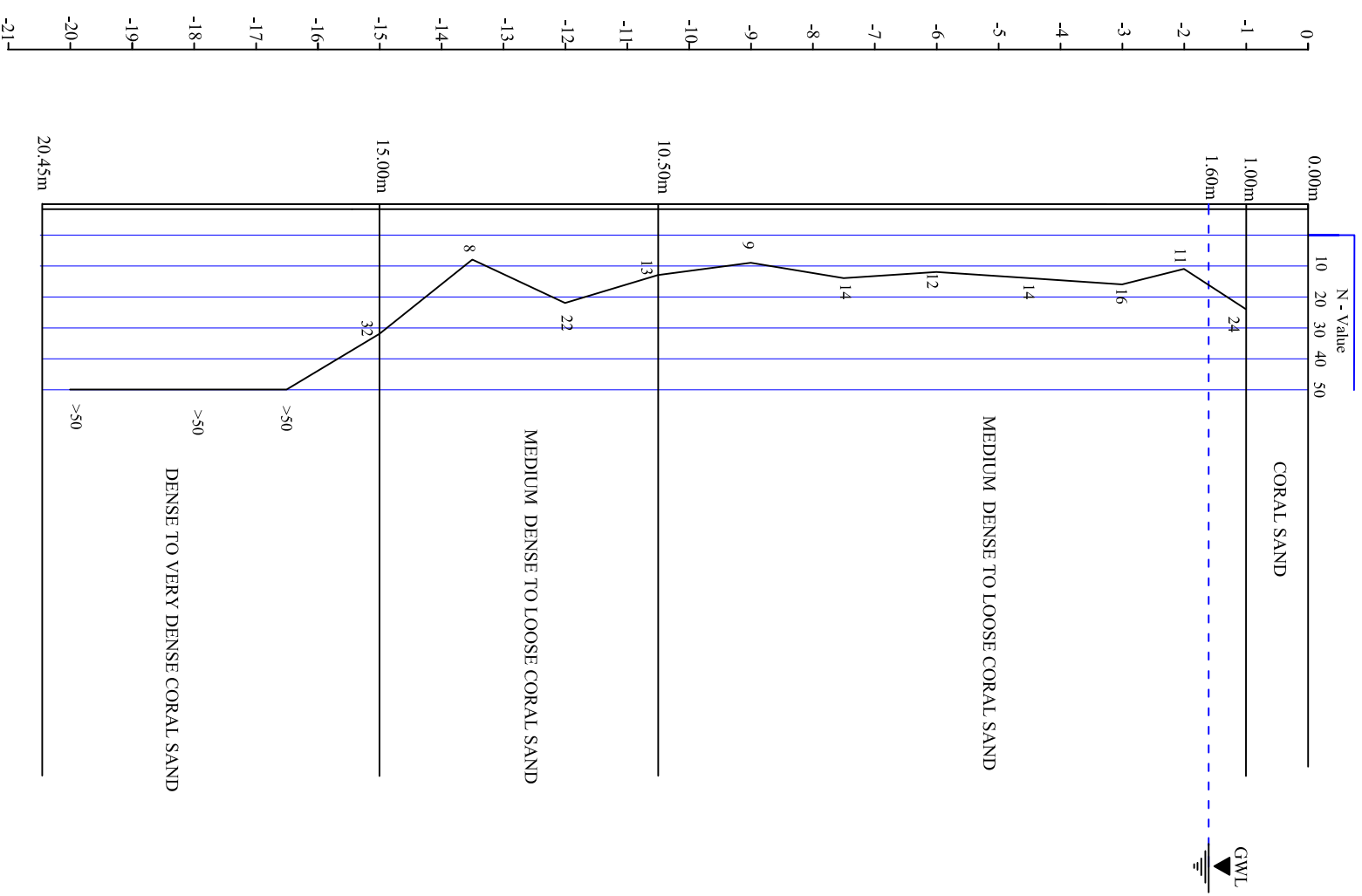
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BH-03



NOTES: Profile is plotted only according to the data obtained from the borehole locations and actual soil profile may vary from this profile

PROJECT: Soil investigation for the Proposed Stelco Fifth Power Development Project at Hulhumale

FIGURE 2(c): Possible Soil Profile across the borehole, BH-03

SCALE : 1:130

PAGE : 11



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INTERPRETATION OF THE RESULTS OF THE SITE INVESTIGATIONS

6.0 Properties of the materials in the subsurface

The energy method of SPT correction (Bowles, 1996) was used to estimate the soil strength parameters of the soil layers. The energy method of SPT correction uses the following relationship to determine the N'_{70} from the field SPT blow counts (N_{Field}):

$$N'_{70} = N_{Field} C_N \eta_1 \eta_2 \eta_3 \eta_4$$

Where

$$C_N = \sqrt{\frac{95.76}{p'_o}}$$

$$\eta_1 = \frac{E_r}{70}$$

p'_o = Effective overburden pressure at the test level

E_r = Efficiency of the hammer used (taken as 55%)

η_i = Modification factors (Bowles, 1996)

The estimated N'_{70} together with the particle size could be used to estimate the soil strength parameters at respective depths. Table 1 shows the estimated soil strength parameters at borehole location with the depth.

Table 1 Estimated soil strength parameters using SPT blow counts at borehole locations

Depth (m)	BH 01			BH 02		
	N	ϕ	State	N	ϕ	State
1.30	15	30	Medium dense	8	29	Loose
2.30	15	30	Medium dense	11	29	Loose
3.30	22	30	Medium dense	20	30	Medium dense
4.80	10	28	Loose	10	28	Loose
6.30	10	28	Loose	10	28	Loose
7.80	5	22	Very Loose	9	27	Loose
9.30	2	19	Very Loose	13	28	Loose
10.80	4	21	Very Loose	9	27	Loose
12.30	13	28	Loose	6	25	Loose
13.80	13	28	Loose	19	29	Loose
15.30	35	31	Medium dense	27	30	Medium dense
16.80	50	36	Very dense	50	36	Very dense
18.30	50	36	Very dense	50	36	Very dense
20.30	50	36	Very dense	50	38	Very dense
Depth (m)	BH 03					
	N	ϕ	State			
1.30	24	31	Medium dense			
2.30	11	28	Loose			

3.30	16	29	Loose
4.80	14	28	Loose
6.30	12	28	Loose
7.80	14	28	Loose
9.30	9	27	Loose
10.80	13	28	Loose
12.30	22	30	Medium dense
13.80	8	26	Loose
15.30	32	31	Medium dense
16.80	50	36	Very dense
18.30	50	36	Very dense
20.30	50	36	Very dense

7.0 General ground conditions at the site

7.1 Condition of the subsurface

The subsurface consists of coral sand and coral rock layers as given below and the thicknesses of each layer at the borehole locations are given in Table 2. Average soil strength parameters and compressibility parameters may be recommended for different soil layers as given in Table 3.

- Layer 1 - Very loose to loose coral SAND
- Layer 2 - Loose to medium dense coral SAND
- Layer 3 - Medium dense coral SAND
- Layer 4 - Very dense coral ROCK

Table 2 – Thicknesses of coral sand and coral rock layers present in the three boreholes with the average SPT blow counts

BH 01				BH 02			
Depth (m)		Layer	Average SPT	Depth (m)		Layer	Average SPT
From	To			From	To		
0.00	4.50	Layer 2	17	0.00	10.50	Layer 2	12
4.50	15.00	Layer 1	8	0.50	13.50	Layer 1	8
15.00	16.50	Layer 3	35	13.50	16.50	Layer 3	23
16.50	20.45	Layer 4	>50	16.50	20.45	Layer 4	>50
BH 03							
0.00	13.50	Layer 2	15				

13.50	15.00	Layer 1	8	
15.00	16.50	Layer 3	35	
16.50	20.45	Layer 4	>50	

Table 3 – Average properties of the Layers in the subsurface

Layer	Strength parameters		Compressibility parameters	
	c'	ϕ'	E (kPa)	Poisson ratio, ν
Loose to medium dense	0	29	7,000	0.30
Very loose to loose	0	27	5,000	0.35
Medium dense	0	30	12,000	0.30
Very dense (Coral rock)	5	36	30,000	0.25

7.2 Condition of the Coral rock

Continuous coral rock was observed in all the boreholes drilled below 17m depth upto the full drilled depth of 20.45m. This layer showed SPT refusal.

8.0 FOUNDATION RECOMMENDATIONS

The proposed structure is a two fourteen storey buildings and hence, both shallow and deep foundation recommendations are given.

8.1 Shallow foundations

The shallow foundation options considered are square footings, strip or combined footings, and raft foundations. The allowable bearing capacities of the shallow foundations are estimated based on the shear failure and settlement considerations.

8.1.1 Shear Failure of Soil

The ultimate carrying capacity (q_{ult}) of shallow foundations on sand is estimated using the following standard bearing capacity equation (Bowles, 1996) assuming general shear failure and vertical applied load.

$$q_{ult} = s_q d_q \bar{q} N_q + s_\gamma d_\gamma \frac{1}{2} B \gamma_{eff} N_\gamma$$

Where

s_i = Shape modification factors

d_i	=	Depth modification factors
i_i	=	Load inclination modification factors (for vertical loads $i_i=1.0$)
N_i	=	Bearing capacity factors
c	=	Cohesion
\bar{q}	=	Effective overburden pressure at the foundation level
B	=	Width of the footing
γ_{eff}	=	Effective unit weight of soil below the foundation.

However, it should be noted here that the estimation of ultimate carrying capacity in a layered medium should be carried out considering the stress distribution through the layered soil medium. When a loose soil layer is present at shallow depths (3 to 4m), ultimate carrying capacities of the foundation at 1m and 2m levels were estimated assuming the friction angle of that loose layer. Allowable bearing pressure (q_{all}) could be obtained from the following relationship:

$$q_{all} = \frac{q_{ult} - \bar{q}}{FoS}$$

8.1.2 Estimation of Settlement of Shallow Foundations

Following assumptions are also made in the estimation of allowable carrying capacities of footings:

- Water table may rise upto the ground surface during high tide;
 - No lateral forces are acting on the foundations;
 - No cavities are present in the subsurface;
 - Ground conditions are represented by the profile obtained at the borehole location;
- and
- The ground surface surrounding the foundation is horizontal.

8.1.3 Allowable carrying capacity of raft foundation

The loadings from the proposed structures, and the depths and sizes of the foundations are not known at the time of writing this report. However, possibility of carrying a multi storey building on individual and combined footings on the given subsurface is very low and therefore, allowable carrying capacity of only raft foundation is given.

The most critical borehole is BH 01 and the carrying capacity of the raft is estimated

assuming the ground profile at BH 01. The allowable carrying capacity of a raft foundation smaller than 15m x 15m placed at 1m depth may be recommended as 125 kPa for an allowable settlement of 100mm.

8.1.4 Piled raft system

The design raft pressure from the foundation is not known. As the structure is a multi storey building, the pressure from the raft may exceed the above recommended 125 kPa. Therefore, there is a likelihood of raft experiencing a settlement higher than the allowable settlement of the raft. Further, the differential settlement of the raft foundation may become a concern. Therefore, in such a scenario, it may be advisable to use a method such as a piled raft where piles will control the settlement of the raft through raft-pile-soil interaction.

If a piled raft system is to be used to support the structure, the forces developed in the raft, pile reactions, and soil pressure should be investigated for different configurations of the arrangements of piles and the depths of penetration of the piles. Based on the results of such an analysis, an appropriate economical pile-raft system should be designed. For this purpose, a technique such as finite element method (FEM) may be use with appropriate soil properties and the pile stiffness. For this study, it is recommended to use the stiffness of the piles obtained from load testing of actual piles.

8.2 Deep foundations

According to the allowable bearing capacities suggested in section 3.1.3, if the proposed structure cannot be supported on shallow foundations, the building may be supported on a piled raft system proposed in section 3.1.4 or a pile foundation. For this purpose, driven spun piles, driven precast piles, micro piles or bored piles may be used. However, if piles are installed closer to an existing structure, effects of the ground vibration and the noise generated should also be considered. Further, if bored piles are selected, collapsing of the sides of the pile bore should be given due consideration during the pile installation.

8.2.1 Skin friction

The allowable skin friction capacities from different layers are given in Table 4.

8.2.2 End bearing

Driven piles should be installed to at least 300 mm into the coral rock layer or until refusal to penetration is achieved and bored piles should be socketed at least minimum of 1m or one pile diameter, whichever is higher, into the coral rock. The allowable end bearing capacities are also given in Table 4.

Table 4 – Allowable skin friction and end bearing capacities.

Layer*	Bored piles or micro piles		Driven piles (spun or precast solid)	
	Allowable skin friction (kPa)	Allowable end bearing (kPa)	Allowable skin friction (kPa)	Allowable end bearing (kPa)
Layer 1	7	-	5	-
Layer 2	15	-	10	-
Layer 3	20	500	30	750
Layer 4	30	1200	50	3000**

* Refer to Table 2 for the identification of layers

** Driven at least four times pile diameter into Layer 4

If a piled raft system is to be used, the block failure mode of the entire piled raft system and the interaction of the raft-pile-soil system should be considered in the estimation of the pile capacities. If piles are used, the carrying capacity should be confirmed using high strain dynamic load testing of working pile(s) near BH 1.

9.0 Shoring systems and dewatering

Temporary shoring systems to prevent collapsing of the sides may be needed during excavation below water table. For this purpose, a shoring system consisting of horizontal timber planks inserted to vertical steel I sections driven at 1.2 to 1.5m spacing may be used. However, if the depth of excavation is large and dewatering of more than about 0.5m is required for construction of foundations, extra care should be exercised not to have piping failure of the sand. If high water inflow with fine sand to the excavation is observed, dewatering should be immediately stopped and the excavation be refilled upto the elevation

of the water table. A properly designed earth retaining system consisting of sheet piles should be used before restarting excavation and dewatering.

If the excavation for the foundations are located very close to existing buildings and dewatering is required during the time excavations are kept open, a properly designed earth retaining system should be in place before the beginning of the excavations. For the design of the earth retaining systems, soil strength parameters given in Table 2 may be used together with the compressibility and permeability of sand relevant to medium dense state. In the design of earth retaining structures close to existing buildings, following factors should be considered:

- Lateral deformation of the earth retaining system so that the lateral displacement of the adjacent structures is within tolerable limits; and
- There is a reasonable factor of safety against piping failure at the toe of the earth retaining system.

10.0 SUMMARY OF RECOMMENDATIONS

- The allowable carrying capacity of a raft foundation smaller than 15m x 15m plan dimensions placed at 1m depth shall be recommended as 125 kPa for 100mm allowable settlement.
- If the working load on the raft exceeds 125 kPa, the settlement of the raft is likely to exceed the allowable limit and it may also undergo appreciable differential settlement. In such a scenario, it is recommended to control the settlement of the raft using a piled raft system.
- If a piled raft is used, it is recommended to obtain the forces developed in the raft, configuration of the arrangement of piles, and the lengths and diameters of the piles using soil-structure interaction model developed using an analytical method such as finite element method (FEM).
- The allowable skin friction and end bearing capacities of different types of piles are given in Table 4 for preliminary design calculations. The stiffness of the piles for the soil structure interaction modelling preferably should be obtained from pile load tests conducted at the site, preferably near BH 1.

- Due attention should be paid to the effects of installation of piles, if used for the foundation, and appropriate remedial actions should be taken to minimise the effects of pile installation.
- If the depth of excavation is large and dewatering of more than about 0.5m height of water is required for the construction of foundations, extra care should be exercised not to have piping failure of the sand and failure of the sides of the excavation.
- In the design of temporary or permanent earth retaining structures close to existing buildings, following factors should be considered:
 - Lateral deformation of the earth retaining system so that the lateral displacements of the adjacent structures are within tolerable limits;
 - Elastic compressibility properties of different subsurface layers given in Table 3 may be used for the estimation of the displacement of the shoring systems; and
 - There is a reasonable factor of safety against piping failure at the toe of the earth retaining system.

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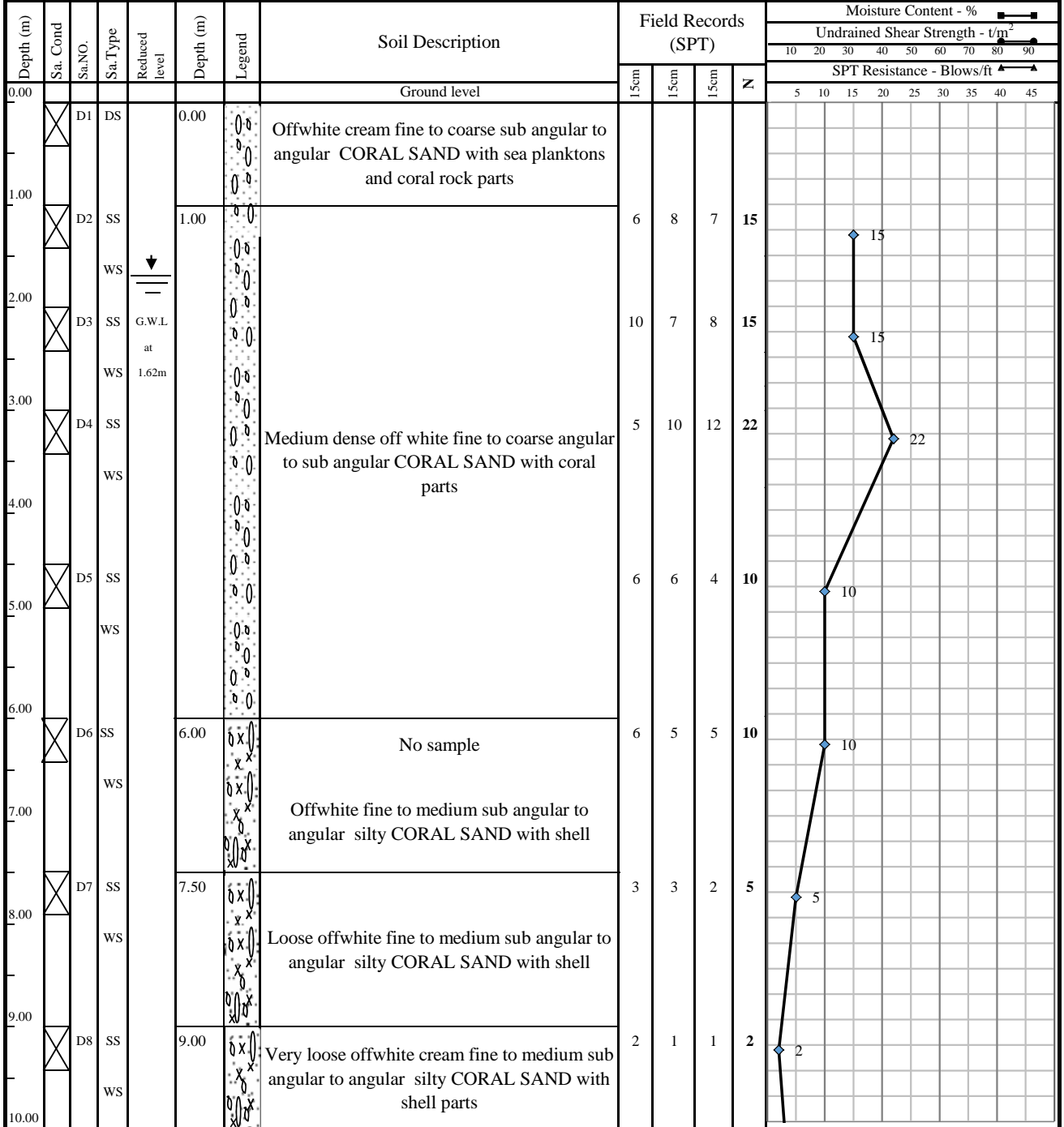
Annexure I: Borehole Logs



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-01
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	1 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level 1.62m	
Date of Started	19.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	
Date of Finished	20.08.2016	Casing Diameter	76mm	Elevation (m)	-		



SPT Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value) GWL : Ground Water Level observed inside the Borehole, after the saturation NE Not Encountered HB -Hammer Bounce FD - Free Down		D - Disturbed Sample SS - SPT Sample W - Water Sample WS -Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD -Rock Quality Designation (%)		N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG -Specific Gravity Test B - Bulk Density V - Vane Shear Test		C - Consolidation UCT -Unconfined Compression CU - Consolidated Undrained UU -Unconsolidated Undrained pH - Chemical O - Organic content SO₄²⁻ - Sulphate Content Cl⁻ - Chloride Content		Remarks Existing ground level considered as the zero level	Logged By: K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
Made Ground Clay	Silt Sand	Gravel Organic Matter	Laterite Nodules Silty Sand	Completely Weathered Rock Highly Weathered Rock	Fresh Rock				



Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-01
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	2 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.62m
Date of Started	19.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	20.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond Sa.NO.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %	
							1.5cm	1.5cm	1.5cm	N	10	20
10.00						Continue from Page 1						
11.00	D9	SS		10.50		No sample	4	2	2	4		
12.00	D10	SS	WS	12.00		Off white fine to medium sub angular to angular CORAL SAND with shell and cemented parts	5	6	7	13		
14.00	D11	SS	WS	15.00		Medium dense greyish white medium to coarse sub angular to angular CORAL SAND with shell parts	10	6	7	13		
15.00	D12	SS	WS	16.00		Dense off white medium to coarse sub angular to angular CORAL SAND with hard coral parts	18	20	15	35		
17.00	D13	SS	TC	16.50		very dense off white medium to coarse sub angular to angular CORAL SAND with hard coral parts	14	35	HB	>50		
18.00	D14	SS	TC	16.95		Very dense CORAL ROCK (NO SAMPLE)	17	35	HB	>50		

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation			Existing ground level considered as the zero level	
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Completely Weathered Rock
	Clay		Sand		Highly Weathered Rock
			Gravel		Fresh Rock
			Organic Matter		
			Laterite Nodules		
			Silty Sand		



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-01
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	3 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.62m
Date of Started	19.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	20.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond	Sa. NO.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
								15cm	15cm	15cm	N	10	20	30	40	50	60	70
20.00							Continue from Page 1											
	X	D15	SS				No sample	28	35	HB	>50							>50
21.00					20.45		The borehole was terminated at a depth of 20.45m											
22.00																		
23.00																		
24.00																		
25.00																		
26.00																		
27.00																		
28.00																		
29.00																		
30.00																		

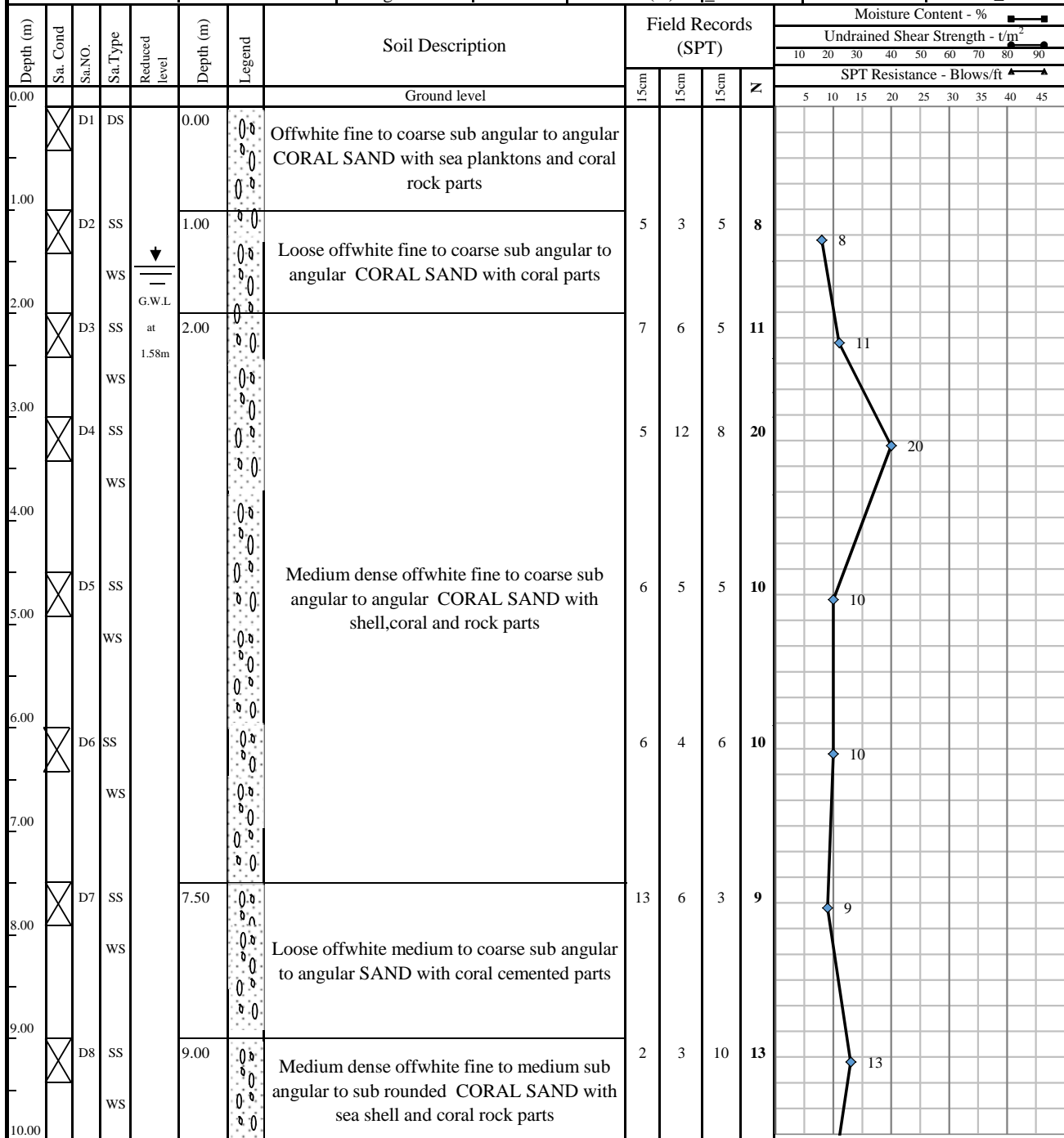
Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation				Existing ground level considered as the zero level
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Gravel
	Clay		Sand		Organic Matter
					Laterite Nodules
					Silty Sand
					Completely Weathered Rock
					Highly Weathered Rock
					Fresh Rock



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-02
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	1 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.58m
Date of Started	20.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	24.08.2016	Casing Diameter	76mm	Elevation (m)	-		



SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	Remarks Existing ground level considered as the zero level	Logged By: K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha					
	Made Ground		Silt		Gravel		Laterite Nodules		Completely Weathered Rock		Fresh Rock
	Clay		Sand		Organic Matter		Silty Sand		Highly Weathered Rock		



Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-02
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	2 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level 1.58m	
Date of Started	20.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	
Date of Finished	24.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond Sa.No.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft			
							1.5m	1.5m	1.5m	N	5	10	15	20	25	30	35	40
10.00						Continue from Page 1												
11.00	D9	SS		10.50		Same as previous description	7	6	3	9								
12.00	D10	SS	WS			Loose off white fine to medium sub angular to sub rounded silty CORAL SAND with shell and cemented parts	6	3	3	6								
14.00	D11	SS	WS	13.50		Medium dense off white medium to coarse sub angular to angular CORAL SAND with shell and hard coral parts	13	10	9	19								
15.00	D12	SS	WS				14	12	15	27								
17.00	D13	SS	TC	16.50		very dense off white medium to coarse sub angular to angular CORAL SAND with hard coral parts	15	35	HB	>50							>50	
18.00	D14	SS	TC	16.95		Very dense CORAL ROCK (NO SAMPLE)	20	35	HB	>50								>50
19.00																		
20.00																		

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) ROD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation			Existing ground level considered as the zero level	
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Laterite Nodules
	Clay		Sand		Silty Sand
	Gravel		Organic Matter		Completely Weathered Rock
	Fresh Rock		Highly Weathered Rock		



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-02
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	3 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.58m
Date of Started	20.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	24.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond Sa.No.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
							15cm	15cm	15cm	N	10	20	30	40	50	60	70
20.00						Continue from Page 1											
	D15	SS				Same as previous description	29	35	HB	>50							>50
21.00				20.45		The borehole was terminated at a depth of 20.45m											
22.00																	
23.00																	
24.00																	
25.00																	
26.00																	
27.00																	
28.00																	
29.00																	
30.00																	

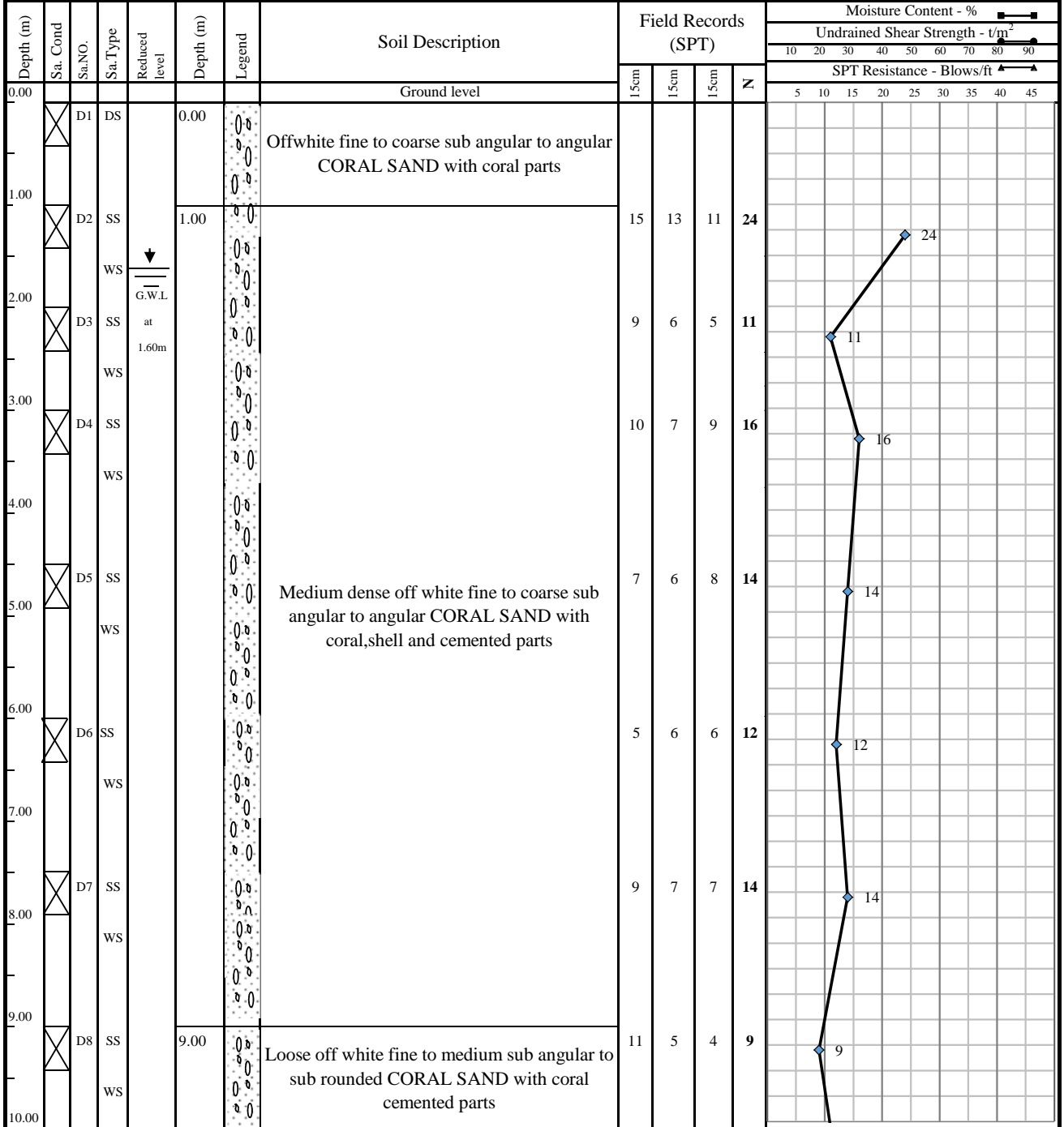
Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation				Existing ground level considered as the zero level
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Gravel
	Clay		Sand		Organic Matter
			Laterite Nodules		Silty Sand
			Completely Weathered Rock		Highly Weathered Rock
			Fresh Rock		



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-03
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	1 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.60m
Date of Started	25.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	26.08.2016	Casing Diameter	76mm	Elevation (m)	-		



SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	Remarks Existing ground level considered as the zero level	Logged By: K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation					
NE	Not Encountered					
HB	- Hammer Bounce					
FD	- Free Down					
	Made Ground					
	Clay					



Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-03
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	2 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level 1.60m	
Date of Started	25.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	
Date of Finished	26.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond Sa.No.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
							1.5cm	1.5cm	1.5cm	N	5	10	15	20	25	30	35
10.00						Continue from Page 1											
						Same as previous description											
11.00	D9	SS		10.50		No sample	16	7	6	13							
		WS				Off white medium to coarse sub angular to angular CORAL SAND with sea shell and coral parts											
12.00	D10	SS				Medium dense off white medium to coarse sub angular to angular CORAL SAND with sea shell and coral parts	7	12	10	22							
		WS															
13.00																	
14.00	D11	SS		13.50		Loose off white fine to medium sub angular to sub rounded CORAL SAND with sea shell	2	3	5	8							
		WS															
15.00	D12	SS		15.00		Dense off white medium to coarse sub angular to angular CORAL SAND with hard coral rock parts	15	16	16	32							
		WS															
16.00																	
17.00	D13	SS		16.50		Very dense off white medium to coarse sub angular to angular CORAL SAND with hard coral parts	19	35	HB	>50							
		TC		16.95													
18.00	D14	SS				Very dense CORAL ROCK (NO SAMPLE)	33	35	HB	>50							
		TC															
19.00																	
20.00																	

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation			Existing ground level considered as the zero level	
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Completely Weathered Rock
	Clay		Sand		Highly Weathered Rock
			Gravel		Fresh Rock
			Organic Matter		
			Laterite Nodules		
			Silty Sand		



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Project		Soil investigation for the Proposed Ocean Front Project at Hulhumale				Borehole No	BH-03
Client		M/s. Rainbow Construction (Pvt)Ltd				Sheet	3 of 3
Location	Hulhumale	Rig	Track wheel	Core Diameter	54mm	Ground Water level	1.60m
Date of Started	25.08.2016	Drilling Method	Rotary	Casing depth	20.45m	Coordinates	-
Date of Finished	26.08.2016	Casing Diameter	76mm	Elevation (m)	-		

Depth (m)	Sa. Cond Sa.No.	Sa. Type	Reduced level	Depth (m)	Legend	Soil Description	Field Records (SPT)				Moisture Content - %		Undrained Shear Strength - t/m ²		SPT Resistance - Blows/ft		
							15cm	15cm	15cm	N	10	20	30	40	50	60	70
20.00						Continue from Page 1											
	D15	SS				Same as previous description	28	35	HB	>50							>50
21.00				20.45		The borehole was terminated at a depth of 20.45m											
22.00																	
23.00																	
24.00																	
25.00																	
26.00																	
27.00																	
28.00																	
29.00																	
30.00																	

Sample Key / Test Key				Remarks	Logged By:
SPT	Where full 0.3m penetration has not been achieved the number of blows for the quoted penetration is given (not N-value)	D - Disturbed Sample SS - SPT Sample W - Water Sample WS - Wgrey Sample UD - Undisturbed Sample CS - Core Sample Cr - Core Recovery (%) RQD - Rock Quality Designation (%)	N - Natural Moisture Content L - Atterberg Limit Test G - Grain Size Analysis SG - Specific Gravity Test B - Bulk Density V - Vane Shear Test	C - Consolidation UCT - Unconfined Compression CU - Consolidated Undrained UU - Unconsolidated Undrained pH - Chemical O - Organic content SO ₄ ²⁻ - Sulphate Content Cl ⁻ - Chloride Content	K.K.D.M.Perera Supervised By: Lasantha Drilled By: Nimal Shantha
GWL	: Ground Water Level observed inside the Borehole, after the saturation			Existing ground level considered as the zero level	
NE	Not Encountered				
HB	- Hammer Bounce				
FD	- Free Down				
	Made Ground		Silt		Gravel
	Clay		Sand		Organic Matter
			Laterite Nodules		Silty Sand
			Completely Weathered Rock		Highly Weathered Rock
			Fresh Rock		